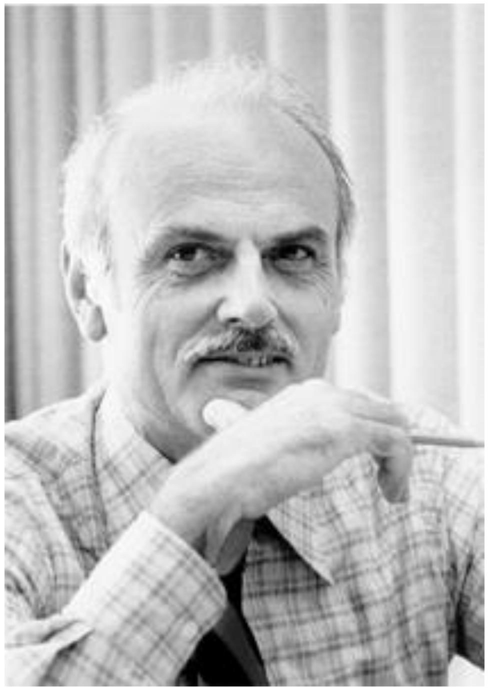
CS371m - Mobile Computing

Persistence - SQLite

In case you have not taken 347: Data Management or worked with databases as part of a job, internship, or project:

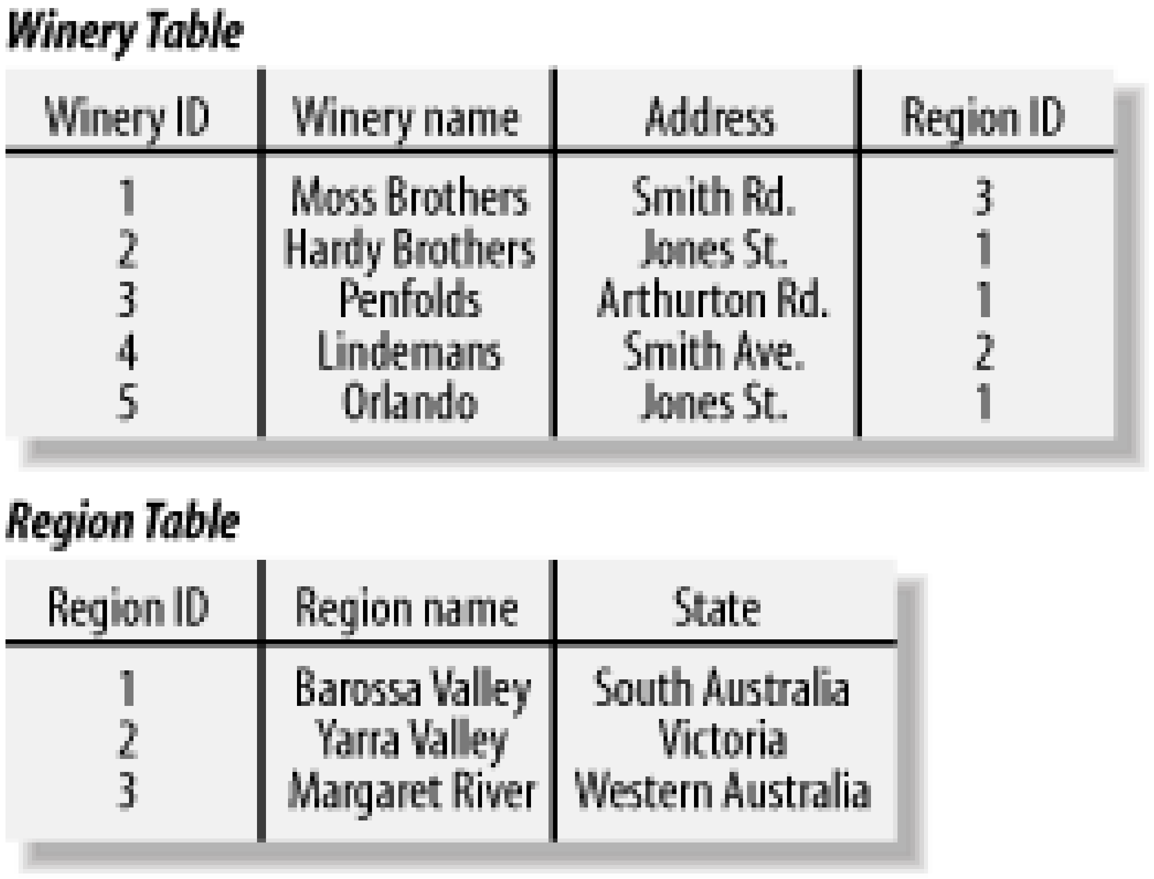
Databases

- RDBMS
  - relational data base management system
- Relational databases introduced by E. F. Codd in the 1970s
- Did Codd win the Turing Award?
  - A. Yes
  - B. No
- Relational Database
  - data stored in tables
  - relationships among data stored in tables
  - data can be accessed and viewed in different ways



Example Database

- Wines



Winery Table

Winery ID	Winery name	Address	Region ID
1	Moss Brothers	Smith Rd.	3
2	Hardy Brothers	Jones St.	1
3	Penfolds	Arthurton Rd.	1
4	Lindemans	Smith Ave.	2
5	Orlando	Jones St.	1

