Informix Product Family
Informix JDBC Driver
Version 3.70

IBM Informix JDBC Driver
Programmer's Guide
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Version 3.70

IBM Informix JDBC Driver
Programmer's Guide
Contents

**Introduction** .................................. ix

- About this publication ................................ ix
- Types of users ........................................... ix
- Software compatibility .................................... ix
- Assumptions about your locale ........................... ix

**What's new in IBM Informix JDBC Driver, Version 3.70** ............................... x

- Example code conventions ................................ xii
- Additional documentation .................................. xii
- Compliance with industry standards ............................ xii

**Syntax diagrams** ............................................ xiii

- How to read a command-line syntax diagram .................. xiv
- Keywords and punctuation ....................................... xv
- Identifiers and names ........................................... xv

- How to provide documentation feedback .......................... xv

**Chapter 1. Getting started** ........................................... 1-1

- What is JDBC? ........................................ 1-1
- What is a JDBC driver? ..................................... 1-1

**Overview of Informix JDBC Driver** ........................................ 1-2

- Classes implemented in Informix JDBC Driver .................. 1-2
- Files in IBM Informix JDBC Driver .............................. 1-4
- Client and server JDBC drivers .................................. 1-5

**Obtain the JDBC driver** ........................................ 1-6

- Installing the JDBC Driver ................................... 1-6
- Installing JDBC driver in graphical or console mode ........... 1-6
- Installing JDBC driver in silent mode .......................... 1-7

**Log installation events** ........................................ 1-7

- Log examples ............................................. 1-8

- Using the driver in an application ................................ 1-8
- Using the driver in an applet .................................. 1-9

**Uninstall the JDBC Driver** ....................................... 1-10

- Uninstall in graphical or console mode ......................... 1-10
- Uninstall in silent mode ..................................... 1-10

**Chapter 2. Connect to the database** ........................................... 2-1

**Load IBM Informix JDBC Driver** ...................................... 2-1

- A DataSource object ....................................... 2-2

- The DriverManager.getConnection() method .................. 2-4

- Format of database URLs ..................................... 2-5

- Specify properties .......................................... 2-9

- Informix environment variables with the IBM Informix JDBC Driver .................. 2-10

**Dynamically reading the Informix sqlhosts file** ............................... 2-16

- Connection property syntax ................................... 2-17

- Administration requirements .................................... 2-18

- Utilities to update the LDAP server with sqlhosts data ........... 2-18

**High-Availability Data Replication** ...................................... 2-19

- Secondary server connection properties ......................... 2-20

- Connect to group entries in an HDR pair ....................... 2-20

- Check for read-only status ................................... 2-20

- Retry connections .......................................... 2-21

**An HTTP proxy server** ............................................ 2-22

- Configuring your environment to use a proxy server ........... 2-23

- The proxy with an LDAP server ................................ 2-25

- Specify sqlhosts file lookup ..................................... 2-26

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Chapter 3. Perform database operations ........................................ 3-1

Query the database ........................................................................... 3-1
  Example of sending a query to an Informix database ..................... 3-1
  Result sets ..................................................................................... 3-2
  Deallocate resources ...................................................................... 3-2
  Execute across threads .................................................................. 3-3
  Scroll cursors ................................................................................ 3-3
  Hold cursors .................................................................................. 3-4
  Update the database ........................................................................ 3-4
  Perform batch updates .................................................................... 3-4
  Perform bulk inserts ....................................................................... 3-5

Parameters, escape syntax, and unsupported methods ..................... 3-5
  The CallableStatement OUT parameters ...................................... 3-6
  Named parameters in a CallableStatement .................................... 3-11
  JDBC support for DESCRIBE INPUT .............................................. 3-16
  The escape syntax ........................................................................ 3-17
  Unsupported methods and methods that behave differently ............ 3-17

Handle transactions .......................................................................... 3-20

Handle errors ................................................................................... 3-21
  Handle errors with the SQLException class .................................. 3-21
  Retrieve the syntax error offset .................................................... 3-22
  Handle errors with the com.informix.jdbc.Message class ............... 3-23

Access database metadata ................................................................ 3-23

Other Informix extensions to the JDBC API ...................................... 3-24
  The Auto Free feature .................................................................. 3-24
  Obtaining driver version information ........................................... 3-25

Store and retrieve XML documents .................................................. 3-25
  Set up your environment to use XML methods .............................. 3-26
  Insert data .................................................................................... 3-27
  Retrieve data ............................................................................... 3-28
  Insert data examples .................................................................... 3-29
  Retrieve data examples ............................................................... 3-30

Chapter 4. Work with Informix types .............................................. 4-1

Distinct data types ........................................................................... 4-1
  Insert data examples .................................................................... 4-1
  Retrieve data example .................................................................. 4-2
  Unsupported methods .................................................................... 4-3

BYTE and TEXT data types ............................................................... 4-3
  Cache large objects ....................................................................... 4-3
  Example: Inserting or updating data ............................................. 4-3
  Example: Selecting data ............................................................... 4-5

SERIAL and SERIAL8 data types ....................................................... 4-6
  BIGINT and BIGSERIAL data types ............................................. 4-7

INTERVAL data type ........................................................................ 4-8
  The Interval class ........................................................................ 4-8
  The IntervalYM class .................................................................... 4-9
  The IntervalDF class .................................................................... 4-11
Chapter 7. Tuning and troubleshooting ................................................. 7-1
Debug your JDBC API program .................................................................. 7-1
Manage performance .............................................................................. 7-1
The FET_BUF_SIZE and SRV_FET_BUF_SIZE environment variables ........ 7-1
Manage memory for large objects ............................................................ 7-2
Reduce network traffic ........................................................................... 7-3
Bulk inserts .............................................................................................. 7-3
A connection pool .................................................................................. 7-3
Avoid application hanging problems (HP-UX only) ................................. 7-8

Appendix A. Sample code files ................................................................. A-1
Summary of available examples .............................................................. A-1
Examples in the demo directory .............................................................. A-1
Examples in the tools directory .............................................................. A-8

Appendix B. DataSource extensions ........................................................ B-1
Read and write properties ....................................................................... B-1
Get and set standard properties .............................................................. B-2
Get and set Informix connection properties ........................................... B-2
Get and set connection pool DataSource properties ................................ B-5

Appendix C. Mapping data types ............................................................. C-1
Data type mapping between Informix and JDBC data types ...................... C-1
Data type mapping between extended types and Java and JDBC types ...... C-2
Data type mapping between C opaque types and Java .............................. C-3
Data type mapping for PreparedStatement.setXXX() extensions .......... C-3
The mapping extensions ......................................................................... C-4
The IfxTypes class ................................................................................ C-8
Extension summary .............................................................................. C-9
Data type mapping for ResultSet.getXXX() methods ............................ C-12
Nonextended data types ........................................................................ C-13
Informix extended data types ................................................................. C-15
Data type mapping for UDT manager and UDR manager ......................... C-16
Mapping for casts ................................................................................ C-17
Mapping for field types ......................................................................... C-17

Appendix D. Convert internal Informix data types .................................... D-1
The IfxToJavaType class ........................................................................ D-1
The convertDateToDays() method ........................................................... D-2
The convertDaysToDate() method ........................................................... D-2
The IfxToJavaChar() method .................................................................. D-2
The IfxToJavaDate() method .................................................................. D-3
The IfxToJavaDateTime() method ............................................................ D-3
The IfxToDateTimeUnloadString() method ............................................. D-3
The IfxToJavaDecimal() method .............................................................. D-4
Introduction

This introduction provides:
• An overview of IBM® Informix® Java documentation
• A description of the conventions used in this publication
• A list of new features

About this publication

This publication describes how to install, load, and use IBM Informix JDBC Driver to connect to an Informix database from within a Java application or applet. You can also use IBM Informix JDBC Driver for writing user-defined routines that are executed in the server.

This publication describes the Informix extensions to JDBC in a task-oriented format; it does not include every method and parameter in the interface. For the complete reference, including all methods and parameters, see the online Javadoc, which appears in the doc/javadoc directory where you installed IBM Informix JDBC Driver.

Types of users

This publication is for Java programmers who use the JDBC API to connect to IBM Informix databases using IBM Informix JDBC Driver. To use this publication, you should know how to program in Java and, in particular, understand the classes and methods of the JDBC API.

Software compatibility

For information about software compatibility, see the IBM Informix JDBC Driver release notes.

Assumptions about your locale

IBM Informix products can support many languages, cultures, and code sets. All the information related to character set, collation and representation of numeric data, currency, date, and time that is used by a language within a given territory and encoding is brought together in a single environment, called a Global Language Support (GLS) locale.

The IBM Informix OLE DB Provider follows the ISO string formats for date, time, and money, as defined by the Microsoft OLE DB standards. You can override that default by setting an Informix environment variable or registry entry, such as DBDATE.

If you use Simple Network Management Protocol (SNMP) in your Informix environment, note that the protocols (SNMPv1 and SNMPv2) recognize only English code sets. For more information, see the topic about GLS and SNMP in the IBM Informix SNMP Subagent Guide.

The examples in this publication are written with the assumption that you are using one of these locales: en_us.8859-1 (ISO 8859-1) on UNIX platforms or
en_us.1252 (Microsoft 1252) in Windows environments. These locales support U.S.
English format conventions for displaying and entering date, time, number, and
currency values. They also support the ISO 8859-1 code set (on UNIX and Linux)
or the Microsoft 1252 code set (on Windows), which includes the ASCII code set
plus many 8-bit characters such as é, è, and ñ.

You can specify another locale if you plan to use characters from other locales in
your data or your SQL identifiers, or if you want to conform to other collation
rules for character data.

For instructions about how to specify locales, additional syntax, and other
considerations related to GLS locales, see the IBM Informix GLS User's Guide.

What's new in IBM Informix JDBC Driver, Version 3.70

This publication includes information about new features and changes in existing
functionality.

The following changes and enhancements are relevant to this publication. For a
complete list of what's new in this release, see the release notes or the information
center at [http://publib.boulder.ibm.com/infocenter/idshelp/v117/topic/]
com.ibm.po.doc/new_features.htm

Table 1. What's new in the IBM Informix JDBC Driver Programmer's Guide for Version
3.70.JC3

<table>
<thead>
<tr>
<th>Overview</th>
<th>Reference</th>
</tr>
</thead>
</table>
| Getting complete Informix and ISAM error messages | See the APPENDISAM environment variable in
                                                      “Informix environment variables with the
                                                      IBM Informix JDBC Driver” on page 2-10 |

When the IBM Informix server encounters an error, it returns an Informix error code and
an associated error description. There is an additional error code, the ISAM error code,
which provides information that is necessary to understand the circumstances that caused
the Informix error code. The APPENDISAM environment variable provides the ISAM
error code and message (if present) to be included in the description field of all
interfaces that currently return Informix error code descriptions.
### Table 2. What's new in the IBM Informix JDBC Driver Programmer's Guide for Version 3.70.JC1

<table>
<thead>
<tr>
<th>Overview</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trusted connections improve security for multiple-tier application environments. You can define trusted contexts, which can then be used to establish trusted connections between an application server and the Informix database server on a network. Trusted connections let you set the identity of each specific user accessing a database through the middle-tier server, which facilitates discretionary access control and auditing based on user identity. Without a trusted connection in such an environment, each action on a database is performed with the single user ID of the middle-tier server, potentially lessening granular control and oversight of database security.</td>
<td>Trusted-context objects and trusted connections (Security Guide)</td>
</tr>
<tr>
<td>New Informix environment variables supported by the client-side JDBC driver. The LOGINTIMEOUT environment variable immediately establishes a connection to the Informix database server if the server is running. If the server is not running, this environment variable specifies how long, in milliseconds, the server port is polled to establish a connection. The TRUSTED_CONTEXT environment variable specifies if a trusted connection can be established between the database server and the client.</td>
<td>“Informix environment variables with the IBM Informix JDBC Driver” on page 2-10</td>
</tr>
<tr>
<td>New editions and product names. IBM Informix Dynamic Server editions were withdrawn and new Informix editions are available. Some products were also renamed. The publications in the Informix library pertain to the following products: * IBM Informix database server, formerly known as IBM Informix Dynamic Server (IDS) * IBM OpenAdmin Tool (OAT) for Informix, formerly known as OpenAdmin Tool for Informix Dynamic Server (IDS) * IBM Informix SQL Warehousing Tool, formerly known as Informix Warehouse Feature.</td>
<td>For more information about the Informix product family, go to <a href="http://www.ibm.com/software/data/informix/">http://www.ibm.com/software/data/informix/</a></td>
</tr>
</tbody>
</table>
Example code conventions

Examples of SQL code occur throughout this publication. Except as noted, the code is not specific to any single IBM Informix application development tool.

If only SQL statements are listed in the example, they are not delimited by semicolons. For instance, you might see the code in the following example:

```
CONNECT TO stores_demo
...

DELETE FROM customer
  WHERE customer_num = 121
...

COMMIT WORK
DISCONNECT CURRENT
```

To use this SQL code for a specific product, you must apply the syntax rules for that product. For example, if you are using an SQL API, you must use EXEC SQL at the start of each statement and a semicolon (or other appropriate delimiter) at the end of the statement. If you are using DB–Access, you must delimit multiple statements with semicolons.

**Tip:** Ellipsis points in a code example indicate that more code would be added in a full application, but it is not necessary to show it to describe the concept being discussed.

For detailed directions on using SQL statements for a particular application development tool or SQL API, see the documentation for your product.

Additional documentation

Documentation about this release of IBM Informix products is available in various formats.

You can access or install the product documentation from the Quick Start CD that is shipped with Informix products. To get the most current information, see the Informix information centers at ibm.com®. You can access the information centers and other Informix technical information such as technotes, white papers, and IBM Redbooks® publications online at [http://www.ibm.com/software/data/sw-library/](http://www.ibm.com/software/data/sw-library/).

Compliance with industry standards

IBM Informix products are compliant with various standards.

IBM Informix SQL-based products are fully compliant with SQL-92 Entry Level (published as ANSI X3.135-1992), which is identical to ISO 9075:1992. In addition, many features of IBM Informix database servers comply with the SQL-92 Intermediate and Full Level and X/Open SQL Common Applications Environment (CAE) standards.

The IBM Informix Geodetic DataBlade® Module supports a subset of the data types from the *Spatial Data Transfer Standard (SDTS)—Federal Information Processing Standard 173*, as referenced by the document *Content Standard for Geospatial Metadata*, Federal Geographic Data Committee, June 8, 1994 (FGDC Metadata Standard).
Syntax diagrams use special components to describe the syntax for statements and commands.

<table>
<thead>
<tr>
<th>Component represented in PDF</th>
<th>Component represented in HTML</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;&gt;&gt;----------------------</td>
<td>&gt;&gt;&gt;----------------------</td>
<td>Statement begins.</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------</td>
<td>Statement continues on next line.</td>
</tr>
<tr>
<td>&gt;-----------------------</td>
<td>&gt;-----------------------</td>
<td>Statement continues from previous line.</td>
</tr>
<tr>
<td>----------------------&lt;</td>
<td>----------------------&lt;</td>
<td>Statement ends.</td>
</tr>
<tr>
<td>SELECT---------------------</td>
<td>SELECT---------------------</td>
<td>Required item.</td>
</tr>
<tr>
<td>LOCAL---------------------</td>
<td>LOCAL---------------------</td>
<td>Optional item.</td>
</tr>
<tr>
<td>ALL---------------------</td>
<td>ALL---------------------</td>
<td>Required item with choice. Only one item must be present.</td>
</tr>
<tr>
<td>DISTINCT------------------</td>
<td>DISTINCT------------------</td>
<td></td>
</tr>
<tr>
<td>UNIQUE-------------------</td>
<td>UNIQUE-------------------</td>
<td></td>
</tr>
<tr>
<td>FOR UPDATE----------------</td>
<td>FOR UPDATE----------------</td>
<td>Optional items with choice are shown below the main line, one of which you might specify.</td>
</tr>
<tr>
<td>FOR READ ONLY-----------</td>
<td>FOR READ ONLY-----------</td>
<td></td>
</tr>
<tr>
<td>NEXT---------------------</td>
<td>NEXT---------------------</td>
<td>The values below the main line are optional, one of which you might specify. If you do not specify an item, the value above the line is used by default.</td>
</tr>
<tr>
<td>PRIOR-------------------</td>
<td>PRIOR-------------------</td>
<td></td>
</tr>
<tr>
<td>PREVIOUS----------------</td>
<td>PREVIOUS----------------</td>
<td></td>
</tr>
<tr>
<td>,------------------------</td>
<td>,------------------------</td>
<td>Optional items. Several items are allowed; a comma must precede each repetition.</td>
</tr>
<tr>
<td>index_name----------------</td>
<td>index_name----------------</td>
<td></td>
</tr>
<tr>
<td>table_name----------------</td>
<td>table_name----------------</td>
<td></td>
</tr>
<tr>
<td>Table Reference----------</td>
<td>Table Reference----------</td>
<td>Reference to a syntax segment.</td>
</tr>
<tr>
<td>Table Reference----------</td>
<td>Table Reference----------</td>
<td>Syntax segment.</td>
</tr>
</tbody>
</table>
How to read a command-line syntax diagram

Command-line syntax diagrams use similar elements to those of other syntax diagrams.

Some of the elements are listed in the table in Syntax Diagrams.

Creating a no-conversion job

```
<table>
<thead>
<tr>
<th>onpladm create job</th>
<th>-p project</th>
<th>-n -d device -D database</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>-t table</td>
</tr>
</tbody>
</table>
```

Notes:

1. See page Z-1

This diagram has a segment named “Setting the Run Mode,” which according to the diagram footnote is on page Z-1. If this was an actual cross-reference, you would find this segment on the first page of Appendix Z. Instead, this segment is shown in the following segment diagram. Notice that the diagram uses segment start and end components.

Setting the run mode:

```
-f d p a l c u n N
```

To see how to construct a command correctly, start at the upper left of the main diagram. Follow the diagram to the right, including the elements that you want. The elements in this diagram are case-sensitive because they illustrate utility syntax. Other types of syntax, such as SQL, are not case-sensitive.

The Creating a No-Conversion Job diagram illustrates the following steps:

1. Type `onpladm create job` and then the name of the job.
2. Optionally, type `-p` and then the name of the project.
3. Type the following required elements:
   - `-n`
   - `-d` and the name of the device
   - `-D` and the name of the database
   - `-t` and the name of the table
4. Optionally, you can choose one or more of the following elements and repeat them an arbitrary number of times:
   • -S and the server name
   • -T and the target server name
   • The run mode. To set the run mode, follow the Setting the Run Mode segment diagram to type -f, optionally type d, p, or a, and then optionally type l or u.
5. Follow the diagram to the terminator.

Keywords and punctuation
Keywords are words reserved for statements and all commands except system-level commands.

When a keyword appears in a syntax diagram, it is shown in uppercase letters. When you use a keyword in a command, you can write it in uppercase or lowercase letters, but you must spell the keyword exactly as it appears in the syntax diagram.

You must also use any punctuation in your statements and commands exactly as shown in the syntax diagrams.

Identifiers and names
Variables serve as placeholders for identifiers and names in the syntax diagrams and examples.

You can replace a variable with an arbitrary name, identifier, or literal, depending on the context. Variables are also used to represent complex syntax elements that are expanded in additional syntax diagrams. When a variable appears in a syntax diagram, an example, or text, it is shown in lowercase italic.

The following syntax diagram uses variables to illustrate the general form of a simple SELECT statement.

```
>>>SELECT—column_name—FROM—table_name
```

When you write a SELECT statement of this form, you replace the variables column_name and table_name with the name of a specific column and table.

How to provide documentation feedback
You are encouraged to send your comments about IBM Informix user documentation.

Use one of the following methods:
• Send email to docinf@us.ibm.com
• In the Informix information center, which is available online at [http://www.ibm.com/software/data/sw-library/](http://www.ibm.com/software/data/sw-library/) open the topic that you want to comment on. Click the feedback link at the bottom of the page, fill out the form, and submit your feedback.
• Add comments to topics directly in the information center and read comments that were added by other users. Share information about the product documentation, participate in discussions with other users, rate topics, and more!

Feedback from all methods is monitored by the team that maintains the user documentation. The feedback methods are reserved for reporting errors and omissions in the documentation. For immediate help with a technical problem, contact IBM Technical Support at [http://www.ibm.com/planetwide/](http://www.ibm.com/planetwide/)

We appreciate your suggestions.
Chapter 1. Getting started

These topics provide an overview of IBM Informix JDBC Driver and the JDBC API.

What is JDBC?

Java database connectivity (JDBC) is the JavaSoft specification of a standard application programming interface (API) that allows Java programs to access database management systems. The JDBC API consists of a set of interfaces and classes written in the Java programming language.

Using these standard interfaces and classes, programmers can write applications that connect to databases, send queries written in structured query language (SQL), and process the results.

Since JDBC is a standard specification, one Java program that uses the JDBC API can connect to any database management system (DBMS), as long as a driver exists for that particular DBMS.

What is a JDBC driver?

The JDBC API defines the Java interfaces and classes that programmers use to connect to databases and send queries. A JDBC driver implements these interfaces and classes for a particular DBMS vendor.

A Java program that uses the JDBC API loads the specified driver for a particular DBMS before it actually connects to a database. The JDBC DriverManager class then sends all JDBC API calls to the loaded driver.

There are four types of JDBC drivers:

**JDBC-ODBC bridge plus ODBC driver, also called Type 1 driver**

Translates JDBC API calls into Microsoft ODBC calls that are then passed to the ODBC driver

The ODBC binary code must be loaded on every client computer that uses this type of driver.

ODBC is an acronym for Open Database Connectivity.

**Native-API, partly Java driver, also called Type 2 driver**

Converts JDBC API calls into DBMS-specific client API calls

Like the bridge driver, this type of driver requires that some binary code is loaded on each client computer.

**JDBC-Net, pure-Java driver, also called Type 3 driver**

Sends JDBC API calls to a middle-tier server that translates the calls into the DBMS-specific network protocol

The translated calls are then sent to a particular DBMS.

**Native-protocol, pure-Java driver, also called Type 4 driver**

Converts JDBC API calls directly into the DBMS-specific network protocol without a middle tier
This driver allows the client applications to connect directly to the database server.

**Overview of Informix JDBC Driver**

IBM Informix JDBC Driver is a native-protocol, pure-Java driver (Type 4). This means that when you use Informix JDBC Driver in a Java program that uses the JDBC API to connect to an Informix database, your session connects directly to the database or database server, without a middle tier.

The Javadoc pages describe the Informix extension classes, interfaces, and methods in detail.

In UNIX, Javadoc pages are located in `$JDBCLOCATION/doc/javadoc`, where `$JDBCLOCATION` refers to the directory where you installed Informix JDBC Driver.

In Windows, Javadoc pages are located in `%JDBCLOCATION%\doc\javadoc`, where `%JDBCLOCATION%` refers to the directory where you installed Informix JDBC Driver.

**Classes implemented in Informix JDBC Driver**

To support `DataSource` objects, connection pooling, and distributed transactions, IBM Informix JDBC Driver provides classes that implement interfaces and classes described in the JDBC 3.0 API.

**Informix classes that implement Java interfaces**

The following table lists the Java interfaces and classes and the IBM Informix classes that implement them.

<table>
<thead>
<tr>
<th>JDBC interface or class</th>
<th>Informix class</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.io.Serializable</td>
<td>com.informix.jdbcx.IfxCoreDataSource</td>
</tr>
<tr>
<td>java.sql.Connection</td>
<td>com.informix.jdbcx.IfxConnection</td>
</tr>
<tr>
<td>javax.sql.ConnectionEventListener</td>
<td>com.informix.jdbcx.IfxConnectionEventListerner</td>
</tr>
<tr>
<td>javax.sql.ConnectionPoolDataSource</td>
<td>com.informix.jdbcx.IfxConnectionPoolDataSource</td>
</tr>
<tr>
<td>javax.sql.DataSource</td>
<td>com.informix.jdbcx.IfxDataSource</td>
</tr>
<tr>
<td>javax.sql.PooledConnection</td>
<td>com.informix.jdbcx.IfxPooledConnection</td>
</tr>
<tr>
<td>javax.sql.XADataSource</td>
<td>com.informix.jdbcx.IfxXADatasource</td>
</tr>
<tr>
<td>java.sql.ParameterMetaData</td>
<td>com.informix.jdbcx.IfxParameterMetaData</td>
</tr>
</tbody>
</table>

IBM Informix JDBC Driver, Version 3.0, and later implements the `updateXXX()` methods defined in the `ResultSet` interface by the JDBC 3.0 specification. These methods, such as `updateClob`, are further defined in the J2SDK 1.4.x API, and later and require that the `ResultSet` object can be updated. The `updateXXX()` methods allow rows to be updated by using Java variables and objects and extend to include additional JDBC types.

These methods update JDBC types implemented with locators, not the data designated by the locators.
**Informix classes that extend the Java specification**

To support the IBM Informix implementation of SQL statements and data types, IBM Informix JDBC Driver provides classes that extend the JDBC 3.0 API. The following table lists the Java classes and the Informix classes that application programs can use to extend them.

<table>
<thead>
<tr>
<th>JDBC interface or class</th>
<th>Informix class</th>
<th>Adds methods or constants for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.sql.Connection</td>
<td>com.informix.jdbc.IfmxConnection</td>
<td>Opaque, distinct, and complex types</td>
</tr>
<tr>
<td>java.sql.Statement</td>
<td>com.informix.jdbc.IfmxStatement</td>
<td>Single result sets, autofree mode, statement types, and SERIAL data type processing</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.lang.IfxTypes</td>
<td>Representing data types</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.jdbc.IfxStatementTypes</td>
<td>Representing SQL statements</td>
</tr>
<tr>
<td>java.sql.CallableStatement</td>
<td>com.informix.jdbc.IfmxCallableStatement</td>
<td>Parameter processing with Informix types</td>
</tr>
<tr>
<td>java.sql.PreparedStatement</td>
<td>com.informix.jdbc.IfmxPreparedStatement</td>
<td>Parameter processing with Informix types</td>
</tr>
<tr>
<td>java.sql.ResultSet</td>
<td>com.informix.jdbc.IfmxResultSet</td>
<td>Informix interval data types</td>
</tr>
<tr>
<td>java.sql.ResultSetMetaData</td>
<td>com.informix.jdbc.IfmxResultSetMetaData</td>
<td>Columns with Informix data types</td>
</tr>
<tr>
<td>java.sql.SQLInput</td>
<td>com.informix.jdbc.IfmxComplexSQLInput</td>
<td>Opaque, distinct, and complex types</td>
</tr>
<tr>
<td>java.sql.SQLOutput</td>
<td>com.informix.jdbc.IfmxComplexSQLOutput</td>
<td>Opaque, distinct, and complex types</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.jdbc.Interval</td>
<td>Interval qualifiers and some common methods for the next two classes (base class for the next two)</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.jdbc.IntervalYM</td>
<td>Interval year-to-month</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.jdbc.IntervalDF</td>
<td>Interval day-to-fraction</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.jdbc.IfxSmartBlob</td>
<td>Access methods for smart large objects</td>
</tr>
<tr>
<td>java.sql.Blob</td>
<td>com.informix.jdbc.IfxBblob</td>
<td>Binary large objects</td>
</tr>
<tr>
<td>java.sql.Clob</td>
<td>com.informix.jdbc.IfxCblob</td>
<td>Character large objects</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.jdbc.IfxLocator</td>
<td>Large object locator pointer</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.jdbc.IfxLobDescriptor</td>
<td>Internal characteristics of smart large objects</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>com.informix.jdbc.IfxUDTInfo</td>
<td>General information about opaque and distinct types, detailed information about complex types</td>
</tr>
<tr>
<td>java.sql.SQLInput</td>
<td>com.informix.jdbc.IfmxUDTSQLInput</td>
<td>Opaque, distinct, and complex types</td>
</tr>
<tr>
<td>java.sql.SQLOutput</td>
<td>com.informix.jdbc.IfmxUDTSQLOutput</td>
<td>Opaque, distinct, and complex types</td>
</tr>
</tbody>
</table>
Informix classes that provide support beyond the Java specification

A number of IBM Informix classes provide support for functionality not present in the Java specification. These classes are listed in the following table.

<table>
<thead>
<tr>
<th>JDBC interface or class</th>
<th>Informix class</th>
<th>Provides support for...</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.lang.Object</td>
<td>UDTManager</td>
<td>Deploying opaque data types in the database server</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>UDTMetaData</td>
<td>Deploying opaque data types in the database server</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>UDRManager</td>
<td>Deploying user-defined routines in the database server</td>
</tr>
<tr>
<td>java.lang.Object</td>
<td>UDRMetaData</td>
<td>Deploying user-defined routines in the database server</td>
</tr>
</tbody>
</table>

UDTManager and UDRManager classes with JDK Version 1.4, and later

In previous releases, the UDTManager and UDRManager helper classes included in ifxtools.jar were not accessible from a packaged class. As of IBM Informix JDBC Driver 2.21.JC3, all these classes are in the udtudrmgr package. For backwards compatibility, unpackaged versions of these classes are also included.

To access a packaged class, use the following import statements in your program:
- `import udtudrmgr.UDTManager;`
- `import udtudrmgr.UDRManager;`

**Files in IBM Informix JDBC Driver**

IBM Informix JDBC Driver is available in the program file, setup.jar. For instructions on how to install the driver, see “Installing the JDBC Driver” on page 1-6.

After installation, the product consists of the following files, some of which are Java archive (JAR) files:
- `lib/ifxjdbc.jar`
  - Optimized implementations of the JDBC API interfaces, classes, and methods
  - The file is compiled with the -O option of the javac command.
- `lib/ifxtools.jar`
  - Utilities: ClassGenerator, lightweight directory access protocol (LDAP) loader, and others
  - The file is compiled with the -O option of the javac command.
- `lib/ifxlang.jar`
  - Localized versions of all message text supported by the driver
  - The file is compiled with the -O option of the javac command.
- `lib/ifxjdbcx.jar`
  - Includes the implementation of DataSource-, connection pooling-, and XA-related class files
  - The file is compiled with the -O option of the javac command.
• lib/ifxsqlj.jar
  Includes the classes for runtime support of SQLJ programs
  The file is compiled with the -O option of the javac command.

• demo/basic/**
  demo/rmi/**
  demo/stores7/**
  demo/clob-blob/**
  demo/complex-types/**
  demo/pickaseat/**
  demo/xml/**
  demo/proxy/**
  demo/connection-pool/**
  demo/udt-distinct/*
  demo/hdr/*
  demo/tools/udtudrmgr/*

  Sample programs that use the JDBC API
  For descriptions of these sample files, see Appendix A, “Sample code files,” on page A-1.

• proxy/IfxJDBCProxy.class
  Http tunneling proxy class file

• proxy/SessionMgr.class
  Session manager class file supporting the http tunneling proxy

• proxy/TimeoutMgr.class
  Timeout manager class file supporting the http tunneling proxy

• doc/release/**
  Online release and documentation notes

• doc/javadoc/**
  The Javadoc pages for Informix extension classes and interfaces

The lib, demo, proxy, and doc directories are subdirectories of the directory where you installed IBM Informix JDBC Driver.

**Client and server JDBC drivers**

The IBM Informix JDBC Driver exists in two versions: a client-side driver and a server-side driver. The client-side driver is intended for client Java applications accessing an Informix database server. The client-side driver includes ifxjdbc.jar and ifxjdbcx.jar plus several support .jar files, as described in the section, “Files in IBM Informix JDBC Driver” on page 1-4.

The server-side driver is installed as part of the database server and includes jdbc.jar. Because jdbc.jar is derived from ifxjdbc.jar, the two drivers share many features.

This guide is primarily concerned with the client-side driver; however information for shared features applies to both the server-side and client-side versions.

**Important:** The server-side and client-side versions are not to be mixed or interchanged.
The J/Foundation Developer’s Guide describes the interfaces and subprotocols that the IBM Informix JDBC Driver provides specifically for server-side JDBC applications, as well as restrictions that apply to server-side JDBC applications.

Obtain the JDBC driver

You can obtain the IBM Informix JDBC Driver from the IBM Informix JDBC Driver product CD, from the JDBC directory of the IBM Informix product bundle CD, or you can download the driver from www.oracle.com.

The CD or website download contain the following files:

- setup.jar
- doc/jdbcrel.htm
- doc/install.txt

The setup.jar file is the IBM Informix JDBC Driver installation program.

The documentation directory, <dir>/doc, contains the release notes file in HTML format. See this document for any new information that is not available in these topics.

Installing the JDBC Driver

To install the IBM Informix JDBC Driver along with Informix, follow the instructions in the IBM Informix Installation Guide for your specific operating system:

- For UNIX: Installing Informix and client products on UNIX and Linux
- For Windows: Installing Informix and client products on Windows

To install the Informix JDBC Driver by itself:

- If you downloaded the IBM Informix JDBC Driver as .zip file from the website, extract the file to a directory.
- If you are installing the driver from a CD, load the CD into the CD-ROM drive.

Installing JDBC driver in graphical or console mode

1. From a command prompt, start the installation program by using one of the following commands:
   
   - To start in graphical mode:
     java -jar <dir>/setup.jar install -i gui
   - To start in console mode:
     java -jar <dir>/setup.jar install -i console

   Where <dir> is the location of the setup.jar file.

   If you want to log information during the installation, also specify the -log parameter. See “Log installation events” on page 1-7 for information about the arguments that you can use with this parameter.

2. Read the license agreement and accept the terms. Respond to the prompts as the installation guides you.

3. When prompted, accept the default directory or specify a different directory.
On a Windows platform, the default directory is C:\Program Files\IBM\Informix_JDBC_Driver
To prevent errors in installation and uninstallation, do not use an exclamation point character (!) in the installation path.

4. When prompted, verify the location of the installation path.
The installer installs the IBM Informix JDBC Driver and notifies you that an uninstaller is being added to the installation directory.

**Tip:** If the installation stalls when connected to an NFS-mounted file system, you should first try resolving NFS issues. In some cases, unmounting and remounting the share can resolve the issue. Otherwise, forcefully terminate the installation, clean up any orphaned processes, and restart the installation.

5. Specify **Finish** when you see this message:
InstallShield Wizard has successfully installed IBM Informix JDBC Driver.

### Installing JDBC driver in silent mode

From a command prompt, run the following command:
```
java -jar <dir>/setup.jar i -silent
-DUSER_INSTALL_DIR=<destination-dir>
```

Where:
- `<dir>` is the location of setup.jar file.
- `<destination-dir>` is the directory where you want to install the JDBC Driver.

The installation is complete when the command has finished executing.

If you want to log information during the installation, also specify the `-log` parameter. See [Log installation events](#) for information about the arguments that you can use with this parameter.

### Log installation events

You can enable logging by specifying the `-log` option when you run the command to install the driver. The `-log` option takes arguments for file type, event type, and file location. For example, to install the IBM Informix JDBC Driver in graphical mode and retain a log of the events, run the following command:
```
java -cp setup.jar run -log #![filename] @<event type>;$<event type>
```

Where:
- `#` echoes the display to standard output.
- `![filename]` is the name for the log file. You can omit the `[filename]` argument to save the log information to the default file name.
- `@<event type>` is the event type that you want to log.

The following list shows the arguments and their associated event types:

<table>
<thead>
<tr>
<th>Argument</th>
<th>Event type</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>err</code></td>
<td>Errors</td>
</tr>
<tr>
<td><code>wrm</code></td>
<td>Warning</td>
</tr>
<tr>
<td><code>msg1</code></td>
<td>Primary events</td>
</tr>
<tr>
<td><code>msg2</code></td>
<td>Secondary events</td>
</tr>
</tbody>
</table>
Log examples

The following command installs IBM Informix JDBC Driver in the graphical mode and logs all events to /tmp/jdbcinstall.log:
```
java -cp setup.jar run -log !/tmp/jdbcinstall.log 0 ALL
```

The following command installs IBM Informix JDBC Driver in silent mode and logs error events to /tmp/jdbcinstall.log:
```
java -cp setup.jar run -silent -P product.installLocation=< > -log !"/tmp/jdbcinstall.log" @err
```

Using the driver in an application

To use IBM Informix JDBC Driver in an application, you must set your CLASSPATH environment variable to point to the driver files. The CLASSPATH environment variable tells the Java virtual machine (JVM) and other applications where to find the Java class libraries used in a Java program.

UNIX

There are two ways to set your CLASSPATH environment variable:

- Add the full path name of ifxjdbc.jar to CLASSPATH:
  ```
  setenv CLASSPATH /jdbcdriv/lib/ifxjdbc.jar:$CLASSPATH
  ```
  To add localized message support, specify ifxlang.jar:
  ```
  setenv CLASSPATH /jdbcdriv/lib/ifxjdbc.jar:/jdbcdriv/lib/ifxlang.jar:
  $$CLASSPATH
  ```

- Unpack ifxjdbc.jar and add its directory to CLASSPATH:
  ```
  cd /jdbcdriv/lib
  jar xvf ifxjdbc.jar
  setenv CLASSPATH /jdbcdriv/lib:$CLASSPATH
  ```
  To add localized message support, specify ifxlang.jar:
  ```
  cd /jdbcdriv/lib
  jar xvf ifxjdbc.jar
  jar xvf ifxlang.jar
  setenv CLASSPATH /jdbcdriv/lib:$CLASSPATH
  ```

Windows

There are two ways to set your CLASSPATH environment variable:

- Add the full path name of ifxjdbc.jar to CLASSPATH:
  ```
  set CLASSPATH=c:\jdbcdriv\lib\ifxjdbc.jar;%CLASSPATH%
  ```
  To add localized message support, specify ifxlang.jar:
  ```
  set CLASSPATH=c:\jdbcdriv\lib\ifxjdbc.jar;c:\jdbcdriv\lib\ifxlang.jar;%CLASSPATH%
  ```

- Unpack ifxjdbc.jar and add its directory to CLASSPATH:
cd c:\jdbcdriv\lib
jar xvf ifxjdbc.jar
set CLASSPATH=c:\jdbcdriv\lib;%CLASSPATH%

To add localized message support, specify ifxlang.jar:

cd c:\jdbcdriv\lib
jar xvf ifxjdbc.jar
jar xvf ifxlang.jar
set CLASSPATH=c:\jdbcdriv\lib;%CLASSPATH%

If you are using javax.sql classes (for example, Datasource), specify ifxjdbcx.jar in addition to ifxjdbc.jar.

**Using the driver in an applet**

You can use IBM Informix JDBC Driver in an applet to connect to an Informix database from a web browser. The following steps show how to specify IBM Informix JDBC Driver in the applet and how to ensure that the driver is correctly downloaded from the web server.

To use IBM Informix JDBC Driver in an applet:
1. Install ifxjdbc.jar in the same directory as your applet class file.
2. Specify ifxjdbc.jar in the ARCHIVE attribute of the APPLET tag in your HTML file, as shown in the following example:

   ```html
   <APPLET ARCHIVE=ifxjdbc.jar CODE=my_applet.class CODEBASE=http://www.myhost.com WIDTH=460 HEIGHT=160>
   </APPLET>
   ```

**Important:** Some browsers do not support the ARCHIVE attribute of the APPLET tag. If this is true of your browser, unpack and install the ifxjdbc.jar file in the root directory of your web server. If your browser also does not support the JDBC API, you must install the class files included in the java.sql package in the root directory of the web server. See your web server documentation for information about installing files in the root directory.

Because unsigned applets cannot access some system resources for security reasons, the following features of IBM Informix JDBC Driver do not work for unsigned applets:

- **The sqlhosts file and LDAP server access.** The host name and port number properties or service name of the Informix database server in the database URL are optional if you are referencing an sqlhosts file directly or through an LDAP server.

  For unsigned applets, however, the host name and the port number or service name of the Informix database server are always required, unless your applet is using the HTTP proxy server. For more information about the HTTP proxy server, see “An HTTP proxy server” on page 2-22.

- **LOBCACHE=0.** Setting the LOBCACHE environment variable to 0 in the database URL specifies that a smart large object is always stored in a file. This setting is not supported for unsigned applets.

**Tip:** You can enable these features for unsigned applets by using Microsoft Internet Explorer, which provides an option to configure the applet permissions.

To access a database on a different host or behind a firewall from an applet, you can use the Informix HTTP proxy servlet in a middle tier. For more information, see “An HTTP proxy server” on page 2-22.

Chapter 1. Getting started 1-9
Uninstall the JDBC Driver

When you install IBM Informix JDBC Driver, the installation program creates an uninstall package in the directory in which you installed the JDBC Driver. Uninstalling Informix JDBC Driver completely removes the driver and all of its components from your computer.

The following section describes how to uninstall Informix JDBC Driver on all platforms.

Tip: If the `<destination-dir>` in which you installed the Informix JDBC Driver includes spaces in its path name, enclose the entire path name in quotation marks when executing the uninstall command.

Uninstall in graphical or console mode

Run one of the following commands to start the uninstall program. The `<destination-dir>` is the directory in which you installed the IBM Informix JDBC Driver.

If you installed the Informix JDBC Driver by using the Informix installation program, you must use run the uninstall executable program that was added to your computer when the driver was installed.

- To uninstall by using the graphical mode:
  `<destination-dir>/uninstall/uninstall_jdbc/uninstalljdbc -i gui`
- To uninstall by using the console mode:
  `<destination-dir>/uninstall/uninstall_jdbc/uninstalljdbc -i console`

If you installed the Informix JDBC Driver separately, run the JAR file to uninstall the driver:

- To uninstall by using the graphical mode:
  `java -jar <destination-dir>/uninstall/uninstall_jdbc/uninstaller.jar -i gui`
- To uninstall by using the console mode:
  `java -jar <destination-dir>/uninstall/uninstall_jdbc/uninstaller.jar -i console`

Follow the prompts to uninstall the JDBC driver.

Uninstall in silent mode

When you uninstall the IBM Informix JDBC Driver in the silent mode, you do not receive any messages about the uninstallation.

How you installed the Informix JDBC Driver determines the program that you use to uninstall the driver.

Run one of the following commands to start the uninstall program in the silent mode. The `<destination-dir>` is the directory in which you installed the Informix JDBC Driver.

If you installed the Informix JDBC Driver by using the Informix installation program, specify the following command to start the uninstall program in the silent mode:

`<destination-dir>/uninstall/uninstall_jdbc/uninstalljdbc -i silent`
If you installed the Informix JDBC Driver separately from installing Informix, specify the following command to run the JAR file in the silent mode:

```
java -jar <destination-dir>/uninstall/uninstall.jdbc/uninstaller.jar -silent
```
Chapter 2. Connect to the database

These topics explain the information you need to use IBM Informix JDBC Driver to connect to an Informix database.

You must first establish a connection to an Informix database server or database before you can start sending queries and receiving results in your Java program.

You establish a connection by completing two actions:
1. Load Informix JDBC Driver.
2. Create a connection to either a database server or a specific database in one of the following ways:
   • Use a DataSource object.
   • Use the DriverManager.getConnection() method.

Using a DataSource object is preferable to using the DriverManager.getConnection() method because a DataSource object is portable and allows the details about the underlying data source to be transparent to the application. The target data source implementation can be modified, or the application can be redirected to a different server without affecting the application code.

A DataSource object can also provide support for connection pooling and distributed transactions. In addition, Enterprise JavaBeans and J2EE require a DataSource object.

The following additional connection options are available:
• Setting environment variables
• Dynamically reading the Informix sqlhosts file
• Using an HTTP proxy server
• Using password encryption
• Using network encryption

Load IBM Informix JDBC Driver

To load IBM Informix JDBC Driver, use the Class.forName() method, passing it the value com.informix.jdbc.IfxDriver:

```java
try {
    Class.forName("com.informix.jdbc.IfxDriver");
} catch (Exception e) {
    System.out.println("ERROR: failed to load Informix JDBC driver.");
    e.printStackTrace();
    return;
}
```

The Class.forName() method loads the Informix implementation of the Driver class, IfxDriver. IfxDriver then creates an instance of the driver and registers it with the DriverManager class.
After you have loaded Informix JDBC Driver, you are ready to connect to an
Informix database or database server.

If you are writing an applet to be viewed with Microsoft Internet Explorer, you
might need to explicitly register Informix JDBC Driver to avoid platform
incompatibilities.

To explicitly register the driver, use the DriverManager.registerDriver() method:

```java
DriverManager.registerDriver(com.informix.jdbc.IfxDriver)
Class.forName("com.informix.jdbc.IfxDriver").newInstance());
```

This method might register Informix JDBC Driver twice, which does not cause a
problem.

**A DataSource object**

IBM Informix JDBC Driver extends the standard **DataSource** interface to allow
connection properties (both the standard properties and Informix environment
variables) to be defined in a **DataSource** object instead of through the URL.

The following table describes how Informix connection properties correspond to
**DataSource** properties.

<table>
<thead>
<tr>
<th>Informix connection property</th>
<th>DataSource property</th>
<th>Data type</th>
<th>Required?</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFXHOST</td>
<td>None; see Appendix B, &quot;DataSource extensions,&quot; on page B-1 for how to set IFXHOST.</td>
<td>String</td>
<td>Yes for client-side JDBC, unless SQLH_TYPE is defined; no for server-side JDBC</td>
<td>The IP address or the host name of the computer running the Informix database server</td>
</tr>
<tr>
<td>PORTNO</td>
<td>portNumber</td>
<td>int</td>
<td>Yes for client-side JDBC, unless SQLH_TYPE is defined; no for server-side JDBC</td>
<td>The port number of the Informix database server. The port number is listed in the /etc/services file.</td>
</tr>
<tr>
<td>DATABASE</td>
<td>databaseName</td>
<td>String</td>
<td>No, except for connections from web applications (such as a browser) running in the database server</td>
<td>The name of the Informix database to which you want to connect If you do not specify the name of a database, a connection is made to the Informix database server.</td>
</tr>
<tr>
<td>INFORMIXSERVER</td>
<td>serverName</td>
<td>String</td>
<td>Yes for client-side JDBC; ignored for server-side JDBC</td>
<td>The name of the Informix database server to which you want to connect</td>
</tr>
</tbody>
</table>
### Informix connection property

<table>
<thead>
<tr>
<th>DataSource property</th>
<th>Data type</th>
<th>Required?</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER</td>
<td>user</td>
<td>String</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The user name controls (or determines) the session privileges when connected to the Informix database or database server</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Normally, you must specify both user name and password; however, if the user running the JDBC application is trusted by the DBMS, you might omit both.</td>
</tr>
<tr>
<td>PASSWORD</td>
<td>password</td>
<td>String</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The password of the user</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Normally, you must specify both the user name and the password; however, if the user running the JDBC application is trusted by the DBMS, you might omit both.</td>
</tr>
<tr>
<td>None</td>
<td>description</td>
<td>String</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A description of the <strong>DataSource</strong> object</td>
</tr>
<tr>
<td>None</td>
<td>dataSourceName</td>
<td>String</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The name of an underlying <strong>ConnectionPoolDataSource</strong> or <strong>XADataSource</strong> object for connection pooling or distributed transactions</td>
</tr>
</tbody>
</table>

### Unsupported connection properties

The **networkProtocol** and **roleName** properties are not supported by IBM Informix JDBC Driver.

### Specify connection information

If an LDAP (Lightweight Directory Access Protocol) server or `sqlhosts` file provides the IP address, host name, or port number or service name of the Informix database server through the **SQLH_TYPE** property, you do not have to specify them using the standard **DataSource** properties. For more information, see “Dynamically reading the Informix sqlhosts file” on page 2-16.

### ConnectionPoolDataSource object

For information about the **ConnectionPoolDataSource** object, see “A connection pool” on page 7-3.

### Environment variables

For a list of supported environment variables (properties), see “Informix environment variables with the IBM Informix JDBC Driver” on page 2-10. For a list of Informix **DataSource** extensions, which allow you to define environment variable values and connection pool tuning parameters, see Appendix B, “DataSource extensions,” on page B-1. The driver does not consult the users environment to determine environment variable values.
High-availability data replication

You can use a `DataSource` object with High-Availability Data Replication. For more information, see “High-Availability Data Replication” on page 2-19.

Example: Use of a DataSource object in an example program

The following code from the `pickaseat` example program defines and uses a `DataSource` object:

```java
IfxConnectionPoolDataSource cpds = null;
try {
    Context initCtx = new InitialContext();
    cpds = new IfxConnectionPoolDataSource();
    cpds.setDescription("Pick-A-Seat Connection pool");
    cpds.setIfxIFXHOST("158.58.60.88");
    cpds.setPortNumber(179);
    cpds.setUser("demo");
    cpds.setPassword("demo");
    cpds.setServerName("ipickdemo_tcp");
    cpds.setDatabaseName("ipickaseat");
    cpds.setIfxGL_DATE("%B %d, %Y");
    initCtx.bind("jdbc/pooling/PickASeat", cpds);
} catch (Exception e) {
    System.out.println("Problem with registering the CPDS");
    System.out.println("Error: " + e.toString());
}
```

Example: Use of a DataSource object with the `IFX_LOCK_MODE_WAIT` connection property

The following are examples of the `IFX_LOCK_MODE_WAIT` connection property that use a `DataSource` object:

Example 1

```java
IfxDataSource ds = new IfxDataSource();
ds.setIfxIFX_LOCK_MODE_WAIT (65); // wait for 65 seconds
...
int waitMode = ds.getIfxIFX_LOCK_MODE_WAIT ();
```

Example 2

```java
An example Using DataSource:
IfxDataSource ds = new IfxDataSource();
ds.setIfxIFX_ISOLATION_LEVEL ("0U"); // set isolation to dirty read with retain
    // update locks.
....
String isoLevel = ds.getIfxIFX_ISOLATION_LEVEL ();
```

The DriverManager.getConnection() method

To create a connection to an IBM Informix database or database server, you can use the DriverManager.getConnection() method. This method creates a `Connection` object, which is used to create SQL statements, send them to an Informix database, and process the results.
The **DriverManager** class tracks the available drivers and handles connection requests between appropriate drivers and databases or database servers. The *url* parameter of the `getConnection()` method is a database URL that specifies the subprotocol (the database connectivity mechanism), the database or database server identifier, and a list of properties.

A second parameter to the `getConnection()` method, *property*, is the property list. See [“Specify properties” on page 2-9](#) for an example of how to specify a property list.

The following example shows a database URL that connects to a database called **testDB** from a client application:

```
jdbc:informix-sqli://123.45.67.89:1533/testDB:
   INFORMIXSERVER=myserver;user=rdtest;password=test
```

The details of the database URL syntax are described in the next section.

The following partial example from the `CreateDB` program shows how to connect to database **testDB** by using `DriverManager.getConnection()`. In the full example, the *url* variable, described in the preceding example, is passed in as a parameter when the program is run at the command line.

```
try {
   conn = DriverManager.getConnection(url);
}
```

```
catch (SQLException e) {
   System.out.println("ERROR: failed to connect!");
   System.out.println("ERROR: "+ e.getMessage());
   e.printStackTrace();
   return;
}
```

**Important:** The only Informix connection type supported by IBM Informix JDBC Driver is *tcp*. Shared memory and other connection types are not supported. For more information about connection types, see the *IBM Informix Administrator’s Guide* for your database server.

**Important:** Not all methods of the **Connection** interface are supported by IBM Informix JDBC Driver. For a list of unsupported methods, see [“Unsupported methods and methods that behave differently” on page 3-17](#).

Client applications do not need to explicitly close a connection; the database server closes the connection automatically. However, if your application is running in the database server using server-side JDBC, you should explicitly close the connection.

### Format of database URLs

For connections from a client, use the following format to specify database URLs:

```
jdbc:informix-sqli://[[ip-address|host-name]:[port-number|server-name]]/[dbname]:
   INFORMIXSERVER=servername[:;user=user;password=password]
   [CSM=(SSO=database_server@realm,ENC=true)]
   [;name=value[;name=value]...]
```

For connections on the database server, use the following format:

```
jdbc:informix-direct://[/dbname::[user=user;password=password] ]
   [;name=value[;name=value]...]
```
In the preceding syntax:

- Braces ({} together with vertical lines (|) denote more than one choice of variable.
- Italic denote a variable value.
- Brackets ([ ]) denote an optional value.
- Words or symbols not enclosed in brackets are required (INFORMIXSERVER=, for example).

Blank spaces are not allowed in the database URL.

For example, on the client you might use:
```
jdbc:informix-sqli://123.45.67.89:1533/testDB:
    INFORMIXSERVER=myserver;user=rdtest;password=test
```

On the server, you might use:
```
jdbc:informix-direct://testDB;user=rdtest;password=test
```

**Important:** Connections that use server-side JDBC have different syntax. For details, see the J/Foundation Developer’s Guide or the release notes for your version of the database server.

The following table describes the variable parts of the database URL and the equivalent IBM Informix connection properties.

<table>
<thead>
<tr>
<th>Informix connection property</th>
<th>Database URL variable</th>
<th>Required?</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>port-number | ip-address</td>
<td>Yes for client-side JDBC, unless SQLH_TYPE is defined or IFXHOST is used; no for server-side JDBC</td>
<td>The IP address or the host name of the computer running the Informix database server</td>
<td></td>
</tr>
<tr>
<td>host-name</td>
<td>IFXHOST</td>
<td>No for server-side JDBC</td>
<td></td>
</tr>
<tr>
<td>PORTNO</td>
<td>Yes for client-side JDBC you must specify either port-number or a server-name, unless SQLH_TYPE is defined or PORTNO is used; no for server-side JDBC</td>
<td>The port number of the Informix database server</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>server-name</td>
<td>The server-name of the Informix database server is listed in the /etc/services file.</td>
<td></td>
</tr>
<tr>
<td>Informix connection property</td>
<td>Database URL variable</td>
<td>Required?</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------</td>
<td>-----------</td>
<td>-------------</td>
</tr>
<tr>
<td>DATABASE</td>
<td>dbname</td>
<td>No, except for connections from web applications (such as a browser) running in the database server</td>
<td>The name of the Informix database to which you want to connect. If you do not specify the name of a database, a connection is made to the Informix database server.</td>
</tr>
<tr>
<td>INFORMIXSERVER</td>
<td>server-name</td>
<td>Yes</td>
<td>The name of the Informix database server to which you want to connect</td>
</tr>
<tr>
<td>USER</td>
<td>user</td>
<td>Yes</td>
<td>The name of the user who wants to connect to the Informix database or database server. You must specify both the user and the password or neither. If you specify neither, the driver calls System.getProperty() to obtain the name of the user currently running the application, and the client is assumed to be trusted.</td>
</tr>
<tr>
<td>name=value PASSWORD</td>
<td>password</td>
<td>Yes</td>
<td>The password of the user. You must specify both the user and the password or neither. If you specify neither, the driver calls System.getProperty() to obtain the name of the user currently running the application, and the client is assumed to be trusted.</td>
</tr>
<tr>
<td>None</td>
<td>database_server@realm</td>
<td>Yes</td>
<td>The service principle for (SSO) access control. For information, see “Using single sign-on access control with the Informix JDBC Driver” on page 2-30.</td>
</tr>
<tr>
<td>None</td>
<td>name</td>
<td>No</td>
<td>A name-value pair that specifies a value for the Informix environment variable contained in the name variable, recognized by either IBM Informix JDBC Driver or Informix database servers. The name variable is not case sensitive. See “Specify properties” on page 2-9 and “Informix environment variables with the IBM Informix JDBC Driver” on page 2-10 for more information.</td>
</tr>
</tbody>
</table>

If an LDAP server or sqlhosts file provides the IP address, host name, or port number through the SQLH_TYPE property, you do not have to specify them in the database URL. For more information, see “Dynamically reading the Informix sqlhosts file” on page 2-16.

**IP address in connection URLs**

The IBM Informix JDBC Driver, Version 3.0, and later supporting the JDK 1.4, is IPv6 aware. That is, the code that parses the connection URL can handle the longer (128-bit mode) IPv6 addresses (as well as IPv4 format). This IP address can be a IPv6 literal, for example:

3ffe:ffff:ffff:ffff:0:0:0:12
To connect to the IPv6 port with an Informix server, use the system property, for example:
java -Djava.net.preferIPv6Addresses=true ...

With the IBM Informix JDBC Driver, Version 3.0, or later handling of URLs without IPv6 literals is unchanged, and legacy behavior is unchanged.

The colon (:) is a key delimiter in a connection URL, especially in IPv6 literal addresses.

You must create a well-formed URL for the driver to recognize an IPv6 literal address. Note, in the following example:
- The jdbc:informix-sqli:// is required.
- The colons surrounding the 8088, (:8088:) are required.
- The 3ffe:ffff:ffff:ffff:0::12 is not validated by the driver.
- The 8088 must be a valid number < 32k.

**Database versus database server connections**

Using the DriveManager.getConnection() method, you can create a connection to either an IBM Informix database or an Informix database server.

To create a connection to an Informix database, specify the name of the database in the dbname variable of the database URL. If you omit the name of a database, a connection is made to the database server specified by the INFORMIXSERVER environment variable of the database URL or the connection property list.

If you connect directly to an Informix database server, you can execute an SQL statement that connects to a database in your Java program.

All connections to both databases and database servers must include the name of an Informix database server via the INFORMIXSERVER environment variable.

**Important:** If you are connecting to an IBM Informix OnLine, IBM Informix SE 5.x, or IBM Informix SE 7.x database server you must specify USEV5SERVER=1.

The example given in "The DriveManager.getConnection() method“ on page 2-4 shows how to create a connection directly to the Informix database called testDB with the database URL.

The following example from the DBConnection.java program shows how to first create a connection to the Informix database server called myserver and then connect to the database testDB by using the Statement.executeUpdate() method.

The following database URL is passed in as a parameter to the program when the program is run at the command line; note that the URL does not include the name of a database:
jdbc:informix-sqli://123.45.67.89:1533:INFORMIXSERVER=myserver;
user=rdtest;password=test

The code is:
String cmd = null;
int rc;
Connection conn = null;

try {
    Class.forName("com.informix.jdbc.IfxDriver");
} catch (Exception e) {
    System.out.println("ERROR: failed to load Informix JDBC driver.");
}
try {
    conn = DriverManager.getConnection(newUrl);
} catch (SQLException e) {
    System.out.println("ERROR: failed to connect!");
e.printStackTrace();
return;
}
try {
    Statement stmt = conn.createStatement();
cmd = "database testDB;"
rc = stmt.executeUpdate(cmd);
stmt.close();
} catch (SQLException e) {
    System.out.println("ERROR: execution failed - statement: " + cmd);
    System.out.println("ERROR: " + e.getMessage());
}

Specify properties

When you use the DriverManager.getConnection() method to create a connection, IBM Informix JDBC Driver reads Informix environment variables only from the name-value pairs in the connection database URL or from a connection property list. The driver does not consult the user's environment for any environment variables.

To specify Informix environment variables in the name-value pairs of the connection database URL, see [Format of database URLs](#) on page 2-5.

To specify Informix environment variables via a property list, use the java.util.Properties class to build the list of properties. The list of properties might include Informix environment variables, such as INFORMIXSERVER, as well as user and password.

After you have built the property list, pass it to the DriverManager.getConnection() method as a second parameter. You still need to include a database URL as the first parameter, although in this case you do not need to include the list of properties in the URL.

The following code from the optofc.java example shows how to use the java.util.Properties class to set connection properties. It first uses the Properties.put() method to set the environment variable OPTOFC to 1 in the connection property list; then it connects to the database.
The DriverManager.getConnection() method in this example takes two parameters: the database URL and the property list. The example creates a connection similar to the example given in "The DriverManager.getConnection() method" on page 2-4.

The following database URL is passed in as a parameter to the example program when the program is run at the command line:

```
jdbc:informix-sqli://myhost:1533:informixserver=myserver;
    user=rdtest;password=test
```

The code is:
```
try
{
    Class.forName("com.informix.jdbc.IfxDriver");
}
catch (Exception e)
{
    System.out.println("ERROR: failed to load Informix JDBC driver.");
}
try
{
    Properties pr = new Properties();
    pr.put("OPTOFC","1");
    conn = DriverManager.getConnection(newURL, pr);
}
catch (SQLException e)
{
    System.out.println("ERROR: failed to connect!");
}
```

Informix environment variables with the IBM Informix JDBC Driver

The following table lists most of the IBM Informix environment variables supported by the client JDBC driver. For server-side JDBC, use property settings in the database URL rather than setting environment variables, because the environment variables would apply to all programs running in the database server. For more information about properties, see "Specify properties" on page 2-9.

For a list of environment variables that provide globalization features, see Chapter 6, "Globalization and date formats," on page 6-1. For a list of environment variables useful for troubleshooting, see Chapter 7, "Tuning and troubleshooting," on page 7-1.

<table>
<thead>
<tr>
<th>Supported Informix environment variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPENDISAM</td>
<td>When set to TRUE, the APPENDISAM environment variable appends the ISAM Error code and message (if present) to the SQL Exception message, which is shown when .toString() or .getMessage() of an SQL Exception is called. The exception message is shown in the following format: &lt;INFORMIX ERROR MESSAGE&gt; (&lt;INFORMIX CODE&gt;) ISAM error: &lt;ISAM MESSAGE&gt;(&lt;ISAM CODE&gt;)</td>
</tr>
<tr>
<td>CSM</td>
<td>To specify that Communication Support Module is to be used. IBM Informix JDBC Driver 3.0 and later supports an encryption CSM. For more information, see &quot;Encryption options&quot; on page 2-26.</td>
</tr>
<tr>
<td>DBANSIWARN</td>
<td>When set to 1, checks for Informix extensions to ANSI-standard syntax</td>
</tr>
<tr>
<td>DBSPACETEMP</td>
<td>Specifies the dbspaces in which temporary tables are built</td>
</tr>
<tr>
<td>Supported Informix environment variables</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>DBTEMP</strong></td>
<td>Specifies the full path name of the directory into which you want IBM Informix Enterprise Gateway products to place their temporary files and temporary tables. The driver does not use this variable; it just passes the value to the server.</td>
</tr>
<tr>
<td><strong>DBUPSPACE</strong></td>
<td>Specifies the amount of disk space and memory that the UPDATE STATISTICS statement can use for sorting rows when it constructs multiple-column distributions, whether to sort with indexes, and whether to save the plan for calculating the column distributions in the sqexplain.out file.</td>
</tr>
<tr>
<td><strong>DELIMIDENT</strong></td>
<td>When set to Y, specifies that strings set off by double quotation marks are delimited identifiers</td>
</tr>
<tr>
<td><strong>ENABLE_CACHE_TYPE</strong></td>
<td>When set to 1, caches the data type information for opaque, distinct, or row data. When a Struct or SQLData object inserts data into a column and getSQLTypeName() returns the type name, the driver uses the cached information instead of querying the database server.</td>
</tr>
<tr>
<td><strong>ENABLE_HDRSWITCH</strong></td>
<td>When set to true, secondary server properties are used to connect to the secondary server in an HDR pair, if the primary server is unavailable.</td>
</tr>
<tr>
<td><strong>FET_BUF_SIZE</strong></td>
<td>Overrides the default setting for the size of the fetch buffer for all data except large objects. The default size is 4096 bytes. This variable is not supported in server-side JDBC.</td>
</tr>
<tr>
<td><strong>IFX_AUTOFREE</strong></td>
<td>When set to 1, specifies that the Statement.close() method does not require a network round trip to free the database server cursor resources if the cursor has already been closed in the database server. The database server automatically frees the cursor resources after the cursor is closed, either explicitly by the ResultSet.close() method or implicitly through the OPTOFC environment variable. After the cursor resources have been freed, the cursor can no longer be referenced. For more information, see &quot;The Auto Free feature&quot; on page 3-24.</td>
</tr>
<tr>
<td><strong>IFX_BATCHUPDATE_PER_SPEC</strong></td>
<td>When set to 1 (the default), returns the number of rows affected by the SQL statements executed in a batch operation by the executeBatch() method.</td>
</tr>
<tr>
<td><strong>IFX_CODESETLOB</strong></td>
<td>If set to a number greater than or equal to 0, automates code-set conversion for TEXT and CLOB data types between client and database locales. The value of this variable determines whether code-set conversion is done in memory in or in temporary files. If set to 0, code-set conversion uses temporary files. If set to a value greater than 0, code-set conversion occurs in the memory of the client computer, and the value represents the number of bytes of memory allocated for the conversion. For more information, see &quot;Convert with the IFX_CODESETLOB environment variable&quot; on page 6-11.</td>
</tr>
<tr>
<td><strong>IFX_DIRECTIVES</strong></td>
<td>Determines whether the optimizer allows query optimization directives from within a query. This variable is set on the client. The driver does not use this variable; it just passes the value to the server.</td>
</tr>
<tr>
<td>Supported Informix environment variables</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>IFX_EXTDIRECTIVES</td>
<td>Specifies whether the query optimizer allows external query optimization directives from the <code>sysdirectives</code> system catalog table to be applied to queries in existing applications. The default is OFF. Possible values:</td>
</tr>
<tr>
<td>ON</td>
<td>External optimizer directives accepted</td>
</tr>
<tr>
<td>OFF</td>
<td>External optimizer directives not accepted</td>
</tr>
<tr>
<td>1</td>
<td>External optimizer directives accepted</td>
</tr>
<tr>
<td>0</td>
<td>External optimizer directives not accepted</td>
</tr>
</tbody>
</table>

| IFX_GET_SMFLOAT_AS_FLOAT                   | When set to 0 (the default), maps the Informix SMALLFLOAT data type to the JDBC REAL data type. This setting conforms to the JDBC specification. When set to 1, maps the Informix SMALLFLOAT data type to the JDBC FLOAT data type. This setting enables compatibility with earlier versions of IBM Informix JDBC Driver. |

| IFX_ISOLATION_LEVEL                        | Defines the degree of concurrency among processes that attempt to access the same rows simultaneously. Gets the value of the `IFX_ISOLATION_LEVEL` variable, which is specific to Informix. The default value is 2 (Committed Read). If the value has been set explicitly, it returns the set value. Returns: integer. |
| Sets the value of the `IFX_ISOLATION_LEVEL` variable, which is specific to Informix. Possible values: |
| 0                                         | Equivalent to `TRANSACTION_NONE` |
| 1                                         | Dirty Read (equivalent to `TRANSACTION_READ_UNCOMMITTED`), |
| 2                                         | Committed Read (equivalent to `TRANSACTION_READ_COMMITTED`), |
| 3                                         | Cursor Stability (equivalent to `TRANSACTION_READ_COMMITTED`), |
| 4                                         | Repeatable Read (equivalent to `TRANSACTION_REPEATABLE_READ`) |
| 5                                         | Committed Read LAST COMMITTED (equivalent to `TRANSACTION_LAST_COMMITTED`) |
| 8                                         | Equivalent to `TRANSACTION_SERIALIZABLE` |

Specifying U after the mode means retain update locks. (See the Important note following table.) For example, a value could be: 2U (equivalent to `SET ISOLATION TO COMMITTED READ RETAIN UPDATE LOCKS`)

The following example shows the code that you would use to specify an isolation level:
```
conn.setTransactionIsolation(IfxConnection.TRANSACTION_LAST_COMMITTED);
```

<p>| IFX_FLAT_UCSQ                              | Overrides the global setting and directs the optimizer to use subquery flattening for all sessions. Default value is 1. |</p>
<table>
<thead>
<tr>
<th>Supported Informix environment variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IFX_LOCK_MODE_WAIT</strong></td>
<td>Application can use this property to override the default server process for accessing a locked row or table. Gets the value of the IFX_LOCK_MODE_WAIT variable, which is specific to Informix. The default value is 0 (do not wait for the lock). If the value has been set explicitly, it returns the set value. Returns: integer.</td>
</tr>
<tr>
<td>Sets the value of the IFX_LOCK_MODE_WAIT variable, which is specific to Informix. Possible values:</td>
<td></td>
</tr>
<tr>
<td>-1</td>
<td>WAIT until the lock is released.</td>
</tr>
<tr>
<td>0</td>
<td>DO NOT WAIT, end the operation, and return with error.</td>
</tr>
<tr>
<td><strong>IFX_PAD_VARCHAR</strong></td>
<td>Controls how data associated with a VARCHAR data type is transmitted to and from an Informix 9.4 or later server. Can be set either on the connection URL when using the Connection class or as a property when using the DataSource class. Valid values are 0 (the default) and 1.</td>
</tr>
<tr>
<td>• When set to 0, only the portion of the VARCHAR that contains data is transmitted (trailing spaces are stripped).</td>
<td></td>
</tr>
<tr>
<td>• When set to 1, the entire VARCHAR data structure is transmitted to and from the server.</td>
<td></td>
</tr>
<tr>
<td><strong>IFX_SET_FLOAT_AS_SMFLOAT</strong></td>
<td>When set to 0 (the default), maps the JDBC FLOAT data type to the Informix FLOAT data type. This setting conforms to the JDBC specification. When set to 1, maps the JDBC FLOAT data type to the Informix SMALLFLOAT data type. This setting enables compatibility with earlier versions of IBM Informix JDBC Driver.</td>
</tr>
<tr>
<td><strong>IFX_TRIMTRAILINGSPACES</strong></td>
<td>Removes trailing spaces. Default value is 1.</td>
</tr>
<tr>
<td><strong>IFX_USEPUT</strong></td>
<td>When set to 1, enables bulk inserts. For more information, see “Perform bulk inserts” on page 3-5.</td>
</tr>
<tr>
<td><strong>IFX_XASPEC</strong></td>
<td>When set to Y, XA transactions with the same global transaction ID are tightly coupled and share the lock space. This only applies to XA connections and cannot be specified in a database URL. It can be specified by DataSource setter (See Appendix B, “DataSource extensions,” on page B-1) or by setting a System (JVM) property with the same name. The DataSource property overrides the System property. Values for the properties other than y, Y, n, or N are ignored. IfxDataSource.getIfxIFX_XASPEC returns the final IFX_SPEC value, which is either y or n. For example if the value of DataSource <strong>IFX_XASPEC</strong> equals n and the value of the System <strong>IFX_XASPEC</strong> equals Y or y, n is returned.</td>
</tr>
<tr>
<td><strong>IFX_XASTCOMPLIANCE_XAEND</strong></td>
<td>Specifies the behavior of XA_END when XA_RB* is returned.</td>
</tr>
<tr>
<td>0</td>
<td>XID is not forgotten. Transaction is in Rollback Only state. This is XA_SPEC+ compliant and is the default behavior with Informix.</td>
</tr>
<tr>
<td>1</td>
<td>XID is forgotten. Transaction is Nonexistent. This is default behavior with IBM Informix 9.40.</td>
</tr>
<tr>
<td>For more information, see IBM Informix Guide to SQL: Reference DISABLE_B162428_XA_FIX (IDS 10.0) ENABLE_B162428_XA_FIX (IDS 9.40)</td>
<td></td>
</tr>
<tr>
<td><strong>IFXHOST</strong></td>
<td>Sets the host name or host IP address</td>
</tr>
<tr>
<td>Supported Informix environment variables</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>IFXHOST_SECONDARY</td>
<td>Sets the secondary host name or host IP address for HDR connection redirection</td>
</tr>
<tr>
<td>INFORMIXCONRETRY</td>
<td>Specifies the maximum number of additional connection attempts that can be made to each database server by the client during the time limit specified by the value of INFORMIXCONTIME</td>
</tr>
<tr>
<td>INFORMIXCONTIME</td>
<td>Sets the timeout period for an attempt to connect to the database server. If a connection attempt does not succeed in this time, the attempt is aborted and a connection error is reported. The default value is 0 seconds. This variable adds timeouts for blocking socket methods and for socket connections.</td>
</tr>
<tr>
<td>INFORMIXOPCACHE</td>
<td>Specifies the size of the memory cache for the staging-area blobspace of the client application</td>
</tr>
<tr>
<td>INFORMIXSERVER</td>
<td>Specifies the default database server to which an explicit or implicit connection is made by a client application</td>
</tr>
<tr>
<td>INFORMIXSERVER_SECONDARY</td>
<td>Specifies the secondary database server in an HDR pair to which an explicit or implicit connection is made by a client application if the primary database server is unavailable</td>
</tr>
<tr>
<td>INFORMIXSTACKSIZE</td>
<td>Specifies the stack size, in kilobytes, that the database server uses for a particular client session</td>
</tr>
<tr>
<td>JDBC_TEMP</td>
<td>Specifies where temporary files for handling smart large objects are created. You must supply an absolute path name.</td>
</tr>
<tr>
<td>LOBCACHE</td>
<td>Determines the buffer size for large object data that is fetched from the database server Possible values are:</td>
</tr>
<tr>
<td><strong>A number greater than 0</strong></td>
<td>The maximum number of bytes is allocated in memory to hold the data. If the data size exceeds the LOBCACHE value, the data is stored in a temporary file; if a security violation occurs during creation of this file, the data is stored in memory.</td>
</tr>
<tr>
<td><strong>Zero</strong></td>
<td>The data is always stored in a file. If a security violation occurs, the driver makes no attempt to store the data in memory.</td>
</tr>
<tr>
<td><strong>A negative number</strong></td>
<td>The data is always stored in memory. If the required amount of memory is not available, an error occurs.</td>
</tr>
<tr>
<td>Logintimeout</td>
<td>Determines whether the Informix database server is running. If the server is running a connection to the server is established immediately. If the server is not running, this environment variable specifies how long, in milliseconds, that the server port is polled to establish a connection. If your application does not connect to the Informix database server within the specified time, an error is returned.</td>
</tr>
<tr>
<td>NEWNLMSAP</td>
<td>Allows new mappings between NLS and JDK locales and JDK codesets to be defined</td>
</tr>
<tr>
<td>Nodefdac</td>
<td>When set to YES, prevents default table and routine privileges from being granted to the PUBLIC user when a new table or routine is created in a database that is not ANSI compliant. Default is NO.</td>
</tr>
<tr>
<td>OPT_GOAL</td>
<td>Specifies the query performance goal for the optimizer. Set this variable in the user environment before you start an application. The driver does not use this variable; it just passes the value to the server.</td>
</tr>
<tr>
<td>Supported Informix environment variables</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td><strong>OPTCOMPIND</strong></td>
<td>Specifies the join method that the query optimizer uses.</td>
</tr>
<tr>
<td><strong>OPTOFC</strong></td>
<td>When set to 1, the ResultSet.close() method does not require a network round trip if all the qualifying rows have already been retrieved in the clients tuple buffer. The database server automatically closes the cursor after all the rows have been retrieved. IBM Informix JDBC Driver might not have additional rows in the clients tuple buffer before the next ResultSet.next() method is called. Therefore, unless IBM Informix JDBC Driver has received all the rows from the database server, the ResultSet.close() method might still require a network round trip when OPTOFC is set to 1.</td>
</tr>
<tr>
<td><strong>PATH</strong></td>
<td>Specifies the directories that are to be searched for executable programs.</td>
</tr>
<tr>
<td><strong>PDQPRORITY</strong></td>
<td>Determines the degree of parallelism used by the database server.</td>
</tr>
<tr>
<td><strong>PLCONFIG</strong></td>
<td>Specifies the name of the configuration file used by the high-performance loader.</td>
</tr>
<tr>
<td><strong>PLOAD_LO_PATH</strong></td>
<td>Specifies the path name for smart-large-object handles (which identify the location of smart large objects such as BLOB, CLOB, and BOOLEAN data types). The driver does not use this variable; it just passes the value to the server.</td>
</tr>
<tr>
<td><strong>PORTNO_SECONDARY</strong></td>
<td>Specifies the port number of the secondary database server in an HDR pair. The port number is listed in the /etc/services file.</td>
</tr>
<tr>
<td><strong>PROXY</strong></td>
<td>Specifies an HTTP proxy server. For more information, see “An HTTP proxy server” on page 2-22.</td>
</tr>
<tr>
<td><strong>PSORT_DBTEMP</strong></td>
<td>Specifies one or more directories to which the database server writes the temporary files it uses when performing a sort.</td>
</tr>
<tr>
<td><strong>PSORT_NPROCS</strong></td>
<td>Enables the database server to improve the performance of the parallel-process sorting package by allocating more threads for sorting.</td>
</tr>
<tr>
<td><strong>SECURITY</strong></td>
<td>Uses 56-bit encryption to send the password to the server. For more information, see “Password encryption” on page 2-28.</td>
</tr>
<tr>
<td><strong>SQLH_TYPE</strong></td>
<td>When set to FILE, specifies that database information (such as host-name, port-number, user, and password) is specified in an sqlhosts file. When set to LDAP, specifies that this information is specified in an LDAP server. For more information, see “Dynamically reading the Informix sqlhosts file” on page 2-16.</td>
</tr>
<tr>
<td><strong>SQLDEBUG</strong></td>
<td>Specifies the path name for the file to which a binary SQLI trace is to be written. A new trace file is generated for every connection and is suffixed with timestamp. Only use the SQLI trace facility when directed by an IBM technical support representative.</td>
</tr>
<tr>
<td><strong>SRV_FET_BUF_SIZE</strong></td>
<td>Overrides the default setting for the size of the fetch buffer on another server. The fetch buffer holds data that is retrieved by a query.</td>
</tr>
<tr>
<td><strong>STMT_CACHE</strong></td>
<td>When set to 1, enables the use of the shared-statement cache in a session. This feature can reduce memory consumption and speed query processing among different user sessions. The driver does not use this variable; it just passes the value to the server.</td>
</tr>
<tr>
<td><strong>TRUSTED_CONTEXT</strong></td>
<td>When set to TRUE, a trusted connection request is sent from client. Either a successful trusted connection is established or the following error is returned from the server: SQL Exception : -28021(Trusted Connection request rejected.)</td>
</tr>
</tbody>
</table>
**Supported Informix environment variables**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>USEV5SERVER</td>
<td>When set to 1, specifies that the Java program is connecting to an IBM Informix OnLine 5.x or IBM Informix SE 5.x or IBM Informix SE 7.x database server. This environment variable is mandatory if you are connecting to an IBM Informix OnLine 5.x or IBM Informix SE 5.x or IBM Informix SE 7.x database server.</td>
</tr>
</tbody>
</table>

**Important:** RETAIN UPDATE LOCKS is not supported in IBM Informix, Version 5.x. The U option is ignored when connecting to a 5.x server.

