MySQL++ User Manual

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1. Introduction

MySQL++ is a powerful C++ wrapper for MySQL's C API. Its purpose is to make working with queries as easy as working with STL containers.

The latest version of MySQL++ can be found at the official web site.

Support for MySQL++ can be had on the mailing list. That page hosts the mailing list archives, and tells you how you can subscribe.

1.1. A Brief History of MySQL++

MySQL++ was created in 1998 by Kevin Atkinson. It started out MySQL-specific, but there were early efforts to try and make it database-independent, and call it SQL++. This is where the old library name "sqlplus" came from. This is also why the old versions prefixed some class names with "Mysql" but not others: the others were supposed to be the database-independent parts.

Then in 1999, Sinisa Milivojevic unofficially took over maintenance of the library, releasing versions 1.0 and 1.1. (All of Kevin's releases were pre-1.0 point releases.) Kevin gave over maintenance to Sinisa officially with 1.2, and ceased to have any involvement with the library's maintenance. Sinisa went on to maintain the library through 1.7.9, released in mid-2001. Since Sinisa is an employee of MySQL AB, it seems to be during this time that the dream of multiple-database compatibility died.

With version 1.7.9, MySQL++ went into a period of stasis, lasting over three years. During this time, Sinisa ran the MySQL++ mailing list and supported its users, but made no new releases. There were many patches submitted during this period, some of which were ignored, others which were just put on the MySQL++ web site for people to try. A lot of these patches were mutually-incompatible, and not all of them gave a fully-functional copy of MySQL++.

In early August of 2004, the current maintainer (Warren Young) got fed up with this situation and took over. He released 1.7.10 later that month.

1.2. If You Have Questions...

If you want to email someone to ask questions about this library, we greatly prefer that you send mail to the MySQL++ mailing list. The mailing list is archived, so if you have questions, do a search to see if the question has been asked before.

You may find people's individual email addresses in various files within the MySQL++ distribution. Please do not send mail to them unless you are sending something that is inherently personal. Not all of the principal developers of MySQL++ are still active in its development; those who have dropped out have no wish to be bugged about MySQL++. Those of us still active in MySQL++ development monitor the mailing list, so you aren't getting any extra "coverage" by sending messages to additional email addresses.

2. Overview

MySQL++ has developed into a very complex and powerful library, with many different ways to accomplish the same task. Unfortunately, this means that figuring out how to perform a simple task can be frustrating for new users. In this section we will provide an overview of the most important user-facing components of the library.

The overall process for using MySQL++ is similar to that of most other database access APIs:

1.   Open the connection

2. Form and execute the query

3. Iterate through the result set

4. Go to 2 :)

There is, however, a lot of extra functionality along each step of the way.

2.1. The Connection Object

A Connection object manages the connection to the MySQL server. You need at least one of these objects to do anything. A Connection object can either create Query objects for you, or you can execute queries directly through the Connection object. The separate Query object is the recommended way as it gives you far more power.

2.2. The Query Object

A Query object is the recommended way of building and executing queries. It is subclassed from `std::stringstream` which means you can write to it like any other C++ stream to form a query. The library includes stream manipulators that make it easy to generate syntactically-correct SQL.

You can also set up Template Queries with this class. Template queries work something like the C `printf()` function: you set up a fixed query string with tags inside that indicate where to insert the variable parts. If you have multiple queries that are structurally similar, you simply set up one template query, and use that in the various locations of your program.

A third method for building queries is to use Specialized SQL Structures (SSQLS). This feature presents your results as a C++ data structure, instead of making you access the data through MySQL++ intermediary classes. It also reduces the amount of embedded SQL code your program needs.

2.3. Result Sets

The field data in a result set are stored in a special `std::string`-like class called ColData. This class has conversion operators that let you automatically convert these objects to any of the basic C data types. Additionally, MySQL++ defines classes like DateTime, which you can initialize from a MySQL `DATETIME` string. These automatic conversions are protected against bad conversions, and can either set a warning flag or throw an exception, depending on how you set the library up.

As for the result sets as a whole, MySQL++ has a number of different ways of representing them:

Queries That Do Not Return Data

Not all SQL queries return data. An example is `CREATE TABLE`. For these types of queries, there is a special result type (ResNSel) that simply reports the state resulting from the query: whether the query was successful, how many rows it impacted (if any), etc.

Queries That Return Data: Dynamic Method

The easiest way to retrieve data from MySQL uses a Result object, which includes one or more Row objects. Because these classes are `std::vector`-like containers, you can treat the result set as a two-dimensional array. For example, you can get the 5th item on the 2nd row by simply saying `result.at(1).at(4)`. You can also access row elements by field name, like this: `result.at(2)["price"]`.

An alternate way of accessing your query results is through a ResUse object. This class acts more like an STL input iterator than a container: you walk through your result set one item at a time, always going forward. You can't seek around in the result set, and you can't know how many results are in the set until you find the end. This method is more efficient when there can be arbitrarily many results, which could pose a memory allocation problem with the

previous technique.

Queries That Return Data: Static Method

The Specialized SQL Structures (SSQLS) feature method above defines C++ structures that match the table structures in your database schema.

We call it the "static" method because the table structure is fixed at compile time. Indeed, some schema changes require that you update your SSQLS definitions and recompile, or else the program could crash or throw "bad conversion" exceptions when MySQL++ tries to stuff the new data into an outdated data structure. (Not all changes require a recompile. Adding a column to a table is safe, for instance, as the program will ignore the new column until you update the SSQLS definition.)

The advantage of this method is that your program will require very little embedded SQL code. You can simply execute a query, and receive your results as C++ data structures, which can be accessed just as you would any other structure. The results can be accessed through the Row object, or you can ask the library to dump the results into a sequential or set-associative STL container for you. Consider this:

```
vector<mystruct> v;
Query q = connection.query();
q << "SELECT * FROM mytable";
q.storein(v);
for (vector<mystruct>::iterator it = v.begin(); it != v.end(); ++it) {
    cout << "Price: " << it->price << endl;
}
```

Isn't that slick?

2.4. Exceptions

By default, the library throws exceptions whenever it encounters an error. You can ask the library to set an error flag instead, if you like, but the exceptions carry more information. Not only do they include a string member telling you why the exception was thrown, there are several exception types, so you can distinguish between different error types within a single `try` block.

3. Tutorial

This tutorial is meant to give you a jump start in using MySQL++. While it is a very complicated and powerful library, it's possible to make quite functional programs without tapping but a fraction of its power. This section will introduce you to the most useful fraction.

This tutorial assumes you know C++ fairly well, in particuler the Standard Template Library (STL) and exceptions.

3.1. Running the Examples

All of the examples are complete running programs. They may or may not be built for you already, depending on how you installed the library.

If you installed MySQL++ from the source tarball on a Unixy system, the examples should have been built along with the library. If not, simply go into the examples directory and type `make`.

If you installed the library via RPM, the examples are in the mysql++-devel RPM. After installing that, the examples are in `/usr/src/mysql++/examples`. To build them, go into that directory and type `make -f Make-file.simple`. See the file `/usr/share/doc/mysql++-devel*/README.examples` for more details.

If you are on a Windows system, the build process for the library should have built the examples as well. Where the programs are depends on which compiler you're using. There should be a README.* file in the distribution specific to your compiler with further instructions.

Once you have the examples building, you need to initialize the sample database by running the resetdb example. The usage of resetdb is as follows:

```
resetdb [host [user [password [port]]]]
```

If you leave off host, localhost is assumed. If you leave off user, your current username is assumed. If you leave of the password, it is assumed that you don't need one. And if you leave off the port, it will use the standard MySQL port number.

The user you give resetdb needs to be an account with permission to create databases. Once the database is created you can use any account that has full permission to the sample database mysql_cpp_data.

You may also have to re-run resetdb after running some of the other examples, as they change the database.

3.2. A Simple Example

The following example demonstrates how to open a connection, execute a simple query, and display the results. This is examples/simple1.cpp:

```cpp
#include "util.h"

#include <mysql++.h>

#include <iostream>
#include <iomanip>

using namespace std;

int
main(int argc, char *argv[])
{
    // Connect to the sample database.
    mysqlpp::Connection con(false);
    if (!connect_to_db(argc, argv, con)) {
        return 1;
    }

    // Retrieve a subset of the sample stock table set up by resetdb
    mysqlpp::Query query = con.query();
    query << "select item from stock";
    mysqlpp::Result res = query.store();

    // Display the result set
    cout << "We have:" << endl;
    if (res) {
        char buf[100];
        mysqlpp::Row row;
        mysqlpp::Row::size_type i;
        for (i = 0; row = res.at(i); ++i) {
            cout << '\t' << utf8trans(row.at(0), buf, sizeof(buf)) << endl;
        }
    }
    else {
        cerr << "Failed to get item list: " << query.error() << endl;
        return 1;
    }

    return 0;
}
```

This example simply gets the entire "item" column from the example table, and prints those values out.

Notice that MySQL++ lets you store result sets in STL containers, such as std::vector. We iterate through the

result set just as you would with any other STL container. The only tricky bit is the `it->at(0)` idiom. This dereferences the iterator, which yields a Row object, on which we call the `at()` method to retrieve the first field.

The only thing that isn't explicitly handled in the code block above is that we delegate connection establishment to `connect_to_db()` in the `util` module. We do this only because that function also handles the command line parsing for the examples, so they have a consistent interface.

