Oracle9*i*

JPublisher User's Guide

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Oracle9*i* JPublisher User's Guide, Release 2 (9.2)

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Preface

This preface introduces you to the *Oracle9i JPublisher User's Guide*, discussing the intended audience, structure, and conventions of this document. A list of related Oracle documents is also provided.

The JPublisher utility translates user-defined SQL object types and PL/SQL packages to Java classes. SQLJ, JDBC, and J2EE programmers who need to have Java classes in their applications to correspond to database object types, VARRAY types, nested table types, object reference types, opaque types, or PL/SQL packages can use the JPublisher utility.

This preface contains these topics:

Intended Audience

This manual is for JDBC and SQLJ programmers who want Java classes in their applications to correspond to object types, VARRAY types, nested table types, object reference types, OPAQUE types, or PL/SQL packages.

It assumes that you are an experienced Java programmer with knowledge of Oracle databases, SQL, PL/SQL, JDBC, and SQLJ. Although general knowledge is sufficient, any knowledge of Oracle-specific features would be helpful as well.

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Organization

This document contains:

Chapter 1, "Introduction to JPublisher"

Introduces the JPublisher utility by way of example, lists new features provided in this release, and provides an overview of JPublisher operations.

Chapter 2, "JPublisher Concepts"

Provides full background and details on the concepts and usage of JPublisher, including datatype mappings, generation of output classes, support for inheritance, migration and backward compatibility, and JPublisher limitations.

Chapter 3, "Command-Line Options and Input Files"

Provides details of the JPublisher command line syntax, command line options, and input file format.

Chapter 4, "JPublisher Examples"

Presents examples of JPublisher usage and output for various object types, wrapper methods, and usage scenarios.

Related Documentation

Also available from the Oracle Java Platform group, for Oracle9*i* releases:

- *Oracle9i Java Developer's Guide*

  This book introduces the basic concepts of Java in Oracle9*i* and provides general information about server-side configuration and functionality. Information that pertains to the Oracle database Java environment in general, rather than to a particular product such as JDBC or SQLJ, is in this book.

- *Oracle9i JDBC Developer's Guide and Reference*

  This book covers programming syntax and features of the Oracle implementation of the JDBC standard (for Java Database Connectivity). This includes an overview of the Oracle JDBC drivers, details of the Oracle implementation of JDBC 1.22, 2.0, and 3.0 features, and discussion of Oracle JDBC type extensions and performance extensions.

- *Oracle9i SQLJ Developer's Guide and Reference*

  This book covers the use of SQLJ to embed static SQL operations directly into Java code, covering SQLJ language syntax and SQLJ translator options and features. Both standard SQLJ features and Oracle-specific SQLJ features are described.

- *Oracle9i Support for JavaServer Pages Reference*

  This book covers the use of JavaServer Pages technology to embed Java code and JavaBean invocations inside HTML pages. Both standard JSP features and Oracle-specific features are described. Discussion covers considerations for the Oracle9*i* release 2 Apache JServ environment, but also covers features for servlet 2.2 environments and emulation of some of those features by the Oracle JSP container for JServ.

- *Oracle9i Java Stored Procedures Developer's Guide*

  This book discusses Java stored procedures—programs that run directly in the Oracle9*i* database. With stored procedures (functions, procedures, triggers, and SQL methods), Java developers can implement business logic at the server level, thereby improving application performance, scalability, and security.

The following OC4J documents, for Oracle9*i* Application Server releases, are also available from the Oracle Java Platform group:

- *Oracle9iAS Containers for J2EE User's Guide*

  This book provides some overview and general information for OC4J; primer chapters for servlets, JSP pages, and EJBs; and general configuration and deployment instructions.

- *Oracle9iAS Containers for J2EE Support for JavaServer Pages Reference*

  This book provides information for JSP developers who want to run their pages in OC4J. It includes a general overview of JSP standards and programming considerations, as well as discussion of Oracle value-added features and steps for getting started in the OC4J environment.

- *Oracle9iAS Containers for J2EE JSP Tag Libraries and Utilities Reference*

  This book provides conceptual information and detailed syntax and usage information for tag libraries, JavaBeans, and other Java utilities provided with OC4J.

- *Oracle9iAS Containers for J2EE Servlet Developer's Guide*

  This book provides information for servlet developers regarding use of servlets and the servlet container in OC4J. It also documents relevant OC4J configuration files.

- *Oracle9iAS Containers for J2EE Services Guide*

  This book provides information about basic Java services supplied with OC4J, such as JTA, JNDI, and the Oracle9*i* Application Server Java Object Cache.

- *Oracle9iAS Containers for J2EE Enterprise JavaBeans Developer's Guide and Reference*

  This book provides information about the EJB implementation and EJB container in OC4J.

The following documents are from the Oracle Server Technologies group:

- *Oracle9i XML Database Developer's Guide - Oracle XML DB*
- *Oracle9i XML Developer's Kits Guide - XDK*
- *Oracle9i Application Developer's Guide - Fundamentals*
- *Oracle9i Application Developer's Guide - Large Objects (LOBs)*
- *Oracle9i Application Developer's Guide - Object-Relational Features*
- *Oracle9i Supplied Java Packages Reference*
- *Oracle9i Supplied PL/SQL Packages and Types Reference*
- *PL/SQL User's Guide and Reference*
- *Oracle9i SQL Reference*
- *Oracle9i Net Services Administrator's Guide*
- *Oracle Advanced Security Administrator's Guide*
- *Oracle9i Database Globalization Support Guide*
- *Oracle9i Database Reference*
- *Oracle9i Database Error Messages*
- *Oracle9i Sample Schemas*

The following documents from the Oracle9*i* Application Server group may also be of some interest:

- *Oracle9i Application Server Administrator's Guide*
- *Oracle Enterprise Manager Administrator's Guide*
- *Oracle HTTP Server Administration Guide*
- *Oracle9i Application Server Performance Guide*
- *Oracle9i Application Server Globalization Support Guide*
- *Oracle9iAS Web Cache Administration and Deployment Guide*
- *Oracle9i Application Server: Migrating from Oracle9i Application Server 1.x*

The following are available from the Oracle9*i* JDeveloper group:

- JDeveloper online help
- JDeveloper documentation on the Oracle Technology Network:

  `http://otn.oracle.com/products/jdev/content.html`

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Conventions

This section describes the conventions used in the text and code examples of this documentation set. It describes:

- Conventions in Text
- Conventions in Code Examples

Conventions in Text

We use various conventions in text to help you more quickly identify special terms. The following table describes those conventions and provides examples of their use.

Convention	Meaning	Example
Italics	Italic typeface indicates book titles or emphasis, or terms that are defined in the text.	*Oracle9i Database Concepts* Ensure that the recovery catalog and target database do *not* reside on the same disk.
`UPPERCASE monospace (fixed-width) font`	Uppercase monospace typeface indicates elements supplied by the system. Such elements include parameters, privileges, datatypes, RMAN keywords, SQL keywords, SQL*Plus or utility commands, packages and methods, as well as system-supplied column names, database objects and structures, usernames, and roles.	You can specify this clause only for a `NUMBER` column. You can back up the database by using the `BACKUP` command. Query the `TABLE_NAME` column in the `USER_TABLES` data dictionary view. Use the `DBMS_STATS.GENERATE_STATS` procedure.
`lowercase monospace (fixed-width) font`	Lowercase monospace typeface indicates executables, filenames, directory names, and sample user-supplied elements. Such elements include computer and database names, net service names, and connect identifiers, as well as user-supplied database objects and structures, column names, packages and classes, usernames and roles, program units, and parameter values. **Note:** Some programmatic elements use a mixture of UPPERCASE and lowercase. Enter these elements as shown.	Enter `sqlplus` to open SQL*Plus. The password is specified in the `orapwd` file. Back up the data files and control files in the `/disk1/oracle/dbs` directory. The `department_id`, `department_name`, and `location_id` columns are in the `hr.departments` table. Set the `QUERY_REWRITE_ENABLED` initialization parameter to `true`. Connect as `oe` user. The `JRepUtil` class implements these methods.

Convention	Meaning	Example
lowercase italic monospace (fixed-width) font	Lowercase italic monospace font represents place holders or variables.	You can specify the *parallel_clause*. Run *old_release*.SQL where *old_release* refers to the release you installed prior to upgrading.

Conventions in Code Examples

Code examples illustrate SQL, PL/SQL, SQL*Plus, or other command-line statements. They are displayed in a monospace (fixed-width) font and separated from normal text as shown in this example:

```
SELECT username FROM dba_users WHERE username = 'MIGRATE';
```

The following table describes typographic conventions used in code examples and provides examples of their use.

Convention	Meaning	Example
[ ]	Brackets enclose one or more optional items. Do not enter the brackets.	`DECIMAL (`*`digits`*` [ , `*`precision`*` ])`
|	A vertical bar represents a choice of two or more options within brackets or braces. Enter one of the options. Do not enter the vertical bar.	`{ENABLE | DISABLE}` `[COMPRESS | NOCOMPRESS]`
...	Horizontal ellipsis points indicate either:	
	■ That we have omitted parts of the code that are not directly related to the example	`CREATE TABLE ... AS `*`subquery`*`;`
	■ That you can repeat a portion of the code	`SELECT `*`col1`*`, `*`col2`*`, ... , `*`coln`*` FROM employees;`
Other notation	You must enter symbols other than brackets, braces, vertical bars, and ellipsis points as shown.	`acctbal NUMBER(11,2);` `acct CONSTANT NUMBER(4) := 3;`
Italics	Italicized text indicates place holders or variables for which you must supply particular values.	`CONNECT SYSTEM/`*`system_password`* `DB_NAME = `*`database_name`*

Convention	Meaning	Example

UPPERCASE	Uppercase typeface indicates elements supplied by the system. We show these terms in uppercase in order to distinguish them from terms you define. Unless terms appear in brackets, enter them in the order and with the spelling shown. However, because these terms are not case sensitive, you can enter them in lowercase.	`SELECT last_name, employee_id FROM employees;`
		`SELECT * FROM USER_TABLES;`
		`DROP TABLE hr.employees;`

lowercase	Lowercase typeface indicates programmatic elements that you supply. For example, lowercase indicates names of tables, columns, or files.
	Note: Some programmatic elements use a mixture of UPPERCASE and lowercase. Enter these elements as shown.
		`SELECT last_name, employee_id FROM employees;`
		`sqlplus hr/hr`
		`CREATE USER mjones IDENTIFIED BY ty3MU9;`

1

Introduction to JPublisher

This chapter starts with a brief introduction and examples for the JPublisher utility, followed by a more complete overview. The following topics are covered:

- Introduction to JPublisher Features
- Understanding JPublisher
- JPublisher Operation

If you are new to JPublisher, start with "Invitation to JPublisher" on page 1-2. If you have used JPublisher before, you may want to skip ahead to "New JPublisher Features in Oracle9i Release 2" on page 1-9.

Introduction to JPublisher Features

This section gives you an introduction to basic features and new features in Oracle9*i* release 2 (9.2).

Invitation to JPublisher

JPublisher is a utility, written entirely in Java, that generates Java classes to represent the following user-defined database entities in your Java program:

- SQL object types
- object reference types ("REF types")
- SQL collection types (VARRAY types or nested table types)
- PL/SQL packages

JPublisher enables you to specify and customize the mapping of SQL object types, object reference types, and collection types (VARRAYs or nested tables) to Java classes in a strongly typed paradigm.

JPublisher generates `get`*`XXX`*`()` and `set`*`XXX`*`()` accessor methods for each attribute of an object type. If your object types have stored procedures, JPublisher can generate wrapper methods to invoke the stored procedures. A wrapper method is a method that invokes a stored procedure that executes in Oracle9*i*.

JPublisher can also generate classes for PL/SQL packages. These classes have wrapper methods to invoke the stored procedures in the PL/SQL packages.

The wrapper methods JPublisher generates contain SQLJ code, so when JPublisher generates wrapper methods, it generally produces `.sqlj` source files. This is true for classes representing PL/SQL packages or object types that define methods, unless you specify (through the `-methods` option) that JPublisher should *not* generate wrapper methods.

If no wrapper methods are generated, JPublisher produces `.java` source files. This is true for classes representing object types without methods, object reference types, or collection types, or for classes where the `-methods` option is off.

Instead of using JPublisher-generated classes directly, you can:

- Extend the generated classes. This is straightforward, since JPublisher can also generate initial versions of the subclasses for you, into which you can add your desired behavior.

- Write your own Java classes by hand, without using JPublisher. This approach is quite flexible, but time-consuming and error-prone.
- Use generic classes to represent object, object reference, and collection types. The `oracle.sql` package contains generic, weakly typed classes that represent object, object reference, and collection types. If these classes meet your requirements, you do not need JPublisher. Typically, you would use this approach if you need to be able to generically process *any* SQL object, collection, reference, or OPAQUE type.

In addition, JPublisher simplifies access to PL/SQL only types from Java. You can employ predefined or user-defined mappings between PL/SQL and SQL types, as well as make use of PL/SQL conversion functions between such types. With such type correspondences in place, JPublisher can automatically generate all of the required Java and PL/SQL code.

Getting Started with JPublisher

JPublisher is distributed with the Oracle SQLJ translator. If you have installed SQLJ through the Oracle Installer, you should already be set up. If you have manually downloaded a version of Oracle SQLJ, however, you have to go through a few manual steps to ensure you can use SQLJ and JPublisher. You can refer to instructions in the *Oracle9i SQLJ Developer's Guide and Reference*.

You must ensure the following:

- A version of the Sun Microsystems JDK is installed such that you can invoke the `javac` compiler from the command line.
- The Oracle JDBC driver is installed and in your classpath, typically `[Oracle_Home]/jdbc/classes`*`XX`*`.jar`.
- The Oracle SQLJ translator and runtime are in your classpath, typically `[Oracle_Home]/sqlj/runtime`*`XX`*`.jar` and `[Oracle_Home]/sqlj/translator.jar`.
- The invocation scripts or executables—`jpub` or `jpub.exe`, `sqlj` or `sqlj.exe`—are in your file path, typically `[Oracle_Home]/bin` or (for manual downloads) `[Oracle_Home]/sqlj/bin`.

  With proper setup, if you type `jpub` to the command line you will see information about common JPublisher option and input settings.

Additionally, if you use JPublisher from release 9.2.0 or later against a 9.2.0 or later Oracle database, the PL/SQL package `SYS.SQLJUTL` should be installed. If your database is Java-enabled, this is already the case. If not, have your database

administrator install the SQL script [Oracle_Home]/sqlj/lib/sqljutl.sql into the SYS schema.

> **Note:** This rest of this section provides introductory discussion and examples. For more examples, go to [Oracle_Home]/sqlj/demo/jpub in your Oracle installation.

Publishing SQL Object Types

It is straightforward to use JPublisher for publishing SQL objects and packages as Java classes. This section provides examples of this for the OE (Order Entry) schema that is part of the Oracle9*i* sample schema (see *Oracle9i Sample Schemas* for detailed information). If you do not have the sample schema installed, but have your own object types or packages that you would like to publish, just replace the user name, password, and object or package names with your own.

Assuming that the password for the OE schema is OE, this is how you can publish the SQL object type CATEGORY_TYP:

```
jpub -user=OE/OE -sql=CATEGORY_TYP:CategoryTyp
```

Use the JPublisher -user option to specify the user name (schema name) and password. The -sql option specifies the types and packages to be published. CATEGORY_TYP is the name of the SQL type and, separated by a colon (":"), CategoryTyp is the name of the corresponding Java class to be generated. JPublisher echoes to the standard output the names of the SQL types and packages that it is publishing:

```
OE.CATEGORY_TYP
```

When you list the files in your current directory, you will notice that in addition to the file CategoryTyp.java, which you would have expected, JPublisher has also generated a file CategoryTypeRef.java. This represents a strongly typed wrapper for SQL object references to OE.CATEGORY_TYP. Both files are ready to be compiled with the Java compiler javac.

Here is another example, for the type CUSTOMER_TYP, using the shorthand -u (followed by a space) for "-user=" and -s for "-sql=":

```
jpub -u OE/OE -s CUSTOMER_TYP:CustomerTyp
```

JPublisher output:

```
OE.CUSTOMER_TYP
OE.CUST_ADDRESS_TYP
OE.PHONE_LIST_TYP
OE.ORDER_LIST_TYP
OE.ORDER_TYP
OE.ORDER_ITEM_LIST_TYP
OE.ORDER_ITEM_TYP
OE.PRODUCT_INFORMATION_TYP
OE.INVENTORY_LIST_TYP
OE.INVENTORY_TYP
OE.WAREHOUSE_TYP
```

JPublisher reports a list of SQL object types, because whenever it encounters an object type for the first time (whether it is an attribute, an object reference, or a collection that has element types which themselves are objects or collections), it will automatically generate a wrapper class for that type as well. Two wrapper files are generated for each object type in this example: 1) a Java class, such as `CustomerTyp`, to represent instances of the object type; and 2) a reference class, such as `CustomerTypeRef`, to represent references to the object type. You may also have noticed the naming scheme that JPublisher uses by default: the SQL type `OE.PRODUCT_INFORMATION_TYP` turns into a Java class `ProductInformationTyp`, for example.

Even though JPublisher automatically generates wrappers for embedded types, it will not do so for subtypes of given object types. In this case, you have to explicitly enumerate all of the subtypes that you want to have published. The `CATEGORY_TYP` type has three subtypes: `LEAF_CATEGORY_TYP`, `COMPOSITE_CATEGORY_TYP`, and `CATALOG_TYP`. The following is a single wraparound JPublisher command line to publish these object types.

```
jpub  -u OE/OE  -s COMPOSITE_CATEGORY_TYP:CompositeCategoryTyp
      -s LEAF_CATEGORY_TYP:LeafCategoryTyp,CATALOG_TYP:CatalogTyp
```

JPublisher output:

```
OE.COMPOSITE_CATEGORY_TYP
OE.SUBCATEGORY_REF_LIST_TYP
OE.LEAF_CATEGORY_TYP
OE.CATALOG_TYP
OE.CATEGORY_TYP
OE.PRODUCT_REF_LIST_TYP
```

Note the following:

- If you want to unparse several types, you can list them all together in the `-sql` (`-s`) option, separated by commas , or you can supply several `-sql` options on the command line, or you can do both.
- Although JPublisher does not automatically generate wrappers for all subclasses, it *will* generate them for all superclasses.
- When you ran JPublisher earlier to generate `CatalogTyp`, a `.java` file was output. This time, however, JPublisher created `.sqlj` files for `CATALOG_TYP` and its three subtypes.

  This is because SQLJ simplifies the coding of SQL invocations from Java. Whenever a SQL object type contains methods, JPublisher by default will generate a `.sqlj` file that includes wrappers for these methods as well. Both `.sqlj` and `.java` files can be immediately translated and compiled with the Oracle SQLJ translator, as follows:

  ```
  sqlj *.sqlj *.java
  ```

  If you are generating Java wrappers for a SQL type hierarchy, and one or more of the types contain methods (as is the case here), then JPublisher will automatically generate `.sqlj` files for all types in the hierarchy. Note that you can always suppress the generation of method wrappers and thus of `.sqlj` files with the JPublisher option `-methods=false`.

In case the code generated by JPublisher does not give you the functionality or behavior you want, you can subclass generated wrapper classes in order to override or complement their functionality. Consider the following example:

```
jpub -u OE/OE -s WAREHOUSE_TYP:JPubWarehouse:MyWarehouse
```

JPublisher output:

```
OE.WAREHOUSE_TYP
```

With this command, JPublisher generates `JPubWarehouse.java` as well as `MyWarehouse.java`. The file `JPubWarehouse.java` is regenerated every time you rerun this command. The file `MyWarehouse.java` is created in order to be customized by you, and will not be overwritten by future runs of this JPublisher invocation. You can add new methods in `MyWarehouse.java`, override the method implementations from `JPubWarehouse.java`, or both. The class used to materialize `WAREHOUSE_TYP` instances in Java is the specialized class `MyWarehouse`. If you want user-specific subclasses for all types in an object type

hierarchy, you will have to specify "triplets" of the form *SQL_TYPE*:*JPubClass*:*UserClass* as above for all members of the hierarchy.

Now that we have generated and compiled some Java wrapper classes—how do you actually use them in Java programs?

Once you have generated and compiled Java wrapper classes with JPublisher, using them is fairly straightforward, especially if you are programming in SQLJ—just use the object wrappers directly. The following example calls a PL/SQL stored procedure that takes a WAREHOUSE_TYPE instance as an IN OUT parameter:

```
java.math.BigDecimal location = ...;
java.math.BigDecimal warehouseId = ...;
MyWarehouse w = new MyWarehouse(warehouseId,"Industrial Park",location);
...
#sql { call register_warehouse(:INOUT w) };
```

In JDBC, you typically register the relationship between the SQL type name and the corresponding Java class in the type map for your connection instance. This is required once per connection, as in the following example:

```
java.util.Map typeMap = conn.getTypeMap();
typeMap.put("OE.WAREHOUSE_TYP", MyWarehouse.class);
conn.setTypeMap(typeMap);
```

The following JDBC code corresponds to the #sql statement shown earlier.

```
CallableStatement cs = conn.prepareCall("{call register_warehouse(?)}");
((OracleCallableStatement)cs).registerOutParameter
                (1,oracle.jdbc.OracleTypes.STRUCT,"OE.WAREHOUSE_TYP");
cs.setObject(w);
cs.executeUpdate();
w = cs.getObject(1);
```

Publishing PL/SQL Packages

As shown in the preceding section, it is straightforward to use SQLJ code to call PL/SQL stored procedures or functions. However, you might prefer to encapsulate entire PL/SQL packages as Java classes, and JPublisher also offers functionality for this.

The concept of representing PL/SQL functions and procedures as Java methods presents a problem—arguments to such functions or procedures might use the PL/SQL mode OUT or IN OUT, but there are no equivalent modes for passing arguments in Java. A method that takes an int argument, for example, is not able

to modify this argument in such a way that its callers can receive a new value for it. As a workaround, JPublisher generates single-element arrays for `OUT` and `IN OUT` arguments. For an array `int[] abc`, for example, the input value is provided in `abc[0]`, and the modified output value is also returned in `abc[0]`. A similar pattern is also used by JPublisher when generating code for SQL object type methods.

The following command line publishes the `SYS.DBMS_LOB` package into Java:

```
jpub  -u SCOTT/TIGER  -s SYS.DBMS_LOB:DbmsLob
```

JPublisher output:

```
SYS.DBMS_LOB
```

Since `DBMS_LOB` is publicly visible, we can access it from a different schema, such as `SCOTT`. Note that this JPublisher invocation creates a SQLJ source file `DbmsLob.sqlj` that contains the calls to the PL/SQL package. The generated Java methods are actually all instance methods. The idea is that you create an instance of the package using a JDBC connection or a SQLJ connection context and then call the methods on that instance.

Use of Object Types Instead of Java Primitive Numbers When you examine the generated code, notice that JPublisher has generated `java.lang.Integer` as arguments to various methods. Using Java object types such as `Integer` instead of Java primitive types such as `int` permits you to represent SQL `NULL` values directly as Java `null`s, and JPublisher generates these by default. However, for the `DBMS_LOB` package we actually prefer `int` over the object type `Integer`. The following modified JPublisher invocation accomplishes this through the `-numbertypes` option.

```
jpub -numbertypes=jdbc  -u SCOTT/TIGER  -s SYS.DBMS_LOB:DbmsLob
```

JPublisher output:

```
SYS.DBMS_LOB
```

Wrapper Code for Procedures at the SQL Top Level JPublisher also allows you to generate wrapper code for the functions and procedures at the SQL top level. Use the special package name `TOPLEVEL`, as in the following example:

```
jpub  -u SCOTT/TIGER  -s TOPLEVEL:SQLTopLevel
```

JPublisher output:

```
SCOTT.<top-level_scope>
```

You will see a warning if there are no stored functions or procedures in the SQL top-level scope.

If your stored procedures or functions use types that are specific to PL/SQL and not supported from Java, you will receive warning messages and no corresponding Java methods are generated. However, you may be able to map PL/SQL types to corresponding SQL types and their Java counterparts, which will permit JPublisher to generate appropriate Java code, and possibly PL/SQL code, to gain access to these types from Java. (See "Using Datatypes Unsupported by JDBC" on page 2-7.)

New JPublisher Features in Oracle9*i* Release 2

With Oracle9*i* release 2 (9.2), JPublisher supports virtually all types that can be used with the Oracle JDBC drivers. Additionally, JPublisher facilitates the use of PL/SQL types in stored procedure and object method signatures through PL/SQL conversion support. The following Oracle JDBC types are now directly supported:

- NCHAR types
- TIMESTAMP types
- SQLJ object types
- SQL OPAQUE types

  Specifically, the OPAQUE type `SYS.XMLTYPE` is supported through the Java type `oracle.xdb.XMLType`. SQL OPAQUE types can be supported through a predefined type correspondence or can trigger JPublisher code generation. (See "Type Mapping Support for OPAQUE Types" on page 2-8.)

Native PL/SQL types can now be more easily accessed by JPublisher code through the automatic generation of PL/SQL wrapper functions and procedures in conjunction with the following mechanisms:

- predefined type conversions, such as between PL/SQL `BOOLEAN` and Java `boolean`, or PL/SQL `INTERVAL` and Java `String`

  See "Type Mapping Support Through PL/SQL Conversion Functions" on page 2-11.

- user-defined mappings for PL/SQL indexed-by tables in conjunction with the JDBC OCI driver

  See "Type Mapping Support for Scalar Indexed-by Tables Using JDBC OCI" on page 2-9.

- user-defined conversion functions for mapping PL/SQL RECORD types and tables of records to SQL object and collection types, and ultimately to Java

  See "Type Mapping Support for PL/SQL RECORD Types" on page 2-14.

JPublisher now provides improved functionality as well as flexibility in the code it generates, as follows:

- JPublisher generates attribute-based constructors for SQL object types.
- New APIs are now provided in the generated classes to convert between strongly typed references and to transfer connection information between objects.
- Generated Java wrappers for SQL object types can be made serializable.

  See "Serializability of Generated Object Wrappers (-serializable)" on page 3-26.

- JPublisher can create `toString()` methods that report the object value.

  See "Generation of toString() Method on Object Wrappers (-tostring)" on page 3-29.

JPublisher now reduces the programming effort even further, as follows:

- When you request user-subclassing of JPublisher-generated classes, an initial version of these user subclasses will now be automatically generated by JPublisher.
- Inheritance hierarchies now require no initialization by the user application.
- Generated files will not be overwritten unnecessarily, improving JPublisher's interaction with `Make` environments.
- Extended syntax for JPublisher properties files permits embedding of JPublisher directives in SQL scripts.

Understanding JPublisher

This section provides a basic understanding of what JPublisher is for and what it accomplishes, covering the following topics:

JPublisher Object Type Mappings and PL/SQL Mappings

JPublisher provides mappings from the following SQL entities to Java classes:

- SQL object types, collection types, reference types, and OPAQUE types
- PL/SQL packages and types

Object Types and JPublisher

JPublisher allows your Java language applications to employ user-defined object types in Oracle9*i*. If you intend to have your Java-language application access object data, then it must represent the data in a Java format. JPublisher helps you do this by creating the mapping between object types and Java classes, and between object attribute types and their corresponding Java types.

Classes generated by JPublisher implement either the `oracle.sql.ORAData` interface or the `java.sql.SQLData` interface, depending on how you set the JPublisher options. Either interface makes it possible to transfer object type instances between the database and your Java program. For more information about the `ORAData` and `SQLData` interfaces, see the *Oracle9i JDBC Developer's Guide and Reference*.

PL/SQL Packages and JPublisher

You might want to call stored procedures in a PL/SQL package from your Java application. The stored procedure can be a PL/SQL subprogram or a Java method

that has been published to SQL. Java arguments and functions are passed to and returned from the stored procedure.

To help you do this, you can direct JPublisher to create a class containing a wrapper method for each subprogram in the package. The wrapper methods generated by JPublisher provide a convenient way to invoke PL/SQL stored procedures from Java code or to invoke a Java stored procedure from a client Java program.

If you call PL/SQL code that includes top-level subprograms (subprograms not in any PL/SQL package), JPublisher can generate a class containing wrapper methods for all top-level procedures and functions, or for a subset of the top-level subprograms that you request.

PL/SQL Types and JPublisher

Java programs only permit you to use SQL types when calling PL/SQL stored procedures or functions. Types that are supported by PL/SQL only, such as `BOOLEAN`, PL/SQL RECORD types, and PL/SQL indexed-by tables cannot be accessed by JDBC programs. One exception to this are scalar PL/SQL indexed-by tables which are currently supported in the client-side JDBC OCI driver only.

JPublisher simplifies the invocation of stored procedures and functions that contain such types: it will automatically create a package with PL/SQL wrapper procedures and functions, as necessary, to convert between signatures containing PL/SQL types and corresponding ones that can be used from Java programs and that reference SQL types only. A mapping has been predefined for the `BOOLEAN` type. However, in general users will have to provide correspondences and conversions between SQL and PL/SQL in order for JPublisher to incorporate a particular PL/SQL type into its code generation.

JPublisher Processes

JPublisher connects to a database and retrieves descriptions of the SQL object types or PL/SQL packages that you specify on the command line or from an input file. By default, JPublisher connects to the database by using the JDBC OCI driver, which requires an Oracle client installation, including Oracle9*i* Net and required support files. If you do not have an Oracle client installation, JPublisher can use the Oracle JDBC Thin driver.

JPublisher generates a Java class for each SQL object type it translates. The Java class includes code required to read objects from and write objects to the database. When you deploy the generated JPublisher classes, your JDBC driver installation includes all the necessary runtime files. If you create wrapper methods (Java methods to wrap stored procedures or functions of the SQL object type), JPublisher

generates SQLJ source code so you must additionally have the SQLJ runtime libraries.

When you call a wrapper method, the SQL value for the object is sent to the server, along with any `IN` our `IN OUT` arguments. Then the method (stored procedure or function) is invoked, and the new object value is returned to the client, along with any `OUT` or `IN OUT` arguments. Note that this results in a database round trip. If the method call only performs a simple state change on the object, it will be much more performant to write and use equivalent Java that affects the state change locally.

JPublisher also generates a class for each PL/SQL package it translates. The class includes code to invoke the package methods on the server. `IN` arguments for the methods are transmitted from the client to the server, and `OUT` arguments and results are returned from the server to the client. In addition, JPublisher may also generate a PL/SQL wrapper package, if required, for converting signatures containing PL/SQL types into corresponding ones containing SQL types only.

The next section furnishes a general description of the source files that JPublisher creates for object types and PL/SQL packages.

What JPublisher Produces

The number of files JPublisher produces depends on whether you request `ORAData` classes (classes that implement the `oracle.sql.ORAData` interface) or `SQLData` classes (classes that implement the standard `java.sql.SQLData` interface).

The `ORAData` interface supports SQL object, object reference, collection, and OPAQUE types in a strongly typed way. That is, for each specific object, object reference, collection, or OPAQUE type in the database, there is a corresponding Java type. The `SQLData` interface, on the other hand, supports only SQL object types in a strongly typed way. All object reference types are represented generically as `java.sql.Ref` instances, and all collection types are represented generically as `java.sql.Array` instances. Therefore, JPublisher generates classes for object reference, collection, and OPAQUE types only if it is generating `ORAData` classes.

When you run JPublisher for a user-defined object type and you request `ORAData` classes, JPublisher automatically creates the following:

- an object class that represents instances of the Oracle object type in your Java program
- a related reference class for object references to your Oracle object type
- Java classes for any object or collection or OPAQUE attributes nested directly or indirectly within the top-level object

This is necessary so that attributes can be materialized in Java whenever an instance of the top-level class is materialized. If an attribute type, such as a SQL OPAQUE type or a PL/SQL type, has been pre-mapped, then JPublisher will use the target Java type from the map.

Note: For `ORAData` implementations, a strongly typed reference class is always generated, regardless of whether the SQL object type uses references.

Advantages of using strongly typed instead of weakly typed references are described in "Strongly Typed Object References for ORAData Implementations" on page 1-24.

If you request `SQLData` classes instead, JPublisher does not generate the object reference class and does not generate classes for nested collection attributes or for OPAQUE attributes.

When you run JPublisher for a user-defined collection type, you must request `ORAData` classes. JPublisher automatically creates the following:

- a collection class to act as a type definition to correspond to your Oracle collection type
- if the elements of the collection are objects, a Java class for the element type, and Java classes for any object or collection attributes nested directly or indirectly within the element type

  This is necessary so object elements can be materialized in Java whenever an instance of the collection is materialized.

When you run JPublisher for an OPAQUE type, you must request `ORAData` classes. JPublisher automatically creates:

- a Java class that acts as a wrapper of the OPAQUE type, providing Java versions of the OPAQUE type methods, as well as `protected` APIs to access the representation of the OPAQUE type in a subclass

  Typically, however, Java wrapper classes for SQL OPAQUE types will be furnished by the provider of the OPAQUE type, such as, for example, `oracle.xdb.XMLType` for the SQL OPAQUE type `SYS.XMLTYPE`. In this case, ensure that the correspondence between the SQL and the Java type is predefined to JPublisher.

When you run JPublisher for a PL/SQL package, it automatically creates the following:

- a Java class with wrapper methods that invoke the stored procedures of the package
- if required, a PL/SQL package definition containing functions and procedures needed to convert from PL/SQL signatures to signatures containing SQL types only

  This may also be generated if you translate methods of an object type, and PL/SQL wrappers are needed for converting PL/SQL to SQL arguments and vice versa.

JPublisher Requirements

JPublisher requires that Oracle SQLJ and Oracle JDBC also be installed on your system and in your classpath appropriately. You will need the following libraries (available as `.jar` or `.zip` files):

- SQLJ translator classes (`translator`)
- SQLJ runtime classes (`runtime12`, `runtime12ee`, or `runtime11`)
- JDBC classes (`classes12`, `ojdbc14`, or `classes111`)

"`12`" refers to versions for JDK 1.2.x or later; "`14`" refers to versions for JDK 1.4.x; "`11`" and "`111`" refer to versions for JDK 1.1.x. See the *Oracle9i SQLJ Developer's Guide and Reference* for more information about these files.

When you use an Oracle9*i* release 2 or later database, then the package `SQLJUTL` should also be installed and publicly accessible in the `SYS` schema. If this is not the case, you will see the following warning message when you invoke JPublisher:

```
Warning: Cannot determine what kind of type is
<schema>.<type.> You likely need to install SYS.SQLJUTL. The
database returns: ORA-06550: line 1, column 7:

PLS-00201: identifier 'SYS.SQLJUTL' must be declared
```

In this situation, ask your database administrator to install the SQL file `[Oracle Home]/sqlj/lib/sqljutl.sql` into the `SYS` schema and make it publicly accessible. This will avoid the above warning message in the future.

When you use Oracle9*i* JPublisher, it is typical to use the equivalent version of SQLJ, because these two products are always installed together. To use all features of JPublisher, you also need the following.

- Oracle9*i* (or version 8.1.7 or 8.1.6)
- Oracle9*i* JDBC drivers (or version 8.1.7 or 8.1.6)
- Java Developer's Kit (JDK) version 1.2 or higher

If you are using only some features of JPublisher, your requirements might be less stringent:

- If you never generate `SQLData` classes, and you never use the `java.sql.Blob` and `java.sql.Clob` classes, you can use JDK version 1.1.x instead of JDK 1.2.x.
- If you never generate classes that implement the Oracle-specific `ORAData` interface (or the deprecated `CustomDatum` interface), you should be able to use a non-Oracle JDBC driver or a non-Oracle SQLJ implementation. When running code generated by JPublisher, you should even be able to connect to a non-Oracle database; however, JPublisher itself must connect to an Oracle database. Oracle does not test or support configurations that use non-Oracle components.
- If you instruct JPublisher to *not* generate wrapper methods (through the setting `-methods=false`), or if your object types define no methods, then JPublisher will not generate wrapper methods or produce any `.sqlj` files. In this case, you would not need the SQLJ translator. See "Generation of Package Classes and Wrapper Methods (-methods)" on page 3-21 for information about the `-methods` option.
- If you want JPublisher to generate wrappers for SQL OPAQUE types, you must use an Oracle 9*i* release 2 or later database and JDBC driver.
- If you use JPublisher to generate only custom object classes that implement the deprecated `CustomDatum` interface, you can use Oracle database version 8.1.5 with JDBC version 8.1.5 and JDK version 1.1.x or higher. (But it is advisable to upgrade to the `ORAData` interface, which requires an Oracle9*i* or higher JDBC implementation.)

JPublisher Input and Output

You can specify input options on the command line and in the properties file. In addition to producing `.sqlj` and `.java` files for the translated objects, JPublisher writes the names of the translated objects and packages to standard output.

JPublisher Input

"JPublisher Options" on page 3-2 describes all the JPublisher options.

In addition, you can use a file known as the `INPUT` file to specify the object types and PL/SQL packages JPublisher should translate. It also controls the naming of the generated packages and classes. "INPUT File Structure and Syntax" on page 3-35 describes `INPUT` file syntax.

A properties file is an optional text file that you can use to specify options to JPublisher. Specify the names of properties files on the command line, using the `-props` option. JPublisher processes the properties files as if their contents were inserted, in sequence, on the command line at that point. For additional flexibility, properties files can also be SQL script files where the JPublisher directives are embedded in SQL comments. For more information about this file and its format, see "Properties File Structure and Syntax" on page 3-33.

JPublisher Output

JPublisher generates a Java class for each object type that it translates. For each object type, whether an `ORAData` or a `SQLData` implementation, JPublisher generates a `<`*`type`*`>.sqlj` file for the class code (or a `<`*`type`*`>.java` file if wrapper methods were suppressed or do not exist, or depending on the JPublisher `-methods` option setting) and a `<`*`type`*`>Ref.java` file for the code for the REF class of the Java type. For example, if you define an `EMPLOYEE` SQL object type, JPublisher generates an `employee.sqlj` file (or an `employee.java` file) and an `employeeRef.java` file. Note that the case of Java class names produced by JPublisher is determined by the `-case` option. See "Case of Java Identifiers (-case)" on page 3-15.

For each collection type (nested table or VARRAY) it translates, JPublisher generates a `<`*`type`*`>.java` file. For nested tables, the generated class has methods to get and set the nested table as an entire array and to get and set individual elements of the table. JPublisher translates collection types when generating `ORAData` classes, but not when generating `SQLData` classes. JPublisher can also generate wrapper classes for OPAQUE types. However, OPAQUE types are more typically already pre-mapped to corresponding Java classes that implement the `ORAData` interface.

For PL/SQL packages, JPublisher generates classes containing wrapper methods as `.sqlj` files.

When JPublisher generates the class files and wrappers, it also writes the names of the translated types and packages to standard output.