For a detailed description of a particular environment variable, see *IBM Informix Guide to SQL: Reference*.

**Code example IFX_LOCK_MODE_WAIT environment variable**

```
IFX_LOCK_MODE_WAIT
Connection conn = DriverManager.getConnection( "jdbc:Informix-sqli://cleo:1550:
INFORMIXSERVER=cleo_921;IFXHOST=cleo;PORTNO=1550;user=rdtest; password=my_passwd;
IFX_LOCK_MODE_WAIT=1";);
```

**Code example IFX_ISOLATION_LEVEL environment variable**

```
IFX_ISOLATION_LEVEL
Connection conn = DriverManager.getConnection( "jdbc:Informix-sqli://cleo:1550:
INFORMIXSERVER=cleo_921;IFXHOST=cleo;PORTNO=1550;user=rdtest; password=my_passwd;
IFX_ISOLATION_LEVEL=1U";);
```

**Important:** The isolation property can be set in the URL only when it is an explicit connection to a database. For server-only connection, this property is ignored at connection time.

**Code example IFX_ISOLATION_LEVEL environment variable**

```
Connection conn = DriverManager.getConnection( "jdbc:informix-sqli://localhost:9088
/csdk_db:INFORMIXSERVER=ol_ids_1150_1;user=informix;password=inform123;
LOGIN_TIMEOUT=60000";);
```

**Dynamically reading the Informix sqlhosts file**

IBM Informix JDBC Driver supports the JNDI (Java naming and directory interface). This support enables JDBC programs to access the Informix sqlhosts file. The sqlhosts file lets a client application find and connect to an Informix database server anywhere on the network. For more information about this file, see the *IBM Informix Administrator’s Guide* for your database server.

You can access sqlhosts data from a local file or from an LDAP server. The system administrator must load the sqlhosts data into the LDAP server using an Informix utility.

Your **CLASSPATH** variable must reference the JNDI JAR (Java archive) files and the LDAP SPI (service provider interface) JAR files. You must use LDAP Version 3.0 or later, which supports the object class **extensibleObject**.
You can use the sqlhosts file group option to specify the name of a database server group for the value of INFORMIXSERVER. The group option is useful with High-Availability Data Replication (HDR); list the primary and secondary database servers in the HDR pair sequentially. For more information on about how to set or use groups in sqlhosts file, see the IBM Informix Administrator’s Guide. For more information about HDR, see “High-Availability Data Replication” on page 2-19.

An unsigned applet cannot access the sqlhosts file or an LDAP server. For more information, see “Using the driver in an applet” on page 1-9.

**Connection property syntax**

You can let IBM Informix JDBC Driver look up the host name or port number in an LDAP server instead of specifying them in a database URL or DataSource object directly. You must specify the following properties in the database URL or DataSource object for the LDAP server:

- **SQLH_TYPE=LDAP**
- **LDAP_URL=ldap://host-name:port-number**
  
  `host-name` and `port-number` are those of the LDAP server, not the database server.
- **LDAP_IFXBASE=Informix-base-DN**
- **LDAP_USER=user**
- **LDAP_PASSWD=password**

If `LDAP_USER` and `LDAP_PASSWD` are not specified, IBM Informix JDBC Driver uses an anonymous search to search the LDAP server. The LDAP administrator must make sure that an anonymous search is allowed on the sqlhosts entry. For more information, see your LDAP server documentation.

`Informix-base-DN` has the following basic format:

```
   cn=common-name,o=organization,c=country
```

If `common-name`, `organization`, or `country` consists of more than one word, you can use one entry for each word. For example:

```
   cn=informix,cn=software
```

Here is an example database URL:

```sql
jdbc:informix-sqli:informixserver=value;SQLH_TYPE=LDAP;
   LDAP_URL=ldap://davinci:329;LDAP_IFXBASE=cn=informix,
       cn=software,o=kmart,c=US;LDAP_USER=abcd;LDAP_PASSWD=secret
```

You can also specify the sqlhosts file in the database URL or DataSource object. The host name and port number or the service name of the Informix database server as specified in the /etc/services file are read from the sqlhosts file. You must specify the following properties for the file:

- **SQLH_TYPE=FILE**
- **SQLH_FILE=sqlhosts-filename**

The sqlhosts file can be local or remote, so you can refer to it in the local file system format or URL format. Here are some examples:

- **SQLH_FILE=http://host-name:port-number/sqlhosts.ius**
- **SQLH_FILE=http://host-name:service-name/sqlhosts.ius**
The host-name and port-number or service-name of the Informix database server (from the etc/services file) elements are those of the server on which the sqlhosts file resides.

- SQLH_FILE=file://D:/local/myown/sqlhosts.ius
- SQLH_FILE=/u/local/sqlhosts.ius

Here is an example database URL:

```java
jdbc:informix-sqli:informixserver=value;SQLH_TYPE=FILE;
   SQLH_FILE=/u/local/sqlhosts.ius
```

If the database URL or DataSource object references the LDAP server or sqlhosts file but also directly specifies the IP address, host name, and port number, then the IP address, host name, and port number specified in the database URL or DataSource object take precedence. For information about how to set these connection properties by using a DataSource object, see Appendix B, “DataSource extensions,” on page B-1.

If you are using an applet or the database is behind a firewall, an HTTP proxy servlet, running in an extra tier, is required for communication. See “An HTTP proxy server” on page 2-22 for more information.

### Administration requirements

If you want the LDAP server to store sqlhosts information that a JDBC program can look up, the following requirements must be met:

- The LDAP server must be installed on a computer that is accessible to the client. The LDAP administrator must create an IFXBASE entry in the LDAP server. For more information about LDAP directory servers, see:
  - www.oracle.com
  - www.openldap.org
- If you want to use the IBM Informix SqlhUpload and SqlhDelete utilities, which can load or delete the sqlhosts entries from a flat ASCII file, the servicename field in the sqlhosts file must specify the database servers port number. For more information, see “Utilities to update the LDAP server with sqlhosts data,” next.
- The LDAP administrator must make sure that anonymous search is allowed on the sqlhosts entry. For more information, see the LDAP server documentation.

### Utilities to update the LDAP server with sqlhosts data

The SqlhUpload and SqlhDelete utilities are packaged in ifxtools.jar, so the CLASSPATH variable must point to ifxtools.jar (which, by default, is in the lib directory under the installation directory for IBM Informix JDBC Driver). Make sure that the CLASSPATH variable also points to the JNDI JAR files and LDAP SPI JAR files.

**The SqlhUpload utility**

This utility loads the sqlhosts entries from a flat ASCII file to the LDAP server in the prescribed format.

Enter the following command:

```
java SqlhUpload sqlhfile.txt host-name:port-number [sqlhostsRdn]
```
The parameters have the following meanings:

- The sqlhosts file to be uploaded is sqlhfile.txt.
- The host name and port number of the LDAP server is host-name:port-number.
- The RDN (relative distinguished name) of the sqlhosts node under the IBM Informix base in LDAP is sqlhostsRdn. The default name is sqlhosts.

The utility prompts for other required information, such as the Informix base distinguished name (DN) in the LDAP server, the LDAP user, and the password.

You must convert the servicename field in the sqlhosts file to a string that represents an integer (the port number), because the Java.Socket class cannot accept an alphanumeric servicename value for the port number. For more information about the servicename field, see the IBM Informix Administrator’s Guide for your database server.

**The SqlhDelete utility**

This utility deletes the sqlhosts entries from the LDAP server. Enter the following command:

`java SqlhDelete host-name:port-number [sqlhostsRdn]`

The parameters of this command have the same meanings as the parameters listed for the SqlhUpload utility. See “The SqlhUpload utility” on page 2-18.

The utility prompts for other required information, such as the IBM Informix base DN in the LDAP server, the LDAP user, and the password.

---

**High-Availability Data Replication**

High-Availability Data Replication (HDR) provides synchronous data replication for IBM Informix by maintaining a backup copy of the entire database server that applications can access quickly in the event of a catastrophic failure. If one of the database servers in the replication pair fails, clients can be redirected to connect to the alternate database server. For more information about HDR, see the *IBM Informix Administrator’s Guide* for your database server.

HDR server pairs are composed of a primary and a secondary server. The primary server is the default server. The secondary server is read-only; update operations are not allowed.

To write application code to support HDR, follow these guidelines, which are explained in the following sections:

- Set the secondary server connection properties and enable HDR.
- Check if the server is read-only (a secondary server) and take appropriate action.
- If a connection fails, retry the connection to the alternate server and rerun the query.

You can use HDR with connection pooling. For more information, see “High-Availability Data Replication with connection pooling” on page 7-6.

Demonstration programs are available in the hdr directory within the demo directory where IBM Informix JDBC Driver is installed. For details about the files, see Appendix A, “Sample code files,” on page A-1.
Secondary server connection properties

Specify the secondary server and enable HDR by using the following connection properties in the connection URL:

- `INFORMIXSERVER_SECONDARY = secondary_server;`
- `PORTNO_SECONDARY = secondary_portnumber;`
- `IFXHOST_SECONDARY = secondary_hostmachine;`
- `ENABLE_HDRSWITCH = true;`

The following example shows a connection URL for an HDR server pair named `hdr1` and `hdr2`:

```
jdbc:informix-sqli://123.45.67.89:1533/testDB:
    INFORMIXSERVER=hdr1;IFXHOST=host1;PORTNO=1500;
        user=rdtest;password=test;INFORMIXSERVER_SECONDARY=hdr2;
            IFXHOST_SECONDARY=host2;PORTNO_SECONDARY=1600;
                ENABLE_HDRSWITCH=true;
```

When using a `DataSource` object, you can set and get the secondary server connection properties with `setXXX()` and `getXXX()` methods. These methods are listed with their corresponding connection property in "Get and set Informix connection properties" on page B-2.

You can manually redirect a connection to the secondary server in an HDR pair by editing the `INFORMIXSERVER`, `PORTNO`, and `IFXHOST` properties in the connection URL. Manual redirection requires editing the application code and then restarting the application.

Connect to group entries in an HDR pair

If a JDBC application uses group entries from the `sqlhosts` file to connect to server, and if group entries are part of an HDR pair, then the JDBC driver connects to the primary server. Consider an `sqlhosts` file that defines a group, as shown:

```
g_1000 group - - i=100
    ids1000_secondary ontlitcp amazon sec_1000 g=g_1000
    ids1000_primary ontlitcp amazon prim_1000 g=g_1000
```

If the JDBC application uses a connection URL that uses this `sqlhosts` file and its group name to make a connection, the JDBC driver always connects to the primary server. The following is an example of such a URL:

```
"jdbc:informix-sqli:informixserver=g_1000;
    user=foo;password=XXXX;SQLH_TYPE=FILE;
    SQLH_FILE=/informix/sqlhosts"
```

An exception is thrown if the JDBC driver cannot find a primary server in the group.

Enforcing connections to the primary server is enabled for IBM Informix, Version 9.40.XC6 and later only.

Check for read-only status

Update operations fail if the connection is to a secondary server, because secondary servers are read-only. Therefore, write applications to check for read-only connections before starting update operations.
Use the methods in the following table to check the server type and whether HDR is enabled.

<table>
<thead>
<tr>
<th>Information obtained</th>
<th>Method signature</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether the server is read-only (a secondary server)</td>
<td>public boolean isReadOnly() throws SQLException</td>
<td>Returns true if the active server is a secondary server. Returns an exception if a database access error occurs. If ENABLE_HDRSWITCH is set to false, isReadOnly() returns the value initially set after the last successful HDR connection was obtained.</td>
</tr>
<tr>
<td>Whether HDR is enabled</td>
<td>public boolean isHDREnabled()</td>
<td>Returns true if both servers in the HDR pair are available. Returns false if one of the servers is unavailable.</td>
</tr>
<tr>
<td>The type of the server (primary, secondary, or standard)</td>
<td>public string getHDRtype()</td>
<td>Returns primary or standard for a primary server, secondary for a secondary server. The database administrator can manually reset the type of the server.</td>
</tr>
</tbody>
</table>

For example, you can use one of the following strategies:

- Use the isReadOnly() method before each SQL statement that might contain an update operation. If the value of isReadOnly() is true, perform an appropriate action, such as sending an error message to the user or notifying the server administrator.
- You call the isReadOnly() method after establishing a connection and then set a flag, like READ_ONLY, and perform operations based on the flag value.

An administrator can manually switch a secondary server to a primary server to allow update operations. However, the server must be shut down in the process, resulting in connections and uncommitted transactions being lost.

**Retry connections**

Write applications so that if a connection is lost during query operations, IBM Informix JDBC Driver returns a new connection to the secondary database server and the application reruns the queries.

The following code shows how to retry a connection with the secondary server information, and then rerun an SQL statement that received an error because the primary server connection failed:

```java
public class HDRConnect {
    static IfmxConnection conn;

    public static void main(String[] args) {
        getConnection(args[0]);
        doQuery( conn );
        closeConnection();
    }
}
```
static void getConnection( String url )
{
    ..
    Class.forName("com.informix.jdbc.IfxDriver");
    conn = (IfmxConnection )DriverManager.getConnection(url);
}

static void closeConnection()
{
    try
    {
        conn.close();
    }
    catch (SQLException e)
    {
        System.out.println("ERROR: failed to close the connection!");
        return;
    }
}

static void doQuery( Connection con )
{
    int rc=0;
    String cmd=null;
    Statement stmt = null;

    try
    {
        // execute some sql statement
    }
    catch (SQLException e)
    {
        if (e.getErrorCode() == -79716 ) || (e.getErrorCode() == -79735)
        // system or internal error
        {
            // This is expected behavior when primary server is down
            getConnection(url);
            doQuery(conn);
        }
        else
        System.out.println("ERROR: execution failed - statement: " + cmd);
        return;
    }
}

An HTTP proxy server

Network security imposes certain restrictions on what client applications are allowed to do:

- Applets can only communicate back to the host from which they were downloaded.
- Direct IP connections between a JDBC client and database are not allowed when a firewall is between the client and the database server.

The IBM Informix HTTP proxy handles both of these problems. The proxy is a servlet that runs in the middle tier between a JDBC client and an Informix database server. The proxy extracts SQL requests from the JDBC client and transmits them to the database server. The client (the end user) is unaware of this middle tier.

The HTTP proxy feature is not part of the JDBC 2.0 specification.
The following figure illustrates how the proxy enables a connection to a database that is behind a firewall.

1. The driver sends the target IP address and port number to the proxy
2. The proxy uses the IP address and port to open a connection to the database.

*Figure 2-1. Connecting through a firewall*

**Configuring your environment to use a proxy server**

The HTTP proxy requires a web server that supports servlets, preferably a web server whose servlet engine uses a 2.1 or greater servlet API. The proxy is compatible with 2.0 and earlier servlet APIs, but the PROXYTIMEOUT feature is only enabled with a 2.1 or greater API.

To configure your environment for a proxy server:
1. Define a servlet alias or context for the proxy servlet in your web server configuration. The JDBC driver directs all client HTTP requests to: `http://your-web-server:port.pathname/IfxJDBCProxy`
   - where `IfxJDBCProxy` is the proxy servlet and `pathname` is the path to the proxy servlet. Consult your web server documentation for the correct way to configure servlets.
2. Copy three class files—`IfxJDBCProxy.class`, `SessionMgr.class`, and `TimeoutMgr.class`—to the servlet directory you specified in the previous step. These class files reside in the directory `proxy`, which is under the installation directory for IBM Informix JDBC Driver after the product bundle is installed.
3. Add the IBM Informix JDBC Driver file, `ifxjdbc.jar`, to the CLASSPATH setting on your web server. Some web servers use the CLASSPATH of the environment under which the server is started, while others get their CLASSPATH from a web server-specific properties file. Consult your web server documentation for the correct place to update the CLASSPATH setting.
4. Start your web server and verify that the proxy is installed correctly by entering the following URL:
   - `http://server-host-name:port-number/servlet/IfxJDBCProxy`
   - The proxy replies with the following banner:
v220 represents the Informix proxy version. Servlet API 2.1 represents the version of your web servers servlet API.

If the servlet API is 2.0 or earlier, the banner says Servlet API 0.0.

5. After configuring the proxy, append the following to your applet or applications URL:
   PROXY=server-host-name:port-number
   For example:
   jdbc:informix-sqli://123.45.67.89:1533:INFORMIXSERVER=myserver;user=rtest;password=test;
   PROXY=webserver:1462;

Depending on your web server, the proxy servlet might be loaded when the web server is started or the first time it is referenced in the URL of your applet or application connection object.

The following websites offer more information about proxy servlets:
- www.oracle.com
- java.apache.org

**Specify a timeout**

You can specify a timeout value for the proxy by using the PROXYTIMEOUT keyword. The PROXYTIMEOUT value specifies how often the client-side JDBC driver sends a keepalive request to the proxy. A PROXYTIMEOUT value is represented in seconds; the value can be 60 or greater.

When PROXYTIMEOUT is specified by the client, the proxy sets the clients session expiration equal to 2 x PROXYTIMEOUT. For example, if PROXYTIMEOUT is set to 60 seconds, the proxy sets the clients expiration time to 120 seconds. When the expiration time is reached, the proxy removes the clients session resources and closes its database connection.

The proxy resets the timeout interval each time a communication is received from the client. Here are some valid values for PROXYTIMEOUT:

**PROXYTIMEOUT=-1**
Disables the client timeout feature.

**PROXYTIMEOUT=nnn**
Client sends a keepalive request to proxy every nnn seconds. The nnn value must be 60 or greater.

**PROXYTIMEOUT=60**
Default value if PROXYTIMEOUT is not specified

The proxy timeout feature is helpful in determining if a client session has terminated without first sending the proxy a close request by closing the JDBC connection. The proxy maintains an open database connection on behalf of the client until the client either:
- Explicitly closes the database connection
- Exceeds its timeout interval

The onstat database utility shows an open session for any client sessions that have unexpectedly terminated and have set PROXYTIMEOUT to -1.
Here is an example that specifies PROXYTIMEOUT:

```java
jdbc:informix-sqli://123.45.67.89:1533:informixserver=myserver;
user=rdtest;password=test;
PROXY=webserver:1462;PROXYTIMEOUT=180;
```

See the demo/proxy directory under the directory where your driver is installed for an example applet and application that uses the proxy.

**The proxy with an LDAP server**

The proxy allows your JDBC applets and applications to alternatively get their database connection information from an LDAP server. If you plan to use this feature, you need to install an LDAP server. For general information about using an LDAP server with IBM Informix JDBC Driver, see the topics beginning with "Connection property syntax" on page 2-17.

The following figure illustrates how the proxy works with an LDAP server. The figure also shows lookup from an sqlhosts file; for more information, see "Specify sqlhosts file lookup" on page 2-26.

![Diagram of proxy with LDAP server](image)

1. The driver sends the LDAP or sqlhosts values to the proxy.
2. The proxy gets the IP address and port from either the LDAP server or the sqlhosts file.
3. The proxy uses the IP address and port to open a connection to the database.

**Figure 2-2. Lookup by the proxy**

The proxy LDAP feature requires the JNDI class libraries and LDAP service provider files (jndi.jar, ldap.jar, and providerutil.jar). These JAR files can be downloaded from www.oracle.com.

After downloading and installing the files, add their full path names to the CLASSPATH setting on your web server. The files are in the lib directory under the installation directory.

**Specify where LDAP lookup occurs**

When used with other LDAP keywords, the SQLH_LOC keyword indicates where an LDAP lookup occurs.
SQLH_LOC can have a value of either CLIENT or PROXY. If the value is CLIENT, the driver performs the LDAP lookup on the client side. If the value is PROXY, the proxy performs the lookup on the server side. If no value is specified, the driver uses CLIENT as the default value.

Here is the format for an applet or application URL with LDAP keywords that specifies a server-side LDAP lookup:

```
jdbc:informix-sqli:informixserver=informix-server-name;
PROXY=proxy-hostname-or-ip-address:proxy-port-no?
PROXYTIMEOUT=60;SQLH_TYPE=LDAP;LDAP_URL=ldap://
//ldap-hostname-or-ip-address:ldap-port-no;LDAP_IFXBASE=dc=mydomain,dc=com;
SQLH_LOC=PROXY;
```

This example obtains the database server host name and port from an LDAP server:
```
jdbc:informix-sqli:informixserver=samsara;SQLH_TYPE=LDAP;
LDAP_URL=ldap://davinci:329;LDAP_IFXBASE=cn=informix,
o=kmart,c=US;LDAP_USER=abcd;LDAP_PASSWD=secret;SQLH_LOC=PROXY;
PROXY=webserver:1462
```

For a complete example of using an LDAP server with the proxy, see the proxy applet and application in the demo directory where your JDBC driver is installed.

### Specify sqlhosts file lookup

The SQLH_LOC keyword also applies to sqlhosts file lookups when you are using the proxy. If the URL includes SQLH_LOC = PROXY, the driver reads the sqlhosts file on the server. If SQLH_LOC = PROXY is not specified, the driver reads the file on the client.

This example obtains the information from an sqlhosts file on the server:
```
jdbc:informix-sqli:informixserver=samsara;SQLH_TYPE=FILE;
SQLH_FILE=/work/9.x/etc/sqlhosts;SQLH_LOC=PROXY;
PROXY=webserver:1462
```

### Other multitier solutions

Other ways to use IBM Informix JDBC Driver in a multiple-tier environment are as follows:

**Remote Method Invocation (RMI)**

IBM Informix JDBC Driver resides on an application server that is a middle tier between the Java applet or application and Informix database machines. An example of RMI is included with IBM Informix JDBC Driver; see Appendix A, “Sample code files,” on page A-1, for details.

**Other communication protocols, such as CORBA**

IBM Informix JDBC Driver resides on an application server that is a middle tier between the Java applet or application and Informix database computers.

### Encryption options

You can use either password (SECURITY=PASSWORD) or network encryption to establish the security of your connection. To use either the password option or to use network encryption, you must have a Java Cryptography Extension (JCE)-compliant encryption services provider installed in your Java runtime.
environment. The JCE-compliant encryption services provider comes bundled with JRE 1.4 or later and with IBM JRE 1.4.2 or later.

It is recommended that you do not mix security packages on the same client. The following topics describe how to configure each package.

Encryption over the network and password encryption should not be used together. Thus, password encryption should not be enabled with the SECURITY environment variable when using JDBC encryption CSM. JDBC Encryption CSM does encrypt passwords before sending them over the network.

### The JCE security package

The JCE has been integrated into the J2 SDK, Version 1.4, but is available only in the US or Canada. If your site does not comply with this or other JCE licensing restrictions, you can try using IBM Informix JDBC Driver with other JCE-certified security package providers. However, be aware that not all packages have been tested and certified to work with Informix database servers configured to use the SPWDCSM CSM option or the encryption CSM. Alternatively you can use the IBM FIPS-compliant security package.

If you are using JDK 1.4 to install the JCE package, download the JCE distribution, extract the .jar file containing the JCE provider packages, and copy them to jre/lib/ext directory where the JDK is installed.

Edit the lib/security/java.security file from JDK installation to include the following two lines:

```
security.provider.1=sun.security.provider.Sun
security.provider.2=com.sun.crypto.provider.SunJCE
```

See the JRE documentation for more details about configuring the encryption services provider.

### The IBM FIPS-compliant security package

The IBM 1.4.2 SR1a JRE or later includes a Federal Information Processing Standards (FIPS) 140-2 compliant package for JCE called IBMJCEFIPS. The IBMJCEFIPS package is implemented as a JCE provider to support FIPS-approved cryptographic operations through JCE framework APIs. The IBMJCEFIPS package can be used with the simple password CSM or with the encryption CSM.

You can download the IBM 1.4.2 Java SDK from www.oracle.com.

To use the FIPS package, add the IBMJCEFIPS provider to the list of security providers in the JVM java.security file, which is in the jre/lib/ext directory where the JRE is installed.

You must specify the IBMJCEFIPS provider at a higher preference order than any non-FIPS security providers in the java.security file. The order is 1-based, meaning that 1 is the most preferred, followed by 2, and so on.

For example:

```
security.provider.1=com.ibm.crypto.fips.provider.IBMJCEFIPS
security.provider.2=com.ibm.crypto.fips.provider.IBMJCE
```

Make sure that the IBMJCEFIPS has a higher preference order than the IBMJCE provider.
No changes to applications are needed for the IBM Informix JDBC Driver to use the FIPS-compliant cryptographic package.

See the IBM JRE documentation for IBM Developer Kits and Runtime Environments at the website listed previously for more details about configuring the encryption services provider.

**Password encryption**

The `SECURITY` environment variable specifies the security operations that are performed when the Informix JDBC client and Informix database server exchange data. The only setting for the `SECURITY` environment variable supported in IBM Informix JDBC Driver is `PASSWORD`.

If `PASSWORD` is specified, the user-provided password is encrypted using 56-bit encryption when it is passed from the client to the database server. There is no default setting.

Here is an example:

```java
String URL = "jdbc:informix-sqli://158.58.10.171:1664:user=myname;
  password=mypassword;INFORMIXSERVER=myserver;SECURITY=PASSWORD";
```

`PASSWORD` is not case sensitive. You can type it in upper or lowercase letters.

**Configure the database server**

The `SECURITY=PASSWORD` setting is supported in the 7.31, 8.3 and later, and 9.x and later versions of the IBM Informix database server. The connection is rejected if used with any other versions of the server.

If the `SECURITY=PASSWORD` setting is specified in the Informix JDBC client, the `SPWDCSM csm` option must be enabled on the Informix database server. Otherwise, an error is returned during connection.

To use the `SPWDCSM csm` server option, which supports password encryption on the database server, you must configure the servers `sqlhosts server name` option. After this option is set on the server, only clients using the `SECURITY=PASSWORD` setting can connect to that server name.

To see if the `SPWDCSM csm` option is supported for your version of Informix database server, or for general details on how to configure the `CSM` options, see the IBM Informix Administrator's Guide for your database server.

**Configure connections to use the SSL protocol**

To configure database connections for the IBM Informix JDBC Driver to use the Secure Socket Layer (SSL) protocol, you need to set the `sslConnection` property to `TRUE`.

Before a connection to a data source can use SSL protocol, the port to which the application connects must be configured in the database server as the SSL listener port.

Set the `sslConnection` property on a Connection or DataSource instance. The following example demonstrates how to set the `sslConnection` property on a Connection instance:
java.util.Properties properties = new java.util.Properties();
properties.put("user", "xxxx");
properties.put("password", "yyyy");
properties.put("sslConnection", "true");
java.sql.Connection con =
java.sql.DriverManager.getConnection(url, properties);

Network encryption

IBM Informix, Version 9.4 and later, enables encryption of data transmitted over a
network by using an encryption communication support module. IBM Informix
JDBC Driver, Version 2.21JC5 and later, makes this feature available to all JDBC
clients by adding a communication support module (CSM) to the JDBC driver.

IBM Informix JDBC encryption module is `com.informix.jdbc.Crypto` class that is
packaged in the IBM Informix JDBC .jar file. IBM Informix JDBC encryption CSM
is a pure Java implementation that uses services from the Java Cryptography
provider.

Network encryption syntax

To configure network encryption, set the CSM environment variable. The following
syntax illustrates the CSM environment variable and encryption options:

**CSM environment variable syntax**

```
CSM=("CLASSNAME=com.informix.jdbc.Crypto")
```

**Option tags**

Specify the syntax of encryption tags. For more information, see "Option
tags."

**config=parameterfile**

Specify encryption options in a file. For more information, see "Option
parameters" on page 2-30.

**Option tags**

The option tags that can be passed on to the encryption CSM are the same as the
encryption option tags that are specified in the CSM configuration file used by the
server or CSDK. There are three option tags:

- **cipher**
  Defines all ciphers that can be used by the session.

- **mac**
  Defines the message authentication code (MAC) key files to be used during
  the MAC generation and the level of MAC generation utilized.

- **switch**
  Defines the frequency at which ciphers or secret keys are renegotiated. The
  longer the secret key and encryption cipher remain in use, the more likely
  that the encryption rules might be broken by an attacker. To avoid this,
  cryptologists recommend periodically changing the secret key and cipher
  on long-term connections. The default for this renegotiation is once an
  hour. By using the switch tag, you can set the time for this renegotiation in
  minutes.

For the syntax of these tags, see the **IBM Informix Security Guide**.

The encryption CSM option parameters are separated by a comma and not by a
semicolon. When using a DataSource, getIfxCSM() and setIfxCSM() methods can be
used to get and set CSM as a property. When setting CSM as a property, make sure that you do not enclose the option string in parentheses. The following is an example that correctly sets the CSM as a property:

```java
connProperties.put("CSM", "classname=com.informix.jdbc.Crypto,cipher[all], mac[<builtin>]);
```

**Option parameters**

You can configure encryption by creating a file with encryption parameters and then specifying the file name. The encryption parameters are:

- **ENCCSM_CIPHERS**: Ciphers to be used
- **ENCCSM_MAC**: MAC level
- **ENCCSM_MACFILES**: MAC file location
- **ENCCSM_SWITCH**: CIPHER and KEY change frequency, separated by a comma

For the syntax of these parameters, see the *IBM Informix Security Guide*.

The following is an example that specifies the CSM parameters in a configuration file:

```java
String newUrl = "jdbc:informix-sqli://beacon:8779/test:INFORMIXSERVER=danon950_beacon_encrypt;user=rdtest;password=test;csm={classname=com.informix.jdbc.Crypto,config=test.cfg}";
try {
    Class.forName("com.informix.jdbc.IfxDriver");
} catch (Exception e) {
    System.out.println("ERROR: failed to load Informix JDBC driver.");
} try {
    Connection con = DriverManager.getConnection( newUrl );
} catch (SQLException e) {
    System.out.println("ERROR: failed to connect.");
    e.printStackTrace();
    return;
}
```

**Configure the encryption CSM in the server**

To be able to connect to IBM Informix database servers on an encrypted port, the JDBC client must use JDBC encryption CSM. Also when using JDBC encryption CSM, attempts to connect to Informix database servers on a non-encrypted port fail. An instance of Informix database server might be configured to listen in on encrypted and non-encrypted ports at the same time. For details about configuring IBM Informix to use encryption CSM, see the *IBM Informix Administrator’s Guide*.

---

**Using single sign-on access control with the Informix JDBC Driver**

Ensure that the database server is set up for SSO authentication. For information, see the “Single Sign-on Access Control” section in the *IBM Informix Security Guide*. 

---

2-30 IBM Informix JDBC Driver Programmer’s Guide
You can use single sign-on (SSO) access control with JDBC by using the DriverManager.getConnection() method and setting the Communication Support Module (CSM) in the connection URL to the service principal. Using SSO access control replaces the user ID and password option.

1. Modify the connection URL so that it includes the service principal. The service principal consists of the database server name and the SSO realm.

   CSM=(SSO=database_server@realm,ENC=true)

   The ENC=true setting means that Generic Security Services (GSS) encryption is enabled. The ENC=true setting is optional because by default, its value is true. If you do not want to enable GSS encryption, set the value to false: ENC=false.

   For complete syntax of the connection URL, see “Format of database URLs” on page 2-5.

2. Create a login configuration file with the following code:

   com.sun.security.jgss.initiate {
       com.sun.security.auth.module.Krb5LoginModule required
       useTicketCache=true
       doNotPrompt=true;
   }

3. Run the application with the java.security.auth.login.config property set to the login configuration files full path name, followed by the TestSso class. The following is an example where IfmxLog.conf is the login configuration file:

   java -Djava.security.auth.login.config=mydirectory/IfmxLog.conf TestSso

---

**PAM authentication method**

The IBM Informix JDBC Driver, Version 2.21, JC5 and later, implements support for handling PAM (Pluggable Authentication Module)-enabled IBM Informix server 9.40 and later servers. This implementation supports a challenge-response dialog between PAM and the end user. To facilitate this dialog, the JDBC developer must implement the com.informix.jdbc.IfmxPAM interface. The IfxPAM() method in the IfmxPAM interface acts as the gateway between PAM and the user.

The IfxPAM() method is called when the JDBC server encounters a PAM challenge method. The return value from the IfxPAM() method acts as the response to the challenge message and is sent to PAM.

The signature for the IfxPAM() method is:

```
public IfxPAMResponse IfxPAM(IfxPAMChallenge challengeMessage)
```

Two classes, IfxPAMChallenge and IfxPAMResponse, usher messages between the JDBC driver and PAM. The IfxPAMChallenge class contains the information that has been sent from PAM to the user.

The challenge message is obtained from the IfxPAMChallenge class by using the getChallenge() method. This message is what is sent directly from PAM running on IBM Informix server to be routed to the end user. The challenge messages are listed in the following table.

<table>
<thead>
<tr>
<th>Message</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAM_PROMPT_ECHO_ON</td>
<td>The message is displayed to the user and the users response can be echoed back.</td>
</tr>
</tbody>
</table>
Table 2-1. Types of challenge messages (continued)

<table>
<thead>
<tr>
<th>Message</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAM_PROMPT_ECHO_OFF</td>
<td>The message is displayed to the user and the user's response is hidden or masked (that is, when the user enters a password, asterisks are displayed instead of the exact characters the user types).</td>
</tr>
<tr>
<td>PAM_PROMPT_ERROR_MSG</td>
<td>The message is displayed to the user as an error, with no response required.</td>
</tr>
<tr>
<td>PAM_TEXT_INFO_MSG</td>
<td>The message is displayed to the user as an informational message, with no response required.</td>
</tr>
</tbody>
</table>

The challenge message type is governed by the PAM standard and can have vendor-specific values. See the PAM standard and vendor-specific information for possible values and interpretations.

The PAM standard defines the maximum size of a PAM message to be 512 bytes (IfxPAMChallenge.PAM_MAX_MESSAGE_SIZE).

The IfxPAMResponse class is similar to IfxPAMChallenge, but instead of being used by PAM to send a message to the user, the IfxPAMResponse class is used to send a message from the user to PAM. Use the IfxPAMResponse.setResponse() method to send the challenge-response string to PAM. However, set the response type (which is set by using the IfxPAMResponse.setResponseType() method) to zero, the default, as the response type is currently reserved for future use.

The challenge-response string is limited to the size of the challenge message: IfxPAMResponse.PAM_MAX_MESSAGE_SIZE or 512 bytes. If the response string exceeds this limit, an SQL exception is thrown.

Additionally, when the challenge message is of type PAM_INFO_TEXT or PAM_PROMPT_ERR_MSG (see PAM standards for meaning and integer values), PAM expects no user response. Thus, a null IfxPAMResponse object or one that has not been set with specific values can be returned to JDBC. The IfxPAMResponse class provides the following method to allow the JDBC developer to stop the connection attempt during a PAM session:

```java
public void setTerminateConnection(boolean flag)
```

The value of the flag can be TRUE or FALSE. If the value of the parameter passed to setTerminateConnection is TRUE, then the connection to the PAM-enabled IBM Informix server immediately terminates upon returning from IfxPAM(). If the value is set to FALSE, then the connection attempt to the PAM-enabled server continues as usual.

**PAM in JDBC**

JDBC developers using PAM to communicate with a PAM-enabled IBM Informix server must implement the com.informix.jdbc.IfmxPAM interface. To do so, put the following on the class declaration line in a Java class file:

```java
implements IfmxPAM
```
That Java class must then implement the IfmxPAM interface conforming to Java standards and the details provided previously. The next step is to inform the JDBC driver what Java class has implemented the IfmxPAM interface. There are two ways to do this:

- Add the key-value pair IFX_PAM_CLASS=your.class.name to the connection URL, where the value your.class.name is the path to the class that has implemented the IfmxPAM interface.
  
  This method is typically used when connecting to an Informix server by using the DriverManager.getConnection (URL) approach.

- Add the property IFX_PAM_CLASS with the value your.class.name to your properties list before attempting the connection to the PAM-enabled server.
  
  This method is used when connecting to an Informix server by using the DataSource.getConnection() approach.

JDBC developers have a wide latitude in implementing the IfmxPAM interface. The following actions happen during authentication that uses PAM:

1. The JDBC driver, when detecting communication with a PAM-enabled server, contacts the IfxPAM() method and passes it a IfxPAMChallenge object containing the PAM challenge question.
2. A dialog box you create appears with a text question containing the challenge message that was sent by PAM.
3. When the user furnishes the response, it is packaged into an IfxPAMResponse object, and it is returned to the JDBC driver by exiting the IfxPAM() method returning the IfxPAMResponse object.
4. When PAM receives the response from the challenge question, it can authorize the user, deny access to the user, or issue another challenge question, in which case the previous process is repeated.

This process continues until either the user is authorized or the user is denied access. The Java developer or user can terminate the PAM authorization sequence by calling the IfxPAMResponse.setTerminateConnection() method with a value of TRUE.

### Close the connection

The following table contrasts the different effects of calling the Connection.close() and scrubConnection() methods in environments that use connection pooling and those that do not.

<table>
<thead>
<tr>
<th>Connection pooling status</th>
<th>Effect of calling Connection.close() method</th>
<th>Effect of calling scrubConnection() method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-connection pool setup</td>
<td>Closes database connection, all associated statement objects, and their result sets. Connection is no longer valid.</td>
<td>Returns connection to original state, keeps opened statements, but closes result sets Connection is still valid.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Releases resources associated with result sets only.</td>
</tr>
</tbody>
</table>

For more information about deallocating resources, see “Deallocate resources” on page 3-2. For more information about the scrubConnection() method, see “Clean pooled connections” on page 7-7.
<table>
<thead>
<tr>
<th>Connection pooling status</th>
<th>Effect of calling Connection.close() method</th>
<th>Effect of calling scrubConnection() method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection pool with IBM Informix Implementation</td>
<td>Closes connection to the database and reopens it to close any statements associated with the connection object and reset the connection to its original state. Connection object is then returned to the connection pool and is available when requested by a new application connection.</td>
<td>Returns a connection to original state and keeps all open statements, but closes all result sets. Calling this method in this situation not recommended.</td>
</tr>
<tr>
<td>Connection pool with application server implementation</td>
<td>Defined by your connection pooling implementation</td>
<td>Returns connection to original state and retains opened statements, but closes result sets. This functionality can be useful if you are using the JDBC 3.0 feature of statement pooling with connections. When your application calls the Connection.close() method, your application servers connection-pool manager can call scrubConnection() for the pooled connection object before returning the object to the connection pool.</td>
</tr>
</tbody>
</table>

**Important:** When calling the scrubConnection() method, your applications should be using server-only connections.
Chapter 3. Perform database operations

These topics explain what you need to use IBM Informix JDBC Driver to perform operations against an Informix database.

Query the database

IBM Informix JDBC Driver complies with the JDBC API specification for sending queries to a database and retrieving the results. The driver supports most of the methods of the Statement, PreparedStatement, CallableStatement, ResultSet, and ResultSetMetaData interfaces.

Example of sending a query to an Informix database

The following example from the SimpleSelect.java program shows how to use the PreparedStatement interface to execute a SELECT statement that has one input parameter:

```java
try {
    PreparedStatement pstmt = conn.prepareStatement("Select *
        from x "+"where a = ?;");
    pstmt.setInt(1, 11);
    ResultSet r = pstmt.executeQuery();
    while(r.next())
    {
        short i = r.getShort(1);
        System.out.println("Select: columna="+i);
    }
    r.close();
    pstmt.close();
} catch (SQLException e) {
    System.out.println("ERROR: Fetch statement failed: " + e.getMessage());
}
```

The program first uses the Connection.prepareStatement() method to prepare the SELECT statement with its single input parameter. It then assigns a value to the parameter by using the PreparedStatement.setInt() method and executes the query with the PreparedStatement.executeQuery() method.

The program returns resulting rows in a ResultSet object, through which the program iterates with the ResultSet.next() method. The program retrieves individual column values with the ResultSet.getShort() method, since the data type of the selected column is SMALLINT.

Finally, both the ResultSet and PreparedStatement objects are explicitly closed with the appropriate close() method.

For more information about which getXXX() methods retrieve individual column values, see "Data type mapping for ResultSet.getXXX() methods" on page C-12.
**Result sets**

The IBM Informix JDBC Driver implementation of the Statement.execute() method returns a single ResultSet object. Because the server does not support multiple ResultSet objects, this implementation differs from the JDBC API specification, which states that the Statement.execute() method can return multiple ResultSet objects.

Returning multiple Result Sets is not supported by the IBM Informix JDBC Driver.

**Scrollable result set for multiple rows**

The Scrollable ResultSet fetches one row at a time from the server. A performance enhancement for Scrollable ResultSet allows multiple rows to be fetched at one time. In the following example, where the rows $m$ through $n$ are desired, the following fetches the rows into a ResultSet. As long as only rows between $m$ and $n$ inclusive are accessed, no further fetches occur. In this example, the rows 50 through 100 are desired and the ResultSet is SCROLL_INSENSITIVE:

```java
rs.setFetchSize(51);
    rs.absolute(49); // one row will be fetched
    rs.next() // rs will contain 51 rows
```

IBM Informix only fetches in the forward direction and only fetches one row, except when a DIR_NEXT fetch is used to fetch rows. For a DIR_NEXT operation, the server sends rows until the fetch buffer is filled or until the last row is sent. Only ResultSet.next() can generate a DIR_NEXT operation.

This performance enhancement does not change the behavior of FORWARD_ONLY ResultSets. The calculation of the size of the fetch buffer is unchanged.

For SCROLL_INSENSITIVE ResultSets, the size of the fetch buffer is determined by the fetch size and row size. Statement.setFetchSize() and ResultSet.setFetchSize() can be used to set the fetch size. If fetch size is zero, the default fetch buffer size is used. The fetch buffer size is limited to 32 K.

Certain ResultSet methods require information about the number of rows generated by the query. The methods might result in fetching a row to obtain the information and then refetching the current row. The methods are isBeforeFirst(), isLast(), and absolute(-row).

Additionally, setMaxRows() can change the fetch buffer size for SCROLL_INSENSITIVE ResultSets. Because additional server support is required to ensure efficient use of setMaxRows(), it is recommended that ResultSet.setMaxRows() is not used as this time.

**Deallocate resources**

Close a Statement, PreparedStatement, and CallableStatement object by calling the appropriate close() method in your Java program when you have finished processing the results of an SQL statement. This closure immediately deallocates the resources that have been allocated to execute your SQL statement. Although the ResultSet.close() method closes the ResultSet object, it does not deallocate the resources allocated to the Statement, PreparedStatement, or CallableStatement objects.

It is good practice to call ResultSet.close() and Statement.close() methods when you have finished processing the results of an SQL statement, to indicate to IBM
Informix JDBC Driver that you are done with the statement or result set. When you do so, your program releases all its resources on the database server. It is, however, not required to call ResultSet.close() and Statement.close() specifically, as long as you call to Connection.close(), which takes care of releasing these resources.

**Execute across threads**

The same **Statement** or **ResultSet** instance cannot be accessed concurrently across threads. You can, however, share a **Connection** object between multiple threads.

For example, if one thread executes the Statement.executeQuery() method on a **Statement** object, and another thread executes the Statement.executeUpdate() method on the same **Statement** object, the results of both methods are unexpected and depend on which method was executed last.

Similarly, if one thread executes the method ResultSet.next() and another thread executes the same method on the same **ResultSet** object, the results of both methods are unexpected and depend on which method was executed last.

**Scroll cursors**

The scroll cursors feature of IBM Informix JDBC Driver follows the JDBC 3.0 specification, with these exceptions:

**Scroll sensitivity**

The IBM Informix database server implementation of scroll cursors places the rows fetched in a temporary table. If another process changes a row in the original table (assuming the row is not locked) and the row is fetched again, the changes are not visible to the client.

This behavior is similar to the SCROLL_INSENSITIVE description in the JDBC 3.0 specification. IBM Informix JDBC Driver does not support SCROLL_SENSITIVE cursors. To see updated rows, your client application must close and reopen the cursor.

**Client-side scrolling**

The JDBC specification implies that the scrolling can happen on the client-side result set. IBM Informix JDBC Driver supports the scrolling of the result set only to the extent that the database server supports scrolling.

**Result set updatability**

The JDBC 3.0 API does not provide exact specifications for SQL queries that yield result sets that can be updated. Generally, queries that meet the following criteria can produce result sets that can be updated:

- The query references only a single table in the database.
- The query does not contain any JOIN operations.
- The query selects the primary key of the table it references.
- Every value expression in the select list must consist of a column specification, and no column specification can appear more than once.
- The WHERE clause of the table expression cannot include a subquery.

IBM Informix JDBC Driver relaxes the primary key requirement, because the driver performs the following operations:

1. The driver looks for a column called ROWID.
2. The driver looks for a SERIAL, SERIAL8, or BIGSERIAL column in the table.
3. The driver looks for the table’s primary key in the system catalogs. If none of these is provided, the driver returns an error.

When you delete a row in a result set, the ResultSet.absolute() method is affected, because the positions of the rows change after the delete.

When the query contains a SERIAL column and the data is duplicated in more than one row, execution of updateRow() or deleteRow() affects all the rows containing that data.

The ScrollCursor.java example file shows how to retrieve a result set with a scroll cursor. For examples of how to use a scrollable cursor that can be updated, see the UpdateCursor1.java, UpdateCursor2.java, and UpdateCursor3.java files.

**Hold cursors**

When transaction logging is used, IBM Informix generally closes all cursors and releases all locks when a transaction ends. In a multiuser environment, this behavior is not always desirable.

IBM Informix JDBC Driver had already implemented holdable cursor support with Informix extensions. Informix database servers (5.x, 7.x, SE, 8.x, 9.x, and 10.x, or later) support adding keywords WITH HOLD in the declaration of the cursor. Such a cursor is referred to as a hold cursor and is not closed at the end of a transaction.

IBM Informix JDBC Driver, in compliance with the JDBC 3.0 specifications, adds methods to JDBC interfaces to support holdable cursors.

For more information about hold cursors, see the IBM Informix Guide to SQL: Syntax.

**Update the database**

You can issue batch update statements or perform bulk inserts to update the database.

**Perform batch updates**

The batch update feature is similar to multiple IBM Informix SQL PREPARE statements. You can issue batch update statements as in the following example:

```sql
PREPARE stmt FROM "insert into tab values (1);
    insert into tab values (2);
    update table tab set col = 3 where col = 2";
```

The batch update feature in IBM Informix JDBC Driver follows the JDBC 3.0 specification, with these exceptions:

- SQL statements
- Return value from Statement.executeBatch()

**SQL statements and batch updates**

The following commands cannot be put into multistatement PREPARE statements:

- SELECT (except SELECT INTO TEMP) statement
- DATABASE statements
CONNECTION statements

For more details, see IBM Informix Guide to SQL: Syntax.

Return value from Statement.executeUpdate() method

The return value differs from the JDBC 3.0 specification in the following ways:

- If the IFX_BATCHUPDATE_PER_SPEC environment variable is set to 0, only the
  update count of the first statement executed in the batch is returned. If the
  IFX_BATCHUPDATE_PER_SPEC environment variable is set to 1 (the default), the
  return value equals the number of rows affected by all SQL statements executed
  by Statement.executeUpdate(). For more information, see "Informix environment
  variables with the IBM Informix JDBC Driver" on page 2-10.

- When errors occur in a batch update executed in a Statement object, no rows are
  affected by the statement; the statement is not executed. Calling
  BatchUpdateException.getUpdateCounts() returns 0 in this case.

- When errors occur in a batch update executed in a PreparedStatement object,
  rows that were successfully inserted or updated on the database server do not
  revert to their pre-updated state. However, the statements are not always
  committed; they are still subject to the underlying autocommit mode.

The BatchUpdate.java example file shows how to send batch updates to the
database server.

Perform bulk inserts

A bulk insert is an IBM Informix extension to the JDBC 3.0 batch update feature.
The bulk insert feature improves the performance of single INSERT statements that
are executed multiple times, with multiple value settings. To enable this feature, set
the IFX_USEPUT environment variable to 1. (The default value is 0.)

This feature does not work for multiple statements passed in the same
PreparedStatement instance or for statements other than INSERT. If this feature is
enabled and you pass in an INSERT statement followed by a statement with no
parameters, the statement with no parameters is ignored.

The bulk insert feature requires the client to convert the Java type to match the
target column type on the server for all data types except opaque types or complex
types.

The BulkInsert.java example, which is installed in the demo directory where your
JDBC driver is installed, shows how to perform a bulk insert.

Parameters, escape syntax, and unsupported methods

This section contains the following information:

- How to use OUT parameters
- How to use named parameters in a CallableStatement
- Support for the DESCRIBE INPUT statement
- How to use escape syntax to translate from JDBC to IBM Informix

It also lists unsupported methods and methods that behave differently from the
standard.

Chapter 3. Perform database operations 3-5
The CallableStatement OUT parameters

The CallableStatement methods handle OUT parameters in C function and Java user-defined routines (UDRs). Two registerOutParameter() methods specify the data type of OUT parameters to the driver. A series of getXXX() methods retrieves OUT parameters.

IBM Informix, Version 9.2x and 9.3x, considers OUT parameters to be statement-local variables (SLVs). SLVs are valid only for the life of a single statement and cannot be returned directly upon executing the routine. The JDBC CallableStatement interface provides a method for retrieving OUT parameters.

With IBM Informix, Version 10.0 and later, the OUT parameter routine makes available a valid blob descriptor and data to the JDBC client for a BINARY OUT parameter. Using receive methods in IBM Informix JDBC Driver, Version 3.0 and later, supporting IDS 10.0 and later, you can use these OUT parameter descriptors and data provided by the server.

Exchange of descriptor and data between Informix and JDBC is consistent with the existing mechanism by which data is exchanged for the result set methods of JDBC, such as passing the blob descriptor and data through SQLI protocol methods. (SPL UDRs are the only type of UDRs supporting BINARY OUT parameters.)

For background information, see the following documentation:
- IBM Informix User-Defined Routines and Data Types Developer’s Guide provides introductory and background information about opaque types and user-defined routines (UDRs) for use in an Informix database.
- J/Foundation Developer’s Guide describes how to write Java UDRs for use in the database server.
- The IBM Informix Guide to SQL: Tutorial describes how to write stored procedure language (SPL) routines.
- The IBM Informix DataBlade API Programmer’s Guide describes how to write external C routines.

Only Informix database servers versions 9.2 and later return an OUT parameter to IBM Informix JDBC Driver. IBM Informix, Version 9.4 and later supports multiple OUT parameters.

For examples of how to use OUT parameters, see the CallOut1.java, CallOut2.java, CallOut3.java, and CallOut4.java example programs in the basic subdirectory of the demo directory where your IBM Informix JDBC Driver is installed.

Server and driver restrictions and limitations

Server restrictions:

This topic describes the restrictions imposed by different versions of the 9.x and later IBM Informix server. It also describes enhancements made to the JDBC driver and the restrictions imposed by it.

Versions 9.2x and 9.3x of IBM Informix have the following requirements and limitations concerning OUT parameters:
• Only a function can have an OUT parameter. A function is defined as a UDR that returns a value. A procedure is defined as a UDR that does not return a value.
• There can be only one OUT parameter per function.
• The OUT parameter has to be the last parameter.
• You cannot specify INOUT parameters.

IBM Informix, Version 10.0, or later allows you to specify INOUT parameters (C, SPL, or Java UDRs).
• The server does not correctly return the value NULL for external functions.
• You cannot specify OUT parameters that are complex types.
• You cannot specify C and SPL routines that use the RETURN WITH RESUME syntax.

These restrictions, for server versions 9.2x and 9.3x, are imposed whether users create C, SPL, or Java UDRs.

The functionality of the IBM Informix, Version 9.4 allows:
• Any parameters to be OUT parameters for C, SPL, or Java UDRs
• User-defined procedures with no return value to have OUT parameters
• Multiple OUT parameters

You cannot specify INOUT parameters.

For more information about UDRs, see IBM Informix User-Defined Routines and Data Types Developer’s Guide and J/Foundation Developer’s Guide.

Driver enhancement:

The CallableStatement object provides a way to call or execute UDRs in a standard way for all database servers. Results from the execution of these UDRs are returned as a result set or as an OUT parameter.

The following is a program that creates a user-defined function, myudr, with two OUT parameters and one IN parameter, and then executes the myudr() function. The example requires server-side support for multiple OUT parameters; hence it only works for IBM Informix, Version 9.4 or above. For more information about UDRs, see IBM Informix User-Defined Routines and Data Types Developer’s Guide and J/Foundation Developer’s Guide.

import java.sql.*;
public class myudr {
    public myudr() {
        
    }

    public static void main(String args[]) {
        Connection myConn = null;
        try {
            Class.forName("com.informix.jdbc.IfxDriver");
            myConn = DriverManager.getConnection(
            "jdbc:informix-sqli:MYSYSTEM:18551/testDB:"
            + "INFORMIXSERVER=patriot1;user=USERID;"
            + "password=MYPASSWORD");
        } catch (ClassNotFoundException e) {
            System.out.println("problem with loading Ifx Driver\n" + e.getMessage());
        }
    }
}
try {
    Statement stmt = myConn.createStatement();
    stmt.execute("DROP FUNCTION myudr");
} catch (SQLException e) {
    System.out.println("problem with connecting to db\n" + e.getMessage());
}

try {
    Statement stmt = myConn.createStatement();
    stmt.execute("CREATE FUNCTION myudr(OUT arg1 int, arg2 int, OUT arg3 int)"
            + "RETURNS boolean; LET arg1 = arg2; LET arg3 = arg2 * 2;"
            + "RETURN 't'; END FUNCTION;"");
} catch (SQLException e) {
    System.out.println("problem with creating function\n" + e.getMessage());
}

Connection conn = myConn;

try {
    String command = "{? = call myudr(? , ?, ?)}";
    CallableStatement cstmt = conn.prepareCall (command);
    
    // Register arg1 OUT parameter
    cstmt.registerOutParameter(1, Types.INTEGER);
    
    // Pass in value for IN parameter
    cstmt.setInt(2, 4);
    
    // Register arg3 OUT parameter
    cstmt.registerOutParameter(3, Types.INTEGER);
    
    // Execute myudr
    ResultSet rs = cstmt.executeQuery();
    
    // executeQuery returns values via a resultSet
    while (rs.next()) {
        // get value returned by myudr
        boolean b = rs.getBoolean(1);
        System.out.println("return value from myudr = " + b);
    } 

    // Retrieve OUT parameters from myudr
    int i = cstmt.getInt(1);
    System.out.println("arg1 OUT parameter value = " + i);
    
    int k = cstmt.getInt(3);
    System.out.println("arg3 OUT parameter value = " + k);

    rs.close();
    cstmt.close();
    conn.close();
} catch (SQLException e) {
    System.out.println("SQLException: " + e.getMessage());
    System.out.println("ErrorCode: " + e.getErrorCode());
}
Driver restrictions and limitations:

IBM Informix JDBC Driver has the following requirements and limitations concerning OUT parameters:

- With IBM Informix, Version 9.2, the driver always returns a -9752 error if a function contains an OUT parameter. The driver creates an SQLWarning object and chains this to the CallableStatement object.

  You can determine if a function contains an OUT parameter by calling the CallableStatement.getWarnings() method or by calling the IfmxCallableStatement.hasOutParameter() method, which return TRUE if the function has an OUT parameter.

  If a function contains an OUT parameter, you must use the CallableStatement.registerOutParameter() method to register the OUT parameter, the setXXX() methods to register the IN and OUT parameter values, and the getXXX() method to retrieve the OUT parameter value.

- The CallableStatement.getMetaData() method returns NULL until the executeQuery() method has been executed. After executeQuery() has been called, the ResultSetMetaData object contains information only for the return value, not the OUT parameter.

- You must specify all IN parameters by using setXXX() methods. You cannot use literals in the SQL statement. For example, the following statement produces unreliable results:

```java
CallableStatement cstmt = myConn.prepareCall("{call myFunction(25, ?)}");
```

  Instead, use a statement that does not specify literal parameters:

```java
CallableStatement cstmt = myConn.prepareCall("{call myFunction(?, ?)}");
```

  Call the setXXX() methods for both parameters.

- Do not close the ResultSet returned by the CallableStatement.executeQuery() method until you have retrieved the OUT parameter value by using a getXXX() method.

- You cannot cast the OUT parameter to a different type in the SQL statement. For example, the following cast is ignored:

```java
CallableStatement cstmt = myConn.prepareCall("{call foo(?, ?::varchar, ?)}");
```

- The setMaxRows() and registerOutParameter() methods both take java.sql.Types values as parameters. There are some one-to-many mappings from java.sql.Types values to Informix types.

  In addition, some Informix types do not map to java.sql.Types values.

  Extensions for setMaxRows() and registerOutParameter() fix these problems. See "IN and OUT parameter type mapping."

These restrictions apply to a JDBC application that handles C, SPL, or Java UDRs.

**IN and OUT parameter type mapping:**
An exception is thrown by the registerOutParameter(int, int),
registerOutParameter(int, int, int), or setNull(int, int) method if the driver cannot
find a matching IBM Informix type or finds a mapping ambiguity (more than one
matching Informix type). The table that follows shows the mappings the
CallableStatement interface uses. Asterisks (*) indicate mapping ambiguities.

<table>
<thead>
<tr>
<th>java.sql.Types</th>
<th>com.informix.lang.IfxTypes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Array*</td>
<td>IFX_TYPE_LIST</td>
</tr>
<tr>
<td></td>
<td>IFX_TYPE_MULTISET</td>
</tr>
<tr>
<td></td>
<td>IFX_TYPE_SET</td>
</tr>
<tr>
<td>Bigint</td>
<td>IFX_TYPE_INT8</td>
</tr>
<tr>
<td>Binary</td>
<td>IFX_TYPE_BYTE</td>
</tr>
<tr>
<td>Bit</td>
<td>Not supported</td>
</tr>
<tr>
<td>Blob</td>
<td>IFX_TYPE_BLOB</td>
</tr>
<tr>
<td>Char</td>
<td>IFX_TYPE_CHAR(n)</td>
</tr>
<tr>
<td>Clob</td>
<td>IFX_TYPE_CLOB</td>
</tr>
<tr>
<td>Date</td>
<td>IFX_TYPE_DATE</td>
</tr>
<tr>
<td>Decimal</td>
<td>IFX_TYPE_DECIMAL</td>
</tr>
<tr>
<td>Distinct*</td>
<td>Depends on base type</td>
</tr>
<tr>
<td>Double</td>
<td>IFX_TYPE_FLOAT</td>
</tr>
<tr>
<td>Float</td>
<td>IFX_TYPE_FLOAT1</td>
</tr>
<tr>
<td>Integer</td>
<td>IFX_TYPE_INT</td>
</tr>
<tr>
<td>Java_Object*</td>
<td>IFX_TYPE_UDTVAR</td>
</tr>
<tr>
<td></td>
<td>IFX_TYPE_UDTFIX</td>
</tr>
<tr>
<td>Long</td>
<td>IFX_TYPE_BIGINT</td>
</tr>
<tr>
<td></td>
<td>IFX_TYPE_BIGSERIAL</td>
</tr>
<tr>
<td>Longvarchar*</td>
<td>IFX_TYPE_BYTE</td>
</tr>
<tr>
<td></td>
<td>IFX_TYPE_BLOB</td>
</tr>
<tr>
<td>Longvarchar*</td>
<td>IFX_TYPE_TEXT</td>
</tr>
<tr>
<td></td>
<td>IFX_TYPE_CLOB</td>
</tr>
<tr>
<td></td>
<td>IFX_TYPE_LVARCHAR</td>
</tr>
<tr>
<td>Null</td>
<td>Not supported</td>
</tr>
<tr>
<td>Numeric</td>
<td>IFX_TYPE_DECIMAL</td>
</tr>
<tr>
<td>Other</td>
<td>Not supported</td>
</tr>
<tr>
<td>Real</td>
<td>IFX_TYPE_SFLOAT</td>
</tr>
<tr>
<td>Ref</td>
<td>Not supported</td>
</tr>
<tr>
<td>Smallint</td>
<td>IFX_TYPE_SMIINT</td>
</tr>
<tr>
<td>Struct</td>
<td>IFX_TYPE_ROW</td>
</tr>
<tr>
<td>Time</td>
<td>IFX_TYPE_DTIME (hour to second)</td>
</tr>
<tr>
<td>Timestamp</td>
<td>IFX_TYPE_DTIME (year to fraction(5))</td>
</tr>
<tr>
<td>Tinyint</td>
<td>IFX_TYPE_SMIINT</td>
</tr>
<tr>
<td>Varbinary</td>
<td>IFX_TYPE_BYTE</td>
</tr>
<tr>
<td>java.sql.Types</td>
<td>com.informix.lang.IfxTypes</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Varchar</td>
<td>IFX_TYPE_VCHAR (n)</td>
</tr>
<tr>
<td>Nothing*</td>
<td>IFX_TYPE_BOOL</td>
</tr>
</tbody>
</table>

1 This mapping is JDBC compliant. You can map the JDBC FLOAT data type to the Informix SMALLFLOAT data type for compatibility with earlier versions by setting the IFX_SET_FLOAT_AS_SMFLOAT connection property to 1.

To avoid mapping ambiguities, use the following extensions to CallableStatement, defined in the IfmxCallableStatement interface:

```java
public void IfxRegisterOutParameter(int parameterIndex,
    int ifxType) throws SQLException;

public void IfxRegisterOutParameter(int parameterIndex,
    int ifxType, String name) throws SQLException;

public void IfxRegisterOutParameter(int parameterIndex,
    int ifxType, int scale) throws SQLException;

public void IfxSetNull(int i, int ifxType) throws SQLException;

public void IfxSetNull(int i, int ifxType, String name) throws SQLException;
```

Possible values for the ifxType parameter are listed in "The IfxTypes class" on page C-8.

IBM Informix, Version 10.0, or later makes available to the JDBC client valid BLOB descriptors and data to support binary OUT parameters for SPL UDRs.

IBM Informix JDBC Driver, Version 3.0, or later can receive the OUT parameter descriptor and data provided by the server and use it in Java applications.

The single correct return value for any JDBC binary type (BINARY, VARBINARY, LONGVARBINARY) retrieved via method getParameterType (ParameterMetaData) is -4, which is associated with java.sql.Type.LONGVARBINARY data type. This reflects the fact that all the JDBC binary types are mapped to the same Informix SQL data type, BYTE.

**Named parameters in a CallableStatement**

A CallableStatement provides a way to call a stored procedure on the server from a Java program. You can use named parameters in a CallableStatement to identify the parameters by name instead of by ordinal position. This enhancement was introduced in the JDBC 3.0 specification. If the procedure is unique, you can omit parameters that have default values and you can enter the parameters in any order. Named parameters are especially useful for calling stored procedures that have many arguments and some of those arguments have default values.

The JDBC driver ignores case for parameter names. If the stored procedure does not have names for all the arguments, the server passes an empty string for missing names.
Requirements and restrictions for named parameters in a CallableStatement

IBM Informix JDBC Driver has the following requirements and restrictions for named parameters in a CallableStatement:

- Minimum requirements are IBM Informix, Version 11.10.UC1 or later and IBM Informix JDBC Driver, Version 3.10.JC1 or later.
- Parameters for the CallableStatement must be specified by either name or by the ordinal format within a single invocation of a routine. If you name a parameter for one argument, for example, you must use parameter names for all of the arguments.
- Named parameters are not supported for a remote CallableStatement.
- Named parameters are supported on JDK, Version 1.4.x or later.
- Support for named parameters is subject to existing limitations for calling stored procedures.

Verify support for named parameters in a CallableStatement:

The JDBC specification provides the `DatabaseMetaData.supportsNamedParameters()` method to determine if the driver and the RDMS support named parameters in a CallableStatement. For example:

```java
Connection myConn = ... // connection to the RDBMS for Database
... 
DatabaseMetaData dbmd = myConn.getMetaData();
if (dbmd.supportsNamedParameters() == true)
{
    System.out.println("NAMED PARAMETERS FOR CALLABLE STATEMENTS IS SUPPORTED");
    ...
}
```

The system returns `true` if named parameters are supported.

Retrieve parameter names for stored procedures

To retrieve the names of parameters for stored procedures, use `DatabaseMetaData` methods defined by the JDBC specification as shown in the following example.

```java
Connection myConn = ... // connection to the RDBMS for Database
... 
DatabaseMetaData dbmd = myConn.getMetaData();
ResultSet rs = dbmd.getProcedureColumns("myDB", schemaPattern, procedureNamePattern, columnNamePattern);
rs.next()
{
    String parameterName = rs.getString(4);
    -- or --
    String parameterName = rs.getString("COLUMN_NAME");
    --
    System.out.println("Column Name: " + parameterName);
}
```

The names of all columns that match the parameters of the getProcedureColumns() method are displayed.

Parameter names are not part of the `ParameterMetaData` interface and cannot be retrieved from a `ParameterMetaData` object.

When you use the getProcedureColumns() method, the query retrieves all procedures owned by `informix` (including system-generated routines) from the
sysprocedures system catalog table. To prevent errors, verify that the stored procedures you are using have been configured with correct permissions on the server.

See "Unsupported methods and methods that behave differently" on page 3-17 for important differences in JDBC API behavior for the getProcedureColumns() method.

**Named parameters and unique stored procedures**

A unique stored procedure has a unique name and a unique number of arguments. Named parameters are supported for unique stored procedures when the number of parameters in the CallableStatement is equal to or less than the number of arguments in the stored procedure.

**Example of number of named parameters equals the number of arguments:**

The following stored procedure has five arguments

```sql
create procedure createProductDef(productname varchar(64),
productdesc varchar(64),
listprice float,
minprice float,
out prod_id float);
```

```java
let prod_id = <value for prod_id>;
end procedure;
```

The following Java code with five parameters corresponds to the stored procedure. The question mark characters (?) within the parentheses of a JDBC call refer to the parameters. (In this case five parameters for five arguments.) Set or register all the parameters. Name the parameters by using the format `cstmt.setString("arg", name);` where `arg` is the name of the argument in the corresponding stored procedure. You do not need to name parameters in the same order as the arguments in the stored procedure.

```java
String sqlCall = "{call CreateProductDef(?,?,?,?,?)}";
CallableStatement cstmt = conn.prepareCall(sqlCall);
    cstmt.setString("productname", name); // Set Product Name.
    cstmt.setString("productdesc", desc); // Set Product Description.
    cstmt.setFloat("listprice", listprice); // Set Product ListPrice.
    cstmt.setFloat("minprice", minprice); // Set Product MinPrice.
    cstmt.registerOutParameter("prod_id", Types.FLOAT);

    // Execute the call.
    cstmt.execute();

    // Get the value of the id from the OUT parameter: prod_id
    float id = cstmt.getFloat("prod_id");
```

The Java code and the stored procedure show the following course of events:

1. A call to the stored procedure is prepared.
2. Parameter names indicate which arguments correspond to which parameter value or type.
3. The values for the input parameters are set and the type of the output parameter is registered.
4. The stored procedure executes with the input parameters as arguments.
5. The stored procedure returns the value of an argument as an output parameter and the value of the output parameter is retrieved.

**Example of number of named parameters is less than the number of arguments:**

If the number of parameters in CallableStatement is less than the number of arguments in the stored procedure, the remaining arguments must have default values. You do not need to set values for arguments that have default values because the server automatically uses the default values. You must, however, indicate the arguments that have non-default values or override default values with a question mark character (?) in the CallableStatement.

For example, if a stored procedure has 10 arguments of which 4 have non-default values and 6 have default values, you must have at least four question marks in the CallableStatement. Alternatively, you can use 5, 6, or up to 10 question marks.

If the CallableStatement is prepared with more parameters than non-default values, but less than the number of stored procedure arguments, it must set the values for non-default arguments. The remaining parameters can be any of the other arguments and they can be changed with each execution.

In the following unique stored procedure, the arguments listprice and minprice have default values:

```sql
create procedure createProductDef(productname varchar(64),
    productdesc varchar(64),
    listprice  float default 100.00,
    minprice   float default 90.00,
    out prod_id  float);

let prod_id = <value for prod_id>
end procedure;
```

The following Java code calls the stored procedure with fewer parameters than arguments in the stored procedure (four parameters for five arguments). Because listprice has a default value, it can be omitted from the CallableStatement.

```java
String sqlCall = "{call CreateProductDef(?,?,?,?)}";
// 4 params for 5 args
CallableStatement cstmt = conn.prepareCall(sqlCall);
    cstmt.setString("productname", name); // Set Product Name.
    cstmt.setString("productdesc", desc); // Set Product Description.
    cstmt.setFloat("minprice", minprice); // Set Product MinPrice.
    // Register out parameter which should return the product id created.
    cstmt.registerOutParameter("prod_id", Types.FLOAT);
    // Execute the call.
    cstmt.execute();
    // Get the value of the id from the OUT parameter: prod_id
    float id = cstmt.getFloat("prod_id");
```

Alternatively, for the same stored procedure you can omit the parameter for the minprice argument. You do not need to prepare the CallableStatement again.

```java
cstmt.setString("productname", name); // Set Product Name.
cstmt.setString("productdesc", desc); // Set Product Description.
cstmt.setFloat("listprice", listprice); // Set Product ListPrice.
```
// Register out parameter which should return the product id created.
cstmt.registerOutParameter("prod_id", Types.FLOAT);

// Execute the call.
cstmt.execute();

// Get the value of the id from the OUT parameter: prod_id
float id = cstmt.getFloat("prod_id");

Or you can omit the parameters for both of the default arguments:
cstmt.setString("productname", name);
cstmt.setString("productdesc", desc);
cstmt.registerOutParameter("prod_id", Types.FLOAT);
cstmt.execute();
float id = cstmt.getFloat("prod_id");

**Named parameters and overloaded stored procedures**

If multiple stored procedures have the same name and the same number of arguments, the procedures are overloaded (also known as overloaded UDRs).