3.3. Examples' Utility Module

I referred to the `util` module above. Following is the source for that module, which also contains other functions used by other examples. It isn't important to understand this module in detail, but understanding its outlines will make the following examples more clear.

```
#include "util.h"

#include <iostream>
#include <iomanip>
#include <stdlib.h>

using namespace std;

const char* kpcSampleDatabase = "mysql_cpp_data";


//// utf8trans ////////////////////////////////////////////////////////
// Converts a Unicode string encoded in UTF-8 form (which the MySQL
// database uses) to a form suitable for outputting to the standard C++
// cout stream.  Functionality is platform-specific.

char*
utf8trans(const char* utf8_str, char* out_buf, int buf_len)
{
#ifdef MYSQLPP_PLATFORM_WINDOWS
    // It's Win32, so assume console output, where output needs to be in
    // local ANSI code page by default.
    wchar_t ucs2_buf[100];
    static const int ub_chars = sizeof(ucs2_buf) / sizeof(ucs2_buf[0]);

    // First, convert UTF-8 string to UCS-2
    if (MultiByteToWideChar(CP_UTF8, 0, utf8_str, -1,
            ucs2_buf, ub_chars) > 0) {
        // Next, convert UCS-2 to local code page.
        CPINFOEX cpi;
        GetCPInfoEx(CP_OEMCP, 0, &cpi);
        WideCharToMultiByte(cpi.CodePage, 0, ucs2_buf, -1,
                out_buf, buf_len, 0, 0);
        return out_buf;
    }
    else {
        int err = GetLastError();
        if (err == ERROR_NO_UNICODE_TRANSLATION) {
            cerr << "Bad data in UTF-8 string" << endl;
        }
        else {
            cerr << "Unknown error in Unicode translation: " <<
                    GetLastError() << endl;
        }
        return 0;
    }
#else
    // Assume a modern Unixy platform, where the system's terminal I/O
    // code handles UTF-8 directly.  (e.g. common Linux distributions
    // since 2001 or so, recent versions of Mac OS X, etc.)
    strncpy(out_buf, utf8_str, buf_len);
    return out_buf;
#endif
}
```

```
//// print_stock_header /////////////////////////////////////////////
// Display a header suitable for use with print_stock_rows().

void
print_stock_header(int rows)
{
    cout << "Records found: " << rows << endl << endl;
    cout.setf(ios::left);
    cout << setw(21) << "Item" <<
            setw(10) << "Num" <<
            setw(10) << "Weight" <<
            setw(10) << "Price" <<
            "Date" << endl << endl;
}


//// print_stock_row ////////////////////////////////////////////////
// Print out a row of data from the stock table, in a format compatible
// with the header printed out in the previous function.

void
print_stock_row(const std::string& item, mysqlpp::longlong num,
        double weight, double price, const mysqlpp::Date& date)
{
    // We do UTF-8 translation on item field because there is Unicode
    // data in this field in the sample database, and some systems
    // cannot handle UTF-8 sent directly to cout.
    char buf[100];
    cout << setw(20) << utf8trans(item.c_str(), buf, sizeof(buf)) << ' ' <<
            setw(9) << num << ' ' <<
            setw(9) << weight << ' ' <<
            setw(9) << price << ' ' <<
            date << endl;
}


//// print_stock_row ////////////////////////////////////////////////
// Take a Row from the example 'stock' table, break it up into fields,
// and call the above version of this function.

void
print_stock_row(const mysqlpp::Row& row)
{
    // The brief code below illustrates several aspects of the library
    // worth noting:
    //
    // 1. You can subscript a row by integer (position of the field in
    // the row) or by string (name of field in the row).  The former is
    // more efficient, while the latter trades some efficiency for
    // robustness in the face of schema changes.  (Consider using SSQLS
    // if you need a tradeoff in between these two positions.)
    //
    // 2. You can also get at a row's field's with Row::at(), which is
    // much like Row::operator[](int).  Besides the syntax difference,
    // the only practical difference is that only at() can access field
    // 0: this is because '0' can be converted to both int and to const
    // char*, so the compiler rightly complains that it can't decide
    // which overload to call.
    //
    // 3. Notice that we make an explicit temporary copy of the first
    // field, which is the only string field.  We must tolerate the
    // inefficiency of this copy, because Row::operator[] returns a
    // ColData object, which goes away after it is converted to some
    // other form.  So, while we could have made print_stock_row()
    // take a const char* argument (as past versions mistakenly did!)
    // this would result in a dangling pointer, since it points into the
    // ColData object, which is dead by the time the pointer is
    // evaluated in print_stock_row().  It will probably even work this
    // way, but like any memory bug, it can wreak subtle havoc.
    std::string item(row.at(0));
```

```
    print_stock_row(item, row["num"], row[2], row[3], row[4]);
}


//// print_stock_rows /////////////////////////////////////////////////
// Print out a number of rows from the example 'stock' table.

void
print_stock_rows(mysqlpp::Result& res)
{
    print_stock_header(res.size());

    // Use the Result class's read-only random access iterator to walk
    // through the query results.
    mysqlpp::Result::iterator i;
    for (i = res.begin(); i != res.end(); ++i) {
        // Notice that a dereferenced result iterator can be converted
        // to a Row object, which makes for easier element access.
        print_stock_row(*i);
    }
}


//// get_stock_table /////////////////////////////////////////////////
// Retreive the entire contents of the example 'stock' table.

void
get_stock_table(mysqlpp::Query& query, mysqlpp::Result& res)
{
    // Reset the query object, in case we're re-using it.
    query.reset();

    // You can write to the query object like you would any ostream.
    query << "select * from stock";

    // Show the query string.  If you call preview(), it must be before
    // you call execute() or store() or use().
    cout << "Query: " << query.preview() << endl;

    // Execute the query, storing the results in memory.
    res = query.store();
}


//// connect_to_db /////////////////////////////////////////////////
// Establishes a connection to a MySQL database server, optionally
// attaching to database kdb.  This is basically a command-line parser
// for the examples, since the example programs' arguments give us the
// information we need to establish the server connection.

bool
connect_to_db(int argc, char *argv[], mysqlpp::Connection& con,
        const char *kdb)
{
    if (argc < 1) {
        cerr << "Bad argument count: " << argc << '!' << endl;
        return false;
    }

    if (!kdb) {
        kdb = kpcSampleDatabase;
    }

    if ((argc > 1) && (argv[1][0] == '-')) {
        cout << "usage: " << argv[0] <<
                " [host] [user] [password] [port]" << endl;
        cout << endl << "\tConnects to database ";
        if (strlen(kdb) > 0) {
            cout << '"' << kdb << '"';
        }
        else {
```

```
            cout << "server";
        }
        cout << " on localhost using your user" << endl;
        cout << "\tname and no password by default." << endl << endl;
        return false;
    }

    if (argc == 1) {
        con.connect(kdb);
    }
    else if (argc == 2) {
        con.connect(kdb, argv[1]);
    }
    else if (argc == 3) {
        con.connect(kdb, argv[1], argv[2]);
    }
    else if (argc == 4) {
        con.connect(kdb, argv[1], argv[2], argv[3]);
    }
    else if (argc >= 5) {
        con.connect(kdb, argv[1], argv[2], argv[3], atoi(argv[4]));
    }

    if (con) {
        return true;
    }
    else {
        cerr << "Database connection failed: " << con.error() << endl;
        return false;
    }
}
```

This is actually an abridged version of util.cpp, with the Unicode stuff removed. The interaction between MySQL, MySQL++ and Unicode is covered in a later chapter, Using Unicode with MySQL++.

3.4. A More Complicated Example

The `simple1` example above was pretty trivial. Let's get a little deeper. Here is `examples/simple2.cpp`:

```
#include "util.h"

#include <mysql++.h>

#include <iostream>
#include <iomanip>

using namespace std;

int
main(int argc, char *argv[])
{
    // Connect to the sample database.
    mysqlpp::Connection con(false);
    if (!connect_to_db(argc, argv, con)) {
        return 1;
    }

    // Retrieve the sample stock table set up by resetdb
    mysqlpp::Query query = con.query();
    query << "select * from stock";
    mysqlpp::Result res = query.store();

    // Display results
    if (res) {
        // Display header
        cout.setf(ios::left);
```

```
        cout << setw(21) << "Item" <<
                setw(10) << "Num" <<
                setw(10) << "Weight" <<
                setw(10) << "Price" <<
                "Date" << endl << endl;

        // Get each row in result set, and print its contents
        char buf[100];
        mysqlpp::Row row;
        mysqlpp::Row::size_type i;
        for (i = 0; row = res.at(i); ++i) {
            cout << setw(20) <<
                    utf8trans(row["item"], buf, sizeof(buf)) << ' ' <<
                    setw(9) << row["num"] << ' ' <<
                    setw(9) << row["weight"] << ' ' <<
                    setw(9) << row["price"] << ' ' <<
                    setw(9) << row["sdate"] <<
                    endl;
        }
    }
    else {
        cerr << "Failed to get stock table: " << query.error() << endl;
        return 1;
    }

    return 0;
}
```

This example illustrates several new concepts.

First, notice that we store the result set in a Result object. Like the a `std::vector` we used in the `simple1` example, `Result` is a container type, so iterating through it is straightforward. The main difference is that `Result` is less distanced from the way the underlying MySQL C API works, so it is somewhat more efficient.

Second, we access each row's data indirectly through a Row object. This affords several nice features, such as the ability to access a field by name. You can also access fields by position, as we did in the `simple1` example, which is more efficient, but makes your code less flexible.

3.5. Exceptions

By default, MySQL++ uses exceptions to signal errors. Most of the examples have a full set of exception handlers. This is worthy of emulation.

All of MySQL++'s custom exceptions derive from a common base class, Exception. That in turn derives from the Standard C++ exception base class, `std::exception`. Since the library can indirectly cause exceptions to come from the Standard C++ Library, it's possible to catch all exceptions from MySQL++ by just catching `std::exception` by reference. However, it's usually better to catch the all of the concret eexception types that you expect, and add a handler for `Exception` or `std::exception` to act as a "catch-all" for unexpected exceptions.

Some of these exceptions are optional. When disabled, the object signals errors in some other way, typically by returning an error code or setting an error flag. Classes that support this feature derive from OptionalExceptions. Moreover, when such an object creates another object that also derives from this interface, it passes on its exception flag. Since everything flows from the Connection object, disabling exceptions on it at the start of the program disables all optional exceptions. You can see this technique at work in the "simple" examples, which keeps them, well, simple.

Real-world code typically can't afford to lose out on the additional information and control offered by exceptions. But at the same time, it is still sometimes useful to disable exceptions temporarily. To do this, put the section of code that you want to not throw exceptions inside a block, and create a NoExceptions object at the top of that block. When created, it saves the exception flag of the `OptionalExceptions` derivative you pass to it, and then disables exceptions on it. When the `NoExceptions` object goes out of scope at the end of the block, it restores the excep-

tions flag to its previous state. See `examples/resetdb.cpp` to see this technique at work.

When one `OptionalExceptions` derivative creates another such object and passes on its exception flag, it passes a copy of the flag. Therefore, the two objects' flags operate independently after the new one is created. There's no way to globally enable or disable this flag on existing objects in a single call.

