Oracle Berkeley DB

Getting Started with Berkeley DB for C++

Release 4.7



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Preface

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Conventions Used in this Book

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                                                         // Street name and number
                         char street[MAXFIELD];
                         char city[MAXFIELD];
                                                         // City
                         char state[3];
                                                         // Two-digit US state code
                         char zipcode[6];
                                                         // US zipcode
                         char phone_number[13];
                                                         // Vendor phone number
                     } VENDOR;
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                                                         // Vendor name
                         char name[MAXFIELD];
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                         char state[3];
                                                         // Two-digit US state code
                         char zipcode[6];
                                                         // US zipcode
                         char phone_number[13];
                                                         // Vendor phone number
                         char sales rep[MAXFIELD];
                                                         // Name of sales representative
                         char sales_rep_phone[MAXFIELD]; // Sales rep's phone number
                     } VENDOR;
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For More Information

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Chapter 1. Introduction to Berkeley DB

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About This Manual

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Berkeley DB Concepts

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Choosing between Queue and Recno

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4 2 2 00 8 Getting Started with DB **9**

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Database Limits and Portability

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                 #include <db cxx.h>
                 try
                  // DB and other code goes here
                 catch(DbException &e)
                // DB error handling goes here
```

Getting Started with DB

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Err r nR r o e

```
}
catch(std::exception &e)
{
    // All other error handling goes here
}
```

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DbException::what()

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Error Returns

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Getting and Using DB

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Chapter 2. Databases

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Opening Databases

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```
#include <db cxx.h>
. . .
Db db(NULL, 0);
                             // Instantiate the Db object
u_int32_t oFlags = DB_CREATE; // Open flags;
try {
   // Open the database
   db.open(NULL,
                                 // Transaction pointer
            "my db.db",
                                // Database file name
                                 // Optional logical database name
           NULL,
           DB BTREE,
                                // Database access method
           oFlags,
                                 // Open flags
                                // File mode (using defaults)
// DbException is not subclassed from std::exception, so
// need to catch both of these.
} catch(DbException &e) {
   // Error handling code goes here
} catch(std::exception &e) {
   // Error handling code goes here
```

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Closing Databases

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```

```
#include <db_cxx.h>
...

Db db(NULL, 0);

// Database open and access operations happen here.

try {
    // Close the database
    db.close(0);

// DbException is not subclassed from std::exception, so
// need to catch both of these.
} catch(DbException &e) {
    // Error handling code goes here
} catch(std::exception &e) {
    // Error handling code goes here
}
```

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Database Open Flags

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u_int32_t open_flags = DB_CREATE | DB_EXCL;

• DB_CREATE

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• DB EXCL

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DB_RDONLY

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• DB TRUNCATE

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Administrative Methods

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• Db::get open flags()

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```
#include <db_cxx.h>
...
Db db(NULL, 0);
u_int32_t open_flags;

// Database open and subsequent operations omitted for clarity

db.get_open_flags(&open_flags);
```

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• Db::remove()

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```
#include <db_cxx.h>
Db db(NULL, 0);
// Database handle creation omitted for clarity
db.remove("mydb.db",
                                // Database file to remove
         NULL,
                                // Database to remove. This is
                                 // NULL so the entire file is
                                 // removed.
         0);
                                 // Flags. None used.
```

• Db::rename()

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```
#include <db_cxx.h>
Db db(NULL, 0);
// Database handle creation omitted for clarity
db.rename("mydb.db",
                                // Database file to rename
         NULL,
                                 // Database to rename. This is
                                 // NULL so the entire file is
                                // renamed.
         "newdb.db",
                                 // New database file name
                                // Flags. None used.
```

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Error Reporting Functions

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                 * Function called to handle any database error messages
                 * issued by DB.
                 * /
                 my_error_handler(const char *error_prefix, char *msg)
```

Getting Started with DB P

```
* Put your code to handle the error prefix and error
* message here. Note that one or both of these parameters
* may be NULL depending on how the error message is issued
* and how the DB handle is configured.
```

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```
#include <db_cxx.h>
Db db(NULL, 0);
std::string dbFileName("my_db.db");
try
    // Set up error handling for this database
    db.set_errcall(my_error_handler);
    db.set_errpfx("my_example_program");
```

Α d sts ei essu e ag m r n ea o

```
// Open the database
db.open(NULL, dbFileName.c_str(), NULL, DB_BTREE, DB_CREATE, 0);
// Must catch both DbException and std::exception
catch(DbException &e)
    db.err(e.get_errno(), "Database open failed %s",
        dbFileName.c_str());
    throw e;
catch(std::exception &e)
    // No DB error number available, so use errx
   db.errx("Error opening database: %s", e.what());
    throw e;
```

Managing Databases in Environments

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```
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. . .
u int32 t env flags = DB CREATE |
                                        // If the environment does not
                                        // exist, create it.
                       DB INIT MPOOL; // Initialize the in-memory cache.
std::string envHome("/export1/testEnv");
DbEnv myEnv(0);
try {
   myEnv.open(envHome.c_str(), env_flags, 0);
} catch(DbException &e) {
    std::cerr << "Error opening database environment: "</pre>
             << envHome << std::endl;</pre>
    std::cerr << e.what() << std::endl;</pre>
    exit( -1 );
} catch(std::exception &e) {
    std::cerr << "Error opening database environment: "</pre>
             << envHome << std::endl;</pre>
    std::cerr << e.what() << std::endl;</pre>
    exit( -1 );
```

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2 2 00 8 Getting Started with DB P

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```
// If the database does not
u_int32_t db_flags = DB_CREATE;
                                   // exist, create it.
std::string dbName("mydb.db");
DbEnv myEnv(0);
Db *myDb;
try {
    myEnv.open(envHome.c_str(), env_flags, 0);
    myDb = new Db(&myEnv, 0);
    myDb->open(NULL,
               dbName.c_str(),
               NULL,
               DB_BTREE,
               db_flags,
               0);
} catch(DbException &e) {
    std::cerr << "Error opening database environment: "
              << envHome
              << " and database "
              << dbName << std::endl;
    std::cerr << e.what() << std::endl;</pre>
    exit( -1 );
} catch(std::exception &e) {
    std::cerr << "Error opening database environment: "
              << envHome
              << " and database "
              << dbName << std::endl;
    std::cerr << e.what() << std::endl;</pre>
    exit( -1 );
```

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```
try {
    if (myDb != NULL) {
        myDb->close(0);
    myEnv.close(0);
} catch(DbException &e) {
    std::cerr << "Error closing database environment: "</pre>
              << envHome
              << " or database "
              << dbName << std::endl;
    std::cerr << e.what() << std::endl;</pre>
    exit( -1 );
} catch(std::exception &e) {
    std::cerr << "Error closing database environment: "
```