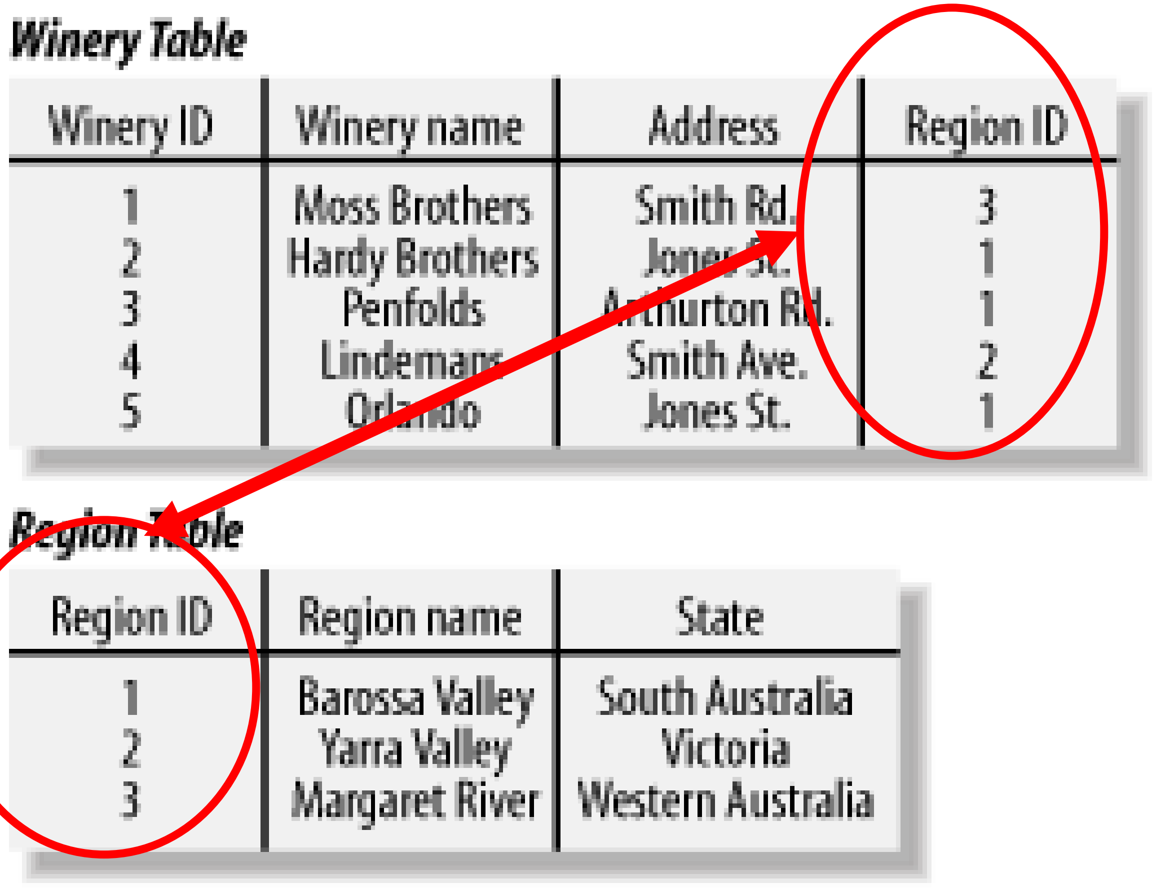
Region Table

Region ID	Region name	State
1	Barossa Valley	South Australia
2	Yarra Valley	Victoria
3	Margaret River	Western Australia

Web Database Applications with PHP and MySQL, 2nd Edition ,
by Hugh E. Williams, David Lane

Relational Data

- Data in different tables can be related
  - hence, ***relational database***



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Region Table

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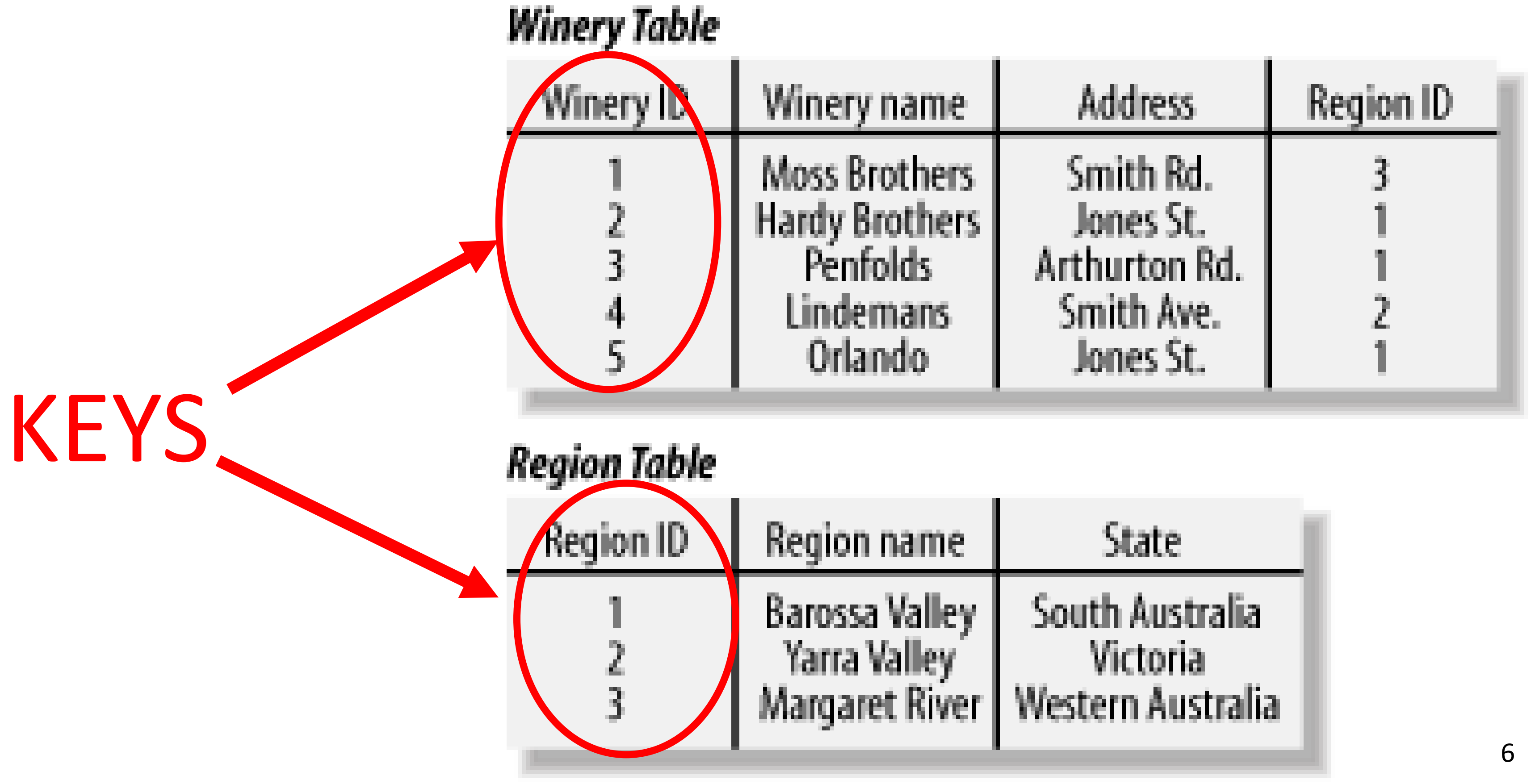
Keys