There are a few classes of exceptions MySQL++ can throw that are not optional:

• The largest set of non-optional exceptions are those from the Standard C++ Library. For instance, if your code said "`row[21]`" on a row containing only 5 fields, the `std::vector` underlying the row object will throw an exception. (It will, that is, if it conforms to the standard.) You might consider wrapping your program's main loop in a try block catching `std::exceptions`, just in case you trigger one of these exceptions.

• ColData will always throw BadConversion when you ask it to do an improper type conversion. For example, you'll get an exception if you try to convert "1.25" to `int`, but not when you convert "1.00" to `int`. In the latter case, MySQL++ knows that it can safely throw away the fractional part.

• If you use template queries and don't pass enough parameters when instantiating the template, `Query` will throw a BadParamCount exception.

It's educational to modify the examples to force exceptions. For instance, misspell a field name, use an out-of-range index, or change a type to force a `ColData` conversion error.

3.6. Quoting and Escaping

SQL syntax often requires certain data to be quoted. Consider this query:

```
SELECT * FROM stock WHERE item = 'Hotdog Buns'
```

Because the string "Hotdog Buns" contains a space, it must be quoted. With MySQL++, you don't have to add these quote marks manually:

```
string s = "Hotdog Buns";
Query q = conn.query();
q << "SELECT * FROM stock WHERE item = " << quote_only << s;
```

That code produces the same query string as in the previous example. We used the MySQL++ `quote_only` manipulator, which causes single quotes to be added around the next item inserted into the stream. This works for various string types, for any type of data that can be converted to MySQL++'s ColData type, and for Specialized SQL Structures. (The next section introduces the SSQLS feature.)

Quoting is pretty simple, but SQL syntax also often requires that certain characters be "escaped". Imagine if the string in the previous example was "Frank's Brand Hotdog Buns" instead. The resulting query would be:

```
SELECT * FROM stock WHERE item = 'Frank's Brand Hotdog Buns'
```

That's not valid SQL syntax. The correct syntax is:

```
SELECT * FROM stock WHERE item = 'Frank''s Brand Hotdog Buns'
```

As you might expect, MySQL++ provides that feature, too, through its `escape` manipulator. But here, we want both quoting and escaping. That brings us to the most widely useful manipulator:

```
string s = "Frank's Brand Hotdog Buns";
Query q = conn.query();
q << "SELECT * FROM stock WHERE item = " << quote << s;
```

The `quote` manipulator both quotes strings, and escapes any characters that are special in SQL.

3.7. Specialized SQL Structures

Retrieving data

The next example introduces one of the most powerful features of MySQL++: Specialized SQL Structures (SSQLS). This is `examples/custom1.cpp`:

```
#include "util.h"

#include <mysql++.h>
#include <custom.h>

#include <iostream>
#include <iomanip>
#include <vector>

using namespace std;

// The following is calling a very complex macro which will create
// "struct stock", which has the member variables:
//
//    string item
//    ...
//    Date sdate
//
// plus methods to help populate the class from a MySQL row
// among other things that I'll get to in a later example.
sql_create_5(stock,
            1, 5,                   // explained in the user manual
            string, item,
            mysqlpp::longlong, num,
            double, weight,
            double, price,
            mysqlpp::Date, sdate)

int
main(int argc, char *argv[])
{
    // Wrap all MySQL++ interactions in one big try block, so any
    // errors are handled gracefully.
    try {
        // Establish the connection to the database server.
        mysqlpp::Connection con(mysqlpp::use_exceptions);
        if (!connect_to_db(argc, argv, con)) {
            return 1;
        }

        // Retrieve the entire contents of the stock table, and store
        // the data in a vector of 'stock' SSQLS structures.
        mysqlpp::Query query = con.query();
        query << "select * from stock";
        vector<stock> res;
        query.storein(res);

        // Display the result set
        print_stock_header(res.size());
        vector<stock>::iterator it;
        for (it = res.begin(); it != res.end(); ++it) {
            print_stock_row(it->item, it->num, it->weight, it->price,
                    it->sdate);
        }
    }
    catch (const mysqlpp::BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
```

```
    }
    catch (const mysqlpp::BadConversion& er) {
        // Handle bad conversions; e.g. type mismatch populating 'stock'
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return -1;
    }
    catch (const mysqlpp::Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
    }

    return 0;
}
```

As you can see, SSQLS is very powerful.

Adding data

SSQLS can also be used to add data to a table. This is `examples/custom2.cpp`:

```cpp
#include "util.h"

#include <mysql++.h>
#include <custom.h>

#include <iostream>
#include <string>
#include <vector>

using namespace std;

sql_create_5(stock,
            1, 5,
            string, item,
            mysqlpp::longlong, num,
            double, weight,
            double, price,
            mysqlpp::Date, sdate)

int
main(int argc, char *argv[])
{
    try {
        // Establish the connection to the database server.
        mysqlpp::Connection con(mysqlpp::use_exceptions);
        if (!connect_to_db(argc, argv, con)) {
            return 1;
        }

        // Create and populate a stock object.  We could also have used
        // the set() member, which takes the same parameters as this
        // constructor.
        stock row("Hot Dogs", 100, 1.5, 1.75, "1998-09-25");

        // Form the query to insert the row into the stock table.
        mysqlpp::Query query = con.query();
        query.insert(row);

        // Show the query about to be executed.
        cout << "Query: " << query.preview() << endl;

        // Execute the query.  We use execute() because INSERT doesn't
        // return a result set.
        query.execute();
```

```
        // Print the new table.
        mysqlpp::Result res;
        get_stock_table(query, res);
        print_stock_rows(res);
    }
    catch (const mysqlpp::BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const mysqlpp::BadConversion& er) {
        // Handle bad conversions
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return -1;
    }
    catch (const mysqlpp::Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
    }

    return 0;
}
```

That's all there is to it!

There is one subtlety: MySQL++ automatically quotes and escapes the data when building SQL queries using SSQLS structures. It's efficient, too: MySQL++ is smart enough to apply quoting and escaping only for those data types that actually require it.

Because this example modifies the sample database, you may want to run resetdb after running this program.

Modifying data

It almost as easy to modify data with SSQLS. This is `examples/custom3.cpp`:

```
#include "util.h"

#include <mysql++.h>
#include <custom.h>

#include <iostream>
#include <string>
#include <vector>

using namespace std;

sql_create_5(stock,
            1, 5,
            string, item,
            mysqlpp::longlong, num,
            double, weight,
            double, price,
            mysqlpp::Date, sdate)

int
main(int argc, char *argv[])
{
    try {
        // Establish the connection to the database server.
        mysqlpp::Connection con(mysqlpp::use_exceptions);
        if (!connect_to_db(argc, argv, con)) {
            return 1;
```

```
        }

        // Build a query to retrieve the stock item that has Unicode
        // characters encoded in UTF-8 form.
        mysqlpp::Query query = con.query();
        query << "select * from stock where item = \"Nürnberger Brats\"";

        // Retrieve the row, throwing an exception if it fails.
        mysqlpp::Result res = query.store();
        if (res.empty()) {
            throw mysqlpp::BadQuery("UTF-8 bratwurst item not found in "
                    "table, run resetdb");
        }

        // Because there should only be one row in the result set,
        // there's no point in storing the result in an STL container.
        // We can store the first row directly into a stock structure
        // because one of an SSQLS's constructors takes a Row object.
        stock row = res.at(0);

        // Create a copy so that the replace query knows what the
        // original values are.
        stock orig_row = row;

        // Change the stock object's item to use only 7-bit ASCII, and
        // to deliberately be wider than normal column widths printed
        // by print_stock_table().
        row.item = "Nuerenberger Bratwurst";

        // Form the query to replace the row in the stock table.
        query.update(orig_row, row);

        // Show the query about to be executed.
        cout << "Query: " << query.preview() << endl;

        // Run the query with execute(), since UPDATE doesn't return a
        // result set.
        query.execute();

        // Print the new table contents.
        get_stock_table(query, res);
        print_stock_rows(res);
    }
    catch (const mysqlpp::BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const mysqlpp::BadConversion& er) {
        // Handle bad conversions
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return -1;
    }
    catch (const mysqlpp::Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
    }

    return 0;
}
```

When you run the example you will notice that in the WHERE clause only the 'item' field is checked for. This is because SSQLS also also less-than-comparable.

Don't forget to run resetdb after running the example.

Less-than-comparable

SSQLS structures can be sorted and stored in STL associative containers as demonstrated in the next example. This is examples/custom4.cpp:

```cpp
#include "util.h"

#include <mysql++.h>
#include <custom.h>

#include <iostream>
#include <iomanip>
#include <string>
#include <vector>

using namespace std;

sql_create_5(stock,
    1,   // This number is used to make a SSQLS less-than-comparable.
         // When comparing two SSQLS structures, the first N elements are
         // compared.  In this instance, we are saying that we only want
         // the first element ('item') to be used when comparing two
         // stock structures.

    5,   // Each SSQLS structure includes a number of constructors.  Some
         // of these are fixed in nature, but one of these will have this
         // number of arguments, one for each of the first N elements in
         // the structure; it is an initialization ctor.  Since N is the
         // same as the number of structure elements in this instance,
         // that ctor will be able to fully initialize the structure. This
         // behavior is not always wanted, however, so the macro allows
         // you make the constructor take fewer parameters, leaving the
         // remaining elements uninitialized.  An example of when this is
         // necessary is when you have a structure containing only two
         // integer elements: one of the other ctors defined for SSQLS
         // structures takes two ints, so the compiler barfs if you pass
         // 2 for this argument.  You would need to pass 0 here to get
         // that SSQLS structure to compile.
    string, item,
    mysqlpp::longlong, num,
    double, weight,
    double, price,
    mysqlpp::Date, sdate)

int
main(int argc, char *argv[])
{
    try {
        // Establish the connection to the database server.
        mysqlpp::Connection con(mysqlpp::use_exceptions);
        if (!connect_to_db(argc, argv, con)) {
            return 1;
        }

        // Retrieve all rows from the stock table and put them in an
        // STL set.  Notice that this works just as well as storing them
        // in a vector, which we did in custom1.cpp.  It works because
        // SSQLS objects are less-than comparable.
        mysqlpp::Query query = con.query();
        query << "select * from stock";
        set<stock> res;
        query.storein(res);

        // Display the result set.  Since it is an STL set and we set up
        // the SSQLS to compare based on the item column, the rows will
        // be sorted by item.
        print_stock_header(res.size());
        set<stock>::iterator it;
        cout.precision(3);
        for (it = res.begin(); it != res.end(); ++it) {
```

```
                print_stock_row(it->item.c_str(), it->num, it->weight,
                        it->price, it->sdate);
            }

            // Use set's find method to look up a stock item by item name.
            // This also uses the SSQLS comparison setup.
            it = res.find(stock("Hotdog Buns"));
            if (it != res.end()) {
                cout << endl << "Currently " << it->num <<
                        " hotdog buns in stock." << endl;
            }
            else {
                cout << endl << "Sorry, no hotdog buns in stock." << endl;
            }
        }
    catch (const mysqlpp::BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const mysqlpp::BadConversion& er) {
        // Handle bad conversions
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return -1;
    }
    catch (const mysqlpp::Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
    }

    return 0;
}
```

For more details on the SSQLS feature, see the Specialized SQL Structures chapter.