The JDBC driver throws an SQLException for overloaded stored procedures because the call cannot resolve to a single stored procedure. To prevent an SQLException, specify the IBM Informix server data type of the named parameters in the parameter list by appending \_data_type\_ to the question mark characters where \_data_type\_ is the Informix server data type. For example \_varchar\_ or \_float\_. You must also enter the named parameters for all the arguments and in the same order as the overloaded stored arguments of procedure.

For example, the following two procedures have the same name (createProductDef) and the same number of arguments. The data type for the \_prod_id\_ argument is a different data type in each procedure.

**Procedure 1**

create procedure createProductDef(productname varchar(64),
    productdesc varchar(64),
    listprice float default 100.00,
    minprice float default 90.00,
    prod_id float);

... let prod_id = <value for prod_id>; end procedure;

**Procedure 2**

create procedure createProductDef(productname varchar(64),
    productdesc varchar(64),
    listprice float default 100.00,
    minprice float default 90.00,
    prod_id int);

... let prod_id = <value for prod_id>; end procedure;

If you use the following Java code, it returns an SQLException because it cannot resolve to only one procedure:

```java
String sqlCall = "\{call CreateProductDef(?\,?,\?,\?,\?)\}";
CallableStatement cstmt = con.prepareCall(sqlCall);
cstmt.setString("productname", name); // Set Product Name.
```
If you specify the Informix data type for the argument that has a different data type, the Java code resolves to one procedure. The following Java code resolves to Stored Procedure 1 because the code specifies the FLOAT data type for the prod_id argument:

```java
String sqlCall = "{call CreateProductDef(?,?,?,?,?::float)}";
CallableStatement cstmt = con.prepareCall(sqlCall);
cstmt.setString("productname", name); // Set Product Name
```

### JDBC support for DESCRIBE INPUT

The SQL 92 and 99 standards specify a DESCRIBE INPUT statement for Dynamic SQL. Version 9.4 of IBM Informix provides support for this statement. (For more information about SQL standards, syntax, and this statement, see IBM Informix Guide to SQL: Syntax.)

The JDBC 3.0 specification introduces a `ParameterMetaData` class and methods that correspond to DESCRIBE INPUT support.

The IBM Informix JDBC Driver implements the `java.sql.ParameterMetaData` class. This interface is used for describing input parameters in prepared statements. The method `getParameterMetaData()` has been implemented to retrieve the metadata for a particular statement.

The `ParameterMetaData` class and the `getParameterMetaData()` method are part of the JDBC 3.0 API and are included as interfaces in J2SDK1.4.0. Details of these interfaces are specified in the JDBC 3.0 specification.

The IBM Informix JDBC Driver has implemented additional methods to the `ParameterMetaData` interface to extend its functionality, as shown in the following table.

<table>
<thead>
<tr>
<th>Return type</th>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>int</td>
<td>getParameterLength (int param)</td>
<td>Retrieves parameters length</td>
</tr>
<tr>
<td>int</td>
<td>getParameterExtendedId (int param)</td>
<td>Retrieves parameters extended ID</td>
</tr>
<tr>
<td>java.lang.String</td>
<td>getParameterExtendedName (int param)</td>
<td>Retrieves parameters extended name</td>
</tr>
<tr>
<td>java.lang.String</td>
<td>getParameterExtendedOwnerName (int param)</td>
<td>Retrieves parameters extended owner name of the type</td>
</tr>
<tr>
<td>int</td>
<td>getParameterSourceType (int param)</td>
<td>Retrieves parameters SourceType</td>
</tr>
<tr>
<td>int</td>
<td>getParameterAlignment (int param)</td>
<td>Retrieves parameters alignment</td>
</tr>
</tbody>
</table>

The following is an example of using the `ParameterMetaData` interface in the IBM Informix JDBC Driver:

```java
try {
    PreparedStatement pstmt = null;
    pstmt = myConn.prepareStatement(
        "select * from table_1 where int_col = ? " +"and string_col = ?");
    ParameterMetaData paramMeta = pstmt.getParameterMetaData();
    int count = paramMeta.getParameterCount();
    System.out.println("Count : " +count);
    for (int i=1; i <= count; i++)
```
The escape syntax

Escape syntax indicates information that must be translated from JDBC format to IBM Informix native format. Valid escape syntax for SQL statements is as follows.

<table>
<thead>
<tr>
<th>Type of statement</th>
<th>Escape syntax</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure</td>
<td>{call procedure}</td>
</tr>
<tr>
<td>Function</td>
<td>{var = call function}</td>
</tr>
<tr>
<td>Date</td>
<td>{d 'yyyy-mm-dd'}</td>
</tr>
<tr>
<td>Time</td>
<td>{t 'hh:mm:ss'}</td>
</tr>
<tr>
<td>Timestamp (Datetime)</td>
<td>{ts 'yyyy-mm-dd hh:mm:ss[.ffffff]'}</td>
</tr>
<tr>
<td>Function call</td>
<td>{fn func(args)}</td>
</tr>
<tr>
<td>Escape character</td>
<td>{escape 'escape-char'}</td>
</tr>
<tr>
<td>Outer join</td>
<td>{oj outer-join-statement}</td>
</tr>
</tbody>
</table>

You can put any of this syntax in an SQL statement, as follows:
```
executeUpdate("insert into tab1 values( {d '1999-01-01'} )");
```

Everything inside the brackets is converted into a valid Informix SQL statement and returned to the calling function.

Unsupported methods and methods that behave differently

The following JDBC API methods are not supported by IBM Informix JDBC Driver and cannot be used in a Java program that connects to an Informix database:

- CallableStatement.getRef(int)
- Connection.setCatalog()
- Connection.setReadOnly()
- PreparedStatement.addBatch(String)
- PreparedStatement.setRef(int, Ref)
- PreparedStatement.setUnicodeStream(int, java.io.InputStream, int)
- ResultSet.getRef(int)
- ResultSet.getRef(String)
- ResultSet.getUnicodeStream(int)
- ResultSet.getUnicodeStream(String)
- ResultSet.refreshRow()
- ResultSet.rowDeleted()
- ResultSet.rowInserted()
- ResultSet.rowUpdated()
- ResultSet.setFetchSize()
- Statement.setMaxFieldSize()

The Connection.setCatalog() and Connection.setReadOnly() methods return with no error. The other methods throw the exception: Method not Supported.

The following JDBC API methods behave other than specified by the JavaSoft specification:
- CallableStatement.executeQuery()
  Returns a single result set
- DatabaseMetaData.getProcedureColumns()
  Example:
  ```java
  DBMD.getProcedureColumns(String catalog,
      String schemaPattern,
      String procedureNamePattern,
      String columnNamePattern)
  ```
  Ignores the columnNamePattern field; returns NULL when used with any server version older than 9.x.

When you use the getProcedureColumns() method, the query retrieves all procedures owned by informix (including system-generated routines) from the sysprocedures system catalog table. To prevent errors, verify that the stored procedures you are using have been configured with correct permissions on the server.

For example, if you use one of the following statements:
- getProcedureColumns("", "", "", "")
- getProcedureColumns("", informix, "", "")

The DatabaseMetaData.getProcedureColumns() method loads all server UDRs or all UDRs owned by user informix. If you chose not to install J/Foundation, or if the configuration parameters for J/Foundation are not set to valid values in your onconfig file, the method fails. Also, if any one UDR is not set up correctly on the server, the method fails.

For information about how to set up J/Foundation on Informix server and how to run Java UDRs on Informix server, see the J/Foundation Developer's Guide. For information about how to set up and run C UDRs, see the IBM Informix User-Defined Routines and Data Types Developer's Guide.

- DatabaseMetaData.othersUpdatesAreVisible()
  Always returns FALSE
- DatabaseMetaData.othersDeletesAreVisible()
  Always returns FALSE
- DatabaseMetaData.othersInsertsAreVisible()
  Always returns FALSE
- DatabaseMetaData.ownUpdatesAreVisible()
  Always returns FALSE
- DatabaseMetaData.ownDeletesAreVisible()
Always returns FALSE
• DatabaseMetaData.ownInsertsAreVisible()
  Always returns FALSE
• DatabaseMetaData.deletesAreDetected()
  Always returns FALSE
• DatabaseMetaData.updatesAreDetected()
  Always returns FALSE
• DatabaseMetaData.insertsAreDetected()
  Always returns FALSE
• PreparedStatement.execute()
  Returns a single result set
• ResultSet.getFetchSize()
  Always returns 0
• ResultSetMetaData.getCatalogName()
  Always returns a String object containing one blank space
• ResultSetMetaData.getSchemaName()
  Always returns a String object containing one blank space
• ResultSetMetaData.getTableName()
  Returns the table name for SELECT, INSERT, and UPDATE statements
  SELECT statements with more than one table name and all other statements return a String object containing one blank space.
• ResultSetMetaData.isDefinitelyWriteable()
  Always returns TRUE
• ResultSetMetaData.isReadOnly()
  Always returns FALSE
• ResultSetMetaData.isWriteable()
  Always returns TRUE
• Statement.execute()
  Returns a single result set
• Connection.isReadOnly()
  Returns TRUE only when connecting to a secondary server in HDR scenario (see the following Important note)

Important: IBM Informix servers do not currently support read-only connections. For the IBM Informix JDBC Driver, Version 2.21.JC4, the implementation of the setReadOnly() method from the java.sql.Connection interface has been changed to accept the value passed to it by the calling process. The setReadOnly() method simply returns to the calling process without any interaction to the Informix database server. (Previous versions of the JDBC driver threw an unsupported method exception.) This change has been made to synchronize the functionality present in the IBM Informix JDBC Driver to the IBM DB2® JDBC driver and also to achieve a higher level of compliance in the Sun Conformance Test (CTS).
Handle transactions

By default, all new Connection objects are in autocommit mode. When autocommit mode is on, a COMMIT statement is automatically executed after each statement that is sent to the database server. To turn off autocommit mode, explicitly call Connection.setAutoCommit(false).

When autocommit mode is off, IBM Informix JDBC Driver implicitly starts a new transaction when the next statement is sent to the database server. This transaction lasts until the user issues a COMMIT or ROLLBACK statement. If the user has already started a transaction by executing setAutoCommit(false) and then calls setAutoCommit(false) again, the existing transaction continues unchanged. The Java program must explicitly terminate the transaction by issuing either a COMMIT or a ROLLBACK statement before it drops the connection to the database or the database server.

If the Java program sets autocommit mode on during a transaction, IBM Informix JDBC Driver commits the current transaction if the JDK is version 1.4 and later. Otherwise the driver rolls back the current transaction before turning on autocommit.

In a database that has been created with logging, if a COMMIT statement is sent to the database server and autocommit mode is on, the error -255: Not in transaction is returned by the database server because there is currently no user transaction started. This occurs whether the COMMIT statement was sent with the Connection.commit() method or directly with an SQL statement.

In a database created in ANSI mode, explicitly sending a COMMIT statement to the database server commits an empty transaction. No error is returned because the database server automatically starts a transaction before it executes the statement if there is no user transaction currently open.

For an XAConnection object, autocommit mode is off by default and must remain off while a distributed transaction is occurring. The transaction manager performs commit and rollback operations; therefore, you avoid performing these operations directly.

For IBM Informix releases later than 11.50.xC2, two JDBC classes support SQL transactions that can be rolled back to a savepoint (rather than canceled in its entirety) after an adverse event is encountered:

- IfmxSavepoint (Interface)
- IfxSavepoint (Savepoint class)

JDBC applications can create, destroy, or rollback to savepoint objects through the following standard JDBC methods:

<table>
<thead>
<tr>
<th>Table 3-1. JDBC savepoint classes and methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>IfxConnection</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Table 3-1. JDBC savepoint classes and methods (continued)

<table>
<thead>
<tr>
<th>Class</th>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfxSavepoint</td>
<td>getSavepointId()</td>
<td>These two methods are not interchangeable. A call to getSavepointName() fails with an error unless the savepoint object is declared with a string argument to the setSavepoint() method or to the setSavepointUnique() method. Similarly, an error is returned if you call getSavepointId() for a named savepoint object.</td>
</tr>
<tr>
<td></td>
<td>getSavepointName()</td>
<td></td>
</tr>
</tbody>
</table>

In addition, the setSavepointUnique() method can set a named savepoint whose identifier is unique. While the unique savepoint is active, Informix issues an exception if the application attempts to reuse its name within the same connection.

The following restrictions apply to savepoint objects in JDBC:
- Savepoints are not valid within XA transactions.
- Savepoints cannot be used unless the current connection sets autocommit mode off.
- Savepoints are not valid in connections to unlogged databases.
- Savepoints cannot be referenced in a triggered action.
- In cross-server distributed queries in which any participating subordinate server does not support savepoint objects, a warning is issued if you set a savepoint after connecting to a server that does not support savepoints, and any call to rollback savepoint fails with an error.

See the descriptions of the SAVEPOINT, RELEASE SAVEPOINT, and ROLLBACK WORK TO SAVEPOINT statements in IBM Informix Guide to SQL: Syntax for more information about using savepoint objects in SQL transactions.

Handle errors

Use the JDBC API SQLException class to handle errors in your Java program. The IBM Informix-specific com.informix.jdbc.Message class can also be used outside a Java program to retrieve the IBM Informix error text for a given error number.

Handle errors with the SQLException class

Whenever an error occurs from either IBM Informix JDBC Driver or the database server, an SQLException is raised. Use the following methods of the SQLException class to retrieve the text of the error message, the error code, and the SQLSTATE value:

- getMessage()  
  Returns a description of the error. SQLException inherits this method from the java.util.Throwable class.

- getErrorCode()  
  Returns an integer value that corresponds to the Informix database server or IBM Informix JDBC Driver error code.
getSQLState()

Returns a string that describes the SQLSTATE value

The string follows the X/Open SQLSTATE conventions.

All IBM Informix JDBC Driver errors have error codes of the form -79XXX, such as -79708: Can't take null input.

For a list of Informix database server errors, see IBM Informix Error Messages. For a list of IBM Informix JDBC Driver errors, see Appendix E, “Error messages,” on page E-1.

The following example from the SimpleSelect.java program shows how to use the SQLException class to catch IBM Informix JDBC Driver or database server errors by using a try-catch block:

```java
try {
    PreparedStatement pstmt = conn.prepareStatement("Select *
    from x 
    + "where a = ?;");
    pstmt.setInt(1, 11);
    ResultSet r = pstmt.executeQuery();
    while(r.next())
    {
        short i = r.getShort(1);
        System.out.println("Select: columna=" + i);
    }
    r.close();
    pstmt.close();
} catch (SQLException e) {
    System.out.println("ERROR: Fetch statement failed: " + e.getMessage());
}
```

Retrieve the syntax error offset

To determine the exact location of a syntax error, use the getSQLStatementOffset() method to return the syntax error offset.

The following example shows how to retrieve the syntax error offset from an SQL statement (which is 10 in this example):

```java
try {
    Statement stmt = conn.createStatement();
    String command = "select * from tt";
    stmt.execute(command);
} catch(Exception e) {
    System.out.println("Error Offset :" + ((IfmxConnection conn).getSQLStatementOffset()));
    System.out.println(e.getMessage());
}
```

Catch RSAM error messages

RSAM messages are attached to SQLCODE messages. For example, if an SQLCODE message says that a table cannot be created, the RSAM message states the reason, which might be insufficient disk space.
You can use the SQLException.getNextException() method to catch RSAM error messages. For an example of how to catch these messages, see the ErrorHandling.java program, which is included in IBM Informix JDBC Driver.

### Handle errors with the com.informix.jdbc.Message class

IBM Informix provides the class `com.informix.jdbc.Message` for retrieving Informix error message text based on the Informix error number. To use this class, call the Java interpreter `java` directly, passing it an Informix error number, as shown in the following example:

```java
java com.informix.jdbc.Message 100
```

The example returns the message text for Informix error 100:

> 100: ISAM error: duplicate value for a record with unique key.

A positive error number is returned if you specify an unsigned number when using the `com.informix.jdbc.Message` class. This differs from the `finderr` utility, which returns a negative error number for an unsigned number.

### Access database metadata

To access information about an IBM Informix database, use the JDBC API `DatabaseMetaData` interface.

IBM Informix JDBC Driver implements all the JDBC 3.0 specifications for `DatabaseMetaData` methods.

The following new methods in `DatabaseMetaData` have been added in IBM Informix JDBC Driver 2.21.JC5 and later for JDBC 3.0 compliance:

- `getSuperTypes()`
- `getSuperTables()`
- `getAttributes()`
- `getResultSetHoldability()`
- `getDatabaseMajorVersion()`
- `getDatabaseMinorVersion()`
- `getJDBCMajorVersion()`
- `getJDBCMinorVersion()`
- `getSQLStateType()`
- `locatorsUpdateCopy()`
- `supportsGetGeneratedKeys()`
- `supportsMultipleOpenResults()`
- `supportsNamedParameters()`
- `supportsGetGeneratedKeys()`
- `supportsMultipleOpenResults()`

Starting with IBM Informix 10.0 and IBM Informix JDBC Driver 3.0, methods have been implemented to retrieve server-generated keys. Retrieving autogenerated keys involves the following actions:

1. The JDBC application programmer provides an SQL statement to be executed.
2. The server executes the SQL statement and an indication that autogenerated keys can be retrieved is returned.

3. Before the server executes the SQL statement, columnNames or columnIndexes (if provided) are validated. An SQLException is thrown if they are invalid.

4. If requested, the JDBC driver and server returns a resultSet object. If no keys were generated, the resultSet is empty, containing no rows or columns.

5. The user can request metadata for the resultSet object, and the JDBC driver and server returns a ResultSetMetaData Object.

For more information about retrieving autogenerated keys, see the JDBC 3.0 Specification, Section 13.6, “Retrieving Auto Generated Keys.”

IBM Informix JDBC Driver uses the sysmaster database to get database metadata. If you want to use the DatabaseMetaData interface in your Java program, the sysmaster database must exist in the Informix database server to which your Java program is connected. For example, IBM Informix SE does not have a sysmaster database, therefore you cannot use the DatabaseMetaData interface with it.

IBM Informix JDBC Driver interprets the JDBC API term schemas to mean the names of Informix users who own tables. The DatabaseMetaData getSchemas() method returns all the users found in the owner column of the systables system catalog.

Similarly, IBM Informix JDBC Driver interprets the JDBC API term catalogs to mean the names of Informix databases. The DatabaseMetaData getCatalogs() method returns the names of all the databases that currently exist in the Informix database server to which your Java program is connected.

The example DBMetaData.java shows how to use the DatabaseMetaData and ResultSetMetaData interfaces to gather information about a new procedure. Refer to Appendix A, “Sample code files,” on page A-1 for more information about this example.

---

**Other Informix extensions to the JDBC API**

This section describes the IBM Informix-specific extensions to the JDBC API not already discussed in this guide. These extensions handle information that is specific to IBM Informix databases.

Another Informix extension, the com.informix.jdbc.Message class, is fully described in “Handle errors” on page 3-21.

---

**The Auto Free feature**

If you enable the IBM Informix Auto Free feature, the database server automatically frees the cursor when it closes the cursor. Therefore, your application does not have to send two separate requests to close and then free the cursor—closing the cursor is sufficient.

You can enable the Auto Free feature by setting the IFX_AUTOFREE variable to TRUE in the database URL, as in this example:

```sql
jdbc:informix-sqli://123.45.67.89:1533:INFORMIXSERVER=myserver;
user=rdtest;password=test;ifx_autofree=true;
```
You can also use one of the following methods:

```java
public void setAutoFree (boolean flag)
public boolean getAutoFree()
```

The setAutoFree() method should be called before the executeQuery() method, but the getAutoFree() method can be called before or after the executeQuery() method.

To use these methods, your applications must import classes from the Informix package `com.informix.jdbc` and cast the `Statement` class to the `IfmxStatement` class, as shown here:

```java
import com.informix.jdbc.*;
(IfmxStatement)stmt.setAutoFree(true);
```

The Auto Free feature is available for the following database server versions:

- Version 7.23 and later
- Version 9.0 and later

### Obtaining driver version information

There are two ways to obtain version information about IBM Informix JDBC Driver: from your Java program or from the UNIX or MS-DOS command prompt.

To get version information from your Java program:

1. Import the Informix package `com.informix.jdbc.*` into your Java program by adding the following line to the import section:
   ```java
   import com.informix.jdbc.*;
   ```
2. Invoke the static method `IfxDriver.getJDBCVersion()`. This method returns a `String` object that contains the complete version of the current IBM Informix JDBC Driver.
   
   An example of a version of IBM Informix JDBC Driver is 2.00.JC1.

   The `IfxDriver.getJDBCVersion()` method returns only the version, not the serial number you provided during installation of the driver.

   **Important:** For version X.Y of IBM Informix JDBC Driver, the JDBC API methods `Driver.getMajorVersion()` and `DatabaseMetaData.getDriverMajorVersion()` always return the value X. Similarly, the methods `Driver.getMinorVersion()` and `DatabaseMetaData.getDriverMinorVersion()` always return the value Y.

To get the version of IBM Informix JDBC Driver from the command line, enter the following command at the UNIX shell prompt or the Windows command prompt:

```
java com.informix.jdbc.Version
```

The command also returns the serial number you provided when you installed the driver.

### Store and retrieve XML documents

Extensible Markup Language (XML), as defined by the World Wide Web Consortium (W3C) provides rules, guidelines, and conventions for describing structured data in a plain text, editable file (called an XML document). XML uses tags only to delimit pieces of data, leaving the interpretation of the data to the application that uses it. XML is an method of representing data in an open, platform-independent format.
The currently available API for accessing XML documents is called JAXP (Java API for XML Parsing). The API has the following two subsets:

- **Simple API for XML (SAX)** is an event-driven protocol, with the programmer providing the callback methods that the XML parser invokes when it analyzes a document.

- **Document Object Model (DOM)** is a random-access protocol, which converts an XML document into a collection of objects in memory that can be manipulated at the programmers discretion. DOM objects have the data type `Document`.

JAXP also contains a *plugability layer* that standardizes programmatic access to SAX and DOM by providing standard factory methods for creating and configuring SAX parsers and creating DOM objects.

IBM Informix extensions to the JDBC API facilitate storage and retrieval of XML data in database columns. The methods used during data storage assist in parsing the XML data, verify that well-formed and valid XML data is stored, and ensure that invalid XML data is rejected. The methods used during data retrieval assist in converting the XML data to DOM objects and to type **InputSource**, which is the standard input type to both SAX and DOM methods. The Informix extensions are designed to support XML programmers while still providing flexibility regarding which JAXP package the programmer is using.

**Set up your environment to use XML methods**

This section contains information you need to know to prepare your system to use the JDBC driver XML methods.

**Set your CLASSPATH**

To use the XML methods, add the path names of the following files to your CLASSPATH setting:

- `ifxtools.jar`
- `xerces.jar`

All of these files are located in the `lib` directory where you installed your driver.

The Xerces XML library `xerces.jar` has been removed from distribution with the IBM Informix JDBC Driver, Version 3.00.

The XML methods are not part of the `ifxjdbc.jar` file. Instead, they are released in a separate `.jar` file named `ifxtools.jar`. To use the methods, you must add this file to your CLASSPATH setting along with `ifxjdbc.jar`.

In addition, building `ifxtools.jar` requires that you use code from a `.jar` file that supports the SAX, DOM, and JAXP methods. To use `ifxtools.jar`, you must add these `.jar` files to your CLASSPATH setting.

JDK version 1.4 or later uses the default XML parser even if the `xml4j` parser is in the CLASSPATH. To use the `xml4j` implementation of the SAX parser, set the following system properties in the application code or use the `-D` command-line option:

- The property `javax.xml.parsers.SAXParserFactory` must be set to `org.apache.xerces.jaxp.SAXParserFactoryImpl`. 

For more info about how to set the properties, see "Specify a parser factory."

**Specify a parser factory**

By default, the xml4j xerces parser (and as a result, ifxtools.jar) uses the non-validating XML parser. To use an alternative SAX parser factory, run your application from the command line as follows:

```shell
% java -Djavax.xml.parsers.SAXParserFactory=new-factory
```

If you are not running from the command line, the factory name must be enclosed in double quotation marks:

```shell
% java -Djavax.xml.parsers.SAXParserFactory="new-factory"
```

You can also set a system property in your code:

```java
System.setProperty("javax.xml.parsers.SAXParserFactory", "new-factory")
```

In this code, `new-factory` is the alternative parser factory. For example, if you are using the xerces parser, then `new-factory` is replaced by `org.apache.xerces.jaxp.SAXParserFactoryImpl`.

It is also possible to use an alternative document factory for DOM methods. Run your application from the command line as follows:

```shell
% java -Djavax.xml.parsers.DocumentBuilderFactory=new-factory
```

If you are not running from the command line, the factory name must be enclosed in double quotation marks:

```shell
% java -Djavax.xml.parsers.DocumentBuilderFactory="new-factory"
```

You can also set a system property in your code:

```java
System.setProperty("javax.xml.parsers.DocumentBuilderFactory", "new-factory")
```

For example, if you are using the xerces parser, then `new-factory` is replaced by `org.apache.xerces.jaxp.DocumentBuilderFactoryImpl`.

**Insert data**

You can use the methods in this section to insert XML data into a database column.

The parameters in method declarations in this section have the following meanings:

- The *file* parameter is an XML document. The document can be referenced by a URL (such as `http://server/file.xml` or `file:///path/file.xml`) or a path name (such as `/tmp/file.xml` or `c:\work\file.xml`).
- The *handler* parameter is an optional class you supply, containing callback routines that the SAX parser invokes as it is parsing the file. If no value is specified, or if *handler* is set to `NULL`, the driver uses empty callback routines that echo success or failure (the driver reports failure in the form of an `SQLException`).
• The `validating` parameter tells the SAX parser factory to use a validating parser instead of a parser that only checks form.

  If you do not specify `nsa` or `validating`, the driver uses the xml4j nonvalidating XML parser. To change the default, see “Specify a parser factory” on page 3-27.

• The `nsa` parameter tells the SAX parser factory whether it can use a parser that can handle namespaces.

The following methods parse a file by using SAX and convert it to a string. You can then use the string returned by these methods as input to the `PreparedStatement.setString()` method to insert the data into a database column.

```java
public String XMLtoString(String file, String handler, boolean validating, boolean nsa) throws SQLException

public String XMLtoString(String file, String handler) throws SQLException

public String XMLtoString(String file) throws SQLException
```

The following methods parse a file by using SAX and convert it to an object of class `InputStream`. You can then use the `InputStream` object as input to the `PreparedStatement.setAsciiStream()`, `PreparedStatement.setBinaryStream()`, or `PreparedStatement.setObject()` methods to insert the data into a database column.

```java
public InputStream XMLtoInputStream(String file, String handler, boolean validating, boolean nsa) throws SQLException;

public InputStream XMLtoInputStream(String file, String handler) throws SQLException;

public InputStream XMLtoInputStream(String file) throws SQLException;
```

For examples of using these methods, see “Insert data examples” on page 3-29.

If no value is specified, or if `handler` is set to `NULL`, the driver uses the default IBM Informix handler.

**Important:** The driver truncates any input data that is too large for a column. For example, if you insert the `x.xml` file into a column of type `char (55)` instead of a column of type `char (255)`, the driver inserts the truncated file with no errors (the driver throws an SQLWarn exception, however). When the truncated row is selected, the parser throws a SAXParseException because the row contains invalid XML.

### Retrieve data

You can use the methods in this section to convert XML data that has been fetched from a database column. These methods help you either convert selected XML text to DOM or parse the data with SAX. The `InputSource` class is the input type to JAXP parsing methods.

For information about the `file`, `handler`, `nsa`, and `validating` parameters, see “Insert data” on page 3-27.

The following methods convert objects of type `String` or `InputStream` to objects of type `InputSource`. You can use the `ResultSet.getString()`, `ResultSet.getAsciiStream()`, or `ResultSet.getBinaryInputStream()` methods to retrieve the data from the database.
column and then pass the retrieved data to getInputSource() for use with any of the SAX or DOM parsing methods. (For an example, see “Retrieve data examples” on page 3-30.)

```java
public InputSource getInputSource(String s) throws SQLException;
public InputSource getInputSource(InputStream is) throws SQLException;
```

The following methods convert objects of type String or InputStream to objects of type Document:

```java
public Document StringtoDOM(String s, String handler, boolean validating, boolean nsa) throws SQLException;
public Document StringtoDOM(String s, String handler) throws SQLException;
public Document StringtoDOM(String s) throws SQLException;
public Document InputStreamtoDOM(String s, String handler, boolean validating, boolean nsa) throws SQLException;
public Document InputStreamtoDOM(String s, String handler) throws SQLException;
public Document InputStreamtoDOM(String file) throws SQLException;
```

For examples of using these methods, see “Retrieve data examples” on page 3-30.

**Insert data examples**

The examples in this section illustrate converting XML documents to formats acceptable for insertion into IBM Informix database columns.

**The XMLtoString() examples**

The following example converts three XML documents to character strings and then uses the strings as parameter values in an SQL INSERT statement:

```java
PreparedStatement p = conn.prepareStatement("insert into tab values(?,?,?)");
p.setString(1, UtilXML.XMLtoString("/home/file1.xml"));
p.setString(2, UtilXML.XMLtoString("http://server/file2.xml");
p.setString(3, UtilXML.XMLtoString("file3.xml");
```

The following example inserts an XML file into an LVARCHAR column. In this example, tab1 is a table created with the SQL statement:

```sql
create table tab1 (col1 lvarchar);
```

The code is:

```java
try {
    String cmd = "insert into tab1 values (?)";
    PreparedStatement pstmt = conn.prepareStatement(cmd);
    pstmt.setString(1, UtilXML.XMLtoString("/tmp/x.xml"));
pstmt.execute();
pstmt.close();
    } 
catch (SQLException e) {
    // Error handling
    }
```

Chapter 3. Perform database operations  3-29
**The XMLtoInputStream() example**

The following example inserts an XML file into a text column. In this example, table `tab2` is created with the SQL statement:

```
create table tab2 (col1 text);
```

The code is:
```java
try {
    String cmd = "insert into tab2 values (?)";
    PreparedStatement pstmt = conn.prepareStatement(cmd);
    pstmt.setAsciiStream(1, UtilXML.XMLtoInputStream("/tmp/x.xml"),
            (int)(new File("/tmp/x.xml").length()));
    pstmt.execute();
    pstmt.close();
} catch (SQLException e) {
    // Error handling
}
```

**Retrieve data examples**

The following examples illustrate retrieving data from IBM Informix database columns and converting the data to formats acceptable to XML parsers.

**The StringtoDOM() example**

This example operates under the assumption that `xmlcol` is a column of type `lvarchar` that contains XML data. The data could be fetched and converted to DOM with the following code:
```java
ResultSet r = stmt.executeQuery("select xmlcol from table where ...");
while (r.next()) {
    Document doc = UtilXML.StringtoDOM(r.getString("xmlcol"));
    // Process 'doc'
}
```

**The InputStreamtoDOM() example**

The following example fetches XML data from a text column into a DOM object:
```java
try {
    String sql = "select col1 from tab2";
    Statement stmt = conn.createStatement();
    ResultSet r = stmt.executeQuery(sql);
    while (r.next()) {
        Document doc = UtilXML.InputStreamtoDOM(r.getAsciiStream(1));
    }
    r.close();
} catch (Exception e) {
    // Error handling
}
```
The `getInputSource()` examples

This example retrieves the XML data stored in column `xmlcol` and converts it to an object of type `InputSource`; the `InputSource` object `i` can then be used with any SAX or DOM parsing methods:

```java
InputSource i = UtilXML.getInputSource(resultset.getString("xmlcol"));
```

This example uses the implementation of JAXP API, in `xerces.jar`, to parse fetched XML data in column `xmlcol`:

```java
InputSource input = UtilXML.getInputSource(resultset.getString("xmlcol"));
SAXParserFactory f = SAXParserFactory.newInstance();
SAXParser parser = f.newSAXParser();
parser.parse(input);
```

In the examples that follow, `tab1` is a table created with the SQL statement:

```sql
create table tab1 (col1 lvarchar);
```

The following example fetches XML data from an `LVARCHAR` column into an `InputSource` object for parsing. This example uses SAX parsing by invoking the parser at `org.apache.xerces.parsers.SAXParser`.

```java
try {
    String sql = "select col1 from tab1";
    Statement stmt = conn.createStatement();
    ResultSet r = stmt.executeQuery(sql);
    Parser p = ParserFactory.makeParser("org.apache.xerces.parsers.SAXParser");
    while(r.next())
    {
        InputSource i = UtilXML.getInputSource(r.getString(1));
        p.parse(i);
    }
    r.close();
} catch (SQLException e) {
    // Error handling
}
```

The following example fetches XML data from a text column into an `InputSource` object for parsing. This example is the same example as the previous one, but it uses JAXP factory methods instead of the SAX parser to analyze the data.

```java
try {
    String sql = "select col1 from tab2";
    Statement stmt = conn.createStatement();
    ResultSet r = stmt.executeQuery(sql);
    SAXParserFactory factory = SAXParserFactory.newInstance();
    Parser p = factory.newSAXParser();
    while(r.next())
    {
        InputSource i = UtilXML.getInputSource(r.getAsciiStream(1));
        p.parse(i);
    }
    r.close();
} catch (Exception e) {
    // Error handling
}
```
Chapter 4. Work with Informix types

These topics explain the data types that are specific to IBM Informix (other than opaque types) supported in IBM Informix JDBC Driver. For information about opaque types, see Chapter 5, “Work with opaque types,” on page 5-1.

Distinct data types

A distinct type can map to the underlying base type or to a user-defined Java object. For example, a distinct type of INT can map to int or to a Java object that encapsulates the data representation. This Java object must implement the java.sql.SQLData interface. You must provide a custom type map as described in Appendix C, “Mapping data types,” on page C-1, to map this Java object to the corresponding SQL type name.

Insert data examples

The following example shows an SQL statement that defines a distinct type:

```sql
CREATE DISTINCT TYPE mymoney AS NUMERIC(10, 2);
CREATE TABLE distinct_tab (mymoney_col mymoney);
```

The following is an example of mapping to the base type:

```java
String s = "insert into distinct_tab (mymoney_col) values (?)";
System.out.println(s);
pstmt = conn.prepareStatement(s);
...
BigDecimal bigDecObj = new BigDecimal(123.45);
pstmt.setBigDecimal(1, bigDecObj);
System.out.println("setBigDecimal...ok");
pstmt.executeUpdate();
```

When you map to the underlying type, IBM Informix JDBC Driver performs the mapping on the client side because the database server provides implicit casting between the underlying type and the distinct type.

You can also map distinct types to Java objects that implement the SQLData interface. The following example shows an SQL statement that defines a distinct type:

```sql
CREATE DISTINCT TYPE mymoney AS NUMERIC(10, 2)
```

The following code maps the distinct type to a Java object named MyMoney:

```java
import java.sql.*;
import com.informix.jdbc.*;
public class myMoney implements SQLData {
    private String sql_type = "mymoney";
    public java.math.BigDecimal value;
    public myMoney() {
    }
    public myMoney(java.math.BigDecimal value) {
        this.value = value;
    }
    public String getSQLTypeName()
```


```java
public void readSQL(SQLInput stream, String type) throws SQLException
{
    sql_type = type;
    value = stream.readBigDecimal();
}

public void writeSQL(SQLOutput stream) throws SQLException
{
    stream.writeBigDecimal(value);
}

// overrides Object.equals()
public boolean equals(Object b)
{
    return value.equals(((myMoney)b).value);
}

public String toString()
{
    return "value" + value;
}
```

... String s = "insert into distinct_tab (mymoney_col) values (?)";
 pstmt = conn.prepareStatement(s);
 myMoney mymoney = new myMoney();
 mymoney.value = new java.math.BigDecimal(123.45);
 pstmt.setObject(1, mymoney);
 System.out.println("setObject(myMoney)...ok");
 pstmt.executeUpdate();

In this case, you use the setObject() method instead of the setBigDecimal() method to insert data.

**Retrieve data example**

You can fetch a distinct type as its underlying base type or as a Java object, if the mapping is defined in a custom type map. Using the previous example, you can fetch the data as a Java object, as shown in the following example:

```java
java.util.Map customtypemap = conn.getTypeMap();
System.out.println("getTypeMap...ok");
if (customtypemap == null) {
    System.out.println("\n***ERROR: typemap is null!\n");
    return;
}
customtypemap.put("mymoney", Class.forName("myMoney"));

... String s = "select mymoney_col from distinct_tab order by 1";
try {
    Statement stmt = conn.createStatement();
    ResultSet rs = stmt.executeQuery(s);
    System.out.println("Fetching data ...");
    int curRow = 0;
    while (rs.next()) {
        curRow++;
        myMoney mymoneyret = (myMoney)rs.getObject("mymoney_col");
    }
    System.out.println("total rows expected: " + curRow);
```

4-2 IBM Informix JDBC Driver Programmer's Guide
stmt.close();
}
catch (SQLException e)
{
    System.out.println("***ERROR: " + e.getErrorCode() + " " +
    e.getMessage());
    e.printStackTrace();
}

In this case, you use the getObject() method instead of the getBigDecimal() method to retrieve data.

Unsupported methods

The following methods of the SQLInput and SQLOutput interfaces are not supported for distinct types:

- java.sql.SQLInput
  - readArray()
  - readCharacterStream()
  - readRef()
- java.sql.SQLOutput
  - writeArray()
  - writeCharacterStream(Reader x)
  - writeRef(Ref x)

BYTE and TEXT data types

This section describes the IBM Informix BYTE and TEXT data types and how to manipulate columns of these data types with the JDBC API.

The BYTE data type is a data type for a simple large object that stores any data in an undifferentiated byte stream. Examples of this binary data include spreadsheets, digitized voice patterns, and video clips. The TEXT data type is a data type for a simple large object that stores any text data. It can contain both single and multibyte characters.

Columns of either data type have a theoretical limit of \(2^{31}\) bytes and a practical limit determined by your disk capacity.

For more detailed information about the Informix BYTE and TEXT data types, see IBM Informix Guide to SQL: Reference and IBM Informix Guide to SQL: Syntax.

Cache large objects

Whenever an object of type BLOB, CLOB, text, or byte is fetched from the database server, the data is cached in client memory. If the size of the large object is bigger than the value in the LOBCACHE environment variable, the large object data is stored in a temporary file. For more information about the LOBCACHE variable, see "Manage memory for large objects" on page 7-2.

Example: Inserting or updating data

To insert into or update BYTE and TEXT columns, read a stream of data from a source, such as an operating system file, and transmit it to the database as a java.io.InputStream object. The PreparedStatement interface provides methods for
setting an input parameter to this Java input stream. When the statement is 
executed, IBM Informix JDBC Driver makes repeated calls to the input stream, 
reading its contents and transmitting those contents as the actual parameter data to 
the database.

For BYTE data types, use the PreparedStatement.setBinaryStream() method to set 
the input parameter to the InputStream object. For TEXT data types, use the 

The following example from the ByteType.java program shows how to insert the 
contents of the operating system file data.dat into a column of data type BYTE:

```java
try {
    stmt = conn.createStatement();
    stmt.executeUpdate("create table tab1(col1 byte)");
} catch (SQLException e) {
    System.out.println("Failed to create table ..." + e.getMessage());
}

try {
    pstmt = conn.prepareStatement("insert into tab1 values (?)");
} catch (SQLException e) {
    System.out.println("Failed to Insert into tab: " + e.toString());
}

File file = new File("data.dat");
int fileLength = (int) file.length();
InputStream value = null;
FileInputStream fileinp = null;
int row = 0;
String str = null;
int rc = 0;
ResultSet rs = null;

System.out.println("Inserting data ...
")

try {
    fileinp = new FileInputStream(file);
    value = (InputStream)fileinp;
} catch (Exception e) {}

try {
    pstmt.setBinaryStream(1,value,10); //set 1st column
} catch (SQLException e) {
    System.out.println("Unable to set parameter");
}

set_execute();

... 
public static void set_execute()
{
    try 
```
The example first creates a `java.io.File` object that represents the operating system file `data.dat`. The example then creates a `FileInputStream` object to read from the object of type `File`. The object of type `FileInputStream` is cast to its superclass `InputStream`, which is the expected data type of the second parameter to the `PreparedStatement.setBinaryStream()` method. The `setBinaryStream()` method executes on the already prepared INSERT statement, which sets the input stream parameter. Finally, the `PreparedStatement.executeUpdate()` method executes, which inserts the contents of the `data.dat` operating system file into the column of type `BYTE`.

The `TextType.java` program shows how to insert data into a column of type `TEXT`. It is similar to inserting into a column of type `BYTE`, except the method `setAsciiStream()` is used to set the input parameter instead of `setBinaryStream()`.

### Example: Selecting data

After you select from a table into a `ResultSet` object, you can use the `ResultSet.getBinaryStream()` method to retrieve a stream of binary or ASCII data from the columns of type `BYTE`. You can also use the `ResultSet.getAsciiStream()` method to retrieve a stream of binary or ASCII data from the columns of type `TEXT`. Both methods return an `InputStream` object, which can be used to read the data in chunks.

All the data in the returned stream in the current row must be read before you call the `next()` method to retrieve the next row.

The following example from the `ByteType.java` program shows how to select data from a column of type `BYTE` and print out the data to the standard output device:

```java
try {
    stmt = conn.createStatement();
    rs = stmt.executeQuery("Select * from tab1");
    while( rs.next() )
    {
        row++;
        value = rs.getBinaryStream(1);
        dispValue(value);
    }
} catch (Exception e) { }
```

```java
public static void dispValue(InputStream in)
{
    int size;
    byte buf;
    int count = 0;
    try
    {
        size = in.available();
```
byte ary[] = new byte[size];
buf = (byte) in.read();
while(buf!=-1)
{
    ary[count] = buf;
    count++;
    buf = (byte) in.read();
}

The example first puts the result of a SELECT statement into a ResultSet object. It then executes the method ResultSet.getBinaryStream() to retrieve the BYTE data into a Java InputStream object.

The method dispValue(), whose Java code is also included in the example, is used to print out the contents of the column to the standard output device. The dispValue() method uses byte arrays and the InputStream.read() method to systematically read the contents of the column of type BYTE.

The TextType.java program shows how to select data from a column of type TEXT. It is similar to selecting from a column of type BYTE, except the getAsciiStream() method is used instead of getBinaryStream().

**SERIAL and SERIAL8 data types**

IBM Informix JDBC Driver provides support for the Informix SERIAL and SERIAL8 data types through the methods getSerial() and getSerial8(), which are part of the implementation of the java.sql.Statement interface.

Because the SERIAL and SERIAL8 data types do not have an obvious mapping to any JDBC API data types from the java.sql.Types class, you must import classes that are specific to Informix into your Java program to handle SERIAL and SERIAL8 columns. To do this, add the following import line to your Java program:

```java
import com.informix.jdbc.*;
```

Use the getSerial() method after an INSERT statement to return the serial value that was automatically inserted into the SERIAL column of a table. Use the getSerial8() method after an INSERT statement to return the serial value that was automatically inserted into the SERIAL8 column of a table. The methods return 0 if any of the following conditions are true:

- The last statement was not an INSERT statement.
- The table being inserted into does not contain a SERIAL or SERIAL8 column.
- The INSERT statement has not executed yet.

If you execute the getSerial() or getSerial8() method after a CREATE TABLE statement, the method returns 1 by default (assuming the new table includes a SERIAL or SERIAL8 column). If the table does not contain a SERIAL or SERIAL8 column, the method returns 0. If you assign a new serial starting number, the method returns that number.
If you want to use the getSerial() and getSerial8() methods, you must cast the 
Statement or PreparedStatement object to IfmxStatement, the implementation of 
the Statement interface, which is specific to Informix. The following example 
shows how to perform the cast:

```java
cmd = "insert into serialTable(i) values (100)";
stmt.executeUpdate(cmd);
System.out.println(cmd + "...okay");
int serialValue = ((IfmxStatement)stmt).getSerial();
System.out.println("serial value: " + serialValue);
```

If you want to insert consecutive serial values into a column of data type SERIAL 
or SERIAL8, specify a value of 0 for the SERIAL or SERIAL8 column in the 
INSERT statement. When the column is set to 0, the database server assigns the 
next-highest value.

For more detailed information about the Informix SERIAL and SERIAL8 data 
types, see the IBM Informix Guide to SQL: Reference and the IBM Informix Guide to 
SQL: Syntax.

---

**BIGINT and BIGSERIAL data types**

The BIGINT and BIGSERIAL data types have the same range of values as INT8 
and SERIAL8 data types. However, BIGINT and BIGSERIAL have advantages for 
storage and computation over INT8 and SERIAL8.

Both the BIGINT and BIGSERIAL data types map to the to BIGINT Java type in 
the class java.sql.Types. When data is retrieved from the database, the BIGINT and 
BIGSERIAL data types map to long Java Type.

The Informix JDBC Driver provides support for the Informix BIGSERIAL and 
BIGINT data types through the getBigSerial() method, which is a part of the 
java.sql.Statement interface

Because the BIGSERIAL and BIGINT data types do not have an obvious mapping 
to any JDBC API data types from the java.sql.Types class, you must import classes 
that are specific to Informix into your Java program to handle BIGSERIAL and 
BIGINT columns. To do this, add the following import line to your Java program:

```java
import com.informix.jdbc.*;
```

Use the getBigSerial() method after an INSERT statement to return the value that 
was inserted into the BIGSERIAL or BIGINT column of a table.

If you want to use the getBigSerial() method, you must cast the Statement or 
PreparedStatement object to IfmxStatement, the implementation of the Statement 
interface, which is specific to Informix. The following example shows how to 
perform the cast:

```java
cmd = "insert into bigserialTable(i) values (100)";
stmt.executeUpdate(cmd);
System.out.println(cmd + "...okay");
long serialValue = ((IfmxStatement)stmt).getBigSerial();
System.out.println("serial value: " + serialValue);
```

These types are part of the com.informix.lang.IfxTypes class. See the "The 
IfxTypes class" on page C-8 table for the IfxTypes constants and the corresponding 
Informix data types.
INTERVAL data type

The IBM Informix INTERVAL data type stores a value that represents a span of time. INTERVAL data types comprise two types: year-month intervals and day-time intervals. A year-month interval can represent a span of years and months, and a day-time interval can represent a span of days, hours, minutes, seconds, and fractions of a second. For more information about the INTERVAL data type and definitions of qualifier, precision, and fraction, see the following publications:

- IBM Informix Guide to SQL: Tutorial
- IBM Informix Guide to SQL: Reference
- IBM Informix Guide to SQL: Syntax

The Interval class

The com.informix.lang.Interval class is an IBM Informix-specific extension to the JDBC specification. Interval is the base class for the INTERVAL data type. Interval has two subclasses: IntervalYM (for year-month qualifiers) and IntervalDF (for day-time qualifiers). You use these subclasses to create and manipulate INTERVAL data types.

Tip: Many of the Interval, IntervalYM, and IntervalDF constructors take a Connection object as a parameter. This passes the value of the CLIENT_LOCALE environment variable to the Interval, IntervalYM, or IntervalDF object, which allows the display of localized error messages if an exception is thrown. For more information, see “Support for globalized error messages” on page 6-14.

For information about the string INTERVAL formats in this section, see the IBM Informix Guide to SQL: Syntax.

This section discusses many of the methods you can use with the INTERVAL data types. For complete reference information, see the online reference documentation in the directory doc/javadoc/* after you install your software. (The doc directory is a subdirectory of the directory where you installed IBM Informix JDBC Driver.)

Variables for binary qualifiers

You can use string qualifiers to manipulate INTERVAL data types, but using binary qualifiers results in faster performance. The following variables are defined in the Interval base class and represent the time unit (start and end code) of a field in the binary qualifier. To use these variables, instantiate objects of the IntervalYM and IntervalDF classes, which inherit these variables from the Interval base class.

TU_YEAR
   Time unit for the YEAR qualifier field

TU_MONTH
   Time unit for the MONTH qualifier field

TU_DAY
   Time unit for the DAY qualifier field

TU_HOUR
   Time unit for the HOUR qualifier field

TU_MINUTE
   Time unit for the MINUTE qualifier field
TU_SECOND
Time unit for the SECOND qualifier field

TU_FRAC
Time unit for the leading FRACTION qualifier field

TU_F1 Time unit for the ending field of the first position of FRACTION
TU_F2 Time unit for the ending field of the second position of FRACTION
TU_F3 Time unit for the ending field of the third position of FRACTION
TU_F4 Time unit for the ending field of the fourth position of FRACTION
TU_F5 Time unit for the ending field of the fifth position of FRACTION

Interval methods

You can use the Interval methods to extract information about binary qualifiers. To use these methods, instantiate objects of the IntervalYM and IntervalDF classes, which inherit these variables from the Interval base class.

Some of the tasks you can perform and the methods you can use follow:

• Extracting the length of a qualifier:
  public static byte getLength(short qualifier)

• Extracting the starting field code (one of the TU_XXX variables) from a qualifier:
  public static byte getStartCode(short qualifier)

• Extracting the ending field code (one of the TU_XXX variables) from a qualifier:
  public static byte getEndCode(short qualifier)

• Obtaining the string value that corresponds to the TU_XXX value of part of an interval (for example, getFieldName(TU_YEAR) returns the string year):
  public static String getFieldName(byte code)

• Obtaining the entire name of the interval as a character string, taking a qualifier as input:
  public static String getIfxTypeName(int type, short qualifier)

• Obtaining the number of digits in the FRACTION part of the INTERVAL data type:
  public static byte getScale(short qualifier)

• Creating a binary qualifier from a length, start code (TU_XXX), and end code (TU_XXX):
  public static short getQualifier(byte length, byte startCode, byte endCode) throws SQLException

  For example, getQualifier(4, TU_YEAR, TU_MONTH) creates a binary representation of the YEAR TO MONTH qualifier.

The IntervalYM class

The com.informix.lang.IntervalYM class allows you to manipulate year-month intervals.

The IntervalYM constructors

The default constructor is defined as follows:
public IntervalYM() throws SQLException
Use this second version of the constructor to display localized error messages if an exception is thrown:

```java
public IntervalYM(Connection conn) throws SQLException
```

Use the following constructors to create year-month intervals from specific input values:

- **Two time stamps, returning the IntervalYM value that equals Timestamp1 - Timestamp2:**
  ```java
  public IntervalYM(Timestamp t1, Timestamp t2) throws SQLException
  ```
  ```java
  public IntervalYM(Timestamp t1, Timestamp t2, Connection conn) throws SQLException
  ```
  The second version allows you to support localized error messages.

- **Year and month values (large month values are converted to year):**
  ```java
  public IntervalYM(int years, int months) throws SQLException
  ```
  ```java
  public IntervalYM(int years, int months, Connection conn) throws SQLException
  ```
  The second version allows you to support localized error messages.

- **A month value and the encoded qualifier:**
  ```java
  public IntervalYM(int months, short qualifier, Connection conn) throws SQLException
  ```
  To specify the qualifier, you can use the getQualifier() method described in "Interval methods" on page 4-9. This constructor supports localized error messages.

- **A string:**
  ```java
  public IntervalYM(String string) throws SQLException
  ```
  ```java
  public IntervalYM(String string, Connection conn) throws SQLException
  ```
  The second version allows you to support localized error messages.

- **A string and qualifier:**
  ```java
  public IntervalYM(String string, short qualifier, Connection conn) throws SQLException
  ```
  To specify the qualifier, you can use the getQualifier() method described in "Interval methods" on page 4-9. This constructor supports localized error messages.

- **A string and qualifier information:**
  ```java
  public IntervalYM(String string, int length, byte startCode, byte endCode) throws SQLException
  ```
  ```java
  public IntervalYM(String string, int length, byte startCode, byte endCode, Connection conn) throws SQLException
  ```
  The second version allows you to support localized error messages.

### The IntervalYM methods

The following methods allow you to manipulate year-month intervals. (You can also use the Interval methods, described previously.) Some of the tasks you can perform with IntervalYM methods include the following:

- **Comparing two intervals:**
  ```java
  boolean equals(Object other)
  ```
  ```java
  boolean greaterThan(IntervalYM other)
  ```
  ```java
  boolean lessThan(IntervalYM other)
  ```
• Setting a value for an interval from:
  – A string:
    void fromString(String other)
    void set(String string)
  – Year and month values (large month values are converted to years):
    void set(int years, int months)
  – Two time stamps:
    void set(Timestamp t1, Timestamp t2)
• Setting the qualifier for an interval:
  – From the length, start code, and end code:
    void setQualifier(int length, byte startcode, byte endcode)
  – Using an existing qualifier:
    void setQualifier(short qualifier)
• Obtaining the number of months in the interval:
  long getMonths()
• Creating a string representation of the interval in the format yyyy-mm:
  String toString()
  The fields present depend on the qualifier. Blanks replace leading zeros.

The IntervalDF class

The com.informix.lang.IntervalDF class allows you to manipulate intervals.

The IntervalDF constructors

The default constructor is defined as follows:
public IntervalDF() throws SQLException

Use this second version of the default constructor to display localized error messages if an exception is thrown:
public IntervalDF(Connection conn) throws SQLException

Use the following constructors to create intervals from specific input values:
• Two time stamps t1 and t2, returning the IntervalDF value that equals t1 - t2:
  public IntervalDF(Timestamp t1, Timestamp t2)
  throws SQLException
  public IntervalDF(Timestamp t1, Timestamp t2, Connection conn)
  throws SQLException
  The second version allows you to support localized error messages.
• A number of seconds and nanoseconds (large second values are converted to minutes, hours, or days):
  public IntervalDF(long seconds, long nanos)
  throws SQLException
  public IntervalDF(long seconds, long nanos, Connection conn)
  throws SQLException
  The second version allows you to support localized error messages.
• A number of seconds, a number of nanoseconds, and qualifier:
public IntervalDF(long seconds, long nanos, short qualifier)
    throws SQLException

public IntervalDF(long seconds, long nanos, short qualifier, Connection conn)
    throws SQLException

To specify the qualifier, you can use the getQualifier() method described in
"Interval methods" on page 4-9. The second version allows you to support
localized error messages.

• A string:
  public IntervalDF(String string)
      throws SQLException
  public IntervalDF(String string, Connection conn)
      throws SQLException

  The second version allows you to support localized error messages.
  When you use these constructors, the default qualifier is set to the following
  values:
  leading field precision: 2 start code: TU_DAY end code: TU_F5
  For information about string INTERVAL formats, see the IBM Informix Guide to
  SQL: Syntax.

• A string and a qualifier:
  public IntervalDF(String string, short qualifier)
      throws SQLException

  public IntervalDF(String string, short qualifier, Connection conn)
      throws SQLException

  To specify the qualifier, you can use the getQualifier() method described in
  "Interval methods" on page 4-9. The second version allows you to support
  localized error messages.

• A string and qualifier information:
  public IntervalDF(String string, int length, byte startcode, byte endcode)
      throws SQLException

  public IntervalDF(String string, int length, byte startcode,
      byte endcode, Connection conn) throws SQLException

  The second version allows you to support localized error messages.

The IntervalDF methods

The following methods allow you to manipulate intervals. (You can also use the
Interval methods, described previously.) The tasks you can perform, and the
methods you can use, are as follows:

• Comparing two intervals:
  boolean equals(Object other)
  boolean greaterThan(IntervalDF other)
  boolean lessThan(IntervalDF other)

• Setting a value for an interval from:
  – A string:
    void fromString(String other)
    void set(String string)
  – Second and nanosecond values (large second values are converted to minutes,
    hours, or days):
    void set(long seconds, long nanos)
  – Two time stamps:
    void set(Timestamp t1, Timestamp t2)

• Setting the qualifier from the length, start code, and end code:
void setQualifier(int length, byte startcode, byte endcode)

- Obtaining the number of nanoseconds in the interval:
  long getNanoSeconds()
- Obtaining the number of seconds in the interval:
  long getSeconds()
- Creating a string representation of the interval in the format dddddd
  hh:mm:ss.nano:
  String toString()

The fields present depend on the qualifier. Blanks replace leading zeros.

Interval example

The Intervaldemo.java program, which is included in IBM Informix JDBC Driver, shows how to insert into and select from the two types of INTERVAL data types.

Collections and arrays

The JDBC 3.0 specification describes only one method to exchange collection data between a Java client and a relational database: an array.

Because the array interface does not include a constructor, IBM Informix JDBC Driver includes an extension that allows a java.util.Collection object to be used in the PreparedStatement.setObject() and ResultSet.getObject() methods.

If you prefer to use an Array object, use the PreparedStatement.setArray() and ResultSet.getArray() methods. A Collection object is easier to use, but an Array object conforms to JDBC 3.0 standards.

By default, the driver maps LIST columns to java.util.ArrayList objects and SET and MULTISET columns to java.util.HashSet objects during a fetch. You can override these defaults, but the class you use must implement the java.util.Collection interface.

To override this default mapping, you can use other classes in the java.util.Collection interface, such as the TreeSet class. You can also create your own classes that implement the java.util.Collection interface. In either case, you must provide a customized type map using the Connection.setTypeMap() method.

During an INSERT operation, any java.util.Collection object that is an instance of the java.util.Set interface is mapped to an Informix MULTISET data type. An instance of the java.util.List interface is mapped to an Informix LIST data type. You can override these defaults by creating a customized type mapping.

For information about customized type mappings, see Appendix C, “Mapping data types,” on page C-1.

Important: Sets are by definition unordered. If you select collection data using a HashSet object, the order of the elements in the HashSet object might not be the same as the order specified when the set was inserted. For example, if the data on the database server is the set {1, 2, 3}, it might be retrieved into the HashSet object as {3, 2, 1} or any other order.
The complete versions of all of the examples in the following sections are in the complex-types directory where you installed the driver. For more information, see Appendix A, “Sample code files,” on page A-1.

Collection examples

Following is a sample database schema:

```sql
create table tab ( a set(integer not null), b integer);
insert into tab values ("set{1, 2, 3}" , 10);
```

The following is a fetch example using a `java.util.HashSet` object:

```java
import java.util.HashSet;

public class HashSetExample {
    public static void main(String[] args) {
        java.util.HashSet set = new HashSet();
        // The user can now use HashSet.iterator() to extract each element in the collection.
        // The following code extracts each element.
        Iterator it = set.iterator();
        Object obj;
        while (it.hasNext()) {
            obj = it.next();
            System.out.println(" Collection class: " + obj.getClass().getName());
            if (cls == null)
            {   // CLASS  
                cls = obj.getClass();
                System.out.println(" Collection class: " + cls.getName());
                System.out.println(" element[ i ] = "+
                obj.toString());
            }
            i++;
        }
    }
}
```

In the `set = (HashSet) rs.getObject(1)` statement of this example, IBM Informix JDBC Driver gets the type for column 1. Because it is a SET type, a `HashSet` object is instantiated. Next, each collection element is converted into a Java object and inserted into the collection.

The following fetch example uses a `java.util.TreeSet` object:

```java
import java.util.TreeSet;

public class TreeSetExample {
    public static void main(String[] args) {
        java.util.TreeSet set = new TreeSet();
        // The user can now use TreeSet.iterator() to extract each element in the collection.
        // The following code extracts each element.
        Iterator it = set.iterator();
        Object obj;
        while (it.hasNext()) {
            obj = it.next();
            System.out.println(" Collection class: " + obj.getClass().getName());
            if (cls == null)
            {   // CLASS  
                cls = obj.getClass();
                System.out.println(" Collection class: " + cls.getName());
                System.out.println(" element[ i ] = "+
                obj.toString());
            }
            i++;
        }
    }
}
```

The following fetch example uses a `java.util.TreeSet` object:

```java
import java.util.TreeSet;

public class TreeSetExample {
    public static void main(String[] args) {
        java.util.TreeSet set = new TreeSet();
        // The user can now use TreeSet.iterator() to extract each element in the collection.
        // The following code extracts each element.
        Iterator it = set.iterator();
        Object obj;
        while (it.hasNext()) {
            obj = it.next();
            System.out.println(" Collection class: " + obj.getClass().getName());
            if (cls == null)
            {   // CLASS  
                cls = obj.getClass();
                System.out.println(" Collection class: " + cls.getName());
                System.out.println(" element[ i ] = "+
                obj.toString());
            }
            i++;
        }
    }
}
```
java.util.Map map = new HashMap();
map.put("set", Class.forName("java.util.TreeSet"));
System.out.println("mapping ... ok");

pstmt = conn.prepareStatement("select * from tab");
System.out.println("prepare ... ok");
rs = pstmt.executeQuery();
System.out.println("executeQuery ... ok");

rs.next();
set = (TreeSet) rs.getObject(1, map);
System.out.println("getObject(Map) ... ok");

/* The user can now use HashSet.iterator() to extract
 * each element in the collection.
 */
Iterator it = set.iterator();
Object obj;
Class cls = null;
int i = 0;
while (it.hasNext())
{
    obj = it.next();
    if (cls == null)
    {
        cls = obj.getClass();
        System.out.println(" Collection class: " + cls.getName());
    }
    System.out.println(" element[" + i + "] = " +
        obj.toString());
    i++;
}
pstmt.close();

In the map.put("set", Class.forName( "java.util.TreeSet" )); statement, the
default mapping of set = HashSet is overridden.

In the set = (TreeSet) rs.getObject(1, map) statement, IBM Informix JDBC
Driver gets the type for column 1 and finds that it is a SET object. Then the driver
looks up the type mapping information, finds TreeSet, and instantiates a TreeSet
object. Next, each collection element is converted into a Java object and inserted
into the collection.

The following example shows an insert. This example inserts the set (0, 1, 2, 3, 4)
into a SET column:
java.util.HashSet set = new HashSet();
Integer intObject;
int i;

/* Populate the Java collection */
for (i=0; i < 5; i++)
{
    intObject = new Integer(i);
    set.add(intObject);
}
System.out.println("populate java.util.HashSet...ok");

PreparedStatement pstmt = conn.prepareStatement
("insert into tab values (?, 20)");
System.out.println("prepare...ok");
pstmt.setObject(1, set);
The pstmt.setObject(1, set) statement in this example first serializes each element of the collection. Next, the type information is constructed as each element is converted into a Java object. If the types of any elements in the collection do not match the type of the first element, an exception is thrown. The type information is sent to the database server.

Array example

Following is a sample database schema:

```
CREATE TABLE tab (a set(integer not null), b integer);
INSERT INTO tab VALUES ('set{1,2,3}', 10);
```

The following example fetches data using a java.sql.Array object:

```
PreparedStatement pstmt = conn.prepareStatement("select a from tab");
System.out.println("prepare ... ok");
ResultSet rs = pstmt.executeQuery();
System.out.println("executeQuery ... ok");

rs.next();
java.sql.Array array = rs.getArray(1);
System.out.println("getArray() ... ok");
pstmt.close();

/*@ The user can now materialize the data into either
 * an array or else a ResultSet. If the collection elements
 * are primitives then the array should be an array of primitives,
 * not Objects. Mapping data can be provided at this point.
 */
Object obj = array.getArray((long) 1, 2);
int [] intArray = (int []) obj; // cast it to an array of ints
int i;
for (i=0; i < intArray.length; i++)
{
    System.out.println("integer element = " + intArray[i]);
}
pstmt.close();
```

The java.sql.Array array = rs.getArray(1) statement instantiates a java.sql.Array object. Data is not converted at this point.

The Object obj = array.getArray((long) 1, 2) statement converts data into an array of integers (int types, not Integer objects). Because the getArray() method has been called with index and count values, only a subset of data is returned.

Named and unnamed rows

The JDBC 3.0 specification refers to an SQL type called a structured type or struct, which is equivalent to an IBM Informix named row. The specification defines two approaches to exchange structured-type data between a Java client and a relational database:
• **Using the SQLData interface.** A single Java class per named row type implements the SQLData interface. The class has a member for each element in the named row.

• **Using the Struct interface.** This interface instantiates the necessary Java object for each element in the named row and constructs an array of java.util.Object Java objects.

Whether IBM Informix JDBC Driver instantiates a Java object or a Struct object for a fetched named row depends on whether there is a customized type-mapping entry or not, as follows:

• If there is an entry for a named row in the Connection.getTypeMap() map, or if you provided a type mapping using the getObject() method, a single Java object is instantiated.

• If there is no entry for a named row in the Connection.getTypeMap() map, and if you have not provided a type mapping using the getObject() method, a Struct object is instantiated.

Unnamed rows are always fetched into Struct objects.

**Important:** Regardless of whether you use the SQLData or Struct interface, if a named or unnamed row contains an opaque data type column, there must be a type-mapping entry for it. If you are using the Struct interface to access a row that contains an opaque data type column, you need a customized type map for the opaque data type column, but not for the row as a whole.

For more information about custom type mapping, see Appendix C, “Mapping data types,” on page C-1.

**Interval and collection support**

The java.sql.SQLOutput and java.sql.SQLInput methods are extended to support Collection and Interval objects in named and unnamed rows. These extensions include the following methods:

• The com.informix.jdbc.IfmxComplexSQLInput.readObject() method returns the appropriate java.util.Collection object if the data is a set, list, or multiset data type.

• The com.informix.jdbc.IfmxComplexSQLInput.readInterval() method returns the appropriate IntervalYM or IntervalDF object for an interval data type, depending on the qualifier.

• The com.informix.jdbc.IfmxComplexSQLOutput.writeObject() method accepts objects derived from the java.util.Collection interface or from IntervalYM and IntervalDF objects.

**Unsupported methods**

The following SQLInput methods are not supported for selecting a ROW column into a Java object that implements SQLData:

• readByte()

• readCharacterStream()

• readRef()

The following SQLOutput methods are not supported for inserting a Java object that implements SQLData into a ROW column:

• writeByte(byte)
The SQLData interface

The Java class for the named row must implement the SQLData interface. The class must have a member for each element in the named row but can have other members in addition to these. The members can be in any order and need not be public.

The Java class must implement the writeSQL(), readSQL(), and getSQLTypeName() methods for the named row as defined in the SQLData interface, but can implement additional methods. You can use the ClassGenerator utility to create the class; for more information, see "The ClassGenerator utility" on page 4-25.

To link this Java class with the named row, create a customized type mapping using the Connection.setTypeMap() method or the getObject() method. For more information about type mapping, see Appendix C, “Mapping data types,” on page C-1.

You cannot use the SQLData interface to access unnamed rows.

SQLData examples

The complete versions of all of the examples in this section are in the demo/complex-types directory where you installed the driver. For more information, see Appendix A, “Sample code files,” on page A-1.

The following example includes a Java class that implements the java.sql.SQLData interface.

Here is a sample database schema:

CREATE ROW TYPE fullname_t (first char(20), last char(20));
CREATE ROW TYPE person_t (id int, name fullname_t, age int);
CREATE TABLE teachers (person person_t, dept char (20));
INSERT INTO teachers VALUES ("row(100, row('Bill', 'Smith'), 27)", "physics");

This is the fullname Java class:

```java
import java.sql.*;
public class fullname implements SQLData
{
  public String first;
  public String last;
  private String sql_type = "fullname_t";

  public String getSQLTypeName()
  {
    return sql_type;
  }
  public void readSQL (SQLInput stream, String type) throws SQLException
  {
    sql_type = type;
    first = stream.readString();
    last = stream.readString();
  }
  public void writeSQL (SQLOutput stream) throws SQLException
  {
    stream.writeString(first);
  }
}
```
This is the `person` Java class:

```java
import java.sql.*;
public class person implements SQLData {
    public int id;
    public fullname name;
    public int age;
    private String sql_type = "person_t";

    public String getSQLTypeName() {
        return sql_type;
    }
    public void readSQL (SQLInput stream, String type) throws SQLException {
        sql_type = type;
        id = stream.readInt();
        name = (fullname)stream.readObject();
        age = stream.readInt();
    }
    public void writeSQL (SQLOutput stream) throws SQLException {
        stream.writeInt(id);
        stream.writeObject(name);
        stream.writeInt(age);
    }
    public String toString() {
        String s = "person:
        s+=" id :" + id + "\n";
        s += " name : " + name.toString() + "\n";
        s += " age: " + age + "\n";
        return s;
    }
}
```

Here is an example of fetching a named row:

```java
java.util.Map map = conn.getTypeMap();
conn.setTypeMap(map);
map.put("fullname_t", Class.forName("fullname"));
map.put("person_t", Class.forName("person"));

... 
PreparedStatement pstmt;
ResultSet rs;
pstmt = conn.prepareStatement("select person from teachers");
System.out.println("prepare ...ok");
rs = pstmt.executeQuery();
System.out.println("executeQuery()...ok");
while (rs.next())
```
The `rs.getObject(1)` statement retrieves the named row into the Java object `who`. IBM Informix JDBC Driver recognizes that this object `who` is a named row, a distinct type, or an opaque type, because the information sent by the database server has an extended name of `person_t`.

The driver looks up `person_t` and finds it is a named row. The driver calls the `map.get()` method with the key `person_t`, which returns the `person` class object. An object of class `person` is instantiated.

The `readSQL()` method in the `person` class calls methods defined in the `SQLInput` interface to convert each field in the ROW column into a Java object and assign each to a member in the `person` class.

The following example shows a method for inserting a Java object into a named row column using the `setObject()` method:

```java
java.util.Map map = conn.getTypeMap();
map.put("fullname_t", Class.forName("fullname"));
map.put("person_t", Class.forName("person"));
...
PreparedStatement pstmt;
System.out.println("Populate person and fullname objects");
person who = new person();
fullname name = new fullname();
name.last = "Jones";
name.first = "Sarah";
who.id = 567;
who.name = name;
who.age = 17;

String s = "insert into teachers values (?, 'physics')";
pstmt = conn.prepareStatement (s);
System.out.println("prepared...ok");
pstmt.setObject(1, who);
System.out.println("setObject()...ok");

int rowcount = pstmt.executeUpdate();
System.out.println("executeUpdate()...ok");
pstmt.close();
```

The `conn.getTypeMap()` method returns the named row mapping information from the `java.util.Map` object through the `Connection` object.
The map.put() method registers the mappings between the nested named row on the database server, `fullname_t`, and the Java class `fullname` and between the named row on the database server, `person_t`, and the Java class `person`.

IBM Informix JDBC Driver recognizes that the object who implements the SQLData interface, so it is either a named row, a distinct type, or an opaque type. IBM Informix JDBC Driver calls the getSQLTypeName() method for this object (required for classes implementing the SQLData interface), which returns `person_t`. The driver looks up `person_t` and finds it is a named row.

The writeSQL() method in the `person` class calls the corresponding SQLOutput.writeXXX() method for each member in the class, each of which maps to one field in the named row `person_t`. The writeSQL() method in the class contains calls to the SQLOutput.writeObject(name) and SQLOutput.writeInt(id) methods. Each member of the class `person` is serialized and written into a stream.

### The Struct interface

The JDBC documentation does not specify that Struct objects can be parameters to the PreparedStatement.setObject() method. However, IBM Informix JDBC Driver can handle any object passed by the PreparedStatement.setObject() or ResultSet.getObject() method that implements the java.sql.Struct interface.

You must use the Struct interface to access unnamed rows.

You do not need to create your own class to implement the java.sql.Struct interface. However, you must perform a fetch to retrieve the ROW data and type information before you can insert or update the ROW data. IBM Informix JDBC Driver automatically calls the getSQLTypeName() method, which returns the type name for a named row or the row definition for an unnamed row.

If you create your own class to implement the Struct interface, the class you create must implement all the java.sql.Struct methods, including the getSQLTypeName() method. You can choose what the getSQLTypeName() method returns.

Although you must return the row definition for unnamed rows, you can return either the row name or the row definition for named rows. Each has advantages:

- **Row definition.** The driver does not need to query the database server for the type information. In addition, the row definition returned does not have to match the named row definition exactly, because the database server provides casting, if needed. This is useful if you want to use strings to insert into an opaque type in a row, for example.

- **Row name.** If a user-defined routine takes a named row as a parameter, the signature has to match, so you must pass in a named row.

For more information about user-defined routines, see the following publications: J/Foundation Developer’s Guide (for information specific to Java); IBM Informix User-Defined Routines and Data Types Developer’s Guide and IBM Informix Guide to SQL: Reference (both for general information about user-defined routines); and IBM Informix Guide to SQL: Syntax (for the syntax to create and invoke user-defined routines).

**Important:** If you use the Struct interface for a named row and provide type-mapping information for the named row, a ClassCastException message is generated when the ResultSet.getObject() method is called, because Java cannot cast between an SQLData object and a Struct object.
Struct examples

The complete versions of all of the examples in this section are in the demo/complex-types directory where you installed the driver. For more information, see Appendix A, "Sample code files," on page A-1.

This example fetches an unnamed ROW column. Here is a sample database schema:

```sql
CREATE TABLE teachers
(
    person row(
        id int,
        name row(first char(20), last char(20)),
        age int,
        dept char(20)
    ),
    dept char(20)
);
INSERT INTO teachers VALUES ("row(100, row('Bill', 'Smith'), 27)", "physics");
```

This is the rest of the example:

```java
PreparedStatement pstmt;
ResultSet rs;
pstmt = conn.prepareStatement("select person from teachers");
System.out.println("prepare ...ok");
rs = pstmt.executeQuery();
System.out.println("executetQuery()...ok");
rs.next();
Struct person = (Struct) rs.getObject(1);
System.out.println("getObject()...ok");
System.out.println("Data fetched:");
Integer id;
Struct name;
Integer age;
Object[] elements;

/* Get the row description */
String personRowType = person.getSQLTypeName();
System.out.println("person row description: "+ personRowType);
System.out.println("");

/* Convert each element into a Java object */
elements = person.getAttributes();

/* */
/* Run through the array of objects in 'person' getting out each structure */
/* field. Use the class Integer instead of int, because int is not an object. */
/* */
id = (Integer) elements[0];
name = (Struct) elements[1];
age = (Integer) elements[2];
System.out.println("person.id: " + id);
System.out.println("person.age: " + age);
System.out.println("name row description: "+ nameRowType);
/* */
```

IBM Informix JDBC Driver Programmer's Guide
/*
 * run through the array of objects in 'name' getting out each structure
 * field.
 */
String first = (String) elements[0];
String last = (String) elements[1];
System.out.println("name.first: " + first);
System.out.println("name.last: " + last);
pstmt.close();

The Struct person = (Struct) rs.getObject(1) statement instantiates a Struct object if column 1 is a ROW type and there is no extended data type name (if it is a named row).