Overview of Datatype Mappings

JPublisher offers different categories of datatype mappings from SQL to Java. JPublisher options to specify these mappings are described below, under "Detailed Descriptions of Options That Affect Datatype Mappings" on page 3-7.

Each type mapping option has at least two possible values: `jdbc` and `oracle`. The `-numbertypes` option has two additional alternatives: `objectjdbc` and `bigdecimal`.

The following sections describe these categories of mappings. For more information about datatype mappings, see "Details of Datatype Mapping" on page 2-2.

JDBC Mapping

The JDBC mapping maps most numeric datatypes to Java primitive types such as `int` and `float`, and maps `DECIMAL` and `NUMBER` to `java.math.BigDecimal`. LOB types and other non-numeric built-in types map to standard JDBC Java types such as `java.sql.Blob` and `java.sql.Timestamp`. For object types, JPublisher generates `SQLData` classes. Predefined datatypes that are Oracle extensions (such as `BFILE` and `ROWID`) do not have JDBC mappings, so only the `oracle.sql.*` mapping is supported for these types.

The Java primitive types used in the JDBC mapping do not support null values and do not guard against integer overflow or floating-point loss of precision. If you are using the JDBC mapping and you attempt to call an accessor or method to get an attribute of a primitive type (`short`, `int`, `float`, or `double`) whose value is `null`, an exception is thrown. If the primitive type is `short` or `int`, then an exception is thrown if the value is too large to fit in a `short` or `int` variable.

Object JDBC Mapping

The Object JDBC mapping maps most numeric datatypes to Java wrapper classes such as `java.lang.Integer` and `java.lang.Float`, and maps `DECIMAL` and `NUMBER` to `java.math.BigDecimal`. It differs from the JDBC mapping only in that it does not use primitive types.

When you use the Object JDBC mapping, all your returned values are objects. If you attempt to get an attribute whose value is `null`, a null object is returned.

The Java wrapper classes used in the Object JDBC mapping do not guard against integer overflow or floating-point loss of precision. If you call an accessor method to get an attribute that maps to `java.lang.Integer`, an exception is thrown if the value is too large to fit.

This is the default mapping for numeric types.

BigDecimal Mapping

`BigDecimal` mapping, as the name implies, maps all numeric datatypes to `java.math.BigDecimal`. It supports null values and very large values.

Oracle Mapping

In the Oracle mapping, JPublisher maps any numeric, LOB, or other built-in type to a class in the `oracle.sql` package. For example, the `DATE` type is mapped to `oracle.sql.DATE`, and all numeric types are mapped to `oracle.sql.NUMBER`. For object, collection, and object reference types, JPublisher generates `ORAData` classes.

Because the Oracle mapping uses no primitive types, it can represent a null value as a Java `null` in all cases. Because it uses the `oracle.sql.NUMBER` class for all numeric types, it can represent the largest numeric values that can be stored in the database.

Other Option Settings

Note that a number of additional option settings influence the nature of the generated code. For example, the option `-compatible` controls generations of the backward compatible `CustomDatum` type, while `-access` specifies the visibility of the generated methods, constructors, and attributes. The option `-serializable` controls whether a generated object wrapper class implements `java.io.Serializable` or not.

Creating Types and Packages in the Database

Before you run JPublisher, you must create any new datatypes that you will require in the database. You must also ensure that any PL/SQL packages, methods, and subprograms that you want to invoke from Java are also installed in Oracle9*i*.

Use the SQL `CREATE TYPE` statement to create object, VARRAY, and nested table types in the database. JPublisher supports the mapping of these datatypes to Java classes. JPublisher also generates classes for references to object types. REF types are not explicitly declared in SQL. For more information on creating object types, see the *Oracle9i SQL Reference*.

Use the `CREATE PACKAGE` and `CREATE PACKAGE BODY` statements to create PL/SQL packages and store them in the database. PL/SQL furnishes all the capabilities necessary to implement the methods associated with object types. These methods (functions and procedures) reside on the server as part of a user's schema. You can implement the methods in PL/SQL or Java.

Packages are often implemented to provide the following advantages:

- encapsulation of related procedures and variables
- declaration of `public` and `private` procedures, variables, constants, and cursors
- better performance

For more information on PL/SQL and creating PL/SQL packages, see the *PL/SQL User's Guide and Reference*.

JPublisher Operation

This section discusses the basic steps in using JPublisher, describes the command-line syntax, and concludes with a more detailed description of a sample translation. The following topics are covered:

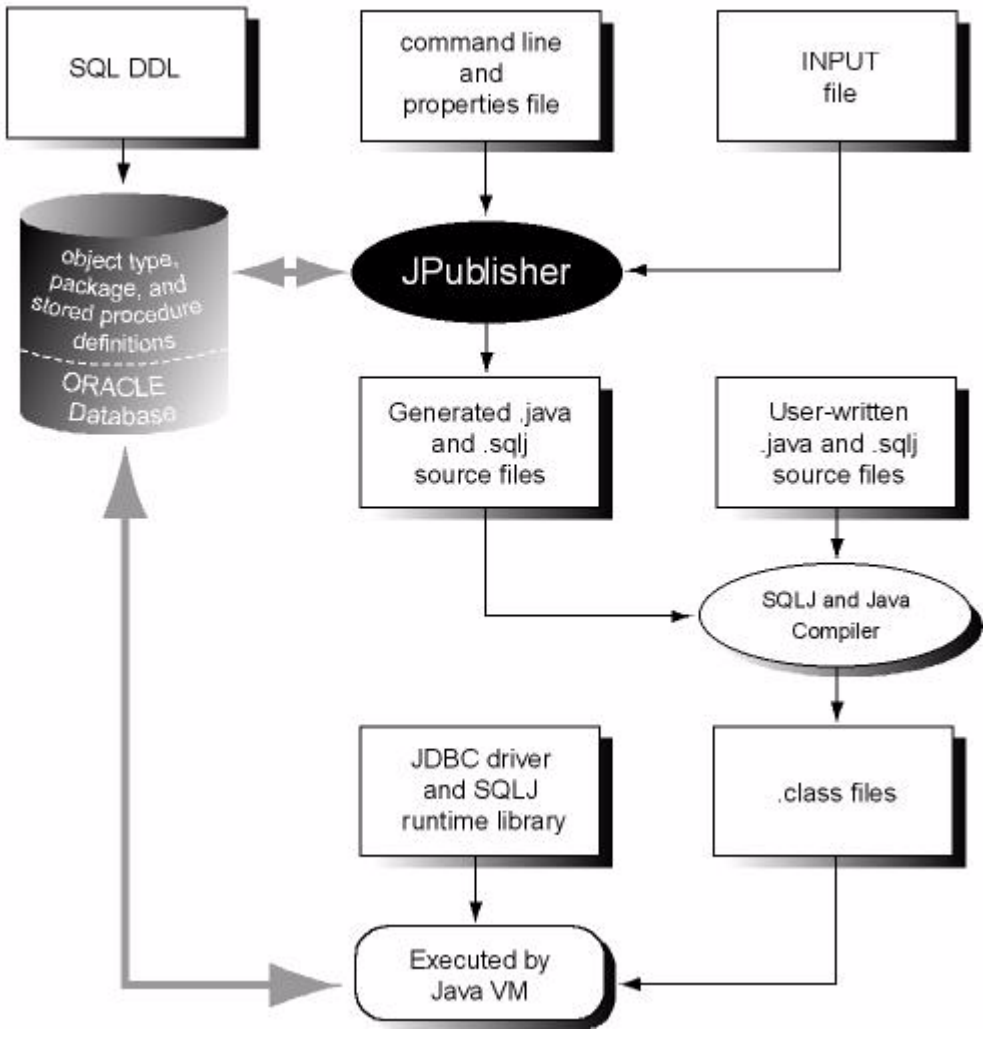
- Translating and Using PL/SQL Packages and User-Defined Types
- Representing User-Defined Object, Collection, and Reference Types in Java
- Strongly Typed Object References for ORAData Implementations
- JPublisher Command-Line Syntax
- Sample JPublisher Translation

Translating and Using PL/SQL Packages and User-Defined Types

This section lists the basic steps, illustrated in Figure 1–1 below, for translating and using code for user-defined types and PL/SQL packages. User-defined types include Oracle objects and Oracle collections—VARRAYs and nested table types.

1. Create the desired user-defined datatypes and PL/SQL packages in the database.
2. Have JPublisher generate source code for Java classes that represent PL/SQL packages, user-defined types, and reference types and places them in specified Java packages. JPublisher generates `.java` files for object reference, VARRAY, and nested table classes. If you instruct JPublisher to generate wrapper methods, it will generate `.sqlj` files for packages and object types (assuming the object types have methods). If you instruct JPublisher to *not* generate wrapper methods, it will generate `.java` files without wrapper methods for object types and will not generate classes for packages (because they contain only wrapper methods). For object types without methods, JPublisher generates `.java` files in any case.
3. Import these classes into your application code.
4. Use the methods in the generated classes to access and manipulate the user-defined types and their attributes.
5. Compile all classes (the JPublisher-generated code and your code). SQLJ translates and compiles `.sqlj` and `.java` files. Or, if you have only `.java` files, you can simply invoke the Java compiler.
6. Run your compiled application.

Figure 1–1 Translating and Using JPublisher-Generated Code



Representing User-Defined Object, Collection, and Reference Types in Java

Here are the three ways to represent user-defined object, collection, object reference, and OPAQUE types in your Java program:

- Use classes that implement the `ORAData` interface.

  JPublisher generates classes that implement the `oracle.sql.ORAData` interface. (You can also write them by hand, but this is not generally recommended.)

- Use classes that implement the `SQLData` interface, as described in the JDBC 2.0 API.

  JPublisher generates classes for SQL object types that implement the `java.sql.SQLData` interface. (You can also write them by hand, but this is not generally recommended. Be aware that if you write them by hand, or if you generate classes for an inheritance hierarchy of object types, your classes must be registered using a type map.)

  When you use the `SQLData` interface, all object reference types are represented generically as `java.sql.Ref` instances, and all collection types are represented generically as `java.sql.Array` instances. There is no mechanism for representing OPAQUE types.

- Use `oracle.sql.*` classes.

  You can use the `oracle.sql.*` classes to represent user-defined types generically. The class `oracle.sql.STRUCT` represents all object types, the class `oracle.sql.ARRAY` represents all VARRAY and nested table types, the class `oracle.sql.REF` represents all REF types, and the class `oracle.sql.OPAQUE` represents all OPAQUE types. These classes are immutable in the same way that `java.lang.String` is.

  You would need to choose this option if you need to write code that processes objects, collections, references, or OPAQUE types in a generic way.

Compared to `oracle.sql.*` classes, classes that implement `ORAData` or `SQLData` are strongly typed. Your connected SQLJ translator will detect an error at translation time if, for example, you mistakenly select a `PERSON` object into an `ORAData` object that represents an `ADDRESS`.

JPublisher-generated classes that implement `ORAData` or `SQLData` have additional advantages:

- The classes are customized, rather than generic. You access attributes of an object using `get`*`XXX`*`()` and `set`*`XXX`*`()` methods named after the particular

attributes of the object. Note that you have to explicitly update the object in the database if there are any changes to its data.

- The classes are mutable. You can generally modify attributes of an object or elements of a collection. The exception is that `ORAData` classes representing object reference types are not mutable, because an object reference does not have any subcomponents that could be sensibly modified. You can, however, use the `setValue()` method of a reference object to change the database value that the reference points to.
- You can generate Java wrapper classes that are serializable, or that have `toString()` method to print out the object together with its attribute values.

Compared to classes that implement `SQLData`, classes that implement `ORAData` are fundamentally more efficient, because `ORAData` classes avoid unnecessary conversions to native Java types. For a comparison of the `SQLData` and `ORAData` interfaces, see the *Oracle9i JDBC Developer's Guide and Reference*.

Strongly Typed Object References for ORAData Implementations

For Oracle `ORAData` implementations, JPublisher always generates strongly typed object reference classes as opposed to using the weakly typed `oracle.sql.REF` class. This is to provide greater type safety and to mirror the behavior in SQL, where object references are strongly typed. The strongly typed classes (with names such as `PersonRef` for references to `PERSON` objects) are essentially wrappers for the `oracle.sql.REF` class.

In these strongly typed `REF` wrappers, there is a `getValue()` method that produces an instance of the SQL object that is referenced, in the form of an instance of the corresponding Java class. (Or, in the case of inheritance, perhaps as an instance of a subclass of the corresponding Java class.) For example, if there is a `PERSON` object type in the database, with a corresponding `Person` Java class, there will also be a `PersonRef` Java class. The `getValue()` method of the `PersonRef` class would return a `Person` instance containing the data for a `PERSON` object in the database. In addition, JPublisher also generates a static `cast()` method on the `PersonRef` class, permitting you to convert other typed references to a `PersonRef` instance.

Whenever a SQL object type has an attribute that is an object reference, the Java class corresponding to the object type would have an attribute that is an instance of a Java class corresponding to the appropriate reference type. For example, if there is a `PERSON` object with a `MANAGER REF` attribute, then the corresponding `Person` Java class will have a `ManagerRef` attribute.

For standard SQLData implementations, strongly typed object references are not supported—they are not part of the standard. JPublisher does not create a custom reference class; you must use java.sql.Ref or oracle.sql.REF as the reference type.

JPublisher Command-Line Syntax

On most operating systems, you invoke JPublisher on the command line, typing jpub followed by a series of options settings as follows:

```
jpub -option1=value1 -option2=value2 ...
```

JPublisher responds by connecting to the database and obtaining the declarations of the types or packages you specify, then generating one or more custom Java files and writing the names of the translated object types or PL/SQL packages to standard output.

Here is an example of a command that invokes JPublisher (single wraparound command line):

```
jpub -user=scott/tiger -input=demoin -numbertypes=oracle -usertypes=oracle
-dir=demo -package=corp
```

Enter the command on one command line, allowing it to wrap as necessary. For clarity, this chapter refers to the input file (the file specified by the -input option) as the INPUT file (to distinguish it from any other kinds of input files).

This command directs JPublisher to connect to the database with username SCOTT and password TIGER and translate datatypes to Java classes, based on instructions in the INPUT file demoin. The -numbertypes=oracle option directs JPublisher to map object attribute types to Java classes supplied by Oracle, and the -usertypes=oracle option directs JPublisher to generate Oracle-specific ORAData classes. JPublisher places the classes that it generates in the package corp in the directory demo.

"JPublisher Options" on page 3-2 describes each of these options in more detail.

Notes:

- No spaces are permitted around the equals sign (=).
- If you execute JPublisher without any options on the command line, it displays an option list and then terminates.

Sample JPublisher Translation

This section provides a sample JPublisher translation of an object type. At this point, do not worry about the details of the code JPublisher generates. You can find more information about JPublisher input and output files, options, datatype mappings, and translation later in this manual.

Create the object type EMPLOYEE:

```
CREATE TYPE employee AS OBJECT
(
    name        VARCHAR2(30),
    empno       INTEGER,
    deptno      NUMBER,
    hiredate    DATE,
    salary      REAL
);
```

The INTEGER, NUMBER, and REAL types are all stored in the database as NUMBER types, but after translation they have different representations in the Java program, based on your choice for the value of the `-numbertypes` option.

JPublisher translates the types according to the following command line:

```
jpub -user=scott/tiger -dir=demo -numbertypes=objectjdbc -builtintypes=jdbc
-package=corp -case=mixed -sql=Employee
```

This is a single wraparound command line. "JPublisher Options" on page 3-2 describes each of these options in detail.

Note that because the EMPLOYEE object type does not define any methods, JPublisher will generate a `.java` file, not a `.sqlj` file.

Because `-dir=demo` and `-package=corp` were specified on the JPublisher command line, the translated class `Employee` is written to `Employee.java` in the following location:

```
./demo/corp/Employee.java          (UNIX)
.\demo\corp\Employee.java          (Windows NT)
```

The `Employee.java` class file would contain the code below.

Note: The details of the code JPublisher generates are subject to change. In particular, non-public methods, non-public fields, and all method bodies may be generated differently.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class Employee implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.EMPLOYEE";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 12,4,2,91,7 };
  private static ORADataFactory[] _factory = new ORADataFactory[5];
  protected static final Employee _EmployeeFactory = new Employee(false);

  public static ORADataFactory getORADataFactory()
  { return _EmployeeFactory; }

  /* constructor */
  protected Employee(boolean init)
  { if(init) _struct = new MutableStruct(new Object[5], _sqlType, _factory); }
  public Employee()
  { this(true); }
  public Employee(String name, Integer empno, java.math.BigDecimal deptno,
java.sql.Timestamp hiredate, Float salary)
   throws SQLException
  { this(true);
    setName(name);
    setEmpno(empno);
    setDeptno(deptno);
    setHiredate(hiredate);
    setSalary(salary);
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _struct.toDatum(c, _SQL_NAME);
```

```
  }

  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  { return create(null, d, sqlType); }
  protected ORAData create(Employee o, Datum d, int sqlType) throws SQLException
  {
    if (d == null) return null;
    if (o == null) o = new Employee(false);
    o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
    return o;
  }
  /* accessor methods */
  public String getName() throws SQLException
  { return (String) _struct.getAttribute(0); }

  public void setName(String name) throws SQLException
  { _struct.setAttribute(0, name); }

  public Integer getEmpno() throws SQLException
  { return (Integer) _struct.getAttribute(1); }

  public void setEmpno(Integer empno) throws SQLException
  { _struct.setAttribute(1, empno); }

  public java.math.BigDecimal getDeptno() throws SQLException
  { return (java.math.BigDecimal) _struct.getAttribute(2); }

  public void setDeptno(java.math.BigDecimal deptno) throws SQLException
  { _struct.setAttribute(2, deptno); }

  public java.sql.Timestamp getHiredate() throws SQLException
  { return (java.sql.Timestamp) _struct.getAttribute(3); }

  public void setHiredate(java.sql.Timestamp hiredate) throws SQLException
  { _struct.setAttribute(3, hiredate); }

  public Float getSalary() throws SQLException
  { return (Float) _struct.getAttribute(4); }

  public void setSalary(Float salary) throws SQLException
  { _struct.setAttribute(4, salary); }

}
```

Code Generation Notes

- Oracle JPublisher in Oracle9*i* release 2 and higher also generates object constructors based on the object attributes.
- Additional `private` or `public` methods may be generated with other settings. For example, the setting `-serializable=true` results in the object wrapper implementing the interface `java.io.Serializable` and in the generation of `private writeObject` and `readObject` methods. The setting `-tostring=true` results in the additional generation of a `public toString()` method.
- For Oracle9*i* releases (as well as Oracle8*i* release 8.1.7), there is a `protected _struct` field in JPublisher-generated code for SQL object types. This is an instance of the internal class `oracle.jpub.runtime.MutableStruct`; this instance contains the data in original SQL format. In general, you should never reference this field directly. Instead, use the setting `-methods=always` or `-methods=named` as necessary to ensure that JPublisher produces `.sqlj` files, then use the methods `setFrom()` and `setValueFrom()` when subclassing. See "The setFrom(), setValueFrom(), and setContextFrom() Methods" on page 2-38.
- In Oracle8*i* compatibility mode, there is also a `protected _ctx` field that is a SQLJ connection context instance. See "Oracle8i Compatibility Mode" on page 2-52 for more information.
- Note that Oracle8*i* JPublisher would generate implementations of the now-deprecated `CustomDatum` and `CustomDatumFactory` interfaces, instead of `ORAData` and `ORADataFactory`. In fact, it is still possible to do this through the JPublisher `-compatible` option, and this is required if you are using an Oracle8*i* JDBC driver.

JPublisher also generates an `EmployeeRef.java` class. The source code is displayed here:

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.REF;
```

```
import oracle.sql.STRUCT;

public class EmployeeRef implements ORAData, ORADataFactory
{
  public static final String _SQL_BASETYPE = "SCOTT.EMPLOYEE";
  public static final int _SQL_TYPECODE = OracleTypes.REF;

  REF _ref;

private static final EmployeeRef _EmployeeRefFactory = new EmployeeRef();

  public static ORADataFactory getORADataFactory()
  { return _EmployeeRefFactory; }
  /* constructor */
  public EmployeeRef()
  {
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _ref;
  }

  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  {
    if (d == null) return null;
    EmployeeRef r = new EmployeeRef();
    r._ref = (REF) d;
    return r;
  }

  public static EmployeeRef cast(ORAData o) throws SQLException
  {
     if (o == null) return null;
     try { return (EmployeeRef) getORADataFactory().create(o.toDatum(null),
OracleTypes.REF); }
     catch (Exception exn)
     { throw new SQLException("Unable to convert "+o.getClass().getName()+" to
EmployeeRef: "+exn.toString()); }
  }
```

```
  public Employee getValue() throws SQLException
  {
     return (Employee) Employee.getORADataFactory().create(
       _ref.getSTRUCT(), OracleTypes.REF);
  }

  public void setValue(Employee c) throws SQLException
  {
    _ref.setValue((STRUCT) c.toDatum(_ref.getJavaSqlConnection()));
  }
}
```

Note that JPublisher in Oracle9i release 2 and higher also generates a `public static cast()` method to cast from other strongly typed references into a strongly typed reference instance.

You can find more examples of object mappings in "Example: JPublisher Object Attribute Mapping" on page 4-8.

2

JPublisher Concepts

This chapter provides a detailed discussion of JPublisher's underlying concepts and of its operation. The following topics are covered:

- Details of Datatype Mapping
- Concepts of JPublisher-Generated Classes
- JPublisher Generation of SQLJ Classes (.sqlj)
- JPublisher Generation of Java Classes (.java)
- User-Written Subclasses of JPublisher-Generated Classes
- JPublisher Support for Inheritance
- Backward Compatibility and Migration
- JPublisher Limitations

Details of Datatype Mapping

As described previously, you can specify one of the following settings for datatype mappings when you use the type mapping options (`-builtintypes`, `-lobtypes`, `-numbertypes`, and `-usertypes`):

- `jdbc`
- `objectjdbc` (for `-numbertypes` only)
- `bigdecimal` (for `-numbertypes` only)
- `oracle`

These mappings, described in "Overview of Datatype Mappings" on page 1-18, affect the argument and result types JPublisher uses in the methods it generates.

The class that JPublisher generates for an object type will have `get`*`XXX`*`()` and `set`*`XXX`*`()` methods for the object attributes. The class that JPublisher generates for a VARRAY or nested table type will have `get`*`XXX`*`()` and `set`*`XXX`*`()` methods that access the elements of the array or nested table. When you use the option `-methods=true`, the class that JPublisher generates for an object type or PL/SQL package will have wrapper methods that invoke server methods of the object type or package. The mapping options control the argument and result types these methods will use.

The JDBC and Object JDBC mappings use familiar Java types that can be manipulated using standard Java operations. If your JDBC program is manipulating Java objects stored as object types, you might prefer the JDBC or Object JDBC mapping.

The Oracle mapping is the most efficient mapping. The `oracle.sql` types match the Oracle internal datatypes as closely as possible so that little or no data conversion is required between the Java and the SQL formats. You do not lose any information and have greater flexibility in how you process and unpack the data. The Oracle mappings for standard SQL types are the most convenient representations if you are manipulating data within the database or moving data (for example, performing `SELECT` and `INSERT` operations from one existing table to another). When data format conversion is necessary, you can use methods in the `oracle.sql.*` classes to convert to Java native types.

When you decide which mapping to use, you should remember that data format conversion is only a part of the cost of transferring data between your program and the server.

SQL and PL/SQL Mappings to Oracle and JDBC Types

Table 2–1 lists the mappings from SQL and PL/SQL datatypes to Java types using the Oracle and JDBC mappings. You can use all the supported datatypes listed in this table as argument or result types for PL/SQL methods. You can use a subset of the datatypes as object attribute types, as listed in "Allowed Object Attribute Types" on page 2-6.

The **SQL and PL/SQL Datatype** column contains all possible datatypes.

The **Oracle Mapping** column lists the corresponding Java types JPublisher uses when all the type mapping options are set to `oracle`. These types are found in the `oracle.sql` package supplied by Oracle and are designed to minimize the overhead incurred when converting Oracle datatypes to Java types. Refer to the *Oracle9i JDBC Developer's Guide and Reference* for more information on the `oracle.sql` package.

The **JDBC Mapping** column lists the corresponding Java types JPublisher uses when all the type mapping options are set to `jdbc`. For standard SQL datatypes, JPublisher uses Java types specified in the JDBC specification. For SQL datatypes that are Oracle extensions, JPublisher uses the `oracle.sql.*` types. When you set the type mapping option to `objectjdbc`, the corresponding types will be the same as in the **JDBC Mapping** column except that primitive Java types, such as `int`, are replaced with their object counterparts, such as `java.lang.Integer`. Type correspondences that are explicitly defined in the JPublisher type map, such as PL/SQL `BOOLEAN` to SQL `NUMBER` to Java `boolean`, are not affected by the mapping option settings.

A few datatypes are not directly supported by JPublisher, in particular those types that pertain to PL/SQL only. You can overcome these limitations by providing equivalent SQL and Java types, as well as PL/SQL conversion functions between PL/SQL and SQL representations. The annotations and subsequent sections explain these conversions further.

Table 2–1 SQL and PL/SQL Datatype to Oracle and JDBC Mapping Classes

SQL and PL/SQL Datatype	Oracle Mapping	JDBC Mapping
CHAR, CHARACTER, LONG, STRING, VARCHAR, VARCHAR2	oracle.sql.CHAR	java.lang.String
NCHAR, NVARCHAR2	oracle.sql.NCHAR (note 1)	oracle.sql.NString (note 1)
RAW, LONG RAW	oracle.sql.RAW	byte[]

Table 2–1 SQL and PL/SQL Datatype to Oracle and JDBC Mapping Classes (Cont.)

SQL and PL/SQL Datatype	Oracle Mapping	JDBC Mapping
BINARY_INTEGER, NATURAL, NATURALN, PLS_INTEGER, POSITIVE, POSITIVEN, SIGNTYPE, INT, INTEGER	oracle.sql.NUMBER	int
DEC, DECIMAL, NUMBER, NUMERIC	oracle.sql.NUMBER	java.math.BigDecimal
DOUBLE PRECISION, FLOAT	oracle.sql.NUMBER	double
SMALLINT	oracle.sql.NUMBER	short
REAL	oracle.sql.NUMBER	float
DATE	oracle.sql.DATE	java.sql.Timestamp
TIMESTAMP, TIMESTAMP WITH TZ, TIMESTAMP WITH LOCAL TZ	oracle.sql.TIMESTAMP, oracle.sql.TIMESTAMPTZ, oracle.sql.TIMESTAMPLTZ	java.sql.Timestamp
INTERVAL YEAR TO MONTH INTERVAL DAY TO SECOND	String (note 2)	String (note 2)
ROWID, UROWID	oracle.sql.ROWID	oracle.sql.ROWID
BOOLEAN	boolean (note 3)	boolean (note 3)
CLOB	oracle.sql.CLOB	java.sql.Clob
BLOB	oracle.sql.BLOB	java.sql.Blob
BFILE	oracle.sql.BFILE	oracle.sql.BFILE
NCLOB	oracle.sql.NCLOB (note 1)	oracle.sql.NCLOB (note 1)
object types	generated class	generated class
SQLJ object types	Java class defined at type creation	Java class defined at type creation
OPAQUE types	generated or predefined class (note 4)	generated or predefined class (note 4)
RECORD types	through mapping to SQL object type (note 5)	through mapping to SQL object type (note 5)
nested table, VARRAY	generated class implemented using oracle.sql.ARRAY	java.sql.Array
reference to object type	generated class implemented using oracle.sql.REF	java.sql.Ref
REF CURSOR	java.sql.ResultSet	java.sql.ResultSet

Table 2–1 SQL and PL/SQL Datatype to Oracle and JDBC Mapping Classes (Cont.)

SQL and PL/SQL Datatype	Oracle Mapping	JDBC Mapping
scalar (numeric or character) indexed-by tables	through mapping to Java array (note 6)	through mapping to Java array (note 6)
indexed-by tables	through mapping to SQL collection (note 7)	through mapping to SQL collection (note 7)
user-defined subtypes	same as for base type	same as for base type

Datatype Mapping Notes The following notes correspond to marked entries in the preceding table.

1. The Java classes `oracle.sql.NCHAR`, `oracle.sql.NCLOB`, and `oracle.sql.NString` are not part of JDBC but are distributed with the SQLJ runtime. SQLJ uses these classes to represent the NCHAR form of use of the corresponding classes `oracle.sql.CHAR`, `oracle.sql.CLOB`, and `java.lang.String`.
2. Mapping of SQL `INTERVAL` types to `VARCHAR2` and Java `String` is defined in a default JPublisher type map. It uses conversion functions from the `SYS.SQLJUTL` package. See also "JPublisher Default Type Map and User Type Map" on page 2-18.
3. Mapping of PL/SQL `BOOLEAN` to SQL `NUMBER` and Java `boolean` is defined in the default JPublisher type map. It uses conversion functions from the `SYS.SQLJUTL` package.
4. Mapping of the SQL OPAQUE type `SYS.XMLTYPE` to the Java class `oracle.xdb.XMLType` is defined in the default JPublisher type map. For other OPAQUE types, the vendor will typically provide a corresponding Java class. In this case you just have to specify a JPublisher type map entry that defines the correspondence between the SQL OPAQUE type and the corresponding Java wrapper class. If JPublisher encounters an OPAQUE type that does not have a type map entry, it will generate a Java wrapper class for that OPAQUE type. See also "Type Mapping Support for OPAQUE Types" on page 2-8.
5. In order to support a PL/SQL RECORD type you must define a corresponding SQL object type and two PL/SQL conversion functions that map between SQL and PL/SQL types (one function to convert in each direction). Additionally, you must publish a Java wrapper class for the SQL type with JPublisher. At this point you can provide a type map entry for JPublisher that defines the correspondences between PL/SQL, SQL, and Java types and the PL/SQL conversion functions. This allows JPublisher to automatically publish PL/SQL

or method signatures that use the PL/SQL RECORD type. See also "Type Mapping Support for PL/SQL RECORD Types" on page 2-14.

6. If you are using the JDBC OCI driver to call PL/SQL stored procedures or object methods, you have direct support for scalar indexed-by tables, also known as PL/SQL TABLE types. In this case, specify a type map entry for JPublisher that contains the PL/SQL scalar indexed-by table type and the corresponding Java array type. JPublisher can then automatically publish PL/SQL or object method signatures that use this scalar indexed-by type. See also "Type Mapping Support for Scalar Indexed-by Tables Using JDBC OCI" on page 2-9.
7. In order to support a PL/SQL indexed-by table type, you must define a corresponding SQL collection type and two PL/SQL conversion functions that map between SQL and PL/SQL types. Additionally, you must publish a Java wrapper class for the SQL collection type with JPublisher. (If the elements of the indexed-by table are PL/SQL records, you also must provide full JPublisher mapping support between these records and corresponding SQL and Java types.) At this point you can provide a type map entry for JPublisher that defines the correspondences between PL/SQL, SQL, and Java types and the PL/SQL conversion functions. Now JPublisher can automatically publish PL/SQL or method signatures that use this PL/SQL indexed-by-table type. See also "Type Mapping Support for PL/SQL Indexed-by Table Types" on page 2-16.

> **Note:** The Object JDBC and `BigDecimal` mappings, which affect numeric types only, are fully described in "Mappings For Numeric Types (-numbertypes)" on page 3-10.

Allowed Object Attribute Types

You can use a subset of the PL/SQL datatypes listed in Table 2–1 as object attribute types. These datatypes are listed here and have the same Oracle mappings and JDBC mappings as described in the table:

- `CHAR`, `VARCHAR`, `VARCHAR2`, `CHARACTER`
- `NCHAR`, `NVARCHAR2`
- `DATE`
- `DECIMAL`, `DEC`, `NUMBER`, `NUMERIC`
- `DOUBLE PRECISION`, `FLOAT`

- `INTEGER`, `SMALLINT`, `INT`
- `REAL`
- `RAW`, `LONG RAW`
- `CLOB`
- `BLOB`
- `BFILE`
- `NCLOB`
- object type, OPAQUE type, SQLJ object type
- nested table, VARRAY type
- reference type

The TIMESTAMP types `TIMESTAMP`, `TIMESTAMP WITH TIMEZONE`, and `TIMESTAMP WITH LOCAL TIMEZONE` are supported by JPublisher as object attributes. However, in Oracle9*i* release 2 (9.2.0), JDBC does not support these types as object attributes.

Using Datatypes Unsupported by JDBC

Generally, if JPublisher encounters a PL/SQL stored procedure or function or an object type method with an unsupported PL/SQL type, it will issue an error message and skip the generation of a corresponding method in the wrapper class. However, if you provide appropriate type mapping information, such methods can still be automatically published by JPublisher. In addition, a JPublisher type map entry can be used to associate types, such as SQL OPAQUE types or certain scalar PL/SQL indexed-by table types, with corresponding Java classes. The following sections discuss various aspects of the type mapping support provided by JPublisher:

- Type Mapping Support for OPAQUE Types
- Type Mapping Support for Scalar Indexed-by Tables Using JDBC OCI
- Type Mapping Support Through PL/SQL Conversion Functions
- Type Mapping Support for PL/SQL RECORD Types
- Type Mapping Support for PL/SQL Indexed-by Table Types
- JPublisher Default Type Map and User Type Map

Type Mapping Support for OPAQUE Types

Oracle JDBC and Oracle SQLJ provide support for SQL OPAQUE types that are published as Java classes implementing the `oracle.sql.ORAData` interface. Such classes must also contain the following `public static` fields and methods:

```
public static String _SQL_NAME = "SQL_name_of_OPAQUE_type";
public static int _SQL_TYPECODE = OracleTypes.OPAQUE;
public static ORADataFactory getORADataFactory() { ... }
```

As of Oracle 9*i* release 2, the SQL OPAQUE type `SYS.XMLTYPE` is supported with the corresponding Java wrapper class `oracle.xdb.XMLType`.

If you have a Java wrapper class for a SQL OPAQUE type that follows the rules outlined here, you can specify this association to JPublisher with the following command line option:

```
-addtypemap=sql_opaque_type:java_wrapper_class
```

In this way the predefined type correspondence for `XMLTYPE` could have been supplied explicitly to JPublisher as follows:

```
-addtypemap=SYS.XMLTYPE:oracle.xdb.XMLType
```

Whenever JPublisher encounters a SQL OPAQUE type for which no type correspondence has been provided, it will actually publish a Java wrapper class. Consider the following SQL type defined in the `SCOTT` schema:

```
CREATE TYPE X_TYP AS OBJECT (xml SYS.XMLTYPE);
```

Notice that the attribute `xml` is published as an `oracle.xdb.XMLType`, which corresponds to the predefined type mapping for `SYS.XMLTYPE`. The following publishes `X_TYP` as a Java class `XTyp`.

```
jpub -u scott/tiger -s X_TYP:XTyp
```

If you clear the JPublisher default type map, then an additional wrapper class `Xmltype` would be automatically generated for the `SYS.XMLTYPE` attribute. You can verify this by invoking JPublisher as follows:

```
jpub -u scott/tiger -s X_TYP:XTyp -defaulttypemap=
```

The option `-defaulttypemap` is for setting the JPublisher default type map. If you give it no value, as in the preceding example, then the default type map is set to the empty string, effectively clearing it. For more information on the default type map refer to "JPublisher Default Type Map and User Type Map" on page 2-18.

Type Mapping Support for Scalar Indexed-by Tables Using JDBC OCI

The Oracle JDBC OCI driver directly supports PL/SQL scalar indexed-by tables with numeric or character elements. (If you are not using the JDBC OCI driver, see "Type Mapping Support for PL/SQL Indexed-by Table Types" on page 2-16.) An indexed-by table with numeric elements can be mapped to the following Java array types:

- `int[]`
- `double[]`
- `float[]`
- `java.math.BigDecimal[]`
- `oracle.sql.NUMBER[]`

An indexed-by table with character elements can be mapped to the following Java array types:

- `String[]`
- `oracle.sql.CHAR[]`

In certain circumstances, as described, you must convey the following information for an indexed-by table type:

- Whenever the indexed-by table is used in an `OUT` or `IN OUT` parameter position, you must specify the maximum number of elements. (This is optional otherwise.) This is defined using the customary syntax for Java array allocation. For example, you could specify `int[100]` to denote a type that can accommodate up to 100 elements, or `oracle.sql.CHAR[20]` for up to 20 elements.
- For indexed-by tables with character elements, you can optionally specify the maximum size of an individual element (in bytes). This setting is defined using SQL-like size syntax. For example, for an indexed-by table used for `IN` arguments, you could specify `String[](30)`. Or specify `oracle.sql.CHAR[20](255)` for an indexed-by table of maximum length 20, each of whose elements will not exceed 255 bytes.

Use the JPublisher option `-addtypemap` to add instructions to the user type map to specify correspondences between PL/SQL types that are scalar indexed-by tables, and corresponding Java array types. The size hints that are given using the syntax outlined above will be embedded into the generated SQLJ statements and thus conveyed to JDBC at runtime.

As an example, consider the following code fragment from the definition of a PL/SQL package `INDEXBY` in the schema `SCOTT`. Assume this is available in a file `indexby.sql`.

```
create or replace package indexby as

--  jpub.addtypemap=SCOTT.INDEXBY.VARCHAR_ARY:String[1000](4000)
--  jpub.addtypemap=SCOTT.INDEXBY.INTEGER_ARY:int[1000]
--  jpub.addtypemap=SCOTT.INDEXBY.FLOAT_ARY:double[1000]

 type varchar_ary IS TABLE OF VARCHAR2(4000) INDEX BY BINARY_INTEGER;
 type integer_ary IS TABLE OF INTEGER        INDEX BY BINARY_INTEGER;
 type float_ary   IS TABLE OF NUMBER         INDEX BY BINARY_INTEGER;

 function get_float_ary RETURN float_ary;
 procedure pow_integer_ary(x integer_ary, y OUT integer_ary);
 procedure xform_varchar_ary(x IN OUT varchar_ary);

end indexby;
/
create or replace package body indexby is ...
/
```

The following are the required `-addtypemap` directives for mapping the three indexed-by table types:

```
-addtypemap=SCOTT.INDEXBY.VARCHAR_ARY:String[1000](4000)
-addtypemap=SCOTT.INDEXBY.INTEGER_ARY:int[1000]
-addtypemap=SCOTT.INDEXBY.FLOAT_ARY:double[1000]
```

Note that depending on the operating system shell you are using, you might have to quote options that contain square brackets **[...]** or parentheses **(...)**. Or you can avoid this by placing such options into a JPublisher properties file, as follows:

```
jpub.addtypemap=SCOTT.INDEXBY.VARCHAR_ARY:String[1000](4000)
jpub.addtypemap=SCOTT.INDEXBY.INTEGER_ARY:int[1000]
jpub.addtypemap=SCOTT.INDEXBY.FLOAT_ARY:double[1000]
```

See "Properties File Structure and Syntax" on page 3-33 for information about properties files.