Database Example

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```

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```
// File: MyDb.hpp
#include <db_cxx.h>

class MyDb
{
  public:
    // Constructor requires a path to the database,
    // and a database name.
    MyDb(std::string &path, std::string &dbName);

    // Our destructor just calls our private close method.
    ~MyDb() { close(); }

    inline Db &getDb() {return db_;}

private:
    Db db_;
    std::string dbFileName_;
    u_int32_t cFlags_;
```

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```
// Make sure the default constructor is private
// We don't want it used.
MyDb() : db_(NULL, 0) {}

// We put our database close activity here.
// This is called from our destructor. In
// a more complicated example, we might want
// to make this method public, but a private
// method is more appropriate for this example.
void close();
};
```

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```
// File: MyDb.cpp
#include "MyDb.hpp"
// Class constructor. Requires a path to the location
// where the database is located, and a database name
MyDb::MyDb(std::string &path, std::string &dbName)
    : db_(NULL, 0),
                                   // Instantiate Db object
      dbFileName_(path + dbName), // Database file name
      cFlags_(DB_CREATE)
                                   // If the database doesn't yet exist,
                                   // allow it to be created.
{
    try
        // Redirect debugging information to std::cerr
        db_.set_error_stream(&std::cerr);
        // Open the database
        db_.open(NULL, dbFileName_.c_str(), NULL, DB_BTREE, cFlags_, 0);
    // DbException is not a subclass of std::exception, so we
    // need to catch them both.
    catch(DbException &e)
        std::cerr << "Error opening database: " << dbFileName_ << "\n";</pre>
        std::cerr << e.what() << std::endl;</pre>
    catch(std::exception &e)
        std::cerr << "Error opening database: " << dbFileName_ << "\n";</pre>
        std::cerr << e.what() << std::endl;</pre>
```

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/ / 4 2 2 00 8 Getting Started with DB P

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```
// Private member used to close a database. Called from the class
// destructor.
void
MyDb::close()
    // Close the db
    try
        db_.close(0);
        std::cout << "Database " << dbFileName_</pre>
                   << " is closed." << std::endl;
    catch(DbException &e)
        std::cerr << "Error closing database: " << dbFileName_ << "\n";</pre>
        std::cerr << e.what() << std::endl;</pre>
    catch(std::exception &e)
        std::cerr << "Error closing database: " << dbFileName_ << "\n";</pre>
        std::cerr << e.what() << std::endl;</pre>
```

Chapter 3. Database Records

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Using Database Records

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```
#include <db_cxx.h>
#include <string.h>
float money = 122.45;
char *description = "Grocery bill.";
Dbt key(&money, sizeof(float));
Dbt data(description, strlen(description)+1);
```

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```
#include <db cxx.h>
#include <string.h>
Dbt key, data;
float money;
char *description;
key.set data(&money);
key.set_ulen(sizeof(float));
```

2 2 00 Getting Started with DB

```
key.set_flags(DB_DBT_USERMEM);
// Database retrieval code goes here
// Money is set into the memory that we supplied.
description = (char *)data.get_data();
```

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Reading and Writing Database Records

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Writing Records to the Database

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```
#include <db_cxx.h>
#include <string.h>
char *description = "Grocery bill.";
float money = 122.45;
Db my_database(NULL, 0);
// Database open omitted for clarity
Dbt key(&money, sizeof(float));
Dbt data(description, strlen(description) + 1);
int ret = my_database.put(NULL, &key, &data, DB_NOOVERWRITE);
if (ret == DB_KEYEXIST) {
    my_database.err(ret, "Put failed because key %f already exists", money);
```

Getting Records from the Database

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```
#include <db_cxx.h>
#include <string.h>
float money;
char description[DESCRIPTION_SIZE + 1];
Db my_database(NULL, 0);
// Database open omitted for clarity
```

```
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```

```
money = 122.45;
Dbt key, data;
key.set_data(&money);
key.set_size(sizeof(float));
data.set_data(description);
data.set_ulen(DESCRIPTION_SIZE + 1);
data.set_flags(DB_DBT_USERMEM);
my_database.get(NULL, &key, &data, 0);
// Description is set into the memory that we supplied.
```

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Deleting Records

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```
#include <db_cxx.h>
Db my_database(NULL, 0);
// Database open omitted for clarity
float money = 122.45;
Dbt key(&money, sizeof(float));
my_database.del(NULL, &key, 0);
```

Data Persistence

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2 2 00 Getting Started with DB

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Berkeley DB Getting Started with Transaction Processing

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Database Usage Example

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```
// File: gettingStartedCommon.hpp
#define MAXFIELD 20
typedef struct vendor {
    char name[MAXFIELD];
                                    // Vendor name
    char street[MAXFIELD];
                                   // Street name and number
    char city[MAXFIELD];
                                   // City
    char state[3];
                                    // Two-digit US state code
    char zipcode[6];
                                    // US zipcode
    char phone_number[13];
                                    // Vendor phone number
    char sales_rep[MAXFIELD];
                                   // Name of sales representative
    char sales_rep_phone[MAXFIELD]; // Sales rep's phone number
} VENDOR;
```

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```
class InventoryData
{
  public:
    inline void setPrice(double price) {price_ = price;}
    inline void setQuantity(long quantity) {quantity_ = quantity;}
    inline void setCategory(std::string &category) {category_ = category;}
    inline void setName(std::string &name) {name_ = name;}
    inline void setVendor(std::string &vendor) {vendor_ = vendor;}
    inline void setSKU(std::string &sku) {sku_ = sku;}

    inline double& getPrice() {return(price_);}
    inline long& getQuantity() {return(quantity_);}
    inline std::string& getCategory() {return(category_);}
```

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```
inline std::string& getName() {return(name_);}
inline std::string& getVendor() {return(vendor_);}
inline std::string& getSKU() {return(sku_);}