The elements = person.getAttributes(); statement performs the following actions:

- Allocates an array of java.lang.Object objects with the correct number of elements
- Converts each element in the row into a Java object

If the element is an opaque type, you must provide type mapping in the Connection object or pass in a java.util.Map object in the call to the getAttributes() method.

The String personrowType = person.getSQLTypeName(); statement returns the row type information. If this type is a named row, the statement returns the name. Because the type is not a named row, the statement returns the row definition: row(int id, row(first char(20), last char(20)) name, int age).

The example then goes through the same steps for the unnamed row name as it did for the unnamed row person.

The following example uses a user-created class, GenericStruct, which implements the java.sql.Struct interface. As an alternative, you can use a Struct object returned from the ResultSet.getObject() method instead of the GenericStruct class.

import java.sql.*;
import java.util.*;
public class GenericStruct implements java.sql.Struct
{
    private Object [] attributes = null;
    private String typeName = null;

    /*
     * Constructor
     */
    GenericStruct() { }

    GenericStruct(String name, Object [] obj)
    {
        typeName = name;
        attributes = obj;
    }

    public String getSQLTypeName()
    {
        return typeName;
    }

    public Object [] getAttributes()
    {
        return attributes;
    }

    public Object [] getAttributes(Map map) throws SQLException
    {
The following Java program inserts a ROW column:

```java
PreparedStatement pstmt;
ResultSet rs;
GenericStruct gs;
String rowType;
pstmt = conn.prepareStatement("insert into teachers values (?, 'Math')");
System.out.println("prepare insert...ok\n");
System.out.println("Populate name struct...");
Object[ ] name = new Object[2];
// populate inner row first
name[0] = new String("Jane");
name[1] = new String("Smith");
rowType = "row(first char(20), last char(20))";
gs = new GenericStruct(rowType, name);
System.out.println("Instantiate GenericStructObject...okay\n");
System.out.println("Populate person struct...");
// populate outer row next
Object[ ] person = new Object[3];
person[0] = new Integer(99);
person[1] = gs;
person[2] = new Integer(56);
rowType = "row(id int, " +
    "name row(first char(20), last char(20)), " +
    "age int)";
gs = new GenericStruct(rowType, person);
System.out.println("Instantiate GenericStructObject...okay\n");
pstmt.setObject(1, gs);
System.out.println("setObject()...okay");
pstmt.executeUpdate();
System.out.println("executeUpdate()...okay");
pstmt.close();
```

At the `pstmt.setObject(1, gs)` statement in this example, IBM Informix JDBC Driver determines that the information is to be transported from the client to the database server as a ROW column, because the `GenericStruct` object is an instance of the `java.sql.Struct` interface.

Each element in the array is serialized, verifying that each element matches the type as defined by the `getSQLTypeName()` method.
The ClassGenerator utility

The ClassGenerator utility generates a Java class for a named row type defined in the system catalog. The utility is an IBM Informix extension to the JDBC specification.

The created Java class implements the java.sql.SQLData interface. The class has members for each field in the named row. The readSQL(), writeSQL(), and SQLData.readSQL() methods read the attributes in the order in which they appear in the definition of the named row type in the database. Similarly, writeSQL() writes the data to the stream in that order.

ClassGenerator is packaged in the ifxtools.jar file, so the CLASSPATH environment variable must point to ifxtools.jar.

The syntax for using ClassGenerator is as follows:
java ClassGenerator rowtypename [-u URL] [-c classname]

The default value for classname is the value for rowtypename.

If the URL parameter is not specified, the required information is retrieved from the setup.std file in the home directory.

The structure of setup.std is as follows:
URL jdbc:host-name:port-number
informixserver informixservername
database database
user user
passwd password

Simple named row example

To use ClassGenerator, you first create the named row on the database server as shown in this example:
create row type employee (name char (20), age int);

Next, run ClassGenerator:
java ClassGenerator employee

The class generator generates employee.java, as shown next, and retrieves the database URL information from setup.std, which has the following contents:
URL jdbc:davinci:1528
database test
user scott
passwd tiger
informixserver picasso_ius

Following is the generated .java file:
import java.sql.*;
import java.math.*;
public class employee implements SQLData
{
    public String name;
    public int age;
    private String sql_type;

    public String getSQLTypeName() { return "employee"; }

    public void readSQL (SQLInput stream, String type) throws

SQLException
{
    sql_type = type;
    name = stream.readString();
    age = stream.readInt();
}

public void writeSQL (SQLOutput stream) throws SQLException
{
    stream.writeString(name);
    stream.writeInt(age);
}

Nested named row example

To use ClassGenerator for a nested row, you first create the named row on the
database server:
create row type manager (emp employee, salary int);

Next, run ClassGenerator. In this case, the setup.std file is not consulted, because
you provide all the needed information at the command line:
java ClassGenerator manager -c Manager -u "jdbc:davinci:1528/test:user=scott;
password=tiger;informixserver=picasso_ius"

The -c option defines the Java class you are creating, which is Manager (with
uppercase M).

The preceding command generates the following Java class:
import java.sql.*;
import java.math.*;
public class Manager implements SQLData
{
    public employee emp;
    public int salary;
    private String sql_type;

    public String getSQLTypeName() { return "manager"; }

    public void readSQL (SQLInput stream, String type) throws
SQLException
    {
        sql_type = type;
        emp = (employee)stream.readObject();
        salary = stream.readInt();
    }

    public void writeSQL (SQLOutput stream) throws SQLException
    {
        stream.writeObject(emp);
        stream.writeInt(salary);
    }
}

Cache type information

When objects of some data types insert data into columns of certain other data
types, IBM Informix JDBC Driver verifies that the data provided matches the data
the database server expects by calling the SQLData.getSQLTypeName() method.
The driver asks the database server for the type information with each insertion.

This occurs in the following cases:
• When an SQLData object inserts data into an opaque type column and getSQLTypeName() returns the name of the opaque type
• When a Struct or SQLData object inserts data into a row column and getSQLTypeName() returns the name of a named row
• When an SQLData object inserts data into a DISTINCT type column

You can set an environment variable, ENABLE_CACHE_TYPE=1, in the database URL to have the driver cache the type information the first time it is retrieved. The driver then asks the cache for the type information before requesting the data from the database server.

**Smart large object data types**

A smart large object is a large object with the following features:

• A smart large object can hold a very large amount of data.
  Currently, a single smart large object can hold up to four terabytes of data. This data is stored in a separate disk space called an sbspace.

• A smart large object is recoverable.
  The database server can log changes to smart large objects and therefore can recover smart-large-object data in the event of a system or hardware failure. Logging of smart large objects is not the default behavior.

• A smart large object supports random access to its data.
  Access to a simple large object (BYTE or TEXT) is on an “all or nothing” basis; that is, the database server returns all of the simple large-object data that you request at one time. With smart large objects, you can seek to a desired location and read or write the desired number of bytes.

• You can customize storage characteristics of a smart large object.
  When you create a smart large object, you can specify storage characteristics for the smart large object such as:
  – Whether the database server logs the smart large object in accordance with the current database log mode
  – Whether the database server keeps track of the last time the smart large object was accessed
  – Whether the database server uses page headers to detect data corruption

Smart large objects are stored in the database as BLOB and CLOB data types, which you can access in two ways:

• In IBM Informix JDBC Driver 3.0, and later, and IBM Informix servers that support smart large object data types, you can use the standard JDBC API methods described in the JDBC 3.0 specifications. This is the simpler approach. The following JDBC 3.0 methods for BLOB and CLOB internal update have already been implemented in previous releases:
  int setBytes(long, byte []) throws SQLException
  void truncate(long) throws SQLException
  The following JDBC 3.0 methods from the BLOB interface are implemented in IBM Informix JDBC Driver, Version 3.0, or later:
  OutputStream setBinaryStream(long) throws SQLException
  int setBytes(long, byte [], int, int) throws SQLException
  The following JDBC 3.0 methods from the CLOB interface are implemented in IBM Informix JDBC Driver, Version 3.0, or later:
Smart large objects in the database server

In the IBM Informix database server, a smart large object has two parts:

- The data, which is stored in an **sbspace**
- A large-object handle, known as an **LO handle**, which identifies the location of the smart-large-object data in its sbspace.

Suppose you store the picture of an employee as a smart large object. The following figure shows how the LO handle contains information about the location of the actual employee picture in the **sbspace1_100** sbspace.

![Figure 4-1. Smart large object in the database server](image)

**In the figure, the sbspace holds the actual employee image that the LO handle identifies. For more information about the structure of an sbspace, and the **onspaces** database utility that creates and drops sbspaces, see the **IBM Informix Administrator’s Guide**.**

**Important:** Smart large objects can only be stored in sbspaces. You must create an sbspace before you attempt to insert smart large objects into the database.

Because a smart large object is potentially very large, the database server stores only its LO handle in a database table; it can then use this handle to find the actual data of the smart large object in the sbspace. This arrangement minimizes the table size.

Applications obtain the LO handle from the database and use it to locate the smart-large-object data and to open the smart large object for read and write operations.

Smart large objects in a client application

On the client, your JDBC application can use **ResultSet** methods to access smart-large-object data, such as:

- **getClob()** and **getAsciiStream()** for CLOB data
- **getBlob()** and **getBinaryStream()** for BLOB data
- **getString()** for both CLOB and BLOB data
On the client side, the JDBC driver references the LO handle through an `IfxLocator` object. Your JDBC application obtains an instance of the `IfxLocator` class to contain the smart-large-object locator handle, as shown in the following figure. Your application creates a smart large object independently and then inserts the smart large object into different columns, even in multiple tables. Using multiple threads, an application can write or read data from various portions of the smart large object in parallel, which is very efficient.

Figure 4-2. Locating a smart large object In a client application

In IBM Informix, support for Informix smart large object data types is available only with 9.x and later versions of the database server.

Creating smart large objects

The IBM Informix smart large object implementation is based on the following classes:

- `IfxLobDescriptor` stores attributes for the large object.
- `IfxLocator` contains the handle to the large object in the database server.
- `IfxSmartBlob` contains methods for working with the smart large object, such as positioning within the object, reading data from the object, and writing data to the object.
- `IfxBblob` and `IfxCblob` implement the `java.sql.Blob` and `java.sql.Clob` interfaces from the JDBC 3.0 specification.
- `IfxLoStat` stores status information about the large object.

Tip: This section describes how to use the Informix smart-large-object interface, but it does not currently document every method and parameter in the interface. For a comprehensive reference to all the methods in the interface and their parameters, see the javadoc files for IBM Informix JDBC Driver, located in the `doc/javadoc` directory where your driver is installed.

To create a smart large object:

1. For a new smart large object, ensure that the smart large object has an sbspace specified for its data.
   For detailed documentation about the `onspaces` utility that creates sbspaces, see the IBM Informix Administrator's Guide. For an example of creating an sbspace, see "Example of setting sbspace characteristics" on page 4-41.

2. Create an `IfxLobDescriptor` object.
   This allows you to set storage characteristics for the smart large object. The driver passes the `IfxLobDescriptor` object to the database server when the `IfxSmartBlob.IfxLoCreate()` method creates the large object.
3. If desired, call methods in the IfxLobDescriptor object to specify storage characteristics.
   For most smart large objects, the sbspace name is the only storage characteristic that you need to specify. The database server can calculate values for all other storage characteristics. You can set particular storage characteristics to override these calculated values. However, most applications do not need to set storage characteristics at this level of detail. For more information, see “Work with storage characteristics” on page 4-39.

4. Create an IfxLocator object.
   This is the pointer to the smart large object on the client.

5. Create an IfxSmartBlob object.
   This lets you perform various common operations on the smart large object.

6. Execute the IfxSmartBlob.IfxLoCreate() method to create the large object in the database server.
   IfxLoCreate() takes the IfxLocator and IfxLobDescriptor objects as parameters to identify the smart large object in the database server.

7. Execute IfxSmartBlob.IfxLoWrite() to write data to the smart large object in the database server.

8. Execute additional IfxSmartBlob methods to position within the object, read from the object, and so forth.

9. Execute IfxSmartBlob.IfxLoClose() to close the large object.

10. Insert the smart large object into the database (see “Inserting a smart large object into a column” on page 4-33).

11. Execute IfxSmartBlob.IfxLoRelease() to release the locator pointer.

Create an IfxLobDescriptor object: The IfxLobDescriptor class stores the internal storage characteristics for a smart large object. Before you can create a smart large object on the database server, you must create an IfxLobDescriptor object, as follows:

   IfxLobDescriptor loDesc = new IfxLobDescriptor(conn);

   The conn parameter is a java.sql.Connection object. The IfxLobDescriptor() constructor sets all the default values for the object.

   For more information about the internal storage characteristics, see “Work with storage characteristics” on page 4-39.

Create an IfxLocator object: The IfxLocator object (usually known as the locator pointer or large object locator) identifies the location of the smart large object, as shown in Figure 4-2 on page 4-29. The locator pointer is the communication link between the database server and the client for a particular large object. Before it creates a large object or opens a large object for reading or writing, an application must create an IfxLocator object:

   IfxLocator loPtr = new IfxLocator();
   IfxLocator loPtr = new IfxLocator(Connection conn);

   Use the second of these constructors to display localized error messages if an exception is thrown. For more information, see “Support for globalized error messages” on page 6-14.

Create an IfxSmartBlob object:
To create a smart large object and obtain access to the methods for performing operations on the object, call the **IfxSmartBlob** constructor, passing a reference to the JDBC connection:

```
IfxSmartBlob smb = new IfxSmartBlob(myConn)
```

Once you have written all the methods that perform operations you need in the smart large object, you can then use the **IfxSmartBlob.IfxLoCreate()** method to create the large object in the database server and open it for access within your application. The method signature is as follows:

```
public int IfxLoCreate(IfxLobDescriptor loDesc, int flag,
                       IfxLocator loPtr) throws SQLException
```

```
public int IfxLoCreate(IfxLobDescriptor loDesc, int flag,
                       IfxBblob blob) throws SQLException
```

```
public int IfxLoCreate(IfxLobDescriptor loDesc, int flag,
                       IfxCblob clob throws SQLException
```

The return value is the locator handle, which you can use in subsequent read, write, seek, and close methods (you can pass it as the locator file descriptor (**lofd**) parameter to the methods that operate on open smart large objects; these methods are described beginning with "Position within a smart large object" on page 4-35).

The **flag** parameter is an integer value that specifies the access mode in which the new smart large object is opened in the server. The access mode determines which read and write operations are valid on the open smart large object. If you do not specify a value, the object is opened in read-only mode.

Use the access mode **flag** values in the following table with the **IfxLoCreate()** and **IfxLoOpen()** methods to open or create smart large objects with specific access modes.

<table>
<thead>
<tr>
<th>Access mode</th>
<th>Purpose</th>
<th>Flag value in IfxSmartBlob</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read only</td>
<td>Allows read operations only</td>
<td>LO_RDONLY</td>
</tr>
<tr>
<td>Write only</td>
<td>Allows write operations only</td>
<td>LO_WRONLY</td>
</tr>
<tr>
<td>Write/Append</td>
<td>Appends data you write to the end of the smart large object By itself, it is equivalent to write-only mode followed by a seek to the end of the smart large object. Read operations fail. When you open a smart large object in write/append mode only, the smart large object is opened in write-only mode. Seek operations move the seek position, but read operations to the smart large object fail, and the seek position remains unchanged from its position just before the write. Write operations occur at the seek position, and then the seek position is moved.</td>
<td>LO_APPEND</td>
</tr>
<tr>
<td>Read/Write</td>
<td>Allows read and write operations</td>
<td>LO_RDWR</td>
</tr>
</tbody>
</table>

The following example shows how to use a LO_RDWR **flag** value:

```
IfxSmartBlob smb = new IfxSmartBlob(myConn);
int loFd = smb.IfxLoCreate(loDesc, smb.LO_RDWR, loPtr);
```

The **loDesc** and **loPtr** objects are previously created **IfxLobDescriptor** and **IfxLocator** objects, respectively.
The database server uses the following system defaults when it opens a smart large object.

**Open-mode information**

**Default open mode**

**Access mode**
- Read-only

**Access method**
- Random

**Buffering**
- Buffered access

**Locking**
- Whole-object locks

For more information about locking, see [“Work with locks” on page 4-48](#).

The following table provides the full set of open-mode flags:

<table>
<thead>
<tr>
<th>Open-mode flag</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO_APPEND</td>
<td>Appends data you write to the end of the smart large object</td>
</tr>
<tr>
<td></td>
<td>By itself, it is equivalent to write-only mode followed by a seek to the end of the smart large object. Read operations fail.</td>
</tr>
<tr>
<td></td>
<td>When you open a smart large object in write/append mode only, the smart large object is opened in write-only mode. Seek operations move the seek position, but read operations to the smart large object fail, and the seek position remains unchanged from its position just before the write. Write operations occur at the seek position, and then the seek position is moved.</td>
</tr>
<tr>
<td>LO_WRONLY</td>
<td>Allows write operations only</td>
</tr>
<tr>
<td>LO_RDONLY</td>
<td>Allows read operations only</td>
</tr>
<tr>
<td>LO_RDWR</td>
<td>Allows read and write operations</td>
</tr>
<tr>
<td>LO_DIRTY_READ</td>
<td>For open only</td>
</tr>
<tr>
<td></td>
<td>Allows you to read uncommitted data pages for the smart large object</td>
</tr>
<tr>
<td></td>
<td>You cannot write to a smart large object after you set the mode to LO_DIRTY_READ.</td>
</tr>
<tr>
<td></td>
<td>When you set this flag, you reset the current transaction isolation mode to Dirty Read for the smart large object.</td>
</tr>
<tr>
<td></td>
<td>Do not base updates on data that you obtain from a smart large object in Dirty Read mode.</td>
</tr>
<tr>
<td>Open-mode flag</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>LO_RANDOM</td>
<td>Overrides optimizer decision</td>
</tr>
<tr>
<td></td>
<td>Indicates that I/O is random and that the database server should not read</td>
</tr>
<tr>
<td></td>
<td>ahead. Default open mode.</td>
</tr>
<tr>
<td>LO_SEQUENTIAL</td>
<td>Overrides optimizer decision</td>
</tr>
<tr>
<td></td>
<td>Indicates that reads are sequential in either forward or reverse</td>
</tr>
<tr>
<td>LO_FORWARD</td>
<td>Used only for sequential access to indicate forward direction</td>
</tr>
<tr>
<td>LO_REVERSE</td>
<td>Used only for sequential access to indicate reverse direction</td>
</tr>
<tr>
<td>LO_BUFFER</td>
<td>Use standard database server buffer pool.</td>
</tr>
<tr>
<td>LO_NOBUFFER</td>
<td>Do not use the standard database server buffer pool. Use private buffers</td>
</tr>
<tr>
<td></td>
<td>from the session pool of the database server.</td>
</tr>
<tr>
<td>LO_NODIRTY_READ</td>
<td>Do not allow dirty reads on smart large object. See LO_DIRTY_READ flag for</td>
</tr>
<tr>
<td></td>
<td>more information.</td>
</tr>
<tr>
<td>LO_LOCKALL</td>
<td>Specifies that locking will occur on entire smart large object</td>
</tr>
<tr>
<td>LO_LOCKRANGE</td>
<td>Specifies that locking will occur for a range of bytes</td>
</tr>
<tr>
<td></td>
<td>You specify the range of bytes through the IfxSmartBlob.IfxLoLock() method</td>
</tr>
<tr>
<td></td>
<td>when you place the lock.</td>
</tr>
</tbody>
</table>

**Inserting a smart large object into a column:**

After creating a smart large object, you must insert it into a BLOB or CLOB column to save it in the database. To do this, you must convert the IfxLocator object to an IfxBblob or IfxCblob object, depending upon the column type.

To insert a smart large object into a BLOB or CLOB column:

1. Create an IfxBblob or IfxCblob object, as follows:
   ```java
   IfxBblob blb = new IfxBblob(loPtr);
   ```
   The `loPtr` parameter is an IfxLocator object obtained from one of the previous sets of steps.
2. Use the PreparedStatement.setBlob() or setClob() method to insert the object into the column.

**Important:** The sbspace for the smart large object must exist in the database server before the insertion executes.

**Accessing smart large objects**

Follow these steps to use the IBM Informix extensions to select a smart large object from a database column.

To access a smart large object:
1. Cast the `java.sql.Blob` or `java.sql.Clob` object to an `IfxBblob` or `IfxCblob` object.
2. Use the `IfxBblob.getLocator()` or `IfxCblob.getLocator()` method to extract an `IfxLocator` object.
3. Create an `IfxSmartBlob` object.
4. Use the `IfxSmartBlob_ifxLoOpen()` method to open the smart large object.
5. Use the `IfxSmartBlob_ifxLoRead()` method to read the data from the smart large object.
6. Close the smart large object using the `IfxSmartBlob_ifxLoClose()` method.
7. Release the locator pointer in the server by calling the `IfxSmartBlob_ifxLoRelease()` method.

Standard JDBC ResultSet methods such as `ResultSet.getBinaryStream()`, `getAsciiStream()`, `getString()`, `getBytes()`, `getBlob()`, and `getClob()` can fetch BLOB or CLOB data from a table. The Informix extension classes can then access the data.

### Perform operations on smart large objects

In the database server, you can store a smart large object directly in a column that has one of the following data types:

- The CLOB data type holds text data.
- The BLOB data type can store any kind of binary data in an undifferentiated byte stream.

The CLOB or BLOB column holds an LO handle for the smart large object. Therefore, when you select a CLOB or BLOB column, you do not obtain the actual data of the smart large object, but the LO handle that identifies this data. Columns for smart large objects have a theoretical limit of 4 terabytes and a practical limit determined by your disk capacity.

You can use either of the following ways to store a smart large object in a column:

- For direct access to the smart large object, create a column of the CLOB or BLOB data type.
- To hide the smart large object within an atomic data type, create an opaque type that holds a smart large object.

In a client application, the `IfxBblob` and `IfxCblob` classes are bridges between the way of handling smart large object data described in the JDBC 3.0 specification and the IBM Informix extensions. The `IfxBblob` class implements the `java.sql.Blob` interface, and the `IfxCblob` class implements the `java.sql.Clob` interface. The Informix extensions require an `IfxLocator` object to identify the smart large object in the database server.

When you query a table containing a column of type BLOB or CLOB, an object of type Blob or Clob is returned, depending upon the column type. You can then use the JDBC 3.0 supporting methods for objects of type Blob or Clob to access the smart large object.

The constructors create an `IfxBblob` or `IfxCblob` object from the `IfxLocator` object `loPtr`:

```java
public IfxBblob(IfxLocator loPtr)
public IfxCblob(IfxLocator loPtr)
```
The following locator method returns an `IfxLocator` object from an `IfxBlob` or `IfxCBlob` object. You can then open, read, and write to the smart large object using the `IfxSmartBlob.IfxLoOpen()`, `IfxLoRead()`, and `IfxLoWrite()` methods:

```java
public IfxLocator getLocator() throws SQLException
```

**Open a smart large object**

The following methods in the `IfxSmartBlob` class open an existing smart large object in the database server:

```java
public int IfxLoOpen(IfxLocator loPtr, int flag) throws SQLException
public int IfxLoOpen(IfxBlob blob, int flag) throws SQLException
public int IfxLoOpen(IfxCblob clob, int flag) throws SQLException
```

The first version opens the smart large object that is referenced by the locator pointer `loPtr`. The second and third versions open the smart large objects that are referenced by the specified `IfxBlob` and `IfxCblob` objects, respectively. The `flag` parameter is a value from the table in "Create an IfxSmartBlob object" on page 4-30.

**Position within a smart large object**

The `IfxLoTell()` method in the `IfxSmartBlob` class returns the current seek position, which is the offset for the next read or write operation on the smart large object. The `IfxLoSeek()` method in the `IfxSmartBlob` class sets the read or write position within an already opened large object.

```java
public long IfxLoTell(int lofd)
public long IfxLoSeek(int lofd, long offset, int whence) throws SQLException
```

The absolute position depends on the value of the second parameter, `offset`, and the value of the third parameter, `whence`.

The `lofd` parameter is the locator file descriptor returned by the `IfxLoCreate()` or `IfxLoOpen()` method. The `offset` parameter is an offset from the starting seek position.

The `whence` parameter identifies the starting seek position. Use the `whence` values in the following table to define the position within a smart large object to start a seek operation.

<table>
<thead>
<tr>
<th>Starting seek position</th>
<th>Whence value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning of the smart large object</td>
<td><code>IfxSmartBlob.LO.Seek_SET</code></td>
</tr>
<tr>
<td>Current location in the smart large object</td>
<td><code>IfxSmartBlob.LO.Seek_CUR</code></td>
</tr>
<tr>
<td>End of the smart large object</td>
<td><code>IfxSmartBlob.LO.Seek_END</code></td>
</tr>
</tbody>
</table>

The return value is a long integer representing the absolute position within the smart large object.

The following example shows how to use a `LO.Seek_SET` `whence` value:

```java
IfxLobDescriptor loDesc = new IfxLobDescriptor(myConn);
IfxLocator loPtr = new IfxLocator();
IfxSmartBlob smb = new IfxSmartBlob(myConn);
int loFd = smb.IfxLoCreate(loDesc, smb.LO_RDWR, loPtr);
int n = smb.IfxLoWrite(loFd, fin, fileLength);
```
smb.IfxLoClose(loFd);
loFd = smb.IfxLoOpen(loPtr, smb.LO_RDWR);
long m = smb.IfxLoSeek(loFd, 200, smb.LO_SEEK_SET);

The writing position is set at an offset of 200 bytes from the beginning of the smart large object.

**Read data from a smart large object**

You can read data from a smart large object in the following ways:

- Read the data from the object into a `byte[]` buffer.
- Read the data from the object into a file output stream.
- Read the data from the object into a file.

Use the `IfxLoRead()` method in the **IfxSmartBlob** class, which has the following signatures, to read from a smart large object into a buffer or file output stream:

```java
public byte[] IfxLoRead(int lofd, int nbytes) throws SQLException
public int IfxLoRead(int lofd, byte[] buffer, int nbytes) throws SQLException
public int IfxLoRead(int lofd, FileOutputStream fout, int nbytes) throws SQLException
public int IfxLoRead(int lofd, byte[] buffer, int nbytes, int offset) throws SQLException
```

The `lofd` parameter is a locator file descriptor returned by the `IfxLoRead()` or `IfxLoOpen()` method.

The first version returns `nbytes` bytes of data into a byte buffer. This version of the method allocates the memory for the buffer. The second version reads `nbytes` bytes of data into an already allocated buffer. The third version reads `nbytes` bytes of data into a file output stream. The fourth version reads `nbytes` bytes of data into a byte buffer starting at the current seek position plus offset into the smart large object. The return values for the last three versions indicate the number of bytes read.

Use the `IfxLoToFile()` method in the **IfxSmartBlob** class, which has the following signatures, to read from a smart large object into a file:

```java
public int IfxLoToFile(IfxLocator loPtr, String filename, int flag, int whence) throws SQLException
public int IfxLoToFile(IfxBlob blob, String filename, int flag, int whence) throws SQLException
public int IfxLoToFile(IfxClob clob, String filename, int flag, int whence) throws SQLException
```

The first version reads the smart large object that is referenced by the locator pointer `loPtr`. The second and third versions read the smart large objects that are referenced by the specified `IfxBlob` and `IfxClob` objects, respectively.

The `flag` parameter indicates whether the file is on the client or the server. The value is either `IfxSmartBlob.LO_CLIENT_FILE` or `IfxSmartBlob.LO_SERVER_FILE`. The `whence` parameter identifies the starting seek position. For the values, see “Position within a smart large object” on page 4-35.

**Tip:** There has been a change in the signature of the following function: `IfxSmartBlob.IfxLoToFile()`.
This function used to accept four parameters, but now only accepts three parameters. All three overloaded functions for IfxLoToFile() accept three parameters.

**Write data to a smart large object**

You can write data to a smart large object in the following ways:

- Write the data from a `byte[]` buffer to the object.
- Write the data from a file input stream to the object.
- Write the data from a file to the object.

Use the IfxLoWrite() methods in the `IfxSmartBlob` class to write to a smart large object from a `byte[]` buffer or file input stream:

```java
public int IfxLoWrite(int lodf, byte[] buffer) throws SQLException

public int IfxLoWrite(int lodf, InputStream fin, int length)
   throws SQLException
```

The first version of the method writes `buffer.length` bytes of data from the buffer into the smart large object. The second version writes `length` bytes of data from an `InputStream` object into the smart large object.

The `lofd` parameter is a locator file descriptor returned by the IfxLoCreate() or IfxLoOpen() method. The `buffer` parameter is the `byte[]` buffer where the data is read. The `fin` parameter is the `InputStream` object from which data is written into the smart large object. The `length` parameter is the number of bytes written into the smart large object. The driver returns the number of bytes written.

Use the IfxLoFromFile() method in the `IfxSmartBlob` class to write data to a smart large object from a file:

```java
public int IfxLoFromFile (int lodf, String filename, int flag, int offset, int amount) throws SQLException
```

The `lofd` parameter is a locator file descriptor returned by the IfxLoCreate() or IfxLoOpen() method. The `flag` parameter indicates whether the file is on the client or the server. The value is either `IfxSmartBlob.LO_CLIENT_FILE` or `IfxSmartBlob.LO_SERVER_FILE`.

The driver returns the number of bytes written.

**Truncate a smart large object**

Use the IfxLoTruncate() method in the `IfxSmartBlob` class to truncate a large object at an offset you specify. The method signature is as follows:

```java
public void IfxLoTruncate(int lodf, long offset) throws SQLException
```

The `offset` parameter is the absolute position at which the smart large object is truncated.

**Measure a smart large object**

Use the IfxLoSize() method in the `IfxSmartBlob` class to return the size of a smart large object. This method returns a long integer representing the size of the large object.

The method signature is as follows:
public long IfxLoSize(int lofd) throws SQLException

**Close and release a smart large object**

After you have performed all the operations your application needs, you must close the object and then release the resources in the server. The methods in the IfxSmartBlob class that perform these tasks are as follows:

```java
public void IfxLoClose(int lofd) throws SQLException
public void IfxLoRelease(IfxLocator loPtr) throws SQLException
public void IfxLoRelease(IfxBblob blob) throws SQLException
public void IfxLoRelease(IfxCblob clob) throws SQLException
```

For any further access to the same large object, you must reopen it with the IfxLoOpen() method.

**Convert IfxLocator to a hexadecimal string**

Some applications, for example, web browsers, can only process ASCII data; they require IfxLocator to be converted to hexadecimal string format. In a typical web-based application, the web server queries the database table and sends the results to the browser. Instead of sending the entire smart large object, the web server converts the locator into hexadecimal string format and sends it to the browser. If the user requests the browser to display the smart large object, the browser sends the locator in hexadecimal format back to the web server. The web server then reconstructs the binary locator from the hexadecimal string and sends the corresponding smart large object data to the browser.

To convert between the IfxLocator byte array and a hexadecimal number, use the methods listed in the following table.

<table>
<thead>
<tr>
<th>Task performed</th>
<th>Method signature</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Converts a byte array to a hexadecimal character string</td>
<td>public static String toHexString(byte[] byteBuf);</td>
<td>Works on data other than IfxLocator Provided in the com.informix.util.stringUtil class</td>
</tr>
<tr>
<td>Converts a hexadecimal character string to a byte array</td>
<td>public static byte[] fromHexString(String str) throws NumberFormatException;</td>
<td>Works on data other than IfxLocator Provided in the com.informix.util.stringUtil class</td>
</tr>
<tr>
<td>Constructs an IfxLocator object using a byte array</td>
<td>public IfxLocator(byte[] byteBuf) throws SQLException;</td>
<td>Provided in the IfxLocator class</td>
</tr>
<tr>
<td>Converts an IfxLocator byte array to a hexadecimal character string</td>
<td>public String toString();</td>
<td>Provided in the IfxLocator class</td>
</tr>
<tr>
<td>Converts a hexadecimal character string to an IfxLocator byte array</td>
<td>public byte[] toBytes();</td>
<td>Provided in the IfxLocator class</td>
</tr>
</tbody>
</table>

The following example uses the toString() and toBytes() methods to fetch the locator from a smart large object and then convert it into a hexadecimal string:

```java
String hexLoc = "";
byte[] blobBytes;
byte[] rawLocA = null;
IfxLocator loc;
try
```
ResultSet rs = stmt.executeQuery("select b1 from btab");
while(rs.next())
{
    IfxBlob b=(IfxBlob)rs.getBlob(1);
    loc = b.getLocator();
    hexLoc = loc.toString();
    rawLocA = loc.toBytes();
}
}

try
{
    IfxLocator loc2 = new IfxLocator(rawLoc);
    IfxSmartBlob b2 = new IfxSmartBlob((IfxConnection)myConn);
    int lofd = b2.IfxLoOpen(loc2, b2.LO_RDWR);
    blobBytes = b2.IfxLoRead(lofd, fileLength);
}

Work with storage characteristics

Storage characteristics tell the database server how to manage a smart large object. These characteristics include such areas as sizing, logging, locking, and open modes. You have the following options with respect to storage characteristics:

- Use the system-specified storage characteristics as a basis for obtaining the storage characteristics of a smart large object.
- Override the system defaults with one of the following:
  - Storage characteristics defined for a particular CLOB or BLOB column in which you want to store the smart large object
  - Storage characteristics that are unique to a particular CLOB or BLOB column called column-level storage characteristics
  - Special storage characteristics that you define for this smart large object only called user-specified storage characteristics

The database server uses a hierarchy, which the following figure shows, to obtain the storage characteristics for a new smart large object.
For a given storage characteristic, any value defined at the column level overrides the system-specified value, and any user-level value overrides the column-level value. You can specify storage characteristics at the three points shown in the following table.

<table>
<thead>
<tr>
<th>When specified</th>
<th>How specified</th>
<th>For more information</th>
</tr>
</thead>
<tbody>
<tr>
<td>When an sbspace is created</td>
<td>Options of onspaces utility</td>
<td>“System-specified storage characteristics” IBM Informix Administrator’s Guide</td>
</tr>
<tr>
<td>When a database table is created</td>
<td>Keywords in PUT clause of CREATE TABLE statement</td>
<td>IBM Informix Guide to SQL: Syntax</td>
</tr>
<tr>
<td>When a smart large object is created</td>
<td>Create flags and methods in the ifxLobDescriptor class</td>
<td>“Set create flags” on page 4-46</td>
</tr>
</tbody>
</table>

**System-specified storage characteristics**

The database administrator establishes system-specified storage characteristics when he or she initializes the database server and creates an sbspace with the onspaces utility, as follows:

- If the onspaces utility has specified a value for a particular storage characteristic, the database server uses the onspaces value as the system-specified storage characteristic.
- If the onspaces utility has not specified a value for a particular storage characteristic, the database server uses the system default as the system-specified storage characteristic.

The system-specified storage characteristics apply to all smart large objects that are stored in the sbspace, unless a smart large object specifically overrides them with column-level or user-specified storage characteristics.

For the storage characteristics that onspaces can set, as well as the system defaults, see Table 4-2 on page 4-43 and Table 4-3 on page 4-44.
For most applications, it is recommended that you use the system-specified default values for the storage characteristics. Note the following exceptions:

- Your application needs to obtain extra performance.
  You can use setXXX() methods in ifxLobDescriptor to change the disk-storage information of a new smart large object. For more information, see "Set create flags" on page 4-46.

- You want to use the storage characteristics of an existing smart large object.
  The IfxLoStat.getLobDescriptor() method can obtain the large-object descriptor of an open smart large object. You can then create a new object and use the IfxSmartBlob.ifxLoAlter() method to set its characteristics to the new descriptor. For more information, see "Changing the storage characteristics" on page 4-46.

- You are working with more than one smart large object and do not want to use the default sbspace.
  The DBA can specify a default sbspace name with the SBSPACENAME configuration parameter in the onconfig file. However, you must ensure that the location (the name of the sbspace) is correct for the smart large object that you create. If you do not specify an sbspace name for a new smart large object, the database server stores it in this default sbspace. This arrangement can lead to space constraints.

- If you know the size of the smart large object, specify this size in your application using the IfxLobDescriptor.setEstBytes() method instead of in the onspaces utility (system level) or the CREATE TABLE or the ALTER TABLE statement (column level).

**Obtain information about storage characteristics:**

To obtain the column-level storage characteristics of a smart large object, your application can call the following method in the IfxSmartBlob class, passing the name of the column for the colname parameter:

```java
IfxLobDescriptor IfxLoColInfo(java.lang.String colname) throws SQLException
```

Most applications only need to ensure correct storage characteristics for an sbspace name (the location of the smart large object). You can get information for this and other storage characteristics by calling the various getXXX() methods in the ifxLobDescriptor class before creating the IfxSmartBlob object. The following table summarizes the getXXX() methods.

<table>
<thead>
<tr>
<th>Method signature in ifxLobDescriptor</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>int getCreateFlags()</td>
<td>Obtains the create flags for the object</td>
</tr>
<tr>
<td>long getEstSize()</td>
<td>Obtains the estimated size, in bytes, of the object</td>
</tr>
<tr>
<td>int getExtSize()</td>
<td>Obtains the extent size of the object</td>
</tr>
<tr>
<td>long getMaxBytes()</td>
<td>Obtains the maximum size, in bytes, of the object</td>
</tr>
<tr>
<td>java.lang.String getSbspace()</td>
<td>Obtains the name of the sbspace in the database server in which the object is stored</td>
</tr>
</tbody>
</table>

**Example of setting sbspace characteristics:**

The following call to the onspaces utility creates an sbspace called sb1 in the /dev/sbspace1 partition:
The following table shows the resulting system-specified storage characteristics for all smart large objects in the sb1 sbspace.

<table>
<thead>
<tr>
<th>Disk-storage information</th>
<th>System-specified value</th>
<th>Specified by onspaces utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size of extent</td>
<td>Calculated by database server</td>
<td>System default</td>
</tr>
<tr>
<td>Size of next extent</td>
<td>Calculated by database server</td>
<td>System default</td>
</tr>
<tr>
<td>Minimum extent size</td>
<td>Calculated by database server</td>
<td>System default</td>
</tr>
<tr>
<td>Size of smart large object</td>
<td>32 kilobytes (database server uses as size estimate)</td>
<td>AVG_LO_SIZE</td>
</tr>
<tr>
<td>Maximum size of I/O block</td>
<td>Calculated by database server</td>
<td>System default</td>
</tr>
<tr>
<td>Name of sbspace</td>
<td>sb1</td>
<td>-S option</td>
</tr>
<tr>
<td>Logging</td>
<td>OFF</td>
<td>System default</td>
</tr>
<tr>
<td>Last-access time</td>
<td>OFF</td>
<td>System default</td>
</tr>
</tbody>
</table>

Work with disk-storage information

Disk-storage information helps the database server determine how to manage the smart large object most efficiently on disk.

Important: For most applications, use the values that the database server calculates for the disk-storage information. Methods provided in IBM Informix JDBC Driver are intended for special situations.

This disk-storage information includes:

- Allocation-extent information:
  - Extent size:
    - An allocation extent is a collection of contiguous bytes within an sbspace that the database server allocates to a smart large object at one time. The database server performs storage allocations for smart large objects in increments of the extent size.
    - You can specify an extent size by calling the ifxLobDescriptor.setExtSize() method.
  - Next-extent size:
    - The database server tries to allocate an extent as a single, contiguous region in a chunk. However, if no single extent is large enough, the database server must use multiple extents as necessary to satisfy the current write request.
      - After the initial extent fills, the database server attempts to allocate another extent of contiguous disk space. This process is called next-extent allocation.

For more information about extents, see the topics on disk structure and storage in the IBM Informix Administrator’s Guide.

- Sizing information:
  - Estimated number of bytes in a new smart large object
  - Maximum number of bytes to which the smart large object can grow

To specify sizing information, you can use the setMaxBytes() and setEstBytes() methods in the ifxLobDescriptor class.
If you know the size of the smart large object, specify this size using the setEstBytes() method. This is the best way to set the extent size because the database server can allocate the entire smart large object as one extent.

- Location:
  The name of the sbspace identifies the location at which to store the smart large object. To set this name, you can use the vixfLobDescriptor.setSbSpace() method.

The database server uses the disk-storage information to determine how best to size, allocate, and manage the extents of the sbspace. It can calculate all disk-storage information for a smart large object except the sbspace name.

The following table summarizes the ways to specify disk-storage information for a smart large object.

Table 4-2. Specifying disk-storage information

<table>
<thead>
<tr>
<th>Disk-storage information</th>
<th>System-specified storage characteristics</th>
<th>Column-level storage characteristics</th>
<th>User-specified storage characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>System default value</td>
<td>Specified by onspaces utility</td>
<td>Specified by PUT clause of CREATE TABLE</td>
</tr>
<tr>
<td>Size of extent</td>
<td>Calculated by database server</td>
<td>EXTENT_SIZE</td>
<td>EXTENT SIZE</td>
</tr>
<tr>
<td>Size of next extent</td>
<td>Calculated by database server</td>
<td>NEXT_SIZE</td>
<td>No</td>
</tr>
<tr>
<td>Minimum extent size</td>
<td>4 kilobytes</td>
<td>MIN_EXT_SIZE</td>
<td>No</td>
</tr>
<tr>
<td>Size of smart large object</td>
<td>Calculated by database server</td>
<td>Average size of all smart large objects in sbspace: AVG_LO_SIZE</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum size of I/O block</td>
<td>Calculated by database server</td>
<td>MAX_IO_SIZE</td>
<td>No</td>
</tr>
<tr>
<td>Name of sbspace</td>
<td>SBSPACENAME</td>
<td>-S option</td>
<td>Name of an existing sbspace in which a smart large object: IN clause</td>
</tr>
</tbody>
</table>

**Work with logging, last-access time, and data integrity**

Database administrators and applications can affect some additional smart-large-object attributes:

- Whether to log changes to the smart large object in the system log file
- Whether to save the last-access time for a smart large object
- How to format the pages in the sbspace of the smart large object

The following table summarizes how you can alter these attributes at the system, column, and application levels.
### Table 4-3. Specifying attribute information

<table>
<thead>
<tr>
<th>Attribute information</th>
<th>System-specified storage characteristics</th>
<th>Column-level storage characteristics</th>
<th>User-specified storage characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>System default value</td>
<td>Specified by onspaces utility</td>
<td>Specified by PUT clause of CREATE TABLE</td>
</tr>
<tr>
<td>Logging</td>
<td>OFF</td>
<td>LOGGING</td>
<td>LOG, NO LOG</td>
</tr>
<tr>
<td></td>
<td></td>
<td>specified by PUT clause of CREATE TABLE</td>
<td>Yes</td>
</tr>
<tr>
<td>Last-access time</td>
<td>OFF</td>
<td>ACCESSSTIME</td>
<td>KEEP ACCESS TIME, NO KEEP ACCESS TIME</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Buffering mode</td>
<td>OFF</td>
<td>BUFFERING</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Lock mode</td>
<td>Lock entire smart large object</td>
<td>LOCK_MODE</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Data integrity</td>
<td>High integrity</td>
<td>NO</td>
<td>HIGH INTEG, MODERATE INTEG</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

**Logg** **in**: By default, the database server does not log the user data of a smart large object. You can control the logging behavior for a smart large object as part of its create flags. For more information, see “Set create flags” on page 4-46.

When a database performs logging, smart large objects might result in long transactions for the following reasons:

- Smart large objects can be very large, even several gigabytes in size.
- The amount of log storage needed to log user data can easily overflow the log.
- Smart large objects might be used in situations where data collection can be quite long.
- For example, if a smart large object holds low-quality audio recording, the amount of data collection might be modest but the recording session might be quite long.

A simple workaround is to divide a long transaction into multiple smaller transactions. However, if this solution is not acceptable, you can control when the database server performs logging of smart large objects. Table 4-3 shows how you can control the logging behavior for a smart large object.

When logging is enabled, the database server logs changes to the user data of a smart large object. It performs this logging in accordance with the current database log mode.

For a database that is not ANSI compliant, the database server does not guarantee that log records that pertain to smart large object are flushed at transaction commit. However, the metadata is always restorable to an action-consistent state; that is, to a state that ensures no structural inconsistencies exist in the metadata (control information of the smart large object, such as reference counts).

An ANSI-compliant database uses unbuffered logging. When smart-large-object logging is enabled, all log records (metadata and user data) that pertain to smart large objects are flushed to the log at transaction commit. However, user data is not guaranteed to be flushed to its stable storage location at commit time.

When logging is disabled, the database server does not log changes to user data even if the database server logs other database changes. However, the database server always logs changes to the metadata. Therefore, the database server can still restore the metadata to an action-consistent state.
Important: Consider carefully whether to enable logging for a smart large object. The database server incurs considerable overhead to log smart large objects. You must also ensure that the system log file is large enough to hold the value of the smart large object. The logical log size must exceed the total amount of data that the database server logs while the update transaction is active.

Write your application so that any transactions with smart large objects that have potentially long updates do not cause other transactions to wait. Multiple transactions can access the same smart-large-object instance if the following conditions are satisfied:

- The transaction can access the database row that contains an LO handle for the smart large object.
  Multiple references can exist on the same smart large object if more than one column holds an LO handle for the same smart large object.
- Another transaction does not hold a conflicting lock on the smart large object.

  For more information about smart large object locks, see "Work with locks" on page 4-48.

The best update performance and fewest logical-log problems result when you disable the logging feature when you load a smart large object and re-enable it after the load operation completes. If logging is turned on, you might want to turn logging off before a bulk load and then perform a level-0 backup.

Last-access time: The last-access time of a smart large object is the system time at which the database server last read or wrote the smart large object. The last-access time records access to the user data and metadata of a smart large object. This system time is stored as number of seconds since January 1, 1970. The database server stores this last-access time in the metadata area of the sbspace.

By default, the database server does not save the last access time. You can specify saving the last-access time by setting the LO_KEEP_LASTACCESS_TIME create flag and calling the IfxLobDescriptor.setCreateFlags() method. For more information, see "Set create flags" on page 4-46.

The database server also tracks the last-modification time and the last change in status for a smart large object. For more information, see "Work with status characteristics" on page 4-47.

Important: Consider carefully whether to track last-access time for a smart large object. The database server incurs considerable overhead in logging and concurrency to maintain last-access times for smart large objects.

Data integrity: You can specify data integrity with the LO_HIGH_INTEG and LO_MODERATE_INTEG create flags, by calling the IfxLobDescriptor.setCreateFlags() method. For more information, see "Set create flags" on page 4-46.

An spage is the unit of allocation for smart large object data, which is stored in the user-data area of an sbspace. The structure of an spage in the sbspace determines how much data integrity the database server can provide. The database server uses the page header and trailer to detect incomplete writes and data corruption.

The database server supports the following levels of data integrity:
High integrity tells the database server to use both a page header and a page trailer in each sbpage.

Moderate integrity tells the database server to use only a page header in each sbpage.

Moderate integrity provides the following benefits:

- It eliminates an additional data copy operation that is necessary when an sbpage has page headers and page trailers.
- It preserves the user data alignments on pages because no page header and page trailer are present.

Moderate integrity might be useful for smart large objects that contain large amounts of audio or video data that is moved through the database server and that do not require a high data integrity. By default, the database server uses high integrity (page headers and page trailers) for sbspace pages. You can control the data integrity for a smart large object as part of its storage characteristics.

Important: Consider carefully whether to use moderate integrity for sbpages of a smart large object. Although moderate integrity takes less disk space per page, it also reduces the ability of the database server to recover information if disk errors occur.

For information about the structure of sbspace pages, see the IBM Informix Administrator’s Guide.

Changing the storage characteristics

The IfxLoAlter() methods in the IfxSmartBlob class let you change the storage characteristics of a smart large object.

To change smart-large-object characteristics:

1. Create a new large-object descriptor. For example:
   ```java
   IfxLobDescriptor loDesc = new IfxLobDescriptor(conn);
   ```

2. Call IfxLobDescriptor.setCreateFlags(), setEstBytes(), IfxLobDescriptor.setMaxBytes(), setExtSize, and setSbspace() to specify the new characteristics:
   ```java
   public void setCreateFlags( int flags )
   public void setEstBytes(long estSize)
   public void setMaxBytes (long maxSize)
   public void setExtSize (long extSize)
   public void setSbspace(java.lang.String sbspacename)
   ```

   The flag parameter is a constant from "Set create flags."

3. Call IfxLoAlter() to alter the existing smart large object to contain the new descriptor:
   ```java
   public int IfxLoAlter(IfxLocator loPtr, IfxLobDescriptor loDesc)
   throws SQLException
   public int IfxLoAlter(IfxBblob blob, IfxLobDescriptor loDesc)
   throws SQLException
   public int IfxLoAlter(IfxCblob clob, IfxLobDescriptor loDesc)
   throws SQLException
   ```

   IfxLoAlter() obtains an exclusive lock in the server for the entire smart large object before it proceeds with the update. It holds this lock until the update completes.

   Set create flags:
You can change the following characteristics by calling the IfxLobDescriptor.setCreateFlags() method:

- **Logging characteristics**
  
  You can specify the LO_LOG or LO_NOLOG constant.
  
  LO_LOG causes the server to follow the logging procedure used with the current database log for the corresponding smart large object. This option can generate large amounts of log traffic and increase the risk that the logical log fills up.
  
  Instead of full logging, you might turn off logging when you load the smart large object initially and then turn logging back on once the smart large object is loaded. If you use NO LOG, you can restore the smart-large-object metadata later to a state in which no structural inconsistencies exist. In most cases, no transaction inconsistencies will exist either, but that result is not guaranteed.

  For more usage details on logging, see "Logging" on page 4-44.

- **Last-access time characteristics**
  
  You can specify the LO_KEEP_LASTACCESS_TIME or LO_NOKEEP_LASTACCESS_TIME constant. LO_KEEP_LASTACCESS_TIME records, in the smart-large-object metadata, the system time at which the corresponding smart large object was last read or written.

  For more usage details on last-access time, see "Last-access time" on page 4-45.

- **Whether to detect incomplete writes and data corruption by producing user-data pages with a page header and page trailer**
  
  You can specify the LO_HIGH_INTEG or LO_moderate_integ constant. LO_HIGH_INTEG is the default data-integrity behavior.

  For more usage details on data integrity, see "Data integrity" on page 4-45.

The following example sets multiple flags:

```java
loDesc.setCreateFlags
(IfxSmartBlob.LO_LOG+IfxSmartBlob.LO_TEMP+...)
```

A parallel getXXX() method lets you obtain the current storage characteristics for the large object:

```java
public int getCreateFlags()
```

For more detailed information about all of the characteristics, see the section describing the PUT clause for the CREATE TABLE statement, in the *IBM Informix Guide to SQL: Syntax*.

### Work with status characteristics

The IfxLoStat class stores some statistical information about a smart large object such as the size, last access time, last modified time, last status change, and so on. The following table shows the status information that you can obtain.

<table>
<thead>
<tr>
<th>Status information</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last-access time</td>
<td>The time, in seconds, that the smart large object was last accessed</td>
</tr>
<tr>
<td></td>
<td>This value is available only if the last-access time attribute is enabled for the smart large object. For more information, see &quot;Last-access time&quot; on page 4-45.</td>
</tr>
</tbody>
</table>

Chapter 4. Work with Informix types 4-47
Table 4-4. Status information for a smart large object (continued)

<table>
<thead>
<tr>
<th>Status information</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last-change time</td>
<td>The time, in seconds, of the last change in status for the smart large object. A change in status includes changes to metadata and user data. (data updates and changes to the number of references). This system time is stored as number of seconds since January 1, 1970.</td>
</tr>
<tr>
<td>Last-modification time</td>
<td>The time, in seconds, that the smart large object was last modified. A modification includes only changes to user data (data updates). This system time is stored as the number of seconds since January 1, 1970. On some platforms, the last-modification time might also have a microseconds component, which can be obtained separately from the seconds component.</td>
</tr>
<tr>
<td>Size</td>
<td>The size, in bytes, of the smart large object</td>
</tr>
</tbody>
</table>

Storage characteristics see “Work with storage characteristics” on page 4-39.

To obtain a reference to the status structure, call the following method in the IfxSmartBlob class:

IfxLoStat IfxLoGetStat(int lofd)

To obtain particular categories of status information, call the methods shown in the following table.

Table 4-5. Methods for obtaining status information

<table>
<thead>
<tr>
<th>Status information</th>
<th>Method signature in IfxLoStat class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last-access time</td>
<td>int getLastAccessTime()</td>
</tr>
<tr>
<td>Last-change time</td>
<td>int getLastStatusTime()</td>
</tr>
<tr>
<td>Last-modification time</td>
<td>int getLastModifyTimeM() - time in microseconds</td>
</tr>
<tr>
<td></td>
<td>int getLastModifyTimeS() - time rounded to seconds</td>
</tr>
<tr>
<td>Size</td>
<td>int getSize()</td>
</tr>
<tr>
<td>Storage characteristics</td>
<td>ifxLobDescriptor getLobDescriptor()</td>
</tr>
</tbody>
</table>

Work with locks

To prevent simultaneous access to smart-large-object data, the database server obtains a lock on this data when you open the smart large object. This smart-large-object lock is distinct from the following kinds of locks:

- Row locks
  
  A lock on a smart large object does not lock the row in which the smart large object resides. However, if you retrieve a smart large object from a row and the
row is still current, the database server might hold a row lock as well as a smart-large-object lock. Locks are held on the smart large object instead of on the row because many columns could be accessing the same smart-large-object data.

- Locks of different smart large objects in the same row of a table
  A lock on one smart large object does not affect other smart large objects in the row.

The following table shows the lock modes that a smart large object can support.

**Table 4-6. Lock modes for a smart large object**

<table>
<thead>
<tr>
<th>Lock mode</th>
<th>Purpose</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lock-all</td>
<td>Lock the entire smart large object</td>
<td>Indicates that lock requests apply to all data for the smart large object</td>
</tr>
<tr>
<td>Byte-range</td>
<td>Lock only specified portions of the smart large object</td>
<td>Indicates that lock requests apply only to the specified number of bytes of smart-large-object data</td>
</tr>
</tbody>
</table>

When the server opens a smart large object, it uses the following information to determine the lock mode of the smart large object:

- The access mode of the smart large object
  The database server obtains a lock as follows:
  - In share mode, when you open a smart large object for reading (read-only)
  - In update mode, when you open a smart large object for writing (write-only, read/write, write/append)
    When a write operation (or some other update) is actually performed on the smart large object, the server upgrades this lock to an exclusive lock.

- The isolation level of the current transaction
  If the database table has an isolation mode of Repeatable Read, the server does not release any locks that it obtains on a smart large object until the end of the transaction.

By default, the server chooses the lock-all lock mode.

The server retains the lock as follows:

- It holds share-mode locks and update locks (which have not yet been upgraded to exclusive locks) until one of the following events occurs:
  - The close of the smart large object
  - The end of the transaction
  - An explicit request to release the lock (for a byte-range lock only)
- It holds exclusive locks until the end of the transaction even if you close the smart large object.

When one of the preceding conditions occurs, the server releases the lock on the smart large object.

**Important:** You lose the lock at the end of a transaction even if the smart large object remains open. When the server detects that a smart large object has no active lock, it automatically obtains a new lock when the first access occurs to the smart large object. The lock that it obtains is based on the original access mode of the smart large object.
The server releases the lock when the current transaction terminates. However, the server obtains the lock again when the next function that needs a lock executes. If this behavior is undesirable, the server-side SQL application can use BEGIN WORK transaction blocks and place a COMMIT WORK or ROLLBACK WORK statement after the last statement that needs to use the lock.

**Byte-range locking**

By default, the database server uses whole lock-all locks when it needs to lock a smart large object. Lock-all locks are an “all or nothing” lock; that is, they lock the entire smart large object. When the database server obtains an exclusive lock, no other user can access the data of the smart large object as long as the lock is held.

If this locking is too restrictive for the concurrency requirements of your application, you can use byte-range locking instead of lock-all locking. With byte-range locking, you can specify the range of bytes to lock in the smart-large-object data. If other users access other portions of the data, they can still acquire their own byte-range lock.

Use the `IfxLoLock()` method in the `IfxSmartBlob` class to specify byte-range locking:

```java
public long IfxLoLock(int lofd, long offset, int whence, long range, int lockmode) throws SQLException
```

To unlock a range of bytes in the object, use the `IfxLoUnLock()` method:

```java
public long IfxLoUnLock(int lofd, long offset, int whence, long range) throws SQLException
```

The `lofd` parameter is the locator file descriptor returned by the `IfxLoCreate()` or `IfxLoOpen()` method. The `offset` parameter is an offset from the starting seek position. The `whence` parameter identifies the starting seek position. The values are described in the table in “Position within a smart large object” on page 4-35.

The `range` parameter indicates the number of bytes to lock or unlock within the smart large object. The `lockmode` parameter indicates what type of lock to create. The values can be either `IfxSmartBlob.LO_EXCLUSIVE_MODE` or `IfxSmartBlob.LO_SHARED_MODE`.

**Cache large objects**

Whenever an object of type BLOB, CLOB, text, or byte is fetched from the database server, the data is cached in client memory. If the size of the large object is bigger than the value in the `LOBCACHE` environment variable, the large object data is stored in a temporary file. For more information about the `LOBCACHE` variable, see “Manage memory for large objects” on page 7-2.

**Avoid errors transferring large objects**

The `IFX_LOB_XFERSIZE` environment variable is used to specify the number of bytes in a CLOB or BLOB to transfer from a client application to the database server before checking whether an error has occurred. The error check occurs each time the specified number of bytes is transferred. If an error occurs, the remaining data is not sent and an error is reported. If no error occurs, the file transfer will continue until it finishes.

For example, if the value of `IFX_LOB_XFERSIZE` is set to 10485760 (10 MB), then error checking will occur after every 10485760 bytes of the CLOB or BLOB is sent.
If the **IFX_LOB_XFERSIZE** environment variable is not set, the error check occurs after the entire BLOB or CLOB is transferred.

The valid range for the **IFX_LOB_XFERSIZE** environment variable is from 1 to 922372036854775808 bytes. The **IFX_LOB_XFERSIZE** environment variable is set on the client.

You should adjust the value of **IFX_LOB_XFERSIZE** to suit your environment. Set the **IFX_LOB_XFERSIZE** environment variable low enough so that transmission errors of large BLOB or CLOB data types are detected early, but not so low that excessive network resources are consumed.

**Smart large object examples**

The following examples illustrate some of the tasks discussed in this section.

**Create a smart large object**

This example illustrates the steps shown in "Creating smart large objects" on page 4-29.

```java
file = new File("data.dat");
FileInputStream fin = new FileInputStream(file);

byte[] buffer = new byte[200];

IfxLobDescriptor loDesc = new IfxLobDescriptor(myConn);
IfxLocator loPtr = new IfxLocator();
IfxSmartBlob smb = new IfxSmartBlob(myConn);

// Now create the large object in server. Read the data from the file
// data.dat and write to the large object.
int loFd = smb.IfxLoCreate(loDesc, smb.LO_RDWR, loPtr);
System.out.println("A smart-blob is created ");
int n = fin.read(buffer);
if (n > 0)
    n = smb.IfxLoWrite(loFd, buffer);
System.out.println("Wrote: " + n + " bytes into it");

// Close the large object and release the locator.
smb.IfxLoClose(loFd);
System.out.println("Smart-blob is closed ");
smb.IfxLoRelease(loPtr);
System.out.println("Smart Blob Locator is released ");
```

The contents of the file `data.dat` are written to the smart large object.

**Insert data into a smart large object**

The following code inserts data into a smart large object:

```java
String s = "insert into large_tab (col1, col2) values (?,?)";
pstmt = myConn.prepareStatement(s);

file = new File("data.dat");
FileInputStream fin = new FileInputStream(file);

byte[] buffer = new byte[200];

IfxLobDescriptor loDesc = new IfxLobDescriptor(myConn);
IfxLocator loPtr = new IfxLocator();
IfxSmartBlob smb = new IfxSmartBlob(myConn);
```
// Create a smart large object in server
int loFd = smb.IfxLoCreate(loDesc, smb.LO_RDWR, loPtr);
System.out.println("A smart-blob has been created ");
int n = fin.read(buffer);
if (n > 0)
n = smb.IfxLoWrite(loFd, buffer);
smb.IfxLoClose(loFd);

System.out.println("Wrote:" + n + " bytes into it ");
System.out.println("Smart-blob is closed ");

Blob blb = new IfxBblob(loPtr);
pstmt.setInt(1, 2); // set the Integer column
pstmt.setBlob(2, blb); // set the blob column
pstmt.executeUpdate();
System.out.println("Binding of smart large object to table is done");
pstmt.close();
smb.IfxLoRelease(loPtr);
System.out.println("Smart Blob Locator is released ");

The contents of the file data.dat are written to the BLOB column of the large_tab table.

Retrieve data from a smart large object

The example in this topic illustrates the steps in "Accessing smart large objects" on page 4-33.

The following code example shows how to access the smart large object data using IBM Informix extension classes:

byte[] buffer = new byte[200];
System.out.println("Reading data now ...");
try
{
    int row = 0;
    Statement stmt = myConn.createStatement();
    ResultSet rs = stmt.executeQuery("Select * from demo_14");
    while( rs.next() )
    {
        row++;
        String str = rs.getString(1);
        InputStream value = rs.getAsciiStream(2);
        IfxBblob b = (IfxBblob) rs.getBlob(2);
        IfxLocator loPtr = b.getLocator();
        IfxSmartBlob smb = new IfxSmartBlob(myConn);
        int loFd = smb.IfxLoOpen(loPtr, smb.LO_RDONLY);
        System.out.println("The Smart Blob is Opened for reading ..");
        int number = smb.IfxLoRead(loFd, buffer, buffer.length);
        System.out.println("Read total " + number + " bytes");
        smb.IfxLoClose(loFd);
        System.out.println("Closed the Smart Blob ..");
        smb.IfxLoRelease(loPtr);
        System.out.println("Locator is released ..");
    }
    rs.close();
}
catch(SQLException e)
{
    System.out.println("Select Failed ...
" + e.getMessage());
}
First, the ResultSet.getBlob() method gets an object of type BLOB. The casting is required to convert the returned object to an object of type IfxBblob. Next, the IfxBblob.getLocator() method gets an IfxLocator object from the IfxBblob object. After the IfxLocator object is available, you can instantiate an IfxSmartBlob object and use the IfxLoOpen() and IfxLoRead() methods to read the smart large object data. Fetching CLOB data is similar, but it uses the methods ResultSet.getClob(), IfxCblob.getLocator(), and so on.

If you use getBlob() or getClob() to fetch data from a column of type BLOB, you do not need to use the Informix extensions to retrieve the actual BLOB content as outlined in the preceding sample code. You can simply use Java.Blob.getBinaryStream() or Java.Clob.getAsciiStream() to retrieve the content. IBM Informix JDBC Driver implicitly gets the content from the database server for you, using basically the same steps as the sample code. This approach is simpler than the approach of the preceding example but does not provide as many options for reading the contents of the BLOB column.
Chapter 5. Work with opaque types

An opaque data type is an atomic data type that you define to extend the database server. The database server has no information about the opaque data type until you provide routines that describe it.

Extending the database server also frequently requires that you create user-defined routines (UDRs) to support the extensions. A UDR is a routine that you create that can be invoked in an SQL statement, by the database server, or from another UDR. UDRs can be part of opaque types, or they can be separate.

The JDBC 3.0 standard provides the java.sql.SQLInput and java.sql.SQLOutput methods to access opaque types. The definition of these interfaces is extended to fully support IBM Informix fixed binary and variable binary opaque types. This extension includes the following interfaces:

- IfmxUdtSQLInput
- IfmxUdtSQLOutput

In addition, the following classes simplify creating Java opaque types and UDRs in the database server from a JDBC client application:

- UDTManager
- UDTMetaData
- UDRManager
- UDRMetaData

The UDTManager and UDRManager classes provide an infrastructure for mapping client-side Java classes as opaque data types and UDRs and storing their instances in the database.

This facility works only in client-side JDBC. For details about the features and limitations of server-side JDBC, see the J/Foundation Developer’s Guide.

For detailed information about opaque types and UDRs, see the following publications:

- IBM Informix User-Defined Routines and Data Types Developer’s Guide discusses the terms and concepts about opaque types and UDRs that you need to use the information in this section, including the internal data structure, support functions, and implicit and explicit casts.
- The J/Foundation Developer’s Guide discusses information specific to writing UDRs in Java.

The IfmxUDTSQLInput interface

The com.informix.jdbc.IfmxUdtSQLInput interface extends java.sql.SQLInput with several added methods. To use these methods, you must cast the SQLInput references to IfmxUdtSQLInput. The methods allow you to perform the following functions:

- Read data.
- Position in the data stream.
- Set or obtain attributes of the data.
Read data

The readString() method reads the next attribute in the stream as a Java string. The readBytes() method reads the next attribute in the stream as a Java byte array. Both methods are similar to the SQInput.readBytes() method except that a fixed length of data is read in:

```java
public String readString(int maxlen) throws SQLException;
public byte[] readBytes(int maxlen) throws SQLException;
```

In both methods, you must supply a length for IBM Informix JDBC Driver to read the next attribute properly, because the characteristics of the opaque type are unknown to the driver. The `maxlen` parameter specifies the maximum length of data to read in.

Position in the data stream

The getCurrentPosition() method retrieves the current position in the input stream. The setCurrentPosition() method changes the position in the input stream to the position specified by the `position` parameter:

```java
public int getCurrentPosition();
public void setCurrentPosition(int position) throws SQLException;
public void skipBytes(int len) throws SQLException;
```

The `position` parameter must be a positive integer. The skipBytes() method changes the position in the input stream by the number of bytes specified by the `len` parameter, relative to the current position. The `len` parameter must be a positive integer.

In both setCurrentPosition() and skipBytes(), IBM Informix JDBC Driver generates an `SQLException` if the new position specified is after the end of the input stream.

Set or obtain data attributes

The length() method returns the total length of the entire data stream. The getAutoAlignment() method retrieves the `TRUE` or `FALSE` (on or off) state of the auto alignment feature. The setAutoAlignment() method sets the state to `TRUE` or `FALSE`:

```java
public int length();
public boolean getAutoAlignment();
public void setAutoAlignment(boolean value);
```

**Important:** Setting the auto alignment feature might result in discarded bytes from the input stream if the data is not already aligned. JDBC applications should provide aligned data or set the auto alignment feature to `FALSE`.

The IfmxUDTSQLOutput interface

The `com.informix.jdbc.IfmxUdtSQLOutput` interface extends `java.sql.SQLOutput` with the following added methods:

```java
public void writeString(String str, int length) throws SQLException;
public void writeBytes(byte[] b, int length) throws SQLException;
```

To use these methods, you must cast the `SQLOutput` references to `IfmxUdtSQLOutput`.

Use the writeString() method to write the next attribute to the stream as a Java string. If the string passed in is shorter than the specified length, IBM Informix JDBC Driver pads the string with zeros.
Use the writeBytes() method to write the next attribute to the stream as a Java byte array.

Both methods are similar to the SQLOutput.writeBytes() method except that a fixed length of data is written to the stream. If the array or string passed in is shorter than the specified length, IBM Informix JDBC Driver pads the array or string with zeros. In both methods, you must supply a length for IBM Informix JDBC Driver to write the next attribute properly, because the opaque type is unknown to the driver.

Map opaque data types

IBM Informix opaque types map to Java objects, which must implement the java.sql.SQLData interface. These Java objects describe all the data members that make up the opaque type. These Java objects are strongly typed; that is, each read or write method in the readSQL or writeSQL method of the Java object must match the corresponding data member in the opaque type definition. IBM Informix JDBC Driver cannot perform any type conversion because the type structure is unknown to it.

IBM Informix JDBC Driver also requires that all opaque data be transported as Informix DataBlade API data types, as defined in mitypes.h (this file is included in all IBM Informix installations). All opaque data is stored in the database server table in a C struct, which is made up of various DataBlade API types, as defined in the opaque type.

You do not need to handle mapping between Java and C if you use the UDT and UDR Manager facility to create opaque types. For more information, see "Creating opaque types and UDRs" on page 5-4.

Cache type information

When objects of some data types insert data into columns of certain other data types, IBM Informix JDBC Driver verifies that the data provided matches the data the database server expects by calling the SQLData.getSQLTypeName() method. The driver asks the database server for the type information with each insertion.

This occurs in the following cases:

- When an SQLData object inserts data into an opaque type column and getSQLTypeName() returns the name of the opaque type
- When a Struct or SQLData object inserts data into a row column and getSQLTypeName() returns the name of a named row
- When an SQLData object inserts data into a DISTINCT type column

You can set an environment variable, ENABLE_CACHE_TYPE=1, in the database URL, to have the driver cache the type information the first time it is retrieved. The driver then asks the cache for the type information before requesting the data from the database server.
Unsupported methods

The following methods of the SQLInput and SQLOutput interfaces are not supported for opaque types:

- **java.sql.SQLInput**
  - readAsciiStream()
  - readBinaryStream()
  - readBytes()
  - readCharacterStream()
  - readObject()
  - readRef()
  - readString()

- **java.sql.SQLOutput**
  - writeAsciiStream(InputStream x)
  - writeBinaryStream(InputStream x)
  - writeBytes(byte[] x)
  - writeCharacterStream(Reader x)
  - writeObject(Object x)
  - writeRef(Ref x)
  - writeString(String x)

Creating opaque types and UDRs

The UDTManager and UDRManager classes allow you to easily create and deploy opaque types and user-defined routines (UDRs) in the database server.

Before using the information in this section, read the following two additional publications:

- For information about configuring your system to support Java UDRs, see the J/Foundation Developer’s Guide.
- For detailed information about developing opaque types, see IBM Informix User-Defined Routines and Data Types Developer’s Guide.

Overview of creating opaque types and UDRs

In the database server, any Java class that implements the java.sql.SQLData interface and is accessible to the Java Virtual Machine can be stored as an opaque type. The UDTManager and UDRManager classes, together with their supporting UDTMetaData and UDRMetaData classes, extend this facility to client applications: your Java client application can use these classes to create opaque types and user-defined routines and transfer their class definitions to the database server. The client does not need to be accessible to the database server to use this functionality.

**Important:** This functionality is tightly coupled with server support for creating and using Java opaque types and user-defined routines. Any limitations on using Java opaque types and user-defined routines that exist in your version of the database server apply equally to Java opaque types and routines you create in your client applications.
When you use the **UDTManager** and **UDTMetaData** classes, IBM Informix JDBC Driver performs all of the following actions for your application:

1. Obtains the JAR file you specify
2. Transports the JAR file from the client local area to the server local area
   You define the server local area using the `UDTManager.setJarFileTmpPath()` method. The default is `/tmp` on UNIX systems and `C:\temp` on Windows systems.
3. Installs the JAR file in the server
4. Registers the opaque data type in the database with the `CREATE OPAQUE TYPE` SQL statement, taking input from the **UDTMetaData** class
5. Registers the support functions and casts you provide for the opaque type using the `CREATE Function` and `CREATE CAST` SQL statements
   You define support functions and casts using the `setSupportUDR()` and `setXXXCast()` methods in the **UDTMetaData** class.
   If you do not provide input and output functions for the opaque type, the driver registers the default functions (see the release notes for any limitations on this feature).
6. Registers any other nonsupport routines or casts (if any) that you specified, taking input from the `UDTMetaData.setUDR()` and `UDTMetaData.setXXXCast()` method calls in your application
7. Creates a mapping between an SQL OPAQUE type and a Java object (using the `sqlj.setUDTExtName()` method)

When you use the **UDRManager** and **UDRMetaData** classes, IBM Informix JDBC Driver performs the following actions:

1. Obtains the JAR file you specify
2. Transports the JAR file from the client local area to the server local area
3. Installs the JAR file in the server
4. Registers the UDRs in the database with the `CREATE FUNCTION` SQL statement, taking input from the **UDRMetaData.setUDR()** method calls in your application

The methods in the UDT and UDR Manager facility perform the following main functions:

- Creating opaque types in Java without preexisting Java classes, using the default input and output methods the server provides
- Converting existing Java classes on the client to opaque types and UDRs in the database server
- Converting Java static methods to UDRs

**Preparing to create opaque types and UDRs**

Before using the UDT and UDR Manager facility, perform the following setup tasks:

- Make sure your database server supports Java.

  The UDT and UDR Manager facility does not work in legacy servers that do not include Java support.

- Include either the `ifxtools.jar` or `ifxtools_g.jar` file in your CLASSPATH setting.
- Create a directory named `/usr/informix` in the database server, with owner and group set to user `informix` and permissions set to 777.
- Add the following entry to the `/etc/group` file in the database server:
  `informix::unique-id-number:`
- Check the release notes for the driver and database server for any further limitations in this release.

Creating opaque types

Using UDT Manager, you can create a Java opaque type from an existing Java class that implements the `SQLData` interface. UDT Manager can also help you create a Java opaque type without requiring that you have the Java class ready; you specify the characteristics of the opaque type you want to create, and the UDT Manager facility creates the Java class and then the Java opaque type.