Also, as a convenience feature, JPublisher directives in a properties file are recognized when placed behind a "`--`" prefix (two dashes), whereas any entry that does not start with "`jpub.`" or with "`-- jpub.`" is simply ignored. This means you can place JPublisher directives into SQL scripts and reuse the same SQL scripts as

JPublisher properties files. Thus, after invoking the `indexby.sql` script in order to define the `INDEXBY` package, you can now run JPublisher to publish this package as a Java class `IndexBy` as follows:

```
jpub -u scott/tiger -s INDEXBY:IndexBy -props=indexby.sql
```

As mentioned previously, this mapping of scalar indexed-by tables can only be used in conjunction with the JDBC OCI driver. If you are using another driver or if you want to create driver-independent code, you will have to define SQL types that correspond to the indexed-by table types as well as conversion functions that map between the two. Please refer to the section "Type Mapping Support for PL/SQL Indexed-by Table Types" on page 2-16.

Type Mapping Support Through PL/SQL Conversion Functions

This section discusses the general mechanism used by JPublisher for supporting PL/SQL types in Java code, through PL/SQL functions that convert to corresponding SQL types. The sections that follow this are concerned with mapping issues that are specific to PL/SQL RECORD types and PL/SQL indexed-by table types, respectively.

In general, Java programs do not support the binding of PL/SQL-specific types. (Although one exception is scalar indexed-by tables. See "Type Mapping Support for Scalar Indexed-by Tables Using JDBC OCI" on page 2-9.) The only way such types can be used from Java is by using PL/SQL code to map them to SQL types and then accessing these SQL types from Java.

JPublisher makes this task more convenient. For a particular PL/SQL type, specify the following information in a JPublisher type map entry.

- the name of the PL/SQL type, typically of the following form:

  `SCHEMA.PACKAGE.TYPE`.

- the name of the corresponding Java (wrapper) class
- the name of the SQL type that corresponds to the PL/SQL type

  You must be able to directly map this type to the Java wrapper class. For example, if the SQL type is `NUMBER`, then the corresponding Java class could be types such as `int`, `double`, `Integer`, `Double`, `java.math.BigDecimal`, or `oracle.sql.NUMBER`. Or, if the SQL type is an object type, then the corresponding Java class would be a corresponding object wrapper class—typically generated by JPublisher—that implements the `ORAData` or `SQLData` interface.

- the name of a PL/SQL function (conversion function) that maps the SQL type to the PL/SQL type
- the name of a PL/SQL function (conversion function) that maps the PL/SQL type to the SQL type

The `-addtypemap` specification for this has the following form:

`-addtypemap=`*`plsql_type`*`:`*`java_type`*`:`*`sql_type`*`:`*`sql_to_plsql_fun`*`:`*`plsql_to_sql_fun`*

As an example, consider a type map entry for supporting the PL/SQL type `BOOLEAN`. It consists of the following specifications:

- the name of the PL/SQL type—`BOOLEAN`
- specification to map it to Java `boolean`
- the corresponding SQL type—`INTEGER`

  JDBC considers `boolean` values as special numeric values.
- the name of the PL/SQL function, `INT2BOOL`, that maps from SQL to PL/SQL (from `NUMBER` to `BOOLEAN`)

  Here is the code for that function:

  ```
  function int2bool(i INTEGER) return BOOLEAN is
  begin if i is null then return null;
        else return i<>0;
        end if;
  end int2bool;
  ```

- the name of the PL/SQL function, `BOOL2INT`, that maps from PL/SQL to SQL (from `BOOLEAN` to `NUMBER`):

  Here is the code for that function:

  ```
  function bool2int(b BOOLEAN) return INTEGER is
  begin if b is null then return null;
        elsif b then return 1;
        else return 0; end if;
  end bool2int;
  ```

Put all this together in the following type map entry:

```
-addtypemap=BOOLEAN:boolean:INTEGER:INT2BOOL:BOOL2INT
```

Such a type map entry assumes that the SQL type, the Java type, and both conversion functions have been defined in SQL, Java, and PL/SQL, respectively.

Note that there already is an entry for PL/SQL `BOOLEAN` in the JPublisher default type map—see "JPublisher Default Type Map and User Type Map" on page 2-18. If you want to try the above type map entry, you would therefore have to override the default type map. You can use the JPublisher `-defaulttypemap` option to accomplish this, as follows:

```
jpub -u scott/tiger -s SYS.SQLJUTL:SQLJUtl
-defaulttypemap=BOOLEAN:boolean:INTEGER:INT2BOOL:BOOL2INT
```

> **Note:** While this manual has described conversions in terms of mapping between SQL and PL/SQL types, there is no intrinsic limitation in this approach that would restrict us to PL/SQL. You could also map between different SQL types. In fact, this is done in the JPublisher default type map to support SQL INTERVAL types, which are mapped to `VARCHAR2` values and back. (See "JPublisher Default Type Map and User Type Map" on page 2-18.)

If the PL/SQL type that we are trying to convert occurs either as an `IN` parameter or as a function return value, then no further effort is necessary. The two conversion functions, from SQL to PL/SQL and vice versa, are entirely sufficient for all such conversion requirements. A problem arises, however, if the PL/SQL type occurs in an `OUT` or `IN OUT` parameter position. In this case, conversions between PL/SQL and SQL representations may be required before or after calling the original procedure or function that is using this type. This means that we may have to generate and load additional PL/SQL code, on a method-by-method basis, for performing this additional conversion task. Fortunately, JPublisher creates this code automatically for you. It remains your responsibility, however, to install this additional PL/SQL code in the database.

The following JPublisher options permit you to control how JPublisher creates this PL/SQL code:

- `-plsqlfile=`*`filename`*

  This specifies the name of the file into which JPublisher generates PL/SQL code. If this file already exists, it will be overwritten. If no file name is specified, JPublisher will write to a file named `plsql_wrapper.sql`. Remember that you will have to run this SQL script in order to install the PL/SQL wrappers in the database.

- `-plsqlpackage=`*`plsql_package`*

  This specifies the name of the PL/SQL package into which JPublisher generates PL/SQL code. If no package name is provided, JPublisher will use `JPUB_PLSQL_WRAPPER`.

- `-plsqlmap=`*`flag`*

  This specifies how JPublisher generates PL/SQL wrapper procedures and functions. The *`flag`* setting can be any of the following:

  – `true` (default)—JPublisher will generate PL/SQL wrapper procedures and functions as needed and use conversion functions only when that is sufficient.

  – `false`—JPublisher will not generate PL/SQL wrapper procedures or functions. If it encounters a PL/SQL type in a signature that cannot be supported by conversion functions alone, then it will skip generation of Java code for the particular procedure or function.

  – `always`—JPublisher will generate a PL/SQL wrapper procedure or function for every stored procedure or function that uses a PL/SQL type. This is useful for generating a "proxy" PL/SQL package that complements an original PL/SQL package, providing Java-accessible signatures for those functions or procedures that were not accessible from JDBC or SQLJ in the original package.

Type Mapping Support for PL/SQL RECORD Types

Publishing PL/SQL RECORD types is just a special case of using conversion functions as described in the previous section. The required steps are most easily illustrated by a concrete example.

Assume that you have method signatures that use the following PL/SQL RECORD type, defined in a PL/SQL package `SCHEM.PACK`:

```
TYPE plsql_record IS RECORD (
     pls_number   NUMBER,
     pls_name     VARCHAR2(60));
```

Also assume that the conversions are to take place in the schema `SCOTT`.

The following list describes the steps to take.

1. Define a SQL type that PLSQL_RECORD can be mapped to. For example:

```
create TYPE sql_record as object (
        sql_number   NUMBER,
        sql_name     VARCHAR2(60));
```

2. Use JPublisher to publish the SQL type to Java. For example, you can create a Java wrapper class SqlRecord for SQL_RECORD as follows:

```
jpub -u scott/tiger -s SQL_RECORD:SqlRecord
```

3. Define PL/SQL stored functions that map from PLSQL_RECORD to SQL_RECORD and vice versa:

```
function plsql_record2sql(r SCHEM.PACK.PLSQL_RECORD)
         return sql_record is
begin
   return sql_record(r.inst_number, r.inst_name);
end plsql_record2sql;

function sql_record2plsql(r sql_record)
         return SCHEM.PACK.PLSQL_RECORD is
 res SCHEM.PACK.PLSQL_RECORD;
begin
 if r IS NOT NULL
 then
   res.plsql_number := r.sql_number;
   res.plsql_name   := r.sql_name;
 end if;
 return res;
end sql_record2plsql;
```

4. Set up a type map entry for JPublisher that tells it how to publish the PLSQL_RECORD type by mapping it to the SQL_RECORD type. You could create the following JPublisher properties file, record.properties, for example (with backslash characters, "\", indicating that continuation lines follow):

```
# Type map entries have the format:
# jpub.sql=PLSQL_type:Java_type:SQL_type:sql_to_plsql_fun:plsql_to_sql_fun
#
# Note the use of line continuation in the entry below.
jpub.addtypemap=SCHEM.PACK.PLSQL_RECORD:\
                SqlRecord:\
                SQL_RECORD:\
                SQL_RECORD2PLSQL:\
                PLSQL_RECORD2SQL
```

5. Use this type map entry whenever you publish a package or type that refers to PLSQL_RECORD. For example, in the following JPublisher invocation we are including record.properties with this type map entry (using the -u shorthand for -users and -p for -props):

   ```
   jpub -u schema/pw_for_schem -p record.properties -s SCHEM.PACK:Pack
   ```

6. If PLSQL_RECORD is used as an OUT or IN OUT parameter in SCHEM.PACK, then JPublisher will also alert you that it has generated a file plsql_wrapper.sql containing PL/SQL wrapper definitions. Make sure to run this script before using the generated Java class Pack. Also note that you can use the -plsqlfile, -plsqlpackage, and -plsqlmap options to customize the PL/SQL script that JPublisher creates.

Type Mapping Support for PL/SQL Indexed-by Table Types

If you are using the JDBC OCI driver and require only the publishing of scalar indexed-by tables, you can use the direct mapping between Java and these types outlined in "Type Mapping Support for Scalar Indexed-by Tables Using JDBC OCI" on page 2-9. In all other cases you must define a SQL collection type that permits conversion to and from the PL/SQL indexed-by table type.

This section continues the example in the preceding section and adds an indexed-by table type PLSQL_INDEXBY with elements of type PLSQL_RECORD. The steps to follow are the same as those outlined previously. We assume once more that the type declarations are defined in the package SCHEM.PACK. In addition to the previous declaration of PLSQL_RECORD, there is also the following definition for PLSQL_INDEXBY:

```
TYPE plsql_indexby IS TABLE OF plsql_record INDEX BY BINARY_INTEGER;
```

Again, assume that the conversions are taking place in the schema SCOTT.

The following list describes the steps to take.

1. Define a SQL type that PLSQL_INDEXBY can be mapped to. For example:

   ```
   create TYPE sql_indexby as table of sql_record;
   ```

   Note that the elements of this type must be mappable to the elements of PLSQL_INDEXBY. We accomplished this previously by creating the type SQL_RECORD and mapping it to PLSQL_RECORD.

2. Use JPublisher to publish the SQL type to Java. For example, to create a Java wrapper class `SqlIndexby` for `SQL_INDEXBY`, you can run JPublisher as follows:

```
jpub -u scott/tiger -s SQL_INDEXBY:SqlIndexby
```

3. Define PL/SQL stored functions that map from `PLSQL_INDEXBY` to `SQL_INDEXBY` and vice versa. The following functions work in conjunction with the previously defined conversion functions `PLSQL_RECORD2SQL` and `SQL_RECORD2PLSQL`:

```
function plsql_indexby2sql (r SCHEM.PACK.PLSQL_INDEXBY)
         return sql_indexby is
  tab sql_indexby := sql_indexby();
begin
  FOR i IN 1..r.LAST LOOP
     tab(i) := plsql_record2sql(r(i));
  END LOOP;
  return tab;
end plsql_indexby2sql;

function sql_indexby2plsql (r sql_indexby)
         return SCHEM.PACK.PLSQL_INDEXBY is
  res SCHEM.PACK.PLSQL_INDEXBY;
begin
  FOR i IN 1..r.LAST LOOP
    res(i) := sql_record2plsql(r(i));
  END LOOP;
  return res;
end sql_indexby2plsql;
```

4. Set up a type map entry for JPublisher that tells it how to publish the `PLSQL_INDEXBY` type by mapping it to the `SQL_INDEXBY` type. For example, you could create the following JPublisher properties file, `indexby.properties`:

```
# Type map entries have the format:
# jpub.sql=PLSQL_type:Java_type:SQL_type:sql_to_plsql_fun:plsql_to_sql_fun
#
# Note the use of line continuation in the entry below.
jpub.addtypemap=SCHEM.PACK.PLSQL_INDEXBY:\
                SqlIndexby:\
                SQL_INDEXBY:\
                SQL_INDEXBY2PLSQL:\
                PLSQL_INDEXBY2SQL
```

5. Use this type map entry whenever you publish a package or type that refers to PLSQL_INDEXBY. For example, in the following JPublisher invocation (a single wraparound command line), the indexby.properties file is included with this type map entry:

```
jpub -u schem/pw_for_schem -p indexby.properties -p record.properties
     -s SCHEM.PACK:Pack
```

   Note that we also included the record.properties file that tells JPublisher how to map PLSQL_RECORD entities. This allows JPublisher to map signatures that contain either PLSQL_RECORD or PLSQL_INDEXBY types or both. Of course you can also combine all the type map entries into a single properties file.

6. If PLSQL_INDEXBY or PLSQL_RECORD is used as an OUT or IN OUT parameter in SCHEM.PACK, then JPublisher will also alert you that it has generated a file plsql_wrapper.sql containing PL/SQL wrapper definitions. Be sure to run this script before using the generated Java class Pack. Also note that you can use the -plsqlfile, -plsqlpackage, and -plsqlmap options to customize the PL/SQL script that JPublisher creates.

JPublisher Default Type Map and User Type Map

JPublisher has a *user type map*, which is controlled by the -typemap and -addtypemap options and starts out empty, and a *default type map*, which is controlled by the -defaulttypemap and -adddefaulttypemap options and starts with the following entries:

```
jpub.defaulttypemap=SYS.XMLTYPE:oracle.xdb.XMLType
jpub.adddefaulttypemap=BOOLEAN:boolean:INTEGER:\
SYS.SQLJUTL.INT2BOOL:SYS.SQLJUTL.BOOL2INT
jpub.adddefaulttypemap=INTERVAL DAY TO SECOND:String:CHAR:\
SYS.SQLJUTL.CHAR2IDS:SYS.SQLJUTL.IDS2CHAR
jpub.adddefaulttypemap=INTERVAL YEAR TO MONTH:String:CHAR:\
SYS.SQLJUTL.CHAR2IYM:SYS.SQLJUTL.IYM2CHAR
```

JPublisher reads the default type map first. If you attempt in the user type map to redefine a mapping that is in the default type map, JPublisher will generate a warning message and ignore the redefinition. Similarly, attempts to add mappings through -adddefaulttypemap or -addtypemap settings that conflict with previous mappings are ignored and generate warnings.

To use custom mappings, it is recommended that you clear the default type map, as follows:

```
-defaulttypemap=
```

and then use the `-addtypemap` option to put any required mappings into the user type map.

The predefined default type map defines a correspondence between the OPAQUE type `SYS.XMLTYPE` and the Java wrapper class `oracle.xdb.XMLType`. In addition, it maps the PL/SQL `BOOLEAN` type to Java `boolean` and to SQL `INTEGER` through two conversion functions defined in the `SYS.SQLJUTL` package. Finally, the default type map provides mappings between SQL `INTERVAL` types and the Java `String` type.

However, you may (for example) prefer mapping the PL/SQL `BOOLEAN` type to the Java object type `Boolean` in order to capture SQL `NULL` values in addition to `true` and `false` values. This can be accomplished by resetting the default type map, as shown by the following (single wraparound line):

```
-defaulttypemap=BOOLEAN:Boolean:INTEGER:SYS.SQLJUTL.INT2BOOL:
SYS.SQLJUTL.BOOL2INT
```

This changes the designated Java type from `boolean` to `Boolean`. The rest of the conversion remains valid.

Other Alternatives for Datatypes Unsupported by JDBC

The preceding sections describe the mechanisms used by JPublisher to access types that are not supported in JDBC. As an alternative to using JPublisher in this way, you can try one of these alternatives:

- Rewrite the PL/SQL method to avoid using the type.
- Write an anonymous block that does the following:
  - Converts input types that JDBC supports into the input types used by the PL/SQL method.
  - Converts output types used by the PL/SQL method into output types that JDBC supports.

  For more information on this technique, see "Example: Using Datatypes Unsupported by JDBC" on page 4-71.

Concepts of JPublisher-Generated Classes

This section covers basic concepts about the code that JPublisher produces, including the following:

- how output parameters of SQL object type methods and PL/SQL methods are treated
- how member methods are called
- how overloaded methods are handled

For more information, see the following sections later in this chapter:

- "JPublisher Generation of SQLJ Classes (.sqlj)" on page 2-24
- "JPublisher Generation of Java Classes (.java)" on page 2-31
- "JPublisher Support for Inheritance" on page 2-39

Passing OUT Parameters

Stored procedures called through SQLJ do not have the same parameter-passing behavior as ordinary Java methods. This affects the code you write when you call a wrapper method that JPublisher generates.

When you call an ordinary Java method, parameters that are Java objects are passed as object references. The method can modify the object.

In contrast, when you call a stored procedure through SQLJ, a copy of each parameter is passed to the stored procedure. If the procedure modifies any parameters, copies of the modified parameters are returned to the caller. Therefore, the "before" and "after" values of a parameter that has been modified appear in separate objects.

A wrapper method JPublisher generates contains SQLJ code to call a stored procedure. The parameters to the stored procedure, as declared in your `CREATE TYPE` or `CREATE PACKAGE` declaration, have three possible parameter modes: `IN`, `OUT`, and `IN OUT`. The `IN OUT` and `OUT` parameters of the stored procedure are returned to the wrapper method in newly created objects. These new values must be returned to the caller somehow, but assignment to the formal parameter within the wrapper method does not affect the actual parameter visible to the caller.

Passing Parameters Other Than the "this" Parameter

The simplest way to solve the problem described above is to pass an `OUT` or `IN OUT` parameter to the wrapper method in a single-element array. The array is a sort of container that holds the parameter.

- You assign the "before" value of the parameter to element 0 of an array.
- You pass the array to your wrapper method.
- The wrapper method assigns the "after" value of the parameter to element 0 of the array.
- After executing the method, you extract the "after" value from the array.

In the following example, you have an initialized variable `p` of class `Person`, and `x` is an object belonging to a JPublisher-generated class that has a wrapper method `f` taking an `IN OUT Person` argument. You create the array and pass the parameter as follows:

```
Person [] pa = {p};
x.f(pa);
p = pa[0];
```

Unfortunately, this technique for passing `OUT` or `IN OUT` parameters requires you to add a few extra lines of code to your program for each parameter. If your stored program has many `OUT` or `IN OUT` parameters, you might prefer to call it directly using SQLJ code, rather than a wrapper method.

Passing the "this" Parameter

Problems similar to what is described above arise when the `this` object of an instance method is modified.

The `this` object is an additional parameter that is passed in a different way. Its mode, as declared in the `CREATE TYPE` statement, may be `IN` or `IN OUT`. If you do not explicitly declare the mode of `this`, its mode is `IN OUT` if the stored procedure does not return a result, or `IN` if it does.

If the mode of the `this` object is `IN OUT`, the wrapper method must return the new value of `this`. The code generated by JPublisher processes this in different ways, depending on the situation:

- For a stored procedure that does not return a result, the new value of `this` is returned as the result of the wrapper method.

As an example, assume the SQL object type MYTYPE has the following member procedure:

```
MEMBER PROCEDURE f1(y IN OUT INTEGER);
```

Also assume that JPublisher generates a corresponding Java class MyJavaType. This class would define the following method:

```
public MyJavaType f1(int[] y)
```

The f1 method returns the modified this object value as a MyJavaType instance.

- For a stored function (a stored procedure that returns a result), the wrapper method returns the result of the stored function as its result. The new value of this is returned in a single-element array, passed as an extra argument (the last argument) to the wrapper method.

  Assume the SQL object type MYTYPE has the following member function:

  ```
  MEMBER FUNCTION f2(x IN INTEGER) RETURNS VARCHAR2;
  ```

  Then the corresponding Java class MyJavaType would define the following method:

  ```
  public String f2(int x, MyJavaType[] newValue)
  ```

  The f2 method returns the VARCHAR2 function-return as a Java string, and returns the modified this object value as an array element in the MyJavaType array.

Note: For PL/SQL static procedures or functions, JPublisher generates instance methods, not static methods, in the wrapper class. This is the logistic for associating a database connection (a SQLJ connection context instance or JDBC connection instance) with each wrapper class instance. The connection instance is used in initializing the wrapper class instance, so that you are not subsequently required to explicitly provide a connection or connection context instance when calling wrapper methods.

Translating Overloaded Methods

PL/SQL, as with Java, lets you create overloaded methods—two or more methods with the same name, but different signatures. If you use JPublisher to generate wrapper methods for PL/SQL methods, it is possible that two overloaded methods with different signatures in PL/SQL might have identical signatures in Java. If this occurs, JPublisher changes the names of the methods to avoid generating two or more methods with the identical signature. For example, consider a PL/SQL package or object type that includes these functions:

```
FUNCTION f(x INTEGER, y INTEGER) RETURN INTEGER
```

and

```
FUNCTION f(xx FLOAT, yy FLOAT) RETURN INTEGER
```

In PL/SQL, these functions have different argument types. However, once they are translated to Java with Oracle mapping, this difference disappears (both `INTEGER` and `FLOAT` map to `oracle.sql.NUMBER`).

Suppose that JPublisher generates a class for the package or object type with the command-line setting `-methods=true` and Oracle mapping. JPublisher responds by generating code similar to this:

```
public oracle.sql.NUMBER f_1 (
  oracle.sql.NUMBER x,
  oracle.sql.NUMBER y)
throws SQLException
{
  /* body omitted */
}

public oracle.sql.NUMBER f_4 (
  oracle.sql.NUMBER xx,
  oracle.sql.NUMBER yy)
throws SQLException
{
  /* body omitted */
}
```

Note that in this example, JPublisher names the first function `f_1` and the second function `f_4`. Each function name ends with `_<`*nn*`>`, where `<`*nn*`>` is a number assigned by JPublisher. The number has no significance of its own, but JPublisher uses it to guarantee that the names of functions with identical parameter types will be unique.

JPublisher Generation of SQLJ Classes (.sqlj)

When `-methods=all` (the default) or `-methods=true`, JPublisher generates `.sqlj` files for PL/SQL packages and for object types—both `ORAData` implementations and `SQLData` implementations (unless an object type does not define any methods, in which case a `.java` file is generated). The classes includes wrapper methods that invoke the server methods of the object types and packages. Run SQLJ to translate the `.sqlj` file.

This section describes how to use these generated classes in your SQLJ code.

Important Notes About Generation of SQLJ Classes

Be aware of the following for JPublisher-generated SQLJ classes:

- Classes produced by JPublisher include a `release()` method. In creating and using an instance of a JPublisher-generated wrapper class, if you do not use the constructor with the `DefaultContext` argument, and you do not subsequently call the `setConnectionContext()` method with a connection context argument, and you then invoke a wrapper method, then the wrapper object will implicitly construct a `DefaultContext` instance. In this case, you should use the `release()` method to release the connection context instance when it is no longer needed.

  In other words, one of the following is recommended:

  – Do not supply connection information, and thus implicitly use the static SQLJ default connection context instance.

  or:

  – Explicitly associate the object with a SQLJ connection context instance through the `setConnectionContext()` method.

  or:

  – Construct the object with an explicitly provided SQLJ connection context.

  See "Use of Connection Contexts and Instances in SQLJ Code Generated by JPublisher" on page 2-27 for more information.

- In Oracle8*i* JPublisher and in the JPublisher Oracle8*i* compatibility mode, instead of the constructor taking a `DefaultContext` instance or user-specified-class instance, there is a constructor that simply takes a `ConnectionContext` instance (an instance of any class that implements the standard `sqlj.runtime.ConnectionContext` interface).

Use of SQLJ Classes JPublisher Generates for PL/SQL Packages

Take the following steps to use a class that JPublisher generates for a PL/SQL package:

1. Construct an instance of the class.
2. Call the wrapper methods of the class.

The constructors for the class associate a database connection with an instance of the class. One constructor takes a SQLJ `DefaultContext` instance (or an instance of a class specified through the `-context` option when you ran JPublisher), one constructor takes a JDBC `Connection` instance, and one constructor has no arguments. Calling the no-argument constructor is equivalent to passing the SQLJ default context to the constructor that takes a `DefaultContext` instance. Oracle JDBC provides the constructor that takes a `Connection` instance for the convenience of the JDBC programmer who knows how to compile a SQLJ program, but is unfamiliar with SQLJ concepts such as `DefaultContext`.

Important: See "Important Notes About Generation of SQLJ Classes" on page 2-24.

The wrapper methods are all instance methods, because the connection context in the `this` object is used in `#sql` statements in the wrapper methods.

Because a class generated for a PL/SQL package has no instance data other than the connection context, you will typically construct one class instance for each connection context you use. If the default context is the only one you use then you can call the no-argument constructor once. However, the *Oracle9i SQLJ Developer's Guide and Reference* discusses reasons for using explicit connection context instances instead.

An instance of a class generated for a PL/SQL package does not contain copies of PL/SQL package variables. It is not an `ORAData` class or a `SQLData` class, and you cannot use it as a host variable.

"Example: Using Classes Generated for Packages" on page 4-66 shows how to use a class generated for a PL/SQL package.

Use of Classes JPublisher Generates for Object Types

To use an instance of a Java class that JPublisher generates for a SQL object type or a SQL OPAQUE type, you must first initialize the Java object. You can accomplish this in one of the following ways:

- Assign an already initialized Java object to your Java object.

or:

- Retrieve a copy of a SQL object into your Java object. You can do this by using the SQL object as an `OUT` argument or as the function call return of a JPublisher-generated wrapper method, or by retrieving the SQL object through `#sql` statements you write, or by retrieving the SQL object through JDBC calls you write.

or:

- Construct the Java object with the no-argument constructor and set its attributes using the `set`*`XXX`*`()` methods, or construct the Java object with the constructor that accepts values for all of the object attributes. Typically, you would subsequently use the `setConnection()` or `setConnectionContext()` method to associate the object with a database connection before invoking any of its wrapper methods. If you do not explicitly associate the object with a JDBC or SQLJ connection and invoke a method on it, it will become implicitly associated with the default (static) SQLJ connection context.

  Other constructors for the class associate a connection with the class instance. One constructor takes a `DefaultContext` instance (or an instance of a class specified through the `-context` option when you ran JPublisher), and one constructor takes a `Connection` instance. The constructor that takes a `Connection` instance is provided for the convenience of the JDBC programmer who knows how to compile a SQLJ program, but is unfamiliar with SQLJ concepts such as `DefaultContext`.

Important: See "Important Notes About Generation of SQLJ Classes" on page 2-24.

Once you have initialized your Java object, you can:

- Call the accessor methods of the object.
- Call the wrapper methods of the object.
- Pass the object to other wrapper methods.

- Use the object as a host variable in `#sql` statements.
- Use the object as a host variable in JDBC calls.

There is a Java attribute for each attribute of the corresponding SQL object type, with `get`*`XXX`*`()` and `set`*`XXX`*`()` accessor methods for each attribute. The accessor method names are of the form `getFoo()` and `setFoo()` for attribute `foo`. JPublisher does not generate fields for the attributes.

By default, the class includes wrapper methods that invoke the associated Oracle object methods executing in the server. The wrapper methods are all instance methods, regardless of whether the server methods are. The `DefaultContext` in the `this` object is used in `#sql` statements in the wrapper methods.

With Oracle mapping, JPublisher generates the following methods for the Oracle JDBC driver to use. These methods are specified in the `ORAData` and `ORADataFactory` interfaces:

- `create()`
- `toDatum()`

These methods are not generally intended for your direct use. In addition, JPublisher generates methods `setFrom(`*`otherObject`*`)`, `setValueFrom(`*`otherObject`*`)`, and `setContextFrom(`*`otherObject`*`)` that can be used to copy value or connection information from one object instance to another.

The sample in "Example: Using Classes Generated for Object Types" on page 4-54 shows how to use a class that was generated for an object type and has wrapper methods.

Use of Connection Contexts and Instances in SQLJ Code Generated by JPublisher

The class that JPublisher uses in creating SQLJ connection context instances depends on how you set the `-context` option when you run JPublisher, as follows:

- A setting of `-context=DefaultContext` (the default) results in JPublisher using instances of the standard `sqlj.runtime.ref.DefaultContext` class.
- A setting of a user-specified class (that is in the classpath and implements the standard `sqlj.runtime.ConnectionContext` interface) results in JPublisher using instances of that class.

- A setting of `-context=generated` results in the following declaration in the JPublisher-generated class.

  ```
  #sql static context _Ctx;
  ```

  In this case, JPublisher uses instances of the `_Ctx` class for connection context instances.

  Note: It is no longer routine (as it was in Oracle8*i* JPublisher) for JPublisher to declare a connection context instance `_ctx`. This is used in Oracle8*i* compatibility mode, however (`-compatible=8i` or `-compatible=both8i`), with `_ctx` being declared as a `protected` instance of the static connection context class `_Ctx`.

  Unless you have legacy code that depends on `_ctx`, it is preferable to use the `getConnectionContext()` and `setConnectionContext()` methods to retrieve and manipulate connection context instances in JPublisher-generated classes. See "Considerations in Using Connection Contexts and Connection Instances" below for more information about these methods.

See "SQLJ Connection Context Classes (-context)" on page 3-16 for more information about the `-context` option.

Considerations in Using Connection Contexts and Connection Instances

Consider the following points in using SQLJ connection context instances or JDBC connection instances in instances of JPublisher-generated wrapper classes:

- Wrapper classes generated by JPublisher provide a `setConnectionContext()` method you can use to explicitly specify a SQLJ connection context instance. (This will not be necessary if you have already specified a connection context instance through the constructor.)

  This method is defined as follows:

  ```
  public void setConnectionContext(conn_ctxt_instance);
  ```

  This installs the passed connection context instance as the SQLJ connection context in the object wrapper instance. The connection context instance must be an instance of the class specified through the `-context` option for JPublisher connection contexts (typically `DefaultContext`).

Be aware that the underlying JDBC connection must be compatible with the connection used to materialize the database object in the first place. Specifically, some objects may have attributes, such as object reference types or BLOBs, that are only valid for a particular connection.

Note: Using the `setConnectionContext()` method to explicitly set a connection context instance avoids a problem of the connection context not being closed properly. This problem only occurs with implicitly created connection context instances.

- Use either of the following methods of an object wrapper instance, as appropriate, to retrieve a connection or connection context instance.
  - `Connection getConnection()`
  - *`ConnCtxtType`* `getConnectionContext()`

  The `getConnectionContext()` method returns an instance of the connection context class specified through the JPublisher `-context` option (typically `DefaultContext`).

  The returned connection context instance might either be an instance that was set explicitly through the `setConnectionContext()` method, or an instance that was created implicitly by JPublisher.

  Note: These methods are available only in generated `.sqlj` files, not generated `.java` files. If necessary, you can use the setting `-methods=always` to ensure that `.sqlj` files are produced. See "Generation of Package Classes and Wrapper Methods (-methods)" on page 3-21.

- If code in a JPublisher-generated class uses any SQLJ statements, and you do not set a connection context instance explicitly, then one will be created implicitly from the JDBC connection instance when the `getConnectionContext()` method is called.

  In this circumstance, you must be careful to use the `release()` method to free resources in the SQLJ runtime that would otherwise result in a memory leak.

- Having different connection context classes in different generated classes gives you the option of checking different classes against different exemplar schemas during SQLJ on-line semantics checking; however, because the SQLJ source is constructed from actual SQL types, this checking is usually not necessary.

See "Releasing Connection Context Resources" (below) and "SQLJ Connection Context Classes (-context)" on page 3-16 for related information.

Releasing Connection Context Resources

In some situations, you *must* use the `release()` method of an instance of a JPublisher-generated wrapper class in order to free SQLJ runtime connection context resources. This is true in the following set of circumstances:

- You used the SQLJ setting `-codegen=iso` in translating SQLJ classes.

and:

- You use JDK 1.1.x or the SQLJ generic `runtime` library (as opposed to `runtime12`, `runtime11`, and so on) when you execute the generated class or classes.

and:

- You did not create the object with the constructor that takes an instance of `DefaultContext` (or some other connection context class you specified through the `-context` option when you ran JPublisher).

and:

- You have called one or more wrapper methods on the wrapper instance.

and:

- You did *not* use the `setConnectionContext()` method of the wrapper instance to explicitly set a connection context instance.

In this set of circumstances, a connection context instance would have been created implicitly on the object and must explicitly be freed through the `release()` method before the object goes out of scope.

(When there is an explicit connection context instance, such as through an explicit constructor or use of the `setConnectionContext()` method, using `release()` is not necessary.)

JPublisher Generation of Java Classes (.java)

When `-methods=false`, or when SQL object types do not define any methods, JPublisher does not generate wrapper methods for object types. In this regard, the behavior is the same for `ORAdata` and `SQLData` implementations. Furthermore, when `-methods=false`, JPublisher does not generate code for PL/SQL packages at all, because they are not useful without wrapper methods. (Note that when `-methods=false`, JPublisher exclusively generates `.java` files.)

JPublisher generates the same Java code for reference, VARRAY, and nested table types regardless of whether `-methods` is `false` or `true`.

To use an instance of a class JPublisher generates for an object type when `-methods=false`, or for a reference, VARRAY, or nested table type, you must first initialize the object.

Similarly to the case with JPublisher-generated SQLJ classes, you can initialize your object in one of the following ways:

- Assign an already initialized Java object to your Java object.

or:

- Retrieve a copy of a SQL object into your Java object. You can do this by using the SQL object as an `OUT` argument or as the function call return of a JPublisher-generated wrapper method in some other class, or by retrieving the SQL object through `#sql` statements you write, or by retrieving the SQL object through JDBC calls you write.

or:

- Construct the Java object with a no-argument constructor and initialize its data, or construct the Java object based on its attribute values.

Unlike the constructors generated in `.sqlj` source files, the constructors generated in `.java` source files do not take a connection argument. Instead, when your object is passed to or returned from a `Statement`, `CallableStatement`, or `PreparedStatement` object, JPublisher applies the connection it uses to construct the `Statement`, `CallableStatement`, or `PreparedStatement` object.

This does not mean you can use the same object with different connections at different times. On the contrary, this is not always possible. An object might have a subcomponent, such as a reference or a `BLOB`, that is valid only for a particular connection.

To initialize the object data, use the `set`*`XXX`*`()` methods if your class represents an object type, or the `setArray()` or `setElement()` method if your class represents

a VARRAY or nested table type. If your class represents a reference type, you can only construct a null reference. All non-null references come from the database.

Once you have initialized your object, you can accomplish the following:

- Pass the object to wrapper methods in other classes.
- Use the object as a host variable in `#sql` statements.
- Use the object as a host variable in JDBC calls.
- Call the methods that read and write the state of the object. These methods operate on the Java object in your program and do not affect data in the database.
  - For a class that represents an object type, you can call the `get`*`XXX`*`()` and `set`*`XXX`*`()` accessor methods.
  - For a class that represents a VARRAY or nested table, you can call the `getArray()`, `setArray()`, `getElement()`, and `setElement()` methods.

    The `getArray()` and `setArray()` methods return or modify an array as a whole. The `getElement()` and `setElement()` methods return or modify individual elements of the array. Then re-insert the Java array into the database if you want to update the data there.
- You cannot modify an object reference, because it is an immutable entity; however, you can read and write the SQL object it references, using the `getValue()` and `setValue()` methods.

  The `getValue()` method returns a copy of the SQL object to which the reference refers. The `setValue()` method updates a SQL object type instance in the database, taking as input an instance of the Java class that represents the object type. Unlike the `get`*`XXX`*`()` and `set`*`XXX`*`()` accessor methods of a class generated for an object type, the `getValue()` and `setValue()` methods read and write SQL objects.

  Note that both, `getValue()` and `setValue()` will result in a database round trip for reading and, respectively, writing the value of the underlying database object that the reference points to.

A few methods have not been mentioned yet. You can use the `getORADataFactory()` method in JDBC code to return an `ORADataFactory` object. You can pass this `ORADataFactory` to the Oracle `getORAData()` methods in the classes `ArrayDataResultSet`, `OracleCallableStatement`, and

`OracleResultSet` in the `oracle.jdbc` package. The Oracle JDBC driver uses the `ORADataFactory` object to create objects of your JPublisher-generated class.

In addition, classes representing VARRAYs and nested tables have a few methods that implement features of the `oracle.sql.ARRAY` class:

- `getBaseTypeName()`
- `getBaseType()`
- `getDescriptor()`

JPublisher-generated classes for VARRAYs and nested tables do not, however, extend `oracle.sql.ARRAY`.

With Oracle mapping, JPublisher generates the following methods for the Oracle JDBC driver to use. These methods are specified in the `ORAData` and `ORADataFactory` interfaces:

- `create()`
- `toDatum()`

These methods are not generally intended for your direct use; however, you may want to use them if converting from one object reference wrapper type to another.

The sample in "Example: Using Classes Generated for Packages" on page 4-66 includes a class that was generated for an object type that does not have wrapper methods.

User-Written Subclasses of JPublisher-Generated Classes

You might want to enhance the functionality of a custom Java class generated by JPublisher by adding methods and transient fields.

One way to accomplish this is to add methods directly to the JPublisher-generated class. However, this is not advisable if you anticipate running JPublisher at some future time to regenerate the class. If you regenerate a class that you have modified in this way, your changes (that is, the methods you have added) will be overwritten. Even if you direct JPublisher output to a separate file, you will still need to merge your changes into the file.

The preferred way to enhance the functionality of a generated class is to extend the class—that is, treat the JPublisher-generated class as a superclass, write a subclass to extend its functionality, then map the object type to the subclass. (This is referred to as the "Generation Gap" pattern in object-oriented terminology.)

This section discusses how to accomplish this.

Extending JPublisher-Generated Classes

Suppose you want JPublisher to generate the class `JAddress` from the SQL object type `ADDRESS`. You also want to write a class `MyAddress` to represent `ADDRESS` objects, where `MyAddress` extends the functionality `JAddress` provides.

Under this scenario, you can use JPublisher to generate a custom Java class `JAddress`, as well as an initial version of a subclass, `MyAddress`, into which you then add the desired functionality. You then use JPublisher to map `ADDRESS` objects to the `MyAddress` class instead of the `JAddress` class.