- Each table has a key
- Column used to uniquely identify each row



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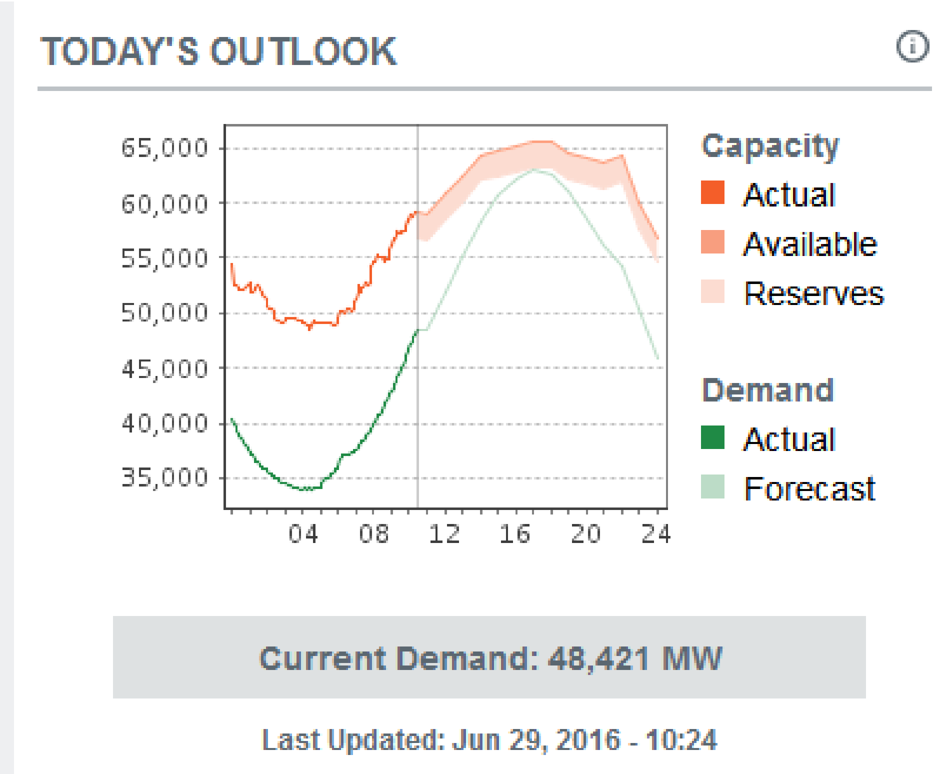
SQL and SQLite

- Structured Query Language
- a programming language to manage data in a RDBMS
- SQLite implements most,
  but not all of SQL
  - http://www.sqlite.org/

Aside - Database Admins

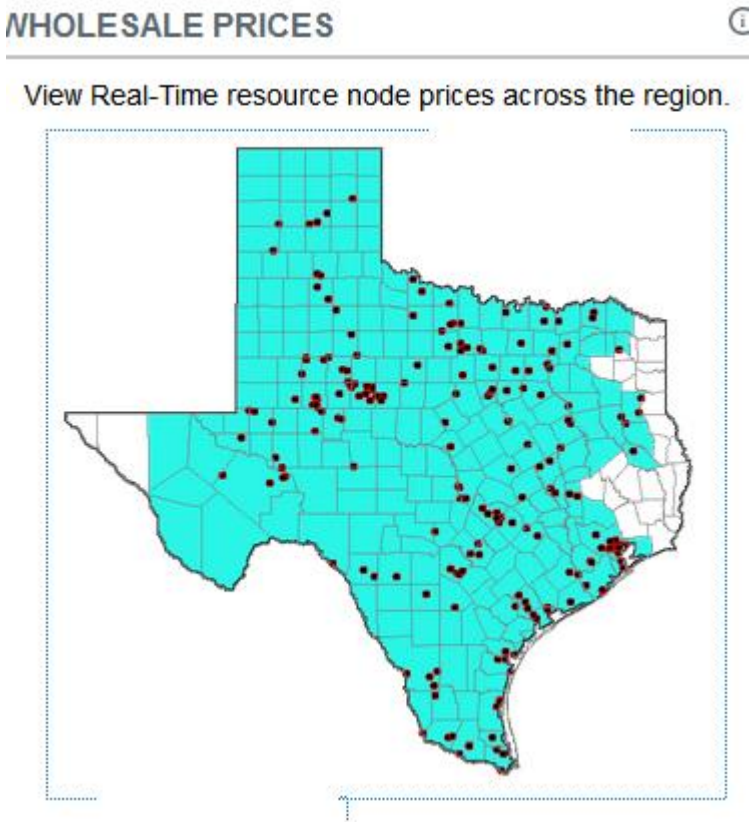
- full time jobs
- ERCOT = Electric Reliability Council of Texas