3.8. Handling SQL Nulls

There is no equivalent of SQL's null in the standard C++ type system.

The primary distinction is one of type: in SQL, null is a column attribute, which affects whether that column can hold a SQL null. Just like the 'const' keyword in the C++ type system, this effectively doubles the number of SQL data types. To emulate this, MySQL++ provides the Null template to allow the creation of distinct "nullable" versions of existing C++ types. So for example, if you have a TINY INT UNSIGNED column that can have nulls, the proper declaration for MySQL++ would be:

```
mysqlpp::Null<unsigned char> myfield;
```

Template instantiations are first-class types in the C++ language, on par with any other type. You can use Null template instantiations anywhere you'd use the plain version of that type. (You can see a complete list of Null template instantiations for all column types that MySQL understands at the top of lib/type_info.cpp.)

There's a secondary distinction between SQL null and anything available in the standard C++ type system: SQL null is a distinct value, equal to nothing else. We can't use C++'s NULL for this because it is ambiguous, being equal to 0 in integer context. MySQL++ provides the global null object, which you can assign to a Null template instance to make it equal to SQL null:

```
myfield = mysqlpp::null;
```

The final aspect of MySQL++'s null handling is that, by default, it will enforce the uniqueness of the SQL null

value. If you try to convert a SQL null to a plain C++ data type, MySQL++ will throw a BadNullConversion exception. If you insert a SQL null into a C++ stream, you get "(NULL)". If you don't like this behavior, you can change it, by passing a different value for the second parameter to template `Null`. By default, this parameter is NullisNull, meaning that we should enforce the uniqueness of the null type. To relax this distinction, you can instantiate the `Null` template with a different behavior type: NullisZero or NullisBlank. Consider this code:

```
mysqlpp::Null<unsigned char, mysqlpp::NullisZero> myfield;

myfield = mysqlpp::null;
cout << myfield << endl;

int x = myfield;
cout << x << endl;
```

This will print "0" twice. If you had used the default for the second `Null` template parameter, the first output statement would have printed "(NULL)", and the second would have thrown a `BadNullConversion` exception.

3.9. Which Query Type to Use?

There are three major ways to execute a query in MySQL++: `Query::execute()`, `Query::store()`, and `Query::use()`. Which should you use, and why?

`execute()` is for queries that do not return data *per se*. For instance, CREATE INDEX. You do get back some information from the MySQL server, which `execute()` returns to its caller in a ResNSel object. In addition to the obvious — a flag stating whether the query succeeded or not — this object also contains things like the number of rows that the query affected. If you only need the success status, there's `Query::exec()`, which just returns bool.

If your query does pull data from the database, the simplest option is `store()`. This returns a Result object, which contains an in-memory copy of the result set. The nice thing about this is that `Result` is a sequential container, like `std::vector`, so you can iterate through it forwards and backwards, access elements with subscript notation, etc. There are also the `storein()` methods, which actually put the result set into an STL container of your choice. The downside of these methods is that a sufficiently large result set will give your program memory problems.

For these large result sets, the superior option is a `use()` query. This returns a ResUse object, which is similar to Result, but without all of the random-access features. This is because a "use" query tells the database server to send the results back one row at a time, to be processed linearly. It's analogous to a C++ stream's input iterator, as opposed to a random-access iterator that a container like vector offers. By accepting this limitation, you can process arbitrarily large result sets. This technique is demonstrated in `examples/simple3.cpp`:

```
#include "util.h"

#include <mysql++.h>

#include <iostream>
#include <iomanip>

using namespace std;

int
main(int argc, char *argv[])
{
    // Connect to the sample database.
    mysqlpp::Connection con(false);
    if (!connect_to_db(argc, argv, con)) {
        return 1;
    }

    // Ask for all rows from the sample stock table set up by resetdb.
    // Unlike simple2 example, we don't store result set in memory.
    mysqlpp::Query query = con.query();
    query << "select * from stock";
    mysqlpp::ResUse res = query.use();
```

```
        // Retreive result rows one by one, and display them.
        if (res) {
            // Display header
            cout.setf(ios::left);
            cout << setw(21) << "Item" <<
                    setw(10) << "Num" <<
                    setw(10) << "Weight" <<
                    setw(10) << "Price" <<
                    "Date" << endl << endl;

            // Get each row in result set, and print its contents
            mysqlpp::Row row;
            while (row = res.fetch_row()) {
                cout << setw(20) << row["item"] << ' ' <<
                        setw(9) << row["num"] << ' ' <<
                        setw(9) << row["weight"] << ' ' <<
                        setw(9) << row["price"] << ' ' <<
                        setw(9) << row["sdate"] <<
                        endl;
            }

            return 0;
        }
        else {
            cerr << "Failed to get stock item: " << query.error() << endl;
            return 1;
        }
}
```

This example does the same thing as simple2, only with a "use" query instead of a "store" query. If your program uses exceptions, you should instead look at examples/usequery.cpp, which does the same thing as simple, but with exception-awareness.

3.10. Getting Field Meta-Information

The following example demonstrates how to get information about the fields in a result set, such as the name of the field and the SQL type. This is examples/fieldinf1.cpp:

```
#include "util.h"

#include <mysql++.h>

#include <iostream>
#include <iomanip>

using namespace std;
using namespace mysqlpp;

int
main(int argc, char *argv[])
{
    try {
        Connection con(use_exceptions);
        if (!connect_to_db(argc, argv, con)) {
            return 1;
        }

        Query query = con.query();
        query << "select * from stock";
        cout << "Query: " << query.preview() << endl;

        Result res = query.store();
        cout << "Records Found: " << res.size() << endl << endl;

        cout << "Query Info:\n";
```

```
        cout.setf(ios::left);

        for (unsigned int i = 0; i < res.names().size(); i++) {
            cout << setw(2) << i
                    // this is the name of the field
                    << setw(15) << res.names(i).c_str()
                    // this is the SQL identifier name
                    // Result::types(unsigned int) returns a mysql_type_info which in many
                    // ways is like type_info except that it has additional sql type
                    // information in it. (with one of the methods being sql_name())
                    << setw(15) << res.types(i).sql_name()
                    // this is the C++ identifier name which most closely resembles
                    // the sql name (its is implementation defined and often not very readable)
                    << setw(20) << res.types(i).name()
                    << endl;
        }

        cout << endl;

        if (res.types(0) == typeid(string)) {
            // this is demonstrating how a mysql_type_info can be
            // compared with a C++ type_info.
            cout << "Field 'item' is of an SQL type which most "
                    "closely resembles\nthe C++ string type\n";
        }

        if (res.types(1) == typeid(longlong)) {
            cout << "Field 'num' is of an SQL type which most "
                    "closely resembles\nC++ long long int type\n";
        }
        else if (res.types(1).base_type() == typeid(longlong)) {
            // you have to be careful as if it can be null the actual
            // type is Null<TYPE> not TYPE.  So you should always use
            // the base_type method to get at the underlying type.
            // If the type is not null than this base type would be
            // the same as its type.
            cout << "Field 'num' base type is of an SQL type which "
                    "most closely\nresembles the C++ long long int type\n";
        }
    }
    catch (const BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const BadConversion& er) {
        // Handle bad conversions
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return -1;
    }
    catch (const Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
    }

    return 0;
}
```

3.11. Let's Do Something Useful

These next few examples demonstrate just how powerful C++ can be, allowing you to do a lot of work in few lines of code without losing efficiency.

Since the code is meant to be re-used as-is, constants that can differ from one case to another have been grouped in

order to simplify editing. Also, all of these examples have full error checking code, showing off the power of MySQL++'s exception handling features.

Loading binary file in a BLOB column

Since MySQL 3.23, BLOB columns have been available, but their use is sometimes not straightforward. Besides showing how easy it can be with MySQL++, this example demonstrates several features of MySQL++. The program requires one command line parameter, which is a full path to the binary file. This is `examples/load_file.cpp`:

```cpp
#include <mysql++.h>

#include <sys/stat.h>

#include <fstream>

#include <stdlib.h>

using namespace std;
using namespace mysqlpp;

const char MY_DATABASE[] = "telcent";
const char MY_TABLE[] = "fax";
const char MY_HOST[] = "localhost";
const char MY_USER[] = "root";
const char MY_PASSWORD[] = "";
const char MY_FIELD[] = "fax";  // BLOB field

int
main(int argc, char *argv[])
{
    if (argc < 2) {
        cerr << "Usage : load_file full_file_path" << endl << endl;
        return -1;
    }

    Connection con(use_exceptions);
    try {
        con.connect(MY_DATABASE, MY_HOST, MY_USER, MY_PASSWORD);
        Query query = con.query();
        ostringstream strbuf;
        ifstream In(argv[1], ios::in | ios::binary);
        struct stat for_len;
        if ((In.rdbuf())->is_open()) {
            if (stat(argv[1], &for_len) == -1)
                return -1;
            unsigned int blen = for_len.st_size;
            if (!blen)
                return -1;
            char *read_buffer = new char[blen];
            In.read(read_buffer, blen);
            string fill(read_buffer, blen);
            strbuf << "INSERT INTO " << MY_TABLE << " (" << MY_FIELD <<
                ") VALUES(\"" << mysqlpp::escape << fill << "\")" << ends;
            query.exec(strbuf.str());
            delete[]read_buffer;
        }
        else
            cerr << "Failed to open " << argv[1] <<
                    '.' << endl;
    }
    catch (const BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const BadConversion& er) {
        // Handle bad conversions
        cerr << "Conversion error: " << er.what() << endl <<
```

```
                  "\tretrieved data size: " << er.retrieved <<
                  ", actual size: " << er.actual_size << endl;
          return -1;
      }
      catch (const Exception& er) {
          // Catch-all for any other MySQL++ exceptions
          cerr << "Error: " << er.what() << endl;
          return -1;
      }

      return 0;
}
```

Notice that we used the escape manipulator when building the INSERT query above. This is because we're not us-
ing one of the MySQL++ types that does automatic escaping and quoting.