To do this, JPublisher must alter the code it generates in the following ways:

- It generates the reference class `MyAddressRef` rather than `JAddressRef`.
- It uses the `MyAddress` class instead of the `JAddress` class to represent attributes whose SQL type is `ADDRESS`, or to represent VARRAY and nested table elements whose SQL type is `ADDRESS`.
- It uses the `MyAddress` factory instead of the `JAddress` factory when the `ORADataFactory` interface is used to construct Java objects whose SQL type is `ADDRESS`.
- It generates or regenerates the code for the `JAddress` class. In addition, it also generates an initial version of the code for the `MyAddress` class, which you can then modify to insert your own additional functionality. If the source file for the

MyAddress class already exists, however, it will be left untouched by JPublisher.

Syntax for Mapping to Alternative Classes

JPublisher has functionality to streamline the process of mapping to alternative classes. Use the following syntax in your -sql command-line option setting:

```
-sql=object_type:generated_class:map_class
```

For the above scenario, this would be:

```
-sql=ADDRESS:JAddress:MyAddress
```

See "Declaration of Object Types and Packages to Translate (-sql)" on page 3-26 for information about the -sql option.

If you were to enter the line in the INPUT file instead of on the command line, it would look like this:

```
SQL ADDRESS GENERATE JAddress AS MyAddress
```

See "INPUT File Structure and Syntax" on page 3-35 for information about the INPUT file.

In this syntax, JAddress indicates the name of the class that JPublisher will generate (typically as JAddress.sqlj), but MyAddress specifies the name of the class that actually maps to ADDRESS. You are ultimately responsible for the code in MyAddress. Update this as necessary to add your custom functionality. If you retrieve an object that has an ADDRESS attribute, this attribute will be created as an instance of MyAddress in Java. Or if you retrieve an ADDRESS object directly, you will retrieve it into an instance of MyAddress.

For an example of how you would use JPublisher to generate the JAddress class, see "Example: Generating a SQLData Class" on page 4-28.

Format of the Class that Extends the Generated Class

For convenience, an initial version of the source file into which you place your custom code—for example, MyAddress.sqlj—is automatically generated by JPublisher, unless it already exists.

The generated code has the following features:

- The class has a no-argument constructor. The easiest way to construct a properly initialized object is to invoke the constructor of the superclass, either explicitly or implicitly.
- The class implements the `ORAData` interface or the `SQLData` interface. This happens implicitly by inheriting the necessary methods from the superclass.
- When extending an `ORAData` class, the subclass will also implement the `ORADataFactory` interface.

  An implementation of the `ORADataFactory` `create()` method might look as follows.

```
public ORAData create(Datum d, int sqlType) throws SQLException
{
   return create(new UserClass(),d,sqlType);
}
```

  When the class is part of an inheritance hierarchy, however, the generated method changes to `protected ORAData createExact()` with the same signature and body as `create()` above.

  The following code shows a more efficient implementation, where an initialized `UserClass` instance is created through the `UserClass(boolean)` constructor. This constructor is provided in JPublisher-generated code, including the superclass that `UserClass` extends. Using this constructor ensures that a `UserClass` instance is not needlessly created if the data object is null, or needlessly re-initialized if the data object is non-null.

```
protected UserClass(boolean init) { super(boolean); }
public ORAData create(Datum d, int sqlType) throws SQLException
{
   return (d==null) ? null : create(new UserClass(false),d,sqlType);
}
```

Changes in User-Written Subclasses of Oracle9*i* JPublisher-Generated Classes

If you have been providing user-written subclasses for JPublisher-generated classes under Oracle8*i* JPublisher, you should be aware that there are a number of relevant changes in how Oracle9*i* JPublisher generates code. You would have to make changes in any applications written against the Oracle8*i* functionality if you want to use it under Oracle9*i*.

Note: If you use the `-compatible=both8i` or `8i` setting, you will not see the changes discussed here and your application will continue to work as before. See "Backward-Compatible Oracle Mapping for User-Defined Types (-compatible)" on page 3-9.

In general, however, it is advisable to make the transformation to Oracle9*i* JPublisher functionality, because this will help insulate your user code from implementation details of JPublisher-generated classes.

Following are the changes:

- Replace any use of the declared `_ctx` connection context field with use of the provided `getConnectionContext()` method. The `_ctx` field is no longer supported under Oracle9*i*.
- Replace the explicit implementation of the `create()` method with a call to a superclass `create()` method.

  Assume that in the example below, `UserClass` extends `BaseClass`. Instead of writing the following method in `UserClass`:

```
public CustomDatum create(Datum d, int sqlType) throws SQLException
{
  if (d == null) return null;
  UserClass o = new UserClass();
  o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
  o._ctx = new _Ctx(((STRUCT) d).getConnection());
  return o;
}
```

  supply the following:

```
public CustomDatum create(Datum d, int sqlType) throws SQLException
{
  return create(new UserClass(),d,sqlType);
}
```

  or, if the class is part of an inheritance hierarchy, write the following:

```
protected CustomDatum createExact(Datum d, int sqlType) throws SQLException
{
  return create(new UserClass(),d,sqlType);
}
```

In addition, in `.sqlj` files, JPublisher now generates a `protected` constructor with a boolean argument that specifies whether the object must be initialized:

```
protected BaseClass(boolean init) { ... }
```

You can use this to optimize the `UserClass` code as described in "Format of the Class that Extends the Generated Class" on page 2-35.

- In addition to the `getConnectionContext()` method, Oracle9*i* JPublisher provides a `getConnection()` method that can be used to obtain the JDBC connection associated with the object.

The setFrom(), setValueFrom(), and setContextFrom() Methods

Oracle9*i* JPublisher provides the following utility methods in generated `.sqlj` files:

- `setFrom(`*`anotherObject`*`)`

  This initializes the calling object from another object of the same base type, including connection and connection context information. An existing, implicitly created, connection context object on the calling object is freed.

- `setValueFrom(`*`anotherObject`*`)`

  This initializes the underlying field values of the calling object from another object of the same base type. This method does not transfer connection or connection context information.

- `setContextFrom(`*`anotherObject`*`)`

  This initializes the connection and connection context information on the calling object from the connection setting of another object of the same base type. An existing, implicitly created, connection context object on the calling object is freed. This method does not transfer any information related to the object value.

Note that there is semantic equivalence between the following:

```
x.setFrom(y);
```

and the following:

```
x.setValueFrom(y);
x.setContextFrom(y);
```

JPublisher Support for Inheritance

This section primarily discusses inheritance support for `ORAData` types, explaining the following related topics:

- how JPublisher implements support for inheritance
- why a reference class for a subtype does not extend the reference class for the base type, and how you can convert from one reference type to another reference type (typically a subclass or superclass)

This information is followed by a brief overview of standard inheritance support for `SQLData` types, with reference to appropriate documentation for further information.

ORAData Object Types and Inheritance

Consider the following SQL object types:

```
CREATE TYPE PERSON AS OBJECT (
...
) NOT FINAL;

CREATE TYPE STUDENT UNDER PERSON (
...
);

CREATE TYPE INSTRUCTOR UNDER PERSON (
...
);
```

And consider the following JPublisher command line to create corresponding Java classes (a single wraparound command):

```
jpub -user=scott/tiger -sql=PERSON:Person,STUDENT:Student,INSTRUCTOR:Instructor
-usertypes=oracle
```

In this example, JPublisher generates a `Person` class, a `Student` class, and an `Instructor` class. The `Student` and `Instructor` classes extend the `Person` class, because `STUDENT` and `INSTRUCTOR` are subtypes of `PERSON`.

The class at the root of the inheritance hierarchy—`Person` in this example—contains the full information for the entire inheritance hierarchy and automatically initializes its type map with the required information. As long as you use JPublisher to generate all the required classes of a class hierarchy together, no

additional action is required in order to appropriately populate the type map of the class hierarchy.

Precautions when Combining Partially Generated Type Hierarchies

If you run JPublisher several times on a SQL type hierarchy, each time generating only part of the corresponding Java wrapper classes, then you must take precautions in the user application in order to ensure that the type map at the root of the class hierarchy is properly initialized.

In our previous example you might have run the following JPublisher command lines:

```
jpub -user=scott/tiger -sql=PERSON:Person,STUDENT:Student -usertypes=oracle
jpub -user=scott/tiger -sql=PERSON:Person,INSTRUCTOR:Instructor
-usertypes=oracle
```

In this case you should create instances of the generated classes—at a minimum, the leaf classes—before using these mapped types in your code. For example:

```
new Instructor(); // required
new Student();    // required
new Person();     // optional
```

The reason for this requirement is explained next.

Mapping of Type Hierarchies in JPublisher-Generated Code

The `Person` class includes the following method:

```
Person create(oracle.sql.Datum d, int sqlType)
```

This method, which converts a `Datum` instance to its representation as a custom Java object, is called by the Oracle JDBC driver whenever a SQL object declared to be a `PERSON` is retrieved into a `Person` variable. The SQL object, however, might actually be a `STUDENT` object. In this case, the `create()` method must create a `Student` instance rather than a `Person` instance.

In general, to handle this kind of situation, the `create()` method of a custom Java class (regardless of whether the class was created by JPublisher) must be able to create instances of any subclass that represents a subtype of the SQL object type corresponding to the `oracle.sql.Datum` argument. This ensures that the actual type of the created Java object will match the actual type of the SQL object.

You might think that the code for the `create()` method in the root class of a custom Java class hierarchy must mention all its subclasses. But if this were the case,

you would have to modify the code for a base class when writing or generating a new subclass. While this would happen automatically if you always use JPublisher to regenerate entire class hierarchies, this might not always be possible. For example, you might not have access to the source code for the Java classes being extended.

Code generated by JPublisher permits incremental extension of a class hierarchy by creating a static initialization block in each subclass of the custom Java class hierarchy. This static initialization block initializes a data structure (equivalent to a type map) declared in the root-level Java class, giving the root class the information it needs about the subclass. When an instance of a subclass is created at runtime, the type is registered in the data structure. Because of this implicit mapping mechanism, no explicit type map, such as those required in `SQLData` scenarios, is required.

Important: This implementation makes it possible to extend existing classes without having to modify them, but it also carries a penalty—the static initialization blocks of the subclasses must be executed before the class hierarchy can be used to read objects from the database. This occurs if you instantiate an object of each subclass by calling `new()`. It is sufficient to instantiate just the leaf classes, because the constructor for a subclass will invoke the constructor for its immediate superclass.

As an alternative, you can always generate (or regenerate) the entire class hierarchy. In this case, there is no need for concern about instantiating the type map through creation of instances of all the leaf classes.

To better understand how code generated by JPublisher supports inheritance, try an example similar to the one at the beginning of this section, and look at the generated code.

ORAData Reference Types and Inheritance

This section shows how to convert from one custom reference class to another, and also generally explains why a custom reference class generated for a subtype by JPublisher does not extend the reference classes of the base type.

Casting a Reference Type Instance into Another Reference Type

Revisiting the example in "ORAData Object Types and Inheritance" on page 2-39, we also obtain `PersonRef`, `StudentRef`, and `InstructorRef`, for strongly typed references, in addition to the underlying object type wrappers.

There may be situations where you have a `StudentRef` instance but you want to use it in a context that requires a `PersonRef` instance. In this case, use the static `cast()` method that is generated on strongly typed reference classes:

```
StudentRef s_ref = ...;  PersonRef p_ref = PersonRef.cast(s_ref);
```

Conversely, you might have a `PersonRef` instance and know that you can narrow it to an `InstructorRef` instance:

```
PersonRef pr = ...; InstructorRef ir = InstructorRef.cast(pr);
```

Next we outline why we need to use a `cast()` function rather than just being able to establish a reference type hierarchy that mirrors the object type hierarchy.

Why Reference Type Inheritance Does Not Follow Object Type Inheritance

The example here helps explain why it is not desirable for reference types to follow the hierarchy of their related object types.

Consider again a subset of the example given in the previous section, repeated here for convenience:

```
CREATE TYPE PERSON AS OBJECT (
...
) NOT FINAL;

CREATE TYPE STUDENT UNDER PERSON (
...
);

jpub -user=scott/tiger -sql=PERSON:Person,STUDENT:Student -usertypes=oracle
```

In addition to generating `Person.sqlj` (or `.java`) and `Student.sqlj` (or `.java`), JPublisher will generate `PersonRef.java` and `StudentRef.java`.

Because the `Student` class extends the `Person` class, you might expect `StudentRef` to extend `PersonRef`. This is not the case, however, because the `StudentRef` class can provide more compile-time type safety as an independent class than as a subtype of `PersonRef`. Additionally, a `PersonRef` can do something that a `StudentRef` cannot do: modify a `Person` object in the database.

The most important methods of the `PersonRef` class would be the following:

- `Person getValue()`
- `void setValue(Person c)`

The corresponding methods of the `StudentRef` class would be as follows:

- `Student getValue()`
- `void setValue(Student c)`

If the `StudentRef` class extended the `PersonRef` class, two problems would occur:

- Java would not permit the `getValue()` method in `StudentRef` to return a `Student` object when the method it would override in the `PersonRef` class returns a `Person` object, even though this is arguably a sensible thing to do.
- The `setValue()` method in `StudentRef` would not override the `setValue()` method in `PersonRef`, because the two methods have different signatures.

It would not be sensible to remedy these problems by giving the `StudentRef` methods the same signatures and result types as the `PersonRef` methods, because the additional type safety provided by declaring an object as a `StudentRef`, rather than as a `PersonRef`, would be lost.

Manually Converting Between Reference Types

Because reference types do not follow the hierarchy of their related object types, there is a JPublisher limitation that you cannot convert directly from one reference type to another. For background information, this section explains how the generated `cast()` methods work to convert from one reference type to another.

It is *not* recommended that you follow these manual steps—they are presented here for illustration only. Simply use the `cast()` method instead.

The following code, for example, could be used to convert from the reference type `XxxxRef` to the reference type `YyyyRef`.

```
java.sql.Connection conn = ...;  // get underlying JDBC connection
XxxxRef xref = ...;
YyyyRef yref = (YyyyRef) YyyyRef.getORADataFactory().
               create(xref.toDatum(conn),oracle.jdbc.OracleTypes.REF);
```

This conversion consists of two steps, each of which can be useful in its own right.

1. Convert `xref` from its strong `XxxxRef` type to the weak `oracle.sql.REF` type:

   ```
   oracle.sql.REF ref  = (oracle.sql.REF) xref.toDatum(conn);
   ```

2. Convert from the `oracle.sql.REF` type to the target `YyyyRef` type:

   ```
   YyyyRef yref = (YyyyRef) YyyyRef.getORADataFactory().
                            create(ref,oracle.jdbc.OracleTypes.REF);
   ```

"Example: Manually Converting Between Reference Types" below provides sample code for such a conversion.

Note: This conversion does not involve any type-checking. Whether this conversion is actually permitted depends on your application and on the SQL schema you are using.

Example: Manually Converting Between Reference Types

The following example, including SQL definitions and Java code, illustrates the points of the preceding discussion.

SQL Definitions Consider the following SQL definitions:

```
create type person_t as object (ssn number, name varchar2 (30), dob date) not
final;
/
show errors

create type instructor_t under person_t (title varchar2(20)) not final;
/
show errors

create type instructorPartTime_t under instructor_t (num_hours number);
/
show errors
```

```
create type student_t under person_t (deptid number, major varchar2(30)) not
final;
/
show errors

create type graduate_t under student_t (advisor instructor_t);
/
show errors

create type studentPartTime_t under student_t (num_hours number);
/
show errors

create table person_tab  of person_t;

insert into person_tab values (1001, 'Larry', TO_DATE('11-SEP-60'));
insert into person_tab values (instructor_t(1101, 'Smith', TO_DATE
('09-OCT-1940'), 'Professor'));
insert into person_tab values (instructorPartTime_t(1111, 'Myers',
TO_DATE('10-OCT-65'), 'Adjunct Professor', 20));
insert into person_tab values (student_t(1201, 'John', To_DATE('01-OCT-78'), 11,
'EE'));
insert into person_tab values (graduate_t(1211, 'Lisa', TO_DATE('10-OCT-75'),
12, 'ICS', instructor_t(1101, 'Smith', TO_DATE ('09-OCT-40'), 'Professor')));
insert into person_tab values (studentPartTime_t(1221, 'Dave',
TO_DATE('11-OCT-70'), 13, 'MATH', 20));
```

JPublisher Mappings Assume the following mappings when you run JPublisher:

```
Person_t:Person,instructor_t:Instructor,instructorPartTime_t:InstructorPartTime,
graduate_t:Graduate,studentPartTime_t:StudentPartTime
```

Java Class Here is a Java class with an example of reference type conversion as discussed above, in "Manually Converting Between Reference Types" on page 2-43:

```
import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sqlj.runtime.Oracle;
import sqlj.runtime.ref.DefaultContext;
import sqlj.runtime.ResultSetIterator;
```

```
public class Inheritance
{
  public static void main(String[] args) throws SQLException
  {
    System.out.println("Connecting.");
    Oracle.connect("jdbc:oracle:oci:@","scott","tiger");

    // The following is only required in 9.0.1
    // or if the Java class hierarchy was created piecemeal
    System.out.println("Initializing type system.");
    new Person();
        new Instructor();
            new InstructorPartTime();
        new StudentT();
            new StudentPartTime();
            new Graduate();

    PersonRef p_ref;
    InstructorRef i_ref;
    InstructorPartTimeRef ipt_ref;
    StudentTRef s_ref;
    StudentPartTimeRef spt_ref;
    GraduateRef g_ref;

    System.out.println("Selecting a person.");
    #sql { select ref(p) INTO :p_ref FROM PERSON_TAB p WHERE p.NAME='Larry' };

    System.out.println("Selecting an instructor.");
    #sql { select ref(p) INTO :i_ref FROM PERSON_TAB p WHERE p.NAME='Smith' };

    System.out.println("Selecting a part time instructor.");
    #sql { select ref(p) INTO :ipt_ref FROM PERSON_TAB p WHERE p.NAME='Myers' };

    System.out.println("Selecting a student.");
    #sql { select ref(p) INTO :s_ref FROM PERSON_TAB p WHERE p.NAME='John' };

    System.out.println("Selecting a part time student.");
    #sql { select ref(p) INTO :spt_ref FROM PERSON_TAB p WHERE p.NAME='Dave' };

    System.out.println("Selecting a graduate student.");
    #sql { select ref(p) INTO :g_ref FROM PERSON_TAB p WHERE p.NAME='Lisa' };


    // Connection object for conversions
    Connection conn = DefaultContext.getDefaultContext().getConnection();
```

```
    // Assigning a part-time instructor ref to a person ref
    System.out.println("Assigning a part-time instructor ref to a person ref");
    oracle.sql.Datum ref = ipt_ref.toDatum(conn);
    PersonRef pref = (PersonRef) PersonRef.getORADataFactory().
                                          create(ref,OracleTypes.REF);
    // or just use:  PersonRef pref = PersonRef.cast(ipt_ref);

    // Assigning a person ref to an instructor ref
    System.out.println("Assigning a person ref to an instructor ref");
    InstructorRef iref = (InstructorRef) InstructorRef.getORADataFactory().
                          create(pref.toDatum(conn), OracleTypes.REF);
    // or just use:  InstructorRef iref = InstructorRef.cast(pref);

    // Assigning a graduate ref to an part time instructor ref
    // ==> this should actually bomb at runtime!
    System.out.println
              ("Assigning a graduate ref to a part time instructor ref");
    InstructorPartTimeRef iptref =
       (InstructorPartTimeRef) InstructorPartTimeRef.getORADataFactory()
                               .create(g_ref.toDatum(conn), OracleTypes.REF);
    // or just use:  InstructorPartTimeRef iptref =
InstructorPartTimeRef.cast(g_ref);

    Oracle.close();
  }
}
```

SQLData Object Types and Inheritance

As described earlier, if you use the JPublisher `-usertypes=jdbc` setting instead of `-usertypes=oracle`, the custom Java class that JPublisher generates will implement the standard `SQLData` interface instead of the Oracle `ORAData` interface. The `SQLData` standard `readSQL()` and `writeSQL()` methods provide equivalent functionality to the `ORAData`/`ORADataFactory` `create()` and `toDatum()` methods for reading and writing data.

As is the case when JPublisher generates `ORAData` classes corresponding to a hierarchy of SQL object types, when JPublisher generates `SQLData` classes corresponding to a SQL hierarchy, the Java types will follow the same hierarchy as the SQL types.

SQLData implementations do not, however, offer the implicit mapping intelligence that JPublisher automatically generates into ORAData classes (as described in "ORAData Object Types and Inheritance" on page 2-39).

In a SQLData scenario, you must manually provide a type map to ensure the proper mapping between SQL object types and Java types. In a JDBC application, you can properly initialize the default type map for your connection, or you can explicitly provide a type map as a getObject() input parameter. (See the *Oracle9i JDBC Developer's Guide and Reference* for information.) In a SQLJ application, use a type map resource that is similar in nature to a properties file. (See the *Oracle9i SQLJ Developer's Guide and Reference* for information.)

In addition, be aware that there is no support for strongly typed object references in a SQLData implementation. All object references are weakly typed java.sql.Ref instances.

Effect of Using SQL FINAL, NOT FINAL, INSTANTIABLE, NOT INSTANTIABLE

This section discusses the effect on JPublisher-generated wrapper classes of using the SQL modifiers FINAL, NOT FINAL, INSTANTIABLE, or NOT INSTANTIABLE.

Using the SQL modifier FINAL or NOT FINAL on a SQL type or on a method of a SQL type has no effect on the generated Java wrapper code. This is so JPublisher users are able in all cases to customize the generated Java wrapper class through subclassing and overriding the generated behavior.

Using the SQL modifier NOT INSTANTIABLE on a method of a SQL type results in no code being generated for that method in the Java wrapper class. Therefore, you must cast to some wrapper class that corresponds to an instantiable SQL subtype in order to call such a method.

Using NOT INSTANTIABLE on a SQL type results in the corresponding wrapper class being generated with protected constructors. This will remind you that instances of that class can only be created through subclasses that correspond to instantiable SQL types.

Backward Compatibility and Migration

This section discusses issues of backward compatibility, compatibility between JDK versions, and migration between Oracle8*i* and Oracle9*i* releases of JPublisher.

JPublisher Backward Compatibility

The JPublisher runtime is packaged with Oracle JDBC in the `classes111`, `classes12`, or `ojdbc14` library. Code generated by an earlier version of JPublisher will:

- continue to run with the current release of the JPublisher runtime
- continue to be compilable against the current release of the JPublisher runtime

If you use an earlier release of the JPublisher runtime and Oracle JDBC in generating code, the code will be compilable against that version of the JPublisher runtime. Specifically, when you use an Oracle8*i* JDBC driver, JPublisher will generate code for the now-deprecated `CustomDatum` interface, not the `ORAData` interface that replaced it.

JPublisher Compatibility Between JDK Versions

Generally speaking, `.sqlj` files generated by JPublisher can be translated under either JDK 1.1.x (assuming you are not using JDBC 2.0-specific types), or JDK 1.2.x or higher. However, if you intend to translate and compile in separate steps (setting `-compile=false` in SQLJ so that only `.java` files, not `.class` files, are produced), then you must use the same JDK version for compilation as for translation unless you use a special JPublisher option setting.

In this situation (translating and compiling in separate steps), the JPublisher default setting `-context=DefaultContext` results in generation of `.sqlj` files that are completely compatible between JDK 1.1.x and JDK 1.2.x or higher. (With this setting, for example, you could translate against JDK 1.1.x but still compile against JDK 1.2.x successfully.)

In this situation, all generated `.sqlj` files use the `sqlj.runtime.ref.DefaultContext` class for all connection contexts. This is as opposed to the setting `-context=generated`, which results in each generated `.sqlj` file declaring its own connection context inner class. This was the Oracle8*i* JPublisher default behavior, and is what makes translated `.java` code incompatible between JDK 1.1.x and 1.2.x or higher.

See "SQLJ Connection Context Classes (-context)" on page 3-16 for more information about the `-context` option.

Important: With some JPublisher option settings under JDK 1.1.x there is risk of memory leakage caused by SQLJ connection context instances that are not closed. See "Releasing Connection Context Resources" on page 2-30 for information.

See the *Oracle9i SQLJ Developer's Guide and Reference* for general information about connection contexts.

Migration Between Oracle8*i* JPublisher and Oracle9*i* JPublisher

In Oracle9*i* JPublisher, default option settings and some features of the generated code have changed. If you wrote an application using JPublisher release 8.1.7 or earlier, it is unlikely that you will be able to simply re-run JPublisher in Oracle9*i* and have the generated classes still work within your application. This section describes how to modify your JPublisher option settings or your application code appropriately.

Note: Also see "Changes in User-Written Subclasses of Oracle9i JPublisher-Generated Classes" on page 2-36 for differences between Oracle8*i* functionality and Oracle9*i* functionality for classes that extend JPublisher-generated classes.

Changes in Behavior in Oracle9*i* JPublisher

Be aware of the following changes in JPublisher behavior in Oracle9*i*:

- By default, JPublisher no longer declares the inner SQLJ connection context class `_Ctx` for every object type. Instead, it uses the connection context class `sqlj.runtime.ref.DefaultContext` throughout.

  Also, user-written code must call the `getConnectionContext()` method to have a connection context handle, instead of using the `_ctx` connection context field that was declared under Oracle8*i* code generation. See "Considerations in Using Connection Contexts and Connection Instances" on page 2-28 for more information about the `getConnectionContext()` method.

- Even with the setting `-methods=true`, `.java` files are generated instead of `.sqlj` files if the underlying SQL object type or PL/SQL package does not define any methods. (But a setting of `-methods=always` will always result in `.sqlj` files being produced.)
- By default, JPublisher now generates code that implements the `oracle.sql.ORAData` interface instead of the deprecated `oracle.sql.CustomDatum` interface.
- By default, JPublisher now places generated code into the current directory, rather than into a package-directory hierarchy under the current directory.

See the following sections, "Individual Settings to Force JPublisher Behavior as in Previous Releases" below and "Oracle8i Compatibility Mode" on page 2-52, for information about how to revert to Oracle8*i* behavior instead.

Individual Settings to Force JPublisher Behavior as in Previous Releases

In Oracle9*i*, if you want JPublisher to behave as it did in release 8.1.7 and prior, there are a number of individual backward-compatibility options you can set. This is detailed in Table 2–2. See descriptions of these options under "Detailed Descriptions of General JPublisher Options" on page 3-13 for more information.

See "Oracle8i Compatibility Mode" on page 2-52 for a single setting that results in the same behavior as for Oracle8*i* JPublisher—backward-compatible code generation plus behavior that is equivalent to what would happen with the combination of these individual option settings.

Table 2–2 JPublisher Backward-Compatibility Options

Option Setting	Behavior
-context=generated	This results in the declaration of an inner class, `_Ctx`, for SQLJ connection contexts. This is used instead of the default `DefaultContext` class or user-specified connection context classes.
-methods=always	This forces generation of `.sqlj` (as opposed to `.java`) source files for all JPublisher-generated classes, regardless of whether the underlying SQL object or package actually defines any methods.
-compatible=customdatum	For Oracle-specific object wrappers, this results in JPublisher implementing the deprecated (but still supported) `oracle.sql.CustomDatum` and `CustomDatumFactory` interfaces instead of the `oracle.sql.ORAData` and `ORADataFactory` interfaces.

Table 2–2 JPublisher Backward-Compatibility Options (Cont.)

Option Setting	Behavior
-dir=.	Setting this option to "." (a period or "dot") results in generation of output files into a hierarchy under the current directory, as was the default behavior in Oracle8*i*.

Unless you have a compelling reason to use the backward-compatibility settings, however, it is recommended that you accept the current default (or other) settings.

Oracle8*i* Compatibility Mode

Either of the JPublisher option settings `-compatible=both8i` and `-compatible=8i` results in what is called *Oracle8i compatibility mode*.

See "Backward-Compatible Oracle Mapping for User-Defined Types (-compatible)" on page 3-9 for more information about this option.

For use of this mode to be permissible, however, at least one of the following circumstances must hold:

- You will translate JPublisher-generated `.sqlj` files with the default SQLJ `-codegen=oracle` setting.

or:

- The JPublisher-generated code will execute under JDK 1.2 or higher and will use the SQLJ `runtime12` or `runtime12ee` library, or will execute in the Oracle9*i* release of the server-side Oracle JVM.

or:

- You will run JPublisher with the `-methods=false` or `-methods=none` setting.

JPublisher has the following functionality in Oracle8*i* compatibility mode:

- It will generate code that implements the deprecated `CustomDatum` and `CustomDatumFactory` interfaces instead of the `ORAData` interface (as with the `-compatible=customdatum` setting). In addition, if you choose the setting `-compatible=both8i`, the generated code will also implement the `ORAData` interface, though not `ORADataFactory`.
- With the `-methods=true` setting, it will always generate SQLJ source code for a SQL object type, even if the object type does not define any methods (as with `-methods=always`).

- It will generate connection context declarations and connection context instances on every object type wrapper, as follows (as with `-context=generated`):

  ```
  #sql static context _Ctx;
  protected _Ctx _ctx;
  ```

- It provides a constructor in the wrapper class that takes a generic `ConnectionContext` instance (an instance of any class implementing the standard `sqlj.runtime.ConnectionContext` interface) as input. In Oracle9*i*, the constructor accepts only a `DefaultContext` instance or an instance of the class specified through the `-context` option when JPublisher was run.
- It does not provide an API for releasing a connection context instance that has been created implicitly on a JPublisher object.

  By contrast, Oracle9*i* JPublisher provides both a `setConnectionContext()` method for explicitly setting the connection context instance for an object, and a `release()` method for releasing an implicitly created connection context instance of an object.

In general, if you must choose Oracle8*i* compatibility mode, it is strongly recommended that you use the setting `-compatible=both8i`. This will permit your application to work in a middle-tier environment such as the Oracle9*i* Application Server, where JDBC connections are obtained through data sources and likely will be wrapped using `oracle.jdbc.Oracle`*Xxxx* interfaces. `CustomDatum` implementations do not support such wrapped connections.

Note: The setting `-compatible=both8i` requires Oracle JDBC 9.0.1 or higher.

Oracle8*i* compatibility mode is now the only way for a connection context instance `_ctx` to be declared in JPublisher-generated code—there is no other option setting to accomplish this particular Oracle8*i* behavior. The `_ctx` instance might be useful if you have legacy code that depends on it, but otherwise you should obtain connection context instances through the `getConnectionContext()` method.

Important: There are circumstances where you should not use Oracle8*i* compatibility mode. If your environment uses any of the following:

- JDK 1.1.x, the SQLJ generic `runtime` library, or the SQLJ `runtime11` library

and you use the following SQLJ translator setting:

- `-codegen=iso`

as well as any of the following JPublisher settings:

- `-methods=named` (or `some`), `-methods=true` (or `all`), or `-methods=always`

then there may be significant memory leakage caused by implicit connection context instances that are not closed.

Avoid the `-compatible=8i` and `-compatible=both8i` settings in these circumstances, and use the `setConnectionContext()` and `release()` methods in manipulating connection contexts. For more information, see "Use of Connection Contexts and Instances in SQLJ Code Generated by JPublisher" on page 2-27.

JPublisher Limitations

This section summarizes limitations in the Oracle9*i* release 2 version of JPublisher.

- Some datatypes are only supported indirectly through JPublisher type maps that map PL/SQL-specific types to SQL types. This includes the following:
  - RECORD types
  - indexed-by tables

  Note that JPublisher has predefined support for mapping PL/SQL `BOOLEAN` to Java `boolean` using conversion functions in the `SYS.SQLJUTL` package. In general, if JPublisher encounters wrapper methods that use one or more unrecognized datatypes, it will not generate a corresponding Java method and will display one or more error messages instead.

  For more information about datatype support, see "SQL and PL/SQL Mappings to Oracle and JDBC Types" on page 2-3.

- `INPUT` file error reporting is sometimes incomplete.

  JPublisher reports most, but not all, errors in the `INPUT` file. The few errors in the `INPUT` file that are not reported by JPublisher are described in "INPUT File Precautions" on page 3-41.

- Although the `-omit_schema_names` option behaves as a boolean option, you cannot set it `=true` or `=false` (unlike other boolean options). Simply specify "`-omit_schema_names`" to enable it. The default is disabled. See "Omission of Schema Name from Generated Names (-omit_schema_names)" on page 3-22 for information about this option.

3

Command-Line Options and Input Files

This chapter describes the use and syntax details of JPublisher option settings and input files to specify program behavior, organized as follows:

- JPublisher Options
- JPublisher Input Files

JPublisher Options

This section lists and discusses JPublisher command-line options, covering the following topics:

- JPublisher Option Summary
- JPublisher Option Tips
- Notational Conventions
- Detailed Descriptions of Options That Affect Datatype Mappings
- Detailed Descriptions of General JPublisher Options

JPublisher Option Summary

Table 3–1 lists the options that you can use on the JPublisher command line, their syntax, and a brief description. The abbreviation "n/a" represents "not applicable".

Table 3–1 Summary of JPublisher Options

Option Name	Description	Default Value
`-access`	Determines the access modifiers that JPublisher includes in generated method definitions.	`public`
`-adddefaulttypemap`	Appends an entry to the JPublisher default type map.	n/a
`-addtypemap`	Appends an entry to the JPublisher user type map.	n/a
`-builtintypes`	Specifies the datatype mappings (`jdbc` or `oracle`) for built-in datatypes that are non-numeric and non-LOB.	`jdbc`
`-case`	Specifies the case of Java identifiers that JPublisher generates.	`mixed`
`-compatible`	Specifies the general Oracle8*i* compatibility mode, or the particular interface to implement in generated classes for Oracle mapping of user-defined types—`ORAData` or `CustomDatum` (supported for backward compatibility); modifies the behavior of `-usertypes=oracle`.	`oradata`

Table 3–1 Summary of JPublisher Options (Cont.)

Option Name	Description	Default Value
`-context`	Specifies the class JPublisher uses for connection contexts—the SQLJ `DefaultContext` class, a user-specified class, or a JPublisher-generated inner class.	`DefaultContext`
`-defaulttypemap`	Sets the default type map used by JPublisher.	See "JPublisher Default Type Map and User Type Map" on page 2-18.
`-dir`	Specifies the directory that holds generated files or packages. An empty directory name results in all generated files being placed in the current directory. A non-empty directory name specifies a directory to be used as the root directory of a class hierarchy.	empty
`-driver`	Specifies the driver class that JPublisher uses for JDBC connections to the database.	`oracle.jdbc.OracleDriver`
`-encoding`	Specifies the Java encoding of JPublisher input files and output files.	the value of the system property `file.encoding`
`-gensubclass`	Specifies whether and how to generate stub code for user subclasses.	`true`
`-input` (or `-i`)	Specifies a file that lists the types and packages JPublisher translates.	n/a
`-lobtypes`	Specifies the datatype mappings (`jdbc` or `oracle`) that JPublisher uses for `BLOB` and `CLOB` types.	`oracle`
`-mapping`	Specifies the mapping that generated methods support for object attribute types and method argument types. **Note**: This is deprecated in favor of the "XXXtypes" mapping options, but is supported for backward compatibility.	`objectjdbc`
`-methods`	Determines whether JPublisher generates wrapper methods for SQL object methods and PL/SQL package methods. Also, as secondary effects, determines whether JPublisher generates `.sqlj` files or `.java` files, and whether it generates PL/SQL wrapper classes at all.	`all`

Table 3–1 Summary of JPublisher Options (Cont.)

Option Name	Description	Default Value
`-numbertypes`	Specifies the datatype mappings (`jdbc`, `objectjdbc`, `bigdecimal`, or `oracle`) that JPublisher uses for numeric datatypes.	`objectjdbc`
`-omit_schema_names`	Specifies whether all object types and package names that JPublisher generates include the schema name.	disabled (do not omit schema names)
`-package`	Specifies the name of the Java package into which JPublisher generates Java wrappers.	n/a
`-plsqlfile`	Specifies a file into which JPublisher generates PL/SQL wrapper functions and procedures.	`plsql_wrapper.sql`
`-plsqlmap`	Specifies whether and how to generate PL/SQL wrapper functions and procedures.	`true`
`-plsqlpackage`	Specifies the PL/SQL package into which JPublisher generates wrapper functions and procedures.	`JPUB_PLSQL_WRAPPER`
`-props` (or `-p`)	Specifies a file that contains JPublisher options in addition to those listed on the command line.	n/a
`-serializable`	Specifies whether code generated for object types implements `java.io.Serializable`.	`false`
`-sql` (or `-s`)	Specifies object types and packages for which JPublisher will generate code.	n/a
`-tostring`	Specifies whether to generate a `toString()` method for object types.	`false`
`-typemap`	Specifies the JPublisher type map (a list of mappings).	empty
`-types`	Specifies object types for which JPublisher will generate code. **Note**: This option is deprecated in favor of `-sql`, but is supported for backward compatibility.	n/a

Table 3–1 Summary of JPublisher Options (Cont.)

Option Name	Description	Default Value
`-url`	Specifies the URL JPublisher uses to connect to the database.	`jdbc:oracle:oci:@`
`-user` (or `-u`)	Specifies an Oracle username and password for connection.	n/a
`-usertypes`	Specifies the type mappings (`jdbc` or `oracle`) JPublisher uses for user-defined SQL types.	`oracle`

JPublisher Option Tips

Be aware of the following usage notes for JPublisher options.

- JPublisher always requires the `-user` option (or `-u`, its shorthand equivalent).
- Options are processed in the order in which they appear. Options from an `INPUT` file are processed at the point where the `-input` (or `-i`) option occurs. Similarly, options from a properties file are processed at the point where the `-props` (or `-p`) option occurs.
- If a particular option appears more than once, JPublisher in general uses the value from the last occurrence. This is *not* true for the following options, however, which are cumulative.

  `-sql` (or the deprecated `-types`)

  `-addtypemap` or `-adddefaulttypemap`
- In general, options and corresponding option values must be separated by an equals sign ("="). When the following options appear on the command line, however, you are also permitted to use a space as a separator:

  `-sql` (or `-s`), `-user` (or `-u`), `-props` (or `-p`), and `-input` (or `-i`)
- It is advisable to specify a Java package for your generated classes, with the `-package` option, either on the command line or in a properties file. For example, on the command line you could enter:

```
jpub -sql=Person -package=e.f ...
```

or in the properties file you could enter:

```
jpub.sql=Person
jpub.package=e.f
...
```

These statements direct JPublisher to create the class `Person` in the Java package `e.f`; that is, to create the class `e.f.Person`.

"Properties File Structure and Syntax" on page 3-33 describes the properties file.

- If you do not specify a type or package in the `INPUT` file or on the command line, then JPublisher translates all types and packages in the user schema according to the options specified on the command line or in the properties file.