// Initialize our data members
void clear()
{
    price_ = 0.0;
    quantity_ = 0;
    category_.clear();
    name_.clear();
    vendor_.clear();
    sku_.clear();
}
```

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```
// Default constructor
InventoryData() { clear(); }
// Constructor from a void *
// For use with the data returned from a bdb get
InventoryData(void *buffer)
    char *buf = (char *)buffer;
   price_ = *((double *)buf);
   bufLen_ = sizeof(double);
   quantity_ = *((long *)(buf + bufLen_));
   bufLen_ += sizeof(long);
   name_ = buf + bufLen_;
   bufLen_ += name_.size() + 1;
   sku_ = buf + bufLen_;
   bufLen_ += sku_.size() + 1;
   category_ = buf + bufLen_;
   bufLen_ += category_.size() + 1;
   vendor_ = buf + bufLen_;
   bufLen_ += vendor_.size() + 1;
```

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```
// Marshalls this classes data members into a single
// contiguous memory location for the purpose of storing
// the data in a database.
char *
getBuffer()
    // Zero out the buffer
    memset(databuf_, 0, 500);
    // Now pack the data into a single contiguous memory location for
    // storage.
    bufLen = 0;
    int dataLen = 0;
    dataLen = sizeof(double);
    memcpy(databuf_, &price_, dataLen);
    bufLen_ += dataLen;
    dataLen = sizeof(long);
    memcpy(databuf_ + bufLen_, &quantity_, dataLen);
    bufLen_ += dataLen;
    packString(databuf_, name_);
    packString(databuf_, sku_);
    packString(databuf_, category_);
    packString(databuf_, vendor_);
   return (databuf_);
}
// Returns the size of the buffer. Used for storing
// the buffer in a database.
inline int getBufferSize() { return (bufLen_); }
```

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```
// Utility function used to show the contents of this class
void
show() {
    std::cout << "\nName:</pre>
                                   " << name << std::endl;
                                   " << sku << std::endl;
    std::cout << "
                      SKU:
                                   " << price_ << std::endl;
    std::cout << "
                      Price:
    std::cout << "
                      Quantity:
                                   " << quantity_ << std::endl;
    std::cout << "
                                   " << category_ << std::endl;
                      Category:
    std::cout << "
                      Vendor:
                                   " << vendor_ << std::endl;</pre>
```

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```
private:
     // Utility function that appends a char * to the end of
     // the buffer.
    void
     packString(char *buffer, std::string &theString)
         int string_size = theString.size() + 1;
        memcpy(buffer+bufLen_, theString.c_str(), string_size);
        bufLen_ += string_size;
     }
     // Data members
    std::string category_, name_, vendor_, sku_;
    double price_;
     long quantity_;
     int bufLen_;
     char databuf_[500];
};
```

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DB_INSTALL/examples_cxx/getting_started

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```
// File: example_database_load.cpp
#include <iostream>
#include <cstdlib>

#include "MyDb.hpp"
#include "gettingStartedCommon.hpp"

// Forward declarations
void loadVendorDB(MyDb&, std::string&);
void loadInventoryDB(MyDb&, std::string&);
```

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```
// Loads the contents of vendors.txt and inventory.txt into
// Berkeley DB databases.
int
main(int argc, char *argv[])
    // Initialize the path to the database files
    std::string basename("./");
    std::string databaseHome("./");
    // Database names
    std::string vDbName("vendordb.db");
    std::string iDbName("inventorydb.db");
    // Parse the command line arguments here and determine
    // the location of the flat text files containing the
    // inventory data here. This step is omitted for clarity.
    // Identify the full name for our input files, which should
    // also include some path information.
    std::string inventoryFile = basename + "inventory.txt";
    std::string vendorFile = basename + "vendors.txt";
    try
        // Open all databases.
        MyDb inventoryDB(databaseHome, iDbName);
        MyDb vendorDB(databaseHome, vDbName);
        // Load the vendor database
        loadVendorDB(vendorDB, vendorFile);
        // Load the inventory database
        loadInventoryDB(inventoryDB, inventoryFile);
    } catch(DbException &e) {
        std::cerr << "Error loading databases. " << std::endl;</pre>
        std::cerr << e.what() << std::endl;</pre>
        return(e.get_errno());
    } catch(std::exception &e) {
        std::cerr << "Error loading databases. " << std::endl;
        std::cerr << e.what() << std::endl;</pre>
        return(-1);
    return(0);
} // End main
```

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```
// Loads the contents of the vendors.txt file into a database
void
loadVendorDB(MyDb &vendorDB, std::string &vendorFile)
    std::ifstream inFile(vendorFile.c_str(), std::ios::in);
    if (!inFile)
         std::cerr << "Could not open file '" << vendorFile
                   << "'. Giving up." << std::endl;
         throw std::exception();
    VENDOR my_vendor;
    while (!inFile.eof())
    {
         std::string stringBuf;
         std::getline(inFile, stringBuf);
        memset(&my_vendor, 0, sizeof(VENDOR));
         // Scan the line into the structure.
         // Convenient, but not particularly safe.
         // In a real program, there would be a lot more
         // defensive code here.
         sscanf(stringBuf.c_str(),
           "\$20[^\#]\#\$20[^\#]\#\$20[^\#]\#\$3[^\#]\#\$6[^\#]\#\$13[^\#]\#\$20[^\#]\#\$20[^\n]\",
          my vendor.name, my vendor.street,
          my_vendor.city, my_vendor.state,
          my_vendor.zipcode, my_vendor.phone_number,
          my_vendor.sales_rep, my_vendor.sales_rep_phone);
         Dbt key(my_vendor.name, strlen(my_vendor.name) + 1);
         Dbt data(&my vendor, sizeof(VENDOR));
        vendorDB.getDb().put(NULL, &key, &data, 0);
    inFile.close();
```