TODAY'S OUTLOOK

Current Demand: 48,421 MW

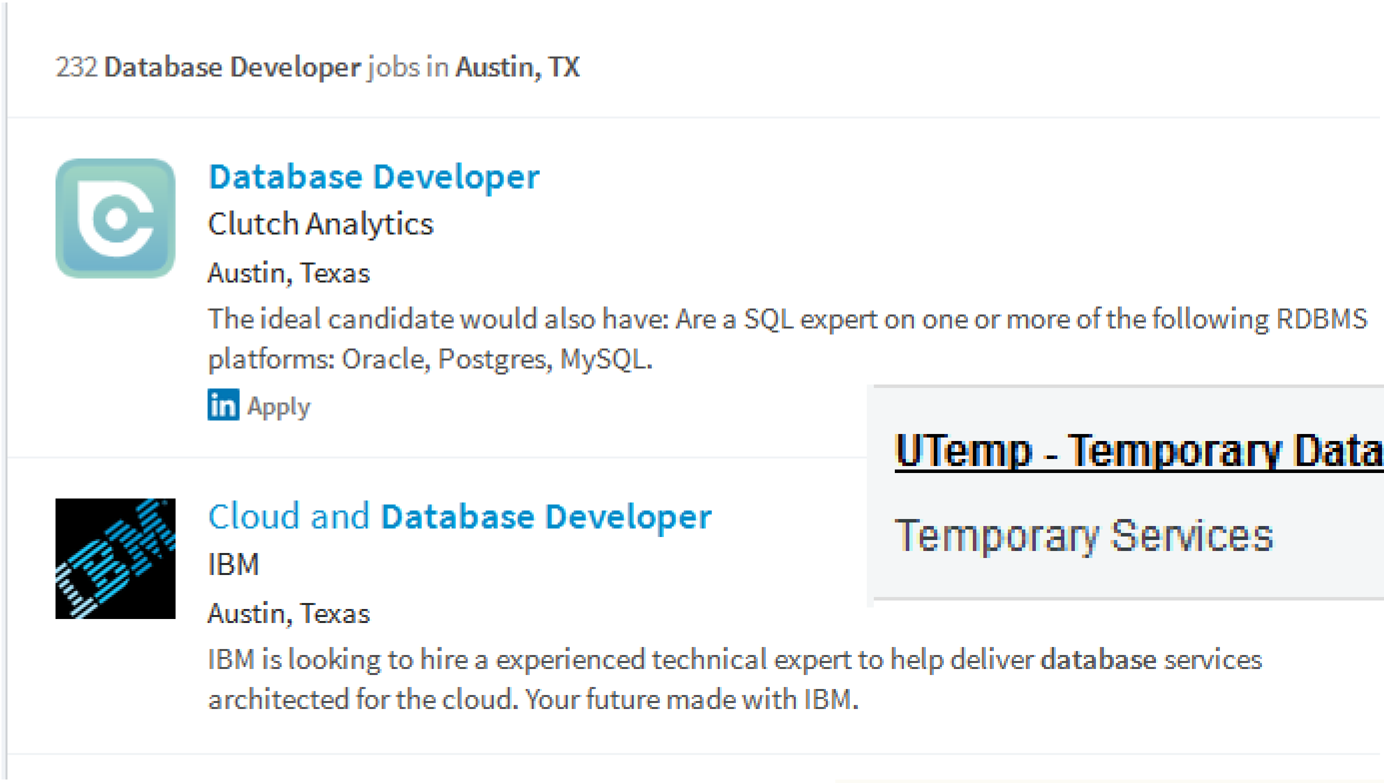
Last Updated: Jun 29, 2016 - 10:24



WHOLESALE PRICES

View Real-Time resource node prices across the region.

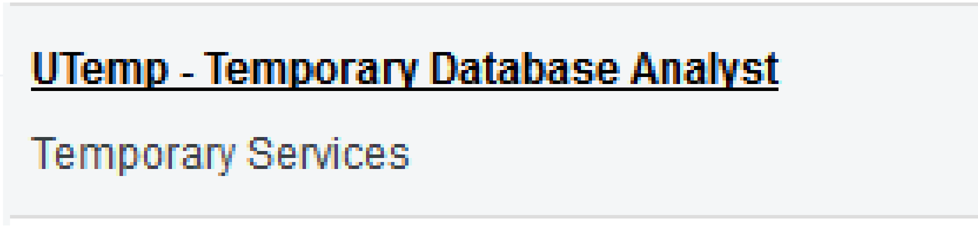
Database Admins



232 **Database Developer** jobs in **Austin, TX**

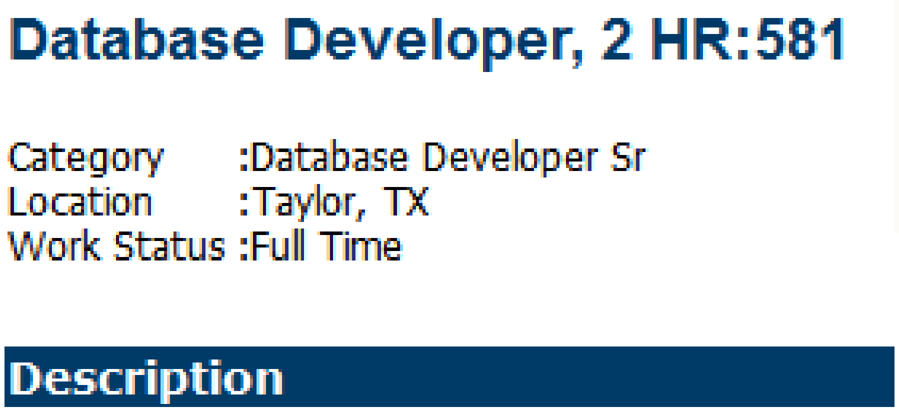
Database Developer
Clutch Analytics
Austin, Texas
The ideal candidate would also have: Are a SQL expert on one or more of the following RDBMS platforms: Oracle, Postgres, MySQL.
Apply

Cloud and **Database Developer**
IBM
Austin, Texas
IBM is looking to hire a experienced technical expert to help deliver **database** services architected for the cloud. Your future made with IBM.



UTemp - Temporary Database Analyst

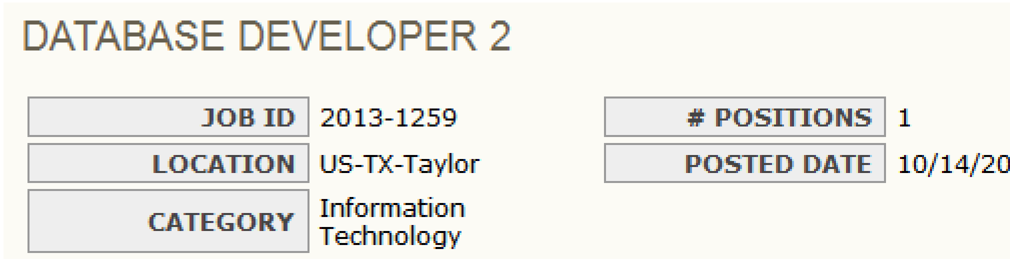
Temporary Services



Database Developer, 2 HR:581

Category	:Database Developer Sr
Location	:Taylor, TX
Work Status	:Full Time

Description



DATABASE DEVELOPER 2

JOB ID	2013-1259	# POSITIONS	1
LOCATION	US-TX-Taylor	POSTED DATE	10/14/20
CATEGORY	Information Technology		

SQLite and Android

- Databases created with applications are accessible by name to all classes in application, but no outside applications
- Creating database:
  - create subclass of **SQLiteOpenHelper** and override onCreate() method
  - execute SQLite command to create tables in database
  - onUpgrade() method for later versions of app and database already present

SQL and Databases

- SQL is a language used to manipulate and manage information in a relational database management system (RDBMS)
- SQL Commands:
- CREATE TABLE - creates a new database table
- ALTER TABLE - alters a database table
- DROP TABLE - deletes a database table
- CREATE INDEX - creates an index (search key)
- DROP INDEX - deletes an index

SQL Commands

- SELECT - get data from a database table
- UPDATE - change data in a database table
- DELETE - remove data from a database table
- INSERT INTO - insert new data in a database table

ANDROID AND SQLITE

Android and SQLite

- SQLite "baked into" Android.
- Device will have SQLite and apps can create and use databases.
- Not necessary to add third party library or jar to your app.
- **Many developers use a third party library to ease the syntax burden of using SQLite directly in their code.**