Notational Conventions

The JPublisher option syntax used in the following sections follows these notational conventions:

- Angle brackets `<...>` enclose strings that the user supplies.
- Braces `{...}` enclose a list of possible values—specify only one of the values within the braces.
- A vertical bar `|` separates alternatives within brackets or braces.
- Terms in italics are like for values to input—specify an actual value or string.
- Square brackets `[...]` enclose optional items. In some cases, however, square brackets or parentheses are part of the syntax and need to be entered verbatim. In this case, this manual uses boldface: **`[`**...**`]`** or **`(`**...**`)`**.
- An ellipsis `...` immediately following an item (or items enclosed in brackets) means that you can repeat the item any number of times.
- Punctuation symbols other than those described above are entered as shown. These include "`.`" and "@", for example.

The next section discusses the options that affect datatype mappings. The remaining options are then discussed in alphabetical order.

Detailed Descriptions of Options That Affect Datatype Mappings

The following options control which datatype mappings JPublisher uses to translate object types, collection types, object reference types, and PL/SQL packages to Java classes:

- The `-usertypes` option controls JPublisher behavior for user-defined types (possibly in conjunction with the `-compatible` option for `oracle` mapping).
- The `-numbertypes` option controls datatype mappings for numeric types.
- The `-lobtypes` option controls datatype mappings for the `BLOB` and `CLOB` types.
- The `-builtintypes` option controls datatype mappings for non-numeric, non-LOB, predefined SQL and PL/SQL types.

These four options are known as the type-mapping options. (Another, less flexible option, `-mapping`, is discussed later. It is deprecated, but still supported for compatibility with older releases of JPublisher.)

In addition, JPublisher code generation is also controlled through entries in the JPublisher user type map or default type map. This is primarily to permit JPublisher to access signatures with PL/SQL types. You can refer to "Using Datatypes Unsupported by JDBC" on page 2-7 for more information.

The following options are used in conjunction with JPublisher type mapping, and are described in the general options section:

- `-addtypemap`, `-adddefaulttypemap`, `-defaulttypemap`, and `-typemap` for specifying type mappings
- `-plsqlfile`, `-plsqlmap`, and `-plsqlpackage` for controlling the generation of PL/SQL wrapper code

For an object type, JPublisher applies the mappings specified by the type mapping options to the object attributes and to the arguments and results of any methods included with the object. The mappings control the types that the generated accessor methods support; that is, what types the `get`*`XXX`*`()` methods return and the `set`*`XXX`*`()` methods require.

For a PL/SQL package, JPublisher applies the mappings to the arguments and results of the methods in the package.

For a collection type, JPublisher applies the mappings to the element type of the collection.

The `-usertypes` option controls whether JPublisher implements the Oracle `ORAData` interface or the standard `SQLData` interface in generated classes, and whether JPublisher generates code for collection and object reference types. In addition, if `-usertypes=oracle`, you can use the `-compatible` option to specify using `CustomDatum` instead of `ORAData` for Oracle mapping. `CustomDatum` is replaced by `ORAData` and deprecated in Oracle9*i*, but is supported for backward compatibility. (Beyond this, you can use the `-compatible` option to specify a more general Oracle8*i* compatibility mode. See "Oracle8i Compatibility Mode" on page 2-52.)

See "Details of Datatype Mapping" on page 2-2 for more information about the different datatype mappings and factors you should consider in deciding which mappings to use.

The following sections provide additional information about these type mapping options.

Mappings for User-Defined Types (-usertypes)

`-usertypes={`**`oracle`**`|jdbc}`

The `-usertypes` option controls whether JPublisher implements the Oracle `ORAData` interface or the standard `SQLData` interface in generated classes for user-defined types.

When `-usertypes=oracle` (the default), JPublisher generates `ORAData` classes for object, collection, and object reference types.

When `-usertypes=jdbc`, JPublisher generates `SQLData` classes for object types. JPublisher does not generate classes for collection or object reference types in this case—use `java.sql.Array` for all collection types and `java.sql.Ref` for all object reference types.

Notes:

- The `-usertypes=jdbc` setting requires JDK 1.2 or higher, because the `SQLData` interface is a JDBC 2.0 feature.
- With certain settings of the `-compatible` option, a `-usertypes=oracle` setting results in classes that implement the deprecated `CustomDatum` interface instead of `ORAData`. See "Backward-Compatible Oracle Mapping for User-Defined Types (-compatible)" below.

Backward-Compatible Oracle Mapping for User-Defined Types (-compatible)

`-compatible={`**`oradata`**`|customdatum|both8i|8i}`

If `-usertypes=oracle`, you have the option of setting `-compatible=customdatum` to implement the `CustomDatum` interface instead of the `ORAData` interface in your generated classes for user-defined types. `CustomDatum` is replaced by `ORAData` and deprecated in Oracle9*i*, but is still supported for backward compatibility. If `-usertypes=jdbc`, a `-compatible` setting of `customdatum` (or `oradata`) is ignored.

The default setting is `oradata`.

This option also has another mode of operation. With a setting of `-compatible=8i` or `-compatible=both8i`, you can specify the general Oracle8*i* compatibility mode. This not only uses `CustomDatum`, but also generates the same code that would be generated by Oracle8*i* JPublisher, and is equivalent to setting other JPublisher options for backward compatibility to Oracle8*i*. Behavior of method generation is equivalent to that for a `-methods=always` setting, and generation of connection context declarations is equivalent to that for a `-context=generated` setting. See "Oracle8i Compatibility Mode" on page 2-52.

Notes: If you use JPublisher in an environment that does not support the `ORAData` interface (such as Oracle8*i* JDBC 8.1.7 or prior releases), then the `CustomDatum` interface is used automatically if `-usertypes=oracle`. (You will receive an informational warning if `-compatible=oradata`, but the generation will take place.)

The option setting `-compatible=both8i` additionally makes the generated object type wrapper implement the `ORAData` interface. This is generally preferred over the `-compatible=8i` setting, because support for `ORAData` is required for programs running in the middle tier, such as in the Oracle9*i* Application Server. Note, however, that the use of `ORAData` requires an Oracle 9.0.1 or higher JDBC driver.

Mappings For Numeric Types (-numbertypes)

`-numbertypes={jdbc|objectjdbc|bigdecimal|oracle}`

The `-numbertypes` option controls datatype mappings for numeric SQL and PL/SQL types. The following four choices are available:

- The JDBC mapping maps most numeric datatypes to Java primitive types such as `int` and `float`, and maps `DECIMAL` and `NUMBER` to `java.math.BigDecimal`.
- The Object JDBC mapping (the default) maps most numeric datatypes to Java wrapper classes such as `java.lang.Integer` and `java.lang.Float`, and maps `DECIMAL` and `NUMBER` to `java.math.BigDecimal`.
- The `BigDecimal` mapping maps all numeric datatypes to `java.math.BigDecimal`.
- The Oracle mapping maps all numeric datatypes to `oracle.sql.NUMBER`.

Table 3–2 lists the SQL and PL/SQL types affected by the `-numbertypes` option, and shows their Java type mappings for `-numbertypes=jdbc` and `-numbertypes=objectjdbc` (the default).

Table 3–2 Mappings for Types Affected by the -numbertypes Option

SQL or PL/SQL Datatype	JDBC Mapping Type	Object JDBC Mapping Type
BINARY_INTEGER, INT, INTEGER, NATURAL, NATURALN, PLS_INTEGER, POSITIVE, POSITIVEN, SIGNTYPE	int	java.lang.Integer
SMALLINT	short	java.lang.Integer
REAL	float	java.lang.Float
DOUBLE PRECISION, FLOAT	double	java.lang.Double
DEC, DECIMAL, NUMBER, NUMERIC	java.math.BigDecimal	java.math.BigDecimal

Mappings For LOB Types (-lobtypes)

`-lobtypes={jdbc|oracle}`

The `-lobtypes` option controls datatype mappings for the LOB types. Table 3–3 shows how these types are mapped for `-lobtypes=oracle` (the default) and for `-lobtypes=jdbc`.

Table 3–3 Mappings for Types Affected by the -lobtypes Option

SQL or PL/SQL Datatype	Oracle Mapping Type	JDBC Mapping Type
CLOB	oracle.sql.CLOB	java.sql.Clob
BLOB	oracle.sql.BLOB	java.sql.Blob
BFILE	oracle.sql.BFILE	oracle.sql.BFILE

Notes:

- `BFILE` is an Oracle-specific SQL type, so there is no standard `java.sql.Bfile` Java type.
- `NCLOB` is an Oracle-specific SQL type. It denotes an NCHAR form of use of a `CLOB` and is represented as an instance of `oracle.sql.NCLOB` in SQLJ programs.
- The `java.sql.Clob` and `java.sql.Blob` interfaces are new in JDK 1.2. If you use JDK 1.1, do not select `-lobtypes=jdbc`.

Mappings For Built-In Types (-builtintypes)

`-builtintypes={jdbc|oracle}`

The `-builtintypes` option controls datatype mappings for all the built-in datatypes except the LOB types (controlled by the `-lobtypes` option) and the different numeric types (controlled by the `-numbertypes` option). Table 3–4 lists the datatypes affected by the `-builtintypes` option and shows their Java type mappings for `-builtintypes=oracle` and `-builtintypes=jdbc` (the default).

Table 3–4 Mappings for Types Affected by the -builtintypes Option

SQL or PL/SQL Datatype	Oracle Mapping Type	JDBC Mapping Type
CHAR, CHARACTER, LONG, STRING, VARCHAR, VARCHAR2	oracle.sql.CHAR	java.lang.String
RAW, LONG RAW	oracle.sql.RAW	byte[ ]
DATE	oracle.sql.DATE	java.sql.Timestamp
TIMESTAMP, TIMESTAMP WITH TZ, TIMESTAMP WITH LOCAL TZ	oracle.sql.TIMESTAMP, oracle.sql.TIMESTAMPTZ, oracle.sql.TIMESTAMPLTZ	java.sql.Timestamp

Mappings for All Types (-mapping)

`-mapping={jdbc|objectjdbc|bigdecimal|oracle}`

> **Note:** This option is deprecated in favor of the more specific type mapping options: `-usertypes`, `-numbertypes`, `-builtintypes`, and `-lobtypes`. It is still supported, however, for backward compatibility.

The `-mapping` option specifies mapping for all datatypes, so offers little flexibility between types.

The setting `-mapping=oracle` is equivalent to setting all the type mapping options to `oracle` . The other `-mapping` settings are equivalent to setting `-numbertypes` equal to the value of `-mapping` and setting the other type mapping options to their defaults, as summarized in Table 3–5.

Table 3–5 Relation of -mapping Settings to Settings of Other Mapping Options

	-builtintypes=	-numbertypes=	-lobtypes=	-usertypes=
-mapping=oracle	oracle	oracle	oracle	oracle
-mapping=jdbc	jdbc	jdbc	oracle	oracle
-mapping=objectjdbc (default)	jdbc	objectjdbc	oracle	oracle
-mapping=bigdecimal	jdbc	bigdecimal	oracle	oracle

Note: Because options are processed in the order in which they appear on the command line, if the `-mapping` option precedes one of the specific type mapping options (`-builtintypes`, `-lobtypes`, `-numbertypes`, or `-usertypes`), the specific type mapping option overrides the `-mapping` option for the relevant types. If the `-mapping` option follows one of the specific type mapping options, the specific type mapping option is ignored.

Detailed Descriptions of General JPublisher Options

This section discusses the remaining JPublisher options, for settings other than datatype mappings. Options in this section are in alphabetical order.

Method Access (-access)

`-access={`**`public`**`|protected|package}`

The `-access` option determines the access modifier that JPublisher includes in generated constructors, attribute setter and getter methods, member methods on object type wrapper classes, and methods on PL/SQL packages.

JPublisher uses the possible option settings as follows:

- `public` (default)—Methods are generated with the `public` access modifier.
- `protected`—Methods are generated with the `protected` access modifier.
- `package`—The access modifier is omitted, which means that generated methods are local to the package.

You might want to use a setting of `-access=protected` or `-access=package` if you need to control the usage of the generated JPublisher wrapper classes. Perhaps you are providing your own customized versions of the wrappers as subclasses of the JPublisher-generated classes, but do not want to provide access to the generated superclasses.

You can specify the `-access` option on the command line or in a properties file.

Note: Wrappers for object references, VARRAYs, and nested tables are not affected by the value of the `-access` option.

Additional Entry to the Default Type Map (-adddefaulttypemap)

`-adddefaulttypemap=<list_of_typemap_entries>`

This option permits you to append an entry or a comma-separated list of entries to the default type map used by JPublisher. This option is used internally by JPublisher for setting up its default type map. The format for type map entries is described in "Additional Entry to the User Type Map (-addtypemap)" below.

> **Note:** Avoid conflicts between the default type map and user type map—see "JPublisher Default Type Map and User Type Map" on page 2-18 for information. That section also describes the initial content of the default type map.

Additional Entry to the User Type Map (-addtypemap)

`-addtypemap=<list_of_typemap_entries>`

This option permits you to append an entry or a comma-separated list of entries to the JPublisher user type map. An entry has one of the following formats:

```
-addtypemap=<opaque_sql_type>:<java_type>
-addtypemap=<numeric_indexed_by_table>:<java_numeric_type>[<max_length>]
-addtypemap=<char_indexed_by_table>:<java_char_type>[<max_length>](<elem_size>)
-addtypemap=<plsql_type>:<java_type>:<sql_type>:<sql_to_plsql_func>:
            <plsql_to_sql_func>
```

Note that **[**...**]** and **(**...**)** are part of the syntax. Also note that some operating systems require you to quote command-line options that contain special characters.

The maximum array length *<max_length>* and the maximum element size designation *<elem_size>* can be omitted in certain cases.

The difference between the `-addtypemap` option and the `-typemap` option is that `-addtypemap` appends entries to the user type map, while `-typemap` replaces the existing type map with the specified entries. See "Replacement of the JPublisher Type Map (-typemap)" on page 3-29.

For more information about the first `-addtypemap` format above, see "Type Mapping Support for OPAQUE Types" on page 2-8. The second and third formats are discussed in "Type Mapping Support for Scalar Indexed-by Tables Using JDBC OCI" on page 2-9. The last format is explained in "Type Mapping Support Through PL/SQL Conversion Functions" on page 2-11.

Note: Avoid conflicts between the default type map and user type map—see "JPublisher Default Type Map and User Type Map" on page 2-18 for information.

Case of Java Identifiers (-case)

`-case={mixed|same|lower|upper}`

For class or attribute names you do not specify in an `INPUT` file or on the command line, the `-case` option affects the case of Java identifiers that JPublisher generates, including class names, method names, attribute names embedded within `getXXX()` and `setXXX()` method names, arguments of generated method names, and Java wrapper names.

Table 3–6 describes the possible values for the `-case` option.

Table 3–6 Values for the -case Option

-case Option Value	Description
`mixed` (default)	The first letter of every word-unit of a class name or every word-unit after the first word-unit of a method name is in uppercase. All other characters are in lower case. An underscore (_), dollar sign ($), or any character that is illegal in Java constitutes a word-unit boundary and is silently removed. A word-unit boundary also occurs after `get` or `set` in a method name.
`same`	JPublisher does not change the case of letters from the way they are represented in the database. Underscores and dollar signs are retained. JPublisher removes any other character that is illegal in Java and issues a warning message.
`upper`	JPublisher converts lowercase letters to uppercase and retains underscores and dollar signs. It removes any other character that is illegal in Java and issues a warning message.
`lower`	JPublisher converts uppercase letters to lowercase and retains underscores and dollar signs. It removes any other character that is illegal in Java and issues a warning message.

For class or attribute names that you enter with the `-sql` option, or class names in the `INPUT` file, JPublisher retains the case of the letters in the specified name, overriding the `-case` option.

JPublisher will retain, as written, the case of the Java class identifier for an object type specified on the command line or in the `INPUT` file. For example, if the command line includes the following:

```
-sql=Worker
```

then JPublisher generates:

```
public class Worker ... ;
```

If the entry in the `INPUT` file is written as:

```
SQL wOrKeR
```

then JPublisher will follow the case for the identifier as it was entered in the `INPUT` file and generate:

```
public class wOrKeR ... ;
```

SQLJ Connection Context Classes (-context)

`-context={generated|`**`DefaultContext`**`|`*`user-specified`*`}`

The `-context` option controls the connection context class that JPublisher may use, and possibly declare, for `.sqlj` wrappers for user-defined object types and PL/SQL packages.

The setting `-context=DefaultContext` is the default and results in any JPublisher-generated `.sqlj` source files using the SQLJ default connection context class—`sqlj.runtime.ref.DefaultContext`—for all connection contexts.

Alternatively, you can specify any class that implements the standard `sqlj.runtime.ConnectionContext` interface and that exists in the classpath. The specified class will be used for all connection contexts.

> **Note:** With a user-specified class setting, instances of that class must be used for output from the `getConnectionContext()` method or input to the `setConnectionContext()` method. See "Considerations in Using Connection Contexts and Connection Instances" on page 2-28 for information about these methods.

The setting `-context=generated` results in the following inner class declaration in all `.sqlj` files generated by JPublisher.

```
#sql static context _Ctx;
```

This means that each PL/SQL package and each object type wrapper uses its own SQLJ connection context class. (Also see "Use of Connection Contexts and Instances in SQLJ Code Generated by JPublisher" on page 2-27.)

Note the following benefits in using the `DefaultContext` setting or user-specified-class setting:

- No additional context classes are generated.
- You have greater flexibility if you translate and compile your `.sqlj` files in separate steps (translating with the SQLJ `-compile=false` setting). Assuming you are not using JDK 1.2-specific types (such as `java.sql.BLOB`, `CLOB`, `Struct`, `Ref`, or `Array`), the resulting `.java` files can be compiled under either JDK 1.1.x or under JDK 1.2.x or higher. This is *not* the case with the setting `-context=generated`, because SQLJ connection contexts in JDK 1.1.x use `java.util.Dictionary` instances for object type maps, while SQLJ connection contexts in JDK 1.2 or higher use `java.util.Map` instances.

A benefit of using the `generated` setting, however, is that it permits full control over the way the SQLJ translator performs online checking. Specifically, every object type and every PL/SQL package can be checked against its own exemplar database schema. However, because JPublisher generates `.sqlj` files from an existing schema, the generated code is already verified as correct through construction from that schema.

Note that using the user-specified-class setting gives you the flexibility of the `generated` setting while still giving you the advantages of the `DefaultContext` setting.

You can specify the `-context` option on the command line or in a properties file.

See the *Oracle9i SQLJ Developer's Guide and Reference* for general information about SQLJ connection contexts.

Default Type Map for JPublisher (-defaulttypemap)

`-defaulttypemap=[<`*`list_of_typemap_entries`*`>]`

This option is used internally by JPublisher to set up predefined type map entries. This is separate from the user type map entries specified with `-addtypemap` or `-typemap`. If you want to clear the default type map, you can use the following option setting:

```
-defaulttypemap=
```

> **Note:** Avoid conflicts between the default type map and user type map—see "JPublisher Default Type Map and User Type Map" on page 2-18 for information. That section also describes the initial content of the default type map.

Output Directory for Generated Files (-dir)

`-dir=<directory name>`

A non-empty `-dir` option setting specifies the root of the directory tree within which JPublisher will place Java and SQLJ source files. JPublisher will nest generated packages in this directory. A setting of "." (a period, or "dot") specifies the current directory as the root of the directory tree.

The empty setting, however, installs all generated file directly into the current directory—there is no hierarchy in this case. This is the default setting, but you can also specify it explicitly as follows:

```
-dir=
```

If you specify a non-empty setting, JPublisher combines the directory, the package name given with the `-package` option, and any package name included in a SQL statement in the `INPUT` file to determine the specific directory within which it will generate a `.java` or `.sqlj` file. The "Name for Generated Packages (-package)" section on page 3-23 discusses this in more detail.

For example, consider the following command line (which is a single wraparound line):

```
jpub -user=scott/tiger -input=demoin -mapping=oracle -case=lower -sql=employee
-package=corp -dir=demo
```

In this case, the `demo` directory will be the base directory for packages JPublisher generates for object types you specify in the `INPUT` file `demoin`.

You can specify `-dir` on the command line or in a properties file. The default value for the `-dir` option is empty.

JDBC Driver Class for Database Connection (-driver)

`-driver=<driver_class_name>`

The `-driver` option specifies the driver class that JPublisher uses for JDBC connections to the database. The default is:

```
-driver=oracle.jdbc.OracleDriver
```

This setting is appropriate for any Oracle JDBC driver.

Java Character Encoding (-encoding)

`-encoding=<name_of_character_encoding>`

The `-encoding` option specifies the Java character encoding of the `INPUT` file JPublisher reads and the `.sqlj` and `.java` files JPublisher writes. The default encoding is the value of the system property `file.encoding`, or, if this property is not set, `8859_1` (ISO Latin-1).

As a general rule, you are not required to specify this option unless you specify an `-encoding` option when you invoke SQLJ and your Java compiler, in which case you should use the same `-encoding` option for JPublisher.

You can use the `-encoding` option to specify any character encoding that is supported by your Java environment. If you are using the Sun Microsystems JDK, these options are listed in the `native2ascii` documentation, which you can find at the following URLs:

```
http://www.javasoft.com/products/jdk/1.2/docs/tooldocs/solaris/native2ascii.html
```

or:

```
http://java.sun.com/j2se/1.3/docs/tooldocs/solaris/native2ascii.html
```

Note: Encoding settings, either set through the JPublisher `-encoding` option or the Java `file.encoding` setting, do not apply to Java properties files, including those specified through the JPublisher `-props` option. Properties files always use the encoding `8859_1`. This is a feature of Java in general, not JPublisher in particular. You can, however, use Unicode escape sequences in a properties file.

Generation of User Subclasses (-gensubclass)

`-gensubclass={true|false|force|call-super}`

The value of the `-gensubclass` option determines whether JPublisher generates initial source files for user-provided subclasses and, if so, what format these subclasses should have.

For `-gensubclass=true` (the default), JPublisher will generate code for the subclass only if it finds that no source file (`.java` or `.sqlj`) is present for the user subclass.

The `-gensubclass=false` setting results in JPublisher not generating any code for user subclasses.

For `-gensubclass=force`, JPublisher will always generate code for user subclasses. It will overwrite any existing code in the corresponding `.java` or `.sqlj` file if it already exists. Use this setting with caution.

The setting `-gensubclass=call-super` is equivalent to `-gensubclass=true`, except that JPublisher will generate slightly different code. By default, JPublisher generates only constructors and methods necessary for implementing, for example, the `ORAData` interface. JPublisher indicates how superclass methods or attribute setter and getter methods can be called, but places this code inside comments. With the `call-super` setting, all methods, getters, and setters are generated as code. The idea is that you can specify this setting if you are using Java development tools that are based on class introspection. Generally only those methods that relate to SQL object attributes and SQL object methods are interesting, while JPublisher implementation details should remain hidden. In this case you can point the tool at the generated user subclass.

You can specify the `-gensubclass` option on the command line or in a properties file.

File Containing Names of Objects and Packages to Translate (-input)

`-input=<`*`filename`*`>`
`-i <`*`filename`*`>`

Both formats are synonymous. The second one is provided for convenience as a command-line abbreviation.

The `-input` option specifies the name of a file from which JPublisher reads the names of object types and PL/SQL packages to translate, and other information it needs for their translation. JPublisher translates each object type and package in the

list. You can think of the INPUT file as a makefile for type declarations—it lists the types that need Java class definitions.

In some cases, JPublisher might find it necessary to translate some additional classes that do not appear in the INPUT file. This is because JPublisher analyzes the types in the INPUT file for dependencies before performing the translation, and translates other types as necessary. For more information on this topic, see "Translating Additional Types" on page 3-39.

If you do not specify any packages or object types in an INPUT file or on the command line, then JPublisher translates all object types and packages declared in the database schema to which it is connected.

For more information about the syntax of the INPUT file, see "INPUT File Structure and Syntax" on page 3-35.

Generation of Package Classes and Wrapper Methods (-methods)

```
-methods={true|all|always|named|some|false|none}
```

The value of the -methods option determines whether JPublisher generates wrapper methods for methods in object types and PL/SQL packages.

For -methods=true or, equivalently, -methods=all (the default), JPublisher generates wrapper methods for all the methods in the object types and PL/SQL packages it processes. In Oracle9*i*, this results in generation of a .sqlj source file whenever the underlying SQL object or package actually defines methods, but a .java source if not. (In previous releases, .sqlj source files were always generated for a true or all setting.)

The -methods=always setting also results in wrapper methods being generated; however, for backward compatibility to earlier JPublisher versions, this setting always results in .sqlj files being generated for all SQL object types, regardless of whether the types define methods.

For -methods=named or, equivalently, -methods=some, JPublisher generates wrapper methods only for the methods explicitly named in the INPUT file.

For -methods=false or, equivalently, -methods=none, JPublisher does not generate wrapper methods. In this case JPublisher does not generate classes for PL/SQL packages, because they would not be useful without wrapper methods.

The default is -methods=all.

You can specify the -methods option on the command line or in a properties file.

Omission of Schema Name from Generated Names (-omit_schema_names)

`-omit_schema_names`

Specifying `-omit_schema_names` determines that certain object type names generated by JPublisher include the schema name. Omitting the schema name makes it possible for you to use classes generated by JPublisher when you connect to a schema other than the one used when JPublisher was invoked, as long as the object types and packages you use are declared identically in the two schemas.

`ORAData` and `SQLData` classes generated by JPublisher include a `static final String` that names the SQL object type matching the generated class. When the code generated by JPublisher executes, the object type name in the generated code is used to locate the object type in the database. If the object type name does not include the schema name, the type is looked up in the schema associated with the current connection when the code generated by JPublisher is executed. If the object type name does include the schema name, the type is looked up in that schema.

If you specify `-omit_schema_names`, every object type or wrapper name generated by JPublisher is qualified with a schema name.

If you do *not* specify `-omit_schema_names`, an object type or wrapper name generated by JPublisher is qualified with a schema name only under the following circumstances:

- You declare the object type or wrapper in a schema other than the one to which JPublisher is connected.

or:

- You declare the object type or wrapper with a schema name on the command line or `INPUT` file.

That is, an object type or wrapper from another schema requires a schema name to identify it, and the use of a schema name with the type or package on the command line or `INPUT` file overrides the `-omit_schema_names` option.

Note: Although this option behaves as a boolean option, as of Oracle9*i* release 2 you cannot set it `=true` or `=false`. Simply specify "`-omit_schema_names`" to enable it, or do nothing to leave it disabled.

Name for Generated Packages (-package)

-package=<*package_name*>

The `-package` option specifies the name of the package JPublisher generates. The name of the package appears in a package declaration in each `.java` or `.sqlj` file. The directory structure also reflects the package name. An explicit name in the `INPUT` file, after the `-sql` option, overrides the value given to the `-package` option.

Example 1 If the command line includes the following:

```
-dir=/a/b -package=c.d -case=mixed
```

and the `INPUT` file contains the following line (and assuming the SQL type `PERSON` has methods defined on it):

```
SQL PERSON AS Person
```

then in the following cases, JPublisher creates the file `/a/b/c/d/Person.sqlj`:

```
-sql=PERSON:Person
-sql=PERSON
SQL PERSON AS Person
SQL PERSON
```

The `Person.sqlj` file contains (among other things) the following package declaration:

```
package c.d;
```

Example 2 Now assume the following is again in the command line:

```
-dir=/a/b -package=c.d -case=mixed
```

but is followed by specification of an `INPUT` file containing the following:

```
-sql=PERSON:e.f.Person
SQL PERSON AS e.f.Person
```

In this case the package information in the `INPUT` file overrides the `-package` option on the command line. JPublisher creates the file `a/b/e/f/Person.sqlj`, which includes the following package declaration:

```
package e.f;
```

If you do not supply a package name for a class by any of the means described in this section, then JPublisher will not supply a name for the package containing the class. In addition, JPublisher will not generate a package declaration, and it will put the file containing the declaration of the class in the directory specified by the `-dir` option.

Occasionally, JPublisher might need to translate a type not explicitly listed in the `INPUT` file, because the type is used by another type that must be translated. In this case, the file declaring the required type is placed in the default package named on the command line, in a properties file, or in the `INPUT` file. JPublisher does not translate non-specified packages, because packages do not have dependencies on other packages.

File for Generated PL/SQL Wrapper Code (-plsqlfile)

`-plsqlfile=<`*`name_of_file_for_generated_PLSQL_code`*`>`

The `-plsqlfile` option specifies the name of the file into which JPublisher writes PL/SQL wrapper stored procedures and functions. If this file already exists, it will be silently overwritten. By default, JPublisher writes PL/SQL code to the file `plsql_wrapper.sql`.

Also note that it is your responsibility to load the generated file into the database (using SQL*Plus, for example).

Generation of PL/SQL Wrapper Code (-plsqlmap)

`-plsqlmap={`**`true`**`|false|always}`

The `-plsqlmap` option specifies how JPublisher generates PL/SQL wrapper procedures and functions.

If this option is set to `true` (the default), JPublisher will generate PL/SQL wrapper procedures and functions as needed and, whenever possible, use conversion functions only.

If this option is set to `false`, JPublisher will not generate PL/SQL wrapper procedures or functions. If it encounters in a signature a PL/SQL type that cannot be supported by conversion functions alone (in other words, that would require generation of a PL/SQL wrapper), then JPublisher will skip generation of Java code for this particular procedure or function.

The setting `always` specifies that JPublisher will generate a PL/SQL wrapper procedure or function for every stored procedure or function that uses a PL/SQL type. This is useful for generating a "proxy" PL/SQL package that complements an

original PL/SQL package. The proxy provides Java-accessible signatures for those functions or procedures that are not directly accessible from JDBC or SQLJ in the original package.

Package for Generated PL/SQL Wrapper Code (-plsqlpackage)

`-plsqlpackage=<name_of_PLSQL_package_to_hold_generated_PLSQL_code>`

The `-plsqlpackage` option specifies the name of a PL/SQL package into which JPublisher places any generated PL/SQL wrapper stored procedures and functions. By default, JPublisher uses the package `JPUB_PLSQL_WRAPPER`.

Note that it is your responsibility to create this package in the database by running the SQL script generated by JPublisher. See "File for Generated PL/SQL Wrapper Code (-plsqlfile)" on page 3-24.

Input Properties File (-props)

`-props=<filename>`
`-p <filename>`

Both formats are synonymous. The second one is provided for convenience as a command-line abbreviation.

The `-props` option, entered on the command line, specifies the name of a JPublisher properties file that lists the values of commonly used options. JPublisher processes the properties file as if its contents were inserted in sequence on the command line at that point.

If more than one properties file appears on the command line, JPublisher processes them with the other command-line options in the order in which they appear.

For information on the contents of the properties file, see "Properties File Structure and Syntax" on page 3-33.

Note: Encoding settings, either set through the JPublisher `-encoding` option or the Java `file.encoding` setting, do not apply to Java properties files, including those specified through the `-props` option. Properties files always use the encoding `8859_1`. This is a feature of Java in general, not JPublisher in particular. You can, however, use Unicode escape sequences in a properties file.

Serializability of Generated Object Wrappers (-serializable)

```
-serializable={true|false}
```

The boolean option `-serializable` specifies whether the Java classes that JPublisher generates for SQL object types implement the `java.io.Serializable` interface. The default setting is `-serializable=false`. Please note the following if you choose to set `-serializable=true`:

- Not all object attributes are serializable. In particular, none of the Oracle LOB types, such as `oracle.sql.BLOB`, `oracle.sql.CLOB`, or `oracle.sql.BFILE`, can be serialized. Whenever you serialize objects with such attributes, the corresponding attribute values will be initialized to `null` after deserialization.
- If you use object attributes of type `java.sql.Blob` or `java.sql.Clob`, then the code generated by JPublisher requires that the Oracle JDBC rowset implementation be available in the classpath. This is provided in the `ocrs12.jar` library at `[Oracle Home]/jdbc/lib`. In this case, the underlying value of `Clob` and `Blob` objects is materialized, serialized, and subsequently retrieved.
- Whenever you deserialize objects containing attributes that are object references, the underlying connection is severed, and you cannot issue `setValue()` or `getValue()` calls on the reference. For this reason, JPublisher generates the following method into your Java classes whenever you specify `-serializable=true`:

  ```
  public void restoreConnection(Connection)
  ```

  After deserialization, call this method once for a given object reference or object in order to restore the current connection into the reference or, respectively, into all transitively embedded references.

Declaration of Object Types and Packages to Translate (-sql)

```
-sql={toplevel|object type and package translation syntax}
-s {toplevel|object type and package translation syntax}
```

The two formats are synonymous. The second one is provided for convenience as a command-line shortcut.

You can use the `-sql` option when you do not need the generality of an `INPUT` file. The `-sql` option lets you list one or more database entities declared in SQL that you want JPublisher to translate. (Alternatively, you can use several `-sql` options

in the same command line, or several `jpub.sql` options in a properties file.) Currently, JPublisher supports translation of object types and packages. JPublisher also translates the top-level subprograms in a schema, just as it does for subprograms in a PL/SQL package.

You can mix object types and package names in the same `-sql` declaration. JPublisher can detect whether each item is an object type or a package.

You can also use the `-sql` option with the keyword `toplevel` to translate all top-level PL/SQL subprograms in a schema. The `toplevel` keyword is not case-sensitive. More information on the `toplevel` keyword is provided later in this section.

If you do not enter any types or packages to translate in the `INPUT` file or on the command line, then JPublisher will translate all the types and packages in the schema to which you are connected.

In this section, the `-sql` option is explained by translating it to the equivalent `INPUT` file syntax. `INPUT` file syntax is explained in "Understanding the Translation Statement" on page 3-35.

The JPublisher command-line syntax for `-sql` lets you indicate three possible type translations.

- `-sql=`*`name_a`*

  JPublisher interprets this syntax as: `SQL` *`name_a`*

- `-sql=`*`name_a:name_c`*

  JPublisher interprets this syntax as: `SQL` *`name_a`* `AS` *`name_c`*

- `-sql=`*`name_a`*`:`*`name_b`*`:`*`name_c`*

  JPublisher interprets this syntax as:
  `SQL` *`name_a`* `GENERATE` *`name_b`* `AS` *`name_c`*

  In this case, *`name_a`* must represent an object type.

Important: Only non-case-sensitive SQL names are supported on the JPublisher command line. If a user-defined type was defined in a case-sensitive way (in quotes) in SQL, then you must specify the name in the JPublisher `INPUT` file instead of on the command line, and in quotes. See "INPUT File Structure and Syntax" on page 3-35 for information.

> **Note:** The *name_a*:*name_b*:*name_c* translation syntax is not meaningful when *name_a* represents a package.

Enter `-sql=...` followed by one or more object types and packages (including top-level "packages") that you want JPublisher to translate. If you enter more than one item for translation, they must be separated by commas, without any white space. This example assumes that `CORPORATION` is a package, and `EMPLOYEE` and `ADDRESS` are object types:

```
-sql=CORPORATION,EMPLOYEE:oracleEmployee,ADDRESS:JAddress:MyAddress
```

JPublisher will interpret this as follows:

```
SQL CORPORATION
SQL EMPLOYEE AS oracleEmployee
SQL ADDRESS GENERATE JAddress AS MyAddress
```

And JPublisher executes the following:

- It creates a wrapper for the `CORPORATION` package.
- It translates the object type `EMPLOYEE` as `oracleEmployee`.
- It translates `ADDRESS` as `JAddress`, generating code so that `ADDRESS` objects will be represented by the `MyAddress` class that you will write to extend `JAddress`.
- It creates the references to the `MyAddress` class that you will write to extend `JAddress`.

If you want JPublisher to translate all the top-level PL/SQL subprograms in the schema to which JPublisher is connected, enter the keyword `toplevel` following the `-sql` option. JPublisher treats the top-level PL/SQL subprograms as if they were in a package. For example:

```
-sql=toplevel
```

JPublisher generates a wrapper class, known as `toplevel`, for the top level subprograms. If you want the class to be generated with a different name, you can declare the name with the `-sql=`*name_a*`:`*name_b* syntax. For example:

```
-sql=toplevel:myClass
```

Note that this is synonymous with the `INPUT` file syntax:

```
SQL toplevel AS myClass
```

Similarly, if you want JPublisher to translate all the top-level PL/SQL subprograms in some other schema, enter:

```
-sql=<schema_name>.toplevel
```

In this example, <*schema_name*> is the name of the schema containing the top-level subprograms.

When you request generation of top-level subprograms, you can also supply a list of names, in which case JPublisher will only generate code for those top-level functions or procedures mentioned in the list. The list of names must follow the TOPLEVEL token and be enclosed in **(**...**)**, and the function names must be separated with "**+**" (the plus character). Consider the following example:

```
-sql=toplevel(BOOL2INT+INT2BOOL):Conversions
```

Function and procedure names specified in the list are sensitive to case. You must specify them in uppercase if they were defined in a case-insensitive way. Also note that if you want to use this option, your operating system shell may require that this option be quoted in the JPublisher command line.

Generation of toString() Method on Object Wrappers (-tostring)

```
-tostring={true|false}
```

You can use the boolean option `-tostring` to tell JPublisher to generate an additional `toString()` method for printing out an object value. The output resembles SQL code you would use to construct the object. The default setting is `false`.

Replacement of the JPublisher Type Map (-typemap)

```
-typemap=[<list_of_typemap_entries>]
```

The difference between the `-addtypemap` option and the `-typemap` option is that `-addtypemap` appends entries to the user type map, while `-typemap` replaces the existing type map with the specified entries. Thus, if you want to clear the user type map, you can use the following option setting.

```
-typemap=
```

Note that this does not clear the content of the default type map, which is controlled independently from the user type map with the `-defaulttypemap` and

`-adddefaulttypemap` options. The format of the type map entries is described in "Additional Entry to the User Type Map (-addtypemap)" on page 3-14.

> **Note:** Avoid conflicts between the default type map and user type map—see "JPublisher Default Type Map and User Type Map" on page 2-18 for information.

Declaration of Object Types to Translate (-types)

`-types=<`*`type_translation_syntax`*`>`

> **Note:** The `-types` option is currently supported for compatibility, but deprecated. Use the `-sql` option instead.

You can use the `-types` option, *for object types only*, when you do not need the generality of an `INPUT` file. The `-types` option lets you list one or more individual object types that you want JPublisher to translate. Except for the fact that the `-types` option does not support PL/SQL packages, it is identical to the `-sql` option.

If you do not enter any types or packages to translate in the `INPUT` file or with the `-types` or `-sql` options, then JPublisher will translate all the types and packages in the schema to which you are connected.

The command-line syntax lets you indicate three possible type translations.