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```
// Used to locate the first pound sign (a field delimiter)
// in the input string.
int
getNextPound(std::string &theString, std::string &substring)
   int pos = theString.find("#");
    substring.assign(theString, 0, pos);
    theString.assign(theString, pos + 1, theString.size());
    return (pos);
}
// Loads the contents of the inventory.txt file into a database
loadInventoryDB(MyDb &inventoryDB, std::string &inventoryFile)
    InventoryData inventoryData;
    std::string substring;
    int nextPound;
    std::ifstream inFile(inventoryFile.c str(), std::ios::in);
    if (!inFile)
        std::cerr << "Could not open file '" << inventoryFile
                  << "'. Giving up." << std::endl;
        throw std::exception();
    }
    while (!inFile.eof())
        inventoryData.clear();
```

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```
std::string stringBuf;
    std::getline(inFile, stringBuf);
    // Now parse the line
   if (!stringBuf.empty())
        nextPound = getNextPound(stringBuf, substring);
        inventoryData.setName(substring);
        nextPound = getNextPound(stringBuf, substring);
        inventoryData.setSKU(substring);
        nextPound = getNextPound(stringBuf, substring);
        inventoryData.setPrice(strtod(substring.c_str(), 0));
       nextPound = getNextPound(stringBuf, substring);
        inventoryData.setQuantity(strtol(substring.c_str(), 0, 10));
        nextPound = getNextPound(stringBuf, substring);
        inventoryData.setCategory(substring);
        nextPound = getNextPound(stringBuf, substring);
        inventoryData.setVendor(substring);
        void *buff = (void *)inventoryData.getSKU().c_str();
        int size = inventoryData.getSKU().size()+1;
       Dbt key(buff, size);
       buff = inventoryData.getBuffer();
        size = inventoryData.getBufferSize();
        Dbt data(buff, size);
        inventoryDB.getDb().put(NULL, &key, &data, 0);
inFile.close();
```

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Chapter 4. Using Cursors

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Opening and Closing Cursors

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mh Db::cursor() e ot d

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#include <db_cxx.h>
```

```
#include <db_cxx.h>
...

Dbc *cursorp;
Db my_database(NULL, 0);

// Database open omitted for clarity

// Get a cursor
my_database.cursor(NULL, &cursorp, 0);
```

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```

```
#include <db_cxx.h>
. . .
Db my_database(NULL, 0);
Dbc *cursorp;
try {
    // Database open omitted for clarity
    // Get a cursor
    my_database.cursor(NULL, &cursorp, 0);
    Dbt key, data;
    int ret;
    // Iterate over the database, retrieving each record in turn.
    while ((ret = cursorp->get(&key, &data, DB_NEXT)) == 0) {
        // Do interesting things with the Dbts here.
    if (ret != DB_NOTFOUND) {
        // ret should be DB_NOTFOUND upon exiting the loop.
        // Dbc::get() will by default throw an exception if any
        // significant errors occur, so by default this if block
        // can never be reached.
} catch(DbException &e) {
        my_database.err(e.get_errno(), "Error!");
} catch(std::exception &e) {
        my_database.errx("Error! %s", e.what());
// Cursors must be closed
if (cursorp != NULL)
    cursorp->close();
my_database.close(0);
```

```
#include <db_cxx.h>
Db my_database(NULL, 0);
Dbc *cursorp;
try {
   // Database open omitted for clarity
    // Get a cursor
    my_database.cursor(NULL, &cursorp, 0);
    Dbt key, data;
   int ret;
    // Iterate over the database, retrieving each record in turn.
    while ((ret = cursorp->get(&key, &data, DB_PREV)) == 0) {
       // Do interesting things with the Dbts here.
    if (ret != DB_NOTFOUND) {
       // ret should be DB_NOTFOUND upon exiting the loop.
        // Dbc::get() will by default throw an exception if any
        // significant errors occur, so by default this if block
        // can never be reached.
} catch(DbException &e) {
        my_database.err(e.get_errno(), "Error!");
} catch(std::exception &e) {
       my_database.errx("Error! %s", e.what());
// Cursors must be closed
if (cursorp != NULL)
    cursorp->close();
my_database.close(0);
```

Searching for Records

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```
#include <db_cxx.h>
#include <string.h>
. . .
Db my_database(NULL, 0);
Dbc *cursorp;
try {
   // database open omitted for clarity
   // Get a cursor
   my_database.cursor(NULL, &cursorp, 0);
    // Search criteria
   char *search_key = "Alaska";
   char *search_data = "Fa";
   // Set up our DBTs
   Dbt key(search_key, strlen(search_key) + 1);
   Dbt data(search_data, strlen(search_data) + 1);
   // Position the cursor to the first record in the database whose
   // key matches the search key and whose data begins with the search
   int ret = cursorp->get(&key, &data, DB_GET_BOTH_RANGE);
   if (!ret) {
       // Do something with the data
```

```
} catch(DbException &e) {
        my_database.err(e.get_errno(), "Error!");
} catch(std::exception &e) {
       my_database.errx("Error! %s", e.what());
// Close the cursor
if (cursorp != NULL)
   cursorp->close();
// Close the database
my database.close(0);
```

Working with Duplicate Records

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DB_NEXT DB_PREV

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• DB_GET_BOTH_RANGE

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• DB_NEXT_NODUP DB_PREV_NODUP

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DB_NEXT_DUP

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```
#include <db_cxx.h>
#include <string.h>
char *search_key = "Al";
Db my_database(NULL, 0);
Dbc *cursorp;
try {
    // database open omitted for clarity
    // Get a cursor
    my_database.cursor(NULL, &cursorp, 0);
    // Set up our DBTs
    Dbt key(search_key, strlen(search_key) + 1);
    Dbt data;
    // Position the cursor to the first record in the database whose
    // key and data begin with the correct strings.
    int ret = cursorp->get(&key, &data, DB_SET);
    while (ret != DB_NOTFOUND) {
        std::cout << "key: " << (char *)key.get_data()</pre>
                  << "data: " << (char *)data.get_data()<< std::endl;</pre>
        ret = cursorp->get(&key, &data, DB_NEXT_DUP);
} catch(DbException &e) {
        my_database.err(e.get_errno(), "Error!");
```

```
} catch(std::exception &e) {
       my_database.errx("Error! %s", e.what());
// Close the cursor
if (cursorp != NULL)
   cursorp->close();
// Close the database
my_database.close(0);
```

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Putting Records Using Cursors

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DB_NODUPDATA

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• DB KEYFIRST

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DB_KEYLAST

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```
#include <db_cxx.h>
#include <string.h>
char *key1str = "My first string";
char *data1str = "My first data";
char *key2str = "A second string";
char *data2str = "My second data";
char *data3str = "My third data";
Db my_database(NULL, 0);
Dbc *cursorp;
try {
   // Set up our DBTs
   Dbt key1(key1str, strlen(key1str) + 1);
   Dbt data1(data1str, strlen(data1str) + 1);
   Dbt key2(key2str, strlen(key2str) + 1);
   Dbt data2(data2str, strlen(data2str) + 1);
   Dbt data3(data3str, strlen(data3str) + 1);
   // Database open omitted
    // Get the cursor
   my_database.cursor(NULL, &cursorp, 0);
   // Assuming an empty database, this first put places
    // "My first string"/"My first data" in the first
    // position in the database
   int ret = cursorp->put(&key1, &data1, DB_KEYFIRST);
   // This put places "A second string"/"My second data" in the
    // the database according to its key sorts against the key
    // used for the currently existing database record. Most likely
    // this record would appear first in the database.
   ret = cursorp->put(&key2, &data2,
```