Android and SQLite

- SQLiteDatabase class
- methods to programmatically interact with SQLite database
- SQLiteDatabase has methods to create, delete, execute SQL commands, and perform other common database management tasks.
- database restricted to application
  - unless create content provider

http://developer.android.com/reference/android/database/sqlite/SQLiteDatabase.html

Android and SQLite

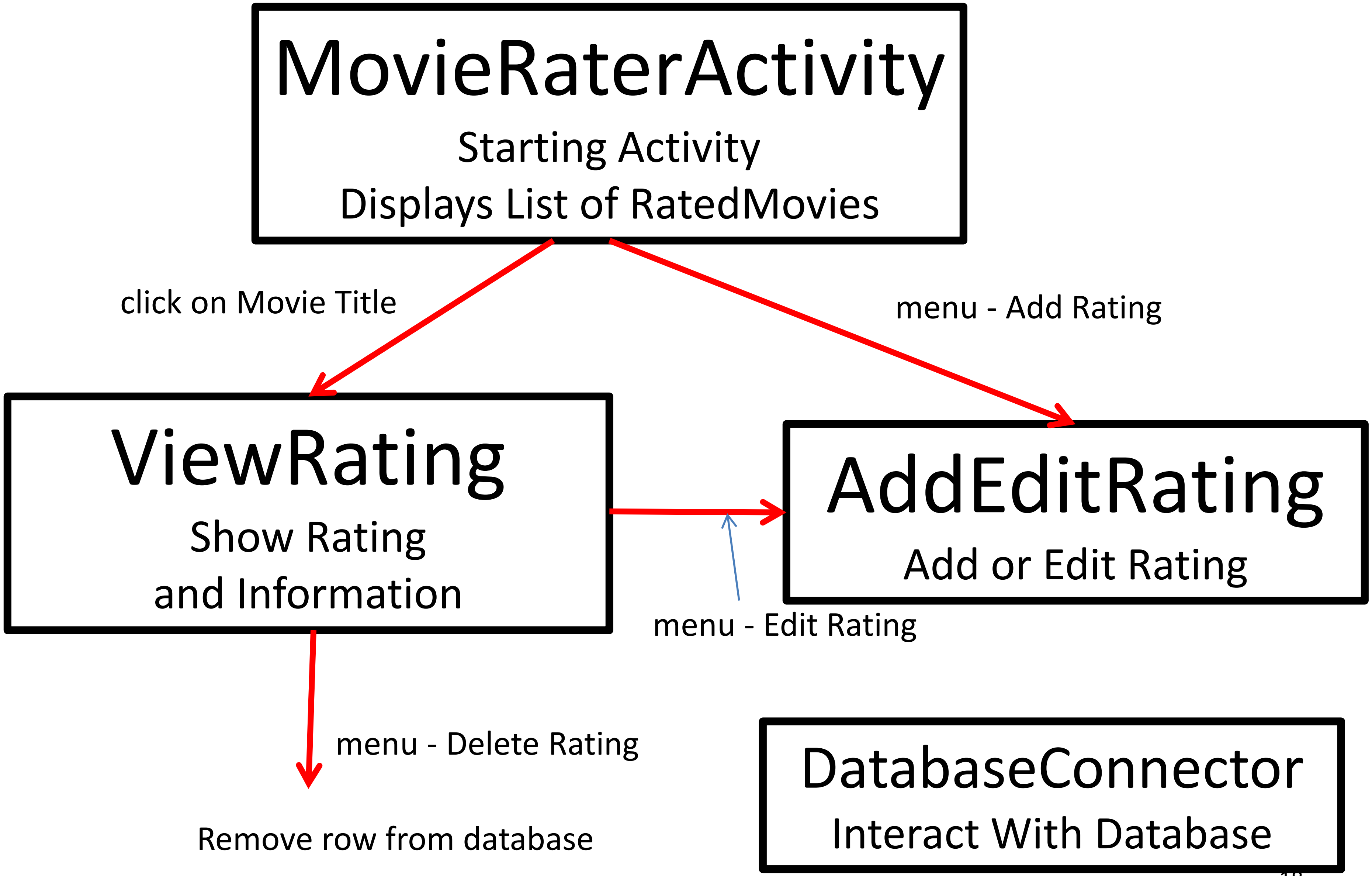
- Build database on the fly in application
- example (movie ratings) has no built in data to start with
- possible to create database ahead of time and include in apk
- move from apk to Android database on first use

http://stackoverflow.com/questions/5627037/how-can-i-embed-an-sqlite-database-into-an-application

Creating Database

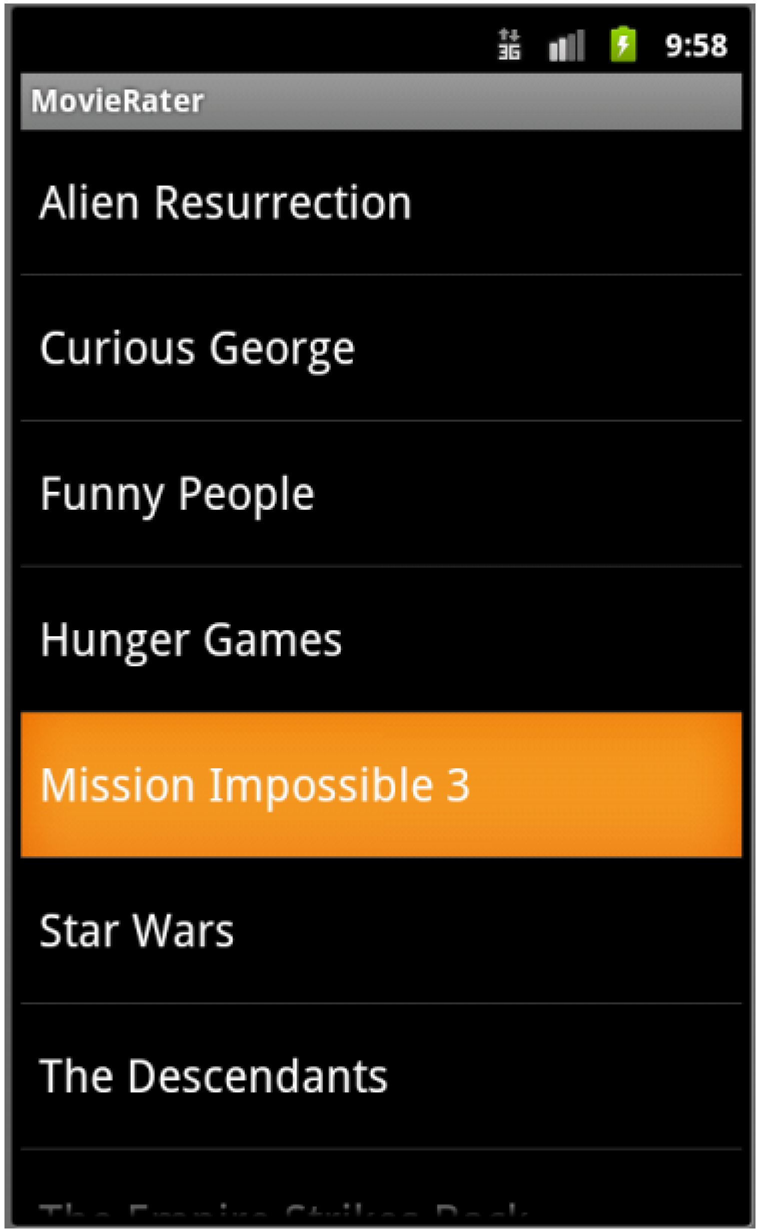
- Example: Movie Rating App
- Stores user ratings
- Not a complex example
- Database only has one table
  - overkill in this scenario
- Adapted from Deitel Address Book Application