Displaying images in HTML from BLOB column

This example is also a very short one, considering the function that it performs. Although all modern versions of
MySQL have a command that dumps data from a BLOB column to a binary file, this example shows how to do it in
your code instead, without requiring an temporary file on disk. This is examples/cgi_image.cpp:

```
#include <mysql++.h>

using namespace std;
using namespace mysqlpp;

#define MY_DATABASE "telcent"
#define MY_TABLE    "fax"
#define MY_HOST     "localhost"
#define MY_USER     "root"
#define MY_PASSWORD ""
#define MY_FIELD    "fax"       // BLOB field
#define MY_KEY      "datet"     // PRIMARY KEY

int
main(int argc, char *argv[])
{
    if (argc < 2) {
        cerr << "Usage : cgi_image primary_key_value" << endl << endl;
        return -1;
    }

    cout << "Content-type: image/jpeg" << endl;
    Connection con(use_exceptions);
    try {
        con.connect(MY_DATABASE, MY_HOST, MY_USER, MY_PASSWORD);
        Query query = con.query();
        query << "SELECT " << MY_FIELD << " FROM " << MY_TABLE << " WHERE "
            << MY_KEY << " = " << argv[1];
        ResUse res = query.use();
        Row row = res.fetch_row();
        long unsigned int *jj = res.fetch_lengths();
        cout << "Content-length: " << *jj << endl << endl;
        fwrite(row.raw_data(0), 1, *jj, stdout);
    }
    catch (const BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
    }
```

```
        return 0;
}
```

DELETE or UPDATE from SELECT

MySQL's SELECT statement has more power to winnow out just the items of interest from the database than do DELETE or UPDATE queries. Therefore, many people have wanted the ability to execute a SELECT statement that in fact deletes or updates the rows matched, rather than returning them. This example implements that feature in just a few lines of code. It is `examples/updel.cpp`:

```cpp
#include <mysql++.h>

#include <string>

using namespace std;
using namespace mysqlpp;

#define MY_DATABASE "telcent"
#define MY_TABLE    "nazivi"
#define MY_HOST     "localhost"
#define MY_USER     "root"
#define MY_PASSWORD ""
#define MY_FIELD    "naziv"
#define MY_QUERY    "SELECT URL from my_table as t1, my_table as t2 where t1.field = t2.field"

int
main()
{
    Connection con(use_exceptions);
    try {
        ostringstream strbuf;
        unsigned int i = 0;
        con.connect(MY_DATABASE, MY_HOST, MY_USER, MY_PASSWORD);
        Query query = con.query();
        query << MY_QUERY;
        ResUse res = query.use();
        Row row;
        strbuf << "delete from " << MY_TABLE << " where " << MY_FIELD <<
            " in (";
        //  for UPDATE just replace the above DELETE FROM with UPDATE statement
        for (; row = res.fetch_row(); i++)
            strbuf << row.at(0) << ",";
        if (!i)
            return 0;
        string output(strbuf.str());
        output.erase(output.size() - 1, 1);
        output += ")";
        query.exec(output);
        //cout << output << endl;
    }
    catch (const BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const BadConversion& er) {
        // Handle bad conversions
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return -1;
    }
    catch (const Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
```

```
    }

    return 0;
}
```

Notice that the row values used in the IN clause aren't escaped or quoted. This is because row elements are ColData types, so they have automatic escaping and quoting, as appropriate to the type being inserted. If you want to disable this feature, it's easily done: click the ColData link for the details.

Users of this example should beware that one more check is required in order to run this query safely: in some extreme cases, the size of the query might grow larger than MySQL's maximum allowed packet size. This check should be added.

4. Template Queries

Another powerful feature of MySQL++ is being able to set up template queries. These are kind of like C's `printf()` facility: you give MySQL++ a string containing the fixed parts of the query and placeholders for the variable parts, and you can later substitute in values into those placeholders.

The following program demonstrates how to use this feature. This is `examples/resetdb.cpp`, the program you've run a few times now if you've worked through all the examples:

```
#include "util.h"

#include <mysql++.h>

#include <iostream>

using namespace std;

int
main(int argc, char *argv[])
{
    // Connect to database server
    mysqlpp::Connection con;
    try {
        cout << "Connecting to database server..." << endl;
        connect_to_db(argc, argv, con, "");
    }
    catch (exception& er) {
        cerr << "Connection failed: " << er.what() << endl;
        return 1;
    }

    // Create new sample database, or re-create it.  We suppress
    // exceptions, because it's not an error if DB doesn't yet exist.
    bool new_db = false;
    {
        mysqlpp::NoExceptions ne(con);
        mysqlpp::Query query = con.query();
        if (con.select_db(kpcSampleDatabase)) {
            // Toss old table, if it exists.  If it doesn't, we don't
            // really care, as it'll get created next.
            cout << "Dropping existing stock table..." << endl;
            query.execute("drop table stock");
        }
        else {
            // Database doesn't exist yet, so create and select it.
            if (con.create_db(kpcSampleDatabase) &&
                    con.select_db(kpcSampleDatabase)) {
                new_db = true;
            }
            else {
                cerr << "Error creating DB: " << con.error() << endl;
```

```
                return 1;
            }
        }
    }

    // Create sample data table within sample database.
    cout << "Creating new stock table..." << endl;
    try {
        // Send the query to create the table and execute it.
        mysqlpp::Query query = con.query();
        query << "create table stock (item char(20) not null, "
                "num bigint, weight double, price double, sdate date)";
        query.execute();

        // Set up the template query to insert the data.  The parse()
        // call tells the query object that this is a template and
        // not a literal query string.
        query << "insert into %5:table values (%0q, %1q, %2, %3, %4q)";
        query.parse();

        // Set the template query parameter "table" to "stock".
        query.def["table"] = "stock";

        // Notice that we don't give a sixth parameter in these calls,
        // so the default value of "stock" is used.  Also notice that
        // the first row is a UTF-8 encoded Unicode string!  All you
        // have to do to store Unicode data in recent versions of MySQL
        // is use UTF-8 encoding.
        cout << "Populating stock table..." << endl;
        query.execute("Nürnberger Brats", 92, 1.5, 8.79, "2005-03-10");
        query.execute("Pickle Relish", 87, 1.5, 1.75, "1998-09-04");
        query.execute("Hot Mustard", 75, .95, .97, "1998-05-25");
        query.execute("Hotdog Buns", 65, 1.1, 1.1, "1998-04-23");

        cout << (new_db ? "Created" : "Reinitialized") <<
                " sample database successfully." << endl;
    }
    catch (const mysqlpp::BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return 1;
    }
    catch (const mysqlpp::BadConversion& er) {
        // Handle bad conversions
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return 1;
    }
    catch (const mysqlpp::Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return 1;
    }

    return 0;
}
```

The line just before the call to `query.parse()` sets the template, and the parse call puts it into effect. From that point on, you can re-use this query by calling any of several Query member functions that accept query template parameters. In this example, we're using `Query::execute()`.

Let's dig into this feature a little deeper.

4.1. Setting up template queries

To set up a template query, you simply insert it into the Query object, using numbered placeholders wherever you

want to be able to change the query. Then, you call the parse() function to tell the Query object that the query string is a template query, and it needs to parse it:

```
query << "select (%2:field1, %3:field2) from stock where %1:wheref = %0q:what";
query.parse();
```

The format of the placeholder is:

```
%###(modifier)(:name)(:)
```

Where '###' is a number up to three digits. It is the order of parameters given to a SQLQueryParms object, starting from 0.

'modifier' can be any one of the following:

%	Print an actual "%"
""	Don't quote or escape no matter what.
q	This will quote and escape the item using the MySQL C API function mysql-escape-string if it is a string or char *, or another MySQL-specific type that needs to be quoted.
Q	Quote but don't escape based on the same rules as for 'q'. This can save a bit of processing time if you know the strings will never need quoting
r	Always quote and escape even if it is a number.
R	Always quote but don't escape even if it is a number.

":name" is for an optional name which aids in filling SQLQueryParms. Name can contain any alpha-numeric characters or the underscore. You can have a trailing colon, which will be ignored. If you need to represent an actual colon after the name, follow the name with two colons. The first one will end the name and the second one won't be processed.

4.2. Setting the parameters at execution time

To specify the parameters when you want to execute a query simply use Query::store(const SQLString &parm0, [..., const SQLString &parm11]). This type of multiple overload also exists for Query::use() and Query::execute(). 'parm0' corresponds to the first parameter, etc. You may specify up to 12 parameters. For example:

```
Result res = query.store("Dinner Rolls", "item", "item", "price")
```

with the template query provided above would produce:

```
select (item, price) from stock where item = "Dinner Rolls"
```

The reason we didn't put the template parameters in numeric order...

```
select (%0:field1, %1:field2) from stock where %2:wheref = %3q:what
```

...will become apparent shortly.

4.3. Using defaults

You can also set the parameters one at a time by means of class Query's public data member def. To change the values of the def, simply use the subscript operator. You can refer to the parameters either by number or by name. The following two examples have the same effect:

```
query.def[0] = "Dinner Rolls";
query.def[1] = "item";
query.def[2] = "item";
query.def[3] = "price";
```

and

```
query.def["what"] = "Dinner Rolls";
query.def["wheref"] = "item";
query.def["field1"] = "item";
query.def["field2"] = "price";
```

Once all the parameters are set simply execute as you would have executed the query before you knew about template queries:

```
Result res = query.store()
```

4.4. Combining the two

You can also combine the use of setting the parameters at execution time and setting them via the def object by calling Query::store() (or use() or execute()) without passing the full number of parameters that the template supports:

```
query.def["field1"] = "item";
query.def["field2"] = "price";
Result res1 = query.store("Hamburger Buns", "item");
Result res2 = query.store(1.25, "price");
```

Would store the query:

```
select (item, price) from stock where item = "Hamburger Buns"
```

for res1 and

```
select (item, price) from stock where price = 1.25
```

for res2.