- `-types=`*`name_a`*

  JPublisher interprets this syntax as

  TYPE *name_a*

- `-types=`*`name_a`*`:`*`name_b`*

  JPublisher interprets this syntax as:

  TYPE *name_a* AS *name_b*

- `-types=`*`name_a`*`:`*`name_b`*`:`*`name_c`*

  JPublisher interprets this syntax as:

  TYPE *name_a* GENERATE *name_b* AS *name_c*

TYPE, TYPE...AS, and TYPE...GENERATE...AS syntax has the same functionality as SQL, SQL...AS and SQL...GENERATE...AS syntax. See "Understanding the Translation Statement" on page 3-35.

Enter `-types=...` on the command line, followed by one or more object type translations you want JPublisher to perform. If you enter more than one item, they must be separated by commas without any white space. For example, if you enter:

```
-types=CORPORATION,EMPLOYEE:oracleEmployee,ADDRESS:JAddress:MyAddress
```

JPublisher will interpret this as:

```
TYPE CORPORATION
TYPE EMPLOYEE AS oracleEmployee
TYPE ADDRESS GENERATE JAddress AS MyAddress
```

Connection URL for Target Database (-url)

`-url=<`*`url`*`>`

You can use the `-url` option to specify the URL of the database to which you want to connect. The default value is:

```
-url=jdbc:oracle:oci:@
```

You can follow the "`@`" symbol with an Oracle SID.

To specify the Thin driver, enter:

`-url=jdbc:oracle:thin:@`*`host`*`:`*`port`*`:`*`sid`*

In this example, *`host`* is the name of the host on which the database is running, *`port`* is the port number, and *`sid`* is the Oracle SID.

Note: With Oracle9*i*, use "oci" in the connect string for the Oracle JDBC OCI driver in any new code. For backward compatibility, however, "oci8" is still accepted. (And "oci7" is accepted for Oracle9*i* version 7.3.4.)

User Name and Password for Database Connection (-user)

-user=<*username/password*>
-u <*username/password*>

Both formats are synonymous. The second one is provided for convenience as a command-line shortcut.

JPublisher requires the `-user` option, which specifies an Oracle user name and password, so that it can connect to the database. If you do not enter the `-user` option, JPublisher prints an error message and stops execution.

For example, the following command line directs JPublisher to connect to your database with username `scott` and password `tiger`:

```
jpub -user=scott/tiger -input=demoin -dir=demo -mapping=oracle -package=corp
```

JPublisher Input Files

These sections describe the structure and contents of JPublisher input files:

- Properties File Structure and Syntax
- INPUT File Structure and Syntax
- INPUT File Precautions

Properties File Structure and Syntax

A properties file is an optional text file where you can specify frequently used options. Specify the name of the properties file on the JPublisher command line with the `-props` option. (And `-props` is the only option that you cannot specify in a properties file.)

In a properties file, enter one option with its associated value on each line. Enter each option name with the following prefix (including the period), case-sensitive:

```
jpub.
```

White space is permitted only directly in front of "`jpub.`"—any other white space within the option line is significant.

Alternatively, JPublisher permits you to specify options using the following prefix, which resembles the syntax of SQL line comments.

```
-- jpub.
```

A line that does not start with either of the prefixes above is simply ignored by JPublisher.

Additionally, you can use line continuation to spread a JPublisher option over several lines in the properties file. A line that is to be continued must have "\" (backslash character) as the last character, immediately after the text of the line. Any leading space, or any leading "`--`" (SQL comment designation), on the following line is ignored. Consider the following sample entries:

```
/* The next three lines represent a JPublisher option
   jpub.sql=SQL_TYPE:JPubJavaType:MyJavaType,\
            OTHER_SQL_TYPE:OtherJPubType:MyOtherJavaType,\
            LAST_SQL_TYPE:My:LastType
*/
-- The next two lines represent another JPublisher option
-- jpub.addtypemap=PLSQL_TYPE:JavaType:SQL TYPE\
--                 :SQL_TO_PLSQL_FUNCTION:PLSQL_TO_SQL_FUNCTION
```

Because of this functionality, it is straightforward to embed JPublisher options in SQL scripts. This can be useful when setting up PL/SQL-to-SQL type mappings.

JPublisher reads the options in the properties file in order, as if its contents were inserted on the command line at the point where the `-props` option is specified. If you specify an option more than once, the last value encountered by JPublisher will override previous values, except for the following options, which are cumulative:

- `jpub.sql`
- `jpub.type`
- `jpub.addtypemap`
- `jpub.adddefaulttypemap`

For example, consider the following command line (a single wraparound line):

```
jpub -user=scott/tiger -sql=employee -mapping=oracle -case=lower -package=corp
-dir=demo
```

This is equivalent to the following:

```
jpub -props=my_properties
```

if you assume `my_properties` has a definition like the following:

```
-- jpub.user=scott\
--          /tiger
// jpub.user=cannot_use/java_line_comments
jpub.sql=employee
/*
jpub.mapping=oracle
*/
Jpub.notreally=a jpub option
   jpub.case=lower
jpub.package=corp
    jpub.dir=demo
```

You must include the "`jpub.`" prefix (including the period) at the beginning of each option name. If you enter anything else except white space or "`--`" before the option name, JPublisher will ignore the entire line.

This example also illustrates that the "`jpub.`" prefix must be all lowercase, otherwise it is ignored, as for "`Jpub.notreally=a jpub option`".

"JPublisher Options" on page 3-2 describes all the JPublisher options.

INPUT File Structure and Syntax

Specify the name of the INPUT file on the JPublisher command line with the -input option. This file identifies the object types and PL/SQL packages JPublisher should translate. It also controls the naming of the generated classes and packages. Although you can use the -sql command-line option to specify object types and packages, an INPUT file allows you a finer degree of control over how JPublisher translates object types and PL/SQL packages.

If you do not specify types or packages to translate in an INPUT file or on the command line, then JPublisher translates all object types and PL/SQL packages in the schema to which it connects.

Understanding the Translation Statement

The translation statement in the INPUT file identifies the names of the object types and PL/SQL packages that you want JPublisher to translate. Optionally, the translation statement can also specify a Java name for the type or package, a Java name for attribute identifiers, and whether there are any extended classes.

One or more translation statements can appear in the INPUT file. The structure of a translation statement is:

```
( SQL <name>
| SQL [<schema_name>.]toplevel  [(<name_list>)]
| TYPE <type_name>)
[GENERATE <java_name_1>]
[AS <java_name_2>]
[TRANSLATE
     <database_member_name> AS <simple_java_name>
 { , <database_member_name> AS <simple_java_name>}*
]
```

The following sections describe the components of the translation statement.

SQL <*name*> | TYPE <*type_name*> Clause Enter SQL <*name*> to identify an object type or a PL/SQL package that you want JPublisher to translate. JPublisher examines the <*name*>, determines whether it is an object type or a package name, and processes it appropriately. If you use the reserved word toplevel in place of <*name*>, JPublisher translates the top-level subprograms in the schema to which JPublisher is connected.

Instead of SQL, it is permissible to enter TYPE <*type_name*> if you are specifying only object types; however, TYPE syntax is deprecated in Oracle9*i*.

You can enter <*name*> as <*schema_name*>.<*name*> to specify the schema to which the object type or package belongs. If you enter <*schema_name*>.toplevel, JPublisher translates the top-level subprograms in schema <*schema_name*>. In conjunction with TOPLEVEL, you can also supply **(**<*name_list*>**)**, a comma-separated list of names, enclosed in parentheses, that are to be published. JPublisher will consider only top-level functions and procedures that match this list. If you do not specify this list, JPublisher will generate code for all top-level subprograms.

Important: If a user-defined type was defined in a case-sensitive way (in quotes) in SQL, then you must specify the name in quotes. For example:

```
SQL "CaseSenstiveType" AS CaseSensitiveType
```

or, if also specifying a non-case-sensitive schema name:

```
SQL SCOTT."CaseSensitiveType" AS CaseSensitiveType
```

or, if also specifying a case-sensitive schema name:

```
SQL "Scott"."CaseSensitiveType AS CaseSensitiveType
```

The AS clauses, described below, are optional.

Avoid situations where a dot (".") is part of the schema name or type name itself.

Note: The TYPE syntax is currently supported for compatibility, but deprecated. Use the SQL syntax instead.

AS <*java_name_2*> Clause This clause optionally specifies the name of the Java class that represents the user-defined type or PL/SQL package. The <*java_name_2*> can be any legal Java name and can include a package identifier. The case of the Java name overrides the value of the -case option. For more information on how to name packages, see "Package Naming Rules in the INPUT File" on page 3-38.

When you use the AS clause without a GENERATE clause, the class in the AS clause is what JPublisher generates and is mapped to the SQL type.

When you use the AS clause with a GENERATE clause, JPublisher generates the class in the GENERATE clause but maps the SQL type to the class in the AS clause. You

manually create the class in the AS clause, extending the class that JPublisher generates.

Also see "Extending JPublisher-Generated Classes" on page 2-34.

GENERATE <*java_name_1*> Clause This clause specifies the name of the class that JPublisher generates when you want to create a subclass for mapping purposes. Use the GENERATE clause in conjunction with the AS clause. JPublisher generates the class in the GENERATE clause. The AS clause specifies the name of the subclass that you create and that your Java program will use to represent the SQL object type.

The <*java_name_1*> can be any legal Java name and can include a package identifier. Its case overrides the value of the `-case` option.

Use the GENERATE clause only when you are translating object types. When you are translating an object type, the code JPublisher generates mentions both the name of the class that JPublisher generates and the name of the class that your Java program will use to represent the SQL object type. When these are two different classes, use GENERATE...AS.

Do not use this clause if you are translating PL/SQL packages. When you are translating a PL/SQL package, the code JPublisher generates mentions only the name of the class that JPublisher generates, so there is no need to use the GENERATE clause in this case.

Also see "Extending JPublisher-Generated Classes" on page 2-34.

TRANSLATE <*database_member_name*> AS <*simple_java_name*> Clause This clause optionally specifies a different name for an attribute or method. The <*database_member_name*> is the name of an attribute of an object type, or a method of a type or package, which is to be translated to the following <*simple_java_name*>. The <*simple_java_name*> can be any legal Java name, and its case overrides the value of the `-case` option. This name cannot have a package name.

If you do not use TRANSLATE...AS to rename an attribute or method, or if JPublisher translates an object type not listed in the INPUT file, then JPublisher uses the database name of the attribute or method as the Java name as modified according to the value of the `-case` option. Reasons why you might want to rename an attribute name or method include:

- The name contains characters other than letters, digits, and underscores.
- The name conflicts with a Java keyword.

- The type name conflicts with another name in the same scope. This can happen, for example, if the program uses two types with the same name from different schemas.

Remember that your attribute names will appear embedded within `get`*`XXX`*`()` and `set`*`XXX`*`()` method names, so you might want to capitalize the first letter of your attribute names. For example, if you enter:

```
TRANSLATE FIRSTNAME AS FirstName
```

JPublisher will generate a `getFirstName()` method and a `setFirstName()` method. In contrast, if you enter:

```
TRANSLATE FIRSTNAME AS firstName
```

JPublisher will generate a `getfirstName()` method and a `setfirstName()` method.

Note: The Java keyword `null` has special meaning when used as the target Java name for an attribute or method, such as in the following example:

```
TRANSLATE FIRSTNAME AS null
```

When you map a SQL method to `null`, JPublisher does not generate a corresponding Java method in the mapped Java class. When you map a SQL object attribute to `null`, JPublisher does not generate the getter and setter methods for the attribute in the mapped Java class.

Package Naming Rules in the INPUT File If you use a simple Java identifier to name a class in the `INPUT` file, its full class name will include the package name from the `-package` option. If the class name in the `INPUT` file is qualified with a package name, then that package name overrides the value of the `-package` option and becomes the full package name of the class.

Note the following:

- If you enter the syntax:

  ```
  SQL A AS B
  ```

  then JPublisher uses the value that was entered for `-package` on the command line or the properties file.

- If you enter the syntax:

  ```
  SQL A AS B.C
  ```

  then JPublisher interprets `B.C` to represent the full class name.

For example, if you enter the following on the command line:

```
-package=a.b
```

and the `INPUT` file contains the following translation statement:

```
SQL scott.employee AS e.Employee
```

then JPublisher will generate the class as follows:

```
e.Employee
```

For more examples of how the package name is determined, see "Name for Generated Packages (-package)" on page 3-23.

Translating Additional Types It might be necessary for JPublisher to translate additional types not listed in the `INPUT` file. This is because JPublisher analyzes the types in the `INPUT` file for dependencies before performing the translation, and translates other types as necessary. Recall the example in "Sample JPublisher Translation" on page 1-26. Assume the object type definition for `EMPLOYEE` had included an attribute called `ADDRESS`, and `ADDRESS` was an object with the following definition:

```
CREATE OR REPLACE TYPE address AS OBJECT
(
    street     VARCHAR2(50),
    city       VARCHAR2(50),
    state      VARCHAR2(30),
    zip        NUMBER
);
```

In this case, JPublisher would first translate `ADDRESS`, because that would be necessary to define the `EMPLOYEE` type. In addition, `ADDRESS` and its attributes would all be translated in the same case, because they are not specifically mentioned in the `INPUT` file. A class file would be generated for `Address.java`, which would be included in the package specified on the command line.

JPublisher does not translate packages you do not request. Because packages do not have attributes, they do not have any dependencies on other packages.

Sample Translation Statement

To better illustrate the function of the INPUT file, consider a more complicated version of the example in "Sample JPublisher Translation" on page 1-26. Consider the following command line (a single wraparound line):

```
jpub -user=scott/tiger -input=demoin -dir=demo -numbertypes=oracle -package=corp
-case=same
```

And assume the INPUT file demoin contains the following:

```
SQL employee AS c.Employee
  TRANSLATE NAME AS Name
            HIRE_DATE AS HireDate
```

The -case=same option indicates that generated Java identifiers should maintain the same case as in the database. Any identifier in a CREATE TYPE or CREATE PACKAGE declaration is stored in upper case in the database unless it is quoted. However, the -case option is applied only to those identifiers not explicitly mentioned in the INPUT file. Therefore, Employee will appear as written. The attribute identifiers not specifically mentioned (that is, EMPNO, DEPTNO, and SALARY) will remain in upper case, but JPublisher will translate the specifically mentioned NAME and HIRE_DATE attribute identifiers as shown.

The translation statement specifies a SQL object type to be translated. In this case, there is only one object type, Employee.

The AS c.Employee clause causes the package name to be further qualified. The translated type will be written to the following file:

```
./demo/corp/c/Employee.sqlj          (UNIX)
.\demo\corp\c\Employee.sqlj          (Windows NT)
```

(This assumes the object type defines methods; otherwise Employee.java will be generated instead.)

The generated file is written in package corp.c in output directory demo. Note that the package name is reflected in the directory structure.

The TRANSLATE...AS clause specifies that the name of any mentioned object attributes should be changed when the type is translated into a Java class. In this case, the NAME attribute is changed to Name and the HIRE_DATE attribute is changed to HireDate.

INPUT File Precautions

This section describes some of the common errors made in INPUT files. Check for these errors before you run JPublisher. Although JPublisher reports most of the errors that it finds in the INPUT file, it does not report these.

Requesting the Same Java Class Name for Different Object Types

If you request the same Java class name for two different object types, the second class will silently overwrite the first. For example, if the INPUT file contains:

```
type PERSON1 as Person
TYPE PERSON2 as Person
```

JPublisher will create the file Person.java for PERSON1 and will then overwrite it for type PERSON2.

Requesting the Same Attribute Name for Different Object Attributes

If you request the same attribute name for two different object attributes, JPublisher will generate get*XXX*() and set*XXX*() methods for both attributes without issuing a warning message. The question of whether the generated class is valid in Java depends on whether the two get*XXX*() methods with the same name and the two set*XXX*() methods with the same name have different argument types so that they may be unambiguously overloaded.

Specifying Nonexistent Attributes

If you specify a nonexistent object attribute in the TRANSLATE clause, JPublisher will ignore it without issuing a warning message.

Consider the following example from an INPUT file:

```
type PERSON translate X as attr1
```

A situation where X is not an attribute of PERSON would not cause JPublisher to issue a warning message.

4

JPublisher Examples

This chapter provides examples of the output JPublisher produces when translating object types and PL/SQL packages. It contains the following sections:

- Example: JPublisher Translations with Different Mappings—Contains examples of JPublisher output, comparing different outputs where only the values of the datatype mapping parameters are changed.
- Example: JPublisher Object Attribute Mapping—Illustrates an example of JPublisher output when translating different object types.
- Example: Generating a SQLData Class—Covers an example of JPublisher output when generating classes that implement the SQLData interface.
- Example: Extending JPublisher Classes—Presents an example of JPublisher output when generating a class that you will extend.
- Example: Wrappers Generated for Methods in Objects—Shows an example of JPublisher output when generating method wrappers for object type attributes and methods.
- Example: Wrappers Generated for Methods in Packages—Shows an example of JPublisher output when generating method wrappers for PL/SQL methods.
- Example: Using Classes Generated for Object Types—Presents a complete program using the classes that JPublisher generates for object types.
- Example: Using Classes Generated for Packages—Presents a complete program using the classes and method wrappers that JPublisher generates for objects and packages respectively.
- Example: Using Datatypes Unsupported by JDBC—Illustrates JPublisher support for PL/SQL types, setting up an object type that uses PL/SQL `BOOLEAN` values. The example compares publishing the type directly through JPublisher, and manually writing conversions for the type.

Example: JPublisher Translations with Different Mappings

This section presents sample output from JPublisher with the only difference in the translations being the values of the datatype mapping parameters. It uses the following type declaration:

```
CREATE TYPE employee AS OBJECT
(
    name       VARCHAR2(30),
    empno      INTEGER,
    deptno     NUMBER,
    hiredate   DATE,
    salary     REAL
);
```

And the following command line (a single wraparound line), but with different `-numbertypes` and `-builtintypes` settings for the two examples:

```
jpub -user=scott/tiger -dir=demo -numbertypes=xxxx -builtintypes=xxxx
-package=corp -case=mixed -sql=Employee
```

In the following two examples, JPublisher uses these datatype mappings:

- first, with `-numbertypes=jdbc` and `-builtintypes=jdbc`
- second, with `-numbertypes=oracle` and `-builtintypes=oracle`

JPublisher Translation with the JDBC Mapping

Because the user requests the JDBC mapping rather than the Object JDBC mapping for numeric types, the `getXXX()` and `setXXX()` accessor methods use the type `int` instead of `Integer` and the type `float` instead of `Float`.

Following are the contents of the `Employee.java` file. The `EmployeeRef.java` file is unchanged because it does not depend on the types of the attributes.

> **Note:** The details of method bodies generated by JPublisher might change in future releases.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
```

```
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class Employee implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.EMPLOYEE";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 12,4,2,91,7 };
  private static ORADataFactory[] _factory = new ORADataFactory[5];
protected static final Employee _EmployeeFactory = new Employee(false);

  public static ORADataFactory getORADataFactory()
  { return _EmployeeFactory; }
  /* constructor */
  protected Employee(boolean init)
  { if(init) _struct = new MutableStruct(new Object[5], _sqlType, _factory); }
  public Employee()
  { this(true); }
  public Employee(String name, int empno, java.math.BigDecimal deptno,
                  java.sql.Timestamp hiredate, float salary) throws SQLException
  { this(true);
    setName(name);
    setEmpno(empno);
    setDeptno(deptno);
    setHiredate(hiredate);
    setSalary(salary);
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _struct.toDatum(c, _SQL_NAME);
  }


  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  { return create(null, d, sqlType); }
  protected ORAData create(Employee o, Datum d, int sqlType) throws SQLException
```

```
  {
    if (d == null) return null;
    if (o == null) o = new Employee(false);
    o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
    return o;
  }
  /* accessor methods */
  public String getName() throws SQLException
  { return (String) _struct.getAttribute(0); }

  public void setName(String name) throws SQLException
  { _struct.setAttribute(0, name); }


  public int getEmpno() throws SQLException
  { return ((Integer) _struct.getAttribute(1)).intValue(); }

  public void setEmpno(int empno) throws SQLException
  { _struct.setAttribute(1, new Integer(empno)); }


  public java.math.BigDecimal getDeptno() throws SQLException
  { return (java.math.BigDecimal) _struct.getAttribute(2); }

  public void setDeptno(java.math.BigDecimal deptno) throws SQLException
  { _struct.setAttribute(2, deptno); }


  public java.sql.Timestamp getHiredate() throws SQLException
  { return (java.sql.Timestamp) _struct.getAttribute(3); }

  public void setHiredate(java.sql.Timestamp hiredate) throws SQLException
  { _struct.setAttribute(3, hiredate); }


  public float getSalary() throws SQLException
  { return ((Float) _struct.getAttribute(4)).floatValue(); }

  public void setSalary(float salary) throws SQLException
  { _struct.setAttribute(4, new Float(salary)); }

}
```

JPublisher Translation with the Oracle Mapping

Because the user requests Oracle type mappings, the `getXXX()` and `setXXX()` accessor methods employ the type `oracle.sql.CHAR` instead of `String`, the type `oracle.sql.DATE` instead of `java.sql.Timestamp`, and the type `oracle.sql.NUMBER` instead of `java.lang.Integer`, `java.math.BigDecimal`, and `java.lang.Float`.

Following are the contents of the `Employee.java` file. The `EmployeeRef.java` file is unchanged, because it does not depend on the types of the attributes.

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class Employee implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.EMPLOYEE";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 12,4,2,91,7 };
  private static ORADataFactory[] _factory = new ORADataFactory[5];
protected static final Employee _EmployeeFactory = new Employee(false);

  public static ORADataFactory getORADataFactory()
  { return _EmployeeFactory; }
  /* constructor */
  protected Employee(boolean init)
  { if(init) _struct = new MutableStruct(new Object[5], _sqlType, _factory); }
  public Employee()
  { this(true); }
```

```
  public Employee(oracle.sql.CHAR name, oracle.sql.NUMBER empno,
oracle.sql.NUMBER deptno,
                  oracle.sql.DATE hiredate, oracle.sql.NUMBER salary) throws
SQLException
  { this(true);
    setName(name);
    setEmpno(empno);
    setDeptno(deptno);
    setHiredate(hiredate);
    setSalary(salary);
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _struct.toDatum(c, _SQL_NAME);
  }


  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  { return create(null, d, sqlType); }
  protected ORAData create(Employee o, Datum d, int sqlType) throws SQLException
  {
    if (d == null) return null;
    if (o == null) o = new Employee(false);
    o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
    return o;
  }
  /* accessor methods */
  public oracle.sql.CHAR getName() throws SQLException
  { return (oracle.sql.CHAR) _struct.getOracleAttribute(0); }

  public void setName(oracle.sql.CHAR name) throws SQLException
  { _struct.setOracleAttribute(0, name); }


  public oracle.sql.NUMBER getEmpno() throws SQLException
  { return (oracle.sql.NUMBER) _struct.getOracleAttribute(1); }

  public void setEmpno(oracle.sql.NUMBER empno) throws SQLException
  { _struct.setOracleAttribute(1, empno); }
```

```
  public oracle.sql.NUMBER getDeptno() throws SQLException
  { return (oracle.sql.NUMBER) _struct.getOracleAttribute(2); }

  public void setDeptno(oracle.sql.NUMBER deptno) throws SQLException
  { _struct.setOracleAttribute(2, deptno); }


  public oracle.sql.DATE getHiredate() throws SQLException
  { return (oracle.sql.DATE) _struct.getOracleAttribute(3); }

  public void setHiredate(oracle.sql.DATE hiredate) throws SQLException
  { _struct.setOracleAttribute(3, hiredate); }


  public oracle.sql.NUMBER getSalary() throws SQLException
  { return (oracle.sql.NUMBER) _struct.getOracleAttribute(4); }

  public void setSalary(oracle.sql.NUMBER salary) throws SQLException
  { _struct.setOracleAttribute(4, salary); }

}
```

Example: JPublisher Object Attribute Mapping

This section provides examples of JPublisher output for a variety of object attribute types, demonstrating the various datatype mappings that JPublisher creates.

The example defines an address object (`address`) and then uses it as the basis of the definition of an address array (`Addr_Array`). The `alltypes` object definition also uses the address and address-array objects to demonstrate the mappings that JPublisher creates for object references and arrays (see `attr17`, `attr18`, and `attr19` in the `alltypes` object definition below).

```
CONNECT SCOTT/TIGER;

CREATE OR REPLACE TYPE address AS object
(
  street varchar2(50),
  city   varchar2(50),
  state  varchar2(30),
  zip    number
);

CREATE OR REPLACE TYPE Addr_Array AS varray(10) OF address;
CREATE OR REPLACE TYPE ntbl AS table OF Integer;
CREATE TYPE alltypes AS object (
  attr1  bfile,
  attr2  blob,
  attr3  char(10),
  attr4  clob,
  attr5  date,
  attr6  decimal,
  attr7  double precision,
  attr8  float,
  attr9  integer,
  attr10 number,
  attr11 numeric,
  attr12 raw(20),
  attr13 real,
  attr14 smallint,
  attr15 varchar(10),
  attr16 varchar2(10),
  attr17 address,
  attr18 ref address,
  attr19 Addr_Array,
  attr20 ntbl);
```

In this example, JPublisher was invoked with the following command line (a single wraparound line):

```
jpub -user=scott/tiger -input=demoin -dir=demo -package=corp -mapping=objectjdbc
-methods=false
```

Note: The `-mapping` option, while deprecated, is still supported so is therefore demonstrated. The `-mapping=objectjdbc` setting is equivalent to the combination of `-builtintypes=jdbc`, `-numbertypes=objectjdbc`, `-lobtypes=oracle`, and `-usertypes=oracle`. See "Mappings for All Types (-mapping)" on page 3-12 for more information.

It is not necessary to create the `demo` and `corp` directories in advance. JPublisher will create the directories for you.

The `demoin` file contains these declarations:

```
SQL ADDRESS AS Address
SQL ALLTYPES AS all.Alltypes
```

JPublisher generates declarations of the types `Alltypes` and `Address`, because `demoin` explicitly lists them. It also generates declarations of the types `ntbl` and `AddrArray`, because the `Alltypes` type requires them.

Additionally, JPublisher generates declarations of the types `AlltypesRef` and `AddressRef`, because it generates a declaration of a reference type for each object type. A reference type is in the same package as the corresponding object type. Reference types are not listed in the `INPUT` file or on the command line. The `Address` and `AddressRef` types are in package `corp`, because `-package=corp` appears on the command line. The `Alltypes` and `AlltypesRef` types are in package `all`, because the `all` in `all.Alltypes` overrides `-package=corp`. The remaining types were not explicitly mentioned, so they go in package `corp`.

Therefore, JPublisher creates the following files in package `corp`:

```
./demo/corp/Address.java
./demo/corp/AddressRef.java
./demo/corp/Ntbl.java
./demo/corp/AddrArray.java
```

and the following files in package `all`:

```
./demo/all/Alltypes.java
./demo/all/AlltypesRef.java
```

Listing and Description of Address.java Generated by JPublisher

The file `./demo/corp/Address.java` reads as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class Address implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.ADDRESS";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 12,12,12,2 };
  private static ORADataFactory[] _factory = new ORADataFactory[4];
protected static final Address _AddressFactory = new Address(false);

  public static ORADataFactory getORADataFactory()
  { return _AddressFactory; }
  /* constructor */
  protected Address(boolean init)
  { if(init) _struct = new MutableStruct(new Object[4], _sqlType, _factory); }
  public Address()
  { this(true); }
```

```
public Address(String street, String city, String state,
               java.math.BigDecimal zip) throws SQLException
{ this(true);
  setStreet(street);
  setCity(city);
  setState(state);
  setZip(zip);
}

/* ORAData interface */
public Datum toDatum(Connection c) throws SQLException
{
  return _struct.toDatum(c, _SQL_NAME);
}


/* ORADataFactory interface */
public ORAData create(Datum d, int sqlType) throws SQLException
{ return create(null, d, sqlType); }
protected ORAData create(Address o, Datum d, int sqlType) throws SQLException
{
  if (d == null) return null;
  if (o == null) o = new Address(false);
  o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
  return o;
}
/* accessor methods */
public String getStreet() throws SQLException
{ return (String) _struct.getAttribute(0); }

public void setStreet(String street) throws SQLException
{ _struct.setAttribute(0, street); }


public String getCity() throws SQLException
{ return (String) _struct.getAttribute(1); }

public void setCity(String city) throws SQLException
{ _struct.setAttribute(1, city); }


public String getState() throws SQLException
{ return (String) _struct.getAttribute(2); }
```

```
  public void setState(String state) throws SQLException
  { _struct.setAttribute(2, state); }


  public java.math.BigDecimal getZip() throws SQLException
  { return (java.math.BigDecimal) _struct.getAttribute(3); }

  public void setZip(java.math.BigDecimal zip) throws SQLException
  { _struct.setAttribute(3, zip); }

}
```

The `Address.java` file illustrates several points about Java source files. JPublisher-generated files begin with a package declaration whenever the generated class is in a named package. Note that you can specify a package in any of these ways:

- a `-package` parameter that you specify on the command line or in the properties file
- the `AS <Java_identifier>` clause in the `INPUT` file, where *`Java_identifier`* includes a package name

Import declarations for specific classes and interfaces mentioned by the `Address` class follow the `package` declaration.

The class definition follows the `import` declarations. All classes JPublisher generates are declared `public`.

SQLJ uses the `_SQL_NAME` and `_SQL_TYPECODE` strings to identify the SQL type matching the `Address` class.

The no-argument constructor is used to create the `_AddressFactory` object, which will be returned by `getORADataFactory()`. For efficiency, JPublisher also generates a `protected boolean` constructor for `Address` objects. This can be used in subclasses of `Address` to create uninitialized `Address` objects. Other `Address` objects are constructed by the `create()` method. The `protected create(...,...,...)` method is used to encapsulate details of the JPublisher implementation in the JPublisher-generated `Address` class, and to simplify the writing of user-provided subclasses. Implementation details, such as generation of the static `_factory` field and the `_struct` field, are implementation-specific and should not be referenced or exploited by any subclass of `Address`. (In this implementation, the `_factory` field is an array of factories for attributes of `Address`, but in this case the factories are null because none of the attribute types

of `Address` require a factory. The `_struct` field holds the object data and is a `MutableStruct` instance.)

The `toDatum()` method converts an `Address` object to a `Datum` object (in this case, a `STRUCT` object). JDBC requires the connection argument, although it might not be logically necessary.

The `getXXX()` and `setXXX()` accessor methods use the `objectjdbc` mapping for numeric attributes and the `jdbc` mapping for other attributes. The method names are in mixed case because `-case=mixed` is the default.

Listing of AddressRef.java Generated by JPublisher

The file `./demo/corp/AddressRef.java` reads as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.REF;
import oracle.sql.STRUCT;

public class AddressRef implements ORAData, ORADataFactory
{
  public static final String _SQL_BASETYPE = "SCOTT.ADDRESS";
  public static final int _SQL_TYPECODE = OracleTypes.REF;

  REF _ref;

private static final AddressRef _AddressRefFactory = new AddressRef();

  public static ORADataFactory getORADataFactory()
  { return _AddressRefFactory; }
  /* constructor */
  public AddressRef()
  {
```

```
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _ref;
  }

  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  {
    if (d == null) return null;
    AddressRef r = new AddressRef();
    r._ref = (REF) d;
    return r;
  }

  public static AddressRef cast(ORAData o) throws SQLException
  {
     if (o == null) return null;
     try { return (AddressRef) getORADataFactory().create(o.toDatum(null),
OracleTypes.REF); }
     catch (Exception exn)
     { throw new SQLException("Unable to convert "+o.getClass().getName()+" to
AddressRef: "+exn.toString()); }
  }

  public Address getValue() throws SQLException
  {
     return (Address) Address.getORADataFactory().create(
       _ref.getSTRUCT(), OracleTypes.REF);
  }

  public void setValue(Address c) throws SQLException
  {
    _ref.setValue((STRUCT) c.toDatum(_ref.getJavaSqlConnection()));
  }
}
```

The `getValue()` method in the `AddressRef` class returns the address referenced by an `AddressRef` object, with its proper type. The `setValue()` method copies the contents of the `Address` argument into the database `Address` object to which the `AddressRef` object refers. The `AddressRef` class also provides a static `cast()` method to convert references to other types into `Address` references.

Listing of Alltypes.java Generated by JPublisher

The file `./demo/all/Alltypes.java` reads as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package all;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class Alltypes implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.ALLTYPES";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  protected MutableStruct _struct;

  private static int[] _sqlType =  {
-13,2004,1,2005,91,3,8,6,4,2,3,-2,7,5,12,12,2002,2006,2003,2003 };
  private static ORADataFactory[] _factory = new ORADataFactory[20];
  static
  {
    _factory[16] = corp.Address.getORADataFactory();
    _factory[17] = corp.AddressRef.getORADataFactory();
    _factory[18] = corp.AddrArray.getORADataFactory();
    _factory[19] = corp.Ntbl.getORADataFactory();
  }
protected static final Alltypes _AlltypesFactory = new Alltypes(false);

  public static ORADataFactory getORADataFactory()
  { return _AlltypesFactory; }
  /* constructor */
  protected Alltypes(boolean init)
  { if(init) _struct = new MutableStruct(new Object[20], _sqlType, _factory); }
  public Alltypes()
```

```
  { this(true); }
  public Alltypes(oracle.sql.BFILE attr1, oracle.sql.BLOB attr2, String attr3,
oracle.sql.CLOB attr4,
                        java.sql.Timestamp attr5, java.math.BigDecimal attr6,
Double attr7, Double attr8,
               Integer attr9, java.math.BigDecimal attr10, java.math.BigDecimal
attr11,
                        byte[] attr12, Float attr13, Integer attr14, String
attr15, String attr16, corp.Address attr17,
               corp.AddressRef attr18, corp.AddrArray attr19, corp.Ntbl attr20)
throws SQLException
  { this(true);
    setAttr1(attr1);
    setAttr2(attr2);
    setAttr3(attr3);
    setAttr4(attr4);
    setAttr5(attr5);
    setAttr6(attr6);
    setAttr7(attr7);
    setAttr8(attr8);
    setAttr9(attr9);
    setAttr10(attr10);
    setAttr11(attr11);
    setAttr12(attr12);
    setAttr13(attr13);
    setAttr14(attr14);
    setAttr15(attr15);
    setAttr16(attr16);
    setAttr17(attr17);
    setAttr18(attr18);
    setAttr19(attr19);
    setAttr20(attr20);
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _struct.toDatum(c, _SQL_NAME);
  }


  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  { return create(null, d, sqlType); }
  protected ORAData create(Alltypes o, Datum d, int sqlType) throws SQLException
```

```
{
  if (d == null) return null;
  if (o == null) o = new Alltypes(false);
  o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
  return o;
}
/* accessor methods */
public oracle.sql.BFILE getAttr1() throws SQLException
{ return (oracle.sql.BFILE) _struct.getOracleAttribute(0); }

public void setAttr1(oracle.sql.BFILE attr1) throws SQLException
{ _struct.setOracleAttribute(0, attr1); }


public oracle.sql.BLOB getAttr2() throws SQLException
{ return (oracle.sql.BLOB) _struct.getOracleAttribute(1); }

public void setAttr2(oracle.sql.BLOB attr2) throws SQLException
{ _struct.setOracleAttribute(1, attr2); }


public String getAttr3() throws SQLException
{ return (String) _struct.getAttribute(2); }

public void setAttr3(String attr3) throws SQLException
{ _struct.setAttribute(2, attr3); }


public oracle.sql.CLOB getAttr4() throws SQLException
{ return (oracle.sql.CLOB) _struct.getOracleAttribute(3); }

public void setAttr4(oracle.sql.CLOB attr4) throws SQLException
{ _struct.setOracleAttribute(3, attr4); }


public java.sql.Timestamp getAttr5() throws SQLException
{ return (java.sql.Timestamp) _struct.getAttribute(4); }

public void setAttr5(java.sql.Timestamp attr5) throws SQLException
{ _struct.setAttribute(4, attr5); }


public java.math.BigDecimal getAttr6() throws SQLException
{ return (java.math.BigDecimal) _struct.getAttribute(5); }
```

```
public void setAttr6(java.math.BigDecimal attr6) throws SQLException
{ _struct.setAttribute(5, attr6); }


public Double getAttr7() throws SQLException
{ return (Double) _struct.getAttribute(6); }

public void setAttr7(Double attr7) throws SQLException
{ _struct.setAttribute(6, attr7); }


public Double getAttr8() throws SQLException
{ return (Double) _struct.getAttribute(7); }

public void setAttr8(Double attr8) throws SQLException
{ _struct.setAttribute(7, attr8); }


public Integer getAttr9() throws SQLException
{ return (Integer) _struct.getAttribute(8); }

public void setAttr9(Integer attr9) throws SQLException
{ _struct.setAttribute(8, attr9); }


public java.math.BigDecimal getAttr10() throws SQLException
{ return (java.math.BigDecimal) _struct.getAttribute(9); }

public void setAttr10(java.math.BigDecimal attr10) throws SQLException
{ _struct.setAttribute(9, attr10); }


public java.math.BigDecimal getAttr11() throws SQLException
{ return (java.math.BigDecimal) _struct.getAttribute(10); }

public void setAttr11(java.math.BigDecimal attr11) throws SQLException
{ _struct.setAttribute(10, attr11); }


public byte[] getAttr12() throws SQLException
{ return (byte[]) _struct.getAttribute(11); }

public void setAttr12(byte[] attr12) throws SQLException
{ _struct.setAttribute(11, attr12); }
```

```
public Float getAttr13() throws SQLException
{ return (Float) _struct.getAttribute(12); }

public void setAttr13(Float attr13) throws SQLException
{ _struct.setAttribute(12, attr13); }


public Integer getAttr14() throws SQLException
{ return (Integer) _struct.getAttribute(13); }

public void setAttr14(Integer attr14) throws SQLException
{ _struct.setAttribute(13, attr14); }


public String getAttr15() throws SQLException
{ return (String) _struct.getAttribute(14); }

public void setAttr15(String attr15) throws SQLException
{ _struct.setAttribute(14, attr15); }


public String getAttr16() throws SQLException
{ return (String) _struct.getAttribute(15); }

public void setAttr16(String attr16) throws SQLException
{ _struct.setAttribute(15, attr16); }


public corp.Address getAttr17() throws SQLException
{ return (corp.Address) _struct.getAttribute(16); }

public void setAttr17(corp.Address attr17) throws SQLException
{ _struct.setAttribute(16, attr17); }


public corp.AddressRef getAttr18() throws SQLException
{ return (corp.AddressRef) _struct.getAttribute(17); }

public void setAttr18(corp.AddressRef attr18) throws SQLException
{ _struct.setAttribute(17, attr18); }


public corp.AddrArray getAttr19() throws SQLException
{ return (corp.AddrArray) _struct.getAttribute(18); }
```