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```
DB_KEYFIRST); /* Added according to sort order */
    // If duplicates are not allowed, the currently existing record that
    // uses "key2" is overwritten with the data provided on this put.
    // That is, the record "A second string"/"My second data" becomes
    // "A second string"/"My third data"
    // If duplicates are allowed, then "My third data" is placed in the
    // duplicates list according to how it sorts against "My second data".
    ret = cursorp->put(&key2, &data3,
            DB_KEYFIRST); // If duplicates are not allowed, record
                          // is overwritten with new data. Otherwise,
                          // the record is added to the beginning of
                          // the duplicates list.
} catch(DbException &e) {
        my_database.err(e.get_errno(), "Error!");
} catch(std::exception &e) {
        my_database.errx("Error! %s", e.what());
// Cursors must be closed
if (cursorp != NULL)
    cursorp->close();
my_database.close(0);
```

Deleting Records Using Cursors

```
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Frmpl: x oe ae

#include <db_cxx.h>
#include <string.h>
```

```
#include <db_cxx.h>
#include <string.h>
...

char *keylstr = "My first string";
Db my_database(NULL, 0);
Dbc *cursorp;

try {
    // Database open omitted

    // Get the cursor
    my_database.cursor(NULL, &cursorp, 0);

    // Set up our DBTs
```

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```
Dbt key(key1str, strlen(key1str) + 1);
    Dbt data;
    // Iterate over the database, deleting each record in turn.
    int ret;
    while ((ret = cursorp->get(&key, &data,
                                  DB_SET)) == 0) {
        cursorp->del(0);
    }
} catch(DbException &e) {
    my_database.err(e.get_errno(), "Error!");
} catch(std::exception &e) {
    my_database.errx("Error! %s", e.what());
// Cursors must be closed
if (cursorp != NULL)
    cursorp->close();
my_database.close(0);
```

Replacing Records Using Cursors

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```
#include <db_cxx.h>
#include <string.h>
...

Db my_database(NULL, 0);
Dbc *cursorp;

int ret;
char *keylstr = "My first string";
char *replacement_data = "replace me";

try {
    // Database open omitted

    // Get the cursor
    my_database.cursor(NULL, &cursorp, 0);

    // Set up our DBTs
    Dbt key(keylstr, strlen(keylstr) + 1);
    Dbt data;

    // Position the cursor */
```

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```
ret = cursorp->get(&key, &data, DB_SET);
if (ret == 0) {
    data.set_data(replacement_data);
    data.set_size(strlen(replacement_data) + 1);
    cursorp->put(&key, &data, DB_CURRENT);
}
catch(DbException &e) {
    my_database.err(e.get_errno(), "Error!");
} catch(std::exception &e) {
    my_database.errx("Error! %s", e.what());
}

// Cursors must be closed
if (cursorp != NULL)
    cursorp->close();

my_database.close(0);
```

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Cursor Example

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                   // File: example_database_read.cpp
                   #include <iostream>
                   #include <fstream>
                    #include <cstdlib>
                   #include "MyDb.hpp"
                   #include "gettingStartedCommon.hpp"
                   // Forward declarations
                   int show_all_records(MyDb &inventoryDB, MyDb &vendorDB);
                   int show_vendor(MyDb &vendorDB, const char *vendor);
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                   // Displays all inventory items and the associated vendor record.
                   int
                   main (int argc, char *argv[])
                       // Initialize the path to the database files
                       std::string databaseHome("./");
                       // Database names
                       std::string vDbName("vendordb.db");
                       std::string iDbName("inventorydb.db");
                       // Parse the command line arguments
                       // Omitted for brevity
                       try
```

Getting Started with DB

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```
// Open all databases.
   MyDb inventoryDB(databaseHome, iDbName);
   MyDb vendorDB(databaseHome, vDbName);

   show_all_records(inventoryDB, vendorDB);
} catch(DbException &e) {
   std::cerr << "Error reading databases. " << std::endl;
   std::cerr << e.what() << std::endl;
   return(e.get_errno());
} catch(std::exception &e) {
   std::cerr << "Error reading databases. " << std::endl;
   std::cerr << e.what() << std::endl;
   return(-1);
}

return(0);
} // End main</pre>
```

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```
// Shows all the records in the inventory database.
// For each inventory record shown, the appropriate
// vendor record is also displayed.
int
show_all_records(MyDb &inventoryDB, MyDb &vendorDB)
    // Get a cursor to the inventory db
    Dbc *cursorp;
    try {
        inventoryDB.getDb().cursor(NULL, &cursorp, 0);
        // Iterate over the inventory database, from the first record
        // to the last, displaying each in turn
        Dbt key, data;
        int ret;
        while ((ret = cursorp->get(&key, &data, DB_NEXT)) == 0 )
            InventoryData inventoryItem(data.get_data());
            inventoryItem.show();
            show_vendor(vendorDB, inventoryItem.getVendor().c_str());
    } catch(DbException &e) {
        inventoryDB.getDb().err(e.get_errno(), "Error in show_all_records");
        cursorp->close();
        throw e;
```

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```
} catch(std::exception &e) {
    cursorp->close();
    throw e;
}

cursorp->close();
return (0);
}
```