Classes


MovieRaterActivity
Starting Activity
Displays List of RatedMovies
click on Movie Title
menu - Add Rating
ViewRating
Show Rating
and Information
AddEditRating
Add or Edit Rating
menu - Edit Rating
menu - Delete Rating
Remove row from database
DatabaseConnector
Interact With Database

MovieRaterActivity

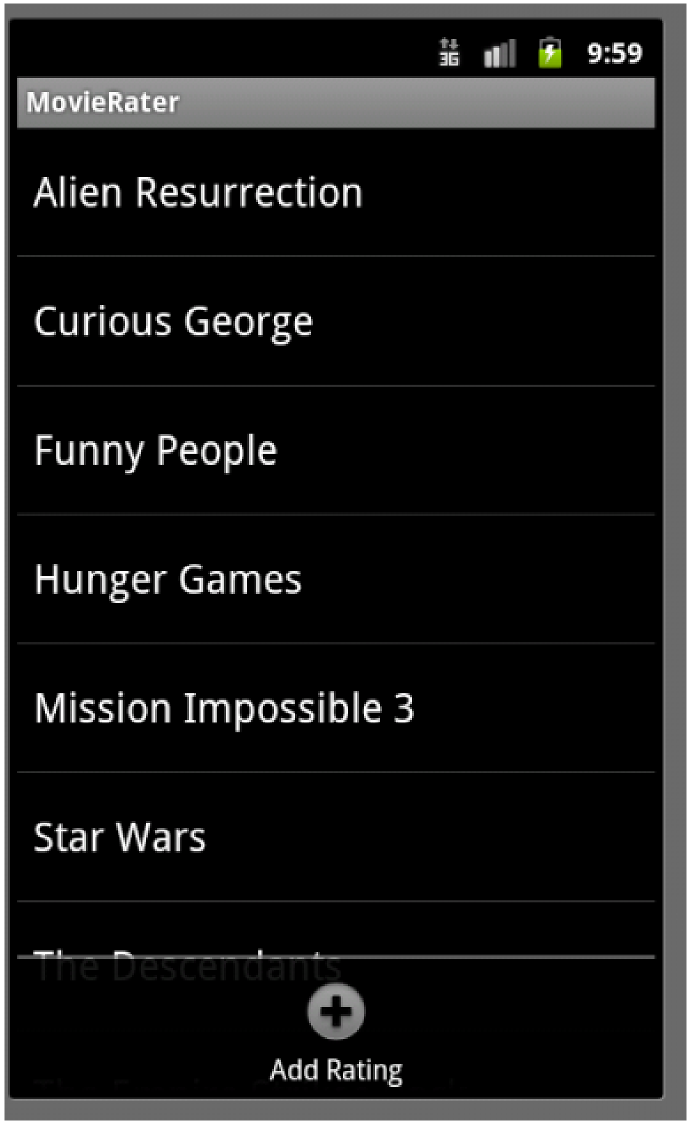
- ListlView
- Queries data base for all names / titles
- Clicking on Title brings up that rating in ViewRating



Alien Resurrection
Curious George
Funny People
Hunger Games
Mission Impossible 3
Star Wars
The Descendants

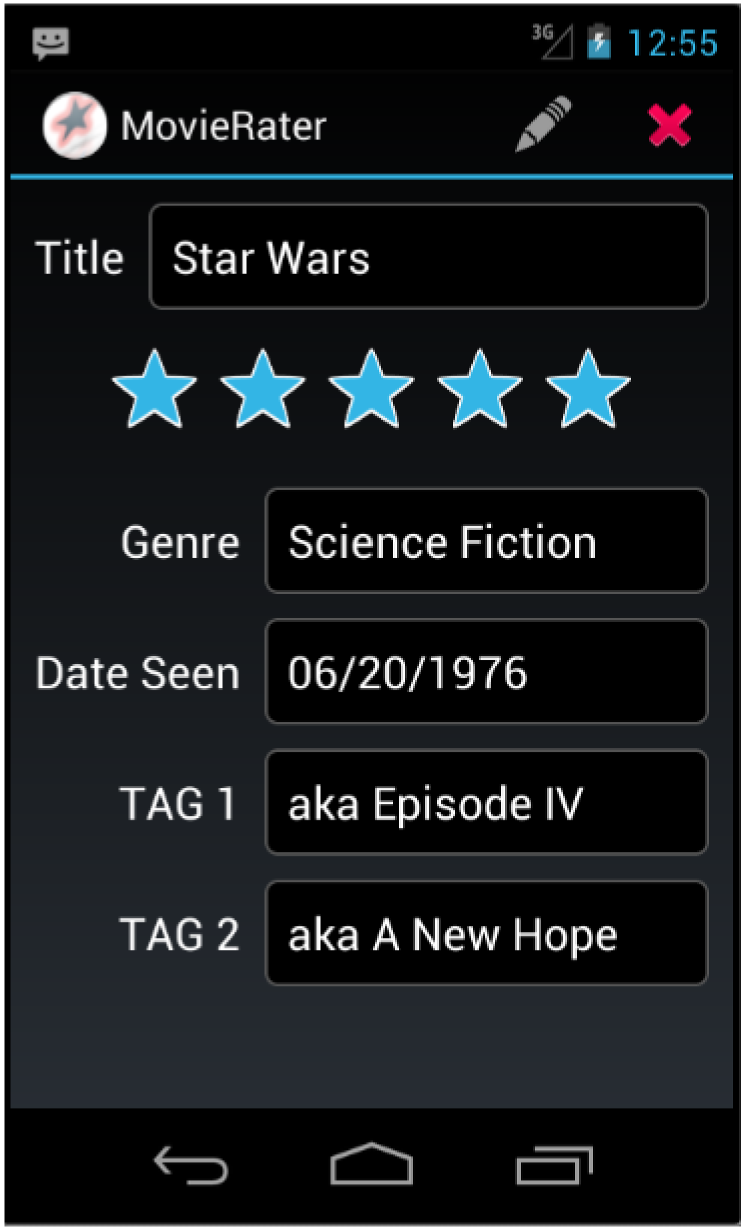
Menu for MovieRaterActivity

- Only one app bar item
- button to Add Rating
- Brings up AddEditRating Activity