Follow the steps in this section to use the `UDTManager` classes.

Creating an opaque type from an existing Java class

To create an opaque type from an existing Java class:
1. Ensure that the class meets the requirements for conversion to an opaque type.
   For the requirements, see "Requirements for the Java class" on page 5-9.
2. If you do not want to use the default input and output routines provided by the server, write support UDRs for input and output.
   For general information about writing support UDRs, see `IBM Informix User-Defined Routines and Data Types Developer's Guide`.
3. Create a default sbspace on the database server to hold the JAR file that contains the code for the opaque type.
   For information about creating an sbspace, see the `IBM Informix Administrator's Guide` for your database server and the `J/Foundation Developer's Guide`.
4. Open a JDBC connection.
   Make sure a database object is associated with the connection object. The driver cannot create an opaque type without a database object. For details about creating a connection with a database object, see Chapter 2, “Connect to the database,” on page 2-1.
5. Instantiate an `UDTManager` object and an `UDTMetaData` object:
   ```java
   UDTManager utmgr = new UDTManager(connection);
   UDTMetaData mdata = new UDTMetaData();
   ```
6. Set properties for the opaque type by calling methods in the `UDTMetaData` object.
   At a minimum, you must specify the SQL name, UDT length, and JAR file SQL name. For an explanation of SQL names, see "SQL names" on page 5-10.
   You can also specify the alignment, implicit and explicit casts, and any support UDRs:
   ```java
   mdata.setSQLName("circle2");
   mdata.setLength(24);
   mdata.setAlignment(UDTMetaData.EIGHT_BYTE)
   mdata.setJarFileSQLName("circle2_jar");
   mdata.setSupportUDR(areamethod, "area");
   mdata.setSupportUDR(input, "input", UDTMetaData.INPUT)
   mdata.setSupportUDR(output, "output", UDTMetaData.OUTPUT)
   ```
If desired, specify a path name where the driver should place the JAR file in the database server file system:

String pathname = "/work/srv93/examples";
udtmgr.setJarFileTmpPath(pathname);

Make sure the path exists in the server file system. For more information, see "Specify a JAR file temporary path" on page 5-14.

Create the opaque type:

udtmgr.createUDT(mdata, "Circle2.jar", "Circle2", 0);

For additional information about creating an opaque type from existing code, see "Creating an opaque type from existing code" on page 5-15.

For a complete code example of using the preceding steps to create an opaque type, see "Create an opaque type from an existing Java class with UDTManager" on page 5-25.

Creating an opaque type without an existing Java class

To create an opaque type without an existing Java class:

1. Create a default sbspace on the database server to hold the JAR file that contains the code for the opaque type.

   For information about creating an sbspace, see the IBM Informix Administrator’s Guide for your database server and the J/Foundation Developer’s Guide.

2. Open a JDBC connection.

   Make sure the connection object has a database object associated with it. For details, see Chapter 2, “Connect to the database,” on page 2-1.

3. Instantiate a UDTManager object and a UDTMetaData object:

   UDTManager udtmgr = new UDTManager(connection);
   UDTMetaData mdata = new UDTMetaData();

4. Specify the characteristics of the opaque type by calling methods in the UDTMetaData class:

   mdata.setSQLName("acircle");
   mdata.setLength(24);
   mdata.setFieldCount(3);
   mdata.setFieldName(1, "x");
   mdata.setFieldName(2, "y");
   mdata.setFieldName(3, "radius");
   mdata.setFieldType(1, com.informix.lang.IfxTypes.IFX_TYPE_INT);
   mdata.setFieldType(2, com.informix.lang.IfxTypes.IFX_TYPE_INT);
   mdata.setFieldType(3, com.informix.lang.IfxTypes.IFX_TYPE_INT);
   mdata.setJarFileSQLName("ACircleJar");

   For more information about setting characteristics for opaque types, see "Specify characteristics for an opaque type" on page 5-10.

5. Create the Java file, the class file, and the JAR file:

   mdata.keepJavaFile(true);
   String classname = udtmgr.createUDTClass(mdata);
   String jarfilename = udtmgr.createJar(mdata, new String[]{classname + ".class"});

   For more information, see "Creating the JAR and class files" on page 5-13.
6. If desired, specify a path name where the driver should place the JAR file in the database server file system:
   ```java
   String pathname = "/work/srv93/examples";
   udrmgr.setJarFileTmpPath(pathname);
   ```
   Make sure the path exists in the server file system. For more information, see 
   "Specify a JAR file temporary path" on page 5-14.

7. Send the class definition to the database server:
   ```java
   udrmgr.createUDT(mdata, jarfilename, classname, 0);
   ```
   For more information, see “Send the class definition to the database server” on 
   page 5-14.

For a complete code example of using the preceding steps to create an opaque type, see “Create an opaque type without an existing Java class” on page 5-32.

### Creating a UDR

The following topics shows you how to create a UDR from a Java class.

To create a UDR:
1. Write a Java class with one or more static method to be registered as UDRs. For more information, see “Requirements for the Java class” on page 5-9.

2. Create an sbspace on the database server to hold the JAR file that contains the code for the UDR. For information about creating an sbspace, see the IBM Informix Administrator’s Guide for your database server and the J/Foundation Developer’s Guide.

3. Open a JDBC connection. Make sure the connection object has a database object associated with it. For details, see Chapter 2, “Connect to the database,” on page 2-1.

4. Instantiate a `UDRManager` object and a `UDRMetaData` object:
   ```java
   UDRManager udrmgr = new UDRManager(myConn);
   UDRMetaData mdata = new UDRMetaData();
   ```

5. Create `java.lang.reflect.Method` objects for the static methods to be registered as UDRs. In the following example, `method1` is an instance that represents the `udr1(string, string)` method in the Group1 java class; `method2` is an instance that represents the `udr2(Integer, String, String)` method in the Group1 Java class:
   ```java
   Class gp1 = Class.forName("Group1");
   Method method1 = gp1.getMethod("udr1",
           new Class[]{String.class, String.class});
   Method method2 = gp1.getMethod("udr2",
           new Class[]{Integer.class, String.class, String.class});
   ```

6. Specify which methods to register as UDRs.
   The second parameter specifies the SQL name of the UDR:
   ```java
   mdata.setUDR(method1, "group1_udr1");
   mdata.setUDR(method2, "group1_udr2");
   ```
   For more information, see “Create UDRs” on page 5-17.

7. Specify the JAR file SQL name:
   ```java
   mdata.setJarFileSQLName("group1_jar");
   ```

8. If desired, specify a path name where the driver should place the JAR file in the database server file system:
   ```java
   String pathname = "/work/srv93/examples";
   udrmgr.setJarFileTmpPath(pathname);
   ```
Make sure the path exists in the database server file system. For more information, see “Specify a JAR file temporary path” on page 5-14.

9. Install the UDRs in the database server:

```java
udmgr.createUDRs(mdata, "Group1.jar", "Group1", 0);
```

For more information, see “Create UDRs” on page 5-17.

For complete code examples of creating UDRs, see “Create UDRs with UDRManager” on page 5-35.

### Requirements for the Java class

To qualify for converting into an opaque type, your Java class must meet the following conditions:

- The class must implement the `java.sql.SQLData` interface. For an example, see “Examples” on page 5-20.
- If the class contains another opaque type, the additional opaque type must be implemented in a similar way and the additional `.class` file must be packaged as part of the same JAR file as the original opaque type.
- If the class contains DISTINCT types, the class can either implement the `SQLData` interface for the DISTINCT types or let the driver map the DISTINCT types to the base types. For more information, see “Distinct data types” on page 4-1.
- The class cannot contain complex types.
- If you are creating an opaque type from an existing Java class and using the default support functions in the database server, you must cast the `SQLInput` and `SQLOutput` streams in `SQLData.readSQL()` and `SQLData.writeSQL()` to `IfmxUDTSQInput` and `IfmxUDTSQOutput`. For a code example that shows how to do this, see “Create an opaque type using default support functions” on page 5-25.
- All Java methods for the opaque type must be in the same `.java` file with the class that defines the opaque type.

Additional requirements for UDRs are as follows:

- All class methods to be registered as UDRs must be static.
- The method argument types and the return types must be valid Java data types.
- The methods can use all basic nongraphic Java packages that are included in the JDK, such as `java.util`, `java.io`, `java.net`, `java.rmi`, `java.sql`, and so forth.
- Data types of method arguments and return types must conform to the data type mapping tables shown in “Data type mapping for UDT manager and UDR manager” on page C-16.
- The following SQL argument or return types are not supported:
  - MONEY
  - DATETIME with qualifier other than hour to second or year to fraction(5)
  - INTERVAL with qualifier other than year to month or day to fraction(5)
  - Any data type not shown in the mapping tables for method arguments and return types; for the tables, see “Data type mapping for UDT manager and UDR manager” on page C-16.
SQL names

Some of the methods in the UDTMetaData class set an SQL name for an opaque type or a JAR file that contains the opaque type or UDR code. The SQL name is the name of the object as referenced in SQL statements. For example, assume your application makes the following call:

```java
mdata.setSQLName("circle2");
```

The name as used in an SQL statement is as follows:

```sql
CREATE TABLE tab (c circle2);
```

Similarly, assume the application sets the JAR file name as follows:

```java
mdata.setJarFileSQLName("circle2_jar");
```

The JAR file name as referenced in SQL is as follows:

```sql
CREATE FUNCTION circle2_output (...) RETURNS circle2 EXTERNAL NAME 'circle2_jar: circle2.fromString (...)' LANGUAGE JAVA NOT VARIANT END FUNCTION;
```

**Important:** There is no default value for an SQL name. Use the setSQLName() or setJarFileSQLName() method to specify a name, otherwise an SQL exception will be thrown.

Specify characteristics for an opaque type

The following topics provide additional information about creating an opaque type without a preexisting Java class. Details about creating an opaque type from an existing Java class begin with "Creating an opaque type from existing code" on page 5-15.

Using the methods in the UDTMetaData class, you can specify characteristics for a new opaque type. These settings apply for new opaque types; for opaque types created from existing files, see "Creating an opaque type from existing code" on page 5-15.

You can set the following characteristics:

- The number of fields in the internal data structure that defines the opaque type
- Additional characteristics, such as data type, name, and scale, of each field in the internal structure that defines the opaque type
- The length of the opaque type
- The alignment of the opaque type
- The SQL name of the opaque type and the JAR file
- The name of the generated Java class
- Whether to keep the generated .java file

Specify field count

The setFieldCount() method specifies the number of fields in the internal data structure that defines the opaque type:

```java
public void setFieldCount(int fieldCount) throws SQLException
```

5-10 IBM Informix JDBC Driver Programmer’s Guide
Specify additional field characteristics

The following methods set additional characteristics for fields in the internal data structure:

- `public void setFieldName(int field, String name) throws SQLException`
- `public void setFieldType(int field, int ifxtype) throws SQLException`
- `public void setFieldTypeName(int field, String sqltypename) throws SQLException`
- `public void setFieldLength(int field, int length) throws SQLException`

The `field` parameter indicates the field for which the driver should set or obtain a characteristic. The first field is 1; the second field is 2, and so forth.

The name you specify with `setFieldName()` appears in the Java class file. The following example sets the first field name to `IMAGE`.

```java
mdata.setFieldName(1, "IMAGE");
```

The `setFieldType()` method sets the data type of a field using a constant from the file `com.informix.lang.IfxTypes`. For more information, see “Mapping for field types” on page C-17. The following example specifies the CHAR data type for values in the third field:

```java
mdata.setFieldType(3, com.informix.lang.IfxTypes.IFX_TYPE_CHAR);
```

The `setFieldTypeName()` method sets the data type of a field using the SQL data type name:

```java
mdata.setFieldTypeName(1, "IMAGE_UDT");
```

This method is valid only for opaque and distinct types; for other types, the driver ignores the information.

The `length` parameter has the following meanings, depending on the data type of the field:

- **Character types**
  - Maximum length in characters

- **DATETIME**
  - Encoded length

- **INTERVAL**
  - Encoded length

- **Other data type or no type specified**
  - Driver ignores the information

The possible values for encoded length are those in the JDBC 2.20 specification: hour to second; year to second; and year to fraction(1), year to fraction(2), up through year to fraction(5).

The following example specifies that the third (VARCHAR) field in an opaque type cannot store more than 24 characters:

```java
mdata.setFieldLength(3, 24);
```

Specify length

The `setLength()` method specifies the total length of the opaque type:

```java
public void setLength(int length) throws SQLException
```
If you are creating an opaque type from an existing Java class and do not specify a length, the driver creates a variable-length opaque type. If you are creating an opaque type without an existing Java class, you must specify a length; UDT Manager creates only fixed-length opaque types in this case.

**Specify alignment**

The setAlignment() method specifies the opaque type's alignment:

```java
public void setAlignment(int alignment)
```

The `alignment` parameter is one of the alignment values shown in the next section. If you do not specify an alignment, the database server aligns the opaque type on 4-byte boundaries.

**Alignment values**

Alignment values are shown in the following table.

<table>
<thead>
<tr>
<th>Value</th>
<th>Constant</th>
<th>Structure begins with</th>
<th>Boundary aligned on</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SINGLE_BYTE</td>
<td>1-byte quantity</td>
<td>single-byte</td>
</tr>
<tr>
<td>2</td>
<td>TWO_BYTE</td>
<td>2-byte quantity (such as SMALLINT)</td>
<td>2-byte</td>
</tr>
<tr>
<td>4</td>
<td>FOUR_BYTE</td>
<td>4-byte quantity (such as FLOAT or UNSIGNED INT)</td>
<td>4-byte</td>
</tr>
<tr>
<td>8</td>
<td>EIGHT BYTE</td>
<td>8-byte quantity</td>
<td>8-byte</td>
</tr>
</tbody>
</table>

**Specify SQL names**

Specify SQL names with the setSQLName() and setJarFileSQLName() methods:

```java
public void setSQLName(String name) throws SQLException
public void setJarFileSQLName(String name) throws SQLException
```

By default, the driver uses the name you set through the setSQLName() method as the file names of the Java class and JAR files generated when you call the UDTManager.createUDTCclass() and UDTManager.createJar() methods. For example, if you called setSQLName("circle") and then called createUDTCclass() and createJar(), the class file name generated would be circle.class and the JAR file name would be circle.jar. You can specify a Java class file name other than the default by calling the setClassName() method.

The JAR file SQL name is the name as it will be referenced in the SQL CREATE FUNCTION statement the driver uses to register a UDR.

**Important**: The JAR file SQL name is the name of the JAR file in SQL statements; it has no relationship to the contents of the JAR file.

**Specify the Java class name**

Use setClassName() to specify the Java class name:

```java
public void setClassName(String name) throws SQLException
```

If you do not set a class name with setClassName(), the driver uses the SQL name of the opaque type (set through setSQLName()) as the name of the Java class and the file name of the .class file generated by the createUDTCclass() method.
Specifying Java source file retention

Use keepJavaFile() to specify whether to retain the .java source file:

```
public void keepJavaFile(boolean value)
```

The `value` parameter indicates whether the createUDTClass() method should retain the .java file that it generates when it creates the Java class file for the new opaque type. The default is to remove the file. The following example specifies keeping the .java file:

```
mdata.keepJavaFile(true);
```

Creating the JAR and class files

Once you have specified the characteristics of the opaque type through the UDTMetaData methods, you can use the methods in the UDTManager class to create opaque types and their class and JAR files in the following order:

1. Instantiate the UDTManager object.
   The constructor is defined as follows:
   ```
   public UDTManager(Connection conn) throws SQLException
   ```
2. Create the .class and .java files with the createUDTClass() method.
3. Create the .jar file with the createJar() method.
4. Create the opaque type with the createUDT() method.

Create the .class and .java files

The createUDTClass() method has the following signature:

```
public String createUDTClass(UDTMetaData mdata) throws SQLException
```

The createUDTClass() method causes the driver to perform all of the following actions for your application:

1. Creates a Java class with the name you specified in the UDTMetaData.setClassName() method
   If no class name was specified, the driver uses the name specified in the UDTMetaData.setSQLName() method.
2. Puts the Java class code into a .java file and then compile the file to a .class file
3. Returns the name of the newly created class to your application

If you specified TRUE by calling the UDTMetaData.keepJavaFile() method, the driver retains the generated .java file. The default is to delete the .java file.

Your application should call the createUDTClass() method only to create new .class and .java files to define an opaque type, not to generate an opaque type from existing files.

Create the .jar file

The createJar() method compiles the class files you specify in the classnames list. The files in the list must have the .class extension.

```
public String createJar(UDTMetaData mdata, String[] classnames)
    throws SQLException;
```
The driver creates a JAR file named sqlname.jar (where sqlname is the name you specified by calling UDTMetaData.setSQLName()) and returns the file name to your application.

**Send the class definition to the database server**

After you have created the JAR file, use the UDTManager.createUDT() method to create the opaque type by sending the class definition to the database server:

```java
public void createUDT(UDTMetaData mdata, String jarfile, String classname, int deploy) throws SQLException;
```

The `jarfile` parameter is the path name of a JAR (.jar) file that contains the class definition for the opaque type. By default, the classes in the java.io package resolve relative path names against the current user directory as named by the system property `user.dir`; it is typically the directory in which the Java Virtual Machine was invoked. The file name must be included in your CLASSPATH setting if you use an absolute path name.

The `classname` parameter is the name of the class that implements the opaque type.

The SQL name of the opaque type defaults to the class name if your application does not call setClassName(). You can specify an SQL name by calling the UDTMetaData.setSQLName() method.

**Important:** If your application calls createUDT() within a transaction or your database is ANSI or enables logging, some extra guidelines apply. For more information, see “Execute in a transaction” on page 5-20.

**Specify deployment descriptor actions**

In the UDTManager and UDRManager methods, the `deploy` parameter indicates whether install_actions should be executed if a deployment descriptor is present in the JAR file. The `undeploy` parameter indicates whether remove_actions should be executed.

- 0 
  Execute install_actions or remove_actions.
- Nonzero 
  Do not execute install_actions or remove_actions.

A deployment descriptor allows you to include the SQL statements for creating and dropping UDRs in a JAR file. For more information about the deployment descriptor, see the J/Foundation Developer's Guide and the SQLJ specification.

**Specify a JAR file temporary path**

When the driver ships the JAR file for an opaque type or UDR, it places the file by default in /tmp (on UNIX) or in C:\temp (on Windows). You can specify an alternative path name by calling the setJarTmpPath() method in either the UDTManager or UDRManager class:

```java
public void setJarTmpPath(String path) throws SQLException
```

You can call this method at any point before calling createUDT() or createUDR(), the UDTManager or UDRManager objects. The `path` parameter must be an absolute path name, and you must ensure that the path exists on the server file system.
Creating an opaque type from existing code

The preceding topics describe methods you use to create a new opaque type without an existing Java class. When you create an opaque type from existing Java code, you specify the SQL name, JAR file SQL name, support UDRs (if any), and any additional nonsupport UDRs that are included in the opaque type. (For an explanation of SQL names, see “SQL names” on page 5-10.) You can also specify the length, alignment, and implicit and explicit casts.

To create an opaque type from existing code, use the following methods:

- **UDTMetaData.setSQLName()** to specify the SQL name of the opaque type as referenced in SQL statements
- **UDTMetaData.setSupportUDR()** for each support UDR in the opaque type
  Support UDRs are input/output, send/receive, and so forth.
- **UDTMetaData.setUDR()** for each nonsupport UDR in the opaque type
- **UDTMetaData.setJarFileSQLName()** to specify an SQL name for the JAR file
- **UDTMetaData.setImplicitCast()** or **UDTMetaData.setExplicitCast()** to specify each cast
- **UDTMetaData.setLength()** if the opaque type is fixed length (the driver defaults to variable length)
- **UDTMetaData.setAlignment()** to specify the byte boundary on which the opaque type is aligned (necessary only if you do not want the database server to default to a 4-byte boundary)
- **UDTManager.createJar()** to create a JAR (.jar) file if you do not already have one
- **UDTManager.createUDT()** to create the opaque type

In addition, the setXXXCast(), setSupportUDR(), and setUDR() methods are used only for creating an opaque type from existing code:

```java
public void setImplicitCast(int ifxtype, String method_sqlname)
    throws SQLException

public void setExplicitCast(int ifxtype, String method_sqlname)
    throws SQLException

public void setSupportUDR(Method method, String sqlname, int type)
    throws SQLException

public void setUDR(Method method, String sqlname)
    throws SQLException
```

### The setXXXCast() methods

The setXXXCast() methods specify the implicit or explicit cast to convert data from an opaque type to the data type specified.

The `ifxtype` parameter is a type code from the class `com.informix.lang.IfxTypes`. Data type mapping between the `ifxtype` parameter and the SQL type in the database server is detailed in “Mapping for casts” on page C-17. The `method_sqlname` parameter is the SQL name of the Java method that implements the cast.

The following example sets an implicit cast implemented by a Java method with the SQL name `circle2_input`:

```java
setImplicitCast(com.informix.lang.IfxTypes.IFX_TYPE_LVARCHAR,
                 "circle2_input")
```
The following example sets an explicit cast implemented by a Java method with the SQL name `circle_output`:

```java
setExplicitCast(com.informix.lang.IfxTypes.IFX_TYPE_LVARCHAR,
        "circle2_output");
```

The following example sets an explicit cast for converting a `circle2` opaque type to an integer:

```java
setExplicitCast(com.informix.lang.IfxTypes.IFX_TYPE_INT,
        "circle2_to_int");
```

**The setSupportUDR() and setUDR() methods**

The `setSupportUDR()` method specifies a Java method in an existing Java class that will be registered as a support UDR for the opaque type.

The `method` parameter specifies an object from `java.lang.reflect.Method` to be registered as a Java support UDR for the opaque type in the database server. Support UDRs are Input, Output, Send, Receive, and so forth (for more information, see [IBM Informix User-Defined Routines and Data Types Developer’s Guide](#)).

The `sqlname` parameter specifies the SQL name of the method. For more information, see “SQL names” on page 5-10.

The `type` parameter specifies the kind of support UDR, as follows:

- `UDTMetaData.INPUT`
- `UDTMetaData.OUTPUT`
- `UDTMetaData.SEND`
- `UDTMetaData.RECEIVE`
- `UDTMetaData.IMPORT`
- `UDTMetaData.EXPORT`
- `UDTMetaData.BINARYIMPORT`
- `UDTMetaData.BINARYEXPORT`

For step-by-step information about creating an opaque type from existing code, see “Creating an opaque type from an existing Java class” on page 5-6.

**Tip:** It is not necessary to register the methods in the SQLData interface. For example, you do not need to register `SQLData.getSQLTypeName()`, `SQLData.readSQL()`, or `SQLData.writeSQL()`.

To specify other UDRs, use `setUDR()` as described in “Create UDRs” on page 5-17.

**Remove opaque types and JAR files**

You can remove opaque types and their JAR files using the following methods:

```java
public static void removeUDT(String sqlname) throws SQLException
public static void removeJar(String jarfilesqlname, int undeploy)
        throws SQLException
```

The `removeUDT()` method removes the opaque type, with all its casts and UDRs, from the database server. It does not remove the JAR file itself because other opaque types or UDRs could be using the same JAR file.

**Important:** If your application calls `removeUDT()` within a transaction or if your database is ANSI or enables logging, some extra guidelines apply. For more information, see “Execute in a transaction” on page 5-20.
The removeJar() method removes the JAR file from the system catalog. The jarfilesqlname parameter is the name you specified with the setJarFileSQLName() method.

For the undeploy parameter, see “Specify deployment descriptor actions” on page 5-14.

Important: Before calling removeJar(), you must first remove all functions and procedures that depend on the JAR file. Otherwise, the database server fails to remove the file.

Create UDRs

Using UDR Manager to create UDRs in the database server involves:

- Coding the UDRs and packaging the code in a JAR file
  For details about coding UDRs, see the J/Foundation Developer’s Guide.
- Creating a default sbspace in the database server to hold the JAR file that contains the code for the UDR
  For information about creating an sbspace, see the IBM Informix Administrator’s Guide for your database server and the J/Foundation Developer’s Guide.
- Calling methods in the UDRMetaData class to specify the information necessary for IBM Informix JDBC Driver to register the UDRs in the database server
- If desired, specifying a path name where the driver should place the JAR file in the database server file system
- Installing the UDRs in the server

Creating a UDR for a C-language opaque type is not supported; the opaque type must be in Java.

To specify a UDR for the driver to register, use this method in UDRMetaData:

```java
public void setUDR(Method method, String sqlname) throws SQLException
```

The method parameter specifies an object from java.lang.reflect.Method to be registered as a Java UDR in the database server. The sqlname parameter is the name of the method as used in SQL statements.

Once you have specified the UDRs to be registered, you can set the JAR file SQL name using UDRMetaData.setJarFileSQLName() and then use the UDRManager.createUDRs() method to install the UDRs in the database server, as follows:

```java
public void createUDRs(UDRMetaData mdata, String jarfile, String classname, int deploy) throws SQLException
```

The jarfile parameter is the absolute or relative path name of the client-side JAR file that contains the Java method definitions. If you use the absolute path name, the JAR file name must be included in your CLASSPATH setting.

The classname parameter is the name of a Java class that contains the methods you want to register as UDRs in the database server. Requirements for preparing the Java methods are described on 1 on page 5-8.

For the deploy parameter, see “Specify deployment descriptor actions” on page 5-14.
The `createUDRs()` method causes the driver to perform all of the following steps for your application:

1. Obtain the JAR file designated by the first parameter.
2. Transport the JAR file from the client local area to the server local area.
3. Register the UDRs specified in the `UDRMetaData` object (set through one or more calls to `UDRMetaData.setUDR()`).
4. Install the JAR file and create the UDRs in the server.

After `createUDRs()` executes, your application can use the UDRs in SQL statements.

**Important:** If your application calls `createUDRs()` within a transaction, or if your database is ANSI or enables logging, some extra guidelines apply. For more information, see “Execute in a transaction” on page 5-20.

### Remove UDRs and JAR files

You can remove UDRs using the following methods:

```java
public void removeUDR(String sqlname) throws SQLException
public void removeJar(String jarfilesqlname, int undeploy) throws SQLException
```

**Tip:** The `removeUDR()` method removes the UDR from the server but does not remove the JAR file, because other opaque types or UDRs could be using the same JAR file.

The `removeJar()` method is described in “Remove opaque types and JAR files” on page 5-16.

### Remove overloaded UDRs

To remove overloaded UDRs, use the `removeUDR()` method with an additional parameter:

```java
public void removeUDR(String sqlname, Class[] methodparams) throws SQLException
```

The `methodparams` parameter specifies the data type of each parameter in the UDR. Specify NULL to indicate no parameters. For example, assume a UDR named `print()` is overloaded with two additional method signatures.

<table>
<thead>
<tr>
<th>Java method signature</th>
<th>Corresponding SQL name</th>
</tr>
</thead>
<tbody>
<tr>
<td>void print()</td>
<td>print1</td>
</tr>
<tr>
<td>void print(String x, String y, int r)</td>
<td>print2</td>
</tr>
<tr>
<td>void print(int a, int b)</td>
<td>print3</td>
</tr>
</tbody>
</table>

The code to remove all three UDRs is:

```java
udrmgr.removeUDR("print1", null );
udrmgr.removeUDR("print2",
    new Class[] {String.class, String.class, int.class} );
udrmgr.removeUDR("print3", new Class[] {int.class, int.class} );
```
Obtain information about opaque types and UDRs

Many of the setXXX() methods in the UDTMetaData and UDRMetaData classes have parallel getXXX() methods for obtaining characteristics of existing opaque types and UDRs.

The getXXX() methods in the UDTMetaData class

The following table summarizes the available getXXX() methods in the UDTMetaData class. For the field parameter, 1 designates the first field in the internal data structure, 2 is the second, and so forth. For details about SQL names, see “SQL names” on page 5-10.

<table>
<thead>
<tr>
<th>Information obtained</th>
<th>Method signature</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of fields in the internal data structure</td>
<td>public int getFieldCount()</td>
<td>Returns 0 if no fields are present</td>
</tr>
<tr>
<td>Name of a field in the internal data structure</td>
<td>public String getFieldName int field) throws SQLException</td>
<td>Returns NULL if no name exists</td>
</tr>
<tr>
<td>Data type code of a field in the internal data structure</td>
<td>public int getType (int field) throws SQLException</td>
<td>Data type codes come from the class com.informix.lang.IfxTypes. Returns -1 if no data type exists</td>
</tr>
<tr>
<td>Data type name of a field in the internal data structure</td>
<td>public String getNameType (int field) throws SQLException</td>
<td>Returns NULL if no name exists</td>
</tr>
<tr>
<td>For character type: maximum number of characters in the field; for date-time or interval type: encoded qualifier</td>
<td>public int getLength (int field) throws SQLException</td>
<td>Returns -1 if no length was set</td>
</tr>
<tr>
<td>SQL name of the opaque type</td>
<td>public String getSQLName()</td>
<td>Returns NULL if no name was set</td>
</tr>
<tr>
<td>SQL name of the JAR file</td>
<td>public String getJarFileSQLName()</td>
<td>Returns NULL if no name was set</td>
</tr>
<tr>
<td>Name of the Java class for the opaque type</td>
<td>public String getName()</td>
<td>If no class name was set through setName(), sqlname is returned (this is the default). If no SQL name was set through setSQLName(), returns NULL</td>
</tr>
<tr>
<td>Length of a fixed-length opaque type</td>
<td>public int getLength()</td>
<td>Returns -1 if no length was set</td>
</tr>
<tr>
<td>Alignment of an opaque type</td>
<td>public int getAlignment()</td>
<td>Returns -1 if no alignment was set</td>
</tr>
<tr>
<td>An array of Method objects that have been specified as support UDRs through setSupportUDR()</td>
<td>public Method[] getSupportUDRs()</td>
<td>For details about support UDRs, see the description of setSupportUDR() in &quot;Creating an opaque type from existing code” on page 5-15. Returns NULL if no support UDRs were specified</td>
</tr>
<tr>
<td>SQL name of a Java method that was specified as a support UDR through setSupportUDR()</td>
<td>public String getSupportUDRSQLName (Method method) throws SQLException</td>
<td>Returns NULL if no name was set</td>
</tr>
</tbody>
</table>
The `getXXX()` methods in the UDRMetaData class

To obtain information about UDRs, use the methods in the following table.

<table>
<thead>
<tr>
<th>Information obtained</th>
<th>Method signature</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>An array of</td>
<td><code>public Method[] getUDRs()</code></td>
<td>To specify a UDR for an opaque type, call the UDTMetaData.setUDR() method. Returns NULL if no UDRs were specified.</td>
</tr>
<tr>
<td><code>java.lang.Method.Reflect</code> methods that have been specified as UDRs for an opaque type.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SQL name of a Java method</td>
<td><code>public String getUDRSQLName(Method method)</code> throws <code>SQLException</code></td>
<td>Returns NULL if no SQL name was specified for the UDR Method object</td>
</tr>
</tbody>
</table>

Execute in a transaction

If your database is ANSI or has logging enabled, and the application is not already in a transaction, the driver executes the SQL statements to create opaque types and UDRs on the server within a transaction. This means that either all the steps will succeed, or all will fail. If the opaque type or UDR creation fails at any point, the driver rolls back the transaction and throws an SQLException.

If the application is already in a transaction when the UDTManager.createUDT() or UDRManager.createUDRs() method calls are issued, the SQL statements are executed within the existing transaction. This means that if the driver returns an SQLException to your application during the creation of the opaque type or UDR, your application must roll back the transaction to ensure the integrity of the database. Otherwise, the opaque type, parts of its casts, or UDRs could be left in the database.

Examples

The rest of this section contains examples for creating and using opaque types and UDRs.

The first four examples are released with your JDBC driver software in the demo/udt-distinct directory; the last two are in the demo/tools/udtudrmgr directory. See the README file in each directory for a description of the files.

Class definition

The class for the C opaque type, `charattrUDT` in the following example, must implement the `SQLData` interface:

```java
import java.sql.*;
import com.informix.jdbc.*;
/**<n
* C struct of charattr_udt:
* */
* typedef struct charattr_type
* {
*     char     chr1[4+1];
*     mi_boolean bold; // mi_boolean (1 byte)
*     mi_smallint fontsize; // mi_smallint (2 bytes)
* } charattr;
* typedef charattr charattr_udt;
```
public class charattrUDT implements SQLData
{
    private String sql_type = "charattr_udt";
    // an ASCII character/a multibyte character, and is null-terminated.
    public String chr1;
    // Is the character in boldface?
    public boolean bold;
    // font size of the character
    public short fontsize;

    public charattrUDT()
    {
    
    
    public charattrUDT(String chr1, boolean bold, short fontsize)
    {
        this.chr1 = chr1;
        this.bold = bold;
        this.fontsize = fontsize;
    }

    public String getSQLTypeName()
    {
        return sql_type;
    }
    // reads a stream of data values and builds a Java object
    public void readSQL(SQLInput stream, String type) throws SQLException
    {
        sql_type = type;
        chr1 = ((IfmxUDTSQLInput)stream).readString(5);
        bold = stream.readBoolean();
        fontsize = stream.readShort();
    }
    // writes a sequence of values from a Java object to a stream
    public void writeSQL(SQLOutput stream) throws SQLException
    {
        ((IfmxUDTSQLOutput)stream).writeString(chr1, 5);
        stream.writeBoolean(bold);
        stream.writeShort(fontsize);
    }
    // overrides Object.equals()
    public boolean equals(Object b)
    {
        return (chr1.equals(((charattrUDT)b).chr1) &&
        bold == ((charattrUDT)b).bold &&
        fontsize == ((charattrUDT)b).fontsize);
    }

    public String toString()
    {
        return "chr1=" + chr1 + " bold=" + bold + " fontsize=" + fontsize;
    }
}

In your JDBC application, a custom type map must map the SQL-type name charattr_udt to the charattrUDT class:
java.util.Map customtypemap = conn.getTypeMap();
if (customtypemap == null)
{
    System.out.println("***ERROR: typemap is null!");
    return;
}
customtypemap.put("charattr_udt", Class.forName("charattrUDT"));
Insert data

You can insert an opaque type as either its original type or its cast type. The following example shows how to insert opaque data using the original type:

```java
String s = "insert into charattr_tab (int_col, charattr_col) values (?, ?)";
System.out.println(s);
pstmt = conn.prepareStatement(s);
...
charattrUDT charattr = new charattrUDT();
charattr.chr1 = "a";
charattr.bold = true;
charattr.fontsize = (short)1;
pstmt.setInt(1, 1);
System.out.println("setInt...ok");
pstmt.setObject(2, charattr);
System.out.println("setObject(charattrUDT)...ok");
pstmt.executeUpdate();
```

If a casting function is defined, and you would like to insert data as the casting type instead of the original type, you must call the setXXX() method that corresponds to the casting type. For example, if you have defined a function casting CHAR or LVARCHAR to a charattrUDT column, you can use the setString() method to insert data, as follows:

```java
// Insert into UDT column using setString(int,String) and Java String object.
String s = "insert into charattr_tab " +
   "(decimal_col, date_col, charattr_col, float_col) " +
   "values (?, ?, ?, ?)"
writeOutputFile(s);
PreparedStatement pstmt = myConn.prepareStatement(s);
...
String strObj = "(A, f, 18)";
pstmt.setString(3, strObj);
...
```

Retrieve data

To retrieve IBM Informix opaque types, you must use ResultSet.getObject(). IBM Informix JDBC Driver converts the data to a Java object according to the custom type map you provide. Using the previous example of the charattrUDT type, you can fetch the opaque data, as in the following example:

```java
String s = "select int_col, charattr_col from charattr_tab order by 1";
System.out.println(s);
Statement stmt = conn.createStatement();
ResultSet rs = stmt.executeQuery(s);
System.out.println("execute...ok");
System.out.println("Fetching data ...");
int curRow = 0;
while (rs.next())
{
   curRow++;
   System.out.println("currentrow=" + curRow + ": ");
   int intret = rs.getInt("int_col");
   ...
```
Smart large objects within an opaque type

A smart large object can be a data member within an opaque type, although you are most likely to create a large object on the database server, outside of the opaque type context, using the IBM Informix extension classes. For more information about smart large objects, see "Smart large object data types" on page 4-27.

A large object is stored as an `IfxLocator` object within the opaque type; in the C struct that defines the opaque type internally, the large object is referenced through a locator pointer of type `MI_LO_HANDLE`. The object is created using the methods provided in the `IfxSmartBlob` class, and the large object handle obtained from these methods becomes the data member within the opaque type. Both BLOB and CLOB objects use the same large object handle, as shown in the following example:

```java
import java.sql.*;
import com.informix.jdbc.*;

public class largebinUDT implements SQLData {
    private String sql_type = "large_bin_udt";
    public Clob lb_handle;

    public largebinUDT() { }
    public largebinUDT(Clob clob) {
        lb_handle = clob;
    }

    public String getSQLTypeName() {
        return sql_type;
    }

    // reads a stream of data values and builds a Java object
    public void readSQL(SQLInput stream, String type) throws SQLException {
```

Chapter 5. Work with opaque types 5-23
public void writeSQL(SQLOutput stream) throws SQLException {
    stream.writeClob(lb_handle);
}

In a JDBC application, you create the MI_LO_HANDLE object using the methods provided by the IfxSmartBlob class:

String s = "insert into largebin_tab (int_col, largebin_col, lvc_col) " +
    "values (?, ?, ?)";
System.out.println(s);
pstmt = conn.prepareStatement(s);
...
// create a large object using IfxSmartBlob's methods
String filename = "lbin_in1.dat";
File file = new File(filename);
int fileLength = (int) file.length();
FileInputStream fin = new FileInputStream(file);
IfxLobDescriptor loDesc = new IfxLobDescriptor(conn);
System.out.println("create large object descriptor...ok");
IfxLocator loPtr = new IfxLocator();
IfxSmartBlob smb = new IfxSmartBlob((IfxConnection)conn);
int loFd = smb.IfxLoCreate(loDesc, 8, loPtr);
System.out.println("create large object...ok");
int n = smb.IfxLoWrite(loFd, fin, fileLength);
System.out.println("write file content into large object...ok");
pstmt.setInt(1, 1);
System.out.println("setInt...ok");
// initialize largebin object using the large object created
// above, before doing setObject for the large_bin_udt column.
largebinUDT largebinObj = new largebinUDT();
largebinObj.lb_handle = new IfxCblob(loPtr);
pstmt.setObject(2, largebinObj);
System.out.println("setObject(largebinUDT)...ok");
pstmt.setString(3, "Hong Kong");
System.out.println("setString...ok");
pstmt.executeUpdate();
System.out.println("execute...ok");
// close/release large object
smb.IfxLoClose(loFd);
System.out.println("close large object...ok");
smb.IfxLoRelease(loPtr);
System.out.println("release large object...ok");

See "Smart large object data types" on page 4-27 for details.
Create an opaque type from an existing Java class with UDTManager

The following example shows how an application can use the UDTManager and UDTMetaData classes to convert an existing Java class on the client (inaccessible to the database server) to an SQL opaque type in the database server.

Create an opaque type using default support functions

The following example creates an opaque type named Circle, using an existing Java class and using the default support functions provided in the database server:

```java
import java.sql.*;
import com.informix.jdbc.IfmxUDTSQLInput;
import com.informix.jdbc.IfmxUDTSQLOutput;

public class Circle implements SQLData {
    private static double PI = 3.14159;
    double x; // x coordinate
dooy y; // y coordinate
dooy radius;

    private String type = "circle";

    public String getSQLTypeName() { return type; }

    public void readSQL(SQLInput stream, String typeName) throws SQLException {
        // To be able to use the DEFAULT support functions supplied
        // by the server, you must cast the stream to IfmxUDTSQLInput.
        // (Server requirement)
        IfmxUDTSQLInput in = (IfmxUDTSQLInput) stream;
        x = in.readDouble();
y = in.readDouble();
    radius = in.readDouble();
    }

    public void writeSQL(SQLOutput stream) throws SQLException {
        // To be able to use the DEFAULT support functions supplied
        // by the server, have to cast the stream to IfmxUDTSQLOutput.
        // (Server requirement)
        IfmxUDTSQLOutput out = (IfmxUDTSQLOutput) stream;
    out.writeDouble(x);
    out.writeDouble(y);
    out.writeDouble(radius);
    }

    public static double area(Circle c) {
        return PI * c.radius * c.radius;
    }
}
```

The opaque type:
The following JDBC client application installs the class Circle (which is packaged in Circle.jar) as an opaque type in the system catalog. Applications can then use the opaque type Circle as a data type in SQL statements:

```java
import java.sql.*;
import java.lang.reflect.*;

public class PlayWithCircle
{
    String dbname = "test";
    String url = null;
    Connection conn = null;

    public static void main (String args[]) {
        new PlayWithCircle(args);
    }

    PlayWithCircle(String args[]) {
        System.out.println("----------------");
        System.out.println("- Start - Demo 1");
        System.out.println("----------------");

        // ------------
        // Getting URL
        // ------------
        if (args.length == 0) {
            System.out.println("***ERROR: connection URL must be provided " +
                                 "in order to run the demo!");
            return;
        }
        url = args[0];

        // ------------
        // Loading driver
        // ------------
        try {
            System.out.println("Loading JDBC driver...");
            Class.forName("com.informix.jdbc.IfxDriver");
            System.out.println("ok");
        } catch (java.lang.ClassNotFoundException e) {
            System.out.println("\n***ERROR: " + e.getMessage());
            e.printStackTrace();
            return;
        }

        // ------------
        // Getting connection
        // ------------
        try {
            System.out.println("Getting connection...");
            conn = DriverManager.getConnection(url);
            System.out.println("ok");
        } catch (SQLException e) {
            System.out.println("URL = " + url + "");
            System.out.println("\n***ERROR: " + e.getMessage());
            e.printStackTrace();
            return;
        }
    }
}
```

5-26 IBM Informix JDBC Driver Programmer's Guide
// -------------------
// Setup UDT meta data
// -------------------
Method areamethod = null;
try {
    Class c = Class.forName("Circle");
    areamethod = c.getMethod("area", new Class[] {c});
} catch (ClassNotFoundException e) {
    System.out.println("Cannot get Class: " + e.toString());
    return;
} catch (NoSuchMethodException e) {
    System.out.println("Cannot get Method: " + e.toString());
    return;
}

UDTMetaData mdata = null;
try {
    System.out.print("Setting mdata...");
    mdata = new UDTMetaData();
    mdata.setSQLName("circle");
    mdata.setLength(24);
    mdata.setAlignment(UDTMetaData.EIGHT_BYTE);
    mdata.setUDR(areamethod, "area");
    mdata.setJarFileSQLName("circle_jar");
    System.out.println("ok");
} catch (SQLException e) {
    System.out.println("***ERROR: " + e.getMessage());
    return;
}

// -------------------------------
// Install the UDT in the database
// -------------------------------
UDTManager udtmgr = null;
try {
    udtmgr = new UDTManager(conn);
    System.out.println("createJar()");
    String jarfilename = udtmgr.createJar(mdata, 
        new String[] {"Circle.class"}); // jarfilename = circle.jar
    System.out.println(" jarfilename = " + jarfilename);
    System.out.println("\nsetJarTmpPath()");
    udtmgr.setJarTmpPath("/tmp");
    System.out.println("\ncreateUDT()...");
    udtmgr.createUDT(mdata, 
        "/vobs/jdbc/demo/tools/udtudrmgr/" + jarfilename, "Circle", 0);
    System.out.println("ok");
} catch (SQLException e) {
    System.out.println("\n***ERROR: " + e.getMessage());
    return;
}
// ---------------
// Now use the UDT
// ---------------
try {
    String s = "drop table tab";
    System.out.print(s + "...");
    Statement stmt = conn.createStatement();
    int count = stmt.executeUpdate(s);
    stmt.close();
    System.out.println("ok");
} catch (SQLException e) {
    // -206 The specified table (%s) is not in the database.
    if (e.getErrorCode() != -206) {
        System.out.println("n***ERROR: " + e.getMessage());
        return;
    }
    System.out.println("ok");
}
executeUpdate("create table tab (c circle)");
// test DEFAULT Input function
executeUpdate("insert into tab values ('10 10 10')");
// test DEFAULT Output function
try {
    String s = "select c::lvarchar from tab"
    System.out.println(s);
    Statement stmt = conn.createStatement();
    ResultSet rs = stmt.executeQuery(s);
    if (rs.next()) {
        String c = rs.getString(1);
        System.out.println(" circle = ' " + c + "'");
    }
    rs.close();
    stmt.close();
} catch (SQLException e) {
    System.out.println("***ERROR: " + e.getMessage());
}
System.out.println();
// test DEFAULT Send function
try {
    // setup type map before using getObject() for UDT data.
    java.util.Map customtypemap = conn.getTypeMap();
    System.out.println("getTypeMap...ok");
    if (customtypemap == null) {
        System.out.println("***ERROR: map is null!");
        return;
    }
    customtypemap.put("circle", Class.forName("Circle");
    System.out.println("put...ok");
    String s = "select c from tab"
    System.out.println(s);
Create an opaque type using support functions you supply

In this example, the Java class Circle on the client is mapped to an SQL opaque type named circle. The circle opaque type uses support functions provided by the programmer.
import java.sql.*;
import java.text.*;
import com.informix.jdbc.IfmxUDTSQLInput;
import com.informix.jdbc.IfmxUDTSQLOutput;

public class Circle2 implements SQLData
{
    private static double PI = 3.14159;

double x; // x coordinate
    double y; // y coordinate
    double radius;

    private String type = "circle2";

    public String getSQLTypeName() { return type; }

    public void readSQL(SQLInput stream, String typeName)
        throws SQLException
    {
        /* commented out - because the first release of the UDT/UDR Manager feature
         * does not support mixing user-supplied support functions
         * with server DEFAULT support functions.
         * However, once the mix is supported, this code needs to be used to
         * replace the existing code.
         * // To be able to use the DEFAULT support functions (other than
         * // Input/Output) supplied by the server, you must cast the stream
         * // to IfmxUDTSQLInput.
         * IfmxUDTSQLInput in = (IfmxUDTSQLInput) stream;
         * x = in.readDouble();
         * y = in.readDouble();
         * radius = in.readDouble();
         */
        x = stream.readDouble();
        y = stream.readDouble();
        radius = stream.readDouble();
    }

    public void writeSQL(SQLOutput stream) throws SQLException
    {
        /* commented out - because the 1st release of UDT/UDR Manager feature
         * doesn't support the mixing of user support functions
         * with server DEFAULT support functions.
         * However, once the mix is supported, this code needs to be used to
         * replace the existing code.
         * // To be able to use the DEFAULT support functions (other than
         * // Input/Output) supplied by the server, you must cast the stream
         * // to IfmxUDTSQLOutput.
         * IfmxUDTSQLOutput out = (IfmxUDTSQLOutput) stream;
         * out.writeDouble(x);
         * out.writeDouble(y);
         * out.writeDouble(radius);
         */
        stream.writeDouble(x);
        stream.writeDouble(y);
        stream.writeDouble(radius);
    }

    /**
     * Input function - return the object from the String representation -
     * 'x y radius'.
     */
public static Circle2 fromString(String text) {
    Number a = null;
    Number b = null;
    Number r = null;
    try {
        ParsePosition ps = new ParsePosition(0);
        a = NumberFormat.getInstance().parse(text, ps);
        ps.setIndex(ps.getIndex() + 1);
        b = NumberFormat.getInstance().parse(text, ps);
        ps.setIndex(ps.getIndex() + 1);
        r = NumberFormat.getInstance().parse(text, ps);
    } catch (Exception e) {
        System.out.println("In exception: " + e.getMessage());
    }
    Circle2 c = new Circle2();
    c.x = a.doubleValue();
    c.y = b.doubleValue();
    c.radius = r.doubleValue();
    return c;
}

/**
   * Output function - return the string of the form 'x y radius'.
   */
public static String makeString(Circle2 c) {
    StringBuffer sbuff = new StringBuffer();
    FieldPosition fp = new FieldPosition(NumberFormat.INTEGER_FIELD);
    NumberFormat.getInstance().format(c.x, sbuff, fp);
    sbuff.append(" ");
    NumberFormat.getInstance().format(c.y, sbuff, fp);
    sbuff.append(" ");
    NumberFormat.getInstance().format(c.radius, sbuff, fp);
    return sbuff.toString();
}

/**
   * user function - get the area of a circle.
   */
public static double area(Circle2 c) {
    return PI * c.radius * c.radius;
}

The opaque type:

The following JDBC client application installs the class Circle2 (which is packaged in Circle2.jar) as an opaque type in the system catalog. Applications can then use the opaque type Circle2 as a data type in SQL statements:
import java.sql.*;
import java.lang.reflect.*;

public class PlayWithCircle2 {
}
String dbname = "test";
String url = null;
Connection conn = null;

public static void main (String args[]) {
    new PlayWithCircle2(args);
}

PlayWithCircle2(String args[]) {

    // -----------------
    // Getting URL
    // -----------------
    if (args.length == 0) {
        System.out.println("\n***ERROR: connection URL must be provided " + "in order to run the demo!"");
        return;
    }

    url = args[0];

    // -------------------
    // Loading driver
    // -------------------
    try {
        System.out.println("Loading JDBC driver...");
        Class.forName("com.informix.jdbc.IfxDriver");
    } catch (java.langClassNotFoundException e) {
        System.out.println("\n***ERROR: " + e.getMessage());
        e.printStackTrace();
        return;
    }

    try {
        conn = DriverManager.getConnection(url);
    } catch (SQLException e) {
        System.out.println("URL = '" + url + "'");
        System.out.println("\n***ERROR: " + e.getMessage());
        e.printStackTrace();
        return;
    }

    System.out.println();

Create an opaque type without an existing Java class

In this example, the Java class MyCircle on the client is used to create a
fixed-length opaque type in the database server named ACircle. The ACircle
opaque type uses the default support functions provided by the database server:
import java.sql.*;

public class MyCircle {
    String dbname = "test";
    String url = null;
    Connection conn = null;
}
public static void main (String args[]) {
    new MyCircle(args);
}

MyCircle(String args[])
{
    System.out.println("----------------");
    System.out.println("- Start - Demo 3");
    System.out.println("----------------");

    // --------------
    // Getting URL
    // --------------
    if (args.length == 0)
    {
        System.out.println("\n***ERROR: connection URL must be provided " +
            "in order to run the demo!\n");
        return;
    }
    url = args[0];

    // --------------
    // Loading driver
    // --------------
    try
    {
        System.out.print("Loading JDBC driver...\n");
        Class.forName("com.informix.jdbc.IfxDriver");
        System.out.println("ok\n");
    }
    catch (java.lang.ClassNotFoundException e)
    {
        System.out.println("\n***ERROR: " + e.getMessage());
        e.printStackTrace();
        return;
    }

    // ----------------
    // Getting connection
    // ----------------
    try
    {
        System.out.print("Getting connection...\n");
        conn = DriverManager.getConnection(url);
        System.out.println("ok\n");
    }
    catch (SQLException e)
    {
        System.out.println("URL = "+ url + "\n");
        System.out.println("\n***ERROR: " + e.getMessage());
        e.printStackTrace();
        return;
    }

    // -------------------
    // Setup UDT meta data
    // -------------------
    UDTMetaData mdata = null;
    try
    {
        mdata = new UDTMetaData();
        System.out.print("Setting fields in mdata...\n");
        mdata.setSQLName("acircle");
        mdata.setLength(24);
        mdata.setFieldCount(3);
        mdata.setFieldName(1, "x");
        Chapter 5. Work with opaque types 5-33
mdata.setFieldName(2, "y");
mdata.setFieldName(3, "radius");
mdata.setFieldType(1, com.informix.lang.IfxTypes.IFX_TYPE_INT);
mdata.setFieldType(2, com.informix.lang.IfxTypes.IFX_TYPE_INT);
mdata.setFieldType(3, com.informix.lang.IfxTypes.IFX_TYPE_INT);
// set class name if don't want to use the default name
// <udtsqlname>.class
mdata.setClassName("ACircle");
mdata.setJarFileSQLName("ACircleJar");
mdata.keepJavaFile(true);
System.out.println("ok");
}

catch (SQLException e)
{
    System.out.println("***ERROR: " + e.getMessage());
    return;
}

// --------------------------------------------------------
// create java file for UDT and install UDT in the database
// --------------------------------------------------------
UDTManager utmgr = null;
try
{
    utmgr = new UDTManager(conn);
    System.out.println("Creating .class/.java files- createUDTClass()");
    String classname = utmgr.createUDTClass(mdata); // generated
    // java file is kept
    System.out.println("   classnam e=" + classname);

    System.out.println("\nCreating .jar file - createJar()");
    String jarfilename = utmgr.createJar(mdata,
        new String[]{"ACircle.class"}); // jarfilename is
    // <udtsqlname>.jar
    // ie. acircle.jar

    System.out.println("\nsetJarTmpPath()");
    utmgr.setJarTmpPath("/tmp");

    System.out.println("\ncreateUDT...");
    utmgr.createUDT(mdata,
        "/vobs/jdbc/demo/tools/udtudrmgr/" + jarfilename, "ACircle", 0);
    System.out.println("ok");
}
catch (SQLException e)
{
    System.out.println("\n***ERROR: " + e.getMessage());
    return;
}
System.out.println();

// -------------
// Now use the UDT
// -------------
try
{
    String s = "drop table tab";
    System.out.print(s + "...");
    Statement stmt = conn.createStatement();
    int count = stmt.executeUpdate(s);
    stmt.close();
    System.out.println("ok");
}
catch (SQLException e)
Create UDRs with UDRManager

The following code shows how an application can use the UDRManager and UDRMetaData classes to convert methods in a Java class on the client (inaccessible to the database server) to Java UDRs in the database server. Applications can later reference the UDRs in SQL statements. In this example, the Java class on the client is named Group1. The class has two routines, udr1 and udr2.
The following code creates methods in the **Group1** class to be registered as UDRs in the database server:

```java
import java.sql.*;

public class Group1
{
    public static String udr1 (String s1, String s2)
        throws SQLException
    {
        return s1 + s2;
    }
    // Return a formatted string with all inputs
    public static String udr2 (Integer i, String s1, 
        String s2) throws SQLException
    {
        return "\{" + i + "," + s1 + "," + s2 + "}";
    }
}
```

The following code creates Java methods **udr1** and **udr2** as UDRs **group1_udr1** and **group1_udr2** in the database server and then uses the UDRs:

```java
import java.sql.*;
import java.lang.reflect.*;

public class PlayWithGroup1
{
    // Open a connection...
    url = "jdbc:informix-sqli://hostname:portnum:db/:
        informixserver=servname;user=scott;password=tiger;"
    myConn = DriverManager.getConnection(url);
    //Install the routines in the database.
    UDRManager utmgr = new UDRManager(myConn);
    UDRMetaData mdata = new UDRMetaData();
    Class gp1 = Class.forName("Group1");
    Method method1 = gp1.getMethod("udr1",
        new Class[]{String.class, String.class});
    Method method2 = gp1.getMethod("udr2",
        new Class[]{Integer.class, String.class, String.class});
    mdata.setUDR(method1, "group1_udr1");
    mdata.setUDR(method2, "group1_udr2");
    mdata.setJarFileSQLName("group1_jar");
    utmgr.createUDRs(mdata, "Group1.jar", "Group1", 0);
    // Use the UDRs in SQL statements:
    Statement stmt = myConn.createStatement();
    stmt.executeUpdate("create table tab (c1 varchar(10),
        c2 char(20), c3 int);" );
    stmt.close();
    Statement stmt = myConn.createStatement();
    stmt.executeUpdate("insert into tab values ('hello', 'world',
        222)" );
    stmt.close();
    Statement stmt = myConn.createStatement();
    ResultSet r = stmt.executeQuery("select c3, group1_udr2(c3, c1, c2)
        from tab where group1_udr1(c1, c2) = 'hello world'" );
    ...
}
```
Chapter 6. Globalization and date formats

These topics explain how IBM Informix JDBC Driver extends the JDK globalization features by providing access to Informix databases that are based on different locales and code sets.

Globalization allows you to develop software independently of the countries or languages of its users and then to localize your software for multiple countries or regions.

For general information about setting up Global Language Support (GLS), see the IBM Informix GLS User’s Guide.

Support for JDK and globalization

The JDK provides a rich set of APIs for developing global applications. These globalization APIs are based on the Unicode 2.0 code set and can adapt text, numbers, dates, currency, and user-defined objects to any country conventions.

The globalization APIs are concentrated in three packages:

- The java.text package contains classes and interfaces for handling text in a locale-sensitive way.
- The java.io package contains new classes for importing and exporting non-Unicode character data.
- The java.util package contains the Locale class, the globalization support classes, and new classes for date and time handling.

Important: There is no connection between JDK locales and JDK code sets; you must keep these code sets in agreement. For example, if you select the Japanese locale ja_JP, there is no Java method that tells you that the SJIS code set is the most appropriate.

Support for IBM Informix GLS variables

Globalization adds several environment variables to IBM Informix JDBC Driver, which are summarized in the following table.

<table>
<thead>
<tr>
<th>Supported Informix environment variables</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLIENT_LOCALE</td>
<td>Specifies the locale of the client that is accessing the database. Provides defaults for user-defined formats such as the GL_DATE format. User-defined data types can use it for code-set conversion. Together with the DB_LOCALE variable, the database server uses this variable to establish the server processing locale. The DB_LOCALE and CLIENT_LOCALE values must be the same, or their code sets must be convertible.</td>
</tr>
<tr>
<td>DBCENTURY</td>
<td>Enables you to specify the appropriate expansion for one- or two-digit year DATE values</td>
</tr>
<tr>
<td>DBDATE</td>
<td>Specifies the end-user formats of values in DATE columns. Supported for compatibility with earlier versions; GL_DATE is preferred.</td>
</tr>
</tbody>
</table>
### Supported Informix environment variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DB_LOCALE</strong></td>
<td>Specifies the locale of the database. IBM Informix JDBC Driver uses this variable to perform code-set conversion between Unicode and the database locale. Together with the <strong>CLIENT_LOCALE</strong> variable, the database server uses this variable to establish the server processing locale. The <strong>DB_LOCALE</strong> and <strong>CLIENT_LOCALE</strong> values must be the same, or their code sets must be convertible.</td>
</tr>
<tr>
<td><strong>GL_DATE</strong></td>
<td>Specifies the end-user formats of values in DATE columns. This variable is supported in Informix database server versions 7.2x, and later.</td>
</tr>
<tr>
<td><strong>GL_USEGLU</strong></td>
<td>To enable Unicode collation by Java/JDBC client applications with the International Components for Unicode (ICU), specify <strong>GL_USEGLU=1</strong> in the connection string before connecting to an Informix instance. This enables the server to use advanced Unicode converters that are required to work with Java.</td>
</tr>
<tr>
<td><strong>NEWCODESET</strong></td>
<td>Allows new code sets to be defined between releases of IBM Informix JDBC Driver.</td>
</tr>
<tr>
<td><strong>NEWLOCALE</strong></td>
<td>Allows new locales to be defined between releases of IBM Informix JDBC Driver.</td>
</tr>
</tbody>
</table>

The IBM Informix JDBC Driver does not change the decimal format, even if there is a **CLIENT_LOCALE** setting available. Globalization should be done within the Java application with the **DecimalFormat** class.

**Important:** The **DB_LOCALE**, **CLIENT_LOCALE**, and **GL_DATE** variables are supported only if the database server supports the IBM Informix GLS feature. If these environment variables are set and your application connects to a non-GLS server (server versions earlier than 7.2), a connection exception occurs. If you connect to a non-GLS server and do not set these variables, the behavior is the same as for older versions of IBM Informix JDBC Driver.

### Support for DATE end-user formats

The end-user format is the format in which a DATE value appears in a string variable. This section describes the **GL_DATE**, **DBDATE**, and **DBCENTURY** variables, which specify DATE end-user formats. These variables are optional.

**Important:** IBM Informix JDBC Driver does not support ALS 6.0, 5.0, or 4.0 formats for the **DBDATE** or **GL_DATE** environment variables.

For more information about **GL_DATE**, see *IBM Informix GLS User's Guide*.

### The GL_DATE variable

The **GL_DATE** environment variable specifies the end-user formats of values in DATE columns. This variable is supported in IBM Informix database servers Version 7.2x, or later. A **GL_DATE** format string can contain the following characters:

- One or more white space characters
- An ordinary character (other than the percent symbol (%) or a white space character)
A formatting directive, which is composed of the percent symbol (%) followed by one or two conversion characters that specify the required replacement.

Date formatting directives are defined in the following table.

<table>
<thead>
<tr>
<th>Directive</th>
<th>Replaced by</th>
</tr>
</thead>
<tbody>
<tr>
<td>%a</td>
<td>The abbreviated weekday name as defined in the locale</td>
</tr>
<tr>
<td>%A</td>
<td>The full weekday name as defined in the locale</td>
</tr>
<tr>
<td>%b</td>
<td>The abbreviated month name as defined in the locale</td>
</tr>
<tr>
<td>%B</td>
<td>The full month name as defined in the locale</td>
</tr>
<tr>
<td>%C</td>
<td>The century number (the year divided by 100 and truncated to an integer) as a decimal number (00 through 99)</td>
</tr>
<tr>
<td>%d</td>
<td>The day of the month as a decimal number (01 through 31)</td>
</tr>
<tr>
<td>%D</td>
<td>Same as the %m/%d/%y format</td>
</tr>
<tr>
<td>%e</td>
<td>The day of the month as a decimal number (1 through 31)</td>
</tr>
<tr>
<td>%h</td>
<td>Same as the %b formatting directive</td>
</tr>
<tr>
<td>%iy</td>
<td>The year as a two-digit decade (00 through 99)</td>
</tr>
<tr>
<td>%iY</td>
<td>The year as a four-digit decade (0000 through 9999)</td>
</tr>
<tr>
<td>%m</td>
<td>The month as a decimal number (01 through 12)</td>
</tr>
<tr>
<td>%n</td>
<td>A newline character</td>
</tr>
<tr>
<td>%t</td>
<td>The TAB character</td>
</tr>
<tr>
<td>%w</td>
<td>The weekday as a decimal number (0 - 6)</td>
</tr>
<tr>
<td>%x</td>
<td>A special date representation that the locale defines</td>
</tr>
<tr>
<td>%y</td>
<td>The year as a two-digit decade (00 - 99)</td>
</tr>
<tr>
<td>%Y</td>
<td>The year as a four-digit decade (0000 - 9999)</td>
</tr>
<tr>
<td>%%</td>
<td>% (to allow % in the format string)</td>
</tr>
</tbody>
</table>

Important: **GL_DATE** optional date format qualifiers for field specifications are not supported.
For example, by using %4m to display a month as a decimal number with a maximum field width of 4 is not supported.

The GL_DATE conversion modifier O, which indicates use of alternative digits for alternative date formats, is not supported.

White space or other nonalphanumeric characters must appear between any two formatting directives. If a GL_DATE variable format does not correspond to any of the valid formatting directives, errors can result when the database server attempts to format the date.

For example, for a U.S. English locale, you can format an internal DATE value for 09/29/1998 using the following format:

* Sep 29, 1998 this day is:(Tuesday), a fine day *

To create this format, set the GL_DATE environment variable to this value:

* %b %d, %Y this day is:(%A), a fine day *

To insert this date value into a database table that has a date column, you can perform the following types of inserts:

- Nonnative SQL, in which SQL statements are sent to the database server unchanged
  Enter the date value exactly as expected by the GL_DATE setting.
- Native SQL, in which escape syntax is converted to a format that is specific to Informix
  Enter the date value in the JDBC escape format yyyy-mm-dd; the value is converted to the GL_DATE format automatically.

The following example shows both types of inserts:

To retrieve the formatted GL_DATE DATE value from the database, call the getString() method of the ResultSet class.

To enter strings that represent dates into database table columns of char, varchar, or lvarchar type, you can also build date objects that represent the date string value. The date string value must be in GL_DATE format.

The following example shows both ways of selecting DATE values:

```java
PreparedStatement pstmt = conn.prepareStatement("Select * from
    + "tablename "
+ "where col2 like ?;";
pstmt.setString(1, "%Tue%";
ResultSet r = pstmt.executeQuery();
while(r.next())
    {
        String s = r.getString(1);
        java.sql.Date d = r.getDate(2);
        System.out.println("Select: column col1 (GL_DATE format) = <" + s + ">");
        System.out.println("Select: column col2 (JDBC Escape format) = <" + d + ">");
    }
r.close();
pstmt.close();
```
The DBDATE variable

Support for the DBDATE environment variable provides compatibility with earlier versions for client applications that are based on IBM Informix database server versions before 7.2x, 8.x, or 9.x. Use the GL_DATE environment variable for new applications.

The DBDATE environment variable specifies the end-user formats of values in DATE columns. End-user formats are used in the following ways:

- When you input DATE values, IBM Informix products use the DBDATE environment variable to interpret the input. For example, if you specify a literal DATE value in an INSERT statement, Informix database servers require this literal value to be compatible with the format specified by the DBDATE variable.
- When you display DATE values, IBM Informix products use the DBDATE environment variable to format the output.

With standard formats, you can specify the following attributes:

- The order of the month, day, and year in a date
- Whether the year is printed with two digits (Y2) or four digits (Y4)
- The separator between the month, day, and year

The format string can include the following characters:

- Hyphen (-), dot (.), and slash (/) are separator characters in a date format. A separator appears at the end of a format string (for example, Y4MD-).
- A 0 indicates that no separator is displayed.
- D and M are characters that represent the day and the month.
- Y2 and Y4 are characters that represent the year and the number of digits in the year.

The following format strings are valid standard DBDATE formats:

- DMY2
- DMY4
- MDY4
- MDY2
- Y4MD
- Y4DM
- Y2MD
- Y2DM

The separator always goes at the end of the format string (for example, DMY2/). If no separator or an invalid character is specified, the slash (/) character is the default.

For the U.S. ASCII English locale, the default setting for DBDATE is Y4MD-, where Y4 represents a four-digit year, M represents the month, D represents the day, and hyphen (-) is the separator (for example, 1998-10-08).

To insert a date value into a database table with a date column, you can perform the following types of inserts:

- Nonnative SQL. SQL statements are sent to the database server unchanged. Enter the date value exactly as expected by the DBDATE setting.
Native SQL. Escape syntax is converted to a format that is specific to Informix. Enter the date value in the JDBC escape format yyyy-mm-dd; the value is converted to the DBDATE format automatically.

The following example shows both types of inserts (the DBDATE value is MDY2-):

```java
stmt = conn.createStatement();
cmd = "create table tablename (col1 date, col2 varchar(20));";
rc = stmt.executeUpdate(cmd);
String[] dateVals = {"'08-10-98'", "{d '1998-08-11'}"};
String[] charVals = {"'08-10-98'", "'08-11-98'"};
int numRows = dateVals.length;
for (int i = 0; i < numRows; i++)
{
    cmd = "insert into tablename values(" + dateVals[i] + ", " +
        charVals[i] + ");"
    rc = stmt.executeUpdate(cmd);
    System.out.println("Insert: column col1 (date) = " + dateVals[i]);
    System.out.println("Insert: column col2 (varchar) = " + charVals[i]);
}
```

To retrieve the formatted DBDATE DATE value from the database, call the getString method of the ResultSet class.

To enter strings that represent dates into database table columns of char, varchar, or lvarchar type, you can build date objects that represent the date string value. The date string value needs to be in DBDATE format.

The following example shows both ways to select DATE values:

```java
PreparedStatement pstmt = conn.prepareStatement("Select * from tablename 
    + where col1 = ?;";
GregorianCalendar gc = new GregorianCalendar(1998, 7, 10);
java.sql.Date dateObj = new java.sql.Date(gc.getTime().getTime());
pstmt.setDate(1, dateObj);
ResultSet r = pstmt.executeQuery();
while(r.next())
{
    String s = r.getString(1);
    java.sql.Date d = r.getDate(2);
    System.out.println("Select: column col1 (DBDATE format) = " + s + "
        + d + ">");
    System.out.println("Select: column col2 (JDBC Escape format) = " +
        s + ">");
}
r.close();
pstmt.close();
```

The DBCENTURY variable

If a String value represents a DATE value that has less than a three-digit year and DBCENTURY is set, IBM Informix JDBC Driver converts the String value to a DATE value and uses the DBCENTURY property to determine the correct four-digit expansion of the year.

The methods affected and the conditions under which they are affected are summarized in the following table.

<table>
<thead>
<tr>
<th>Method</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>PreparedStatement.setString</td>
<td>The target column is DATE.</td>
</tr>
<tr>
<td>PreparedStatement setObject</td>
<td>The target column is DATE.</td>
</tr>
<tr>
<td>Method</td>
<td>Condition</td>
</tr>
<tr>
<td>--------</td>
<td>-----------</td>
</tr>
<tr>
<td><code>IfxPreparedStatement.setObject(String)</code></td>
<td>The target column is DATE.</td>
</tr>
<tr>
<td><code>ResultSet.getDate(int)</code></td>
<td>The source column is a <code>String</code> type.</td>
</tr>
<tr>
<td><code>ResultSet.getDate(int, Calendar)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.getDate(String)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.getDate(String, Calendar)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.getTimestamp(int)</code></td>
<td>The source column is a <code>String</code> type.</td>
</tr>
<tr>
<td><code>ResultSet.getTimestamp(int, Calendar)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.getTimestamp(String)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.getTimestamp(String, Calendar)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.updateString(int, String)</code></td>
<td>The target column is DATE.</td>
</tr>
<tr>
<td><code>ResultSet.updateString(String, String)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.updateObject(int, String)</code></td>
<td>The target column is DATE.</td>
</tr>
<tr>
<td><code>ResultSet.updateObject(int, String, int)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.updateObject(String, String)</code></td>
<td></td>
</tr>
<tr>
<td><code>ResultSet.updateObject(String, String, int)</code></td>
<td></td>
</tr>
</tbody>
</table>

The following table describes the four possible settings for the `DBCENTURY` environment variable.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Meaning</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>Past</td>
<td>Uses past and present centuries to expand the year value.</td>
</tr>
<tr>
<td>F</td>
<td>Future</td>
<td>Uses present and next centuries to expand the year value.</td>
</tr>
<tr>
<td>C</td>
<td>Closest</td>
<td>Uses past, present, and next centuries to expand the year value.</td>
</tr>
<tr>
<td>R</td>
<td>Present</td>
<td>Uses present century to expand the year value.</td>
</tr>
</tbody>
</table>

See the “Environment Variables” section in the *IBM Informix Guide to SQL: Reference* for a discussion of the algorithms used for each setting and examples of each setting.

Here is an example of a URL that sets the `DBCENTURY` value:
```
jdbc:informix-sqli://myhost:1533;informixserver=myserver;
    user=mname;password=mypassword;DBCENTURY=F;
```

A URL must not have a line break.

IBM Informix JDBC Driver always includes four-digit years when it sends `java.sql.Date` and `java.sql.Timestamp` values to the server. Similarly, the server always includes four-digit years when it sends Informix date values to IBM Informix JDBC Driver.

For examples of how to use `DBCENTURY` with IBM Informix JDBC Driver, see the `DBCENTURYSelect.java`, `DBCENTURYSelect2.java`, `DBCENTURYSelect3.java`, `DBCENTURYSelect4.java`, and `DBCENTURYSelect5.java` example programs.

**Precedence rules for end-user formats**

The precedence rules that define how to determine an end-user format for an internal DATE value are listed here:

- If a `DBDATE` format is specified, this format is used.
- If a `GL_DATE` format is specified, a locale must be determined:

Chapter 6. Globalization and date formats   6-7
- If a `CLIENT_LOCALE` value is specified, it is used with the `GL_DATE` format string to display DATE values.
- If a `DB_LOCALE` value is specified but a `CLIENT_LOCALE` value is not, the `DB_LOCALE` value is compared with the database locale (read from the `systables` table of the user database) to verify that the `DB_LOCALE` value is valid. If the `DB_LOCALE` value is valid, it is used with the `GL_DATE` format string to display DATE values. If the `DB_LOCALE` value is not valid, the database locale is used with the `GL_DATE` format string.
- If the `CLIENT_LOCALE` or `DB_LOCALE` values are not specified, the database locale is used with the `GL_DATE` format string to display DATE values.

- If a `CLIENT_LOCALE` value is specified, the DATE formats conform to the default formats associated with this locale.
- If a `DB_LOCALE` value is specified but no `CLIENT_LOCALE` value is specified, the `DB_LOCALE` value is compared with the database locale to verify that the `DB_LOCALE` value is valid. If the `DB_LOCALE` value is valid, the `DB_LOCALE` default formats are used. If the `DB_LOCALE` value is not valid, the default formats for dates associated with the database locale are used.
- If the `CLIENT_LOCALE` or `DB_LOCALE` values are not specified, all DATE values are formatted in U.S. English format, `Y4MD-`.

**Support for code-set conversion**

Code-set conversion converts character data from one code set to another. In a client/server environment, character data might need to be converted from one code set to another if the client and database server computers use different code sets to represent the same characters. For detailed information about code-set conversion, see the *IBM Informix GLS User’s Guide*.

You must specify code-set conversion for the following types of character data:

- SQL data types (char, varchar, nchar, nvarchar)
- SQL statements
- Database objects such as database names, column names, table names, statement identifier names, and cursor names
- Stored procedure text
- Command text
- Environment variables

IBM Informix JDBC Driver converts character data as it is sent between client and database server. The code set (encoding) used for the conversion is specified in the `systables` catalog for the opened database. You set the `DB_LOCALE` and `CLIENT_LOCALE` values in the connection properties or database URL.