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```
// Shows a vendor record. Each vendor record is an instance of
// a vendor structure. See loadVendorDB() in
// example_database_load for how this structure was originally
// put into the database.
show_vendor(MyDb &vendorDB, const char *vendor)
    Dbt data;
    VENDOR my_vendor;
    try {
        // Set the search key to the vendor's name
        // vendor is explicitly cast to char * to stop a compiler
        // complaint.
        Dbt key((char *)vendor, strlen(vendor) + 1);
        // Make sure we use the memory we set aside for the VENDOR
        // structure rather than the memory that DB allocates.
        // Some systems may require structures to be aligned in memory
        // in a specific way, and DB may not get it right.
        data.set_data(&my_vendor);
        data.set ulen(sizeof(VENDOR));
        data.set_flags(DB_DBT_USERMEM);
        // Get the record
        vendorDB.getDb().get(NULL, &key, &data, 0);
        std::cout << "
                              " << my_vendor.street << "\n"
                             " << my_vendor.city << ", "
                  << "
                  << my_vendor.state << "\n"
                              " << my_vendor.zipcode << "\n"
                              " << my vendor.phone number << "\n"
```

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Getting Started with DB

Chapter 5. Secondary Databases

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#include <db cxx.h>
Db my_database(NULL, 0); // Primary
Db my_index(NULL, 0); // Secondary
// Open the primary
my_database.open(NULL,
                            // Transaction pointer
                 "my_db.db", // On-disk file that holds the database.
                            // Optional logical database name
                            // Database access method
               DB BTREE,
                            // Open flags
               DB_CREATE,
                            // File mode (using defaults)
// Setup the secondary to use sorted duplicates.
// This is often desirable for secondary databases.
my_index.set_flags(DB_DUPSORT);
// Open the secondary
my_index.open(NULL,
                                // Transaction pointer
              "my_secondary.db", // On-disk file that holds the database.
                                // Optional logical database name
              NULL,
                                // Database access method
              DB_BTREE,
              DB CREATE,
                                // Open flags.
              0);
                                // File mode (using defaults)
// Now associate the primary and the secondary
my_database.associate(NULL,
                                  // Txn id
                                    // Associated secondary database
                     &my_index,
                      get_sales_rep, // Callback used for key extraction.
                                     // This is described in the next
```

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```
VENDOR *vendor;
// First, extract the structure contained in the primary's data
vendor = (VENDOR *)pdata->get_data();
// Now set the secondary key's data to be the representative's name
skey->set_data(vendor->sales_rep);
skey->set_size(strlen(vendor->sales_rep) + 1);
// Return 0 to indicate that the record can be created/updated.
return (0);
```

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```
// Secondary database
       get_sales_rep, // Callback used for key creation.
       0); // Flags
```

Working with Multiple Keys

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```
my_callback(Db *dbp, const Dbt *pkey, const Dbt *pdata, Dbt *skey)
   Dbt *tmpdbt;
    char *tmpdata1, tmpdata2;
    // This example skips the step of extracting the data you
```

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```
// want to use for building your secondary keys from the
// pkey or pdata Dbt.
// Assume for the purpose of this example that the data
// is temporarily stored in two variables,
// tmpdata1 and tmpdata2.
// Create an array of Dbts that is large enough for the
// number of keys that you want to return. In this case,
// we go with an array of size two.
tmpdbt = malloc(sizeof(Dbt) * 2);
memset(tmpdbt, 0, sizeof(Dbt) * 2);
// Now assign secondary keys to each element of the array.
tmpdbt[0].set_data(tmpdata1);
tmpdbt[0].set_size((u_int32_t)strlen(tmpdbt[0].data) + 1);
tmpdbt[1].set_data(tmpdata2);
tmpdbt[1].set_size((u_int32_t)strlen(tmpdbt[1].data) + 1);
// Now we set flags for the returned Dbt. DB_DBT_MULTIPLE is
// required in order for DB to know that the Dbt references an
// array. In addition, we set DB_DBT_APPMALLOC because we
// dynamically allocated memory for the Dbt's data field.
// DB_DBT_APPMALLOC causes DB to release that memory once it
// is done with the returned Dbt.
skey->set_flags(DB_DBT_MULTIPLE | DB_DBT_APPMALLOC);
// Point the results data field to the arrays of Dbts
skey->set_data(tmpdbt);
// Indicate the returned array is of size 2
skey->size = 2;
return (0);
```

Reading Secondary Databases

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```
#include <db cxx.h>
#include <string.h>
// The string to search for
char *search name = "John Doe";
// Instantiate our Dbt's
Dbt key(search_name, strlen(search_name) + 1);
Dbt pkey, pdata; // Primary key and data
Db my_secondary_database(NULL, 0);
// Primary and secondary database opens omitted for brevity
// Returns the key from the secondary database, and the data from the
// associated primary database entry.
my_secondary_database.get(NULL, &key, &pdata, 0);
// Returns the key from the secondary database, and the key and data
// from the associated primary database entry.
my_secondary_database.pget(NULL, &key, &pkey, &pdata, 0);
```

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Deleting Secondary Database Records

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```
#include <db_cxx.h>
#include <string.h>
Db my_database(NULL, 0); // Primary
Db my_index(NULL, 0);
                       // Secondary
// Open the primary
my_database.open(NULL,
                            // Transaction pointer
                 "my_db.db", // On-disk file that holds the database.
               NULL,
                             // Optional logical database name
                DB_BTREE,
                            // Database access method
                DB_CREATE, // Open flags
                0);
                            // File mode (using defaults)
// Setup the secondary to use sorted duplicates.
// This is often desireable for secondary databases.
my_index.set_flags(DB_DUPSORT);
// Open the secondary
                                // Transaction pointer
my_index.open(NULL,
              "my_secondary.db", // On-disk file that holds the database.
                                // Optional logical database name
              DB_BTREE,
                                // Database access method
              DB_CREATE,
                                // Open flags.
                                // File mode (using defaults)
              0);
// Now associate the primary and the secondary
my_database.associate(NULL,
                                   // Txn id
                                   // Associated secondary database
                      &my_index,
                      get_sales_rep, // Callback used for key extraction.
                      0);
                                   // Flags
// Name to delete
char *search_name = "John Doe";
// Get a search key
Dbt key(search_name, strlen(search_name) + 1);
// Now delete the secondary record. This causes the associated primary
// record to be deleted. If any other secondary databases have secondary
// records referring to the deleted primary record, then those secondary
// records are also deleted.
my_index.del(NULL, &key, 0);
```