ViewRating

- Pulls all data from database for row based on name / title
- Use of a RatingBar
- ViewRating has its own Action Bar items


12:55

MovieRater

Title: Star Wars

Genre: Science Fiction

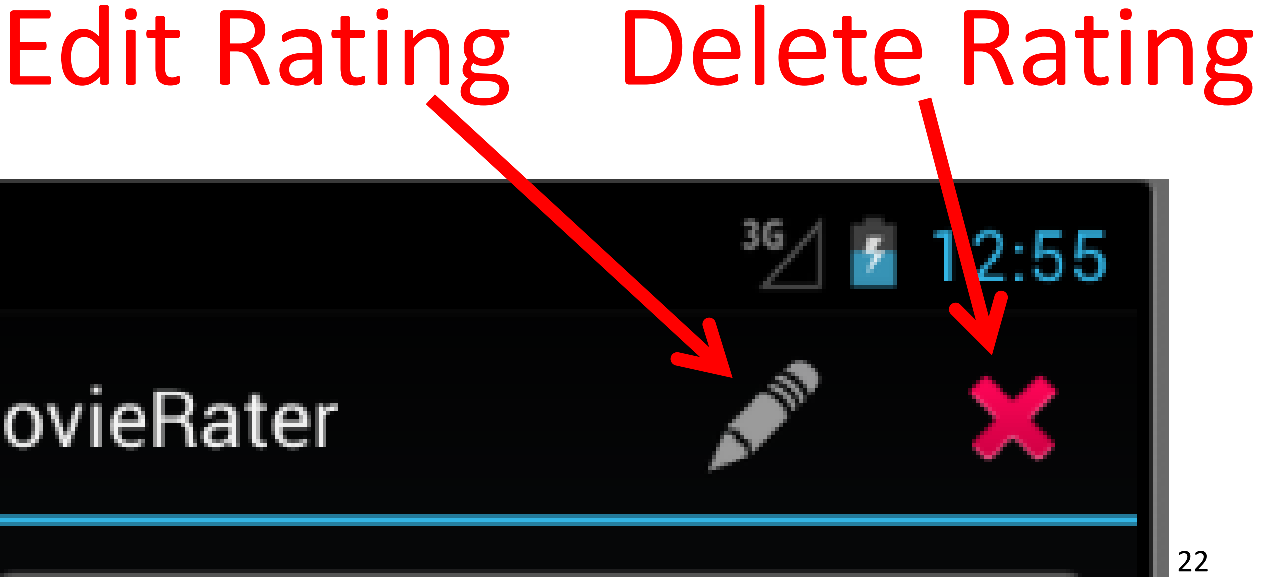
Date Seen: 06/20/1976

TAG 1: aka Episode IV

TAG 2: aka A New Hope

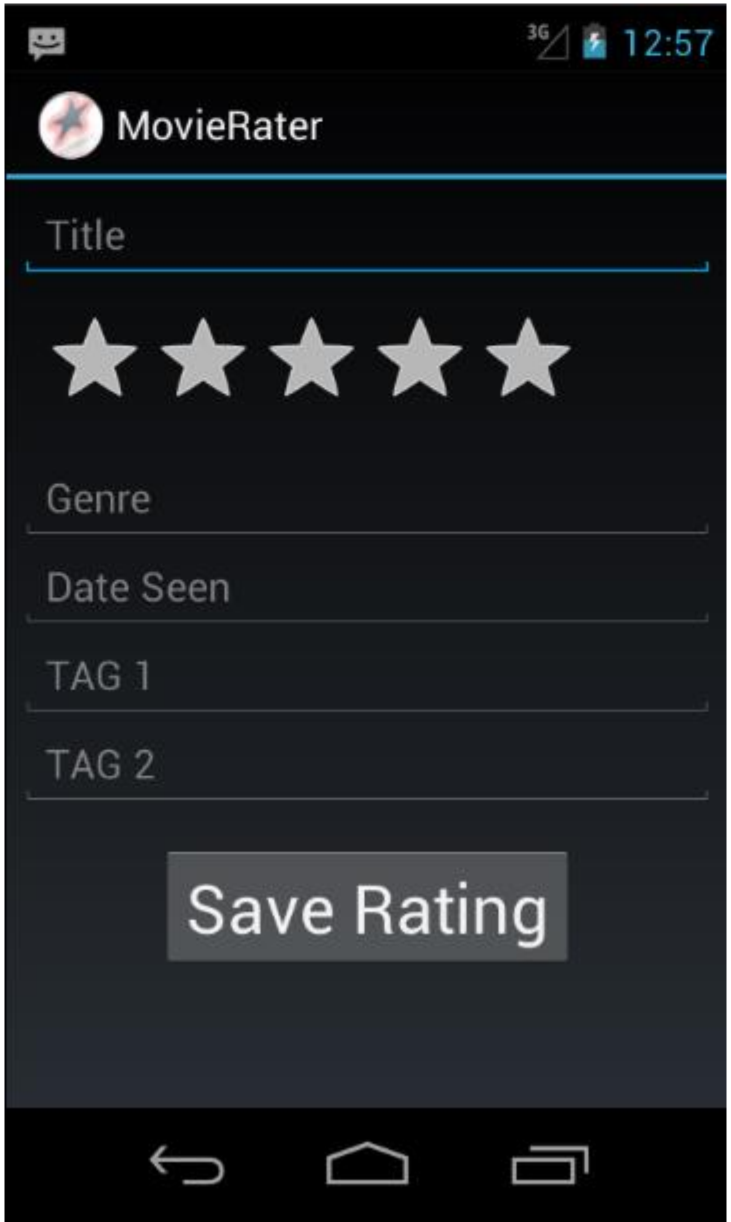
ViewRating Menu

- Edit Rating starts AddEditRating activity and populates fields with these values (place in Extras)
- Delete Rating brings up confirmation Dialog