Now you see why we ordered the placeholders in the template above as we did: we used positions 0 and 1 for the ones we want to change frequently, and used 2 and 3 for the parameters that seldom change.

One thing to watch out for, however, is that Query::store(const char* q) is also defined for executing the query q. Therefore, when you call Query::store() (or use(), or execute()) with only one item and that item is a const char*, you need to explicitly convert it into a SQLString to get the right overload:

```
Result res = query.store(SQLString("Hamburger Buns"));
```

4.5. Error Handling

If for some reason you did not specify all the parameters when executing the query and the remaining parameters do not have their values set via def, the query object will throw a BadParamCount object. If this happens, you can get an explanation of what happened by checking the value of `SQLQueryNEParms::string`, like so:

```
query.def["field1"] = "item";
query.def["field2"] = "price";
Result res = query.store(1.25);
```

This would throw `SQLQueryNEParms` because the wheref is not specified.

In theory, this exception should never be thrown. If the exception is thrown it probably a logic error in your program.

5. Specialized SQL Structures

The Specialized SQL Structure (SSQLS) feature lets you easily define C++ structures that match the form of your SQL tables. Because of the extra functionality that this feature builds into these structures, MySQL++ can populate them automatically when retrieving data from the database; with queries returning many records, you can ask MySQL++ to populate an STL container of your SSQLS records with the results. When updating the database, MySQL++ can use SSQLS structures to match existing data, and it can insert SSQLS structures directly into the database.

You define an SSQLS using one of several macros. (These are in the file custom.h, and in the file that it includes, custom-macros.h.) There are a bunch of different macros, for different purposes. The following sections will discuss each macro type separately, beginning with the easiest and most generally useful.

5.1. sql_create

This is the most basic sort of SSQLS declaration:

```
sql_create_5(stock, 0, 0,
    string, item,
    int, num,
    double, weight,
    double, price,
    mysqlpp::Date, date)
```

This creates a C++ structure called 'stock' containing five member variables, along with some constructors and other member functions useful with MySQL++.

One of the generated constructors takes a reference to a mysqlpp::Row object, allowing you to easily populate a vector of stocks like so:

```
vector<stock> result;
query.storein(result);
```

That's all there is to it. The only requirements are that the table structure be compatible with the SSQLS's member variables, and that the fields are in the same order.

The general format of this set of macros is:

```
sql_create_#(NAME, KEYS, INITPARMS, TYPE1, ITEM1, ... TYPE#, ITEM#)
```

Where # is the number of member variables, NAME is the name of the structure you wish to create, TYPE*x* is the type name for a member variable, and ITEM*x* is that variable's name.

The KEYS and INITPARMS arguments can always be zero, to keep things simple. We will discuss what happens if

you use different values in the next few sections.

5.2. sql_create with Compare

SSQLS structures can also have member functions that allow you to compare one structure to another. You simply change the first 0 in the previous example (KEYS) to a higher value. If this number is N, then two structures are considered equal if the first N members of each are equal.

For example:

```
sql_create_5(stock, 1, 0,
    string, item,
    int, num,
    double, weight,
    double, price,
    mysqlpp::Date, date)
```

Here we are saying that the 'item' field is a kind of key field: it is always unique between any two 'stock' items, so if two stock records have equal item values, they are the same stock item.

That change adds the following members to the SSQLS:

```
struct stock {
    ...
    stock(const std::string &p1);
    set(const std::string &p1);
    bool operator ==(const stock &other) const;
    bool operator !=(const stock &other) const;
    bool operator >(const stock &other) const;
    bool operator <(const stock &other) const;
    bool operator >=(const stock &other) const;
    bool operator <=(const stock &other) const;
    int cmp(const stock &other) const;
    int compare(const stock &other) const;
}

int compare(const stock &x, const stock &y);
```

The global `compare()` function compares x to y and returns <0 if x < y, 0 if x = y, and >0 if x > y. `stock::cmp()` and `stock::compare()` are the same thing as `compare(*this, other)`.

The additional constructor initializes the key fields of the structure and leaves the other member variables undefined. This is useful for creating temporary objects to use for comparisons like `x <= stock("Hotdog")`.

Because stock is now less-than-comparable you can store the query results in an STL associative container:

```
std::set<stock> result;
query.storein(result);
```

And you can now use it like any other set:

```
cout << result.lower_bound(stock("Hamburger"))->item << endl;
```

This will return the first item that begins with "Hamburger".

You can also use it will any STL algorithm that require the values to be less-than-comparable.

5.3. sql_create with Additional Initializers

If third parameter for this macro (INITPARMS) is nonzero, the SSQLS will have two additional members functions

that make it easier to initialize the structure's data members. For example:

```
sql_create_5(stock, 1, 5,
    string, item,
    int, num,
    double, weight,
    double, price,
    mysqlpp::Date, date)
```

will add these functions to the structure relative to that in the previous example:

```
struct stock {
    ...
    stock(const string&, const int&, const double&,
            const double&, const mysqlpp::Date&);
    void set(const string&, const int&, const double&,
            const double&, const mysqlpp::Date&);
}
```

There is one trick with this: because each SSQLS has at least one other constructor besides the one defined by this feature, not every logical value for INITPARMS results in working code. A simple example is setting KEYS and INITPARMS to the same value: you get two identical constructor definitions, so the compiler refuses to compile the code. If you are getting compiler errors having to do with duplicate definitions, try changing this value to zero.

5.4. An Important Limitation of sql_create

The features described in the two previous sections work together nicely most of the time. However, if you try to use the same value for the second and third parameters to `sql_create_N`, your program will fail to compile.

Why is this?

The second parameter sets up SSQLS comparisons, one aspect of which defines a constructor taking just the table's key fields. The third parameter sets up an initialization constructor, taking as many fields as you request. When these two values are equal, you get two identical constructor definitions, which is illegal in C++.

The solution is to use 0 for the third parameter, indicating that you do not need a separate full-initialization constructor. `examples/custom6.cpp` illustrates this:

```
#include "util.h"

#include <mysql++.h>
#include <custom.h>

#include <iostream>
#include <iomanip>
#include <vector>

using namespace std;

// To store a subset of a row, we define an SSQLS containing just the
// fields that we will store.  There are complications here that are
// covered in the user manual.
sql_create_1(stock_subset,
            1, 0,
            string, item)

int
main(int argc, char *argv[])
{
    try {
        // Establish the connection to the database server.
        mysqlpp::Connection con(mysqlpp::use_exceptions);
        if (!connect_to_db(argc, argv, con)) {
```

```
                return 1;
        }

        // Retrieve a subset of the stock table, and store the data in
        // a vector of 'stock_subset' SSQLS structures.
        mysqlpp::Query query = con.query();
        query << "select item from stock";
        vector<stock_subset> res;
        query.storein(res);

        // Display the result set
        cout << "We have:" << endl;
        vector<stock_subset>::iterator it;
        for (it = res.begin(); it != res.end(); ++it) {
            cout << '\t' << it->item << endl;
        }
    }
    catch (const mysqlpp::BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const mysqlpp::BadConversion& er) {
        // Handle bad conversions; e.g. type mismatch populating 'stock'
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return -1;
    }
    catch (const mysqlpp::Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
    }

    return 0;
}
```

This example shows one other thing, which is how to retrieve a subset of a table using SSQLS. Because we wanted only one column from the table, we had to pass 0 for the third parameter to `sql_create_N` to get the code to compile.

(See the simple1 example in the Tutorial for another way to accomplish the same thing.)

5.5. Additional Features of Specialized SQL Structures

Up to this point, we haven't been using all of the features in the SSQLS structures we've been generating. We could have used the `sql_create_basic_*` macros instead, which would have worked just as well for what we've seen so far, and the generated code would have been smaller.

Why is it worth ignoring the "basic" variants of these macros, then? Consider this:

```
query.insert(s);
```

This does exactly what you think it does: it inserts 's' into the database. This is possible because a standard SSQLS has functions that the query object can call to get the list of fields and such, which it uses to build an insert query. `query::update()` and `query::replace()` also rely on this SSQLS feature. A basic SSQLS lacks these functions.

Another feature of standard SSQLSes you might find a use for is changing the table name used in queries. By default, the table in the MySQL database is assumed to have the same name as the SSQLS structure type. But if this is inconvenient, you can globally change the table name used in queries like this:

```
stock::table() = "MyStockData";
```

5.6. Harnessing SSQLS Internals

Continuing the discussion in the previous section, there is a further set of methods that the non-"basic" versions of the `sql_create` macros define for each SSQLS. These methods are mostly for use within the library, but some of them are useful enough that you might want to harness them for your own ends. Here is some pseudocode showing how the most useful of these methods would be defined for the `stock` structure used in all the `custom*.cpp` examples:

```
// Basic form
template <class Manip>
stock_value_list<Manip> value_list(cchar *d = ",",
    Manip m = mysqlpp::quote) const;

template <class Manip>
stock_field_list<Manip> field_list(cchar *d = ",",
    Manip m = mysqlpp::do_nothing) const;

template <class Manip>
stock_equal_list<Manip> equal_list(cchar *d = ",",
    cchar *e = " = ", Manip m = mysqlpp::quote) const;


// Boolean argument form
template <class Manip>
stock_cus_value_list<Manip> value_list([cchar *d, [Manip m,] ]
    bool i1, bool i2 = false, ... , bool i5 = false) const;

// List form
template <class Manip>
stock_cus_value_list<Manip> value_list([cchar *d, [Manip m,] ]
    stock_enum i1, stock_enum i2 = stock_NULL, ...,
    stock_enum i5 = stock_NULL) const;

// Vector form
template <class Manip>
stock_cus_value_list<Manip> value_list([cchar *d, [Manip m,] ]
    vector<bool> *i) const;

...Plus the obvious equivalents for field_list() and equal_list()
```

Rather than try to learn what all of these methods do at once, let's ease into the subject. Consider this code:

```
stock s("Dinner Rolls", 75, 0.95, 0.97, "1998-05-25");
cout << "Value list: " << s.value_list() << endl;
cout << "Field list: " << s.field_list() << endl;
cout << "Equal list: " << s.equal_list() << endl;
```

That would produce something like:

```
Value list: 'Dinner Rolls',75,0.95,0.97,'1998-05-25'
Field list: item,num,weight,price,date
Equal list: item = 'Dinner Rolls',num = 75,weight = 0.95, price = 0.97,date = '1998-05-25'
```

That is, a "value list" is a list of data member values within a particular SSQLS instance, a "field list" is a list of the fields (columns) within that SSQLS, and an "equal list" is a list in the form of an SQL equals clause.