Using Cursors with Secondary Databases

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Database Joins

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Using Join Cursors

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```
#include <db_cxx.h>
#include <string.h>
// Exception handling omitted
int ret;
Db automotiveDB(NULL, 0);
Db automotiveColorDB(NULL, 0);
Db automotiveMakeDB(NULL, 0);
Db automotiveTypeDB(NULL, 0);
// Database and secondary database opens omitted for brevity.
// Assume a primary database:
    automotiveDB
//
// Assume 3 secondary databases:
     automotiveColorDB -- secondary database based on automobile color
     automotiveMakeDB -- secondary database based on the manufacturer
//
     automotiveTypeDB -- secondary database based on automobile type
//
// Position the cursors
Dbc *color_curs;
automotiveColorDB.cursor(NULL, &color_curs, 0);
char *the_color = "red";
Dbt key(the_color, strlen(the_color) + 1);
Dbt data;
if ((ret = color_curs->get(&key, &data, DB_SET)) != 0) {
    // Error handling goes here
Dbc *make_curs;
automotiveMakeDB.cursor(NULL, &make_curs, 0);
char *the_make = "Toyota";
key.set_data(the_make);
key.set_size(strlen(the_make) + 1);
if ((ret = make_curs->get(&key, &data, DB_SET)) != 0) {
```

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```
// Error handling goes here
Dbc *type_curs;
automotiveTypeDB.cursor(NULL, &type_curs, 0);
char *the_type = "minivan";
key.set_data(the_type);
key.set_size(strlen(the_type) + 1);
if ((ret = type_curs->get(&key, &data, DB_SET)) != 0) {
   // Error handling goes here
// Set up the cursor array
Dbc *carray[4];
carray[0] = color_curs;
carray[1] = make_curs;
carray[2] = type_curs;
carray[3] = NULL;
// Create the join
Dbc *join_curs;
if ((ret = automotiveDB.join(carray, &join_curs, 0)) != 0) {
   // Error handling goes here
// Iterate using the join cursor
while ((ret = join_curs->get(&key, &data, 0)) == 0) {
   // Do interesting things with the key and data
// If we exited the loop because we ran out of records,
// then it has completed successfully.
if (ret == DB_NOTFOUND) {
    // Close all our cursors and databases as is appropriate, and
     // then exit with a normal exit status (0).
```

Secondary Database Example

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                          // File: gettingStartedCommon.hpp
                          // Forward declarations
                          class Db;
                          class Dbt;
                          // Used to extract an inventory item's name from an
                          // inventory database record. This function is used to create
                          // keys for secondary database records.
                          get_item_name(Db *dbp, const Dbt *pkey, const Dbt *pdata, Dbt *skey)
                              // Obtain the buffer location where the we placed the item's name. In
                              // this example, the item's name is located in the primary data. It is
                              // the first string in the buffer after the price (a double) and
                              // the quantity (a long).
```

/ / 4 2 2 00 8 Getting Started with DB P

// unused

size_t offset = sizeof(double) + sizeof(long);

char * itemname = (char *)pdata->get data() + offset;

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```
(void)pkey;

// If the offset is beyond the end of the data, then there is a
// problem with the buffer contained in pdata, or there's a
// programming error in how the buffer is marshalled/unmarshalled.
// This should never happen!
if ((u_int32_t)id.getBufferSize() != pdata->get_size()) {
```

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```
// Make sure the default constructor is private
// We don't want it used.
MyDb() : db_(0, 0) {}

// We put our database close activity here.
// This is called from our destructor. In
// a more complicated example, we might want
// to make this method public, but a private
// method is more appropriate for this example.
void close();
};
```

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```
// File: MyDb.cpp
#include "MyDb.hpp"
// Class constructor. Requires a path to the location
// where the database is located, and a database name
MyDb::MyDb(std::string &path, std::string &dbName,
           bool isSecondary)
    : db_(NULL, 0),
                                   // Instantiate Db object
      dbFileName_(path + dbName), // Database file name
      cFlags (DB CREATE)
                                  // If the database doesn't yet exist,
                                   // allow it to be created.
{
    try
        // Redirect debugging information to std::cerr
        db_.set_error_stream(&std::cerr);
        // If this is a secondary database, support
        // sorted duplicates
        if (isSecondary)
            db_.set_flags(DB_DUPSORT);
        // Open the database
        db_.open(NULL, dbFileName_.c_str(), NULL, DB_BTREE, cFlags_, 0);
    // DbException is not a subclass of std::exception, so we
    // need to catch them both.
    catch(DbException &e)
        std::cerr << "Error opening database: " << dbFileName_ << "\n";</pre>
        std::cerr << e.what() << std::endl;</pre>
    catch(std::exception &e)
```

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```
std::cerr << "Error opening database: " << dbFileName_ << "\n";
std::cerr << e.what() << std::endl;
}</pre>
```

pomble example ada tabas der atbad

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```
// Loads the contents of vendors.txt and inventory.txt into
// Berkeley DB databases.
int
main(int argc, char *argv[])
    // Initialize the path to the database files
   std::string basename("./");
   std::string databaseHome("./");
    // Database names
   std::string vDbName("vendordb.db");
   std::string iDbName("inventorydb.db");
   std::string itemSDbName("itemname.sdb");
   // Parse the command line arguments here and determine
   // the location of the flat text files containing the
    // inventory data here. This step is omitted for clarity.
   // Identify the full name for our input files, which should
    // also include some path information.
    std::string inventoryFile = basename + "inventory.txt";
   std::string vendorFile = basename + "vendors.txt";
    try
        // Open all databases.
        MyDb inventoryDB(databaseHome, iDbName);
        MyDb vendorDB(databaseHome, vDbName);
        MyDb itemnameSDB(databaseHome, itemSDbName, true);
        // Associate the primary and the secondary
        inventoryDB.getDb().associate(NULL,
                                      &(itemnameSDB.getDb()),
                                      get_item_name,
                                      0);
        // Load the vendor database
```

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```
loadVendorDB(vendorDB, vendorFile);
         // Load the inventory database
         loadInventoryDB(inventoryDB, inventoryFile);
     } catch(DbException &e) {
         std::cerr << "Error loading databases. " << std::endl;
         std::cerr << e.what() << std::endl;</pre>
         return(e.get_errno());
     } catch(std::exception &e) {
         std::cerr << "Error loading databases. " << std::endl;</pre>
         std::cerr << e.what() << std::endl;</pre>
         return(-1);
     return(0);
} // End main
```

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Secondary Databases with example_database_read

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```
// File: example_database_read.cpp
#include <iostream>
#include <fstream>
#include <cstdlib>
```

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```
#include "MyDb.hpp"
#include "gettingStartedCommon.hpp"