```
  public void setAttr19(corp.AddrArray attr19) throws SQLException
  { _struct.setAttribute(18, attr19); }


  public corp.Ntbl getAttr20() throws SQLException
  { return (corp.Ntbl) _struct.getAttribute(19); }

  public void setAttr20(corp.Ntbl attr20) throws SQLException
  { _struct.setAttribute(19, attr20); }

}
```

When a declared class requires user-defined classes from another package, JPublisher generates `import` declarations for those user-defined classes following the `import` declaration for the `oracle.sql` package. In this case, JDBC requires the `Address` and `AddressRef` classes from package `corp`.

The attributes with types `Address`, `AddressRef`, `AddrArray`, and `Ntbl` require the construction of factories. The static block puts the correct factories in the `_factory` array.

> **Note:** Notice that the `SMALLINT` SQL type for `attr14` maps to the Java type `short`, but this maps to `Integer` in `-numbertypes=objectjdbc` mapping. This was a JPublisher implementation decision. See "Mappings For Numeric Types (-numbertypes)" on page 3-10 for related information.

Listing of AlltypesRef.java Generated by JPublisher

The file `./demo/corp/all/AlltypesRef.java` reads as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package all;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
```

```
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.REF;
import oracle.sql.STRUCT;

public class AlltypesRef implements ORAData, ORADataFactory
{
  public static final String _SQL_BASETYPE = "SCOTT.ALLTYPES";
  public static final int _SQL_TYPECODE = OracleTypes.REF;

  REF _ref;

private static final AlltypesRef _AlltypesRefFactory = new AlltypesRef();

  public static ORADataFactory getORADataFactory()
  { return _AlltypesRefFactory; }
  /* constructor */
  public AlltypesRef()
  {
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _ref;
  }

  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  {
    if (d == null) return null;
    AlltypesRef r = new AlltypesRef();
    r._ref = (REF) d;
    return r;
  }

  public static AlltypesRef cast(ORAData o) throws SQLException
  {
     if (o == null) return null;
     try { return (AlltypesRef) getORADataFactory().create(o.toDatum(null),
OracleTypes.REF); }
     catch (Exception exn)
     { throw new SQLException("Unable to convert "+o.getClass().getName()+" to
AlltypesRef: "+exn.toString()); }
  }
```

```
  public Alltypes getValue() throws SQLException
  {
     return (Alltypes) Alltypes.getORADataFactory().create(
       _ref.getSTRUCT(), OracleTypes.REF);
  }

  public void setValue(Alltypes c) throws SQLException
  {
    _ref.setValue((STRUCT) c.toDatum(_ref.getJavaSqlConnection()));
  }
}
```

Listing of Ntbl.java Generated by JPublisher

The file `./demo/corp/Ntbl.java` reads as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.ARRAY;
import oracle.sql.ArrayDescriptor;
import oracle.jpub.runtime.MutableArray;

public class Ntbl implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.NTBL";
  public static final int _SQL_TYPECODE = OracleTypes.ARRAY;

  MutableArray _array;

private static final Ntbl _NtblFactory = new Ntbl();

  public static ORADataFactory getORADataFactory()
```

```
{ return _NtblFactory; }
/* constructors */
public Ntbl()
{
  this((Integer[])null);
}

public Ntbl(Integer[] a)
{
  _array = new MutableArray(4, a, null);
}

/* ORAData interface */
public Datum toDatum(Connection c) throws SQLException
{
  return _array.toDatum(c, _SQL_NAME);
}

/* ORADataFactory interface */
public ORAData create(Datum d, int sqlType) throws SQLException
{
  if (d == null) return null;
  Ntbl a = new Ntbl();
  a._array = new MutableArray(4, (ARRAY) d, null);
  return a;
}

public int length() throws SQLException
{
  return _array.length();
}

public int getBaseType() throws SQLException
{
  return _array.getBaseType();
}

public String getBaseTypeName() throws SQLException
{
  return _array.getBaseTypeName();
}

public ArrayDescriptor getDescriptor() throws SQLException
{
  return _array.getDescriptor();
```

```
  }

  /* array accessor methods */
  public Integer[] getArray() throws SQLException
  {
    return (Integer[]) _array.getObjectArray();
  }

  public void setArray(Integer[] a) throws SQLException
  {
    _array.setObjectArray(a);
  }

  public Integer[] getArray(long index, int count) throws SQLException
  {
    return (Integer[]) _array.getObjectArray(index, count);
  }

  public void setArray(Integer[] a, long index) throws SQLException
  {
    _array.setObjectArray(a, index);
  }

  public Integer getElement(long index) throws SQLException
  {
    return (Integer) _array.getObjectElement(index);
  }

  public void setElement(Integer a, long index) throws SQLException
  {
    _array.setObjectElement(a, index);
  }

}
```

Listing of AddrArray.java Generated by JPublisher

JPublisher generates declarations of the type `AddrArray` because they are required by the `Alltypes` type. The file `./demo/corp/AddrArray.java` reads as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.ARRAY;
import oracle.sql.ArrayDescriptor;
import oracle.jpub.runtime.MutableArray;

public class AddrArray implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.ADDR_ARRAY";
  public static final int _SQL_TYPECODE = OracleTypes.ARRAY;

  MutableArray _array;

private static final AddrArray _AddrArrayFactory = new AddrArray();

  public static ORADataFactory getORADataFactory()
  { return _AddrArrayFactory; }
  /* constructors */
  public AddrArray()
  {
    this((Address[])null);
  }

  public AddrArray(Address[] a)
  {
    _array = new MutableArray(2002, a, Address.getORADataFactory());
  }
```

```
/* ORAData interface */
public Datum toDatum(Connection c) throws SQLException
{
  return _array.toDatum(c, _SQL_NAME);
}

/* ORADataFactory interface */
public ORAData create(Datum d, int sqlType) throws SQLException
{
  if (d == null) return null;
  AddrArray a = new AddrArray();
  a._array = new MutableArray(2002, (ARRAY) d, Address.getORADataFactory());
  return a;
}

public int length() throws SQLException
{
  return _array.length();
}

public int getBaseType() throws SQLException
{
  return _array.getBaseType();
}

public String getBaseTypeName() throws SQLException
{
  return _array.getBaseTypeName();
}

public ArrayDescriptor getDescriptor() throws SQLException
{
  return _array.getDescriptor();
}

/* array accessor methods */
public Address[] getArray() throws SQLException
{
  return (Address[]) _array.getObjectArray(
    new Address[_array.length()]);
}

public void setArray(Address[] a) throws SQLException
{
  _array.setObjectArray(a);
```

```
  }

  public Address[] getArray(long index, int count) throws SQLException
  {
    return (Address[]) _array.getObjectArray(index,
      new Address[_array.sliceLength(index, count)]);
  }

  public void setArray(Address[] a, long index) throws SQLException
  {
    _array.setObjectArray(a, index);
  }

  public Address getElement(long index) throws SQLException
  {
    return (Address) _array.getObjectElement(index);
  }

  public void setElement(Address a, long index) throws SQLException
  {
    _array.setObjectElement(a, index);
  }

}
```

Example: Generating a SQLData Class

This example is identical to the previous one, except that JPublisher generates a `SQLData` class rather than an `ORAData` class. The command line for this example is:

```
jpub -user=scott/tiger -input=demoin -dir=demo -package=corp -mapping=objectjdbc
-usertypes=jdbc -methods=false
```

(This is a single wraparound command line.)

> **Note:** The `-mapping` option, while deprecated, is still supported so is therefore demonstrated. The `-mapping=objectjdbc` setting is equivalent to the combination of `-builtintypes=jdbc`, `-numbertypes=objectjdbc`, `-lobtypes=oracle`, and `-usertypes=oracle`; however, this command line overrides the `-usertypes=oracle` setting with a `-usertypes=jdbc` setting. See "Mappings for All Types (-mapping)" on page 3-12 for more information about the `-mapping` option.

The option `-usertypes=jdbc` instructs JPublisher to generate classes that implement the `SQLData` interface. The `SQLData` interface supports reference and collection classes generically, using the generic types `java.sql.Ref` and `java.sql.Array` rather than using custom classes. Therefore, JPublisher generates only two classes:

```
./demo/corp/Address.java
./demo/all/Alltypes.java
```

Listing of Address.java Generated by JPublisher

Because we specified `-usertypes=jdbc` in this example, the `Address` class implements the `java.sql.SQLData` interface rather than the `oracle.sql.ORAData` interface. The file `./demo/corp/Address.java` reads as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class Address implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.ADDRESS";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 12,12,12,2 };
  private static ORADataFactory[] _factory = new ORADataFactory[4];
protected static final Address _AddressFactory = new Address(false);

  public static ORADataFactory getORADataFactory()
  { return _AddressFactory; }
  /* constructor */
  protected Address(boolean init)
  { if(init) _struct = new MutableStruct(new Object[4], _sqlType, _factory); }
  public Address()
  { this(true); }
  public Address(String street, String city, String state, java.math.BigDecimal
zip) throws SQLException
  { this(true);
    setStreet(street);
    setCity(city);
    setState(state);
    setZip(zip);
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _struct.toDatum(c, _SQL_NAME);
  }
```

```
  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  { return create(null, d, sqlType); }
  protected ORAData create(Address o, Datum d, int sqlType) throws SQLException
  {
    if (d == null) return null;
    if (o == null) o = new Address(false);
    o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
    return o;
  }
  /* accessor methods */
  public String getStreet() throws SQLException
  { return (String) _struct.getAttribute(0); }

  public void setStreet(String street) throws SQLExcept
```

Listing of Alltypes.java Generated by JPublisher

Because `-usertypes=jdbc` was specified in this example, the `Alltypes` class implements the `java.sql.SQLData` interface rather than the `oracle.sql.ORAData` interface. Although the `SQLData` interface is a vendor-neutral standard, there is Oracle-specific code in the `Alltypes` class because it uses Oracle-specific types such as `oracle.sql.BFILE` and `oracle.sql.CLOB`. The file `./demo/corp/Alltypes.java` reads as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package all;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class Alltypes implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.ALLTYPES";
```

```
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  protected MutableStruct _struct;

  private static int[] _sqlType =  {
-13,2004,1,2005,91,3,8,6,4,2,3,-2,7,5,12,12,2002,2006,2003,2003 };
  private static ORADataFactory[] _factory = new ORADataFactory[20];
  static
  {
    _factory[16] = corp.Address.getORADataFactory();
    _factory[17] = corp.AddressRef.getORADataFactory();
    _factory[18] = corp.AddrArray.getORADataFactory();
    _factory[19] = corp.Ntbl.getORADataFactory();
  }
protected static final Alltypes _AlltypesFactory = new Alltypes(false);

  public static ORADataFactory getORADataFactory()
  { return _AlltypesFactory; }
  /* constructor */
  protected Alltypes(boolean init)
  { if(init) _struct = new MutableStruct(new Object[20], _sqlType, _factory); }
  public Alltypes()
  { this(true); }
  public Alltypes(oracle.sql.BFILE attr1, oracle.sql.BLOB attr2, String attr3,
oracle.sql.CLOB attr4,
                        java.sql.Timestamp attr5, java.math.BigDecimal attr6,
Double attr7, Double attr8,
                         Integer attr9, java.math.BigDecimal attr10,
java.math.BigDecimal attr11, byte[] attr12,
                         Float attr13, Integer attr14, String attr15, String
attr16, corp.Address attr17,
                         corp.AddressRef attr18, corp.AddrArray attr19,
corp.Ntbl attr20) throws SQLException
  { this(true);
    setAttr1(attr1);
    setAttr2(attr2);
    setAttr3(attr3);
    setAttr4(attr4);
    setAttr5(attr5);
    setAttr6(attr6);
    setAttr7(attr7);
    setAttr8(attr8);
    setAttr9(attr9);
    setAttr10(attr10);
    setAttr11(attr11);
```

```
  setAttr12(attr12);
  setAttr13(attr13);
  setAttr14(attr14);
  setAttr15(attr15);
  setAttr16(attr16);
  setAttr17(attr17);
  setAttr18(attr18);
  setAttr19(attr19);
  setAttr20(attr20);
}

/* ORAData interface */
public Datum toDatum(Connection c) throws SQLException
{
  return _struct.toDatum(c, _SQL_NAME);
}


/* ORADataFactory interface */
public ORAData create(Datum d, int sqlType) throws SQLException
{ return create(null, d, sqlType); }
protected ORAData create(Alltypes o, Datum d, int sqlType) throws SQLException
{
  if (d == null) return null;
  if (o == null) o = new Alltypes(false);
  o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
  return o;
}
/* accessor methods */
public oracle.sql.BFILE getAttr1() throws SQLException
{ return (oracle.sql.BFILE) _struct.getOracleAttribute(0); }

public void setAttr1(oracle.sql.BFILE attr1) throws SQLException
{ _struct.setOracleAttribute(0, attr1); }


public oracle.sql.BLOB getAttr2() throws SQLException
{ return (oracle.sql.BLOB) _struct.getOracleAttribute(1); }

public void setAttr2(oracle.sql.BLOB attr2) throws SQLException
{ _struct.setOracleAttribute(1, attr2); }


public String getAttr3() throws SQLException
{ return (String) _struct.getAttribute(2); }
```

```
public void setAttr3(String attr3) throws SQLException
{ _struct.setAttribute(2, attr3); }


public oracle.sql.CLOB getAttr4() throws SQLException
{ return (oracle.sql.CLOB) _struct.getOracleAttribute(3); }

public void setAttr4(oracle.sql.CLOB attr4) throws SQLException
{ _struct.setOracleAttribute(3, attr4); }


public java.sql.Timestamp getAttr5() throws SQLException
{ return (java.sql.Timestamp) _struct.getAttribute(4); }

public void setAttr5(java.sql.Timestamp attr5) throws SQLException
{ _struct.setAttribute(4, attr5); }


public java.math.BigDecimal getAttr6() throws SQLException
{ return (java.math.BigDecimal) _struct.getAttribute(5); }

public void setAttr6(java.math.BigDecimal attr6) throws SQLException
{ _struct.setAttribute(5, attr6); }


public Double getAttr7() throws SQLException
{ return (Double) _struct.getAttribute(6); }

public void setAttr7(Double attr7) throws SQLException
{ _struct.setAttribute(6, attr7); }


public Double getAttr8() throws SQLException
{ return (Double) _struct.getAttribute(7); }

public void setAttr8(Double attr8) throws SQLException
{ _struct.setAttribute(7, attr8); }


public Integer getAttr9() throws SQLException
{ return (Integer) _struct.getAttribute(8); }

public void setAttr9(Integer attr9) throws SQLException
{ _struct.setAttribute(8, attr9); }
```

```
public java.math.BigDecimal getAttr10() throws SQLException
{ return (java.math.BigDecimal) _struct.getAttribute(9); }

public void setAttr10(java.math.BigDecimal attr10) throws SQLException
{ _struct.setAttribute(9, attr10); }


public java.math.BigDecimal getAttr11() throws SQLException
{ return (java.math.BigDecimal) _struct.getAttribute(10); }

public void setAttr11(java.math.BigDecimal attr11) throws SQLException
{ _struct.setAttribute(10, attr11); }


public byte[] getAttr12() throws SQLException
{ return (byte[]) _struct.getAttribute(11); }

public void setAttr12(byte[] attr12) throws SQLException
{ _struct.setAttribute(11, attr12); }


public Float getAttr13() throws SQLException
{ return (Float) _struct.getAttribute(12); }

public void setAttr13(Float attr13) throws SQLException
{ _struct.setAttribute(12, attr13); }


public Integer getAttr14() throws SQLException
{ return (Integer) _struct.getAttribute(13); }

public void setAttr14(Integer attr14) throws SQLException
{ _struct.setAttribute(13, attr14); }


public String getAttr15() throws SQLException
{ return (String) _struct.getAttribute(14); }

public void setAttr15(String attr15) throws SQLException
{ _struct.setAttribute(14, attr15); }


public String getAttr16() throws SQLException
```

```
  { return (String) _struct.getAttribute(15); }

  public void setAttr16(String attr16) throws SQLException
  { _struct.setAttribute(15, attr16); }


  public corp.Address getAttr17() throws SQLException
  { return (corp.Address) _struct.getAttribute(16); }

  public void setAttr17(corp.Address attr17) throws SQLException
  { _struct.setAttribute(16, attr17); }


  public corp.AddressRef getAttr18() throws SQLException
  { return (corp.AddressRef) _struct.getAttribute(17); }

  public void setAttr18(corp.AddressRef attr18) throws SQLException
  { _struct.setAttribute(17, attr18); }


  public corp.AddrArray getAttr19() throws SQLException
  { return (corp.AddrArray) _struct.getAttribute(18); }

  public void setAttr19(corp.AddrArray attr19) throws SQLException
  { _struct.setAttribute(18, attr19); }


  public corp.Ntbl getAttr20() throws SQLException
  { return (corp.Ntbl) _struct.getAttribute(19); }

  public void setAttr20(corp.Ntbl attr20) throws SQLException
  { _struct.setAttribute(19, attr20); }

}
```

Example: Extending JPublisher Classes

Here is an example of the scenario described in "Extending JPublisher-Generated Classes" on page 2-34.

The following code is the initial version for the class `MyAddress.java`. This code is automatically created by JPublisher and stored in the directory `demo/corp`. You can subsequently modify this code, since JPublisher will regenerate the superclass `JAddress`, not `MyAddress` (if it already exists), whenever it is invoked again with the same command line.

> **Note:** There way the `ORADataFactory` `create()` method is coded here ensures that an object instance is not needlessly created if the data object is null, or needlessly re-initialized if the data object is non-null. This is discussed in "Format of the Class that Extends the Generated Class" on page 2-35.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class MyAddress extends JAddress implements ORAData, ORADataFactory
{
   private static final MyAddress _MyAddressFactory = new MyAddress();
   public static ORADataFactory getORADataFactory()
   { return _MyAddressFactory; }

   public MyAddress() { super(); }
  public MyAddress(String street, String city, String state,
                   java.math.BigDecimal zip) throws SQLException
  {
    setStreet(street);
    setCity(city);
    setState(state);
    setZip(zip);
  }
```

```
   /* ORAData interface */
   public ORAData create(Datum d, int sqlType) throws SQLException
   { return create(new MyAddress(), d, sqlType); }

  /* superclass accessors */

/*
  public String getStreet() throws SQLException { return super.getStreet(); }
  public void setStreet(String street) throws SQLException {
super.setStreet(street); }
 */

/*
  public String getCity() throws SQLException { return super.getCity(); }
  public void setCity(String city) throws SQLException { super.setCity(city); }
 */

/*
  public String getState() throws SQLException { return super.getState(); }
  public void setState(String state) throws SQLException {
super.setState(state); }
 */

/*
  public java.math.BigDecimal getZip() throws SQLException { return
super.getZip(); }
  public void setZip(java.math.BigDecimal zip) throws SQLException {
super.setZip(zip); }
 */

}
```

Enter the following command line to have JPublisher generate code for the superclass `JAddress`, and also to generate an initial stub for the class `MyAddress` that is to extend `JAddress`. (The stub is only created if `MyAddress.java` does not already exist.)

```
jpub -user=scott/tiger -input=demoin -dir=demo -package=corp
```

Assume the `demoin` file includes the following:

```
SQL ADDRESS GENERATE JAddress AS MyAddress
```

JPublisher will generate these files:

```
demo/corp/JAddress.java
demo/corp/MyAddressRef.java
```

Because an ADDRESS object will be represented in the Java program as a `MyAddress` instance, JPublisher generates the class `MyAddressRef` rather than `JAddressRef`.

Here is a listing of the `demo/corp/JAddress.java` class file, which will always be generated by JPublisher:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;

public class JAddress implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.ADDRESS";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 12,12,12,2 };
  private static ORADataFactory[] _factory = new ORADataFactory[4];
protected static final JAddress _JAddressFactory = new JAddress(false);

  public static ORADataFactory getORADataFactory()
  { return _JAddressFactory; }
  /* constructor */
  protected JAddress(boolean init)
  { if(init) _struct = new MutableStruct(new Object[4], _sqlType, _factory); }
  public JAddress()
  { this(true); }
```

```
public JAddress(String street, String city, String state,
                java.math.BigDecimal zip) throws SQLException
{ this(true);
  setStreet(street);
  setCity(city);
  setState(state);
  setZip(zip);
}

/* ORAData interface */
public Datum toDatum(Connection c) throws SQLException
{
  return _struct.toDatum(c, _SQL_NAME);
}


/* ORADataFactory interface */
public ORAData create(Datum d, int sqlType) throws SQLException
{ return create(null, d, sqlType); }
protected ORAData create(JAddress o, Datum d, int sqlType) throws SQLException
{
  if (d == null) return null;
  if (o == null) o = new JAddress(false);
  o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
  return o;
}
/* accessor methods */
public String getStreet() throws SQLException
{ return (String) _struct.getAttribute(0); }

public void setStreet(String street) throws SQLException
{ _struct.setAttribute(0, street); }


public String getCity() throws SQLException
{ return (String) _struct.getAttribute(1); }

public void setCity(String city) throws SQLException
{ _struct.setAttribute(1, city); }


public String getState() throws SQLException
{ return (String) _struct.getAttribute(2); }
```

```
  public void setState(String state) throws SQLException
  { _struct.setAttribute(2, state); }


  public java.math.BigDecimal getZip() throws SQLException
  { return (java.math.BigDecimal) _struct.getAttribute(3); }

  public void setZip(java.math.BigDecimal zip) throws SQLException
  { _struct.setAttribute(3, zip); }

}
```

Here is a listing of the `demo/corp/MyAddressRef.java` class file generated by JPublisher:

```
package corp;

import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.REF;
import oracle.sql.STRUCT;

public class MyAddressRef implements ORAData, ORADataFactory
{
  public static final String _SQL_BASETYPE = "SCOTT.ADDRESS";
  public static final int _SQL_TYPECODE = OracleTypes.REF;

  REF _ref;

private static final MyAddressRef _MyAddressRefFactory = new MyAddressRef();

  public static ORADataFactory getORADataFactory()
  { return _MyAddressRefFactory; }
  /* constructor */
  public MyAddressRef()
  {
  }
```

```
  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _ref;
  }

  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  {
    if (d == null) return null;
    MyAddressRef r = new MyAddressRef();
    r._ref = (REF) d;
    return r;
  }

  public static MyAddressRef cast(ORAData o) throws SQLException
  {
     if (o == null) return null;
     try { return (MyAddressRef) getORADataFactory().create(o.toDatum(null),
OracleTypes.REF); }
     catch (Exception exn)
     { throw new SQLException("Unable to convert "+o.getClass().getName()+" to
MyAddressRef: "+exn.toString()); }
  }

  public MyAddress getValue() throws SQLException
  {
     return (MyAddress) MyAddress.getORADataFactory().create(
       _ref.getSTRUCT(), OracleTypes.REF);
  }

  public void setValue(MyAddress c) throws SQLException
  {
    _ref.setValue((STRUCT) c.toDatum(_ref.getJavaSqlConnection()));
  }
}
```

Example: Wrappers Generated for Methods in Objects

> **Note:** The wrapper methods that JPublisher generates to invoke stored procedures are generated in SQLJ code; therefore, JPublisher-generated classes that contain wrapper methods must be processed by the SQLJ translator.

This section describes an example of JPublisher output given the definition below of a SQL type containing methods. The example defines a type `Rational` with `numerator` and `denominator` attributes and the following functions and procedures:

- `MEMBER FUNCTION toReal`: Given two integers, this function converts a rational number to a real number and returns a real number.
- `MEMBER PROCEDURE normalize`: Given two integers, representing a numerator and a denominator, this procedure reduces a fraction by dividing the numerator and denominator by their greatest common divisor.
- `STATIC FUNCTION gcd`: Given two integers, this function returns their greatest common divisor.
- `MEMBER FUNCTION plus`: This function adds two rational numbers and returns the result.

The code for `rational.sql` follows:

```
CREATE TYPE Rational AS OBJECT (
 numerator INTEGER,
 denominator INTEGER,
 MAP MEMBER FUNCTION toReal RETURN REAL,
 MEMBER PROCEDURE normalize,
 STATIC FUNCTION gcd(x INTEGER,
                     y INTEGER) RETURN INTEGER,
 MEMBER FUNCTION plus ( x Rational) RETURN Rational
);

CREATE TYPE BODY Rational AS

MAP MEMBER FUNCTION toReal RETURN REAL IS
-- convert rational number to real number
BEGIN
  RETURN numerator / denominator;
END toReal;
```

```
MEMBER PROCEDURE normalize IS
 g INTEGER;
BEGIN
 g := Rational.gcd(numerator, denominator);
 numerator := numerator / g;
 denominator := denominator / g;
END normalize;

STATIC FUNCTION gcd(x INTEGER,
                    y INTEGER) RETURN INTEGER IS
-- find greatest common divisor of x and y
ans INTEGER;
z INTEGER;
BEGIN
IF x < y THEN
   ans := Rational.gcd(y, x);
ELSIF (x MOD y = 0) THEN
   ans := y;
ELSE
   z := x MOD y;
   ans := Rational.gcd(y, z);
END IF;
RETURN ans;
END gcd;

MEMBER FUNCTION plus (x Rational) RETURN Rational IS
BEGIN
 return Rational(numerator * x.denominator + x.numerator * denominator,
                 denominator * x.denominator);
END plus;
END;
```

In this example, JPublisher is invoked with the following command line:

```
jpub -user=scott/tiger -sql=Rational -methods=true
```

The `-user` parameter directs JPublisher to login to the database as user `scott` with password `tiger`. The `-methods` parameter directs JPublisher to generate wrappers for the methods contained in the type `Rational`. You can omit this parameter, because `-methods=true` is the default.

Listing and Description of Rational.sqlj Generated by JPublisher

JPublisher generates the file `Rational.sqlj`. This file reads as follows:

Notes:

- The details of method bodies that JPublisher generates might change in future releases.
- Notice the `release()` calls, which are to avoid memory leaks related to SQLJ connection contexts. See "Releasing Connection Context Resources" on page 2-30 for more information.

```
import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;
import sqlj.runtime.ref.DefaultContext;
import sqlj.runtime.ConnectionContext;
import java.sql.Connection;

public class Rational implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.RATIONAL";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  /* connection management */
  protected DefaultContext __tx = null;
  protected Connection __onn = null;
  public void setConnectionContext(DefaultContext ctx) throws SQLException
  { release(); __tx = ctx; }
  public DefaultContext getConnectionContext() throws SQLException
  { if (__tx==null)
    { __tx = (__onn==null) ? DefaultContext.getDefaultContext() : new
DefaultContext(__onn); }
    return __tx;
  };
  public Connection getConnection() throws SQLException
  { return (__onn==null) ? ((__tx==null) ? null : __tx.getConnection()) : __onn;
}
```

```
  public void release() throws SQLException
  { if (__tx!=null && __onn!=null)
__tx.close(ConnectionContext.KEEP_CONNECTION);
    __onn = null; __tx = null;
  }

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 4,4 };
  private static ORADataFactory[] _factory = new ORADataFactory[2];
protected static final Rational _RationalFactory = new Rational(false);

  public static ORADataFactory getORADataFactory()
  { return _RationalFactory; }
  /* constructors */
  protected Rational(boolean init)
  { if (init) _struct = new MutableStruct(new Object[2], _sqlType, _factory); }
  public Rational()
  { this(true); __tx = DefaultContext.getDefaultContext(); }
  public Rational(DefaultContext c) /*throws SQLException*/
  { this(true); __tx = c; }
  public Rational(Connection c) /*throws SQLException*/
  { this(true); __onn = c; }
  public Rational(Integer numerator, Integer denominator) throws SQLException
   {
    this(true);
    setNumerator(numerator);
    setDenominator(denominator);
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    if (__tx!=null && __onn!=c) release();
    __onn = c;
    return _struct.toDatum(c, _SQL_NAME);
  }


  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  { return create(null, d, sqlType); }
  public void setFrom(Rational o) throws SQLException
  { setContextFrom(o); setValueFrom(o); }
  protected void setContextFrom(Rational o) throws SQLException
```

```
{ release(); __tx = o.__tx; __onn = o.__onn; }
protected void setValueFrom(Rational o) { _struct = o._struct; }
protected ORAData create(Rational o, Datum d, int sqlType) throws SQLException
{
  if (d == null) { if (o!=null) { o.release(); }; return null; }
  if (o == null) o = new Rational(false);
  o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
  o.__onn = ((STRUCT) d).getJavaSqlConnection();
  return o;
}
/* accessor methods */
public Integer getNumerator() throws SQLException
{ return (Integer) _struct.getAttribute(0); }

public void setNumerator(Integer numerator) throws SQLException
{ _struct.setAttribute(0, numerator); }


public Integer getDenominator() throws SQLException
{ return (Integer) _struct.getAttribute(1); }

public void setDenominator(Integer denominator) throws SQLException
{ _struct.setAttribute(1, denominator); }


public Integer gcd (
  Integer x,
  Integer y)
throws SQLException
{
  Integer __jPt_result;
  #sql [getConnectionContext()] __jPt_result = { VALUES(SCOTT.RATIONAL.GCD(
    :x,
    :y)) };
  return __jPt_result;
}

public Rational normalize ()
throws SQLException
{
  Rational __jPt_temp = this;
  #sql [getConnectionContext()] {
    BEGIN
    :INOUT __jPt_temp.NORMALIZE();
    END;
```

```
    };
    return __jPt_temp;
  }

  public Rational plus (
    Rational x)
  throws SQLException
  {
    Rational __jPt_temp = this;
    Rational __jPt_result;
    #sql [getConnectionContext()] {
      BEGIN
      :OUT __jPt_result := :__jPt_temp.PLUS(
      :x);
      END;
    };
    return __jPt_result;
  }

  public Float toreal ()
  throws SQLException
  {
    Rational __jPt_temp = this;
    Float __jPt_result;
    #sql [getConnectionContext()] {
      BEGIN
      :OUT __jPt_result := :__jPt_temp.TOREAL();
      END;
    };
    return __jPt_result;
  }
}
```

All the methods that JPublisher generates invoke the corresponding PL/SQL methods executing in the server.

JPublisher declares the *sql_name* for the object to be `SCOTT.RATIONAL`, and its *sql_type_code* to be `OracleTypes.STRUCT`. By default, it uses the SQLJ connection context class `sqlj.runtime.ref.DefaultContext`. It creates accessor methods `getNumerator()`, `setNumerator()`, `getDenominator()`, and `setDenominator()` for the object attributes `numerator` and `denominator`.

JPublisher generates source code for the `gcd` static function, which takes two `Integer` values as input and returns an `Integer` result. This `gcd` function invokes the `RATIONAL.GCD` stored function with `IN` host variables `:x` and `:y`.

JPublisher generates source code for the `normalize` member procedure, which defines a PL/SQL block containing an `IN OUT` parameter inside the SQLJ statement. The `this` parameter passes the values to the PL/SQL block.

JPublisher generates source code for the `plus` member function, which takes an object `x` of type `Rational` and returns an object of type `Rational`. It defines a PL/SQL block inside the SQLJ statement. The `IN` host variables are `:x` and a copy of `this`. The result of the function is an `OUT` host variable.

JPublisher generates source code for the `toReal` member function, which returns a `Float` value. It defines a host `OUT` variable that is assigned the value returned by the function. A copy of the `this` object is an `IN` parameter.

Example: Wrappers Generated for Methods in Packages

> **Note:** The wrapper methods that JPublisher generates to invoke stored procedures are generated in SQLJ code; therefore, JPublisher-generated classes that contain wrapper methods must be processed by the SQLJ translator.

This section describes an example of JPublisher output given the definition below of a PL/SQL package containing methods. The example defines the package `RationalP` with the following functions and procedures, which manipulate the numerators and denominators of fractions.

- `FUNCTION toReal`: Given two integers, this function converts a rational number to a real number and returns a real number.
- `PROCEDURE normalize`: Given two integers (representing a numerator and a denominator), this procedure reduces a fraction by dividing the numerator and denominator by their greatest common divisor.
- `FUNCTION gcd`: Given two integers, this function returns their greatest common divisor.
- `PROCEDURE plus`: Adds two rational numbers and returns the result.

The code for `RationalP.sql` follows:

```
CREATE PACKAGE RationalP AS

 FUNCTION toReal(numerator   INTEGER,
                 denominator INTEGER) RETURN REAL;

 PROCEDURE normalize(numerator   IN OUT INTEGER,
                     denominator IN OUT INTEGER);

 FUNCTION gcd(x INTEGER, y INTEGER) RETURN INTEGER;

 PROCEDURE plus (n1 INTEGER, d1 INTEGER,
                 n2 INTEGER, d2 INTEGER,
                 n3 OUT INTEGER, d3 OUT INTEGER);
END rationalP;

/
```

```
CREATE PACKAGE BODY rationalP AS

  FUNCTION toReal(numerator INTEGER,
                  denominator INTEGER) RETURN real IS
  -- convert rational number to real number
  BEGIN
    RETURN numerator / denominator;
  END toReal;

  FUNCTION gcd(x INTEGER, y INTEGER) RETURN INTEGER IS
  -- find greatest common divisor of x and y
  ans INTEGER;
  BEGIN
  IF x < y THEN
     ans := gcd(y, x);
  ELSIF (x MOD y = 0) THEN
     ans := y;
  ELSE
     ans := gcd(y, x MOD y);
  END IF;
  RETURN ans;
  END gcd;

  PROCEDURE normalize( numerator IN OUT INTEGER,
                       denominator IN OUT INTEGER) IS
   g INTEGER;
   BEGIN
   g := gcd(numerator, denominator);
   numerator := numerator / g;
   denominator := denominator / g;
   END normalize;

  PROCEDURE plus (n1 INTEGER, d1 INTEGER,
                  n2 INTEGER, d2 INTEGER,
                  n3 OUT INTEGER, d3 OUT INTEGER) IS
  BEGIN
  n3 := n1 * d2 + n2 * d1;
  d3 := d1 * d2;
  END plus;

END rationalP;
```

In this example, JPublisher is invoked with the following command line:

```
jpub -user=scott/tiger -sql=RationalP -methods=true
```

The `-user` parameter directs JPublisher to login to the database as user `scott` with password `tiger`. The `-methods` parameter directs JPublisher to generate wrappers for the methods in the package `RationalP`. You can omit this parameter, because `-methods=true` is the default.

Listing and Description of RationalP.sqlj Generated by JPublisher

JPublisher generates the file `RationalP.sqlj`, as follows:

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
import java.sql.SQLException;
import sqlj.runtime.ref.DefaultContext;
import sqlj.runtime.ConnectionContext;
import java.sql.Connection;

public class RationalP
{
  /* connection management */
  protected DefaultContext __tx = null;
  protected Connection __onn = null;
  public void setConnectionContext(DefaultContext ctx) throws SQLException
  { release(); __tx = ctx; }
  public DefaultContext getConnectionContext() throws SQLException
  { if (__tx==null)
    { __tx = (__onn==null) ? DefaultContext.getDefaultContext() : new
DefaultContext(__onn); }
    return __tx;
  };
  public Connection getConnection() throws SQLException
  { return (__onn==null) ? ((__tx==null) ? null : __tx.getConnection()) : __onn;
}
  public void release() throws SQLException
  { if (__tx!=null && __onn!=null)
__tx.close(ConnectionContext.KEEP_CONNECTION);
    __onn = null; __tx = null;
  }

  /* constructors */
  public RationalP() throws SQLException
```

```
  { __tx = DefaultContext.getDefaultContext();
 }
  public RationalP(DefaultContext c) throws SQLException
  { __tx = c; }
  public RationalP(Connection c) throws SQLException
  {__onn = c; __tx = new DefaultContext(c); }

  public Integer gcd (
    Integer x,
    Integer y)
  throws SQLException
  {
    Integer __jPt_result;
    #sql [getConnectionContext()] __jPt_result = { VALUES(SCOTT.RATIONALP.GCD(
      :x,
      :y)) };
    return __jPt_result;
  }
  public void plus (
    Integer n1,
    Integer d1,
    Integer n2,
    Integer d2,
    Integer n3[],
    Integer d3[])
  throws SQLException
  {
    #sql [getConnectionContext()] { CALL SCOTT.RATIONALP.PLUS(
      :n1,
      :d1,
      :n2,
      :d2,
      :OUT (n3[0]),
      :OUT (d3[0])) };
  }
  public Float toreal (
    Integer numerator,
    Integer denominator)
  throws SQLException
  {
    Float __jPt_result;
    #sql [getConnectionContext()] __jPt_result = {
VALUES(SCOTT.RATIONALP.TOREAL(
      :numerator,
      :denominator)) };
```

```
    return __jPt_result;
  }

  public void normalize (
    Integer numerator[],
    Integer denominator[])
  throws SQLException
  {
    #sql [getConnectionContext()] { CALL SCOTT.RATIONALP.NORMALIZE(
      :INOUT (numerator[0]),
      :INOUT (denominator[0])) };
  }
}
```

All the methods that JPublisher generates invoke the corresponding PL/SQL methods executing in the server.

By default, JPublisher uses the existing SQLJ connection context class `sqlj.runtime.ref.DefaultContext` and associates an instance of it with the `RationalP` package.

JPublisher generates source code for the `gcd` function, which takes two `BigDecimal` values—`x` and `y`—and returns a `BigDecimal` result. This `gcd` function invokes the stored function `RATIONALP.GCD` with `IN` host variables `:x` and `:y`.

JPublisher generates source code for the `normalize` procedure, which takes two `BigDecimal` values—`numerator` and `denominator`. This normalize procedure invokes the stored procedure call `RATIONALP.NORMALIZE` with `IN OUT` host variables `:numerator` and `:denominator`. Because these are `IN OUT` parameters, JPublisher passes their values as the first element of an array.

JPublisher generates source code for the `plus` procedure, which has four `BigDecimal IN` parameters and two `BigDecimal OUT` parameters. This `plus` procedure invokes the stored procedure call `RATIONALP.PLUS`, with `IN` host variables `:n1`, `:d1`, `:n2`, and `:d2`. It also defines the `OUT` host variables `:n3` and `:d3`. Because these are `OUT` variables, JPublisher passes each of their values as the first element of an array.

JPublisher generates source code for the `toReal` function, which takes two `BigDecimal` values—`numerator` and `denominator`—and returns a `BigDecimal` result. This `toReal` function invokes the stored function call `RATIONALP.TOREAL`, with `IN` host variables `:numerator` and `:denominator`.

Example: Using Classes Generated for Object Types

This section illustrates an example of how you can use the classes that JPublisher generates for object types. Suppose you have defined a SQL object type that contains attributes and methods. You use JPublisher to generate a `<name>.sqlj` file and a `<name>Ref.java` file for the object type. To enhance the functionality of the Java class generated by JPublisher for the object type, you can extend the class. After translating (if applicable) and compiling the classes, you can use them in a program. For more information on this topic, see "Use of Classes JPublisher Generates for Object Types" on page 2-26.

The following steps demonstrate the scenario described above. In this case, define a `RationalO` SQL object type that contains `numerator` and `denominator` attributes and several methods to manipulate rational numbers. After using JPublisher to generate `JPubRationalO.sqlj`, `RationalORef.java`, and an initial version of `RationalO.sqlj`, edit `RationalO.sqlj` to extend and enhance the functionality of the `JPubRationalO` class. After translating and compiling the necessary files, use the classes in a test file to test the performance of the `RationalO.java` class.

Here are the steps, followed by listings of the files:

1. Create the SQL object type `RationalO`. "Listing of RationalO.sql (Definition of Object Type)" on page 4-56 contains the code for the `RationalO.sql` file.
2. Use JPublisher to generate Java classes for the object—a `JPubRationalO.sqlj` file, a `RationalORef.java` file, and an initial `RationalO.sqlj` file for the subclass. Use this command line:

   ```
   jpub -props=RationalO.props
   ```

   Assume the properties file `RationalO.props` contains the following:

   ```
   jpub.user=scott/tiger
   jpub.sql=RationalO:JPubRationalO:RationalO
   jpub.methods=true
   ```

   According to the properties file, JPublisher will log into the database with user name `scott` and password `tiger`. The `sql` parameter directs JPublisher to translate the object type `RationalO` (declared by `RationalO.sql`) and generate `JPubRationalO` as `RationalO`, where the second `RationalO` indicates a subclass (`RationalO.sqlj`) that extends the functionality of the original `RationalO`. The value of the `methods` parameter indicates that JPublisher will generate classes for PL/SQL packages and wrapper methods.

JPublisher produces the following files:

```
JPubRational0.sqlj
Rational0Ref.java
Rational0.sqlj
```

See sections that follow for listings of these files.

3. Edit `Rational0.sqlj` to extend and enhance the functionality of `JPubRational0.sqlj`. In particular, add code for a `toString()` method, which is used in the last two `System.out.println()` calls in the test program `TestRational0.java`.

4. Use SQLJ to translate and compile the necessary files. Enter the following:

   ```
   sqlj JPubRational0.sqlj Rational0.sqlj
   ```

   This translates and compiles the `JPubRational0.sqlj` and `Rational0.sqlj` files.

5. Write a program `TestRational0.java` that uses the `Rational0` class. "Listing of TestRational0.java Written by User" on page 4-64 contains the code.

6. Create the file `connect.properties`, which `TestRational0` uses to determine how to connect to the database. The file reads as follows:

   ```
   sqlj.user=scott
   sqlj.password=tiger
   sqlj.url=jdbc:oracle:oci:@
   sqlj.driver=oracle.jdbc.driver.OracleDriver
   ```

7. Compile and run `TestRational0`:

   ```
   javac TestRational0.java
   java TestRational0
   ```

   The program produces the following output:

   ```
   gcd: 5
   real value: 0.5
   sum: 100/100
   sum: 1/1
   ```

Listing of RationalO.sql (Definition of Object Type)

This section contains the code that defines the `RationalO` SQL object type.