Just knowing that much, it shouldn't surprise you to learn that `Query::insert()` is implemented more or less like this:

```
*this << "INSERT INTO " << v.table() << " (" << v.field_list() <<
```

```
        ") VALUES (" << v.value_list() << ")";
```

where 'v' is the SSQLS you're asking the Query object to insert into the database.

Now let's look at a complete example, which uses one of the more complicated forms of `equal_list()`. This example builds a query with fewer hard-coded strings than the most obvious technique requires, which makes it more robust in the face of change. Here is `examples/custom5.cpp`:

```
#include "util.h"

#include <mysql++.h>
#include <custom.h>

#include <iostream>
#include <iomanip>
#include <vector>

using namespace std;

sql_create_5(stock,
             1, 5,
             string, item,
             mysqlpp::longlong, num,
             double, weight,
             double, price,
             mysqlpp::Date, sdate)

int
main(int argc, char *argv[])
{
    try {
        mysqlpp::Connection con(mysqlpp::use_exceptions);
        if (!connect_to_db(argc, argv, con)) {
            return 1;
        }

        // Get all the rows in the stock table.
        mysqlpp::Query query = con.query();
        query << "select * from stock";
        vector<stock> res;
        query.storein(res);

        if (res.size() > 0) {
            // Build a select query using the data from the first row
            // returned by our previous query.
            query.reset();
            query << "select * from stock where " <<
                res[0].equal_list(" and ", stock_weight, stock_price);

            // Display the finished query.
            cout << "Custom query:\n" << query.preview() << endl;
        }
    }
    catch (const mysqlpp::BadQuery& er) {
        // Handle any query errors
        cerr << "Query error: " << er.what() << endl;
        return -1;
    }
    catch (const mysqlpp::BadConversion& er) {
        // Handle bad conversions
        cerr << "Conversion error: " << er.what() << endl <<
                "\tretrieved data size: " << er.retrieved <<
                ", actual size: " << er.actual_size << endl;
        return -1;
    }
    catch (const mysqlpp::Exception& er) {
        // Catch-all for any other MySQL++ exceptions
        cerr << "Error: " << er.what() << endl;
        return -1;
```

```
    }

    return 0;
}
```

This example uses the list form of `equal_list()`. The arguments `stock_weight` and `stock_price` are enum values equal to the position of these columns within the `stock` table. `sql_create_`*x* generates this enum for you automatically.

The boolean argument form of that `equal_list()` call would look like this:

```
query << "select * from stock where " <<
        res[0].equal_list(" and ", false, false, true, true, false);
```

It's a little more verbose, as you can see. And if you want to get really complicated, use the vector form:

```
vector<bool> v(5, false);
v[stock_weight] = true;
v[stock_price] = true;
query << "select * from stock where " <<
        res[0].equal_list(" and ", v);
```

This form makes the most sense if you are building many other queries, and so can re-use that vector object.

Many of these methods accept manipulators and custom delimiters. The defaults are suitable for building SQL queries, but if you're using these methods in a different context, you may need to override these defaults. For instance, you could use these methods to dump data to a text file using different delimiters and quoting rules than SQL.

At this point, we've seen all the major aspects of the SSQLS feature. The final sections of this chapter look at some of the peripheral aspects.

5.7. Alternate Creation Methods

If for some reason you want your SSQLS data members to have different names than used in the MySQL database, you can do so like this:

```
sql_create_c_names_5(stock, 1, 5,
    string, item, "item",
    int, num, "quantity",
    double, weight, "weight",
    double, price, "price"
    mysqlpp::Date, date, "shipment")
```

If you want your SSQLS to have its data members in a different order from those in the MySQL table, you can do it like this:

```
sql_create_c_order_5(stock, 2, 5,
    mysqlpp::Date, date, 5,
    double, price, 4,
    string, item, 1,
    int, num, 2,
    double, weight, 3)
```

You can combine the custom names and custom ordering like this:

```
sql_create_complete_5(stock, 2, 5,
    mysqlpp::date, date, "shipment", 5,
    double, price, "price", 4,
```

```
    string, item, "item", 1,
    int, num, "quantity", 2,
    double, weight, "weight", 3)
```

All three of these macro types have "basic" variants that work the same way. Again, basic SSQLSes lack the features necessary for automatic insert, update and replace query creation.

5.8. Expanding SSQLS Macros

If you ever need to see the code that a given SSQLS declaration expands out to, use the utility `doc/ssqls-pretty`, like so:

```
ssqls-pretty < myprog.cpp |less
```

This locates the first SSQLS declaration in that file and uses the C++ preprocessor to expand that macro. You may have to change the script to tell it where your MySQL++ header files are.

5.9. Extending the SSQLS Mechanism

The SSQLS headers — custom.h and custom-macros.h — are automatically generated by the Perl script custom.pl. Although it is possible to change this script to get additional functionality, it's usually better to do that through inheritance.

A regular user may find it helpful to change the the limit on the maximum number of SSQLS data members allowed. It's 25 out of the box. A smaller value may speed up compile time, or you may require a higher value because you have more complex tables than that. Simply change the `max_data_members` variable at the top of custom.pl and say 'make'. The limit for Visual C++ is 31, according to one report. There doesn't seem to be a practical limit with GCC 3.3 at least: I set the limit to 100 and the only thing that happened is that custom-macros.h went from 1.3 MB to 18 MB and the build time for `examples/custom.*` got a lot longer.

6. Using Unicode with MySQL++

6.1. A Short History of Unicode

...with a focus on relevance to MySQL++

In the old days, computer operating systems only dealt with 8-bit character sets. This only gives you 256 possible characters, but the modern Western languages have more characters combined than that by themselves. Add in all the other lanauges of the world, plus the various symbols people use, and you have a real mess! Since no standards body held sway over things like international character encoding in the early days of computing, many different character sets were invented. These character sets weren't even standardized between operating systems, so heaven help you if you needed to move localized Greek text on a Windows machine to a Russian Macintosh! The only way we got any international communication done at all was to build standards on the common 7-bit ASCII subset. Either people used approximations like a plain "c" instead of the French "ç", or they invented things like HTML entities ("ç" in this case) to encode these additional characters using only 7-bit ASCII.

Unicode solves this problem. It encodes every character in the world, using up to 4 bytes per character. The subset covering the most economically valuable cases takes two bytes per character, so most Unicode-aware programs deal in 2-byte characters, for efficiency.

Unfortunately, Unicode came about two decades too late for Unix and C. Converting the Unix system call interface to use multi-byte Unicode characters would break all existing programs. The ISO lashed a wide character sidecar onto C in 1995, but in common practice C is still tied to 8-bit characters.

As Unicode began to take off in the early 1990s, it became clear that some sort of accommodation with Unicode was needed in legacy systems like Unix and C. During the development of the Plan 9 operating system (a kind of successor to Unix) Ken Thompson invented the UTF-8 encoding. UTF-8 is a superset of 7-bit ASCII and is compatible with C strings, since it doesn't use 0 bytes anywhere as multi-byte Unicode encodings do. As a result, many pro-

grams that deal in text will cope with UTF-8 data even though they have no explicit support for UTF-8. (Follow the last link above to see how the design of UTF-8 allows this.)

The MySQL database server comes out of the Unix/C tradition, so it only supports 8-bit characters natively. All versions of MySQL could store UTF-8 data, but sometimes the server actually needs to understand the data; when sorting, for instance. To support this, explicit UTF-8 support was added to MySQL in version 4.1.

Because MySQL++ does not need to understand the text flowing through it, it neither has nor needs explicit UTF-8 support. C++'s `std::string` stores UTF-8 data just fine. But, your program probably *does* care about the text it gets from the database via MySQL++. The remainder of this chapter covers the choices you have for dealing with UTF-8 encoded Unicode data in your program.

6.2. Unicode and Unix

Modern Unices support UTF-8 natively. Red Hat Linux, for instance, has had system-wide UTF-8 support since version 8. This continues in the Enterprise and Fedora forks of Red Hat Linux, of course.

On such a Unix, the terminal I/O code understands UTF-8 encoded data, so your program doesn't require any special code to correctly display a UTF-8 string. If you aren't sure whether your system supports UTF-8 natively, just run the simple1 example: if the first item has two high-ASCII characters in place of the "ü" in "Nürnberger Brats", you know it's not handling UTF-8.

If your Unix doesn't support UTF-8 natively, it likely doesn't support any form of Unicode at all, for the historical reasons I gave above. Therefore, you will have to convert the UTF-8 data to the local 8-bit character set. The standard Unix function `iconv()` can help here. If your system doesn't have the `iconv()` facility, there is a free implementation available from the GNU Project. Another library you might check out is IBM's ICU. This is rather heavyweight, so if you just need basic conversions, `iconv()` should suffice.

6.3. Unicode and Win32

Each Win32 API function that takes a string actually has two two versions. One version supports only 1-byte "ANSI" characters (a superset of ASCII), so they end in 'A'. Win32 also supports the 2-byte subset of Unicode called UCS-2. Some call these "wide" characters, so the other set of functions end in 'W'. The `MessageBox()` API, for instance, is actually a macro, not a real function. If you define the `UNICODE` macro when building your program, the `MessageBox()` macro evaluates to `MessageBoxW()`; otherwise, to `MessageBoxA()`.

Since MySQL uses UTF-8 and Win32 uses UCS-2, you must convert data going between the Win32 API and MySQL++. Since there's no point in trying for portability — no other OS I'm aware of uses UCS-2 — you might as well use native Win32 functions for doing this translation. The following code is distilled from `utf8_to_win32_ansi()` in `examples/util.cpp`:

```
void utf8_to_win32_ansi(const char* utf8_str, char* ansi_str, int ansi_len)
{
    wchar_t ucs2_buf[100];
    static const int ub_chars = sizeof(ucs2_buf) / sizeof(ucs2_buf[0]);

    MultiByteToWideChar(CP_UTF8, 0, utf8_str, -1, ucs2_buf, ub_chars);
    CPINFOEX cpi;
    GetCPInfoEx(CP_OEMCP, 0, &cpi);
    WideCharToMultiByte(cpi.CodePage, 0, ucs2_buf, -1,
            ansi_str, ansi_len, 0, 0);
}
```

The examples use this function automatically on Windows systems. To see it in action, run simple1 in a console window (a.k.a. "DOS box"). The first item should be "Nürnberger Brats". If not, see the last paragraph in this section.