// Forward declarations
int show_all_records(MyDb &inventoryDB, MyDb &vendorDB);
int show_item(MyDb &itemnameSDB, MyDb &vendorDB, std::string &itemName);
int show_vendor(MyDb &vendorDB, const char *vendor);
```

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```
// Displays all inventory items and the associated vendor record.
main (int argc, char *argv[])
    // Initialize the path to the database files
    std::string databaseHome("./");
    std::string itemName;
    // Database names
    std::string vDbName("vendordb.db");
    std::string iDbName("inventorydb.db");
    std::string itemSDbName("itemname.sdb");
    // Parse the command line arguments
    // Omitted for brevity
    try
        // Open all databases.
        MyDb inventoryDB(databaseHome, iDbName);
        MyDb vendorDB(databaseHome, vDbName);
        MyDb itemnameSDB(databaseHome, itemSDbName, true);
        // Associate the secondary to the primary
        inventoryDB.getDb().associate(NULL,
                                      &(itemnameSDB.getDb()),
                                      get_item_name,
                                       0);
        if (itemName.empty())
            show_all_records(inventoryDB, vendorDB);
        } else {
            show_item(itemnameSDB, vendorDB, itemName);
```

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```
}
} catch(DbException &e) {
    std::cerr << "Error reading databases. " << std::endl;
    std::cerr << e.what() << std::endl;
    return(e.get_errno());
} catch(std::exception &e) {
    std::cerr << "Error reading databases. " << std::endl;
    std::cerr << e.what() << std::endl;
    return(-1);
}

return(0);
} // End main</pre>
```

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m show_item}()$ footi u

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DB_INSTALL/examples_cxx/getting_started

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```
// Shows the records in the inventory database that
// have a specific item name. For each inventory record
// shown, the appropriate vendor record is also displayed.
show_item(MyDb &itemnameSDB, MyDb &vendorDB, std::string &itemName)
    // Get a cursor to the itemname secondary db
    Dbc *cursorp;
    try {
        itemnameSDB.getDb().cursor(NULL, &cursorp, 0);
        // Get the search key. This is the name on the inventory
        // record that we want to examine.
        std::cout << "Looking for " << itemName << std::endl;
        Dbt key((void *)itemName.c_str(), itemName.length() + 1);
        Dbt data;
        // Position the cursor to the first record in the secondary
        // database that has the appropriate key.
        int ret = cursorp->get(&key, &data, DB_SET);
        if (!ret) {
            do {
                InventoryData inventoryItem(data.get_data());
                inventoryItem.show();
```

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```
show_vendor(vendorDB, inventoryItem.getVendor().c_str());
        } while(cursorp->get(&key, &data, DB_NEXT_DUP) == 0);
    } else {
        std::cerr << "No records found for '" << itemName</pre>
                  << "'" << std::endl;
    }
} catch(DbException &e) {
    itemnameSDB.getDb().err(e.get_errno(), "Error in show_item");
    cursorp->close();
    throw e;
} catch(std::exception &e) {
    itemnameSDB.getDb().errx("Error in show_item: %s", e.what());
    cursorp->close();
    throw e;
cursorp->close();
return (0);
```

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example_inventory_read -i "Zulu Nut"

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Chapter 6. Database Configuration

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Overflow Pages

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Page Sizing Advice

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// 4 2 2 00 8 Getting Started with DB P

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Selecting the Cache Size

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Allowing Duplicate Records

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Sorted Duplicates

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Unsorted Duplicates

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2 2 00 8 Getting Started with DB P e 2ag

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DB_AFTER

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Configuring a Database to Support Duplicates

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.hnr T: yefsagtoatc ae ea uu

DB_DUP

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• DB DUPSORT

b pp r rp lT r r e datsæsa ossot e tolud c ei aetco sod

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```
#include <db_cxx.h>
. . .
Db db(NULL, 0);
const char *file_name = "myd.db";
try {
    // Configure the database for sorted duplicates
    db.set_flags(DB_DUPSORT);
    // Now open the database
    db.open(NULL,
                        // Txn pointer
            file_name, // File name
                        // Logical db name (unneeded)
            DB BTREE,
                        // Database type (using btree)
            DB_CREATE, // Open flags
            0);
                        // File mode. Using defaults
} catch(DbException &e) {
    db.err(e.get_errno(), "Database '%s' open failed.", file_name);
} catch(std::exception &e) {
    db.errx("Error opening database: %s : %s\n", file_name, e.what());
. . .
try {
    db.close(0);
} catch(DbException &e) {
    db.err(e.get_errno(), "Database '%s' close failed.", file_name);
} catch(std::exception &e) {
    db.errx("Error closing database: %s : %s\n", file_name, e.what());
```

Setting Comparison Functions

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/ / 2 2 00 Getting Started with DB

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Creating Comparison Functions

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```
int (*function)(Db *db, const Dbt *key1, const Dbt *key2)
```

nm rn nr n Tr l lhn sfic þtins reptNnntn a kæiet guea less. tók ug oa ót e goyuat t0 a fe rb r hnnk hnh, n sncomis e dêrmod ne ye offe at to2r ortis e tu t0 yuafd leofis iet s enst h Ir. hlnh, n nm w t0na froe t offi,e oa kog a e t ke foortis e tu t0 yuafd leofis iet s ensis n hnh n nm rn nn t a e tsecol de t e foc. o tis vetov t ea u gaatiu ea u

ln mp, lm h x onne kærneha æbo eti tsatsieudynot: teiuetges ietdatsaeas i

```
int
compare_int(Db *dbp, const Dbt *a, const Dbt *b)
{
   int ai, bi;

   // Returns:
   // < 0 if a < b
   // = 0 if a = b
   // > 0 if a > b
   memcpy(&ai, a->get_data(), sizeof(int));
   memcpy(&bi, b->get_data(), sizeof(int));
```

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```
return (ai - bi);
}
```

æig ds ohe t toppeterprodentas lfmslietco şeu jdoite o tysat i ao br р n m m eiat DB n n kn y nnh ne e ka n oeds nndry t gnaeætnl, a u oidí a igy y oft et ed igd atac i kBrl n r nr mup nr fo mro Wandamibow, henti eb u itaiog soa io t atd atsaes n h n etsie e eu m nm hn nr hr m one e abd nornaesiofb ffde ie rograevorit ests a e a tiftey ie teiet g eot ed hr h mp nw fo cyio.coed eeu d cot e s e at r m n У

DB h mp nr nT n oc sea: o te toto sua if c o ti u

```
#include <db_cxx.h>
#include <string.h>
...

Db db(NULL, 0);

// Set up the btree comparison function for this database
db.set_bt_compare(compare_int);

// Database open call follows sometime after this.
```