**Unicode to database code set**

Java is Unicode based, so IBM Informix JDBC Driver converts data between Unicode and the Informix database code set. The code-set conversion value is extracted from the `DB_LOCALE` value specified at the time the connection is made. If the `DB_LOCALE` value is incorrect, a Database Locale information mismatch error occurs.
The `DB_LOCALE` value must be a valid Informix locale, with a valid Informix code-set name or number as shown in the compatibility table that follows. The following table maps the supported JDK 1.4 encodings to Informix code sets.

<table>
<thead>
<tr>
<th>Informix code set name</th>
<th>Informix code set number</th>
<th>JDK code set</th>
</tr>
</thead>
<tbody>
<tr>
<td>8859-1</td>
<td>819</td>
<td>8859_1</td>
</tr>
<tr>
<td>8859-2</td>
<td>912</td>
<td>8859_2</td>
</tr>
<tr>
<td>8859-3</td>
<td>57346</td>
<td>8859_3</td>
</tr>
<tr>
<td>8859-4</td>
<td>57347</td>
<td>8859_4</td>
</tr>
<tr>
<td>8859-5</td>
<td>915</td>
<td>8859_5</td>
</tr>
<tr>
<td>8859-6</td>
<td>1089</td>
<td>8859_6</td>
</tr>
<tr>
<td>8859-7</td>
<td>813</td>
<td>8859_7</td>
</tr>
<tr>
<td>8859-8</td>
<td>916</td>
<td>8859_8</td>
</tr>
<tr>
<td>8859-9</td>
<td>920</td>
<td>8859_9</td>
</tr>
<tr>
<td>ASCII</td>
<td>364</td>
<td>ASCII</td>
</tr>
<tr>
<td>sjis-s</td>
<td>932</td>
<td>SJIS</td>
</tr>
<tr>
<td>sjis</td>
<td>57350</td>
<td>SJIS</td>
</tr>
<tr>
<td>utf8</td>
<td>57372</td>
<td>UTF8</td>
</tr>
<tr>
<td>big5</td>
<td>57352</td>
<td>Big5</td>
</tr>
<tr>
<td>CP1250</td>
<td>1250</td>
<td>Cp1250</td>
</tr>
<tr>
<td>CP1251</td>
<td>1251</td>
<td>Cp1251</td>
</tr>
<tr>
<td>CP1252</td>
<td>1252</td>
<td>Cp1252</td>
</tr>
<tr>
<td>CP1253</td>
<td>1253</td>
<td>Cp1253</td>
</tr>
<tr>
<td>CP1254</td>
<td>1254</td>
<td>Cp1254</td>
</tr>
<tr>
<td>CP1255</td>
<td>1255</td>
<td>Cp1255</td>
</tr>
<tr>
<td>CP1256</td>
<td>1256</td>
<td>Cp1256</td>
</tr>
<tr>
<td>CP1257</td>
<td>1257</td>
<td>Cp1257</td>
</tr>
<tr>
<td>cp_949</td>
<td>57356</td>
<td>Cp949</td>
</tr>
<tr>
<td>KS5601</td>
<td>57356</td>
<td>Cp949</td>
</tr>
<tr>
<td>ksc</td>
<td>57356</td>
<td>Cp949</td>
</tr>
<tr>
<td>ujis</td>
<td>57351</td>
<td>EUC_JP</td>
</tr>
<tr>
<td>gb</td>
<td>57357</td>
<td>ISO2022CN_GB</td>
</tr>
<tr>
<td>GB2312-80</td>
<td>57357</td>
<td>ISO2022CN_GB</td>
</tr>
<tr>
<td>cp936</td>
<td>57357</td>
<td>ISO2022CN_GB</td>
</tr>
</tbody>
</table>

You cannot use an Informix locale with a code set for which there is no JDK-supported encoding. This incorrect usage results in an Encoding or code set not supported error message.

The following table shows the supported locales.

<table>
<thead>
<tr>
<th>Supported Locales</th>
</tr>
</thead>
<tbody>
<tr>
<td>ar_ae</td>
</tr>
<tr>
<td>ar_sa</td>
</tr>
<tr>
<td>de_at</td>
</tr>
</tbody>
</table>

Chapter 6. Globalization and date formats 6-9
Unicode to client code set

Because the Unicode code set includes all existing code sets, the Java virtual machine (JVM) must render the character with the platforms local code set. Inside the Java program, you must always use Unicode characters. The JVM on that platform converts input and output between Unicode and the local code set.

For example, you specify button labels in Unicode, and the JVM converts the text to display the label correctly. Similarly, when the getText() method gets user input from a text box, the client program gets the string in Unicode, no matter how the user entered it.

Never read a text file one byte at a time. Always use the InputStreamReader() or OutputStreamWriter() methods to manipulate text files. By default, these methods use the local encoding, but you can specify an encoding in the constructor of the class, as follows:

```java
InputStreamReader = new InputStreamReader (in, "SJIS");
```

You and the JVM are responsible for getting external input into the correct Java Unicode string. Thereafter, the database locale encoding is used to send the data to and from the database server.

Connect to a database with non-ASCII characters

If you do not specify the database name at connection time, the connection must be opened with the correct `DB_LOCALE` value for the specified database.

If close database and database `dbname` statements are issued, the connection continues to use the original `DB_LOCALE` value to interpret the database name. If the `DB_LOCALE` value of the new database does not match, an error is returned. In this case, the client program must close and reopen the connection with the correct `DB_LOCALE` value for the new database.

If you supply the database name at connection time, the `DB_LOCALE` value must be set to the correct database locale.

You can connect to an NLS database by defining a locale with `NEWCODESET` and `NEWLOCALE` connection properties. For information about their formats, see [Connecting with the NEWLOCALE and NEWCODESET Environment Variables](#).
Code-set conversion for TEXT and CLOB data types

IBM Informix JDBC Driver does not automatically convert between code sets for TEXT, BYTE, CLOB, and BLOB data types.

You can convert between code sets for TEXT and CLOB data types in one of the following ways:

- You can automate code-set conversion for TEXT or CLOB data between the client and database locales by using the IFX_CODESETLOB environment variable.
- You can convert between code sets for TEXT data by using the getBytes(), getString(), InputStreamReader(), and OutputStreamWriter() methods.

Convert with the IFX_CODESETLOB environment variable

You can automate the following pair of code-set conversions for TEXT and CLOB data types:

- Convert from client locale to database locale before the data is sent to the database server.
- Convert from database locale to client locale before the data is retrieved by the client.

To automate code-set conversion for TEXT and CLOB data types, set the IFX_CODESETLOB environment variable in the connection URL. For example:

IFX_CODESETLOB = 4096. You can also use the following methods of the IfxDataSource class to set and get the value of IFX_CODESETLOB:

public void setIfxIFX_CODESETLOB(int codesetlobFlag);
public int getIfxIFX_CODESETLOB();

IFX_CODESETLOB can have the following values:

- none  Default
  - Automatic code-set conversion is not enabled.
- 0  Automatic code-set conversion takes place in internal temporary files.
- > 0  Automatic code-set conversion takes place in the memory of the client computer. The value indicates the number of bytes allocated for the conversion.
  - If the number of allocated bytes is less than the size of the large object, an error is returned.

To perform conversion in memory, you must specify an amount that is smaller than the memory limits of the client machines and larger than the possible size of any converted large object.

When you are using any of the following java.sql.Clob interface methods or Informix extensions to the Clob interface, no code-set conversion is performed, even if the IFX_CODESETLOB environment variable is set. These methods include:

- Ifxclob::setAsciiStream(long)
- Clob::setAsciiStream(long position, InputStream fin, int length)

IFX_CODESETLOB takes effect only for methods from the java.sql.PreparedStatement interface.
However when using any of the following java.sql.Clob interface methods or Informix
extensions to Clob interface, Unicode characters are always converted
automatically to the database locale code set. Here is a list of those methods:
Clob::setCharacterStream(long) throws SQLException
Clob::setString(long, String) throws SQLException
Clob:: setString(long pos, String str, int offset, int len)
IfxCblob::setSubString(long position, String str, int length)

**Convert with JDK methods**

The getBytes(), getString(), InputStreamReader(), and OutputStreamWriter()
methods take a code-set parameter that converts to and from Unicode and the
specified code set.

Here is sample code that shows how to convert a file from the client code set to
Unicode and then from Unicode to the database code set:

```java
File infile = new File("data_jpn.dat");
File outfile = new File("data_conv.dat");
.pstmt = conn.prepareStatement("insert into t_text values (?)");
// Convert data from client encoding to database encoding
System.out.println("Converting data ...
"); try
{
    String from = "SJIS";
    String to = "8859_1";
    convert(infile, outfile, from, to);
} catch (Exception e)
{
    System.out.println("Failed to convert file");
}
System.out.println("Inserting data ...
"); try
{
    int fileLength = (int) outfile.length();
    fin = new FileInputStream(infile);
    fin = new FileInputStream(outfile);
    pstmt.setAsciiStream(1, fin, fileLength);
    pstmt.executeUpdate();
} catch (Exception e)
{
    System.out.println("Failed to setAsciiStream");
}

.method public static void convert(File infile, File outfile, String from, String to)
    throws IOException
    { InputStream in = new FileInputStream(infile);
      OutputStream out = new FileOutputStream(outfile);
      Reader r = new BufferedReader( new InputStreamReader( in, from));
      Writer w = new BufferedWriter( new OutputStreamWriter( out, to));
      //Copy characters from input to output. The InputStreamReader converts
      // from the input encoding to Unicode, and the OutputStreamWriter
      // converts from Unicode to the output encoding. Characters that can
      // not be represented in the output encoding are output as '?'
      char[] buffer = new char[4096];
      int len;
      while (((len = r.read(buffer)) != -1)
        w.write(buffer, 0, len);
    }
```

IBM Informix JDBC Driver Programmer's Guide
When you retrieve data from the database, you can use the same approach to convert the data from the database code set to the client code set.

**Code-set conversion for BLOB and BYTE data types**

When you use `java.sql.PreparedStatement::setCharacterStream()` to insert in a CLOB column, Java Unicode characters are converted automatically to the database locale code set. If the environment variable `IFX_CODESETLOB` is set, its value determine whether to perform code set conversion using temporary files or to perform the code set conversion in memory. If `IFX_CODESETLOB` is not set, the `LOBCACHE` environment variable determines whether the code set conversion takes place in temporary files or in memory.

However, you are discouraged from using `java.sql.PreparedStatement::setCharacterStream()` to insert BLOB or BYTE columns. The JDBC driver cannot insert Java characters in a database and consequently attempts code set conversion of the characters. Using `java.sql.PreparedStatement::setBinaryStream()` is the preferred way to insert BLOB or BYTE columns.

**User-defined locales**

IBM Informix JDBC Driver uses the JDK globalization API to manipulate international data. The classes and methods in this API take a JDK locale or encoding as a parameter, but because the Informix `DB_LOCALE` and `CLIENT_LOCALE` properties specify the locale and code set based on Informix names, these Informix names are mapped to the JDK names. These mappings are kept in internal tables, which are updated periodically.

For example, the Informix and JDK names for the ASCII code set are 8859-1 and 8859_1, respectively. IBM Informix JDBC Driver maps 8859-1 to 8859_1 in its internal tables and uses the appropriate JDK name in the JDK classes and methods.

**Connect with the NEWLOCALE and NEWCODESET environment variables**

Because new locales may be created between updates of these tables, two connection properties, `NEWLOCALE` and `NEWCODESET`, let you specify a locale or code set that is not specified in the tables. Here is an example URL using these properties:

```
jdbc:informix-sqli://myhost:1533:informixserver=myserver;
  user=mynname; password=mypasswd;NEWLOCALE=en_us,en_us;
  NEWCODESET=8859_1,8859-1,819;
```

A URL must be on one line.

The `NEWLOCALE` and `NEWCODESET` properties have the following formats:

```
NEWLOCALE=JDK-locale,Ifx-locale:JDK-locale,Ifx-locale...

NEWCODESET=JDK-encoding,Ifx-codeset,Ifx-codeset-number:JDK-
  encoding, Ifx-codeset,Ifx-codeset-number...
```
There is no limit to the number of locale or code-set mappings you can specify.

You can connect to an NLS database by defining a locale using NEWCODESET and NEWLOCALE connection properties.

If you specify an incorrect number of parameters or values, you get a Locale Not Supported or Encoding or Code Set Not Supported message.

If these properties are set in the URL or a DataSource object, the new values in NEWLOCALE and NEWCODESET override the values in the JDBC internal tables. For example, if JDBC already maps 8859-1 to 8859_1 internally, but you specify NEWCODESET=8888,8859_1,819 instead, the new value 8888 is used for the code-set conversion.

**Connect with the NEWNLSMAP environment variable**

To support connecting to NLS databases, IBM Informix JDBC Driver maintains a table mapping NLS locale to the corresponding JDK locale and JDK codeset. As JDK support for more locales and codesets becomes available, an NLS locale not previously supported can be supported with newer JDKs. IBM Informix JDBC Driver supports a connection property, NEWNLSMAP, which lets you specify mappings for an NLS locale that is not specified in the tables.

The NEWNLSMAP property has the following format:

NEWNLSMAP=NLS-locale,JDK-locale,JDK-codeset:NLS-locale,JDK-locale, JDK-codeset,....

Here is an example URL using these properties:

```
jdbc:informix-sqli://myhost:1533:informixserver=myserver;
user=myname;password=mypassword;NEWNLSMAP=rumanian,ro_RO,ISO8859_2;
```

There is no limit to the number of mappings you can specify. If you specify an incorrect number of parameters or values, you get a Locale Not Supported or Encoding or Code Set Not Supported message.

**Support for globalized error messages**

Message text is usually the text of an SQLException object, but can also be an SQLWarn object or any other text output from the driver.

There are two requirements to enable globalized message text output, as follows:

- You must add the full path of the ifxlang.jar file to the $CLASSPATH (UNIX) or %CLASSPATH% (Windows) environment variable. This JAR file contains globalized versions of all message text supported by IBM Informix JDBC Driver. Supported languages are English, German, French, Spanish, Russian, Polish, Czech, Slovak, Chinese (simplified and traditional), Korean, and Japanese.

- The CLIENT_LOCALE environment variable value must be passed through the property list to the connection object at connection time if you are using a nondefault locale. For more information about CLIENT_LOCALE and GLS features in general, see "Support for IBM Informix GLS variables" on page 6-1.

Several public classes have constructors that take the current connection object as a parameter so they have access to the CLIENT_LOCALE value. If you want access to non-English error messages, you must use the constructors that include the connection object. Otherwise, any error message text from those classes is in...
English only. Affected public classes are Interval, IntervalYM, IntervalDF, and IfxLocator. For more information about the constructors to use for these classes, see Chapter 4, “Work with Informix types,” on page 4-1.

For an example of how to use the globalized error message support feature, see the locmsg.java program, which is included with IBM Informix JDBC Driver.
Chapter 7. Tuning and troubleshooting

These topics provide tuning and troubleshooting information for IBM Informix JDBC Driver.

Debug your JDBC API program

You can set the SQLDEBUG connection property to generate binary protocol trace. You set the connection property SQLDEBUG to specify a file. For example:

`SQLDEBUG=C:\tmp\ifxjdbctrace`

A new trace file is generated for every connection and is suffixed with a timestamp. If you are using the IfxDataSource interface, you can use the IfxDataSource.setIfxSQLDEBUG (String frame) method. Debug versions of the JDBC jar files are not included in IBM Informix JDBC Driver, Version 3.00.JC1 and later.

**Important:** The binary SQLI protocol trace feature (SQLDEBUG) should only be used when directed by an IBM technical support representative.

Manage performance

This section describes issues that might affect the performance of your queries:

- The FET_BUF_SIZE and BIG_FET_BUF_SIZE environment variables
- Memory management of large objects
- Reducing network traffic
- Using bulk inserts
- Tuning the connection pool.

**The FET_BUF_SIZE and SRV_FET_BUF_SIZE environment variables**

When a SELECT statement is sent from a Java program to an IBM Informix database, the returned rows, or tuples, are stored in a tuple buffer in IBM Informix JDBC Driver. The default size of the tuple buffer is the larger of the returned tuple size or 4096 bytes.

You can use the Informix FET_BUF_SIZE environment variable to override the default size of the tuple buffer. FET_BUF_SIZE can be set to any positive integer less than or equal to 32,767. If the FET_BUF_SIZE environment variable is set, and its value is larger than the default tuple buffer size, the tuple buffer size is set to the value of **FET_BUF_SIZE**.

Increasing the size of the tuple buffer can reduce network traffic between your Java program and the database, often resulting in better performance of queries. There are times, however, when increasing the size of the tuple buffer can actually degrade the performance of queries. This could happen if your Java program has many active connections to a database or if the swap space on your computer is limited. If this is true for your Java program or computer, you might not want to use the FET_BUF_SIZE or SRV_FET_BUF_SIZE environment variable to increase the size of the tuple buffer.
For more information about setting Informix environment variables, see Chapter 2, "Connect to the database," on page 2-1. For more information about increasing the fetch buffer size, see the IBM Informix Guide to SQL: Reference.

Manage memory for large objects

Whenever a large object (a BYTE, TEXT, BLOB, or CLOB data type) is fetched from the database server, the data is either cached into memory or stored in a temporary file (if it exceeds the memory buffer). A JDBC applet can cause a security violation if it tries to create a temporary file on the local computer. In this case, the entire large object must be stored in memory.

You can specify how large object data is stored by using an environment variable, LOBCACHE, that you include in the connection property list, as follows:

- To set the maximum number of bytes allocated in memory to hold the data, set the LOBCACHE value to that number of bytes.
  - If the data size exceeds the LOBCACHE value, the data is stored in a temporary file. If a security violation occurs during creation of this file, the data is stored in memory.
- To always store the data in a file, set the LOBCACHE value to 0.
  - In this case, if a security violation occurs, IBM Informix JDBC Driver makes no attempt to store the data in memory. This setting is not supported for unsigned applets. For more information, see “Using the driver in an applet” on page 1-9.
- To always store the data in memory, set the LOBCACHE value to a negative number.
  - If the required amount of memory is not available, IBM Informix JDBC Driver throws the SQLException message Out of Memory.

If the LOBCACHE size is invalid or not defined, the default size is 4096.

You can set the LOBCACHE value through the database URL, as follows:

```java
URL = jdbc:informix-sqli://158.58.9.37:7110/test:user=guest;
    password=iamaguest;informixserver=oltapshm;
    lobcache=4096;
```

The preceding example stores the large object in memory if the size is 4096 bytes or fewer. If the large object exceeds 4096 bytes, IBM Informix JDBC Driver tries to create a temporary file. If a security violation occurs, memory is allocated for the entire large object. If that fails, the driver throws an SQLException message.

Here is another example:

```java
URL = "jdbc:informix-sqli://icarus:7110/testdb:
    user=guest:passwd=whoknows;informixserver=olserv01;lobcache=0";
```

The preceding example uses a temporary file for storing the fetched large object.

Here is a third example:

```java
URL = "jdbc:informix-sqli://icarus:7110/testdb:user=guest:
    passwd=whoknows;informixserver=olserv01;lobcache=-1";
```

The preceding example always uses memory to store the fetched large object.

For programming information about how to use the TEXT and BYTE data types in a Java program, see “BYTE and TEXT data types” on page 4-3. For programming
information about how to use the BLOB and CLOB data types in a Java program, see "Smart large object data types" on page 4-27.

Reduce network traffic

The two environment variables OPTOFC and IFX_AUTOFREE can be used to reduce network traffic when you close Statement and ResultSet objects.

Set OPTOFC to 1 to specify that the ResultSet.close() method does not require a network round trip if all the qualifying rows have already been retrieved in the clients tuple buffer. The database server automatically closes the cursor after all the rows have been retrieved.

IBM Informix JDBC Driver might or might not have additional rows in the clients tuple buffer before the next ResultSet.next() method is called. Therefore, unless IBM Informix JDBC Driver has received all rows from the database server, the ResultSet.close() method might still require a network round trip when OPTOFC is set to 1.

Set IFX_AUTOFREE to 1 to specify that the Statement.close() method does not require a network round trip to free the database server cursor resources if the cursor has already been closed in the database server.

You can also use the setAutoFree(boolean flag) and getAutoFree() methods to free database server cursor resources. For more information, see "The Auto Free feature" on page 3-24.

The database server automatically frees the cursor resources after the cursor is closed, either explicitly by the ResultSet.close() method or implicitly by the OPTOFC environment variable.

When the cursor resources have been freed, the cursor can no longer be referenced.

For examples of how to use the OPTOFC and IFX_AUTOFREE environment variables, see the autofree.java and optofc.java demonstration examples described in Appendix A, “Sample code files,” on page A-1. In these examples, the variables are set with the Properties.put() method.

For more information about setting Informix environment variables, see "Informix environment variables with the IBM Informix JDBC Driver" on page 2-10.

Bulk inserts

The bulk insert feature improves the performance of single INSERT statements that are executed multiple times with multiple value settings. For more information, see "Perform bulk inserts" on page 3-5.

A connection pool

To improve the performance and scalability of your application, you can obtain your connection to the database server through a DataSource object that references a ConnectionPoolDataSource object. IBM Informix JDBC Driver provides a Connection Pool Manager as a transparent component of the ConnectionPoolDataSource object. The Connection Pool Manager keeps a closed connection in a pool instead of returning the connection to the database server as
closed. Whenever a user requests a new connection, the Connection Pool Manager gets the connection from the pool, avoiding the overhead of having the server close and re-open the connection.

Using the `ConnectionPoolDataSource` object can significantly improve performance in cases where your application receives frequent, periodic connection requests.

For complete information about how and why to use a `DataSource` or `ConnectionPoolDataSource` object, see the JDBC 3.0 API.

**Important:** This feature does not affect IfxAConnectionPoolDataSource, which operates under the assumption that connection pooling is handled by the transaction manager.

**Deploying a ConnectionPoolDataSource object**

In the following steps:

- The variable `cpds` refers to a `ConnectionPoolDataSource` object.
- The JNDI logical name for the `ConnectionPoolDataSource` object is `myCPDS`.
- The variable `ds` refers to a `DataSource` object.
- The logical name for the `DataSource` object is `DS_Pool`.

To deploy a ConnectionPoolDataSource object:

1. Instantiate an `IfxConnectionPoolDataSource` object.
2. Set any desired tuning properties for the object:
   ```java
   cpds.setIfxCPMInitPoolSize(15);
   cpds.setIfxCPMMinPoolSize(2);
   cpds.setIfxCPMMaxPoolSize(20);
   cpds.setIfxCPMServiceInterval(30);
   ```
3. Register the `ConnectionPoolDataSource` object using JNDI to map a logical name to the object:
   ```java
   Context ctx = new InitialContext();
   ctx.bind("myCPDS", cpds);
   ```
4. Instantiate an `IfxDataSource` object.
5. Associate the `DataSource` object with the logical name you registered for the `ConnectionPoolDataSource` object:
   ```java
   ds.setDataSourceName("myCPDS",ds);
   ```
6. Register the `DataSource` object using JNDI:
   ```java
   Context ctx = new InitialContext();
   ctx.bind("DS.Pool",ds);
   ```

**Tune the Connection Pool Manager**

During the deployment phase, you or your database administrator can control how connection pooling works in your applications by setting values for any of these Connection Pool Manager properties:

- `IFMX_CPM_INIT_POOLSIZE` lets you specify the initial number of connections to be allocated for the pool when the `ConnectionPoolDataSource` object is first instantiated and the pool is initialized. The default is 0.

  Set this property if your application will need many connections when the `ConnectionPoolDataSource` object is first instantiated.

  To obtain the value, call `getIfxCPMInitPoolSize()`.
To set the value, call `setIfxCPMInitPoolSize(int init)`.

- `IFMX_CPM_MAX_CONNECTIONS` lets you specify the maximum number of simultaneous physical connections that the DataSource object can have with the server.
  
The value -1 specifies an unlimited number. The default is -1.
  
To obtain the value, call `getIfxCPMMaxConnections()`.
To set the value, call `setIfxCPMMaxConnections(int limit)`.

- `IFMX_CPM_MIN_POOLSIZE` lets you specify the minimum number of connections to maintain in the pool. See the `IFMX_CPM_MIN_AGELIMIT` parameter for what to do when this minimum number of connections kept in the pool exceeds the age limit. The default is 0.
  
To obtain the value, call `getIfxCPMMinPoolSize()`.
To set the value, call `setIfxCPMMinPoolSize(int min)`.

- `IFMX_CPM_MAX_POOLSIZE` lets you specify the maximum number of connections to maintain in the pool. When the pool reaches this size, all connections return to the server. The default is 50.
  
To obtain the value, call `getIfxCPMMaxPoolSize()`.
To set the value, call `setIfxCPMMaxPoolSize(int max)`.

- `IFMX_CPM_AGELIMIT` lets you specify the time, in seconds, that a free connection is kept in the free connection pool.
  
The default is -1, which means that the free connections are retained until the client terminates.
  
To obtain the value, call `getIfxCPMAgeLimit()`.
To set the value, call `setIfxCPMAgeLimit(long limit)`.

- `IFMX_CPM_MIN_AGELIMIT` lets you specify the additional time, in seconds, that a connection in the free connection pool is retained when no connection requests have been received.
  
Use this setting to reduce resources held in the pool when there are expected periods in which no connection requests will be made. A value of 0 indicates that no additional time is given to a connection in the minimum pool: the connection is released to the server whenever it exceeds `IFMX_CPM_AGELIMIT`. The default is -1, which means that a minimum number of free connections is retained until the client terminates.
  
To obtain the value, call `getIfxCPMMinAgeLimit()`.
To set the value, call `setIfxCPMMinAgeLimit(long limit)`.

- `IFMX_CPM_SERVICE_INTERVAL` lets you specify the pool service frequency, in milliseconds.
  
Pool service activity includes adding free connections (if the number of free connections falls below the minimum value) and removing free connections. The default is 50.
  
To obtain the value, call `getIfxCPSMServiceInterval()`.
To set the value, call `setIfxCPSMServiceInterval (long interval)`.

- `IFMX_CPM_ENABLE_SWITCH_HDRPOOL` lets you specify whether to allow automatic switching between the primary and secondary connection pools of an HDR database server pair.
  
Set this property if your application relies on High-Availability Data Replication with connection pooling. The default is false.
  
To obtain the value, call `getIfxCPMSwitchHDRPool()`.
To set the value, call `setIfxCPMSwitchHDRPool(boolean flag)`.
A demonstration program is available in the connection-pool directory within the demo directory where your JDBC driver is installed. For connection pooling with HDR, a demonstration program is available in the hdr directory within the demo directory. For details about the files, see Appendix A, “Sample code files,” on page A-1.

Some of these properties overlap Sun JDBC 3.0 properties. The following table lists the Sun JDBC 3.0 properties and their Informix equivalents.

<table>
<thead>
<tr>
<th>Sun JDBC property name</th>
<th>Informix property name</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>initialPoolSize</td>
<td>IFMX_CPM_INIT_POOLSIZE</td>
<td></td>
</tr>
<tr>
<td>maxPoolSize</td>
<td>IFMX_CPM_MAX_POOLSIZE</td>
<td>For maxPoolSize, 0 indicates no maximum size. For IFMX_CPM_MAX_POOLSIZE, you must specify a value.</td>
</tr>
<tr>
<td>minPoolSize</td>
<td>IFMX_CPM_MIN_POOLSIZE</td>
<td></td>
</tr>
<tr>
<td>maxIdleTime</td>
<td>IFMX_CPM_AGELIMIT</td>
<td>For maxIdleTime, 0 indicates no time limit. For IFMX_CPM_AGELIMIT, -1 indicates no time limit.</td>
</tr>
</tbody>
</table>

The following Sun JDBC 3.0 properties are not supported:
- maxStatements
- propertyCycle

High-Availability Data Replication with connection pooling

IBM Informix JDBC Driver implementation of connection pooling provides the ability to pool connections with database servers in an HDR pair:
- The primary pool contains connections to the primary server in an HDR pair.
- The secondary pool contains connections to the secondary server in an HDR pair.

You do not have to change application code to take advantage of connection pooling with HDR. Set the IFMX_CPM_ENABLE_SWITCH_HDRPOOL property to TRUE to allow switching between the two pools. When switching is allowed, the Connection Pool Manager validates and activates the appropriate connection pool.

When the primary server fails, the Connection Pool Manager activates the secondary pool. When the secondary pool is active, the Connection Pool Manager validates the state of the pool to check if the primary server is running. If the primary server is running, the Connection Pool Manager switches new connections to the primary server and sets the active pool to the primary pool.

If IFMX_CPM_ENABLE_SWITCH_HDRPOOL is set to FALSE, you can force switching to the other connection pool by calling the activateHDRPool_Primary() or activateHDRPool_Secondary() methods:

```java
public void activateHDRPool_Primary(void) throws SQLException
public void activateHDRPool_Secondary(void) throws SQLException
```

The activateHDRPool_Primary() method switches the primary connection pool to be the active connection pool. The activateHDRPool_Secondary() method switches the secondary connection pool to be the active pool.
You can use the isReadOnly(), isHDREnabled(), and getHDRtype() methods with connection pooling (see "Check for read-only status" on page 2-20).

A demonstration program is available in the hdr directory within the demo directory where IBM Informix JDBC Driver is installed. For details about the files, see Appendix A, “Sample code files,” on page A-1.

### Clean pooled connections

You can alter connections from their original, default properties by setting database properties, such as AUTOCOMMIT and TRANSACTION ISOLATION. When a connection is closed, these properties revert to their default values. However, a pooled connection does not automatically revert to default properties when it is returned to the pool.

In IBM Informix JDBC Driver, you can call the scrubConnection() method to:

- Reset the database properties and connection level properties to the default values.
- Close open cursors and transactions.
- Retain all statements.

This now enables the application server to cache the statements, and it can be used across applications and sessions to provide better performance for end-user applications.

The signature of the scrubConnection() method is:

```java
public void scrubConnection() throws SQLException
```

The following example demonstrates how to call scrubConnection():

```java
try {
    IfmxConnection conn = (IfmxConnection)myConn;
    conn.scrubConnection();
} catch (SQLException e) {
    e.printStackTrace();
}
```

The following method verifies whether a call to scrubConnection() has released all statements:

```java
public boolean scrubConnectionReleasesAllStatements()
```

### Manage connections

The following table contrasts different implementations of the connection.close() and scrubConnection() methods when they are in connection pool setup or not.

<table>
<thead>
<tr>
<th>Connection pooling status</th>
<th>Behavior with connection.close() method</th>
<th>Behavior with scrubConnection() method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-connection pool setup</td>
<td>Closes database connection, all associated statement objects, and their result sets Connection is no longer valid.</td>
<td>Returns connection to default state, keeps opened statements, but closes result sets Connection is still valid. Releases resources associated with result sets only.</td>
</tr>
</tbody>
</table>

Chapter 7. Tuning and troubleshooting 7-7
<table>
<thead>
<tr>
<th>Connection pooling status</th>
<th>Behavior with connection.close() method</th>
<th>Behavior with scrubconnection() method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connection Pool with IBM Informix Implementation</td>
<td>Closes connection to the database and reopens it to close any statements associated with the connection object and reset the connection to its original state. Connection object is then returned to the connection pool and is available when requested by a new application connection.</td>
<td>Returns a connection to the default state and keeps all open statements, but closes all result sets. Calling this method is not recommended here.</td>
</tr>
<tr>
<td>Connection Pool with AppServer Implementation</td>
<td>Defined by users connection pooling implementation</td>
<td>Returns connection to default state and retains opened statements, but closes result sets</td>
</tr>
</tbody>
</table>

**Avoid application hanging problems (HP-UX only)**

If your JDBC application hangs on your HP-UX server, check the setting for the PTHREAD_COMPAT_MODE environment variable on the HP-UX server. The PTHREAD_COMPAT_MODE environment variable should be set to 1. This variable tells the pthread library (libpthread) to run in 1 X 1 mode instead of MxN mode. 1 X 1 is the default mode now on HP-UX. Setting this environment variable should resolve the hang problem.
Appendix A. Sample code files

This section contains tables that list and briefly describe the code examples provided with the client-side version of IBM Informix JDBC Driver.

Most of these examples can be adapted to work with server-side JDBC by changing the syntax of the connection URL. For more information, see “Format of database URLs” on page 2-5.

The examples in the tools/udtudrmgr directory and the demo/xml directory are for client-side JDBC only in the 2.2 release.

Summary of available examples

The examples are provided in two directories:
• The demo directory where your IBM Informix JDBC Driver software is installed
• The tools directory beneath the demo directory

Examples in the demo directory

Each example has its own subdirectory. Most of the directories include a README file that describes the examples and how to run them.

<table>
<thead>
<tr>
<th>Directory</th>
<th>Type of examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>basic</td>
<td>Examples that show common database operations</td>
</tr>
<tr>
<td>clob-blob</td>
<td>Examples that use smart large objects</td>
</tr>
<tr>
<td>udt-distinct</td>
<td>Examples that use opaque and DISTINCT data types (there are additional examples using opaque types in “Examples in the udtudrmgr directory” on page A-8)</td>
</tr>
<tr>
<td>complex-types</td>
<td>Examples that use row and collection types</td>
</tr>
<tr>
<td>rmi</td>
<td>An example using Remote Method Invocation</td>
</tr>
<tr>
<td>stores7</td>
<td>The stores7 demonstration database</td>
</tr>
<tr>
<td>pickaseat</td>
<td>An example using DataSource objects</td>
</tr>
<tr>
<td>connection-pool</td>
<td>Examples that illustrate using a connection pool</td>
</tr>
<tr>
<td>proxy</td>
<td>Examples that illustrate using an HTTP proxy server</td>
</tr>
<tr>
<td>xml</td>
<td>Examples that illustrate storing and retrieving XML documents</td>
</tr>
<tr>
<td>hdr</td>
<td>Examples that illustrate using High-Availability Data Replication</td>
</tr>
</tbody>
</table>
# Examples in the basic directory

The following table lists the files in the basic directory.

<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>autofree.java</td>
<td>Shows how to use the <code>IFX_AUTOFREE</code> environment variable</td>
</tr>
<tr>
<td>BatchUpdate.java</td>
<td>Shows how to send batch updates to the server</td>
</tr>
<tr>
<td>ByteType.java</td>
<td>Shows how to insert into and select from a table that contains a column of data type BYTE</td>
</tr>
<tr>
<td>CallOut1.java</td>
<td>Executes a C function that has an OUT parameter using <code>CallableStatement</code> methods</td>
</tr>
<tr>
<td>CallOut2.java</td>
<td>Executes an SPL function that has an OUT parameter using <code>CallableStatement</code> methods</td>
</tr>
<tr>
<td>CallOut3.java</td>
<td>Executes a C function that has a Boolean OUT parameter using the <code>IfmxCallableStatement.IfRegisterOutParameter</code> method</td>
</tr>
<tr>
<td>CallOut4.java</td>
<td>Executes a C function that has a CLOB type OUT parameter and uses the <code>IfmxCallableStatement.hasOutParameter</code> method</td>
</tr>
<tr>
<td>CreateDB.java</td>
<td>Creates a database called testDB</td>
</tr>
<tr>
<td>DBCENTURYSelect.java</td>
<td>Uses the <code>getString()</code> method to retrieve a date string representation in which the four-digit year expansion is based on the <code>DBCENTURY</code> property value</td>
</tr>
<tr>
<td>DBCENTURYSelect2.java</td>
<td>Retrieves a date string representation in which the four-digit year expansion is based on the <code>DBCENTURY</code> property value using string-to-binary conversion</td>
</tr>
<tr>
<td></td>
<td>Uses the <code>getDate()</code> method to build a <code>java.sql.Date</code> object upon which the date string representation is based</td>
</tr>
<tr>
<td>DBCENTURYSelect3.java</td>
<td>Retrieves a date string representation in which the four-digit year expansion is based on the <code>DBCENTURY</code> property value using string-to-binary conversion</td>
</tr>
<tr>
<td></td>
<td>Uses the <code>getTimestamp()</code> method to build a <code>java.sql.Timestamp</code> object upon which the date string representation is based</td>
</tr>
<tr>
<td>DBCENTURYSelect4.java</td>
<td>Retrieves a date string representation in which the four-digit year expansion is based on the <code>DBCENTURY</code> property value using binary-to-string conversion</td>
</tr>
<tr>
<td></td>
<td>Uses the <code>getDate()</code> method to build a <code>java.sql.Date</code> object upon which the date string representation is based</td>
</tr>
<tr>
<td>Demo program name</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>DBCENTURYSelect5.java</td>
<td>Retrieves a date string representation in which the four-digit year expansion is based on the DBCENTURY property value using binary-to-string conversion. Uses the getTimestamp() method to build a java.sql.Timestamp object upon which the date string representation is based.</td>
</tr>
<tr>
<td>DBConnection.java</td>
<td>Creates connections to both a database and a database server.</td>
</tr>
<tr>
<td>DBDATESelect.java</td>
<td>Shows how to retrieve a date object and a date string representation from the database based on the DBDATE property value from the URL string.</td>
</tr>
<tr>
<td>DBMetaData.java</td>
<td>Shows how to retrieve information about a database with the DatabaseMetaData interface.</td>
</tr>
<tr>
<td>DropDB.java</td>
<td>Drops a database called testDB.</td>
</tr>
<tr>
<td>ErrorHandling.java</td>
<td>Shows how to retrieve RSAM error messages.</td>
</tr>
<tr>
<td>GLDATESelect.java</td>
<td>Shows how to retrieve a date object and a date string representation from the database based on the GL_DATE property value from the URL string.</td>
</tr>
<tr>
<td>Intervaldemo.java</td>
<td>Shows how to insert and select IBM Informix interval data.</td>
</tr>
<tr>
<td>LOCALESelect.java</td>
<td>Shows how to retrieve a date object and a date string representation from the database based on the CLIENT_LOCALE property value from the URL string.</td>
</tr>
<tr>
<td>locmsg.java</td>
<td>Shows how to use Informix extension methods that support localized error messages.</td>
</tr>
<tr>
<td>MultiRowCall.java</td>
<td>Shows how to return multiple rows in a stored procedure call.</td>
</tr>
<tr>
<td>OptimizedSelect.java</td>
<td>Shows how to use the FET_BUF_SIZE environment variable to adjust the IBM Informix JDBC Driver tuple buffer size.</td>
</tr>
<tr>
<td>optofc.java</td>
<td>Shows how to use the OPTOFC environment variable.</td>
</tr>
<tr>
<td>PropertyConnection.java</td>
<td>Shows how to specify connection environment variables via a property list.</td>
</tr>
<tr>
<td>RSMetaData.java</td>
<td>Shows how to retrieve information about a result set with the ResultSetMetaData interface.</td>
</tr>
<tr>
<td>ScrollCursor.java</td>
<td>Shows how to retrieve a result set with a scroll cursor.</td>
</tr>
<tr>
<td>Serial.java</td>
<td>Shows how to insert and select Informix SERIAL and SERIAL8 data.</td>
</tr>
<tr>
<td>SimpleCall.java</td>
<td>Shows how to call a stored procedure.</td>
</tr>
<tr>
<td>SimpleConnection.java</td>
<td>Shows how to connect to a database or database server.</td>
</tr>
<tr>
<td>Demo program name</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>SimpleSelect.java</td>
<td>Shows how to send a simple SELECT query to the database server</td>
</tr>
<tr>
<td>TextConv.java</td>
<td>Shows how to convert a file from the client code set to Unicode and then from Unicode to the database code set</td>
</tr>
<tr>
<td>TextType.java</td>
<td>Shows how to insert into and select from a table that contains a column of data type TEXT</td>
</tr>
<tr>
<td>UpdateCursor1.java</td>
<td>Shows how to create an updatable scroll cursor using a ROWID column in the query</td>
</tr>
<tr>
<td>UpdateCursor2.java</td>
<td>Shows how to create an updatable scroll cursor using a SERIAL column in the query</td>
</tr>
<tr>
<td>UpdateCursor3.java</td>
<td>Shows how to create an updatable scroll cursor using a primary key column in the query</td>
</tr>
</tbody>
</table>

**Examples in the clob-blob directory**

The following table lists the files in the clob-blob directory.

<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>demo1.java</td>
<td>Shows how to create two tables with BLOB and CLOB columns and compare the data</td>
</tr>
<tr>
<td>demo2.java</td>
<td>Shows how to create one table with BYTE and TEXT columns and a second table with BLOB and CLOB columns and how to compare the data</td>
</tr>
<tr>
<td>demo3.java</td>
<td>Shows how to create one table with BLOB and CLOB columns and a second table with BYTE and TEXT columns and how to compare the data</td>
</tr>
<tr>
<td>demo4.java</td>
<td>Shows how to create two tables with BYTE and TEXT columns and compare the data</td>
</tr>
<tr>
<td>demo5.java</td>
<td>Shows how to store data from a file into a BLOB table column</td>
</tr>
<tr>
<td>demo6.java</td>
<td>Shows how to read a portion of the data in a smart large object</td>
</tr>
<tr>
<td>demo_11.java</td>
<td>Shows how to read data from a file into a buffer and write the contents of the buffer into a smart large object</td>
</tr>
<tr>
<td>demo_13.java</td>
<td>Shows how to write data into a smart large object and then insert the smart large object into a table</td>
</tr>
<tr>
<td>demo_14.java</td>
<td>Shows how to fetch smart large object data from a table</td>
</tr>
</tbody>
</table>

**Examples in the udt-distinct directory**

The following table lists the files in the udt-distinct directory (there are additional examples using opaque types in "Examples in the udtudrmgr directory" on page A-8.)
<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>charattrUDT.java</td>
<td>Shows how to implement an opaque fixed-length type using SQLData</td>
</tr>
<tr>
<td>createDB.java</td>
<td>Creates a database that the other udt-distinct demonstration files use</td>
</tr>
<tr>
<td>createTypes.java</td>
<td>Shows how to create opaque and distinct types in the database</td>
</tr>
<tr>
<td>distinct_d1.java</td>
<td>Shows how to create a distinct type without using SQLData</td>
</tr>
<tr>
<td>distinct_d2.java</td>
<td>Shows how to create a second distinct type without using SQLData</td>
</tr>
<tr>
<td>dropDB.java</td>
<td>Drops the database that the other udt-distinct demonstration files use</td>
</tr>
<tr>
<td>largebinUDT.java</td>
<td>Shows how to implement an opaque type (smart large object embedded) using SQLData</td>
</tr>
<tr>
<td>manualUDT.java</td>
<td>Shows how to implement an opaque type that allows you to change the position in the input stream</td>
</tr>
<tr>
<td>myMoney.java</td>
<td>Shows how to implement a distinct type using SQLData</td>
</tr>
<tr>
<td>udt_d1.java</td>
<td>Shows how to create a fixed-length opaque type</td>
</tr>
<tr>
<td>udt_d2.java</td>
<td>Shows how to create an opaque type with an embedded smart large object</td>
</tr>
<tr>
<td>udt_d3.java</td>
<td>Shows how to create an opaque type that allows you to change the position in the input stream</td>
</tr>
</tbody>
</table>

**Examples in the complex-types directory**

The following table lists the files in the complex-types directory.

<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>createDB.java</td>
<td>Creates a database with named rows</td>
</tr>
<tr>
<td>list1.java</td>
<td>Inserts and selects a simple collection using both the java.sql.Array and java.util.Collection classes</td>
</tr>
<tr>
<td>list2.java</td>
<td>Inserts and selects a collection with a nested row element</td>
</tr>
<tr>
<td></td>
<td>Uses both the java.sql.Array and java.util.Collection classes for the collection and both the SQLData and Struct interfaces for the nested row</td>
</tr>
<tr>
<td>r1_t.java</td>
<td>Defines the SQLData class for named row r1_t</td>
</tr>
<tr>
<td>r2_t.java</td>
<td>Defines the SQLData class for named row r2_t</td>
</tr>
<tr>
<td>GenericStruct.java</td>
<td>Instantiates a java.sql.Struct object for inserting into named or unnamed rows</td>
</tr>
<tr>
<td>Demo program name</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>row1.java</td>
<td>Inserts and selects a simple named row using both the SQLData and Struct interfaces</td>
</tr>
<tr>
<td>row2.java</td>
<td>Inserts and selects a named row with a nested collection using both the SQLData and Struct interfaces</td>
</tr>
<tr>
<td></td>
<td>The SQLData interface uses the IBM Informix IfmxComplexSQLOutput.writeObject() and IfmxComplexSQLOutput.readObject() extension methods to write and read the nested collection.</td>
</tr>
<tr>
<td>row3.java</td>
<td>Inserts and selects an unnamed row with a nested collection</td>
</tr>
<tr>
<td>fullname.java</td>
<td>Contains the SQLData class for the named row fullname_t</td>
</tr>
<tr>
<td></td>
<td>Used by the demo1.java and demo2.java files</td>
</tr>
<tr>
<td>person.java</td>
<td>Contains the SQLData class for the named row person_t Used by the demo1.java and demo2.java files</td>
</tr>
<tr>
<td>demo1.java</td>
<td>Fetches a named row into an SQLData object</td>
</tr>
<tr>
<td>demo2.java</td>
<td>Inserts an SQLData object into a named row column</td>
</tr>
<tr>
<td>demo3.java</td>
<td>Fetches an unnamed row column into a Struct object</td>
</tr>
<tr>
<td>demo4.java</td>
<td>Inserts a Struct object into a named row column</td>
</tr>
<tr>
<td>demo5.java</td>
<td>Fetches an Informix SET column into a java.util.HashSet object</td>
</tr>
<tr>
<td>demo6.java</td>
<td>Fetches an Informix SET column into a java.util.TreeSet object</td>
</tr>
<tr>
<td></td>
<td>A customized type mapping is provided to override the default.</td>
</tr>
<tr>
<td>demo7.java</td>
<td>Inserts a java.util.HashSet object into an Informix SET column</td>
</tr>
<tr>
<td>demo8.java</td>
<td>Fetches an Informix SET column into a java.sql.Array object</td>
</tr>
<tr>
<td>dropDB.java</td>
<td>Drops the database</td>
</tr>
</tbody>
</table>

**Examples in the proxy directory**

The following table lists the files in the proxy directory. A README file in the directory contains setup information.
<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
</table>
| ProxySelect.java  | (application) Creates a sample database and connects to it using four scenarios:  
|                   | • Connection with a proxy server and no LDAP server  
|                   | • Connection with an LDAP server and no proxy server  
|                   | • Connection using an sqlhosts file  
|                   | • Direct connection (no proxy servlet, sqlhosts file, or LDAP server) |
| proxy.sh          | (shell script) Launches ProxySelect.java. To run the script (and the demo), type:  
|                   | proxy.sh -d ProxySelect -s 2 |
| proxy.java        | (applet) Performs the same operations as ProxySelect.java from an applet. To run the applet, type:  
|                   | appletviewer proxy.html |
| proxy.html        | HTML file for proxy.java |
| ifmx.conf          | Sample LDAP configuration file |
| ifmx.ldif          | Sample LDAP ldif file |

### Examples in the connection-pool directory

The following table lists the files in the connection-pool directory. A README file in the directory contains setup information.

<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AppSimulator.java</td>
<td>Simulates multiple client threads making DataSource connections</td>
</tr>
<tr>
<td>SetupDB.java</td>
<td>Creates and populates a sample database. See the comments at the beginning of the code for a sample run command</td>
</tr>
<tr>
<td>DS_Pool.prop</td>
<td>Lists properties for a connection-pooling application</td>
</tr>
<tr>
<td>myCPDS.prop</td>
<td>Lists properties for a connection-pooling application, with the optional tuning parameters included</td>
</tr>
<tr>
<td>DS_no_Pool.prop</td>
<td>Lists properties for an application without connection pooling</td>
</tr>
</tbody>
</table>
| Register.java     | Registers a DataSource object with a JNDI Name registry  
|                   | A sample run command is:  
|                   | java Register DS_no_Pool /tmp |
| runDemo           | (Shell script) Creates and populates a sample database; registers the data sources DS_no_Pool and DS_Pool; and runs an application to simulate multiple client threads that connect to the sample database |
Examples in the xml directory

The following table lists the files in the xml directory.

<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CreateDB.java</td>
<td>Creates a sample database</td>
</tr>
<tr>
<td>makefile</td>
<td>Compiles the examples</td>
</tr>
<tr>
<td>myHandler.java</td>
<td>Sample class of callback routines for the SAX parser</td>
</tr>
<tr>
<td>sample1.xml</td>
<td>Simple XML slide</td>
</tr>
<tr>
<td>sample2.xml</td>
<td>Sample set of XML slides</td>
</tr>
<tr>
<td>sample2.dtd</td>
<td>Document-type definition for sample1.xml</td>
</tr>
<tr>
<td>xmldemo1.java</td>
<td>Uses XMLtostring(), getInputSource(), and myHandler.java to convert the XML in sample1.xml to an InputSource object and then parses it using the SAX parser</td>
</tr>
</tbody>
</table>

Examples in the hdr directory

The following table lists the files in the hdr directory. A README file in the directory contains setup information.

<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SetupDB.java</td>
<td>Creates a sample database and table</td>
</tr>
<tr>
<td>Register.java</td>
<td>Registers the DS_no_Pool and DS_Pool DataSource objects with a JNDI Name registry. A sample run command is: java Register DS_no_Pool /tmp</td>
</tr>
<tr>
<td>AppSimulator.java</td>
<td>Simulates High-Availability Data Replication redirection for pooled and nonpooled connections made with the DataSource.getConnection() method</td>
</tr>
<tr>
<td>HdrSimpleConnect.java</td>
<td>Shows how to implement HDR redirection with the DriverManager.getConnection() method</td>
</tr>
</tbody>
</table>

Examples in the tools directory

The tools directory includes the following subdirectories:
- The udtudrmgr directory contains examples that use UDT and UDR Manager to create opaque types and UDRs.
- The classgenerator directory contains sample output files of the ClassGenerator utility.

Examples in the udtudrmgr directory

The following table lists the files in the udtudrmgr directory. A README file in the directory contains setup information.

<table>
<thead>
<tr>
<th>Demo program name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>createDB.java</td>
<td>Creates a sample database</td>
</tr>
<tr>
<td>Demo program name</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>dropDB.java</td>
<td>Drops the sample database</td>
</tr>
<tr>
<td>Circle.java</td>
<td>(Demo application 1) Implements a Java class, using the default Input and Output functions, to be converted to a Java opaque type</td>
</tr>
<tr>
<td>PlayWithCircle.java</td>
<td>(Demo application 1) Uses the Circle opaque type in a client application</td>
</tr>
<tr>
<td>Circle2.java</td>
<td>(Demo application 2) Implements a Java class, with user-supplied Input and Output functions, to be converted to a Java opaque type</td>
</tr>
<tr>
<td>PlayWithCircle2.java</td>
<td>(Demo application 2) Uses the Circle2 opaque type in a client application</td>
</tr>
<tr>
<td>MyCircle.java</td>
<td>(Demo application 3) Creates a fixed-length opaque type without a preexisting Java class</td>
</tr>
<tr>
<td>Group1.java</td>
<td>(Demo application 4) Maps methods in an existing Java class to Java UDRs</td>
</tr>
<tr>
<td>PlayWithGroup1.java</td>
<td>(Demo application 4) Uses the UDRs from Group1.java in a client application</td>
</tr>
</tbody>
</table>
Appendix B. DataSource extensions

This section lists the IBM Informix extensions to standard JDBC classes:

- The `IfxDataSource` class, which implements the `DataSource` interface
- The `IfxConnectionPoolDataSource` class, which implements the `ConnectionPoolDataSource` interface

For information about how and why to use a `DataSource` or `ConnectionPoolDataSource` object, see the JDBC 3.0 API.

IBM Informix JDBC Driver provides extensions for the following purposes:

- Reading and writing properties
- Getting and setting standard properties
- Getting and setting Informix connection properties
- Getting and setting Connection Pool DataSource properties

Read and write properties

The following methods are defined in the extended `DataSource` interface for reading and writing properties. These methods allow you to define a new `DataSource` object by editing the property list of an existing `DataSource` object.

```plaintext
public Properties getDsProperties();

Returns the Property object contained in the DataSource object

public void addProp(String key, Object value);

Adds a property to the property list

The key parameter specifies which property is to be added.

The value parameter is the value of the property.

public Object getProp(String key);

Gets the value of a property from the property list

The key parameter specifies which property is to be retrieved.

public void removeProperty(String key);

Removes a property from the property list

The key parameter specifies which property is to be removed.

public void readProperties(InputStream in) throws IOException;

Reads properties into a DataSource object from an InputStream object

The in parameter is the InputStream object from which the properties are to be read.

An exception occurs when an I/O error is encountered while reading from the input stream.
public void writeProperties(OutputStream out) throws IOException;

Writes the properties of the DataSource object to an OutputStream object

The out parameter is the OutputStream object to which the properties are to be written.

An exception occurs when an I/O error is encountered while writing to the output stream.

Get and set standard properties

The following methods are defined in the extended DataSource interface for getting and setting properties defined in the JDBC 3.0 API.

<table>
<thead>
<tr>
<th>Property</th>
<th>getXXX() and setXXX() method signatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>portNumber</td>
<td>public int getPortNumber(); public void setPortNumber(int value);</td>
</tr>
<tr>
<td>databaseName</td>
<td>public String getDatabaseName(); public void setDatabaseName(String value);</td>
</tr>
<tr>
<td>serverName</td>
<td>public String getServerName(); public void setServerName(String value);</td>
</tr>
<tr>
<td>user</td>
<td>public String getUser(); public void setUser(String value);</td>
</tr>
<tr>
<td>password</td>
<td>public String getPassword(); public void setPassword(String value);</td>
</tr>
<tr>
<td>description</td>
<td>public String getDescription(); public void setDescription(String value);</td>
</tr>
<tr>
<td>dataSourceName</td>
<td>public String getDataSourceName(); public void setDataSourceName(String value);</td>
</tr>
</tbody>
</table>

The networkProtocol and roleName properties are not supported by IBM Informix JDBC Driver.

Get and set Informix connection properties

The following methods are defined in the extended DataSource interface for getting and setting IBM Informix environment variable values.

| Environment variable | getIfxXXX() and setIfxXXX() method signatures                  |
|----------------------|-----------------------------------------------------------------
<p>| CLIENT_LOCALE        | public String getIfxCLIENT_LOCALE() public void setIfxCLIENT_LOCALE(String value) |
| CSM                  | public String getIfxCSM() public void setIfxCSM(String csm)     |
| DBANSIWARN           | public boolean isIfxDBANSIWARN() public void setIfxDBANSIWARN(boolean value) |
| DBCENTURY            | public String getIfxDBCENTURY() public void setIfxDBCENTURY(String value) |
| DBDATE               | public String getIfxDBDATE() public void setIfxDBDATE(String value) |</p>
<table>
<thead>
<tr>
<th>Environment variable</th>
<th>getIfxXXX() and setIfxXXX() method signatures</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB_LOCALE</td>
<td>public String getIfxDB_LOCALE() public void setIfxDB_LOCALE(String value)</td>
</tr>
<tr>
<td>DBSPACETEMP</td>
<td>public String getIfxDBSPACETEMP() public void setIfxDBSPACETEMP(String value)</td>
</tr>
<tr>
<td>DBTEMP</td>
<td>public String getIfxDBTEMP() public void setIfxDBTEMP(String value)</td>
</tr>
<tr>
<td>DBUPSPACE</td>
<td>public String getIfxDBUPSPACE() public void setIfxDBUPSPACE(String value)</td>
</tr>
<tr>
<td>DELIMIDENT</td>
<td>public boolean isIfxDELIMIDENT() public void setIfxDELIMIDENT(boolean value)</td>
</tr>
<tr>
<td>ENABLE_CACHE_TYPE</td>
<td>public boolean isIfxENABLE_CACHE_TYPE() public void setIfxENABLE_CACHE_TYPE(boolean value)</td>
</tr>
<tr>
<td>ENABLE_HDRSWITCH</td>
<td>public boolean getIfxENABLE_HDRSWITCH() public void setIfxENABLE_HDRSWITCH(boolean value)</td>
</tr>
<tr>
<td>FET_BUF_SIZE</td>
<td>public int getIfxFET_BUF_SIZE() public void setIfxFET_BUF_SIZE(int value)</td>
</tr>
<tr>
<td>GL_DATE</td>
<td>public String getIfxGL_DATE() public void setIfxGL_DATE(String value)</td>
</tr>
<tr>
<td>IFX_AUTOFREE</td>
<td>public boolean isIfxIFX_AUTOFREE() public void setIfxIFX_AUTOFREE(boolean value)</td>
</tr>
<tr>
<td>IFX_CODESETLOB</td>
<td>public int getIfxIFX_CODESETLOB() public void setIfxIFX_CODESETLOB(int codesetlobFlag)</td>
</tr>
<tr>
<td>IFX_DIRECTIVES</td>
<td>public String getIfxIFX_DIRECTIVES() public void setIfxIFX_DIRECTIVES(String value)</td>
</tr>
<tr>
<td>IFX_EXTDIRECTIVES</td>
<td>public String getIfxIFX_EXTDIRECTIVES() public void setIfxIFX_EXTDIRECTIVES(String value)</td>
</tr>
<tr>
<td>IFX_FLAT_UCSQ</td>
<td>public int getIfxIFX_FLAT_UCSQ() public void setIfxIFX_FLAT_UCSQ(int value)</td>
</tr>
<tr>
<td>IFX_GET_SMFLOAT_AS_FLOAT</td>
<td>public boolean getIfxIFX_GET_SMFLOAT_AS_FLOAT() public void setIfxIFX_IFX_GET_SMFLOAT_AS_FLOAT(boolean value)</td>
</tr>
<tr>
<td>IFX_ISOLATION_LEVEL</td>
<td>public String getIfxIFX_ISOLATION_LEVEL() public void setIfxIFX_ISOLATION_LEVEL(String iso_level)</td>
</tr>
<tr>
<td>IFX_LOCK_MODE_WAIT</td>
<td>public int getIfxIFX_LOCK_MODE_WAIT() public void setIfxIFX_LOCK_MODE_WAIT(int lock_time)</td>
</tr>
<tr>
<td>IFX_SET_FLOAT_AS_SMFLOAT</td>
<td>public boolean getIfxIFX_SET_FLOAT_AS_SMFLOAT() public void setIfxIFX_SET_FLOAT_AS_SMFLOAT(boolean value)</td>
</tr>
<tr>
<td>IFX_TRIMTRAILINGSPACES</td>
<td>public int getIfxIFX_TRIMTRAILINGSPACES() public void setIfxIFX_TRIMTRAILINGSPACES(int value)</td>
</tr>
<tr>
<td>IFXHOST</td>
<td>public String getIfxIFXHOST() public void setIfxIFXHOST(String value)</td>
</tr>
<tr>
<td>IFXHOST_SECONDARY</td>
<td>public String getIfxIFXHOST_SECONDARY() public void setIfxIFXHOST_SECONDARY(String value)</td>
</tr>
<tr>
<td>IFX_USEPUT</td>
<td>public boolean isIfxIFX_USEPUT() public void setIfxIFX_USEPUT(boolean value)</td>
</tr>
<tr>
<td>IFX_XASPEC</td>
<td>public String getIfxIFX_XASPEC() (returns y or n) public void setIfxIFX_XASPEC(String XASPEC_flag) (only y, Y, n, or N are valid)</td>
</tr>
<tr>
<td>Environment variable</td>
<td>getIfxXXX() and setIfxXXX() method signatures</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| IFX_XASTDCOMPLIANCE_XAEND      | public int getIfxIFX_XASTDCOMPLIANCE_XAEND()  
|                                 | public void setIfxIFX_XASTDCOMPLIANCE_XAEND(int value)                                                       |
| INFORMIXCONRETRY               | public int getIfxINFORMIXCONRETRY()  
|                                 | public void setIfxINFORMIXCONRETRY(int value)                                                                |
| INFORMIXCONTIME                | public int getIfxINFORMIXCONTIME()  
|                                 | public void setIfxINFORMIXCONTIME(int value)                                                                |
| INFORMIXOPCACHE                | public String getIfxINFORMIXOPCACHE()  
|                                 | public void setIfxINFORMIXOPCACHE(String value)                                                              |
| INFORMIXSERVER_SECONDARY       | public String getIfxINFORMIXSERVER_SECONDARY()  
|                                 | public void setIfxINFORMIXSERVER_SECONDARY(String value)                                                      |
| INFORMIXSTACKSIZE              | public int getIfxINFORMIXSTACKSIZE()  
|                                 | public void setIfxINFORMIXSTACKSIZE(int value)                                                               |
| JDBCTEMP                       | public String getIfxJDBCTEMP()  
|                                 | public void setIfxJDBCTEMP(String value)                                                                     |
| LDAP_IFXBASE                   | public String getIfxLDAP_IFXBASE()  
|                                 | public void setIfxLDAP_IFXBASE(String value)                                                                |
| LDAP_PASSWD                    | public String getIfxLDAP_PASSWD()  
|                                 | public void setIfxLDAP_PASSWD(String value)                                                                 |
| LDAP_URL                       | public String getIfxLDAP_URL()  
|                                 | public void setIfxLDAP_URL(String value)                                                                    |
| LDAP_USER                      | public String getIfxLDAP_USER()  
|                                 | public void setIfxLDAP_USER(String value)                                                                   |
| LOBCACHE                       | public int getIfxLOBCACHE()  
|                                 | public void setIfxLOBCACHE(int value)                                                                       |
| NEWCODESET                     | public String getIfxNEWCODESET()  
|                                 | public void setIfxNEWCODESET(String value)                                                                  |
| NEWLOCALE                      | public String getIfxNEWLOCALE()  
|                                 | public void setIfxNEWLOCALE(String value)                                                                   |
| NEWNLSMAP                      | public String getIfxNEWNLSMAP()  
|                                 | public void setIfxNEWNLSMAP(String value)                                                                   |
| NODEFDAC                       | public String getIfxNODEFDAC()  
|                                 | public void setIfxNODEFDAC(String value)                                                                    |
| OPT_GOAL                       | public String getIfxOPT_GOAL()  
|                                 | public void setIfxOPT_GOAL(String value)                                                                    |
| OPTCOMPIND                     | public String getIfxOPTCOMPIND()  
|                                 | public void setIfxOPTCOMPIND(String value)                                                                   |
| OPTOFC                         | public String getIfxOPTOFC()  
|                                 | public void setIfxOPTOFC(String value)                                                                       |
| PATH                           | public String getIfxPATH()  
|                                 | public void setIfxPATH(String value)                                                                        |
| PDQPRIORITY                    | public String getIfxPDQPRIORITY()  
|                                 | public void setIfxPDQPRIORITY(String value)                                                                  |
| PLCONFIG                       | public String getIfxPLCONFIG()  
|                                 | public void setIfxPLCONFIG(String value)                                                                     |
| PLOAD_LO_PATH                  | public String getIfxPLOAD_LO_PATH()  
|                                 | public void setIfxPLOAD_LO_PATH(String value)                                                                |
| PORTNO_SECONDARY               | public String getIfxPORTNO_SECONDARY  
<p>|                                 | public void setIfxPORTNO_SECONDARY(int value)                                                                |</p>
<table>
<thead>
<tr>
<th>Environment variable</th>
<th>getIfxXXX() and setIfxXXX() method signatures</th>
</tr>
</thead>
</table>
| PROXY                  | public String getIfxPROXY()  
|                        | public void setIfxPROXY(String value)                                                                      |
| PSORT_DBTEMP           | public String getIfxPSORT_DBTEMP()  
|                        | public void setIfxPSORT_DBTEMP(String value)                                                                |
| PSORT_NPROCS           | public String getIfxPSORT_NPROCS()  
|                        | public void setIfxPSORT_NPROCS(String value)                                                                |
| SECURITY               | public String getIfxSECURITY()  
|                        | public void setIfxSECURITY(String value)                                                                   |
| SQLH_FILE              | public String getIfxSQLH_FILE()  
|                        | public void setIfxSQLH_FILE(String value)                                                                   |
| SQLH_TYPE              | public String getIfxSQLH_TYPE()  
|                        | public void setIfxSQLH_TYPE(String value)                                                                   |
| SQLDEBUG               | public String getIfxSQLDEBUG()  
|                        | public void setIfxSQLDEBUG(String value)                                                                   |
| STMT_CACHE             | public String getIfxSTMT_CACHE()  
|                        | public void setIfxSTMT_CACHE(String value)                                                                   |
| USEV5SERVER            | public boolean isIfxUSEV5SERVER()  
|                        | public void setIfxUSEV5SERVER(boolean value)                                                                |

### Get and set connection pool DataSource properties

The code you write to use a `ConnectionPoolDataSource` object is the same as the code you write to use a `DataSource` object. Additional tuning parameters let you or your database administrator control some aspects of connection pool management with the Connection Pool Manager. These are more fully described in “A connection pool” on page 7-3. The following table summarizes them.

<table>
<thead>
<tr>
<th>Property</th>
<th>getXXX() and setXXX() method signatures</th>
</tr>
</thead>
</table>
| IFMX_CPM_ENABLE_SWITCH_HDRPOOL               | public void setIfxCPMSwitchHDRPool(boolean flag)  
|                                               | public int getIfxCPMSwitchHDRPool()                                                                       |
| IFMX_CPM_INIT_POOLSIZE                        | public void setIfxCPMInitPoolSize(int init)  
|                                               | public int getIfxCPMInitPoolSize()                                                                       |
| IFMX_CPM_MAX_CONNECTIONS                      | public void setIfxCPMMaxConnections(int limit)  
|                                               | public int getIfxCPMMaxConnections()                                                                     |
| IFMX_CPM_MIN_POOLSIZE                         | public void setIfxCPMMinPoolSize(int min)  
|                                               | public int getIfxCPMMinPoolSize()                                                                       |
| IFMX_CPM_MAX_POOLSIZE                         | public void setIfxCPMMaxPoolSize(int max)  
|                                               | public int getIfxCPMMaxPoolSize()                                                                       |
| IFMX_CPM_MIN_AGELIMIT                         | public void setIfxCPMMinAgeLimit(long limit)  
|                                               | public long getIfxCPMMinAgeLimit()                                                                      |
| IFMX_CPM_MAX_AGELIMIT                         | public void setIfxCPMMaxAgeLimit(long limit)  
|                                               | public long getIfxCPMMaxAgeLimit()                                                                      |
| IFMX_CPM_SERVICE_INTERVAL                     | public void setIfxCPMServiceInterval(long interval)  
|                                               | public long getIfxCPMServiceInterval()                                                                   |
Appendix C. Mapping data types

This section discusses mapping issues between data types defined in a Java program and the data types supported by the IBM Informix database server.

Data type mapping between Informix and JDBC data types

Because there are variations between the SQL data types supported by each database vendor, the JDBC API defines a set of generic SQL data types in the class java.sql.Types. Use these JDBC API data types to reference generic SQL types in your Java programs that use the JDBC API to connect to IBM Informix databases.

The following table shows the Informix data type to which each JDBC API data type maps.

<table>
<thead>
<tr>
<th>JDBC API data type</th>
<th>Informix data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIGINT</td>
<td>INT8, BIGINT, BIGSERIAL</td>
</tr>
<tr>
<td>BINARY</td>
<td>BYTE</td>
</tr>
<tr>
<td>BIT ¹</td>
<td>BOOLEAN</td>
</tr>
<tr>
<td>REF</td>
<td>Not supported</td>
</tr>
<tr>
<td>CHAR</td>
<td>CHAR(n)</td>
</tr>
<tr>
<td>DATE</td>
<td>DATE</td>
</tr>
<tr>
<td>DECIMAL</td>
<td>DECIMAL</td>
</tr>
<tr>
<td>DOUBLE</td>
<td>FLOAT</td>
</tr>
<tr>
<td>FLOAT</td>
<td>FLOAT²</td>
</tr>
<tr>
<td>INTEGER</td>
<td>INTEGER</td>
</tr>
<tr>
<td>LONGVARBINARY</td>
<td>BYTE or BLOB</td>
</tr>
<tr>
<td>LONGVARCHAR</td>
<td>TEXT or CLOB</td>
</tr>
<tr>
<td>NUMERIC</td>
<td>DECIMAL</td>
</tr>
<tr>
<td>NUMERIC</td>
<td>MONEY</td>
</tr>
<tr>
<td>REAL</td>
<td>SMALLFLOAT</td>
</tr>
<tr>
<td>SMALLINT</td>
<td>SMALLINT</td>
</tr>
<tr>
<td>TIME</td>
<td>DATETIME HOUR TO SECOND²</td>
</tr>
<tr>
<td>TIMESTAMP</td>
<td>DATETIME YEAR TO FRACTION(5)³</td>
</tr>
<tr>
<td>TINYINT</td>
<td>SMALLINT</td>
</tr>
<tr>
<td>VARBINARY</td>
<td>BYTE</td>
</tr>
<tr>
<td>VARCHAR</td>
<td>VARCHAR(n,r)</td>
</tr>
<tr>
<td>BOOLEAN</td>
<td>BOOLEAN</td>
</tr>
<tr>
<td>SMALLINT</td>
<td>SMALLINT</td>
</tr>
</tbody>
</table>

¹ With Java 1.4 is, java.sql.Types.BOOLEAN maps to BOOLEAN.
This mapping is JDBC compliant. You can map the JDBC FLOAT data type to the Informix SMALLFLOAT data type for backward compatibility by setting the `IFX_SET_FLOAT_AS_SMFLOAT` environment variable to 1.

Informix DATETIME types are very restrictive and are not interchangeable. For more information, see "Field lengths and date-time data" on page C-18.

Data type mapping between extended types and Java and JDBC types

The following table lists mappings between the extended data types supported in IBM Informix and the corresponding Java and JDBC types.

<table>
<thead>
<tr>
<th>JDBC type</th>
<th>Java object type</th>
<th>Informix type</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.sql.Types.LONGVARCHAR</td>
<td>java.sql.String</td>
<td>LVARCHAR IfxTypes.IFX_TYPE_LVARCHAR</td>
</tr>
<tr>
<td>java.sql.Types.LONGVARCHAR</td>
<td>java.io.InputStream</td>
<td>LVARCHAR IfxTypes.IFX_TYPE_LVARCHAR</td>
</tr>
<tr>
<td>java.sql.Types.JAVA_OBJECT</td>
<td>java.sql.SQLData</td>
<td>Opaque type IfxTypes.IFX_TYPE_UDTFIXED IfxTypes.IFX_TYPE_UDTVAR</td>
</tr>
<tr>
<td>java.sql.Types.LONGVARBINARY</td>
<td>java.sql.Blob</td>
<td>BLOB IfxTypes.IFX_TYPE_BLOB</td>
</tr>
<tr>
<td>java.sql.Types.BLOB</td>
<td>java.io.InputStream</td>
<td>BLOB IfxTypes.IFX_TYPE_BLOB</td>
</tr>
<tr>
<td>java.sql.Types.LONGVARBINARY</td>
<td>java.lang.String</td>
<td>CLOB IfxTypes.IFX_TYPE_CLOB</td>
</tr>
<tr>
<td>java.sql.Types.CLOB</td>
<td>java.io.InputStream</td>
<td>CLOB IfxTypes.IFX_TYPE_CLOB</td>
</tr>
<tr>
<td>java.sql.Types.CLOB</td>
<td>java.sql.InputStream</td>
<td>CLOB IfxTypes.IFX_TYPE_CLOB</td>
</tr>
<tr>
<td>java.sql.Types.LONGVARBINARY</td>
<td>java.sql.InputStream</td>
<td>CLOB IfxTypes.IFX_TYPE_CLOB</td>
</tr>
<tr>
<td>java.sql.Types.BLOB</td>
<td>java.sql.InputStream</td>
<td>CLOB IfxTypes.IFX_TYPE_CLOB</td>
</tr>
<tr>
<td>java.sql.Types.LONGVARBINARY</td>
<td>java.sql.InputStream</td>
<td>CLOB IfxTypes.IFX_TYPE_CLOB</td>
</tr>
<tr>
<td>java.sql.Types.BLOB</td>
<td>java.sql.InputStream</td>
<td>CLOB IfxTypes.IFX_TYPE_CLOB</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.sql.Array</td>
<td>set, multiset IfxTypes.IFX_TYPE_SET IfxTypes.IFX_TYPE_MULTISET</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.LinkedList</td>
<td>set, multiset IfxTypes.IFX_TYPE_SET IfxTypes.IFX_TYPE MULTISET</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.List</td>
<td>LIST IfxTypes.IFX_TYPE_LIST</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.LinkedList</td>
<td>LIST IfxTypes.IFX_TYPE_LIST</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.List</td>
<td>LIST IfxTypes.IFX_TYPE_LIST</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.LinkedList</td>
<td>LIST IfxTypes.IFX_TYPE_LIST</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.TreeSet</td>
<td>LIST IfxTypes.IFX_TYPE_LIST</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.TreeSet</td>
<td>LIST IfxTypes.IFX_TYPE_LIST</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.List</td>
<td>LIST IfxTypes.IFX_TYPE_LIST</td>
</tr>
<tr>
<td>java.sql.Types.ARRAY</td>
<td>java.util.LinkedList</td>
<td>LIST IfxTypes.IFX_TYPE_LIST</td>
</tr>
</tbody>
</table>

A Java boolean object can map to an Informix smallint data type or an Informix boolean data type. IBM Informix JDBC Driver attempts to map it according to the column type. However, in cases such as PreparedStatement host variables, IBM Informix JDBC Driver cannot access the column types, so the mapping is somewhat limited. For more details on data type mapping, see "Data type mapping for PreparedStatement.setXXX() extensions" on page C-3.
Data type mapping between C opaque types and Java

To create an opaque type using Java, you can use the UDT and UDR Manager facility. For more information, see Chapter 5, “Work with opaque types,” on page 5-1.

All opaque data is stored in the database server table in a C struct, which is made up of various DataBlade API types, as defined in the opaque type. (For more information, see the IBM Informix DataBlade API Programmer’s Guide.)

The following table lists the mapping of DataBlade API types to their corresponding Java types.

<table>
<thead>
<tr>
<th>DataBlade API type</th>
<th>Java type</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI_LO_HANDLE</td>
<td>BLOB or CLOB</td>
</tr>
<tr>
<td>gl_wchar_t</td>
<td>String</td>
</tr>
<tr>
<td>mi_boolean</td>
<td>boolean</td>
</tr>
<tr>
<td>mi_char</td>
<td>String</td>
</tr>
<tr>
<td>mi_char1</td>
<td>String</td>
</tr>
<tr>
<td>mi_date</td>
<td>Date</td>
</tr>
<tr>
<td>mi_datetime</td>
<td>TimeStamp</td>
</tr>
<tr>
<td>mi_decimal</td>
<td>BigDecimal</td>
</tr>
<tr>
<td>mi_double_precision</td>
<td>double</td>
</tr>
<tr>
<td>mi_int1</td>
<td>byte</td>
</tr>
<tr>
<td>mi_int8</td>
<td>long</td>
</tr>
<tr>
<td>mi_integer</td>
<td>int</td>
</tr>
<tr>
<td>mi_interval</td>
<td>Not supported</td>
</tr>
<tr>
<td>mi_money</td>
<td>BigDecimal</td>
</tr>
<tr>
<td>mi_numeric</td>
<td>BigDecimal</td>
</tr>
<tr>
<td>mi_real</td>
<td>float</td>
</tr>
<tr>
<td>mi_smallint</td>
<td>short</td>
</tr>
<tr>
<td>mi_string</td>
<td>String</td>
</tr>
<tr>
<td>mi_unsigned_char1</td>
<td>String</td>
</tr>
<tr>
<td>mi_unsigned_int8</td>
<td>long</td>
</tr>
<tr>
<td>mi_unsigned_integer</td>
<td>int</td>
</tr>
<tr>
<td>mi_unsigned_smallint</td>
<td>short</td>
</tr>
<tr>
<td>mi_wchar</td>
<td>String</td>
</tr>
</tbody>
</table>

The C struct may contain padding bytes. IBM Informix JDBC Driver automatically skips these padding bytes to make sure the next data member is properly aligned. Therefore, your Java objects do not have to take care of alignment themselves.

Data type mapping for PreparedStatement.setXXX() extensions

IBM Informix introduces many extended data types. As a result, there can be multiple mappings between a JDBC or Java data type and the corresponding Informix data type.
For example, you can use PreparedStatement.setAsciiStream() to insert into either a

text column or a CLOB column. Similarly, you can also use

PreparedStatement.setBinaryStream() to insert into a byte column or a BLOB
column. Because the actual column information is not available to IBM Informix

JDBC Driver at all times, there can be ambiguity for the driver when it maps data
types.

Normally, with INSERT, SELECT, or DELETE statements, the column information

is available to the driver, so the driver can determine how the data can be sent to
the database server.

However, when the data is referenced in an UPDATE statement or inside a

WHERE clause, IBM Informix JDBC Driver does not have access to the column
information. In those cases, unless you use the Informix extensions, the driver
maps those columns using the corresponding Informix data types listed in the first

table in "Data type mapping between Informix and JDBC data types" on page C-1.

For the PreparedStatement.setAsciiStream() method, the driver tries to map to a
text data type, and for the PreparedStatement.setBinaryStream() method, it tries to
map to a byte data type.

The mapping extensions

To direct the driver to map to a certain data type (so there is no ambiguity in

UPDATE statements and WHERE clauses), you can use extensions to the

PreparedStatement.setXXX() methods. The only data types that might have
ambiguity are boolean, lvarchar, text, byte, BLOB, and CLOB.

To use these extended methods, you must cast your PreparedStatement references
to IfmxPreparedStatement. For example, the following code casts the statement
variable p_stmt to IfmxPreparedStatement to call the IfxSetObject() method and
insert the contents of a file as a large object of type CLOB. IfxSetObject() is defined
as I:

```java
public void IfxSetObject(int i, Object x, int scale, int ifxType)
    throws SQLException
public void IfxSetObject(int i, Object x, int ifxType) throws
    SQLException
```

The code is:

```java
File file = new File("sblob_06.dat");
int fileLength = (int)file.Length();
byte[] buffer = new byte[fileLength];
FileInputStream fin = new FileInputStream(file);
fin.read(buffer,0,fileLength);
String str = new String(buffer);

writeOutputFile("Prepare");
PreparedStatement p_stmt = myConn.prepareStatement
    ("insert into sblob_t20(c1) values(?)");

writeOutputFile("IfxSetObject");
((IfmxPreparedStatement)p_stmt).IfxSetObject(1,str,30,IfxTypes.IFX
    _TYPE_CLOB);
```

For the IfmxPreparedStatement.IfxSetObject extension, you cannot simply
overload the method signature with an added ifxType parameter, because such
overloading creates method ambiguity. You must name the method to IfxSetObject
instead.
The extensions for opaque types

The extensions for processing opaque types allow your application to specify the return type to which the database server should cast the opaque type before returning it to the client. This is known as **prebinding** the return value. The methods are:

- **setBindColType()**, which allows applications to specify the output type of result-set values using standard JDBC data types from `java.sql.Types`
- **setBindColIfxType()**, which allows applications to specify the output type of result-set values using IBM Informix data types from `com.informix.lang.IfxTypes`

For more information about the available types, see "The IfxTypes class" on page C-8.

- **clearBindColType()**, which resets values set through the previous two methods

In the following topics:

- The `colIndex` parameter specifies the column: 1 is the first column, 2 the second, and so forth
- The `sqltype` parameter is a value from `java.sql.Types`: for example, `Types.INTEGER`
- The `ifxtype` parameter is a value from `IfxTypes`: for example, `IfxTypes.IFX_TYPE_DECIMAL`

### The setBindColType() methods:

The methods are as follows:

```java
public void setBindColType(int colIndex, int sqltype) throws SQLException;
public void setBindColType(int colIndex, int sqltype, int scale) throws SQLException;
public void setBindColType(int colIndex, int sqltype, String name) throws SQLException;
```

The first overloaded method allows applications to specify the output type to be `java.sql.DECIMAL` or `java.sql.NUMERIC`; the `scale` parameter specifies the number of digits to the right of the decimal point. The second overloaded method allows applications to specify the output type to be `java.sql.STRUCT`, `java.sql.ARRAY`, `java.sql.DISTINCT`, or `java.sql.JAVA_OBJECT` by assigning one of these values to the `name` parameter.

### The setBindColIfxType() methods:

The methods are as follows:

```java
public void setBindColIfxType(int colIndex, int ifxtype) throws SQLException;
public void setBindColIfxType(int colIndex, int ifxtype, int scale) throws SQLException;
public void setBindColIfxType(int colIndex, int ifxtype, String name) throws SQLException;
```

The first overloaded method allows applications to specify the output type to be `IFX_TYPE_DECIMAL` or `IFX_TYPE_NUMERIC`; the `scale` parameter specifies the number of digits to the right of the decimal point. The second overloaded method allows applications to specify the output type to be `IFX_TYPE_LIST`, `IFX_TYPE_ROW`, `IFX_TYPE_MULTISET`, `IFX_TYPE_SET`, `IFX_TYPE_UDTVAR`, or `IFX_TYPE_UDTFIXED` by assigning one of these values to the `name` parameter.
The `clearBindColType()` method:

The method is as follows:
```java
public void clearBindColType() throws SQLException;
```

**Prebinding example:**

The following code from the `udt_bindCol.java` sample program prebinds an opaque type to an IBM Informix VARCHAR and then to a standard Java Integer type. The table used in this example has one `int` column and one opaque type column and is defined as follows:
```
create table charattr_tab (int_col int, charattr_col charattr_udt)
```

The code to select and prebind the opaque type in the `charattr_col` column is as follows:
```java
String s = "select int_col, charattr_col as cast_udt_to_lvc, " +
    "charattr_col as cast_udt_to_int from charattr_tab order by 1";
```
```
pstmt = conn.prepareStatement(s);
    ((IfxPreparedStatement)pstmt).setBindColIfxType(2,IfxTypes.IFX_TYPE_LVARCHAR);
    ((IfxPreparedStatement)pstmt).setBindColType(3,Types.INTEGER);
```
```
ResultSet rs = pstmt.executeQuery();
```
```
System.out.println("Fetching data ...");
int curRow = 0;
while (rs.next())
{
    curRow++;
    int intret = rs.getInt("int_col");
    String strret = rs.getString("cast_udt_to_lvc");
    int intret2 = rs.getInt("cast_udt_to_int");
} // end while
```

**Other mapping extensions**

The remaining method signatures are listed next, along with any additional considerations that apply. In each case, the IBM Informix type must be the last parameter to the standard JDBC `PreparedStatement.setXXX()` interface.

**IfmxPreparedStatement.setArray()**
```java
public void setArray(int parameterIndex, Array x, int ifxType)
    throws SQLException
```

**IfmxPreparedStatement.setAsciiStream()**
```java
public void setAsciiStream(int i, InputStream x, int length, int ifxType)
    throws SQLException
```

When your application is inserting a very large ASCII value into a `LONGVARCHAR` column, it is sometimes more efficient to send the ASCII value to the server using `java.io.InputStream`.

**IfmxPreparedStatement.setBigDecimal()**
```java
public void setBigDecimal(int i, BigDecimal x, int ifxType)
    throws SQLException
```

**IfmxPreparedStatement.setBinaryStream()**
```java
public void setBinaryStream(int i, InputStream x, int length, int ifxType)
    throws SQLException
```
When your application is inserting a very large binary value into a LONGVARbinary column, it is sometimes more efficient to send the binary value to the server using java.io.InputStream.

IfmxPreparedStatement.setBlob()
public void setBlob(int parameterIndex, Blob x, int ifxType) throws SQLException

IfmxPreparedStatement.setBoolean()
publuc void setBoolean(int i, boolean x, int ifxType) throws SQLException

IfmxPreparedStatement.setByte()
public void setByte(int i, byte x, int ifxType) throws SQLException

IfmxPreparedStatement.setBytes()
public void setBytes(int i, byte x[], int ifxType) throws SQLException

IfmxPreparedStatement.setCharacterStream()
publuc void setCharacterStream(int parameterIndex, Reader reader, int length, int ifxType) throws SQLException

When your application is setting a LONGVARCHAR parameter to a very large UNICODE value, it is sometimes more efficient to send the UNICODE value to the server using java.io.Reader.

IfmxPreparedStatement.setClob()
publuc void setClob(int parameterIndex, Clob x, int ifxType) throws SQLException

IfmxPreparedStatement.setDate()
publuc void setDate(int i, Date x, int ifxType) throws SQLException
publuc void setDate(int parameterIndex, Date x, Calendar Cal, int ifxType) throws SQLException

IfmxPreparedStatement.setDouble()
publuc void setDouble(int i, double x, int ifxType) throws SQLException

IfmxPreparedStatement.setFloat()
publuc void setFloat(int i, float x, int ifxType) throws SQLException

IfmxPreparedStatement.setInt()
publuc void setInt(int i, int x, int ifxType) throws SQLException

IfmxPreparedStatement.setLong()
publuc void setLong(int i, long x, int ifxType) throws SQLException

IfmxPreparedStatement.setNull()
publuc void setNull(int i, int sqlType, int ifxType) throws SQLException
IfmxPreparedStatement

IfmxPreparedStatement.setShort()
public void setShort(int i, short x, int ifxType) throws SQLException

IfmxPreparedStatement.setString()
public void setString(int i, String x, int ifxType) throws SQLException

IfmxPreparedStatement.setTime()
public void setTime(int i, Time x, int ifxType) throws SQLException

IfmxPreparedStatement.setTime(int parameterIndex, Time time, Calendar Cal, int ifxType) throws SQLException

IfmxPreparedStatement.setTimestamp()
public void setTimestamp(int i, Timestamp x, int ifxType) throws SQLException

IfmxPreparedStatement.setTimestamp(int parameterIndex, Timestamp x, Calendar Cal) throws SQLException

The IfxTypes class

The extended IfmxPreparedStatement methods require you to pass in the IBM Informix data type to which you want to map. These types are part of the com.informix.lang.IfxTypes class.

The following table shows the IfxTypes constants and the corresponding Informix data types.

<table>
<thead>
<tr>
<th>IfxTypes constant</th>
<th>Informix data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfxTypes.IFX_TYPE_BIGINT</td>
<td>BIGINT</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_BIGSERIAL</td>
<td>BIGSERIAL</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_CHAR</td>
<td>CHAR</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_SMALLINT</td>
<td>SMALLINT</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_INT</td>
<td>INT</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_FLOAT</td>
<td>FLOAT</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_SMFLOAT</td>
<td>SMALLFLOAT</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_DECIMAL</td>
<td>DECIMAL</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_SERIAL</td>
<td>SERIAL</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_DATE</td>
<td>DATE</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_MONEY</td>
<td>MONEY</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_NULL</td>
<td>NULL</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_DATETIME</td>
<td>DATETIME</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_BYTE</td>
<td>BYTE</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_TEXT</td>
<td>TEXT</td>
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<td>IfxTypes.IFX_TYPE_VARCHAR</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_INTERVAL</td>
<td>INTERVAL</td>
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<tr>
<td>IfxTypes.IFX_TYPE_NCHAR</td>
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<tr>
<td>IfxTypes.IFX_TYPE_NVARCHAR</td>
<td>NVARCHAR</td>
</tr>
<tr>
<td>IfxTypes constant</td>
<td>Informix data type</td>
</tr>
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<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_INT8</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_SERIAL8</td>
<td>SERIAL8</td>
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<tr>
<td>IfxTypes.IFX_TYPE_SET</td>
<td>SQLSET</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_MULTISET</td>
<td>SQLMULTISET</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_LIST</td>
<td>SQLLIST</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_ROW</td>
<td>SQLROW</td>
</tr>
<tr>
<td>IfxTypes.IFX_TYPE_COLLECTION</td>
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<tr>
<td>IfxTypes.IFX_TYPE_UDTVAR</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_UDTFIXED</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_REFSER8</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_LVARCHAR</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_SENDRECV</td>
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<tr>
<td>IfxTypes.IFX_TYPE_BOOL</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_IMPEXP</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_IMPEXPBIN</td>
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</tr>
<tr>
<td>IfxTypes.IFX_TYPE_CLOB</td>
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<tr>
<td>IfxTypes.IFX_TYPE_BLOB</td>
<td>BLOB</td>
</tr>
</tbody>
</table>

**Extension summary**

The tables in this section list the PreparedStatement.setXXX() methods that IBM Informix JDBC Driver supports for nonextended data types and Informix extended data types.

**Nonextended data types**

The following tables list the PreparedStatement.setXXX() methods that IBM Informix JDBC Driver supports for nonextended data types. The top heading lists the standard JDBC API data types defined in the java.sql.Types class. These translate to specific Informix data types, as shown in the table in “Data type mapping between extended types and Java and JDBC types” on page C-2. The tables below list the setXXX() methods you can use to write data of a particular JDBC API data type. An uppercase and bold X indicates the setXXX() method that it is recommended you use with IBM Informix JDBC Driver; a lowercase x indicates other setXXX() methods that IBM Informix JDBC Driver supports.

**Numeric JDBC API data types**

<table>
<thead>
<tr>
<th>setXXX() method</th>
<th>Numeric JDBC API data types from java.sql.Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TINYINT</td>
</tr>
<tr>
<td>setByte()</td>
<td>X</td>
</tr>
<tr>
<td>setShort()</td>
<td></td>
</tr>
<tr>
<td>setInt()</td>
<td></td>
</tr>
<tr>
<td>setLong()</td>
<td></td>
</tr>
<tr>
<td>setFloat()</td>
<td></td>
</tr>
</tbody>
</table>

Table C-1. Numeric JDBC API data types from java.sql.Types
### Table C-1. Numeric JDBC API data types from java.sql.Types (continued)

<table>
<thead>
<tr>
<th>setXXX0 method</th>
<th>Numeric JDBC API data types from java.sql.Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TINYINT</td>
</tr>
<tr>
<td>setDouble()</td>
<td>x</td>
</tr>
<tr>
<td>setBigDecimal()</td>
<td>x</td>
</tr>
<tr>
<td>setBoolean()</td>
<td>x</td>
</tr>
<tr>
<td>setString()</td>
<td>x</td>
</tr>
<tr>
<td>setObject()</td>
<td>x</td>
</tr>
</tbody>
</table>

### Table C-2. Numeric JDBC API data types from java.sql.Types (continued)

<table>
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<tr>
<th>setXXX0 method</th>
<th>Numeric JDBC API data types from java.sql.Types</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>REAL</td>
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<tr>
<td>setByte()</td>
<td>x</td>
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<td>setShort()</td>
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<tr>
<td>setInt()</td>
<td>x</td>
</tr>
<tr>
<td>setLong()</td>
<td>x</td>
</tr>
<tr>
<td>setFloat()</td>
<td>X</td>
</tr>
<tr>
<td>setDouble()</td>
<td>x</td>
</tr>
<tr>
<td>setBigDecimal()</td>
<td>x</td>
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<tr>
<td>setBoolean()</td>
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</tr>
<tr>
<td>setString()</td>
<td>x</td>
</tr>
<tr>
<td>setObject()</td>
<td>x</td>
</tr>
</tbody>
</table>

### Character and chronological JDBC API data types

### Table C-3. Character and chronological JDBC API data types from java.sql.Types

<table>
<thead>
<tr>
<th>setXXX0 method</th>
<th>Character and chronological JDBC API data types from java.sql.Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CHAR</td>
</tr>
<tr>
<td>setByte()</td>
<td>x^1</td>
</tr>
<tr>
<td>setShort()</td>
<td>x^1</td>
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<tr>
<td>setInt()</td>
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<tr>
<td>setLong()</td>
<td>x^1</td>
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<td>setFloat()</td>
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<td>setDouble()</td>
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<td>setBigDecimal()</td>
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<td>setBoolean()</td>
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<tr>
<td>setString()</td>
<td>X</td>
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<td>setBytes()</td>
<td>x</td>
</tr>
<tr>
<td>setDate()</td>
<td>x</td>
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<tr>
<td>setTime()</td>
<td>x</td>
</tr>
<tr>
<td>setTimestamp()</td>
<td>x</td>
</tr>
<tr>
<td>setAsciiStream()</td>
<td>x</td>
</tr>
<tr>
<td>setCharacterStream()</td>
<td>x</td>
</tr>
</tbody>
</table>
Table C-3. Character and chronological JDBC API data types from java.sql.Types (continued)

<table>
<thead>
<tr>
<th>setXXX() method</th>
<th>Character and chronological JDBC API data types from java.sql.Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CHAR</td>
</tr>
<tr>
<td>setBinaryStream()</td>
<td></td>
</tr>
<tr>
<td>setObject()</td>
<td>x</td>
</tr>
</tbody>
</table>

Notes:

1. The column value must match the type of setXXX() exactly, or an SQLException is raised. If the column value is not within the allowed value range, the setXXX() method raises an exception instead of converting the data type. For example, setByte(1) raises an SQLException if the value being written is 1000.

2. A byte array is written.

3. A Timestamp object is written instead of a Time object.

Table C-4. Character and chronological JDBC API data types from java.sql.Types (continued)

<table>
<thead>
<tr>
<th>setXXX() method</th>
<th>Character and chronological JDBC API data types from java.sql.Types</th>
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<tbody>
<tr>
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<tr>
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<td>setDate()</td>
<td></td>
</tr>
<tr>
<td>setTime()</td>
<td></td>
</tr>
<tr>
<td>setTimestamp()</td>
<td></td>
</tr>
<tr>
<td>setAsciiStream()</td>
<td>x</td>
</tr>
<tr>
<td>setCharacterStream()</td>
<td>x</td>
</tr>
<tr>
<td>setBinaryStream()</td>
<td>x</td>
</tr>
<tr>
<td>setObject()</td>
<td>x</td>
</tr>
</tbody>
</table>

Notes:

1. The column value must match the type of setXXX() exactly, or an SQLException is raised. If the column value is not within the allowed value range, the setXXX() method raises an exception instead of converting the data type. For example, setByte(1) raises an SQLException if the value being written is 1000.

2. A byte array is written.

3. A Timestamp object is written instead of a Time object.

The setMaxRows() method writes an SQL null value.

**Informix extended data types**

The following table lists the PreparedStatement.setXXX() methods that IBM Informix JDBC Driver supports for the Informix extended data types, the mappings for which are shown in the table "Data type mapping between extended types and Java and JDBC types" on page C-2. The table lists the setXXX() methods you can use to write data of a particular extended data type.

An uppercase and bold X indicates the recommended setXXX() method to use; a lowercase x indicates other setXXX() methods supported by IBM Informix JDBC Driver. The table does not include setXXX() methods that you cannot use with any of the Informix extended data types.
Table C-5. Informix extended data types

<table>
<thead>
<tr>
<th>setXXX() method</th>
<th>BOOLEAN</th>
<th>LVARCHAR</th>
<th>Opaque types</th>
<th>BLOB</th>
<th>CLOB</th>
<th>BYTE</th>
<th>TEXT</th>
</tr>
</thead>
<tbody>
<tr>
<td>setByte()</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td>setShort()</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>setInt()</td>
<td>x</td>
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<td></td>
<td></td>
</tr>
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<td>setBoolean()</td>
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<td></td>
</tr>
<tr>
<td>setString()</td>
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<td>x</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>setAsciiStream()</td>
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<td></td>
</tr>
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</tr>
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Table C-6. Informix extended data types (continued)

<table>
<thead>
<tr>
<th>setXXX() method</th>
<th>NAMED ROW</th>
<th>UNNAMED ROW</th>
<th>SET or MULTISET</th>
<th>LIST</th>
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</thead>
<tbody>
<tr>
<td>setObject()</td>
<td>X</td>
<td>X</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>setArray()</td>
<td>x</td>
<td></td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

The setMaxRows() method writes an SQL null value.

Data type mapping for ResultSet.getXXX() methods

Use the ResultSet.getXXX() methods to transfer data from an IBM Informix database to a Java program that uses the JDBC API to connect to an Informix database. For example, use the ResultSet.getString() method to get the data stored in a column of data type LVARCHAR.

Important: If you use an expression within an SQL statement—for example, SELECT mytype::LVARCHAR FROM mytab—you might not be able to use ResultSet.getXXX(columnName) to retrieve the value. Use ResultSet.getXXX(columnIndex) to retrieve the value instead.

The getXXX() methods return a null value if the retrieved column value is an SQL null value.

The tables in this section list the ResultSet.getXXX() methods that IBM Informix JDBC Driver supports for nonextended data types and Informix extended data types.
Nonextended data types

The following tables list the ResultSet.getXXX() methods that IBM Informix JDBC Driver supports for nonextended data types. The top heading lists the standard JDBC API data types defined in the `java.sql.Types` class. These translate to specific Informix data types, as shown in the first table in “Data type mapping between Informix and JDBC data types” on page C-1. The tables list the getXXX() methods you can use to retrieve data of a particular JDBC API data type.

An uppercase and bold X indicates the recommended getXXX() method to use; a lowercase x indicates other getXXX() methods supported by IBM Informix JDBC Driver.

### Numeric JDBC API data types

**Table C-7. Numeric JDBC API data types from java.sql.Types**

<table>
<thead>
<tr>
<th>getXXX() method</th>
<th>TINYINT</th>
<th>SMALLINT</th>
<th>INTEGER</th>
<th>BIGINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>getByte()</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getShort()</td>
<td>x</td>
<td>x</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>getInt()</td>
<td>x</td>
<td>x</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>getLong()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>X</td>
</tr>
<tr>
<td>getFloat()</td>
<td>x</td>
<td>x</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>getDouble()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getBigDecimal()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getBoolean()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getString()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getObject()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Table C-8. Numeric JDBC API data types from java.sql.Types (continued)**

<table>
<thead>
<tr>
<th>getXXX() method</th>
<th>REAL</th>
<th>FLOAT</th>
<th>DOUBLE</th>
<th>DECIMAL</th>
<th>NUMERIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>getByte()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getShort()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getInt()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getLong()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getFloat()</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getDouble()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getBigDecimal()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getBoolean()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getString()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getObject()</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
## Character and chronological JDBC API data types

**Table C-9. Character and chronological JDBC API data types from java.sql.Types**

<table>
<thead>
<tr>
<th>getXXX() method</th>
<th>CHAR</th>
<th>VARCHAR</th>
<th>LONGVARCHAR</th>
<th>BINARY</th>
</tr>
</thead>
<tbody>
<tr>
<td>getByte()</td>
<td>x¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getShort()</td>
<td>x¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getInt()</td>
<td>x¹</td>
<td>x¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>getLong()</td>
<td>x¹</td>
<td>x¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>getFloat()</td>
<td>x¹</td>
<td>x¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>getDouble()</td>
<td>x¹</td>
<td>x¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td>getBigDecimal()</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getBoolean()</td>
<td>x²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getString()</td>
<td>x²</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getBytes()</td>
<td>x²</td>
<td>x²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>getDate()</td>
<td>x²</td>
<td>x²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>getTime()</td>
<td>x²</td>
<td>x²</td>
<td></td>
<td></td>
</tr>
<tr>
<td>getTimestamp()</td>
<td>x²</td>
<td>x²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**getAsciiStream()**

**getCharacterStream()**

**getBinaryStream()**

**getObject()**

**Notes:**

1. The column value must match the type of getXXX() exactly, or an `SQLException` is raised. If the column value is not within the allowed value range, the getXXX() method raises an exception instead of converting the data type. For example, `getByte(1)` raises an `SQLException` if the column value is 1000.

2. A byte array is returned.

3. A `Timestamp` object is returned instead of a `Time` object.

**Table C-10. Character and chronological JDBC API data types from java.sql.Types (continued)**

<table>
<thead>
<tr>
<th>getXXX() method</th>
<th>VARBINARY</th>
<th>LONGVARBINARY</th>
<th>DATE</th>
<th>TIME</th>
<th>TIMESTAMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>getString()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
<tr>
<td>getBytes()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
<tr>
<td>getDate()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
<tr>
<td>getTime()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
<tr>
<td>getTimestamp()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
<tr>
<td>getAsciiStream()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
<tr>
<td>getCharacterStream()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
<tr>
<td>getBinaryStream()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
<tr>
<td>getObject()</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
<td>x²</td>
</tr>
</tbody>
</table>
Table C-10. Character and chronological JDBC API data types from java.sql.Types (continued) (continued)

<table>
<thead>
<tr>
<th>getXXX() method</th>
<th>Character and chronological JDBC API data types from java.sql.Types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VARBINARY</td>
</tr>
</tbody>
</table>

Notes:

1. The column value must match the type of getXXX() exactly, or an **SQLException** is raised. If the column value is not within the allowed value range, the getXXX() method raises an exception instead of converting the data type. For example, getByte(1) raises an **SQLException** if the column value is 1000.

2. A byte array is returned.

3. A **Timestamp** object is returned instead of a **Time** object.

---

**Informix extended data types**

The following table lists the ResultSet.getXXX() methods that IBM Informix JDBC Driver supports for the Informix extended data types, the mappings for which are shown in the table "Data type mapping between extended types and Java and JDBC types" on page C-2. The table lists the getXXX() methods you can use to retrieve data of a particular extended data type.

An uppercase and bold X indicates the recommended getXXX() method to use; a lowercase x indicates other getXXX() methods supported by IBM Informix JDBC Driver. The table does not include getXXX() methods that you cannot use with any of the Informix extended data types.

Table C-11. Informix extended data types

<table>
<thead>
<tr>
<th>getXXX() method</th>
<th>Informix extended data types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BOOLEAN</td>
</tr>
<tr>
<td>getByte()</td>
<td>x</td>
</tr>
<tr>
<td>getShort()</td>
<td>x</td>
</tr>
<tr>
<td>getInt()</td>
<td>x</td>
</tr>
<tr>
<td>getBoolean()</td>
<td>X</td>
</tr>
<tr>
<td>getString()</td>
<td></td>
</tr>
<tr>
<td>getBytes()</td>
<td></td>
</tr>
<tr>
<td>getAsciiStream()</td>
<td></td>
</tr>
<tr>
<td>getCharacterStream()</td>
<td></td>
</tr>
<tr>
<td>getBinaryStream()</td>
<td>x</td>
</tr>
<tr>
<td>getObject()</td>
<td>x</td>
</tr>
<tr>
<td>getBlob()</td>
<td></td>
</tr>
<tr>
<td>getClob()</td>
<td></td>
</tr>
</tbody>
</table>

Table C-12. Informix extended data types (continued)

<table>
<thead>
<tr>
<th>getXXX() method</th>
<th>Informix extended data types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TEXT</td>
</tr>
<tr>
<td>getString()</td>
<td></td>
</tr>
<tr>
<td>getBytes()</td>
<td></td>
</tr>
</tbody>
</table>
Table C-12. Informix extended data types (continued) (continued)

<table>
<thead>
<tr>
<th>getXXX() method</th>
<th>TEXT</th>
<th>NAMED ROW</th>
<th>UNNAMED ROW</th>
<th>SET or MULTISET</th>
<th>LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>getAsciiStream()</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getCharacterStream()</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getBinaryStream()</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getObject()</td>
<td>x</td>
<td>X</td>
<td>X</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>getArray()</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getBlob()</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>getClob()</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data type mapping for UDT manager and UDR manager

When you use the UDTManager and UDRManager classes to create opaque types and Java UDRs in the database server, the driver maps Java method arguments and return types to SQL data types according to the tables in this section. Any data type not shown in these tables is not supported.

If the Java method has arguments of any of the following Java types, the arguments and return type are mapped to SQL types in the server as shown in the following table. The table shows the IBM Informix data type to which each Java data type maps.

<table>
<thead>
<tr>
<th>Java data type</th>
<th>SQL data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>boolean, java.lang.Boolean</td>
<td>BOOLEAN</td>
</tr>
<tr>
<td>char</td>
<td>CHAR(1)</td>
</tr>
<tr>
<td>byte</td>
<td>CHAR(1)</td>
</tr>
<tr>
<td>short, java.lang.Short</td>
<td>SMALLINT</td>
</tr>
<tr>
<td>int, java.lang.Integer</td>
<td>INT</td>
</tr>
<tr>
<td>long, java.lang.Long</td>
<td>INT8</td>
</tr>
<tr>
<td>float, java.lang.Float</td>
<td>SMALLFLOAT</td>
</tr>
<tr>
<td>double, java.lang.Double</td>
<td>FLOAT</td>
</tr>
<tr>
<td>java.lang.String</td>
<td>LVARCHAR</td>
</tr>
<tr>
<td>java.math.BigDecimal</td>
<td>DECIMAL</td>
</tr>
</tbody>
</table>

Default precision is set by the server to be: DECIMAL(16,8) for an ANSI database decimal (16,255) for a non-ANSI database

<table>
<thead>
<tr>
<th>Java data type</th>
<th>SQL data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>java.sql.Date</td>
<td>DATE</td>
</tr>
<tr>
<td>java.sql.Time</td>
<td>DATETIME HOUR TO SECOND</td>
</tr>
<tr>
<td>java.sql.Timestamp</td>
<td>DATETIME YEAR TO FRACTION(5)</td>
</tr>
<tr>
<td>com.informix.lang.IntervalYM</td>
<td>INTERVAL YEAR TO MONTH</td>
</tr>
<tr>
<td>com.informix.lang.IntervalDF</td>
<td>INTERVAL DAY TO FRACTION(5)</td>
</tr>
<tr>
<td>java.sql.Blob</td>
<td>BLOB</td>
</tr>
<tr>
<td>java.sql.Clob</td>
<td>CLOB</td>
</tr>
</tbody>
</table>
This mapping is JDBC compliant. You can map the Java double data type (via the JDBC FLOAT data type) to the Informix SMALLFLOAT data type for backward compatibility by setting the `IFX_GET_SMFLOAT_AS_FLOAT` environment variable to 1.

### Mapping for casts

The following table shows the mapping supported between the type defined for the `ifxtype` parameter in the `UDTMetaData.setXXXCast()` methods and SQL data types in the server.

<table>
<thead>
<tr>
<th><code>ifxtype</code> parameter type from com.informix.lang.IfxTypes</th>
<th>Informix data type</th>
</tr>
</thead>
<tbody>
<tr>
<td>IFX_TYPE_CHAR</td>
<td>CHAR</td>
</tr>
<tr>
<td>IFX_TYPE_SMALLINT</td>
<td>SMALLINT</td>
</tr>
<tr>
<td>IFX_TYPE_INT</td>
<td>INT</td>
</tr>
<tr>
<td>IFX_TYPE_FLOAT</td>
<td>FLOAT</td>
</tr>
<tr>
<td>IFX_TYPE_SMFLOAT</td>
<td>SMALLFLOAT</td>
</tr>
<tr>
<td>IFX_TYPE_DECIMAL</td>
<td>DECIMAL</td>
</tr>
<tr>
<td>IFX_TYPE_SERIAL</td>
<td>SERIAL</td>
</tr>
<tr>
<td>IFX_TYPE_DATE</td>
<td>DATE</td>
</tr>
<tr>
<td>IFX_TYPE_MONEY</td>
<td>MONEY</td>
</tr>
<tr>
<td>IFX_TYPE_DATETIME</td>
<td>DATETIME</td>
</tr>
<tr>
<td>IFX_TYPE_BYTE</td>
<td>BYTE</td>
</tr>
<tr>
<td>IFX_TYPE_TEXT</td>
<td>TEXT</td>
</tr>
<tr>
<td>IFX_TYPE_VARCHAR</td>
<td>VARCHAR</td>
</tr>
<tr>
<td>IFX_TYPE_INTERVAL</td>
<td>INTERVAL</td>
</tr>
<tr>
<td>IFX_TYPE_NCHAR</td>
<td>NCHAR</td>
</tr>
<tr>
<td>IFX_TYPE_NVARCHAR</td>
<td>NVARCHAR</td>
</tr>
<tr>
<td>IFX_TYPE_INT8</td>
<td>INT8</td>
</tr>
<tr>
<td>IFX_TYPE_SERIAL8</td>
<td>SERIAL8</td>
</tr>
<tr>
<td>IFX_TYPE_LVARCHAR</td>
<td>LVARCHAR</td>
</tr>
<tr>
<td>IFX_TYPE_SENDRECV</td>
<td>SENDRECV</td>
</tr>
<tr>
<td>IFX_TYPE_BOOL</td>
<td>BOOLEAN</td>
</tr>
<tr>
<td>IFX_TYPE_IMPEXP</td>
<td>IMPEXP</td>
</tr>
<tr>
<td>IFX_TYPE_IMPEXPBIN</td>
<td>IMPEXPBIN</td>
</tr>
<tr>
<td>IFX_TYPE_CLOB</td>
<td>CLOB</td>
</tr>
<tr>
<td>IFX_TYPE_BLOB</td>
<td>BLOB</td>
</tr>
</tbody>
</table>

### Mapping for field types

The following table shows the mapping supported between the types defined for the `ifxtype` parameter in the `UDTMetaData.setFieldType()` method and the Java data types as they appear in the Java class file. Data types not shown in this table are not supported within the opaque type.
### IfxType Parameter Type from com.informix.lang.IfxTypes

| IFX_TYPE_BIGINT         | long            |
| IFX_TYPE_BIGSERIAL      | long            |
| IFX_TYPE_CHAR           | java.lang.String |
| IFX_TYPE_SMALLINT       | short           |
| IFX_TYPE_INT            | int             |
| IFX_TYPE_FLOAT          | double          |
| IFX_TYPE_SMFLOAT        | float¹          |
| IFX_TYPE_DECIMAL        | java.lang.BigDecimal |
| IFX_TYPE_SERIAL         | int             |
| IFX_TYPE_DATE           | java.util.Date  |
| IFX_TYPE_MONEY          | java.lang.BigDecimal |
| IFX_TYPE_DATETIME       | java.lang.Timestamp if starting qualifier is Year, Month, or Day; otherwise, java.lang.Time (see “Field lengths and date-time data”). |
| IFX_TYPE_INTERVAL       | com.informix.lang.IfxIntervalYM if starting qualifier is Year or Month; otherwise, com.informix.lang.IfxIntervalDF (see “Field lengths and date-time data”). |
| IFX_TYPE_NCHAR          | java.lang.String |
| IFX_TYPE_INT8           | long            |
| IFX_TYPE_SERIAL8        | long            |
| IFX_TYPE_BOOL           | boolean         |
| IFX_TYPE_CLOB           | java.sql.Clob   |
| IFX_TYPE_BLOB           | java.sql.Blob   |

¹ This mapping is JDBC compliant. You can map IFX_TYPE_SMFLOAT data type (via the JDBC FLOAT data type) to the Java double data type for backward compatibility by setting the IFX_GET_SMFLOAT_AS_FLOAT environment variable to 1.

### Field lengths and date-time data

When you set a field type to a date-time or interval data type by calling setFieldType(IFX_TYPE_DATETIME) or setFieldType(IFX_TYPE_INTERVAL), the driver maps the date-time field to either `java.sql.Timestamp` or `java.sql.Time`, depending on the encoded length you set by calling setFieldLength().

For example, given that the standard format for a date-time field is YYYY-MM-DD HH:MM:SS, the driver uses the following mapping algorithm:

- If the encoded length has the start code from hour or less, it is mapped to `java.sql.Time`.
- If the encoded length has the start code from year or less, it is mapped to `java.sql.Timestamp`.

For intervals, the standards are either YYYY-MM or DD HH:MM:SS.frac. The mapping is as follows:
• If the encoded length has the start code from day or less, it is mapped to `com.informix.jdbc.IfxIntervalDF`.
• If the encoded length has the start code from year or less, it is mapped to `com.informix.jdbc.IfxIntervalYM`.
Appendix D. Convert internal Informix data types

For your Java application to work with the internal server representation of IBM Informix data types, use the IfxToJavaType class. For example, if your application is using the IBM Informix Change Data Capture API, you can use the IfxToJavaType class to interpret the byte stream.

The IfxToJavaType class

The IfxToJavaType class handles all the IBM Informix to Java data type conversions. Separate methods are provided for converting each Informix data type.

The primitive data types of Java are boolean, char, byte, short, int, long, float, double. When ever possible, the conversion returns the primitive data type rather than the Object.

The following table shows the data types that can be converted between the Informix data types to Java data types.

Table D-1. Conversion between Informix and Java data types

<table>
<thead>
<tr>
<th>Informix data types</th>
<th>Java data types</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIGINT</td>
<td>long</td>
</tr>
<tr>
<td>BYTE</td>
<td>int (pass as a BLOB ID)</td>
</tr>
<tr>
<td>CHAR (n) / CHARACTER (n)</td>
<td>string</td>
</tr>
<tr>
<td>DATE</td>
<td>java.sql.Date</td>
</tr>
<tr>
<td>DATETIME</td>
<td>java.sql.Timestamp</td>
</tr>
<tr>
<td>DATETIME</td>
<td>interval</td>
</tr>
<tr>
<td>DEC/DECIMAL (p,s)</td>
<td>java.lang.Bignum</td>
</tr>
<tr>
<td>DOUBLE PRECISION (n)</td>
<td>double</td>
</tr>
<tr>
<td>FLOAT</td>
<td>Same as DOUBLE PRECISION</td>
</tr>
<tr>
<td>INT8</td>
<td>long</td>
</tr>
<tr>
<td>INT/INTEGER</td>
<td>int</td>
</tr>
<tr>
<td>INTERVAL</td>
<td>interval</td>
</tr>
<tr>
<td>MONEY (p,s)</td>
<td>Same as DECIMAL</td>
</tr>
<tr>
<td>NUMERIC (p,s)</td>
<td>Same as DECIMAL</td>
</tr>
<tr>
<td>REAL</td>
<td>real</td>
</tr>
<tr>
<td>SERIAL (n)</td>
<td>int</td>
</tr>
<tr>
<td>SMALLFLOAT</td>
<td>Same as REAL</td>
</tr>
<tr>
<td>SMALLINT</td>
<td>short</td>
</tr>
<tr>
<td>TEXT</td>
<td>int (pass as a BLOB ID)</td>
</tr>
<tr>
<td>VARCHAR (m,r)</td>
<td>string</td>
</tr>
</tbody>
</table>

In addition to the conversion methods, the follow methods are also provided
The `convertDateToDays()` method

The `convertDateToDays()` method converts `java.sql.Date` to an `int` data type that encodes the number of days since January 1, 1900 as 1. Dates earlier than January 1, 1900 are encoded as negative numbers.

**Method signature**

```java
public static int convertDateToDays (java.sql.Date dt)
```

**Input parameter**

`dt` The `java.sql.Date`.

The `convertDaysToDate()` method

The `convertDaysToDate()` method converts days to year, date, or month. The `convertDaysToDate()` method handles negative days, interpreted as backwards from December 31, 1899 as 0. The `convertDaysToDate()` method interprets January 1, 1900 as 1. No dates before January 1, 0000 are allowed. The method relies on IBM Informix to generate valid dates.

**Method signature**

```java
public static java.sql.Date convertDaysToDate (int dt)
```

**Input parameter**

`dt` The number of days since January 1, 1900 (as 1).

The `IfxToJavaChar()` method

The `IfxToJavaChar()` method converts the IBM Informix `CHAR (n)` and `CHARACTER (n)` data types to the Java `String` data type. The conversion is achieved by creating a string from given bytes.

**Method signature**

```java
public String IfxToJavaChar (byte b [], short prec, boolean encoption)
pUBLIC String IfxToJavaChar (byte b [], boolean encoption)
pUBLIC String IfxToJavaChar (byte b [], int offset, int length, short prec, boolean encoption)
pUBLIC String IfxToJavaChar (byte b [], int offset, int length, boolean encoption)
pUBLIC String IfxToJavaChar (byte b [], int offset, int length, String dbEnc, boolean encoption)
pUBLIC String IfxToJavaChar (byte b [], short prec, String dbEnc, boolean encoption)
pUBLIC String IfxToJavaChar (byte b [], String dbEnc, boolean encoption)
throws IOException
```

**Input parameters**

`b` The bytes encoding data

`dbEnc` The JDK encoding.
offset  The offset into byte array.
prec   The precision as received from Informix.
length The data length.

The IfxToJavaDate() method
The IfxToJavaDate() method converts the IBM Informix DATE data type to the Java java.sql.Date data type.

Method signature
public static java.sql.Date IfxToJavaDate (byte [] b, short prec)
public static java.sql.Date IfxToJavaDate (byte [] b)
public static java.sql.Date IfxToJavaDate (byte [] b[], int offset, int length, short prec)
public static java.sql.Date IfxToJavaDate (byte [] b[], int offset)

Input parameters
b       The bytes encoding data
offset  The offset into byte array.
prec    The precision as received from Informix.
length  The data length.

The IfxToJavaDateTime() method
The IfxToJavaDateTime() method converts the IBM Informix DATETIME data type to the Java java.sql.Timestamp data type. The conversion path is Informix to decimal to timestamp.

Method signature
public static java.sql.Timestamp IfxToJavaDateTime (byte [] b, short prec)
public static java.sql.Timestamp IfxToJavaDateTime (byte [] b[], int offset, int length, short prec)
public static java.sql.Timestamp IfxToJavaDateTime (byte [] b[], int offset, int length, short prec, Calendar cal)

Input parameters
b       The bytes encoding data
offset  The offset into byte array.
prec    The precision as received from Informix.
length  The data length.

The IfxToDateTimeUnloadString() method
The IfxToDateTimeUnloadString() method converts the IBM Informix DATETIME data type to the Java string data type, which is in format compatible with SQL LOAD/UNLOAD format. The conversion path is Informix to decimal to string.

Method signature
public static String IfxToDateTimeUnloadString (byte [] b, int offset, int length, short prec)

Input parameters
b       The bytes encoding data
offset  The offset into byte array.
prec    The precision as received from Informix.
length  The data length.

The IfxToJavaDecimal() method
The IfxToJavaDecimal() method converts the IBM Informix DECIMAL data type to the Java java.lang.BigDecimal data type.

Method signature
public static java.math.BigDecimal IfxToJavaDecimal (byte b [], short prec)
public static java.math.BigDecimal IfxToJavaDecimal (byte b [], int offset, int length, short prec)

Input parameters
b The bytes encoding data
offset The offset into byte array.
prec   The precision as received from Informix.
length The data length.

The IfxToJavaDouble() method
The IfxToJavaDouble() method converts the IBM Informix DOUBLE PRECISION data type to the Java double data type.

Method signature
public static double IfxToJavaDouble (byte b [], short prec)
public static double IfxToJavaDouble (byte b [])
public static double IfxToJavaDouble (byte b [], int offset, int length, short prec)
public static double IfxToJavaDouble (byte b [], int offset)

Input parameters
b The bytes encoding data
offset The offset into byte array.
prec   The precision as received from Informix.
length The data length.

The IfxToJavaInt() method
The IfxToJavaInt() method converts the IBM Informix INTEGER data type to the Java int data type.

Method signature
public static int IfxToJavaInt (byte b [], short prec)
public static int IfxToJavaInt (byte b [])
public static int IfxToJavaInt (byte b [], int offset, int length, short prec)
public static int IfxToJavaInt (byte b [], int offset)

Input parameters
b The bytes encoding data
offset The offset into byte array.
The precision as received from Informix.

The data length.

The IfxToJavaInterval() method
The IfxToJavaInterval() method converts the IBM Informix DATETIME data type to the Java interval data type. The conversion path is Informix to decimal to interval.

Method signature
public static Interval IfxToJavaInterval (byte b [], short prec)
public static Interval IfxToJavaInterval (byte b [], int offset, int length, short prec)

Input parameters
b The bytes encoding data
offset The offset into byte array.
prec The precision as received from Informix.
length The data length.

The IfxToJavaLongBigInt() method
The IfxToJavaLongBigInt() method converts the IBM Informix BIGINT data type to the Java long data type.

Method signature
public static long IfxToJavaLongBigInt(byte b [], short prec)
public static long IfxToJavaLongBigInt(byte b []),
public static long IfxToJavaLongBigInt(byte buff [], int offset, int length, short prec)
public static long IfxToJavaLongBigInt(byte buff [], int offset)

Input parameters
b and buff The bytes encoding data
offset The offset into byte array.
prec The precision as received from Informix.
length The data length.

The IfxToJavaLongInt() method
The IfxToJavaLongInt() method converts the IBM Informix INT8 data type to the Java long data type.

Method signature
public static long IfxToJavaLongInt(byte b [], short prec)
public static long IfxToJavaLongInt(byte b []),
public static long IfxToJavaLongInt(byte buff [], int offset, int length, short prec)
public static long IfxToJavaLongInt(byte buff [], int offset)

Input parameters
b and buff The bytes encoding data
offset  The offset into byte array.
nprec   The precision as received from Informix.

length  The data length.

The IfxToJavaReal() method
The IfxToJavaReal() method converts the IBM Informix REAL data type to the Java real data type.

Method signature
public static float IfxToJavaReal (byte b [], short nprec)
public static float IfxToJavaReal (byte b [])
public static float IfxToJavaReal (byte b [], int noffset,
   int nlength, short nprec)
public static float IfxToJavaReal (byte b [], int noffset)

Input parameters
  b  The bytes encoding data
  noffset The offset into byte array.
nprec  The precision as received from Informix.

length  The data length.

The IfxToJavaSmallInt() method
The IfxToJavaSmallInt() method converts the IBM Informix SMALLINT data type to the Java short data type.

Method signature
public static short IfxToJavaSmallInt (byte b [], short nprec)
public static short IfxToJavaSmallInt (byte b [])
public static short IfxToJavaSmallInt (byte b [], int noffset,
   int nlength, short nprec)
public static short IfxToJavaSmallInt (byte b [], int noffset)

Input parameters
  b  The bytes encoding data
  noffset The offset into byte array.
nprec  The precision as received from Informix.

length  The data length.

The rleapyear() method
The rleapyear() method determines if the year is a leap year.

Method signature
public static final boolean rleapyear(int yr)

The widenByte() method
The widenByte() method moves BYTE into the short data type in such a way that the high bit is not propagated.

Method signature
protected static final short widenByte(byte b)
Appendix E. Error messages

-79700 Method not supported

Explanation: IBM Informix JDBC Driver does not support this JDBC method.

User response: Check the input string to ensure that it has the proper value.

-79702 Cannot create new object

Explanation: The software could not allocate memory for a new String object.

User response: Check the date and verify that it has a four-digit year, followed by a valid two-digit month and two-digit day. The delimiter must be a hyphen (-).

-79703 Row/column index out of range

Explanation: The row or column index is out of range.

User response: Compare the index to the number of rows and columns expected from the query to ensure that it is within range.

-79704 Cant load driver

Explanation: IBM Informix JDBC Driver could not create an instance of itself and register it in the DriverManager class. The rest of the SQLException text describes what failed.

User response: Check the JDBC specification for a list of valid escape clause keywords and syntax.

-79705 Incorrect URL format

Explanation: The database URL you have submitted is invalid. IBM Informix JDBC Driver does not recognize the syntax.

User response: Check the syntax and try again.

-79706 Incomplete input

Explanation: An invalid character was found during conversion of a String value to an IntervalIF or IntervalYM object.

User response: Check the syntax and try again.

-79707 Incorrect number of arguments

Explanation: An incorrect number of arguments was passed to the scalar function escape syntax. The correct syntax is \{fn function(arguments)\}.

User response: Check that the correct number of arguments was passed to the function.

-79708 Type not supported

Explanation: You have specified a data type that is not supported by IBM Informix JDBC Driver.

User response: Check your program to make sure the data type used is supported by the driver.

-79709 Error in date format

Explanation: The expected input is a valid date string in the following format: yyyy-mm-dd.

User response: Check the date and verify that it has a four-digit year, followed by a valid two-digit month and two-digit day. The delimiter must be a hyphen (-).

-79710 Syntax error in SQL escape clause

Explanation: Invalid syntax was passed to a jdbc escape clause. Valid JDBC escape clause syntax is demarcated by braces and a keyword: for example, \{keyword syntax\}.

User response: Check the JDBC specification for a list of valid escape clause keywords and syntax.

-79711 Error in time format

Explanation: An invalid time format was passed to a JDBC escape clause. The escape clause syntax for time literals has the following format: \{t 'hh:mm:ss\}.

User response: Check the date and verify that it has a four-digit year, followed by a valid two-digit month and two-digit day. The delimiter must be a hyphen (-).

-79712 Error in timestamp format

Explanation: An invalid time stamp format was passed to a JDBC escape clause. The escape clause syntax for time stamp literals has the following format: \{ts 'yyyy-mm-dd hh:mm:ss.f\}.

User response: Check the date and verify that it has a four-digit year, followed by a valid two-digit month and two-digit day. The delimiter must be a hyphen (-).

-79713 Incorrect number of arguments

Explanation: An incorrect number of arguments was passed to the scalar function escape syntax. The correct syntax is \{fn function(arguments)\}.

User response: Check that the correct number of arguments was passed to the function.

-79714 Type not supported

Explanation: You have specified a data type that is not supported by IBM Informix JDBC Driver.

User response: Check your program to make sure the data type used is supported by the driver.

-79715 Syntax error

Explanation: Invalid syntax was passed to a jdbc escape clause. Valid JDBC escape clause syntax is

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demarcated by braces and a keyword: \textit{(keyword syntax)}.

\textbf{User response:} Check the JDBC specification for a list of valid escape clause keywords and syntax.

-79716 System or internal error

\textbf{Explanation:} An operating or runtime system error or a driver internal error occurred. The accompanying message describes the problem.

-79717 Invalid qualifier length

\textbf{Explanation:} The length value for an Interval object is incorrect.

\textbf{User response:} See \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for correct values.

-79718 Invalid qualifier start code

\textbf{Explanation:} The start value for an Interval object is incorrect.

\textbf{User response:} See \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for correct values.

-79719 Invalid qualifier end code

\textbf{Explanation:} The end value for an Interval object is incorrect.

\textbf{User response:} See \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for correct values.

-79720 Invalid qualifier start or end code

\textbf{Explanation:} The start or end value for an Interval object is incorrect.

\textbf{User response:} See \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for correct values.

-79721 Invalid interval string

\textbf{Explanation:} An error occurred during conversion of a String value to an IntervalDF or IntervalYM object. Check \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for the correct format.

-79722 Numeric character(s) expected

\textbf{Explanation:} An error occurred during conversion of a String value to an IntervalDF or IntervalYM object. A numeric value was expected and not found. Check \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for the correct format.

-79723 Delimiter character(s) expected

\textbf{Explanation:} An error occurred during conversion of a String value to an IntervalDF or IntervalYM object. A delimiter was expected and not found. Check the \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for the correct format.

-79724 Character(s) expected

\textbf{Explanation:} An error occurred during conversion of a String value to an IntervalDF or IntervalYM object. End of string was encountered before conversion was complete.

\textbf{User response:} Check \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for the correct format.

-79725 Extra character(s) found

\textbf{Explanation:} An error occurred during conversion of a String value to an IntervalDF or IntervalYM object. End of string was expected, but there were more characters in the string.

\textbf{User response:} Check \enquote{INTERVAL data type\textit{\textup{on page 4-8}}} for the correct format.

-79726 Null SQL statement

\textbf{Explanation:} The SQL statement passed in was null.

\textbf{User response:} Check the SQL statement string of your program to make sure that it contains a valid statement.

-79727 Statement was not prepared

\textbf{Explanation:} The SQL statement was not prepared properly. If you use host variables (for example, \texttt{insert into mytab values (?, ?);} in your SQL statement, you must use \texttt{connection.prepareStatement()} to prepare the SQL statement before you can execute it.

-79728 Unknown object type

\textbf{Explanation:} If this object type is a null opaque type, the type is unknown and cannot be processed. If this object type is a complex type, the data in the collection or array is of an unknown type and cannot be mapped to an IBM Informix type. If this object type is a row, one of the elements in the row cannot be mapped to an Informix type. Verify the customized type mapping or data type of the object.

-79729 Method cannot take argument

\textbf{Explanation:} The method does not take an argument. See your Java API specification or the appropriate section of this guide to make sure that you are using the method properly.
Connection not established
Explanation: A connection was not established.
User response: You must obtain the connection by calling the DriverManager.getConnection() or DataSource.getConnection() method first.

MaxRows out of range
Explanation: You have specified an out-of-range maxRow value. Make sure that you specify a value between 0 and Integer.MAX_VALUE.

Illegal cursor name
Explanation: The cursor name specified is not valid. Make sure the string passed in is not null or empty.

No active result
Explanation: The statement does not contain an active result. Check your program logic to make sure that you have called the executeXXX() method before you attempt to refer to the result.

INFORMIXSERVER has to be specified
Explanation: INFORMIXSERVER is a property required for connecting to an IBM Informix database. You can specify it in the database URL or as part of a Properties object that is passed to the connect() method.

Can't instantiate protocol
Explanation: An internal error occurred during a connection attempt. Call technical support.

No connection/statement establish yet
Explanation: There is no current connection or statement.
User response: Check your program to make sure that a connection was properly established or a statement was created.

No metadata
Explanation: There is no metadata available for this SQL statement.
User response: Make sure that the statement generates a result set before you attempt to use it.

No such column name
Explanation: The column name specified does not exist. Make sure that the column name is correct.

No current row
Explanation: The cursor is not properly positioned. You must first position the cursor within the result set by using a method such as ResultSet.next(), ResultSet.beforeFirst(), ResultSet.first(), or ResultSet.absolute().

No statement created
Explanation: There is no current statement. Make sure that the statement was properly created.

Cannot convert to
Explanation: There is no data conversion possible from the column data type to the one specified. The actual data type is appended to the end of this message.
User response: Review your program logic to make sure that the conversion you have asked for is supported. See Appendix C, “Mapping data types,” on page C-1 for the data mapping matrix.

Cannot convert from
Explanation: No data conversion is possible from the data type you specified to the column data type. The actual data type is appended to the end of this message.
User response: Check your program logic to make sure that the conversion you have asked for is supported. See Appendix C, “Mapping data types,” on page C-1 for the data mapping matrix.

Transactions not supported
Explanation: The user has tried to call commit() or rollback() on a database that does not support transactions or has tried to set autoCommit to False on a nonlogging database.
User response: Verify that the current database has the correct logging mode and review the program logic.

Read only mode not supported
Explanation: IBM Informix does not support read-only mode.

No Transaction Isolation on non-logging db's
Explanation: IBM Informix does not support setting the transaction isolation level on nonlogging databases.
-79747  Invalid transaction isolation level

Explanation: If the database server could not complete the rollback, this error occurs. See the rest of the SQLException message for more details about why the rollback failed.

This error also occurs if an invalid transaction level is passed to setTransactionIsolation(). The valid values are:

- TRANSACTION_NONE
- TRANSACTION_READ_UNCOMMITTED
- TRANSACTION_READ_COMMITTED
- TRANSACTION_REPEATABLE_READ
- TRANSACTION_SERIALIZABLE
- TRANSACTION_LAST_COMMITTED

-79748  Cannot lock the connection

Explanation: IBM Informix JDBC Driver normally locks the connection object just before beginning the data exchange with the database server. The driver could not obtain the lock. Only one thread at a time should use the connection object.

-79749  Number of input values does not match number of question marks

Explanation: The number of variables that you set with the PreparedStatement.setXXX() methods in this statement does not match the number of ? placeholders that you wrote into the statement.

User response: Locate the text of the statement and verify the number of placeholders and then check the calls to PreparedStatement.setXXX().

-79750  Method only for queries

Explanation: The Statement.executeQuery(String) and PreparedStatement.executeQuery() methods should only be used if the statement is a SELECT statement. For other statements, use the Statement.execute(String), Statement.executeBatch(), Statement.executeUpdate(String), Statement.getUpdateCount(), Statement.getResultSet(), or PreparedStatement.executeUpdate() method.

-79755  Object is null

Explanation: The object passed in is null. Check your program logic to make sure that your object reference is valid.

-79756  Must start with 'jdbc'

Explanation: The first token of the database URL must be the keyword jdbc (is not case sensitive), as in the following example:

```
jdbc:informix-sqli://mymachine:1234/
mydatabase:user=me:
password=secret
```

-79757  Invalid subprotocol

Explanation: The current valid subprotocol is informix-sqli.

-79758  Invalid IP address

Explanation: When you connect to an IBM Informix database server through an IP address, the IP address must be valid. A valid IP address is a set of four numbers 0 - 255, separated by dots (.): for example, 127.0.0.1.

In this example, 1234 is the port number.

-79759  Invalid port number

Explanation: The port number must be a valid four-digit number, as follows:

```
jdbc:informix-sqli://mymachine:1234/
mydatabase:user=me:
password=secret
```

For IBM Informix SE, database names should be no longer than 10 characters (fewer in some host operating systems).

Both database and cursor names must begin with a letter and contain only letters, numbers, and underscore characters. In the 6.0 and later versions of the database server, database and cursor names can begin with an underscore.

In MS-DOS systems, file names can be a maximum of eight characters plus a three-character extension.

-79760  Invalid database name

Explanation: This statement contains the name of a database in some invalid format.

The maximum length for database names and cursor names depends on the version of the database server. In 7.x, 8.x, and 9.1x versions of the IBM Informix database server, the maximum length is 18 characters.

For IBM Informix SE, database names should be no longer than 10 characters (fewer in some host operating systems).

Both database and cursor names must begin with a letter and contain only letters, numbers, and underscore characters. In the 6.0 and later versions of the database server, database and cursor names can begin with an underscore.

In MS-DOS systems, file names can be a maximum of eight characters plus a three-character extension.

-79761  Invalid property format

Explanation: The database URL accepts property values in key=value pairs. For example, user=informix:password=informix adds the key=value pairs to the list of properties that are passed to the connection object.

User response: Check the syntax of the key=value pair for syntax errors. Make sure that there is only one = sign; that there are no spaces separating the key, value, or =; and that key=value pairs are separated by one colon (:), again with no spaces.

IBM Informix JDBC Driver Programmer's Guide
-79762  Attempt to connect to a non 5.x server
Explanation: When connecting to a Version 5.x database server, the user must set the database URL property USE5SERVER to any non-null value. If a connection is then made to a Version 6.0 or later database server, this exception is thrown.
User response: Verify that the version of the database server is correct and modify the database URL as needed.

-79764  Invalid fetch direction value
Explanation: An invalid fetch direction was passed as an argument to the Statement.setFetchDirection() or ResultSet.setFetchDirection() method. Valid values are FETCH_FORWARD, FETCH_REVERSE, and FETCH_UNKNOWN.

-79765  ResultSet type is TYPE_FETCH_FORWARD, direction can only be FETCH_FORWARD
Explanation: The result set type has been set to TYPE_FORWARD_ONLY, but the setFetchDirection() method has been called with a value other than FETCH_FORWARD. The direction specified must be consistent with the result type specified.

-79766  Incorrect fetch size value
Explanation: The Statement.setFetchSize() method has been called with an invalid value. Verify that the value passed in is greater than 0. If the setMaxRows() method has been called, the fetch size must not exceed that value.

-79767  ResultSet type is TYPE_FORWARD_ONLY
Explanation: A method such as ResultSet.beforeFirst(), ResultSet.afterLast(), ResultSet.first(), ResultSet.last(), ResultSet.absolute(), ResultSet.relative(), ResultSet.current(), or ResultSet.previous() has been called, but the result set type is TYPE_FORWARD_ONLY. Call only the ResultSet.next() method if the result set type is TYPE_FORWARD_ONLY.

-79768  Incorrect row value
Explanation: The ResultSet.absolute(int) method has been called with a value of 0. The parameter must be greater than 0.

-79769  A customized type map is required for this data type
Explanation: You must register a customized type map to use any opaque types.

-79770  Cannot find the SQLTypeName specified in the SQLData or Struct
Explanation: The SQLTypeName object you specified in the SQLData or Struct class does not exist in the database. Make sure that the type name is valid.

-79771  Input value is not valid
Explanation: The input value is not accepted for this data type. Make sure this input value is a valid input for this data type.

-79772  No more data to read or write. Verify your SQLData class or getSQLTypeName()
Explanation: This error occurs when a Java user-defined routine attempts to read or set a position beyond the end of the opaque type data available from a data input stream.
User response: Check the length and structure of the opaque type carefully against the data-input UDR code. The SQLTypeName object that was returned by the getSQLTypeName() method might also be incorrect.

-79774  Unable to create local file
Explanation: Large object data read from the database server can be stored either in memory or in a local file. If the LOBCACHE value is 0 or the large object size is greater than the LOBCACHE value, the large object data from the database server is always stored in a file. In this case, if a security exception occurs, IBM Informix JDBC Driver makes no attempt to store the large object into memory and throws this exception.

-79775  Only TYPE_SCROLL_INSENSITIVE and TYPE_FORWARD_ONLY are supported
Explanation: IBM Informix JDBC Driver only supports a result set type of TYPE_SCROLL_INSENSITIVE and TYPE_FORWARD_ONLY. Only these values should be used.

-79776  Type requested (%s) does not match row type information (%s) type
Explanation: Row type information was acquired either through the system catalogs or through the supplied row definition. The row data provided does not match this row element type. The type information must be modified, or the data must be provided.
readObject/writeObject() only supports UDTs, Distincts, and complex types

Explanation: The SQLData.writeObject() method was called for an object that is not a user-defined, distinct, or complex type.

User response: Verify that you have provided customized type-mapping information.

Type mapping class must be a java.util.Collection implementation

Explanation: You provided a type mapping to override the default for a set, list, or multiset data type, but the class does not implement the java.util.Collection interface.

Data within a collection must all be the same Java class and length

Explanation: Verify that all the objects in the collection are of the same class.

Index/Count out of range

Explanation: Array.getArray() or Array.getResultSet() was called with index and count values. Either the index is out of range or the count is too large.

User response: Verify that the number of elements in the array is sufficient for the index and count values.

Method can be called only once

Explanation: Make sure methods such as Statement.getUpdateCount() and Statement.getResultSet() are called only once per result.

Encoding or code set not supported

Explanation: The encoding or code set entered in the DB_LOCALE or CLIENT_LOCALE variable is not valid.

User response: Check Support for code-set conversion on page 6-8 for valid code sets.

Locale not supported

Explanation: The locale entered in the DB_LOCALE or CLIENT_LOCALE variable is not valid.

User response: Check Support for code-set conversion on page 6-8 for valid locales.

Unable to convert JDBC escape format date string to localized date string

Explanation: The JDBC escape format for date values must be specified in the format {d 'yyyy-mm-dd'}. Verify that the JDBC escape date format specified is correct.

User response: Verify the DBDATE and GL_DATE settings for the correct date string format if either of these environment variables was set to a value in the connection database URL string or property list.

Unable to build a Date object based on localized date string representation

Explanation: The localized date string representation specified in a char, varchar, or lvarchar column is not correct, and a date object cannot be built based on the year, month, and day values.

User response: Verify that the date string representation conforms to the DBDATE or GL_DATE date formats if either one of these is specified in a connection database URL string or property list. If neither DBDATE or GL_DATE is specified but a CLIENT_LOCALE or DB_LOCALE is explicitly set in a connection database URL string or property list, verify that the date string representation conforms to the JDK short default format (DateFormat.SHORT).

User name must be specified

Explanation: The user name is required to establish a connection with IBM Informix JDBC Driver.

User response: Make sure that you pass in user=your_user_name as part of the database URL or one of the properties.

Server does not support GLS variables DB_LOCALE, CLIENT_LOCALE or GL_DATE

Explanation: These variables can only be used if the database server supports GLS.

User response: Check the documentation for your database server version and omit these variables if they are not supported.

Invalid complex type definition string

Explanation: The value returned by the getSQLTypeName() method is either null or invalid.

User response: Check the string to verify that it is either a valid named-row name or a valid row type definition.

Row must contain data

Explanation: The Array.getAttributes() or Array.getAttributes(Map) method has returned 0 elements. These methods must return a nonzero number.
-79793  Data in array does not match getBaseType() value

Explanation: The Array.getArray() or Array.getArray(Map) method has returned an array where the element type does not match the JDBC base type.

-79794  Row length provided (%s) does not match row type information (%s)

Explanation: Data in the row does not match the length in the row type information. You do not have to pad string lengths to match what is in the row definition, but lengths for other data types should match.

-79795  Row extended ID provided (%s) does not match row type information (%s)

Explanation: The extended ID of the object in the row does not match the extended ID as defined in row type information.

User response: Either update the row type information (if you are providing the row definition) or check the type mapping information.

-79796  Cannot find UDT, distinct, or named row (%s) in database

Explanation: The getSQLTypeName() method has returned a name that cannot be found in the database.

User response: Verify that the Struct or SQLData object returns the correct information.

-79797  DBDATE setting must be at least four characters and no longer than six characters

Explanation: This error occurs because the DBDATE format string that is passed to the database server either has too few characters or too many.

User response: To fix the problem, verify the DBDATE format string with the user documentation and make sure that the correct year, month, day, and possibly era parts of the DBDATE format string are correctly identified.

-79798  A numeric year expansion is required after 'Y' character in DBDATE string

Explanation: This error occurs because the DBDATE format string has a year designation (specified by the character Y), but there is no character following the year designation to denote the numeric year expansion (2 or 4).

User response: To fix the problem, modify the DBDATE format string to include the numeric year expansion value after the Y character.

-79799  An invalid character is found in the DBDATE string after the 'Y' character

Explanation: This error occurs because the DBDATE format string has a year designation (specified by the character Y), but the character following the year designation is not a 2 (two-digit years) or 4 (four-digit years).

User response: To fix the problem, modify the DBDATE format string to include the required numeric year expansion value after the Y character. Only a 2 or 4 character should immediately follow the Y character designation.

-79800  No 'Y' character is specified before the numeric year expansion value

Explanation: This error occurs because the DBDATE format string has a numeric year expansion (2 to denote two-digit years or 4 to denote four-digit years), but the year designation character (Y) was not found immediately before the numeric year expansion character specified.

User response: To fix the problem, modify the DBDATE format string to include the required Y character immediately before the numeric year expansion value requested.

-79801  An invalid character is found in DBDATE format string

Explanation: This error occurs because the DBDATE format string has a character that is not allowed.

User response: To fix the problem, modify the DBDATE format string to only include the correct date part designations: year (Y), numeric year expansion value (2 or 4), month (M), and day (D). Optionally, you can include an era designation (E) and a default separator character (hyphen, dot, or slash), which is specified at the end of the DBDATE format string. Refer to the user documentation for further information about correct DBDATE format string character designations.

-79802  Not enough tokens are specified in the string representation of a date value

Explanation: This error occurs because the date string specified does not have the minimum number of tokens or separators needed to form a valid date value (composed of year, month, and day numeric parts). For example, 12/15/98 is a valid date string representation with the slash character as the separator or token. But 12/1598 is not a valid date string representation, because there are not enough separators or tokens.

User response: To fix the problem, modify the date string representation to include a valid format for
-79803  Date string index out of bounds during date format parsing to build Date object

Explanation: This error occurs because there is not a one-to-one correspondence between the date string format required by DBDATE or GL_DATE and the actual date string representation you defined. For example, if GL_DATE is set to %b %d %y and you specify a character string of Oct, there is a definite mismatch between the format required by GL_DATE and the actual date string.

User response: To fix the problem, modify the date string representation of the DBDATE or GL_DATE setting so that the date format specified matches one-to-one with the required date string representation.

-79804  No more tokens are found in DBDATE string representation of a date value

Explanation: This error occurs because the date string specified does not have any more tokens or separators needed to form a valid date value (composed of year, month, and day numeric parts) based on the DBDATE format string. For example, 12/15/98 is a valid date string representation when DBDATE is set to MDY/. But 12/1598 is not a valid date string representation, because there are not enough separators or tokens.

User response: To fix the problem, modify the date string representation to include a valid format for separating the day, month, and year parts of a date value based on the DBDATE format string setting.

-79805  No era designation found in DBDATE/GL_DATE string representation of date value

Explanation: This error occurs because the date string specified does not have a valid era designation, as required by the DBDATE or GL_DATE format string setting. For example, if DBDATE is set to YMD-, but the date string representation specified by the user is 98-12-15, this is an error because there is no era designation at the end of the date string value.

User response: To fix the problem, modify the date string representation to include a valid era designation based on the DBDATE or GL_DATE format string setting. In this example, a date string representation of 98-12-15 AD would probably suffice, depending on the locale.

-79806  Numerical day value can not be determined from date string based on DBDATE

Explanation: This error occurs because the date string specified does not have a valid numeric day designation as required by the DBDATE format string setting. For example, if DBDATE is set to YMD-, but the date string representation you specify is 98-12-blah, this is an error, because blah is not a valid numeric day representation.

User response: To fix the problem, modify the date string representation to include a valid numeric day designation (from 1 to 31) based on the DBDATE format string setting.

-79807  Numerical month value can not be determined from date string based on DBDATE

Explanation: This error occurs because the date string specified does not have a valid numeric month designation as required by the DBDATE format string setting. For example, if DBDATE is set to YMD-, but the date string representation you specify is 98-blah-15, this is an error, because blah is not a valid numeric month representation.

User response: To fix the problem, modify the date string representation to include a valid numeric month designation (from 1 to 12) based on the DBDATE format string setting.

-79808  Not enough tokens specified in %D directive representation of date string

Explanation: This error occurs because the date string specified does not have the correct number of tokens or separators needed to form a valid date value based on the GL_DATE %D directive (mm/dd/yy format). For example, 12/15/98 is a valid date string representation based on the GL_DATE %D directive, but 12/1598 is not a valid date string representation, because there are not enough separators or tokens.

User response: To fix the problem, modify the date string representation to include a valid format for the GL_DATE %D directive.

-79809  Not enough tokens specified in %x directive representation of date string

Explanation: This error occurs because the date string specified does not have the correct number of tokens or separators needed to form a valid date value based on the GL_DATE %x directive (format required is based on day, month, and year parts, and the ordering of these parts is determined by the specified locale). For example, 12/15/98 is a valid date string representation based on the GL_DATE %x directive for the U.S. English locale, but 12/1598 is not a valid date string representation because there are not enough separators or tokens.

User response: To fix the problem, modify the date string representation to include a valid format for the GL_DATE %x directive based on the locale.
-79811 Connection without user/password not supported

**Explanation:** You called the getConnection() method for the `DataSource` object, and the user name or the password is null.

**User response:** Use the user name and password arguments of the getConnection() method or set these values in the `DataSource` object.

-79812 User/Password does not match with datasource

**Explanation:** You called the getConnection(user, passwd) method for the `DataSource` object, and the values you supplied did not match the values already found in the data source.

-79814 Blob/Clob object is either closed or invalid

**Explanation:** If you retrieve a smart large object using the ResultSet.getBlob() or ResultSet.getClob() method or create one using the IfxBlob() or IfxCblob() constructor, a smart large object is opened. You can then read from or write to the smart large object. After you execute the IfxBlob.close() method, do not use the smart large object handle for further read/write operations, or this exception is thrown.

-79815 Not in Insert mode. Need to call moveToInsertRow() first

**Explanation:** You tried to use the insertRow() method, but the mode is not set to Insert.

**User response:** Call the moveToInsertRow() method before calling insertRow().

-79816 Cannot determine the table name

**Explanation:** The table name in the query is either incorrect or refers to a table that does not exist.

-79817 No serial, rowid, or primary key specified in the statement

**Explanation:** The updatable scrollable feature works only for tables that have a SERIAL column, a primary key, or a row ID specified in the query. If the table does not have any of the above, an updatable scrollable cursor cannot be created.

-79818 Statement concurrency type is not set to CONCUR_UPDATABLE

**Explanation:** You tried to call the insertRow(), updateRow(), or deleteRow() method for a statement that has not been created with the CONCUR_UPDATABLE concurrency type.

**User response:** Re-create the statement with this type set for the concurrency attribute.

-79819 Still in Insert mode. Call moveToCurrentRow() first

**Explanation:** You cannot call the updateRow() or deleteRow() method while still in Insert mode. Call the moveToCurrentRow() method first.

-79820 Function contains an output parameter

**Explanation:** You have passed in a statement that contains an OUT parameter, but you have not used the drivers CallableStatement.registerOutParameter() and getXXX() methods to process the OUT parameter.

-79821 Name unnecessary for this data type

**Explanation:** If you have a data type that requires a name (an opaque type or complex type) you must call a method that has a parameter for the name, such as the following methods:

```java
public void IfxSetNull(int i, int ifxType, String name)
public void registerOutParameter(int parameterIndex,
                                int sqlType, java.lang.String name);
public void IfxRegisterOutParameter(int parameterIndex,
                                     int ifxType, java.lang.String name);
```

The data type you have specified does not require a name.

**User response:** Use another method that does not have a type parameter.

-79822 OUT parameter has not been registered

**Explanation:** The function specified using the CallableStatement interface has an OUT parameter that has not been registered.

**User response:** Call one of the registerOutParameter() or IfxRegisterOutParameter() methods to register the OUT parameter type before calling the executeQuery() method.

-79823 IN parameter has not been set

**Explanation:** The function specified using the CallableStatement interface has an IN parameter that has not been set.

**User response:** Call the setMaxRows() or IfxSetNull() method if you want to set a null IN parameter. Otherwise, call one of the set methods inherited from the PreparedStatement interface.
OUT parameter has not been set

Explanation: The function specified using the CallableStatement interface has an OUT parameter that has not been set.

User response: Call the setMaxRows() or IfxSetNull() method if you want to set a null OUT parameter. Otherwise, call one of the set methods inherited from the PreparedStatement interface.

Type name is required for this data type

Explanation: This data type is an opaque type, distinct type, or complex type, and it requires a name.

User response: Use set methods for IN parameters and register methods for OUT parameters that take a type name as a parameter.

Ambiguous java.sql.Type, use IfxRegisterOutParameter()

Explanation: The SQL type specified either has no mapping to an IBM Informix data type or has more than one mapping.

User response: Use one of the IfxRegisterOutParameter() methods to specify the Informix data type.

Function doesn't have an output parameter

Explanation: This function does not have an OUT parameter, or this function has an OUT parameter whose value the server version does not return. None of the methods in the CallableStatement interface apply. Use the inherited methods from the PreparedStatement interface.

Function parameter specified isn't an OUT parameter

Explanation: IBM Informix functions can have only one OUT parameter, and it is always the last parameter.

Invalid directive used for the GL_DATE environment variable

Explanation: One or more of the directives specified by the GL_DATE environment variable is not allowed. Refer to the GL_DATE variable on page 6-2 for a list of the valid directives for a GL_DATE format.

Insufficient information given for building a time or timestamp Java object.

Explanation: To perform string-to-binary conversions correctly for building a java.sql.Timestamp or java.sql.Time object, all the DATETIME fields must be specified for the chosen date string representation. For java.sql.Timestamp objects, the year, month, day, hour, minute, and second parts must be specified in the string representation. For java.sql.Time objects, the hour, minute, and second parts must be specified in the string representation.

Exceeded maximum no. of connections configured for Connection Pool Manager

Explanation: If you repeatedly connect to a database using a DataSource object without closing the connection, connections accumulate. When the total number of connections for the DataSource object exceeds the maximum limit (100), this error is thrown.

Distributed transactions (XA) are not supported by this database server.

Explanation: This error occurs when the user calls the method XAConnection.getConnection() against an unsupported server.

Proxy Error: No database connection

Explanation: This error is thrown by the IBM Informix HTTP Proxy if you try to communicate with the database on an invalid or bad database connection.

User response: Make sure your application has opened a connection to the database, check your web server and database error logs.

Proxy Error: Input/output error while communicating with database

Explanation: This error is thrown by the IBM Informix HTTP Proxy if an error is detected while the proxy is communicating with the database. This error can occur if your database server is not accessible.

User response: Make sure your database server is accessible, check your database and web server error logs.

Cannot execute change permission command (chmod/attrib)

Explanation: The driver is unable to change the permissions on the client JAR file. This could happen if your client platform does not support the chmod or attrib command, or if the user running the JDBC application does not have the authority to change access permissions on the client JAR file.

User response: Make sure that the chmod or attrib command is available for your platform and that the user running the application has the authority to change access permissions on the client JAR file.
Same Jar SQL name already exists in the system catalog

Explanation: The JAR file name specified when your application called UDTManager.createJar() has already been registered in the database server.

User response: Use UDTMetaData.setJarFileSQLName() to specify a different SQL name for the JAR file.

Unable to copy jar file from client to server

Explanation: This error occurs when the path name set using setJarTmpPath() is not writable by user informix or the user specified in the JDBC connection.

User response: Make sure the pathname is readable and writable by any user.

No UDR information was set in UDRMetaData

Explanation: Your application called the UDRManager.createUDRs() method without specifying any UDRs for the database server to register.

User response: Specify UDRs for the database server to register by calling the UDRMetaData.setUDR() method before calling the UDRManager.createUDRs() method.

SQL name of the jar file was not set in UDR/UDT MetaData

Explanation: Your application called either the UDTManager.createUDT() or the UDRManager.createUDRs() method without specifying an SQL name for the JAR file containing the opaque types or UDRs for the database server to register.

User response: Specify an SQL name for a JAR file by calling the UDRMetaData.setJarFileSQLName() method before calling the UDRManager.createUDT() or UDRManager.createUDRs() method.

Can't create/remove UDT/UDR as no database is specified in the connection

Explanation: Your application created a connection without specifying a database. The following example establishes a connection and opens a database named test:

```java
url = "jdbc:informix-sqli:myhost:1533:" + "informixserver=myserver;user=rdtest;
password=test";
conn = DriverManager.getConnection(url);
```

User response: To resolve this problem, use the following SQL statements after the connection is established and before calling the createUDT() or createUDRs() methods:

```java
Statement stmt = conn.createStatement();
stmt.executeUpdate("create database test ...");
```

Alternatively, use the following code:

```java
stmt.executeUpdate("database test");
```

JAR file on the client does not exist or can't be read

Explanation: This error occurs for one of the following reasons:

- You failed to create a client JAR file.
- You specified an incorrect pathname for the client JAR file.
- The user running the JDBC application or the user specified in the connection does not have permission to open or read the client JAR file.

Invalid JAR file name

Explanation: The client JAR file your application specified as the second parameter to UDTManager.createUDT() or UDRManager.createUDRs() must end with the .jar extension.

The 'javac' or 'jar' command failed

Explanation: The driver encountered compilation errors in one of the following cases:

- Compiling .class files into .jar files, using the jar command, in response to a createJar() command from the JDBC application
- Compiling .java files into .class files and .jar files, using the javac and jar commands, in response to a UDTManager.createUDTClass() method call from the JDBC application.

Same UDT SQL name already exists in the system catalog

Explanation: Your application called UDTMetaData.setSQLName() and specified a name that is already in the database server.
-79849  UDT SQL name was not set in UDTMetaData

**Explanation:** Your application failed to call UDTMetaData.setSQLName() to specify an SQL name for the opaque type.

-79850  UDT field count was not set in UDTMetaData

**Explanation:** Your application called UDTManager.createUDTClass() without first specifying the number of fields in the internal data structure that defines the opaque type.

**User response:** Specify the number of fields by calling UDTMetaData.setFieldCount().

-79851  UDT length was not set in UDTMetaData

**Explanation:** Your application called UDTManager.createUDTClass() without first specifying a length for the opaque type.

**User response:** Specify the total length for the opaque type by calling UDTMetaData.setLength().

-79852  UDT field name or field type was not set in UDTMetaData

**Explanation:** Your application called UDTManager.createUDTClass() without first specifying a field name and data type for each field in the data structure that defines the opaque type.

**User response:** Specify the field name by calling UDTMetaData.setFieldName(); specify a data type by calling UDTMetaData.setFieldType().

-79853  No class files to be put into the jar

**Explanation:** Your application called the createJar() method and passed a zero-length string for the classnames parameter. The method signature is as follows:

createJar(UDTMetaData mdata, String[] classnames)

-79854  UDT java class must implement java.sql.SQLData interface

**Explanation:** Your application called UDTManager.createUDT() to create an opaque type whose class definition does not implement the java.sql.SQLData interface. UDTManager cannot create an opaque type from a class that does not implement this interface.

-79855  Specified UDT java class is not found

**Explanation:** Your application called the UDTManager.createUDT() method but the driver could not find a class with the name you specified for the third parameter.

-79856  Specified UDT does not exists in the database.

**Explanation:** Your application called UDTManager.removeUDT(String sqlname) to remove an opaque type named sqlname from the database, but the opaque type with that name does not exist in the database.

-79857  Invalid support function type

**Explanation:** This error occurs only if your application called the UDTMetaData.setSupportUDR() method and passed an integer other than 0 through 7 for the type parameter.

**User response:** Use the constants defined for the support UDR types. For more information, see “The setSupportUDR() and setUDR() methods” on page 5-16.

-79858  The command to remove file on the client failed

**Explanation:** If UDTMetaData.keepJavaFile() is not called or is set to FALSE, the driver removes the generated .java file when the UDTManager.createUDTClass() method executes. This error results if the driver was unable to remove the .java file.

-79859  Invalid UDT field number

**Explanation:** Your application called a UDTMetaData.setXXX() or UDTMetaData.getXXX() method and specified a field number that was less than 0 or greater than the value set through the UDTMetaData.setFieldCount() method.

-79860  Ambiguous java type(s) - can't use Object/SQLData as method argument(s)

**Explanation:** One or more parameters of the method to be registered as a UDR is of type java.lang.Object or java.sql.SQLData. These Java data types can be mapped to more than one IBM Informix data type, so the driver is unable to choose a type.

**User response:** Avoid using java.lang.Object or java.sql.SQLData as method arguments.
-79861 Specified UDT field type has no Java type match

Explanation: Your application called UDTMetaData.setFieldType() and specified a data type that has no 100 percent match in Java. The following data types are in this category:

- IfxTypes.IFX_TYPE_BYTE
- IfxTypes.IFX_TYPE_TEXT
- IfxTypes.IFX_TYPE_VARCHAR
- IfxTypes.IFX_TYPE_NVARCHAR
- IfxTypes.IFX_TYPE_LVARCHAR

User response: Use IFX_TYPE_CHAR or IFX_TYPE_NCHAR instead; these data types map to java.lang.String.

-79862 Invalid UDT field type

Explanation: Your application called UDTMetaData.setFieldType() and specified an unsupported data type for the opaque type. For supported data types, see "Mapping for field types" on page C-17.

-79863 UDT field length was not set in UDTMetaData

Explanation: Your application specified a field of character, date-time, or interval type by calling UDTMetaData.setFieldType(), but failed to specify a field length. Call UDTMetaData.setFieldLength() to set a field length.

-79864 Statement length exceeds the maximum

Explanation: Your application issued an SQL PREPARE, DECLARE, or EXECUTE IMMEDIATE statement that is longer than the database server can handle. The limit differs with different implementations, but in most cases is up to 32,000 characters.

User response: Review the program logic to ensure that an error has not caused your application to present a string that is longer than intended. If the text has the intended length, revise the application to present fewer statements at a time.

This is the same as error -460 returned by the database server.

-79865 Statement already closed

Explanation: This error occurs when an application attempts to access a statement method after the stmt.close() method.

-79868 Result set not open, operation not permitted

Explanation: This error occurs when an application attempts to access a ResultSet method after the ResultSet.close() method.

-79877 Invalid parameter value for setting maximum field size to a value less than zero

Explanation: This error occurs when an application attempts to set the maximum field size to a value less than zero.

-79878 Result set not open, operation next not permitted. Verify that autocommit is OFF

Explanation: This error occurs when an application attempts to access the ResultSet.next() method without executing a result set query.

-79879 An unexpected exception was thrown. See next exception for details

Explanation: This error occurs when a non-SQL exception occurs; for example, an IO exception.

-79880 Unable to set JDK Version for the Driver

Explanation: This error occurs when the driver cannot obtain the JDK version from the Java virtual machine.

-79881 Already in local transaction, so cannot start XA transaction

Explanation: This error occurs when the application attempts to start an XA transaction while a local transaction is still in progress.
Appendix F. Accessibility

IBM strives to provide products with usable access for everyone, regardless of age or ability.

Accessibility features for IBM Informix products

Accessibility features help a user who has a physical disability, such as restricted mobility or limited vision, to use information technology products successfully.

### Accessibility features

The following list includes the major accessibility features in IBM Informix products. These features support:

- Keyboard-only operation.
- Interfaces that are commonly used by screen readers.
- The attachment of alternative input and output devices.

**Tip:** The information center and its related publications are accessibility-enabled for the IBM Home Page Reader. You can operate all features by using the keyboard instead of the mouse.

### Keyboard navigation

This product uses standard Microsoft Windows navigation keys.

### Related accessibility information

IBM is committed to making our documentation accessible to persons with disabilities. Our publications are available in HTML format so that they can be accessed with assistive technology such as screen reader software.

You can view the publications in Adobe Portable Document Format (PDF) by using the Adobe Acrobat Reader.

### IBM and accessibility

See the [IBM Accessibility Center](http://www.ibm.com/able) for more information about the IBM commitment to accessibility.

### Dotted decimal syntax diagrams

The syntax diagrams in our publications are available in dotted decimal format, which is an accessible format that is available only if you are using a screen reader.

In dotted decimal format, each syntax element is written on a separate line. If two or more syntax elements are always present together (or always absent together), the elements can appear on the same line, because they can be considered as a single compound syntax element.

Each line starts with a dotted decimal number; for example, 3 or 3.1 or 3.1.1. To hear these numbers correctly, make sure that your screen reader is set to read punctuation. All syntax elements that have the same dotted decimal number (for example, all syntax elements that have the number 3.1) are mutually exclusive.
alternatives. If you hear the lines 3.1 USERID and 3.1 SYSTEMID, your syntax can include either USERID or SYSTEMID, but not both.

The dotted decimal numbering level denotes the level of nesting. For example, if a syntax element with dotted decimal number 3 is followed by a series of syntax elements with dotted decimal number 3.1, all the syntax elements numbered 3.1 are subordinate to the syntax element numbered 3.

Certain words and symbols are used next to the dotted decimal numbers to add information about the syntax elements. Occasionally, these words and symbols might occur at the beginning of the element itself. For ease of identification, if the word or symbol is a part of the syntax element, the word or symbol is preceded by the backslash (\) character. The * symbol can be used next to a dotted decimal number to indicate that the syntax element repeats. For example, syntax element *FILE with dotted decimal number 3 is read as 3* FILE. Format 3* FILE indicates that syntax element FILE repeats. Format 3* \* FILE indicates that syntax element * FILE repeats.

Characters such as commas, which are used to separate a string of syntax elements, are shown in the syntax just before the items they separate. These characters can appear on the same line as each item, or on a separate line with the same dotted decimal number as the relevant items. The line can also show another symbol that provides information about the syntax elements. For example, the lines 5.1*, 5.1 LASTRUN, and 5.1 DELETE mean that if you use more than one of the LASTRUN and DELETE syntax elements, the elements must be separated by a comma. If no separator is given, assume that you use a blank to separate each syntax element.

If a syntax element is preceded by the % symbol, that element is defined elsewhere. The string following the % symbol is the name of a syntax fragment rather than a literal. For example, the line 2.1 %OP1 refers to a separate syntax fragment OP1.

The following words and symbols are used next to the dotted decimal numbers:

? Specifies an optional syntax element. A dotted decimal number followed by the ? symbol indicates that all the syntax elements with a corresponding dotted decimal number, and any subordinate syntax elements, are optional. If there is only one syntax element with a dotted decimal number, the ? symbol is displayed on the same line as the syntax element (for example, 5? NOTIFY). If there is more than one syntax element with a dotted decimal number, the ? symbol is displayed on a line by itself, followed by the syntax elements that are optional. For example, if you hear the lines 5 ?, 5 NOTIFY, and 5 UPDATE, you know that syntax elements NOTIFY and UPDATE are optional; that is, you can choose one or none of them. The ? symbol is equivalent to a bypass line in a railroad diagram.

! Specifies a default syntax element. A dotted decimal number followed by the ! symbol and a syntax element indicates that the syntax element is the default option for all syntax elements that share the same dotted decimal number. Only one of the syntax elements that share the same dotted decimal number can specify a ! symbol. For example, if you hear the lines 2? FILE, 2.1! (KEEP), and 2.1 (DELETE), you know that (KEEP) is the default option for the FILE keyword. In this example, if you include the FILE keyword but do not specify an option, default option KEEP is applied. A default option also applies to the next higher dotted decimal number. In this example, if the FILE keyword is omitted, default FILE(KEEP) is used.
However, if you hear the lines 2? FILE, 2.1, 2.1.1! (KEEP), and 2.1.1 (DELETE), the default option KEEP only applies to the next higher dotted decimal number, 2.1 (which does not have an associated keyword), and does not apply to 2? FILE. Nothing is used if the keyword FILE is omitted.

* Specifies a syntax element that can be repeated zero or more times. A dotted decimal number followed by the * symbol indicates that this syntax element can be used zero or more times; that is, it is optional and can be repeated. For example, if you hear the line 5.1* data-area, you know that you can include more than one data area or you can include none. If you hear the lines 3*, 3 HOST, and 3 STATE, you know that you can include HOST, STATE, both together, or nothing.

Notes:
1. If a dotted decimal number has an asterisk (*) next to it and there is only one item with that dotted decimal number, you can repeat that same item more than once.
2. If a dotted decimal number has an asterisk next to it and several items have that dotted decimal number, you can use more than one item from the list, but you cannot use the items more than once each. In the previous example, you can write HOST STATE, but you cannot write HOST HOST.
3. The * symbol is equivalent to a loop-back line in a railroad syntax diagram.

+ Specifies a syntax element that must be included one or more times. A dotted decimal number followed by the + symbol indicates that this syntax element must be included one or more times. For example, if you hear the line 6.1+ data-area, you must include at least one data area. If you hear the lines 2+, 2 HOST, and 2 STATE, you know that you must include HOST, STATE, or both. As for the * symbol, you can repeat a particular item if it is the only item with that dotted decimal number. The + symbol, like the * symbol, is equivalent to a loop-back line in a railroad syntax diagram.
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Index

Special characters
.java file, retaining 5-12
(!) exclamation point 1-6

Numerics
5.x database servers 2-10

A
absolute() method 3-3, E-3, E-5
Accessibility F-1
dotted decimal format of syntax diagrams F-1
keyboard F-1
shortcut keys F-1
syntax diagrams, reading in a screen reader F-1
Accessing a database remotely 2-22
activateHDRPool_Primary() method 7-6
activateHDRPool_Secondary() method 7-6
addBatch() method 3-17
addProp() method B-1
afterLast() method E-5
Alignment values 5-12
Anonymous search of sqlhosts information 2-17
APPENDISAM environment variable 2-10
APPLET tag 1-9
Applets
and database access 2-22
using IBM Informix JDBC Driver in 1-9, 2-1
ARCHIVE attribute of APPLET tag 1-9
Array class 4-16
ArrayList class 4-13
Arrays 4-13, 4-16
Autocommit transaction mode 3-20
autofree.java example program 7-3, A-2
Automatically freeing the cursor 3-24, 7-3

B
Batch updates to the database 3-4
BatchUpdate.java example program 3-5, A-2
BatchUpdateException interface 3-5
beforeFirst() method E-3, E-5
BEGIN WORK statement 4-48
BIG_FET_BUF_SIZE environment variable 2-10, 7-1
BIGINT
data type 4-7
BIGINT data type D-5
BIGSERIAL
data type 4-7
Binary qualifiers for INTERVAL data types 4-8
BLOB and CLOB data types, accessing 4-27
BLOB and CLOB example programs A-4
BLOB data type
caching 4-3, 4-50, 7-2
code set conversion 6-13
definition of 4-34

BLOB data type (continued)
examples of creation 4-51
data retrieval 4-52
extensions for 4-27
format of 4-34
BOOLEAN data type C-2
Browsers 1-9
Bulk inserts 3-5
BulkInsert.java example program 3-5
BYTE and TEXT example programs A-4
BYTE data type
caching 7-2
code set conversion 6-13
data inserts and updates 4-3
data retrieval 4-5
extensions for 4-3
ByteType.java example program 4-3, 4-5, A-2

C
Caching large objects 7-2
Caching type information 4-26, 5-3
CallableStatement
named parameters 3-11
with overloaded stored procedures 3-15
CallableStatement interface 3-1, 3-6, E-9, E-10
CallOut1.java example program A-2
CallOut2.java example program A-2
CallOut3.java example program A-2
CallOut4.java example program A-2
Catalogs
IBM Informix JDBC Driver interpretation 3-23
systables 3-23, 6-8
CHAR (n) data type D-2
CHARACTER (n) data type D-2
charattrUDT.java example program A-4
Class name 5-12
Classes
Array 4-16
ArrayList 4-13
textsibleObject 2-16
HashSet 4-13, 4-14
helper 1-4
IfmxStatement 3-24
IfxBlob 4-34
IfxClob 4-34
IfxConnectionEventListener 1-2
IfxConnectionPoolDataSource 1-2, B-1
IfxCoreDataSource 1-2
IfxDataSource 1-2, B-1
IfxDriver 2-1
IfxJDBCProxy 2-23
IfxLobDescriptor 4-30
IfxLocator 4-38
IfxPooledConnection 1-2
IfxTypes C-5, C-8
IfxUDTManager 5-4
IfxUDTMetaData 5-4

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Classes (continued)

- IfxXADataSource 1-2
- Interval 4-8
- IntervalDF 4-11
- IntervalYM 4-9
- Java.Socket 2-18
- Locales 6-1
- Message 3-23
- ResultSet 6-2, 6-5
- SessionMgr 2-23
- SQLException 3-21, 3-22, C-9, C-12, C-13, C-15
- SqlbDelete 2-19
- SqlbUpload 2-18
- TimeoutMgr 2-23
- TreeSet 4-14
- UDRManager 5-4
- UDRMetaData 5-4
- Version 3-25

Classes implemented 1-2

- beyond Java specification 1-4
- extending Java specification 1-3
- Java interfaces 1-2

ClassGenerator utility 1-4, 4-25, A-8

CLASSPATH environment variable 1-8, 3-26, 4-25

Cleaning connections 7-7

CLIENT_LOCALE environment variable 6-1, 6-7

CLOB data type

- caching 4-3, 4-50, 7-2
- code set conversion 6-11
- code set conversion for 6-11
- definition of 4-34
- examples of
  - creation 4-51
  - data retrieval 4-52
- extensions for 4-27
- format of 4-34
- close() method 2-10, 3-2, 7-3

Code sets

- conversion of 6-8, 6-11
- converting TEXT data types 6-11
- synchronizing with locales 6-1
- table of 6-8
- user-defined 6-13

Collection data types

- examples of
  - using the array interface 4-16
  - using the collection interface 4-14
- extensions for 4-13
- in named and unnamed rows 4-17

Collection interface 4-13

com.informix.jdbc.Message class 3-24

COMMUT WORK statement 4-48

commit() method 3-20

compliance with standards xii

Concurrency and multiple threads 3-3

connect() method E-3

Connection interface 3-1, 3-20

Connection pool 7-3

- cleaning connections 7-7
- demo program 7-4
- example programs A-7
- properties for B-5
- Sun JDBC 3.0 properties 7-4
- tuning parameters 7-4
- using 7-3
- with HDR 7-6

Connection Pool Manager 7-4

- properties B-5

Connection pooling 1-2, 2-1, 2-2, B-1

Connection properties

- DATABASE 2-2
- IFXHOST 2-2
- INFORMIXSERVER 2-2
- PASSWORD 2-2, 2-5
- PORTNO 2-2
- USER 2-2, 2-5

Connection.close() method 2-33

ConnectionEventListener interface 1-2

ConnectionPoolDataSource B-5

ConnectionPoolDataSource interface 1-2

ConnectionPoolDataSource object 7-3

Connections

- cleaning 7-7
- creating using a DataSource object 2-2
- creating using DriverManager.getConnection() 2-4
to a database with non-ASCII characters 6-10

 Constructors

- IfxBlob() 4-34
- IfxClob() 4-34
- IfxLobDescriptor() 4-30
- IfxLocator() 4-30
- IntervalDF() 4-11
- IntervalYM() 4-9

- convertDateToDays() method
  - input parameters D-2
  - method signature D-2

- convertDaysToDate() method
  - input parameters D-2
  - method signature D-2

Converting

- decimal notation 6-1
- IfxLocator to hexadecimal 4-38
- internal Informix data types D-1
  - CORBA 2-26

Create opaque type from existing code 5-15

- createJar() method 5-13
- createTypes.java example program A-4
- createUDRs() method 5-17
- createUDT() method 5-14
- createUDTClass() method 5-13

Creating opaque type without preexisting class 5-10

Creating smart large objects 4-29

Cryptology options 2-26

CSM environment variable 2-10

- current() method E-5

Cursors

- automatically freeing 2-10, 3-24, 7-3
- hold 3-4
- scroll 3-3

D

Data integrity 4-45

Data types

- BLOB 7-2
- BOOLEAN C-2
- BYTE 4-3, 7-2
- CLOB 7-2
- collection 4-13
- conversion between Informix and Java D-1
- DataBlade API 5-3
- distinct 4-1
- INTERVAL 4-8
Data types (continued)
LVARCHAR C-2, C-12, C-13, C-15
mapping
for CallableStatement parameters 3-9
opaque data types 5-3
named row 4-16
opaque 5-1
and transactions 5-20
SERIAL 4-6
SERIAL8 4-6
TEXT 4-3, 7-2
unnamed row 4-16
DATABASE environment variable 2-2, 2-5
Database Locale information mismatch 6-8
Database server name
setting in database URLs 2-5
setting in DataSource objects 2-2
DatabaseMetaData interface 3-23, 3-25
DatabaseMetaData methods 3-23
DatabaseMetaData.supportsNamedParameters() method 3-12
Databases
batch updates of 3-4
names of, setting
in database URLs 2-5
in DataSource objects 2-2
querying 3-1
remote access options 2-22
specifying the locale of 6-1
URL 2-4, 2-5
with non-ASCII characters 6-10
DataBlade API data types 5-3
DataSource interface
element of A-1
extensions of B-1
Informix classes supporting 1-2
standard properties 2-2, B-2
DATE data type D-3
Dates
DBDATE formats of 6-5
formatting directives for 6-2
four-digit year expansion 6-6
GL_DATE formats of 6-2
inserting values 6-2, 6-5
native SQL formats of 6-2, 6-5
nonnative SQL formats of 6-2, 6-5
precedence rules for end-user formats 6-7
represented by strings 6-2
retrieving values 6-2, 6-5
string-to-date conversion 6-6
support for end-user formats 6-2
DATETIME data type D-3, D-5
DB_LOCALE environment variable 6-1, 6-7
DBANSIWARN environment variable 2-10
DBCENTURY environment variable 6-1, 6-6
DBCENTURYSelect.java example program 6-6, A-2
DBCENTURYSelect2.java example program 6-6, A-2
DBCENTURYSelect3.java example program 6-6, A-2
DBCENTURYSelect4.java example program 6-6, A-2
DBCENTURYSelect5.java example program 6-6, A-2
DBConnection.java example program 2-8, A-2
DBDATE environment variable 6-1, 6-5, 6-7
DBDATESelect.java example program A-2
DBMetaData.java example program A-2
DBSPACETIME environment variable 2-10
DBTEMP environment variable 2-10
DBUPSPACE environment variable 2-10
Deallocating resources 3-2
Debugging 7-1
Decimal conversion 6-1
DECIMAL data type D-4
deleteRow() method 3-3, E-9
deletesAreDetected() method 3-17
DELIMIDENT environment variable 2-10
Deploy parameter 5-14
Deployment descriptor 5-14
DESCRIBE INPUT statement 3-16
Directives, formatting, for dates 6-2
Disabilities, visual
reading syntax diagrams F-1
Disability F-1
dispValue() method 4-5
Distinct data types
caching type information 4-26, 5-3
examples for
inserting data 4-1
retrieving data 4-2
extensions for 4-1
unsupported methods for 4-3
distinct_d1.java example program A-4
distinct_d2.java example program A-4
Distributed transactions 1-2, 2-1, 2-2, 3-20
DOM (Document Object Model) 3-25
Dotted decimal format of syntax diagrams F-1
double data type D-4
DOUBLE PRECISION data type D-4
Driver interface 3-25
Driver restrictions, limitations 3-9
DriverManager interface 1-1, 2-1, 2-4, 2-9
Dynamic SQL 3-16

E
ENABLE_CACHE_TYPE environment variable 2-10, 4-26, 5-3
ENABLE_HDRSWITCH environment variable 2-10, 2-20
End-user formats for dates
precedence rules for 6-7
support for 6-2
Environment variables
APPENDISAM 2-10
BIG_FET_BUF_SIZE 2-10
CLASSPATH 1-8, 3-26, 4-25
CLIENT_LOCALE 6-1, 6-7
CSM 2-10
DATABASE 2-2, 2-5
DB_LOCALE 6-1, 6-7
DBANSIWARN 2-10
DBCENTURY 6-1, 6-6
DBDATE 6-1, 6-5, 6-7
DBSPACETIME 2-10
DBTEMP 2-10
DBUPSPACE 2-10
DELIMIDENT 2-10
ENABLE_CACHE_TYPE 2-10, 4-26, 5-3
ENABLE_HDRSWITCH 2-10, 2-20
FET_BUF_SIZE 2-10, 7-1, A-2
GL_DATE 6-1, 6-2, 6-7
GL_USEGLU 6-1
IFMX_CPM_AGELIMIT 7-4
IFMX_CPM_ENABLE_SWITCH_HDRPOOL 7-4
IFMX_CPM_INIT_POOLSIZE 7-4
IFMX_CPM_MAX_CONNECTIONS 7-4
IFMX_CPM_MAX_POOLSIZE 7-4
IFMX_CPM_MIN_AGELIMIT 7-4
IFMX_CPM_MIN_POOLSIZE 7-4

Index X-3
Environment variables (continued)

IFMX_CPM_SERVICE_INTERVAL 7-4
IFX_AUTOFREE 2-10, 7-3, A-2
IFX_BATCHUPDATE_PER_SPEC 2-10, 3-5
IFX_CODECETLOB 2-10, 6-11
IFX_DIRECTIVES 2-10
IFX_EXTDIRECTIVES 2-10
IFX_GET_SMFLOAT_AS_FLOAT 2-10
IFX_ISOLATION_LEVEL 2-10
IFX_LOB_XFERSIZE 4-50
IFX_PAD_VARCHAR 2-10
IFX_SET_FLOAT_AS_SMFLOAT 2-10
IFX_TRIMTRAILINGSpaces 2-10
IFX_USEPUT 2-10, 3-5
IFX_XASPEC 2-10
IFX_XASTDCOMPLIANCE_XAEND 2-10
IFXHOST 2-2, 2-5, 2-10
IFXHOST_SECONDARY 2-10, 2-20
INFORMIXCONRETRY 2-10
INFORMIXCONTIME 2-10
INFORMIXSERVER 2-2, 2-5, 2-8, 2-10
INFORMIXSERVER_SECONDARY 2-10, 2-20
INFORMIXOPCACHE 2-10
INFORMIXSERVER 2-2, 2-5, 2-8, 2-10
INFORMIXSTACKSIZE 2-10
JDBCTEMP 2-10
LOBCACHE 2-10, 4-3, 4-50, 7-2
LOGINTIMEOUT 2-10
NEWCODESET 6-1, 6-13
NEWLOCAL 6-1, 6-13
NEWNLISMAP 2-10, 6-14
NODEFDAC 2-10
OPT_GOAL 2-10
OPTCOMPIND 2-10
OPTOFC 2-10, 7-3, A-2
PATH 2-10
PDQPRIORITY 2-10
PLCONFIG 2-10
POOLD_LO_PATH 2-10
PORTNO 2-2, 2-5
PORTNO_SECONDARY 2-10, 2-20
PROXY 2-10
PSORT_DBTEMP 2-10
PSORT_NPROCS 2-10
SECURITY 2-10
specifying 2-5, 2-9
SQLH_TYPE 2-10
SQLDEBUG 2-10
STMT_CACHE 2-10
supported 6-1
TRUSTED_CONTEXT 2-10
USEVSERVER 2-10
equals() method 4-10, 4-12
Error messages
globalization of 6-14
RSAM 3-22
SQLCODE 3-22
standard Informix E-1
ErrorHandling.java example program 3-22, A-2
Errors
handling 3-21
retrieving message text 3-23
retrieving syntax error offset 3-22
SQLException class, using 3-21
Escape syntax 3-17
Example programs
connection pool A-7
Example programs (continued)
HDR A-8
proxy server A-6
XML documents A-8
Examples
autofree.java 7-3, A-2
BatchUpdate.java 3-5, A-2
BLOB and CLOB A-4
BLOB and CLOB data types
creation 4-51
data retrieval 4-52
BulkInsert.java 3-5
BYTE and TEXT A-4
BYTE and TEXT data types 4-3, 4-5
ByteType.java 4-3, 4-5, A-2
CallOut1.java A-2
CallOut2.java A-2
CallOut3.java A-2
CallOut4.java A-2
charattrUDT.java A-4
collection data types
using the array interface 4-16
using the collection interface 4-14
createTypes.java A-4
DataSource A-1
eDBCENTURYSelect.java 6-6, A-2
eDBCENTURYSelect2.java 6-6, A-2
eDBCENTURYSelect3.java 6-6, A-2
eDBCENTURYSelect4.java 6-6, A-2
eDBCENTURYSelect5.java 6-6, A-2
eDBConnection.java 2-8, A-2
eDBDATESelect.java A-2
eDBMetaData.java A-2
distinct data types
inserting data 4-1
retrieving data 4-2
distinct_d1.java A-4
distinct_d2.java A-4
ErrorHandling.java 3-22, A-2
GenericStruct.java A-5
eGLDATESelect.java A-2
Intervaldemo.java 4-13, A-2
largebinUDT.java A-4
eList1.java A-5
eList2.java A-5
eLOCALESelect.java A-2
eLocmsg.java 6-14, A-2
manualUDT.java A-4
MultiRowCall.java A-2
myMoney.java A-4
named and unnamed rows
creating a Struct class for 4-22
using the SQLData interface for a named row 4-18
using the Struct interface 4-22
named row A-5
opaque data types
defining a class for 5-20
large objects 5-23
retrieving data 5-22
OptimizedSelect.java A-2
optofc.java 2-9, 7-3, A-2
OUT parameter 3-6
PropertyConnection.java A-2
row3.java A-5
eRSMetaData.java A-2
ScrollCursor.java 3-3, A-2
Serial.java A-2

X-4 IBM Informix JDBC Driver Programmer's Guide
Examples (continued)
SimpleCall.java A-2
SimpleConnection.java A-2
SimpleSelect.java A-2
smart large object A-4
TextConv.java A-2
TextType.java 4-3, 4-5, A-2
UDR Manager A-8
UDT Manager A-8
udt_d1.java A-4
udt_d2.java A-4
udt_d3.java A-4
UpdateCursor1.java 3-3, A-2
UpdateCursor2.java 3-3, A-2
UpdateCursor3.java 3-3, A-2
user-defined routines 5-35
XML documents 3-29
Exclamation point (!) in installation path 1-6
execute() method 3-2, 3-17, E-4
executeBatch() method E-4
executeQuery() method 3-1, 3-9, 3-24
executeUpdate() method 2-8, 4-3, E-4
executeXXX() method E-3
extensibleObject class 2-16

F
Federal Information Processing Standards compliance 2-27
FET_BUF_SIZE environment variable 2-10, 7-1, A-2
File interface 4-3
FileStream interface 4-3
Files
SessionMgr.class 2-23
FilesTimeoutMgr.class 2-23
FIPS compliance 2-27
first() method E-3, E-5
Formatting directives for dates 6-2
forName() method 2-1
Freeing cursors 2-10
fromHexString() method 4-38
fromString() method 4-10, 4-12

G
GenericStruct.java example program A-5
getAlignment() method 5-19
getArray() method 4-13, 4-16, E-7
getAsciiStream() method 4-5, 4-33
getAttributes() method 4-22, E-6
getAutoAlignment() method 5-2
getAutoFree() method 3-24, 7-3
getBigSerial() method 4-7
getBinaryStream() method 4-5, 4-33
getBlob() method 4-33, 4-52, E-9
getBytes() method 4-33, 6-11, 6-12
getCatalogName() method 3-17
getCatalogs() method 3-23
getClassName() method 5-19
getCllob() method 4-33, 4-52, E-9
getConnection() method 2-8, 2-9, E-3
getCurrentPosition() method 5-2
getDatabaseName() method B-2
getDataSourceName() method B-2
getDate() method 6-6
getDescription() method B-2
getDriverMajorVersion() method 3-25
getDriverMinorVersion() method 3-25
getDsProperties() method B-1
getErrorCode() method 4-9
getExecute() method 3-21
getFetchSize() method 3-17
getFieldCount() method 5-19
getFieldLength() method 5-19
getFieldName() method 5-19
getFieldName() method 4-9
getFieldType() method 5-19
getHDRtype() method 2-20
getIfxCLIENT_LOCALE() method B-2
getIfxCPMInitPoolSize() method B-2
getIfxCPMMaxAgeLimit() method B-5
getIfxCPMMaxConnections() method B-5
getIfxCPMMaxPoolSize() method B-5
getIfxCPMMinAgeLimit() method B-5
getIfxCPMMinPoolSize() method B-5
getIfxCPServiceInterval() method B-5
getIfxCPSwitchHDPool() method B-5
getIfxCSM() method B-2
getIfxDB_LOCALE() method B-2
getIfxDBCENTURY() method B-2
getIfxDBDATE() method B-2
getIfxGL_DATE() method B-2
getIfxIFX_CODESETLOB() method B-2
getIfxIFX_DIRECTIVES() method B-2
getIfxIFX_EXDIRECTIVES() method B-2
getIfxIFX_CODECSETLOB() method B-2
getIfxIFX_FLAT_UCSQ() method B-2
getIfxIFX_GET_SMFLOAT_AS_FLOAT() method B-2
getIfxIFX_ISOATION_LEVEL() method B-2
getIfxIFX_LOCK_MODE_WAIT() method B-2
getIfxIFX_LOCK_MODE_WAIT() method B-2
getIfxIFX_SET_FLOAT_AS_SMFLOAT() method B-2
getIfxIFX_TRIMTRAILINGSPACES() method B-2
getIfxIFX_XASPEC() method B-2
getIfxIFXHOST_SECONDARY() method B-2
getIfxIFXHOST() method B-2
getIfxINFORMIXCONRETRY() method B-2
getIfxINFORMIXCONTIME() method B-2
getIfxINFORMIXDCACHE() method B-2
getIfxINFORMIXSERVER_SECONDARY() method B-2
getIfxINFORMIXSTACKSIZE() method B-2
getIfxJDBCTEMP() method B-2
getIfxLDAP_IFXBASE() method B-2
getIfxLDAP_PASSWD() method B-2
getIfxLDAP_URL() method B-2
getIfxLDAP_USER() method B-2
getIfxLIBCACHE() method B-2
getIfxNEWCODESET() method B-2
getIfxNEWlocale() method B-2
getIfxNEWNLSMAP() method B-2
getIfxNODEFDAC() method B-2
getIfxOPT_GOAL() method B-2
getIfxOPTCOMPIND() method B-2
getIfxOPTOFC() method B-2
getIfxPATH() method B-2
getIfxPDQPRIORITY() method B-2
getIfxPLCONFIG() method B-2
getIfxLOAD_LO_PATH() method B-2
getIfxPORTNO_SECONDARY() method B-2
getIfxPROXY() method B-2
getIfxPSORT_DBTEMP() method B-2
getIfxPSORT_NPROCS() method B-2
getIfxSECURITY() method B-2
getIfxSQLH_FILE() method B-2
getIfxSQLH_TYPE() method B-2
getIfxSQLDEBUG () method B-2
getIfxSTMT_CACHE() method B-2
getIfxTypeName() method 4-9
getInputSource() method 3-28
getJarFileSQLName() method 5-19
getJDBCVersion() method 3-25
getLength() method 4-9, 5-19
getLocator() method 4-34, 4-52
getMajorVersion() method 3-25
getMessage() method 3-21
getMetaData() method 3-9
getMinorVersion() method 3-25
getMonths() method 4-10
getNanoSeconds() method 4-12
getNextException() method 3-22
getObject() method 4-13, 4-16, 4-18, 4-21, 4-22
getParameterAlignment method 3-16
getParameterExtendedId method 3-16
getParameterExtendedName method 3-16
getParameterExtendedOwnerName method 3-16
getParameterLength method 3-16
getPassword() method B-2
getPortNumber() method B-2
getProcedureColumns() method 3-17
getProp() method B-1
getQualifier() method 4-9
getRef() method 3-17
getResultSet() method E-4, E-6
getSavepointId() method 3-20
getSavepointName() method 3-20
getScale() method 4-9
getSchemaName() method 3-17
getSchemas() method 3-23
getSeconds() method 4-12
getSerial() method 4-6
getSerial8() method 4-6
getServerName() method B-2
getSQLName() method 5-19
getSQLState() method 3-21
getSQLTypeName() method 4-18, 4-21, 4-22, 4-26, 5-3
getStartCode() method 4-9
getString() method 4-33, 6-2, 6-5, 6-11, 6-12
getTableColumn() method 3-17
getText() method 6-10
getTimestamp() method 6-6
getTypeMap() method 4-16, 4-18
getUDR() method 5-20
getUDRSQLName() method 5-20
getUnicodeStream() method 3-17
getUpdateCount() method E-4, E-6
getUpdateCounts() method 3-5
getUser() method B-2
getWarnings() method 3-9
getXXX() method 3-1, 3-6, C-12, C-13, C-15, E-9
GL_DATE environment variable 6-1, 6-2, 6-7
GL_USEGLU environment variable 6-1
GLDATESelect.java example program A-2
Global Language Support (GLS) 6-1
Globalization (continued)
decimal notation 6-1
greaterThan() method 4-10, 4-12
Group entries in an HDR pair 2-20
group option, of sqlhosts file 2-16

H
Hashset class 4-13, 4-14
hasOutParameter() method 3-9
HDR
group entry 2-20
HDR pair 2-20
Hexadecimal format, converting between 4-38
Hexadecimal string format 4-38
High-Availability Data Replication
checking read-only status 2-20
demo for 2-19
evironment variables for 2-20
example programs A-8
IFMX_CPM_ENABLE_SWITCH_HDRPOOL 7-4
reetrying connections 2-21
specifying secondary servers 2-20
using 2-19
with connection pooling 7-6
Hold cursors 3-4
Host names, setting
in database URLs 2-5
in DataSource objects 2-2
HP-UX
PTHREAD_COMPAT_MODE 7-8
HTTP proxy 2-22, 2-23

I
IBM Informix JDBC Driver
connection pools, using with 7-3
IBM xml4j parser 3-26
IFMX_CPM_AGELIMIT environment variable 7-4
IFMX_CPM_ENABLE SWITCH_HDRPOOL environment variable 7-4
IFMX_CPM_INIT_POOLSIZE environment variable 7-4
IFMX_CPM_MIN_AGELIMIT environment variable 7-4
IFMX_CPM_MAX_CONNECTIONS environment variable 7-4
IFMX_CPM_MAX_POOLSIZE environment variable 7-4
IFMX_CPM_MIN_POOLSIZE environment variable 7-4
IFMX_CPM_SERVICE_INTERVAL environment variable 7-4
IfmxCallableStatement interface 3-9
IfmxStatement class 3-24
IfmxUdtSQLInput interface 5-1
IfmxUdtSQLOutput interface 5-1, 5-2
IFX_AUTOFREE environment variable 2-10, 7-3, A-2
IFX_BATCHUPDATE_PER_SPEC environment variable 2-10, 3-5
IFX_CODESETLOB environment variable 2-10, 6-11
IFX_DIRECTIVES environment variable 2-10
IFX_EXTDIRECTIVES environment variable 2-10
IFX_FLAT_UCSQ environment variable 2-10
IFX_GET_SMFLOAT_AS_FLOAT environment variable 2-10
IFX_INSERT_UPDATE environment variable 2-10
IFX_ISO16655 environment variable 2-10
IFX_ISO16655 environment variable 2-10
IFX_ISO16655 environment variable 2-10
IFX_LOB_XFERSIZE environment variable 4-50
IFX_LOCK_MODE_WAIT 2-10
IFX_LOCK_MODE_WAIT environment variable 2-10
IFX_PADVARCHAR environment variable 2-10
IFX_SET_FLOAT AS SMFLOAT environment variable 2-10

X-6 IBM Informix JDBC Driver Programmer's Guide
Index
Interfaces (continued)
DriverManager 1-1, 2-1, 2-4, 2-9
FileInputStream 4-3
Files 4-3
IfmxCallableStatement 3-9
IfmxUdtSQLInput 5-1
IfmxUdtSQLOutput 5-2
IfxCblob 4-34
InputStream 4-3
java.sql.Blob 4-34
List 4-13
PooledConnection 1-2
PreparedStatement 3-1, 3-5, C-3, C-12, C-13, C-15
ResultSet 3-1, 3-2, 7-3, C-12, C-13, C-15
ResultSetMetaData 3-1
Set 4-13
SQLData 4-16, 4-18, 4-25, 5-3, 5-4
SQLInput 4-18
Statements 2-8, 3-1, 3-5, 7-3
Struct 4-16, 4-21
Types 4-6, C-1
XACConnection 3-20
XDataSource 1-2
Internationalization 6-1, 6-14
Interval class 4-8
interval data type D-5
INTERVAL data type
  binary qualifiers for 4-8
  extensions for 4-8
  in named and unnamed rows 4-17
IntervalDemo.java example program 4-13, A-2
IntervalDF class 4-11
IntervalDF() constructor 4-11
IntervalYM class 4-9
IntervalYM() constructor 4-9
IP address, setting
  in database URLs 2-5
  in DataSource objects 2-2
IPv6 aware 2-7
isDefinitelyWriteable() method 3-17
isHDREnabled() method 2-20
isIfxDBANSIWARN() method B-2
isIfxDELIMIDENT() method B-2
isIfxENABLE_CACHE_TYPE() method B-2
isIfxAUTOFREE() method B-2
isIfxUSEV5SERVER() method B-2
isReadable() method 2-20, 3-17
isWriteable() method 3-17

J
JAR file, location on server 5-14
JAR files
  for JNDI 2-16
  for LDAP SPI 2-16
  ifxjdbc.jar 1-4, 1-9
  ifxjbc.jar 1-4
  ifxlang.jar 1-4, 6-14
  ifxsqli.jar 1-4
  ifxtools.jar 1-4, 4-25
jar utility 1-8
Java naming and directory interface (JNDI)
  and the sqlhosts file 2-16
Java virtual machine (JVM) 1-8
java.io file 6-1

K
keepJavaFile() method 5-12

L
LargeBinUDT.java example program A-4
last() method E-5
LDAP server 2-2
  and HTTP proxy 2-25
  updating with sqlhosts data 2-18
length() method 5-2
lessThan() method 4-10, 4-12
Lightweight directory access protocol (LDAP) server
  administration requirements for 2-18
  and the sqlhosts file 2-16
  and unsigned applets 1-9
  JAR files for 2-16
  loader for 1-4
  URL syntax for 2-17
  utilities for 2-18
  version requirement 2-16
Limitations, driver 3-9
Limitations, server 3-6
List interface 4-13
list1.java example program A-5
list2.java example program A-5
LO handle
  in BLOB column 4-34
  in CLOB column 4-34
Loading IBM Informix JDBC Driver 2-1
LOBCACHE environment variable 2-10, 4-3, 4-50, 7-2
Locale class 6-1
Locales
  client, specifying 6-1
  database, specifying 6-1
  synchronizing with code sets 6-1
  table of 6-8
  user-defined 6-13
LOCALSELECT.java example program A-2
Locator object 4-30
Lock
  row 4-48
locmsg.java example program 6-14, A-2
Logging installation events 1-7
LOGINTIMEOUT environment variable 2-10
long data type D-5
LVARCHAR data type C-2, C-12, C-13, C-15

M
manualUDT.java example program A-4
map.get() method 4-18
map.put() method 4-18
Mapping
for CallableStatement parameters 3-9
opaque data types 5-3
maxIdleTime 7-4
maxPoolSize 7-4
maxStatements 7-4
Message class 3-23
Metadata, accessing database 3-23
Methods
absolute() 3-3, E-3, E-5
activateHDRPool_Primary() 7-6
activateHDRPool_Secondary() 7-6
addBatch() 3-17
addProp() B-1
afterLast() E-5
beforeFirst() E-3, E-5
close() 2-10, 3-2, 7-3
commit() 3-20
close() 2-10, 3-2, 7-3
connect() E-3
createJar() 5-14
createUDRs() 5-17
createUDT() 5-14
createUDTClass() 5-14
current() E-3
createJar() 5-14
createUDRs() 5-17
createUDT() 5-14
createUDTClass() 5-14
current() E-3
DatabaseMetaData 3-12
DatabaseMetaData.supportsNamedParameters() 3-12
deleteRow() E-9
deleteRow(), and scroll cursors 3-3
deletesAreDetected() 3-17
dispValue() 4-5
equals() 4-10, 4-12
execute() 3-2, 3-17, E-4
executeBatch() E-4
executeQuery() 3-1, 3-9, 3-24
executeUpdate() 2-8, 4-3, E-4
executeXXX() E-3
first() E-3, E-5
forName() 2-1
fromHexString() 4-38
fromString() 4-10, 4-12
getAlignment() 5-11
getArray() 4-13, 4-16, E-7
getAsciiStream() 4-5, 4-33
getAttributes() 4-22, E-6
getAutoAlignment() 5-2
getAutoFree() 3-24, 7-3
getBigSerial() 4-7
getBinaryStream() 4-5, 4-33
getBlob() 4-33, 4-52, E-9
getBytes() 4-33, 6-11, 6-12
getCatalogName() 3-17
getCatalogs() 3-23
getClass() 5-19
clob() 4-33, 4-52, E-9
getConnection() 2-4, 2-8, 2-9, E-3
currentPosition() 5-2
currentPosition() 5-2
currentRow() B-2
currentRow() B-2
Methods (continued)
getIfxPROXY() B-2
getIfxPSORT_DBTEMPI() B-2
getIfxPSORT_NPROC() B-2
getIfxSECURITY() B-2
getIfxSQLFILE() B-2
getIfxSQL_TYPE() B-2
getIfxSTMT_CACHE() B-2
getIfxTypeName() 4-9
getInputSource() 3-28
getJarFileSQLName() 5-19
getJDBCVersion() 3-25
getLength() 4-9, 5-11
getMajorVersion() 3-25
getMessage() 3-21
getMetaData() 3-9
getMinorVersion() 3-25
getMonths() 4-10
getNanoSeconds() 4-12
getNextException() 3-22
getObject() 4-13, 4-16, 4-18, 4-21, 4-22
getPassword() B-2
getPortNumber() B-2
getProcedureColumns() 3-17
getProp() B-1
getQualifier() 4-9
getRef() 3-17
getResultSet() 4-14, 5-6
getSavepointId() 3-20
getSavepointName() 3-20
getScale() 4-9
getSchemaName() 3-17
getSchemas() 3-23
getSeconds() 4-12
getServerName() B-2
getSQLNAME() 5-19
getSQLSTATE() 3-21
getSQLStatementOffset() 3-22
getSQLType() 3-19, 4-22, 4-26, 5-3
getStartCode() 4-9
getString() 4-33, 6-12, 6-2, 6-5, 6-11, 6-12
getText() 4-33
getTimestamp() 6-6
getTypeMap() 4-16, 4-18
getUDR() 5-17
getUDRNamed() 5-17
getUnicodeStream() 3-17
getUpdateCount() 3-5
getUpdateCounts() 3-5
getUser() B-2
getWarnings() 3-9
getUser() B-2
getXXX() 3-1, 3-6, 12, C-13, C-15, E-9
greaterThan() 4-10, 4-12
hasOutParameter() 3-9
IFX_XASTDCOMPLIANCE_XAEND() B-2
IFX_XASTDCOMPLIANCE_XAEND(int value) B-2
IfxLoClose() 4-38
IfxLoCreate() 4-30
IfxLoOpen() 4-30, 4-34, 4-35, 4-52
IfxLoRead() 4-34, 4-36, 4-52
IfxLoRelease() 4-38

Methods (continued)
IfxLoSeek() 4-35
IfxLoSize() 4-37
IfxLoTell() 4-35
IfxLoTruncate() 4-37
IfxLoWrite() 4-34, 4-37
IfxRegisterOutParameter() 3-9, E-9, E-10
IfxSetNull() 3-9, E-9
IfxSetObject() 6-6, C-4
InputStreamReader() 6-10, 6-11, 6-12
InputStreamToDOM() 3-26
insertRow() E-9
insertsAreDetected() 3-17
isDefinitelyWriteable() 3-17
isHDREnabled() 2-20
isIfxDBANSIWARN() B-2
isIfxDELIMIDENT() B-2
isIfxENABLE_CACHE_TYPE() B-2
isIfxFX_AUTOFREE() B-2
isIfxIFX_USEPUT() B-2
isIfxUSEV5SERVER() B-2
isReadOnly() 3-17
isWriteable() 3-17
keepJavaFile() 5-12
last() E-5
length() 5-2
lessThan() 4-10, 4-12
map.get() 4-18
map.put() 4-18
moveToCurrentRow() E-9
moveToInsertRow() E-9
next() 3-1, 4-5, 7-3
others DeletesAreVisible() 3-17
othersInsertsAreVisible() 3-17
othersUpdatesAreVisible() 3-17
OutputStreamWriter() 6-10, 6-11, 6-12
ownDeletesAreVisible() 3-17
ownInsertsAreVisible() 3-17
ownUpdatesAreVisible() 3-17
prepareStatement() 3-1
previous() E-5
put() 2-9, 7-3
read() 4-5
readArray() 4-3
readAsciiStream() 5-4
readBinaryStream() 5-4
readByte() 4-17
readBytes() 5-2, 5-4
readCharacterStream() 4-3, 4-17, 5-4
readObject() 4-17, 5-4
readProperties() B-1
readRef() 4-3, 4-17, 5-4
readSQL() 4-18, 4-25, 5-3
readString() 5-2, 5-4
refreshRow() 3-17
registerDriver() 2-1
resetOutParameter() 3-6, E-9
resetParameter() 3-6, E-9
relative() E-5
releaseSavepoint() 3-20
removeJar() 5-18
removeProperty() B-1
removeUDR() 5-18
rollbackSavepoint() 3-20
rowDeleted() 3-17
rowInserted() 3-17
rowUpdated() 3-17
scrubConnection() 7-7
Methods (continued)

set() 4-10, 4-12
setAlignment() 5-11
setArray() 4-13, C-6
setAsciiStream() 4-3, C-3, C-6
setAutoAlignment() 5-2
setAutoCommit() 3-20
setAutoFree() 3-24, 7-3
setBigDecimal() 4-1, 4-2, C-6
setBinaryStream() 4-3, C-3, C-6
setBlob() C-6
setBoolean() C-6
setByte() C-6
setBytes() C-6
setCatalog() 3-17
setCharacterStream() C-6
setClassName() 5-12
setClob() C-6
setCurrentPosition() 5-2
setDatabaseName() B-2
setDataSourceName() B-2
setDate() C-6
setDescription() B-2
setDouble() C-6
setExplicitCast() 5-15
setFetchDirection() E-5
setFetchSize() 3-17, E-5
setFieldCount() 5-10
setFieldLength() 5-11
setFieldTypeName() 5-11
setFloat() C-6
setIfxCLIENT_LOCALE() B-2
setIfxCPMinitPoolSize() B-5
setIfxCPMMaxPoolSize() B-5
setIfxCPMMaxAgeLimit() B-5
setIfxCPMMinPoolSize() B-5
setIfxCPMServiceInterval() B-5
setIfxCPMSwitchHDRPool() B-5
setIfxCSCM (String csm) B-2
setIfxDB_LOCALE() B-2
setIfxDBANSIWARN() B-2
setIfxDBCENTURY() B-2
setIfxDBSPACETEMP() B-2
setIfxDBTEMP() B-2
setIfxDELIMIDENT() B-2
setIfxENABLE__HDRSWITCH() B-2
setIfxENABLE_CACHE_TYPE() B-2
setIfxBUF_SIZE() B-2
setIfxGL_DATE() B-2
setIfx_AUTOFREE() B-2
setIfxCODESETLOB() B-2
setIfxDIRECTIVES() B-2
setIfx_EXDIRECTIVES() B-2
setIfx_FLAT_UCSQ() B-2
setIfx_ISOINTEGRATION_LEVEL B-2
setIfx_LOCK_MODE_WAIT B-2
setIfx_TRIMTRAILINGSPACES() B-2
setIfx_USEPUT() B-2
setIfxHOST() B-2
setIfxINFORMIXSERVER_SECONDARY() B-2
setIfxINFORMIXSTACKSIZE() B-2
setIfxDBCTEMP() B-2
setIfxLDAP_IFXBASE() B-2
setIfxLDAP_PASSWD() B-2
setIfxLDAP_URL() B-2
setIfxLDAP_USER() B-2
setIfxLOBCACHE() B-2
setIfxNEWCODESET() B-2
setIfxNEWLOCAL() B-2
setIfxNODEFDAC(String value) B-2
setIfxOPT_GOAL() B-2
setIfxOPTCOMPIND() B-2
setIfxOPTFOC() B-2
setIfxPATH() B-2
setIfxPDQ_PRIORITY() B-2
setIfxPLCONFIG() B-2
setIfxLOAD_LO_PATH() B-2
setIfxPROXY() B-2
setIfxPSORT_DBTEMP() B-2
setIfxPSORT_NPROCS() B-2
setIfxSECURITY() B-2
setIfxSQLH_FILE() B-2
setIfxSQLH_TYPE() B-2
setIfxSQLDEBUG B-2
setIfxSTMT_CACH() B-2
setIfxUSESERVER() B-2
setIfxVSTREAM() B-2
setIfxx() 3-1, C-6
setJarFileSQLName() 5-12, 5-16
setJarTmpPath() 5-14
setLength() 5-11
setLong() C-6
setMaxFieldSize() 3-17
setMaxRows() E-5
setNull() 4-1, 4-2, 4-13, 4-21, 6-6
setObject() B-2
setPortNumber() B-2
setQualifier() 4-10, 4-12
setReadOnly() 3-17
setRel() 3-17
setSavepoint() 3-20
setServerName() B-2
setShort() C-6
setSQLName() 5-12, 5-13, E-11, E-12
setString() 5-22, 6-6, C-6
setTime() C-6
setTimestamp() C-6
setTypeMap() 4-13, 4-18
setUDR() 5-17
setUDTExtName() 5-4
setUnideStream() 3-17
setUser() B-2
setXXX() 3-9, 5-22, C-4, C-9, C-11
skipBytes() 5-2
SQLInput() 4-17, 5-1
SQLOutput() 4-17, 5-1
StringtoDOM() 3-28
toString() 4-38
toUTF8() 4-38
toUTF8() 4-10, 4-12
unsupported
for distinct data types 4-3
for named rows 4-17
for opaque data types 5-4
Methods (continued)

unsupported (continued)
for querying the database 3-17
updateObject() 6-6
updateRow() E-9
updatesAreDetected() 3-17
updateString() 6-6
writeArray() 4-3
writeBinaryStream() 5-4
writeByte() 4-17
writeBytes() 5-2, 5-4
writeCharacterStream() 4-3, 4-17, 5-4
writeInt() 4-18
writeObject() 4-17, 4-18, 5-4, E-6
writeProperties() B-1
writeSQL() 4-3, 4-17, 5-4
writeString() 4-18, 4-25, 5-3
writeXXX() 4-18
XMLInputString 3-27
XMLoString() 3-27

Methods, DatabaseMetaData 3-23
minPoolSize 7-4
mitypes.h file 5-3
moveToCurrentRow() method E-9
moveToInsertRow() method E-9
Multiple OUT parameters 3-6
MultiRowCall.java example program A-2
myMoney.java example program A-4

N
Name-value pairs of database URL 2-5
Named notation 3-11
Named parameters
and stored procedures 3-13
in a CallableStatement 3-11
Named row data types
examples of
creating a Struct class for 4-22
using the SQLData interface 4-18
using the Struct interface 4-22
extensions for 4-16
generating using the ClassGenerator utility 4-25
intervals and collections in 4-17
opaque data type columns in 4-16
unsupported methods for 4-17
using the SQLData interface for 4-18
using the Struct interface for 4-21
Named row example programs A-5
Native SQL date formats 6-2, 6-5
NEWCODESET environment variable 6-1, 6-13
NEWLOCALE environment variable 6-1, 6-13
NEWNLSMAP environment variable 2-10, 6-14
next() method 2-10, 3-1, 4-5, 7-3
NODEFDAC environment variable 2-10
Nonnative SQL date formats 6-2, 6-5

O
Objects
IfxLocator 4-30
Locator 4-30
ODBC 1-1

Onspaces utility 4-40
Opaque data types
creating 5-4
definition of 5-1
elements of
defining a class for 5-20
large objects 5-23
retrieving data 5-22
examples of creating 5-25
mappings for 5-3
steps for creating 5-6
unsupported methods 5-4
Opaque type
SQL name 5-12
Opaque types
and transactions 5-20
creating 5-4
OPT_GOAL environment variable 2-10
OPTCOMPIND environment variable 2-10
OptimizedSelect.java example program A-2
OPTOFC environment variable 2-10, 7-3, A-2
optofc.java example program 2-9, 7-3, A-2
othersDeletesAreVisible() method 3-17
othersInsertsAreVisible() method 3-17
othersUpdatesAreVisible() method 3-17
OUT parameter 3-6
OUT parameter example programs 3-6
OutputStreamWriter() method 6-10, 6-11, 6-12
Overloaded UDRs
with a CallableStatement 3-15
Overloaded UDRs, removing 5-18
Overview of IBM Informix JDBC Driver 1-2
ownDeletesAreVisible() method 3-17
ownInsertsAreVisible() method 3-17
ownUpdatesAreVisible() method 3-17

P
ParameterMetaData class 3-12, 3-16
Parameters
named in a CallableStatement 3-11
retrieving names 3-12
PASSWORD connection property 2-2, 2-5
Passwords
setting in DataSource object 2-2
URL syntax of 2-5
PATH environment variable 2-10
OptimizedSelect.java example program A-2
PDQPRIORTY environment variable 2-10
Performance 7-1
PLCONFIG environment variable 2-10
PLOAD_LO_PATH environment variable 2-10
PooledConnection interface 1-2
Port numbers, setting
in database URLs 2-5
in DataSource objects 2-2
in sqlhosts file or LDAP server 2-17
PORTNO environment variable 2-2, 2-5
PORTNO_SECONDARY environment variable 2-10, 2-20
Precedence rules for date formats 6-7
PREPARE statements, executing multiple 3-4
PreparedStatement interface 3-1, 3-5, C-3, C-12, C-13, C-15
PreparedStatement.setXXX() methods
support for Informix extended data types C-9, C-11
support for nonextended data types C-9
prepareStatement() method 3-1
previous() method E-5
Q
Qualifiers, binary, for INTERVAL data types 4-8
Querying the database 3-1

R
Read-only connections 3-17
read() method 4-5
readArray() method 4-3
readAsciiStream() method 5-4
readBinaryStream() method 5-4
readByte() method 4-17
readBytes() method 5-2, 5-4
readCharacterStream() method 4-3, 4-17, 5-4
readObject() method 4-17, 5-4
readProperties() method B-1
readRef() method 4-3, 4-17, 5-4
readSQL() method 4-18, 4-25, 5-3
readString() method 5-2, 5-4
real data type D-6
REAL data type D-6
Ref type C-1
refreshRow() method 3-17
registerDriver() method 2-1
Registering IBM Informix JDBC Driver 2-1
registerOutParameter() method 3-6, E-9
type mappings for 3-9
Relative distinguished name (RDN) 2-18
relative() method E-5
releaseSavepoint() method 3-20
Remote database access 2-22
Remote method invocation (RMI) 2-26
remove() method 5-16, 5-18
removeProperty() method B-1
removeUDDR() method 5-18
removeUDTI() method 5-16
Restrictions, driver 3-9
Restrictions, server 3-6
ResultSet class 6-2, 6-5
ResultSet interface 3-1, 3-2, 7-3, C-12, C-13, C-15
ResultSet.getXXX() method
  support for Informix extended data types C-12
  support for nonextended data types C-12
Retrieving
  database names 3-23
date values 6-2, 6-5
Informix error message text 3-23
syntax error offset 3-22
Retrieving (continued)
  user names 3-23
  version information 3-25
XML data 3-28
Retrieving parameter names 3-12
reapeat() method
  method signature D-6
RMI 2-26
ROLLBACK WORK statement 4-48
rollbackSavepoint() method 3-20
row3.java example program A-5
rowDeleted() method 3-17
rowInserted() method 3-17
rowUpdated() method 3-17
RSMetaData.java example program A-2
S
Savepoint objects 3-20
SAX (Simple API for XML) 3-25
SBSPACENAME configuration parameter 4-40, 4-42
sbspaces
  metadata area 4-44
  name of 4-42
user-data area 4-44
Schemas, IBM Informix JDBC Driver interpretation 3-23
Screen reader
  reading syntax diagrams F-1
Scroll cursors 3-3
SCROLL_INSENSITIVE ResultSets 3-2
Scrollable Result Sets 3-2
ScrollCursor.java example program 3-3, A-2
scrubConnection() method 2-33, 7-7
Search, anonymous, of sqlhosts information 2-17
SECURITY environment variable 2-10
Selecting smart large objects 4-33
SERIAL columns and scroll cursors 3-3
SERIAL data type 4-6
Serial.java example program A-2
SERIAL8 data type 4-6
Server restrictions, limitations 3-6
Service provider interface (SPI) 2-16
Servlets 2-22
SessionMgr class 2-23
SessionMgr.class file 1-4, 2-23
Set interface 4-13
set() method 4-10, 4-12
setAlignment() method 5-12
setArray() method 4-13, C-6
setAsciiStream() method 4-3, C-3, C-6
setAutoAlignment() method 5-2
setAutoCommit() method 3-20
setAutoFree() method 3-24, 7-3
setBigDecimal() method 4-1, 4-2, C-6
setBinaryStream() method 4-3, C-3, C-6
setBlob() method C-6
setBoolean() method C-6
setByte() method C-6
setBytes() method C-6
setCatalog() method 3-17
setCharacterStream() method C-6
setClassName() method 5-12
setClob() method C-6
setCurrentPosition() method 5-2
setDatabaseName() method B-2
setDataSourceName() method B-2
setDate() method C-6
Smart large objects (continued)
  last-modification time 4-47
  locking 4-43
  logging 4-46
  logging of 4-43, 4-44, 4-46
  maximum I/O block size 4-42
  metadata 4-44, 4-45, 4-47
  minimum extent size 4-42
  next-extent size 4-42
  sbspaces 4-42
  selecting 4-33
  size of 4-40, 4-42, 4-47
  transactions with 4-44, 4-48
  unlocking 4-48
  user data 4-45, 4-47
Smart large objects, accessing 4-27
Smart large objects, implementation classes
  IfxBlob 4-29
  IfxCBlob 4-29
  IfxLobDescriptor 4-29
  IfxLocator 4-29
  IfxLoStat 4-29
  IfxSmartBlob 4-29
Smart-large-object lock
  exclusive 4-46, 4-48, 4-50
  lock-all 4-48
  releasing 4-48
  share-mode 4-48
  update 4-48
  update mode 4-48
Smart-large-object support in IDS 4-27
SQL date formats
  native 6-2, 6-5
  nonnative 6-2, 6-5
SQL name 5-10, 5-12, 5-15
SQLCODE messages 3-22
SQLData interface 4-16, 4-18, 4-25, 5-3, 5-4
SQLException class 3-21, 3-22, C-9, C-11, C-12, C-13, C-15
SQLH_TYPE environment variable 2-10
SQLH_TYPE property 2-2
SqlhDelete utility 2-19
Sqlhosts file
  administration requirements for 2-18
  and unsigned applets 1-9
  group option 2-16
  reading 2-16
  URL syntax for 2-17
  utilities for 2-18
SqlhUpload utility 2-18
SQLDEBUG environment variable 2-10
SQLDEBUG tracing 7-1
SQLInput interface 4-18
SQLInput() method 4-17, 5-1
SQLOutput() method 4-17, 5-1
SQLSTATE values 3-21
SSL protocol 2-28
sslConnection property 2-28
standards xii
Statement interface 2-8, 3-1, 3-5, 7-3
Statement Local Variables 3-6
Status information
  definition of 4-47
  last-access time 4-47
  last-change time 4-47
Status information (continued)
  last-modification time 4-47
  size 4-47
STMT_CACHE environment variable 2-10
Storage characteristics
  attribute information 4-43
  column-level 4-42, 4-43
  definition of 4-39
  disk-storage information 4-42
  system default 4-40, 4-42, 4-43
  system-specified 4-42, 4-43
  user-specified 4-42, 4-43
Stored procedures
  and named parameters 3-13
  string data type D-2
  compatible format with SQL LOAD/UNLOAD D-3
Strings, representing dates using 6-2
StringtoDOM() method 3-28
Struct interface 4-16, 4-21
Struct objects
  caching type information 4-26, 5-3
Structured type (Struct) 4-16
Sun JDBC 3.0 properties 7-4
Supported environment variables 6-1
Syntax diagrams
  reading in a screen reader F-1
  Syntax error offset, retrieving 3-22
  Syntax of database URLs 2-5
  sysmaster database 3-23
  systables catalog
    and code set conversion 6-8
    and metadata 3-23
T
TEXT data type
  caching 7-2
  code set conversion 6-11
  code set conversion for 6-11
  examples for
    data inserts and updates 4-3
    data retrieval 4-5
    extensions for 4-3
TextConv.java example program A-2
TextType.java example program 4-3, 4-5, A-2
Threads, multiple, and concurrency 3-3
TimeoutMgr class 2-23
TimeoutMgr.class file 1-4, 2-23
toBytes() method 4-38
toHexString() method 4-38
toString() method 4-10, 4-12
Methods
toString() 4-38
Transaction management
  smart large objects and 4-44, 4-48
Transactions
  beginning 4-48
  committing 4-48
  distributed 1-2, 2-1, 2-2, 3-20
  handling 3-20
  rolling back 4-48
Transactions, creating opaque types and UDRs 5-20
TreeSet class 4-14
TRUSTED_CONTEXT environment variable 2-10
TU_DAY variable 4-8, 4-11
TU_F1 variable 4-8
TU_F2 variable 4-8

Index  X-15
TU_F3 variable 4-8
TU_F4 variable 4-8
TU_F5 variable 4-8, 4-11
TU_FRAC variable 4-8
TU_HOUR variable 4-8
TU_MINUTE variable 4-8
TU_MONTH variable 4-8
TU_SECOND variable 4-8
TU_YEAR variable 4-8
Tuple buffer 2-10, 7-1
Types interface 4-6, C-1

U
UDR Manager
  example programs A-8
  UDR 4-1
UDRManager class 1-4, 5-1, 5-4
UDRMetaData class 5-1, 5-4
UDT Manager
  example programs A-8
  udt_d1.java example program A-4
  udt_d2.java example program A-4
  udt_d3.java example program A-4
  UDT 4-1
UDTManager class 1-4, 5-1
UDTMetaData class 5-1
udtudrmgr package 1-4
Unicode
  and internationalization APIs 6-1
  and the client code set 6-10
  and the database code set 6-8
Uninstalling
  in console mode 1-10
  in graphical mode 1-10
  in silent mode 1-10
  preventing errors 1-6
Uninstalling driver 1-10
Unique names
  for stored procedures and named parameters 3-13
Unnamed row data types
  examples of
    creating a Struct class for 4-22
    using the Struct interface 4-22
  extensions for 4-16
  intervals and collections in 4-17
  using the Struct interface for 4-21
Unsupported methods
  for distinct data types 4-3
  for named rows 4-17
  for opaque data types 5-4
  for querying the database 3-17
UpdateCursor1.java example program 3-3, A-2
UpdateCursor2.java example program 3-3, A-2
UpdateCursor3.java example program 3-3, A-2
updateObject() method 6-6
updateRow() method 3-3, E-9
Updates, batch 3-4
updatesAreDetected() method 3-17
updateString() method 6-6
URLs
  database 2-4, 2-5
  syntax for LDAP server and sqlhosts file 2-17
USER connection property 2-2, 2-5
User names, setting
  in database URLs 2-5
  in DataSource object 2-2

V
Variables for binary qualifiers 4-8
Version class 3-25
Version, of IBM Informix JDBC Driver 3-25
Visual disabilities
  reading syntax diagrams F-1

W
widenByte method
  method signature D-6
writeArray() method 4-3
writeAsciiStream() method 5-4
writeBinaryStream() method 5-4
writeByte() method 4-17
writeBytes() method 5-2, 5-4
writeCharacterStream() method 4-3, 4-17, 5-4
writeInt() method 4-18
writeObject() method 4-17, 4-18, 5-4, E-6
writeProperties() method B-1
writeRef() method 4-3, 4-17, 5-4
writeSQL() method 4-18, 4-25, 5-3
writeString() method 5-2, 5-4
writeXXX() method 4-18

X
XA (distributed transactions) 1-2, 2-1, 2-2, 3-20
XAConection interface 3-20
XDataSource interface 1-2
xerces parser 3-26
xerces.jar file 3-26
XML documents
  example programs A-8
  examples 3-29
setting up environment for 3-26
XMLInputString() method 3-27
XMLtoInputStream() method 3-27