`utf8_to_win32_ansi()` converts `utf8_str` from UTF-8 to UCS-2, and from there to the local code page. "Waitaminnit," you shout! "I thought we were trying to get away from the problem of local code pages!" The console is

one of the few Win32 facilities that doesn't support UCS-2 by default. It can be put into UCS-2 mode, but that seems like more work than we'd like to go to in a portable example program. Since the default code page in most versions of Windows includes the "ü" character used in the sample database, this conversion works out fine for our purposes.

If your program is using the GUI to display text, you don't need the second conversion. Prove this to yourself by adding the following to `utf8_to_win32_ansi()` after the `MultiByteToWideChar()` call:

```
MessageBox(0, ucs2_buf, "UCS-2 version of Item", MB_OK);
```

All of this assumes you're using Windows NT or one of its direct descendants: Windows 2000, Windows XP, Windows 2003 Server, and someday "Longhorn". Windows 95/98/ME and Windows CE do not support UCS-2. They still have the 'W' APIs for compatibility, but they just smash the data down to 8-bit and call the 'A' version for you.

6.4. For More Information

The Unicode FAQs page has copious information on this complex topic.

When it comes to Unix and UTF-8 specific items, the UTF-8 and Unicode FAQ for Unix/Linux is a quicker way to find basic information.

7. Incompatible Library Changes

This chapter documents those library changes since the epochal 1.7.9 release that break end-user programs. You can dig this stuff out of the ChangeLog, but the ChangeLog focuses more on explaining and justifying the facets of each change, while this section focuses on how to migrate your code between these library versions.

Since pure additions do not break programs, those changes are still documented only in the ChangeLog.

7.1. API Changes

This section documents files, functions, methods and classes that were removed or changed in an incompatible way. If your program uses the changed item, you will have to change something in your program to get it to compile after upgrading to each of these versions.

v1.7.10

Removed `Row::operator[]()` overloads except the one for `size_type`, and added `Row::lookup_by_name()` to provide the "subscript by string" functionality. In practical terms, this change means that the `row["field"]` syntax no longer works; you must use the new `lookup_by_name` method instead.

Renamed the generated library on POSIX systems from `libsqlplus` to `libmysqlpp`.

v1.7.19

Removed `SQLQuery::operator=()`, and the same for its `Query` subclass. Use the copy constructor instead, if you need to copy one query to another query object.

v1.7.20

The library used to have two names for many core classes: a short one, such as `Row` and a longer one, `MysqlRow`. The library now uses the shorter names exclusively.

All symbols within MySQL++ are in the `mysqlpp` namespace now if you use the new `mysql++.h` header. If you use the older `sqlplus.hh` or `mysql++.hh` headers, these symbols are hoist up into the global namespace. The older headers cause the compiler to emit warnings if you use them, and they will go away someday.

v2.0.0

Connection class changes

- `Connection::create_db()` and `drop_db()` return `true` on success. They returned `false` in v1.7.*x*! This change will only affect your code if you have exceptions disabled.

- Renamed `Connection::real_connect()` to `connect()`, made several more of its parameters default, and removed the old `connect()` method, as it's now a strict subset of the new one. The only practical consequence is that if your program was using `real_connect()`, you will have to change it to `connect()`.

- Replaced `Connection::read_option()` with new `set_option()` mechanism. In addition to changing the name, programs using this function will have to use the new `Connection::Option` enumerated values, accept a `true` return value as meaning success instead of 0, and use the proper argument type. Regarding the latter, `read_option()` took a `const char*` argument, but because it was just a thin wrapper over the MySQL C API function mysql-options, the actual value being pointed to could be any of several types. This new mechanism is properly type-safe.

Exception-related changes

- Classes `Connection`, `Query`, `Result`, `ResUse`, and `Row` now derive from OptionalExceptions which gives these classes a common interface for disabling exceptions. In addition, almost all of the per-method exception-disabling flags were removed. The preferred method for disabling exceptions on these objects is to create an instance of the new NoExceptions class on the stack, which disables exceptions on an `OptionalExceptions` subclass as long as the `NoExceptions` instance is in scope. You can instead call `disable_exceptions()` on any of these objects, but if you only want them disabled temporarily, it's easy to forget to re-enable them later.

- In the previous version of MySQL++, those classes that supported optional exceptions that could create instances of other such classes were supposed to pass this flag on to their children. That is, if you created a `Connection` object with exceptions enabled, and then asked it to create a `Query` object, the `Query` object also had exceptions disabled. The problem is, this didn't happen in all cases where it should have in v1.7. This bug is fixed in v2.0. If your program begins crashing due to uncaught exceptions after upgrading to v2.0, this is the most likely cause. The most expeditious fix in this situation is to use the new `NoExceptions` feature to return these code paths to the v1.7 behavior. A better fix is to rework your program to avoid or deal with the new exceptions.

- All custom MySQL++ exceptions now derive from the new Exception interface. The practical upshot of this is that the variability between the various exception types has been eliminated. For instance, to get the error string, the `BadQuery` exception had a string member called `error` plus a method called `what()`. Both did the same thing, and the `what()` method is more common, so the error string was dropped from the interface. None of the example programs had to be changed to work with the new exceptions, so if your program handles MySQL++ exceptions the same way they do, your program won't need to change, either.

- Renamed `SQLQueryNEParams` exception to `BadParamCount` to match style of other exception names.

- Added BadOption, ConnectionFailed, DBSelectionFailed, EndOfResults, EndOfResultSets, LockFailed, and ObjectNotInitialized exception types, to fix overuse of `BadQuery`. Now the latter is used only for errors on query execution. If your program has a "catch-all" block taking a `std::exception` for each try block containing MySQL++ statements, you probably won't need to change your program. Otherwise, the new exceptions will likely show up as program crashes due to unhandled exceptions.

Query class changes

- In previous versions, `Connection` had a querying interface similar to class `Query`'s. These methods were intended only for `Query`'s use; no example ever used this interface directly, so no end-user code is likely to be affected by this change.

- A more likely problem arising from the above change is code that tests for query success by calling the `Connection` object's `success()` method or by casting it to `bool`. This will now give misleading results, because queries no longer go through the `Connection` object. Class `Query` has the same success-testing interface, so use it instead.

- `Query` now derives from `std::ostream` instead of `std::stringstream`.

Result/ResUse class changes

- Renamed `ResUse::mysql_result()` to `raw_result()` so it's database server neutral.

- Removed `ResUse::eof()`, as it wrapped the deprecated and unnecessary MySQL C API function mysql-eof. See the `simple3` and `usequery` examples to see the proper way to test for the end of a result set.

Row class changes

- Removed "field name" form of `Row::field_list()`. It was pointless.

- `Row` subscripting works more like v1.7.9: one can subscript a `Row` with a string (e.g. `row["myfield"]`), or with an integer (e.g. `row[5]`). `lookup_by_name()` was removed. Because `row[0]` is ambiguous (0 could mean the first field, or be a null pointer to `const char*`), there is now `Row::at()`, which can look up any field by index.

Miscellaneous changes

- Where possible, all distributed Makefiles only build dynamic libraries. (Shared objects on most Unices, DLLs on Windows, etc.) Unless your program is licensed under the GPL or LGPL, you shouldn't have been using the static libraries from previous versions anyway.

- Removed the backwards-compatibility headers `sqlplus.hh` and `mysql++.hh`. If you were still using these, you will have to change to `mysql++.h`, which will put all symbols in `namespace mysqlpp`.

- Can no longer use arrow operator (`->`) on the iterators into the `Fields`, `Result` and `Row` containers.

7.2. ABI Changes

This section documents those library changes that require you to rebuild your program so that it will link with the new library. Most of the items in the previous section are also ABI changes, but this section is only for those items that shouldn't require any code changes in your program.

If you were going to rebuild your program after installing the new library anyway, you can probably ignore this section.

v1.7.18

The `Query` classes now subclass from `stringstream` instead of the deprecated `strstream`.

v1.7.19

Fixed several `const`-incorrectnesses in the `Query` classes.

v1.7.22

Removed "reset query" parameters from several `Query` class members. This is not an API change, because the parameters were given default values, and the library would ignore any value other than the default. So, any program that tried to make them take another value wouldn't have worked anyway.

v1.7.24

Some freestanding functions didn't get moved into `namespace mysqlpp` when that namespace was created. This release fixed that. It doesn't affect the API if your program's C++ source files say `using namespace mysqlpp` within them.

v2.0.0

Removed `Connection::infoo()`. (I'd call this an API change if I thought there were any programs out there actually using this...)

Collapsed the `Connection` constructor taking a bool (for setting the throw_exceptions flag) and the default constructor into a single constructor using a default for the parameter.

Classes `Connection` and `Query` are now derived from the `Lockable` interface, instead of implementing their own lock/unlock functions.

In several instances, functions that took objects by value now take them by const reference, for efficiency.

Merged `SQLQuery` class's members into class `Query`.

Merged `RowTemplate` class's members into class `Row`.

Reordered member variable declarations in some classes. The most common instance is when the private section was declared before the public section; it is now the opposite way. This can change the object's layout in memory, so a program linking to the library must be rebuilt.

Simplified the date and time class hierarchy. Date used to derive from `mysql_date`, Time used to derive from `mysql_time`, and DateTime used to derive from both of those. All three of these classes used to derive from `mysql_dt_base`. All of the `mysql_*` classes' functionality and data has been folded into the leaf classes, and now the only thing shared between them is their dependence on the DTbase template. Since the leaf classes' interface has not changed and end-user code shouldn't have been using the other classes, this shouldn't affect the API in any practical way.

`mysql_type_info` now always initializes its private `num` member. Previously, this would go uninitialized if you used the default constructor. Now there is no default ctor, but the ctor taking one argument (which sets `num`) has a default.

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Version 2.1, February 1999

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