```
CREATE TYPE RationalO AS OBJECT (
   numerator INTEGER,
   denominator INTEGER,
   MAP MEMBER FUNCTION toReal RETURN REAL,
   MEMBER PROCEDURE normalize,
   STATIC FUNCTION gcd(x INTEGER,
                       y INTEGER) RETURN INTEGER,
   MEMBER FUNCTION plus ( x RationalO) RETURN RationalO
);

CREATE TYPE BODY RationalO AS

  MAP MEMBER FUNCTION toReal RETURN REAL IS
  -- convert rational number to real number
  BEGIN
    RETURN numerator / denominator;
  END toReal;

  MEMBER PROCEDURE normalize IS
   g BINARY_INTEGER;
  BEGIN
   g := RationalO.gcd(numerator, denominator);
   numerator := numerator / g;
   denominator := denominator / g;
  END normalize;

  STATIC FUNCTION gcd(x INTEGER,
                      y INTEGER) RETURN INTEGER IS
  -- find greatest common divisor of x and y
  ans BINARY_INTEGER;
  BEGIN
  IF x < y THEN
     ans := RationalO.gcd(y, x);
  ELSIF (x MOD y = 0) THEN
     ans := y;
  ELSE
     ans := RationalO.gcd(y, x MOD y);
  END IF;
  RETURN ans;
  END gcd;

  MEMBER FUNCTION plus (x RationalO) RETURN RationalO IS
```

```
  BEGIN
   return RationalO(numerator * x.denominator + x.numerator * denominator,
                    denominator * x.denominator);
  END plus;
END;
```

Listing of JPubRationalO.sqlj Generated by JPublisher

This section lists the code in `JPubRationalO.java` that JPublisher generates.

```
import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;
import sqlj.runtime.ref.DefaultContext;
import sqlj.runtime.ConnectionContext;
import java.sql.Connection;

public class JPubRationalO implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.RATIONALO";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  /* connection management */
  protected DefaultContext __tx = null;
  protected Connection __onn = null;
  public void setConnectionContext(DefaultContext ctx) throws SQLException
  { release(); __tx = ctx; }
  public DefaultContext getConnectionContext() throws SQLException
  { if (__tx==null)
    { __tx = (__onn==null) ? DefaultContext.getDefaultContext() : new
DefaultContext(__onn); }
    return __tx;
  };
  public Connection getConnection() throws SQLException
  { return (__onn==null) ? ((__tx==null) ? null : __tx.getConnection()) : __onn;
}
  public void release() throws SQLException
  { if (__tx!=null && __onn!=null)
__tx.close(ConnectionContext.KEEP_CONNECTION);
```

```
    __onn = null; __tx = null;
  }

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 4,4 };
  private static ORADataFactory[] _factory = new ORADataFactory[2];
  protected static final JPubRationalO _JPubRationalOFactory = new
JPubRationalO(false);

  public static ORADataFactory getORADataFactory()
  { return _JPubRationalOFactory; }
  /* constructors */
  protected JPubRationalO(boolean init)
  { if (init) _struct = new MutableStruct(new Object[2], _sqlType, _factory); }
  public JPubRationalO()
  { this(true); __tx = DefaultContext.getDefaultContext(); }
  public JPubRationalO(DefaultContext c) /*throws SQLException*/
  { this(true); __tx = c; }
  public JPubRationalO(Connection c) /*throws SQLException*/
  { this(true); __onn = c; }
  public JPubRationalO(Integer numerator, Integer denominator) throws
SQLException
   {
    this(true);
    setNumerator(numerator);
    setDenominator(denominator);
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    if (__tx!=null && __onn!=c) release();
    __onn = c;
    return _struct.toDatum(c, _SQL_NAME);
  }

  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  { return create(null, d, sqlType); }
  public void setFrom(JPubRationalO o) throws SQLException
  { setContextFrom(o); setValueFrom(o); }
  protected void setContextFrom(JPubRationalO o) throws SQLException
  { release(); __tx = o.__tx; __onn = o.__onn; }
  protected void setValueFrom(JPubRationalO o) { _struct = o._struct; }
```

```
  protected ORAData create(JPubRationalO o, Datum d, int sqlType) throws
SQLException
  {
    if (d == null) { if (o!=null) { o.release(); }; return null; }
    if (o == null) o = new JPubRationalO(false);
    o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
    o.__onn = ((STRUCT) d).getJavaSqlConnection();
    return o;
  }
  /* accessor methods */
  public Integer getNumerator() throws SQLException
  { return (Integer) _struct.getAttribute(0); }

  public void setNumerator(Integer numerator) throws SQLException
  { _struct.setAttribute(0, numerator); }

  public Integer getDenominator() throws SQLException
  { return (Integer) _struct.getAttribute(1); }

  public void setDenominator(Integer denominator) throws SQLException
  { _struct.setAttribute(1, denominator); }

  public Integer gcd (
    Integer x,
    Integer y)
  throws SQLException
  {
    Integer __jPt_result;
    #sql [getConnectionContext()] __jPt_result = { VALUES(SCOTT.RATIONALO.GCD(
      :x,
      :y)) };
    return __jPt_result;
  }

  public RationalO normalize ()
  throws SQLException
  {
    RationalO __jPt_temp = (RationalO) this;
    #sql [getConnectionContext()] {
      BEGIN
      :INOUT __jPt_temp.NORMALIZE();
      END;
    };
    return __jPt_temp;
  }
```

```
  public RationalO plus (
    RationalO x)
  throws SQLException
  {
    JPubRationalO __jPt_temp = this;
    RationalO __jPt_result;
    #sql [getConnectionContext()] {
      BEGIN
      :OUT __jPt_result := :__jPt_temp.PLUS(
      :x);
      END;
    };
    return __jPt_result;
  }

  public Float toreal ()
  throws SQLException
  {
    JPubRationalO __jPt_temp = this;
    Float __jPt_result;
    #sql [getConnectionContext()] {
      BEGIN
      :OUT __jPt_result := :__jPt_temp.TOREAL();
      END;
    };
    return __jPt_result;
  }
}
```

Listing of RationalORef.java Generated by JPublisher

This section lists the code in `RationalORef.java` that JPublisher generates.

> **Note:** The details of method bodies that JPublisher generates might change in future releases.

```
import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
```

```
import oracle.sql.Datum;
import oracle.sql.REF;
import oracle.sql.STRUCT;

public class RationalORef implements ORAData, ORADataFactory
{
  public static final String _SQL_BASETYPE = "SCOTT.RATIONALO";
  public static final int _SQL_TYPECODE = OracleTypes.REF;

  REF _ref;

private static final RationalORef _RationalORefFactory = new RationalORef();

  public static ORADataFactory getORADataFactory()
  { return _RationalORefFactory; }
  /* constructor */
  public RationalORef()
  {
  }

  /* ORAData interface */
  public Datum toDatum(Connection c) throws SQLException
  {
    return _ref;
  }

  /* ORADataFactory interface */
  public ORAData create(Datum d, int sqlType) throws SQLException
  {
    if (d == null) return null;
    RationalORef r = new RationalORef();
    r._ref = (REF) d;
    return r;
  }

  public static RationalORef cast(ORAData o) throws SQLException
  {
     if (o == null) return null;
     try { return (RationalORef) getORADataFactory().create(o.toDatum(null),
OracleTypes.REF); }
     catch (Exception exn)
     { throw new SQLException("Unable to convert "+o.getClass().getName()+" to
RationalORef: "+exn.toString()); }
  }
```

```
  public RationalO getValue() throws SQLException
  {
     return (RationalO) RationalO.getORADataFactory().create(
       _ref.getSTRUCT(), OracleTypes.REF);
  }

  public void setValue(RationalO c) throws SQLException
  {
    _ref.setValue((STRUCT) c.toDatum(_ref.getJavaSqlConnection()));
  }
}
```

Listing of RationalO.sqlj Generated by JPublisher and Modified by User

This section lists the code for the `RationalO` class that extends the JPublisher-generated superclass `JpubRationalO`. This is for the default mode (`-gensubclass=true`), where JPublisher generates an initial `.sqlj` source file for the class, which the user then modifies as desired.

Typically, a user-written subclass needs to accomplish the following:

- It declares a factory object, `_JPubRationalO`.
- It implements a `getORADataFactory()` method.
- It implements a `create()` method.
- It implements the constructors by calling the constructors in the superclass.

This particular subclass also requires a `toString()` method, which is used in the last two `System.out.println()` calls in `TestRationalO.java` (described in "Listing of TestRationalO.java Written by User" on page 4-64). See "Manually Coded toString() Method" at the end of the generated code.

JPublisher-Generated Code

This section lists the `RationalO.sqlj` source code generated by JPublisher.

```
import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;
```

```
import sqlj.runtime.ref.DefaultContext;
import sqlj.runtime.ConnectionContext;
import java.sql.Connection;

public class RationalO extends JPubRationalO implements ORAData, ORADataFactory
{
   private static final RationalO _RationalOFactory = new RationalO(false);
   public static ORADataFactory getORADataFactory()
   { return _RationalOFactory; }

   public RationalO() { super(); }
   public RationalO(Connection conn) throws SQLException { super(conn); }
   public RationalO(DefaultContext ctx) throws SQLException { super(ctx); }
   protected RationalO(boolean init) { super(init); }

  public RationalO(Integer numerator, Integer denominator) throws SQLException
  {
    setNumerator(numerator);
    setDenominator(denominator);
  }
   /* ORAData interface */
   public ORAData create(Datum d, int sqlType) throws SQLException
   { return create(new RationalO(false), d, sqlType); }

  /* superclass accessors */

/*
  public Integer getNumerator() throws SQLException { return
super.getNumerator(); }
  public void setNumerator(Integer numerator) throws SQLException {
super.setNumerator(numerator); }
 */

/*
  public Integer getDenominator() throws SQLException { return
super.getDenominator(); }
  public void setDenominator(Integer denominator) throws SQLException {
super.setDenominator(denominator); }
 */

  /* superclass methods */
/*
  public Integer gcd(Integer x, Integer y) throws SQLException
  { return super.gcd(x, y); }
 */
```

```
/*
  public RationalO normalize() throws SQLException
  { return super.normalize(); }
 */
/*
  public RationalO plus(RationalO x) throws SQLException
  { return super.plus(x); }
 */
/*
  public Float toreal() throws SQLException
  { return super.toreal(); }
 */
}
```

Manually Coded toString() Method

This section shows the `toString()` method required by `TestRationalO`. In this example, you would have to add this method definition to the JPublisher-generated `RationalO.sqlj` source file.

Alternatively, you could use the JPublisher option setting `-tostring=true` to have JPublisher automatically generate a `toString()` method into the Java object type wrappers.

```
/* additional method not in base class */
public String toString()
{
  try
  {
     return getNumerator().toString() + "/" + getDenominator().toString();
  }
  catch (SQLException e)
  {
     return null;
  }
}
```

Listing of TestRationalO.java Written by User

This section lists the contents of a user-written file, `TestRationalO.java`, that tests the performance of the `RationalO` class, given initial values for `numerator` and `denominator`. Note that the `TestRationalO.java` file also demonstrates how to perform the following tasks.

- Connect to the database by calling the `Oracle.connect()` method.
- Declare a Java object representing a SQL object type and initialize it by setting its attributes.
- Use the object to call server methods.

```
import oracle.sqlj.runtime.Oracle;
import oracle.sql.Datum;
import java.sql.Connection;
import java.sql.DriverManager;
import java.sql.Driver;

public class TestRational0
{

  public static void main(String[] args)
  throws java.sql.SQLException
  {
    Oracle.connect(new TestRational0().getClass(),
                   "connect.properties");

    Rational0 r = new Rational0();

    Integer n = new Integer(5);
    Integer d = new Integer(10);

    r.setNumerator(n);
    r.setDenominator(d);

    Integer g = r.gcd(n, d);
    System.out.println("gcd: " + g);

    Float f = r.toreal();
    System.out.println("real value: " + f);

    Rational0 s = r.plus(r);
    System.out.println("sum: " + s);

    s = s.normalize();
    System.out.println("sum: " + s);
  }
}
```

Example: Using Classes Generated for Packages

This section provides an example of how you can use the classes and method wrappers that JPublisher generates for objects and packages, respectively. Suppose you have defined a SQL object type that contains attributes and a package with methods. Use JPublisher to generate `<name>.sqlj` files for the object and the package. After translating the classes, you can use them in a program. For more information on this topic, see "Use of SQLJ Classes JPublisher Generates for PL/SQL Packages" on page 2-25.

The following steps demonstrate the scenario described above. In this case, you define a `Rational` SQL object type that contains `numerator` and `denominator` integer attributes, and a package `RationalP` that contains methods to manipulate rational numbers. After using JPublisher to generate the `Rational.sqlj` and `RationalP.sqlj` files, translate them with SQLJ, then use them in a test file to test the performance of the `Rational` and `RationalP` classes.

Here are the steps, followed by listings of the files:

1. Create the SQL object type `Rational` and package `RationalP`. "Listing of RationalP.sql (Definition of the Object Type and Package)" on page 4-67 contains the SQL code for the `RationalP.sql` file.
2. Use JPublisher to generate a Java class file and a SQLJ class file (`Rational.java` and `RationalP.sqlj`) for the object and package, respectively. Use this command line:

   ```
   jpub -props=RationalP.props
   ```

   Assume the properties file `RationalP.props` contains the following:

   ```
   jpub.user=scott/tiger
   jpub.sql=RationalP,Rational
   jpub.mapping=oracle
   jpub.methods=true
   ```

   According to the properties file, JPublisher will log into the database with user name `scott` and password `tiger`. The `sql` parameter directs JPublisher to translate the object type `Rational` and package `RationalP` (declared in `RationalP.sql`). JPublisher will translate the type and package according to the `oracle` mapping. The value of the `methods` parameter indicates that JPublisher will generate classes for PL/SQL packages, including wrapper methods. Since the object type `Rational` does not have any member functions, JPublisher will translate it into a `.java` file, not a `.sqlj` file. By using the `-methods=always` setting for JPublisher, however, you could have requested

the generation of a `.sqlj` file regardless. See "Generation of Package Classes and Wrapper Methods (-methods)" on page 3-21 for more information.

JPublisher produces the following files:

```
Rational.java
RationalP.sqlj
```

3. Translate / compile the `RationalP.sqlj` and `Rational.java` files:

```
sqlj RationalP.sqlj Rational.java
```

4. Write a program, `TestRationalP.java`, that uses the `RationalP` class.

5. Write the file `connect.properties`, which `TestRationalP.java` uses to determine how to connect to the database. The file is as follows:

```
sqlj.user=scott
sqlj.password=tiger
sqlj.url=jdbc:oracle:oci:@
sqlj.driver=oracle.jdbc.driver.OracleDriver
```

6. Compile and run `TestRationalP`:

```
javac TestRationalP.java
java TestRationalP
```

The program produces the following output:

```
gcd: 5
real value: 0.5
sum: 100/100
sum: 1/1
```

Listing of RationalP.sql (Definition of the Object Type and Package)

This section lists the contents of the file `RationalP.sql`, which defines the `Rational` SQL object type and the `RationalP` package.

```
CREATE TYPE Rational AS OBJECT (
   numerator INTEGER,
   denominator INTEGER
);
/
CREATE PACKAGE RationalP AS

 FUNCTION toReal(r Rational) RETURN REAL;
```

```
 PROCEDURE normalize(r IN OUT Rational);

 FUNCTION gcd(x INTEGER, y INTEGER) RETURN INTEGER;

 FUNCTION plus (r1 Rational, r2 Rational) RETURN Rational;

END rationalP;
/
CREATE PACKAGE BODY rationalP AS

  FUNCTION toReal(r Rational) RETURN real IS
  -- convert rational number to real number
  BEGIN
    RETURN r.numerator / r.denominator;
  END toReal;

  FUNCTION gcd(x INTEGER, y INTEGER) RETURN INTEGER IS
  -- find greatest common divisor of x and y
  result INTEGER;
  BEGIN
  IF x < y THEN
     result := gcd(y, x);
  ELSIF (x MOD y = 0) THEN
     result := y;
  ELSE
     result := gcd(y, x MOD y);
  END IF;
  RETURN result;
  END gcd;

  PROCEDURE normalize( r IN OUT Rational) IS
   g INTEGER;
   BEGIN
   g := gcd(r.numerator, r.denominator);
   r.numerator := r.numerator / g;
   r.denominator := r.denominator / g;
   END normalize;

  FUNCTION plus (r1 Rational,
                 r2 Rational) RETURN Rational IS
  n INTEGER;
  d INTEGER;
  result Rational;
  BEGIN
  n := r1.numerator * r2.denominator + r2.numerator * r1.denominator;
```

```
  d := r1.denominator * r2.denominator;
  result := Rational(n, d);
  RETURN result;
  END plus;

END rationalP;
/
```

Listing of TestRationalP.java Written by User

The test program, `TestRationalP.java`, uses the package `RationalP` and the object type `Rational`, which does not have methods. The test program creates an instance of package `RationalP` and two `Rational` objects.

`TestRationalP` connects to the database through the Oracle SQLJ `Oracle.connect()` method. In this example, the `Oracle.connect()` call specifies the file `connect.properties`, which contains these connection properties:

```
sqlj.url=jdbc:oracle:oci:@
sqlj.user=scott
sqlj.password=tiger
```

Following is a listing of `TestRationalP.java`:

```
import oracle.sql.Datum;
import oracle.sql.NUMBER;
import java.math.BigDecimal;
import sqlj.runtime.ref.DefaultContext;
import oracle.sqlj.runtime.Oracle;
import java.sql.Connection;

public class TestRationalP
{

  public static void main(String[] args)
  throws java.sql.SQLException
  {

    Oracle.connect(new TestRationalP().getClass(),
                   "connect.properties");

    RationalP p = new RationalP();
```

```
    NUMBER n = new NUMBER(5);
    NUMBER d = new NUMBER(10);
    Rational r = new Rational();
    r.setNumerator(n);
    r.setDenominator(d);

    NUMBER f = p.toreal(r);
    System.out.println("real value: " + f.stringValue());

    NUMBER g = p.gcd(n, d);
    System.out.println("gcd: " + g.stringValue());

    Rational s = p.plus(r, r);
    System.out.println("sum: " + s.getNumerator().stringValue() +
                       "/" + s.getDenominator().stringValue());

    Rational[] sa = {s};
    p.normalize(sa);
    s = sa[0];
    System.out.println("sum: " + s.getNumerator().stringValue() +
                       "/" + s.getDenominator().stringValue());
  }
}
```

Example: Using Datatypes Unsupported by JDBC

JPublisher provides a number of mechanisms to facilitate the use of types that are PL/SQL-specific and cannot be accessed directly from Java. This example sets up a SQL object type that uses the PL/SQL BOOLEAN type in its object methods.

We contrast publishing this type directly using JPublisher, with writing conversions for this type manually. Since JPublisher can deal automatically with the BOOLEAN type, there is no question as to which approach brings you the quickest result. However, the manual approach provides a good illustration of the basic conversion idea that is also employed by JPublisher. Also, remember that for types that do not have predefined conversions, you will still have to create corresponding SQL types as well as conversion functions. Fortunately, once you have done this for a particular type, you can provide the type map entry to JPublisher, which will use the information to properly map every method in which the type occurs.

The User-Defined BOOLEANS Datatype

The following `.sql` file defines an object type with methods that use PL/SQL BOOLEAN arguments. The methods this program uses are elementary; they serve only to demonstrate that arguments are passed correctly.

Note: Do not confuse the user-defined BOOLEANS object type with the PL/SQL BOOLEAN type.

```
CREATE TYPE BOOLEANS AS OBJECT (
 iIn     INTEGER,
 iInOut  INTEGER,
 iOut    INTEGER,

 MEMBER PROCEDURE p(i1 IN BOOLEAN,
                    i2 IN OUT BOOLEAN,
                    i3 OUT BOOLEAN),

 MEMBER FUNCTION f(i1 IN BOOLEAN) RETURN BOOLEAN
);

CREATE TYPE BODY BOOLEANS AS

MEMBER PROCEDURE p(i1 IN BOOLEAN,
                   i2 IN OUT BOOLEAN,
                   i3 OUT BOOLEAN) IS
```

```
BEGIN
  iOut := iIn;

  IF iInOut IS NULL THEN
    iInOut := 0;
  ELSIF iInOut = 0 THEN
    iInOut := 1;
  ELSE
    iInOut := NULL;
  END IF;

  i3 := i1;
  i2 := NOT i2;
END;

MEMBER FUNCTION f(i1 IN BOOLEAN) RETURN BOOLEAN IS
BEGIN
  return i1 = (iIn = 1);
END;

END;
```

Alternative 1: Using JPublisher for the Entire Process

You can directly publish the BOOLEANS object type, as shown in the JPublisher command line below, because conversions for BOOLEAN are defined in the SYS.SQLJUTL package to convert between PL/SQL BOOLEAN and SQL INTEGER. Additionally, SQL INTEGER itself is directly mappable to Java boolean, so there is a natural correspondence. Also, remember to install the PL/SQL wrapper script before using the SQLJ code that JPublisher generates in Boolean.sqlj.

```
jpub -u scott/tiger -s BOOLEANS:Booleans -plsqlfile=BWrap.sql
-plsqlpackage=B_WRAP
sqljplus scott/tiger @BWrap.sql
```

As noted in "Type Mapping Support Through PL/SQL Conversion Functions" on page 2-11, the JPublisher default type map relates PL/SQL BOOLEAN to Java boolean. To preserve the ability to represent null data, you might prefer mapping to the Java object type Boolean instead. You can accomplish this by redefining the default type map.

For completeness, the content of the JPublisher-generated file Booleans.sqlj follows.

```
import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;
import sqlj.runtime.ref.DefaultContext;
import sqlj.runtime.ConnectionContext;
import java.sql.Connection;

public class Booleans implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.BOOLEANS";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  /* connection management */
  protected DefaultContext __tx = null;
  protected Connection __onn = null;
  public void setConnectionContext(DefaultContext ctx) throws SQLException
  { release(); __tx = ctx; }
  public DefaultContext getConnectionContext() throws SQLException
  { if (__tx==null)
    { __tx = (__onn==null) ? DefaultContext.getDefaultContext() : new
DefaultContext(__onn); }
    return __tx;
  };
  public Connection getConnection() throws SQLException
  { return (__onn==null) ? ((__tx==null) ? null : __tx.getConnection()) : __onn;
}
  public void release() throws SQLException
  { if (__tx!=null && __onn!=null)
__tx.close(ConnectionContext.KEEP_CONNECTION);
    __onn = null; __tx = null;
  }

  protected MutableStruct _struct;

  private static int[] _sqlType =  { 4,4,4 };
  private static ORADataFactory[] _factory = new ORADataFactory[3];
protected static final Booleans _BooleansFactory = new Booleans(false);

  public static ORADataFactory getORADataFactory()
  { return _BooleansFactory; }
```

```
/* constructors */
protected Booleans(boolean init)
{ if (init) _struct = new MutableStruct(new Object[3], _sqlType, _factory); }
public Booleans()
{ this(true); __tx = DefaultContext.getDefaultContext(); }
public Booleans(DefaultContext c) /*throws SQLException*/
{ this(true); __tx = c; }
public Booleans(Connection c) /*throws SQLException*/
{ this(true); __onn = c; }
public Booleans(Integer iin, Integer iinout, Integer iout) throws SQLException
 {
  this(true);
  setIin(iin);
  setIinout(iinout);
  setIout(iout);
}

/* ORAData interface */
public Datum toDatum(Connection c) throws SQLException
{
  if (__tx!=null && __onn!=c) release();
  __onn = c;
  return _struct.toDatum(c, _SQL_NAME);
}


/* ORADataFactory interface */
public ORAData create(Datum d, int sqlType) throws SQLException
{ return create(null, d, sqlType); }
public void setFrom(Booleans o) throws SQLException
{ setContextFrom(o); setValueFrom(o); }
protected void setContextFrom(Booleans o) throws SQLException
{ release(); __tx = o.__tx; __onn = o.__onn; }
protected void setValueFrom(Booleans o) { _struct = o._struct; }
protected ORAData create(Booleans o, Datum d, int sqlType) throws SQLException
{
  if (d == null) { if (o!=null) { o.release(); }; return null; }
  if (o == null) o = new Booleans(false);
  o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
  o.__onn = ((STRUCT) d).getJavaSqlConnection();
  return o;
}
/* accessor methods */
public Integer getIin() throws SQLException
{ return (Integer) _struct.getAttribute(0); }
```

```
public void setIin(Integer iin) throws SQLException
{ _struct.setAttribute(0, iin); }


public Integer getIinout() throws SQLException
{ return (Integer) _struct.getAttribute(1); }

public void setIinout(Integer iinout) throws SQLException
{ _struct.setAttribute(1, iinout); }


public Integer getIout() throws SQLException
{ return (Integer) _struct.getAttribute(2); }

public void setIout(Integer iout) throws SQLException
{ _struct.setAttribute(2, iout); }


public boolean  f (
  boolean  i1)
throws SQLException
{
  Booleans __jPt_temp = this;
  boolean  __jPt_result;
  #sql [getConnectionContext()] {
    BEGIN
    :OUT __jPt_result := SYS.SQLJUTL.BOOL2INT(:__jPt_temp.F(
    SYS.SQLJUTL.INT2BOOL(:i1)));
    END;
  };
  return __jPt_result;
}

public Booleans p (
  boolean  i1,
  boolean  i2[],
  boolean  i3[])
throws SQLException
{
  Booleans __jPt_temp = this;
  #sql [getConnectionContext()] {
    BEGIN
    B_WRAP.BOOLEANS$P(:INOUT __jPt_temp,
    :i1,
```

```
      :INOUT (i2[0]),
      :OUT (i3[0]));
      END;
    };
    return __jPt_temp;
  }
}
```

And this is the content of the file `BWrap.sql` generated by JPublisher that contains PL/SQL wrapper code. Note that JPublisher must generate wrappers only in those cases where PL/SQL arguments occur as IN OUT or as OUT parameters.

```
CREATE OR REPLACE PACKAGE B_WRAP AS
   PROCEDURE BOOLEANS$P (SELF_ IN OUT SCOTT.BOOLEANS,I1 INTEGER,I2 IN OUT
INTEGER,I3 OUT INTEGER);
END B_WRAP;
/
CREATE OR REPLACE PACKAGE BODY B_WRAP IS

   PROCEDURE BOOLEANS$P (SELF_ IN OUT SCOTT.BOOLEANS,I1 INTEGER,I2 IN OUT
INTEGER,I3 OUT INTEGER) IS
      I1_ BOOLEAN;
      I2_ BOOLEAN;
      I3_ BOOLEAN;
   BEGIN
      I1_ := SYS.SQLJUTL.INT2BOOL(I1);
      I2_ := SYS.SQLJUTL.INT2BOOL(I2);
      SELF_.P(I1_,I2_,I3_);
      I2 := SYS.SQLJUTL.BOOL2INT(I2_);
      I3 := SYS.SQLJUTL.BOOL2INT(I3_);
   END BOOLEANS$P;

END B_WRAP;
/
```

Alternative 2: Manual Conversion

Another technique you can employ to use datatypes not supported by JDBC is to write an anonymous PL/SQL block that converts JDBC-supported input types into input types that the PL/SQL method uses. Then convert the output types that the PL/SQL method uses into output types that JDBC supports. For more information on this topic, see "Using Datatypes Unsupported by JDBC" on page 2-7.

The following steps offer a general outline of how you would do this. The steps assume that you used JPublisher to translate an object type with methods that contain argument types not supported by JDBC. The steps describe the changes you must make. You could make changes by extending the class or by modifying the generated files. Extending the classes is generally a better technique; however, in this example, the generated files are modified.

1. In Java, convert each `IN` or `IN OUT` argument having a type that JDBC does not support to a Java type that JDBC does support.
2. Pass each `IN` or `IN OUT` argument to a PL/SQL block.
3. In the PL/SQL block, convert each `IN` or `IN OUT` argument to the correct type for the PL/SQL method.
4. Call the PL/SQL method.
5. In PL/SQL, convert each `OUT` argument, `IN OUT` argument, or function result from the type that JDBC does not support to the corresponding type that JDBC does support.
6. Return each `OUT` argument, `IN OUT` argument, or function result from the PL/SQL block.
7. In Java, convert each `OUT` argument, `IN OUT` argument, or function result from the type JDBC does support to the type it does not support.

Here is an example of how to handle an argument type not directly supported by JDBC. The example converts from or to a type that JDBC does not support (`Boolean`/`BOOLEAN`) to or from a type that JDBC does support (`String`/`VARCHAR2`).

The following `.sqlj` file was first generated by JPublisher and then user-modified, according to the preceding steps. The wrapper methods accomplish the following:

- Convert each argument from `Boolean` to `String` in Java.
- Pass each argument into a PL/SQL block.
- Convert the argument from `VARCHAR2` to `BOOLEAN` in PL/SQL.
- Call the PL/SQL method.
- Convert each `OUT` argument, `IN OUT` argument, or function result from `BOOLEAN` to `VARCHAR2` in PL/SQL.
- Return each `OUT` argument, `IN OUT` argument, or function result from the PL/SQL block.

- Finally, convert each OUT argument, IN OUT argument, or function result.

Here is the code:

```
import java.sql.SQLException;
import java.sql.Connection;
import oracle.jdbc.OracleTypes;
import oracle.sql.ORAData;
import oracle.sql.ORADataFactory;
import oracle.sql.Datum;
import oracle.sql.STRUCT;
import oracle.jpub.runtime.MutableStruct;
import sqlj.runtime.ref.DefaultContext;
import sqlj.runtime.ConnectionContext;
import java.sql.Connection;

public class Booleans implements ORAData, ORADataFactory
{
  public static final String _SQL_NAME = "SCOTT.BOOLEANS";
  public static final int _SQL_TYPECODE = OracleTypes.STRUCT;

  /* connection management */
  protected DefaultContext __tx = null;
  protected Connection __onn = null;
  public void setConnectionContext(DefaultContext ctx) throws SQLException
  { release(); __tx = ctx; }
  public DefaultContext getConnectionContext() throws SQLException
  { if (__tx==null)
    { __tx = (__onn==null) ? DefaultContext.getDefaultContext() : new
DefaultContext(__onn); }
    return __tx;
  };
  public Connection getConnection() throws SQLException
  { return (__onn==null) ? ((__tx==null) ? null : __tx.getConnection()) : __onn;
}
  public void release() throws SQLException
  { if (__tx!=null && __onn!=null)
__tx.close(ConnectionContext.KEEP_CONNECTION);
    __onn = null; __tx = null;
  }

  protected MutableStruct _struct;

  static int[] _sqlType =
  {
    4, 4, 4
```

```
};

static ORADataFactory[] _factory = new ORADataFactory[3];

static final Booleans _BooleansFactory = new Booleans(false);
public static ORADataFactory getORADataFactory()
{
  return _BooleansFactory;
}

/* constructors */
protected Booleans(boolean init)
{ if (init) _struct = new MutableStruct(new Object[3], _sqlType, _factory); }
public Booleans()
{ this(true); __tx = DefaultContext.getDefaultContext(); }
public Booleans(DefaultContext c) throws SQLException
{ this(true); __tx = c; }
public Booleans(Connection c) throws SQLException
{ this(true); __onn = c; }

/* ORAData interface */
public Datum toDatum(Connection c) throws SQLException
{
  if (__tx!=null && __onn!=c) release();
  __onn = c;
  return _struct.toDatum(c, _SQL_NAME);
}

/* ORADataFactory interface */
public ORAData create(Datum d, int sqlType) throws SQLException
{ return create(null, d, sqlType); }
public void setFrom(Booleans o) throws SQLException
{ release(); _struct = o._struct; __tx = o.__tx; __onn = o.__onn; }
protected void setValueFrom(Booleans o) { _struct = o._struct; }
protected ORAData create(Booleans o, Datum d, int sqlType) throws SQLException
{
  if (d == null) { if (o!=null) { o.release(); }; return null; }
   if (o == null) o = new Booleans(false);
  o._struct = new MutableStruct((STRUCT) d, _sqlType, _factory);
  o.__onn = ((STRUCT) d).getJavaSqlConnection();
  return o;
}

/* accessor methods */
public Integer getIin() throws SQLException
```

```
  { return (Integer) _struct.getAttribute(0); }

  public void setIin(Integer iin) throws SQLException
  { _struct.setAttribute(0, iin); }


  public Integer getIinout() throws SQLException
  { return (Integer) _struct.getAttribute(1); }

  public void setIinout(Integer iinout) throws SQLException
  { _struct.setAttribute(1, iinout); }


  public Integer getIout() throws SQLException
  { return (Integer) _struct.getAttribute(2); }

  public void setIout(Integer iout) throws SQLException
  { _struct.setAttribute(2, iout); }



/* Unable to generate method "f"
   because it uses a type that is not supported

  public <unsupported type> f (
    <unsupported type> i1)
  throws SQLException
  {
    Booleans __jPt_temp = this;
    <unsupported type> __jPt_result;
    #sql [getConnectionContext()] {
      BEGIN
      :OUT __jPt_result := :__jPt_temp.F(
      :i1);
      END;
    };
    return __jPt_result;
  } */

  public Boolean f (
    Boolean i1)
  throws SQLException
  {
    Booleans _temp = this;
    String _i1 = null;
```

```
    String _result = null;

    if (i1 != null) _i1 = i1.toString();

    #sql [getConnectionContext()] {
      DECLARE
      i1_ BOOLEAN;
      result_ BOOLEAN;
      t_ VARCHAR2(5);

      BEGIN
      i1_ := :_i1 = 'true';

      result_ := :_temp.F(i1_);

      IF result_ THEN
        t_ := 'true';
      ELSIF NOT result_ THEN
        t_ := 'false';
      ELSE
        t_ := NULL;
      END IF;
      :OUT _result := t_;

      END;
    };

    if (_result == null)
       return null;
    else
       return new Boolean(_result.equals("true"));
  }


/* Unable to generate method "p"
   because it uses a type that is not supported

  public Booleans p (
    <unsupported type> i1,
    <unsupported type> i2[],
    <unsupported type> i3[])
  throws SQLException
  {
    Booleans __jPt_temp = this;
    #sql [getConnectionContext()] {
```

```
    BEGIN
    :INOUT __jPt_temp.P(
    :i1,
    :INOUT (i2[0]),
    :OUT (i3[0]));
    END;
  };
  return __jPt_temp;
} */

public Booleans p (
  Boolean i1,
  Boolean i2[],
  Boolean i3[])
throws SQLException
{
  String _i1 = (i1 == null) ? null
                            : i1.toString();

  String _i2 = (i2[0] == null) ? null
                               : i2[0].toString();

  String _i3 = (i3[0] == null) ? null
                               : i3[0].toString();

  Booleans _temp = this;

  #sql [getConnectionContext()] {
    DECLARE
    i1_ BOOLEAN;
    i2_ BOOLEAN;
    i3_ BOOLEAN;
    t_ VARCHAR2(5);

    BEGIN
    i1_ := :_i1 = 'true';
    i2_ := :_i2 = 'true';

    :INOUT _temp.P( i1_, i2_, i3_);

    IF i2_ THEN
      t_ := 'true';
    ELSIF NOT i2_ THEN
      t_ := 'false';
    ELSE
```

```
        t_ := NULL;
      END IF;
      :OUT _i2 := t_;

      IF i3_ THEN
        t_ := 'true';
      ELSIF NOT i3_ THEN
        t_ := 'false';
      ELSE
        t_ := NULL;
      END IF;
      :OUT _i3 := t_;

      END;
    };

    i2[0] = (_i2 == null) ? null
                          : new Boolean(_i2.equals("true"));
    i3[0] = (_i3 == null) ? null
                          : new Boolean(_i3.equals("true"));
    return _temp;
  }
}
```

Note: Because of the semantics of SQLJ parameters, it is necessary to assign to each output parameter exactly once within the block.

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