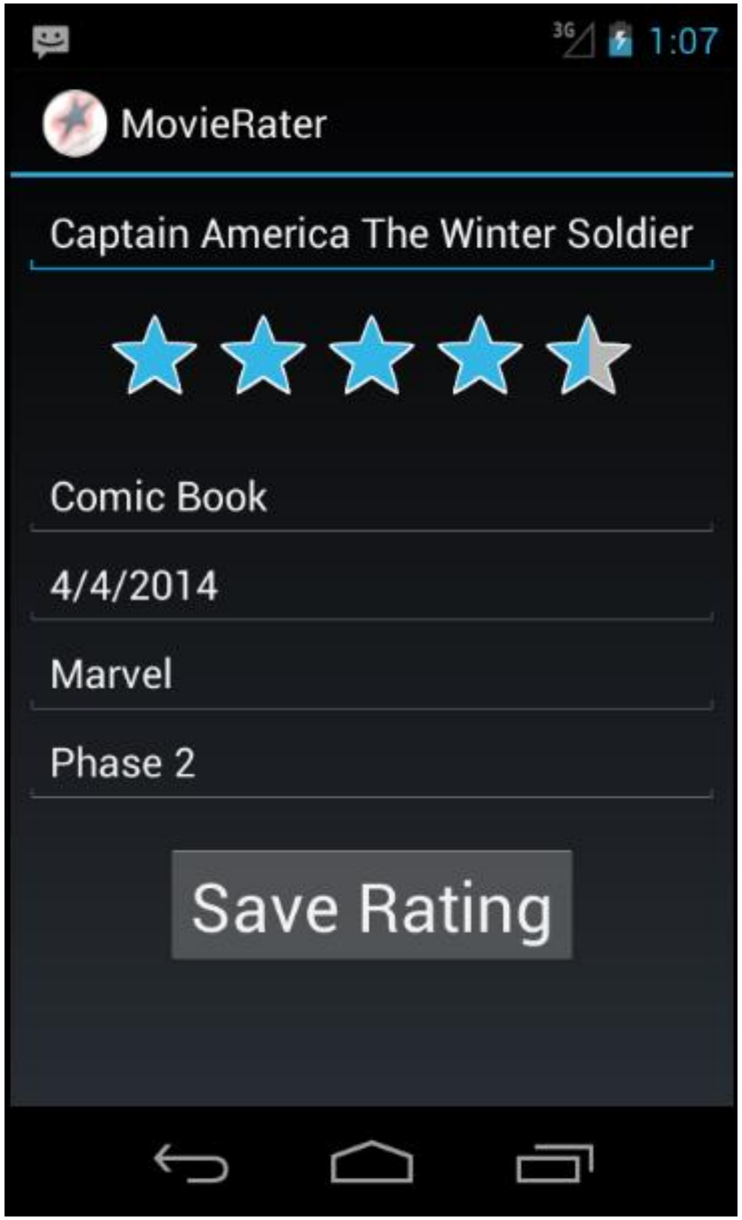
AddEditRating

- Add Rating
  - fields are blank
- Consider adding a button for date picker instead of typing data
- Must enter title / name
- other fields can be blank



AddEditRating

- When title clicked in main Activity, MovieRaterActivity
- Make changes and click save


1:07

MovieRater

Captain America The Winter Soldier

Comic Book

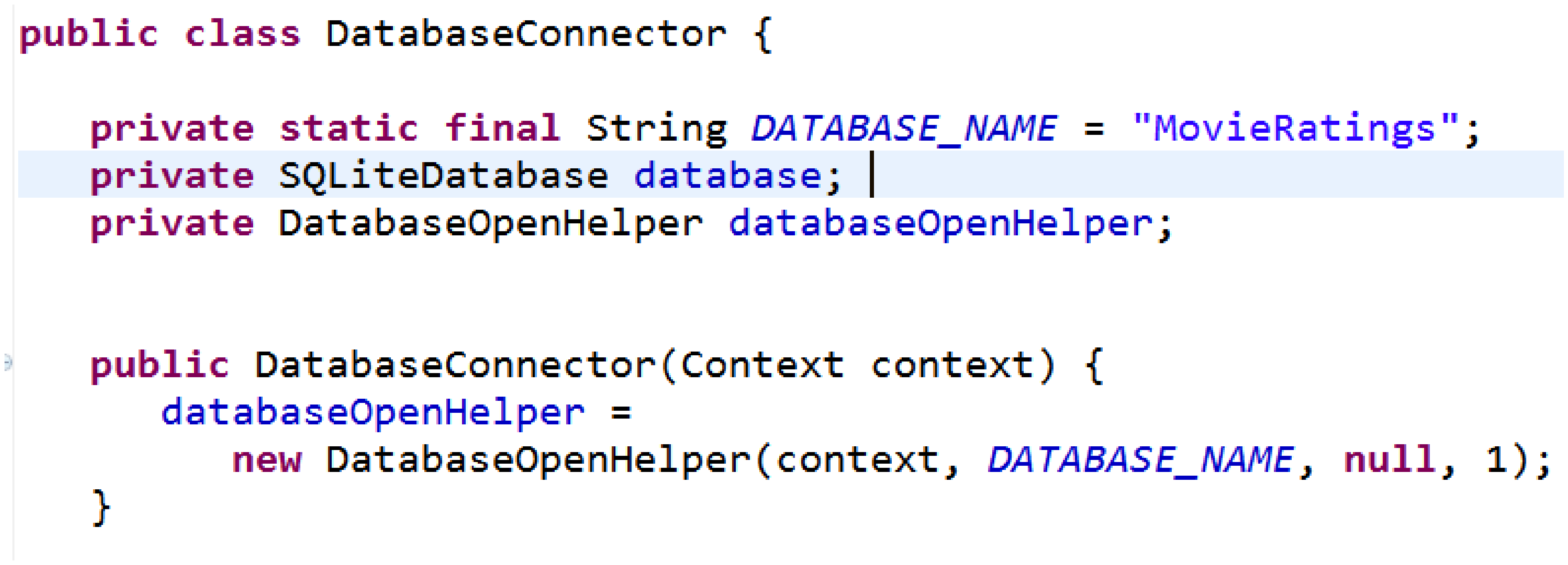
4/4/2014

Marvel

Phase 2

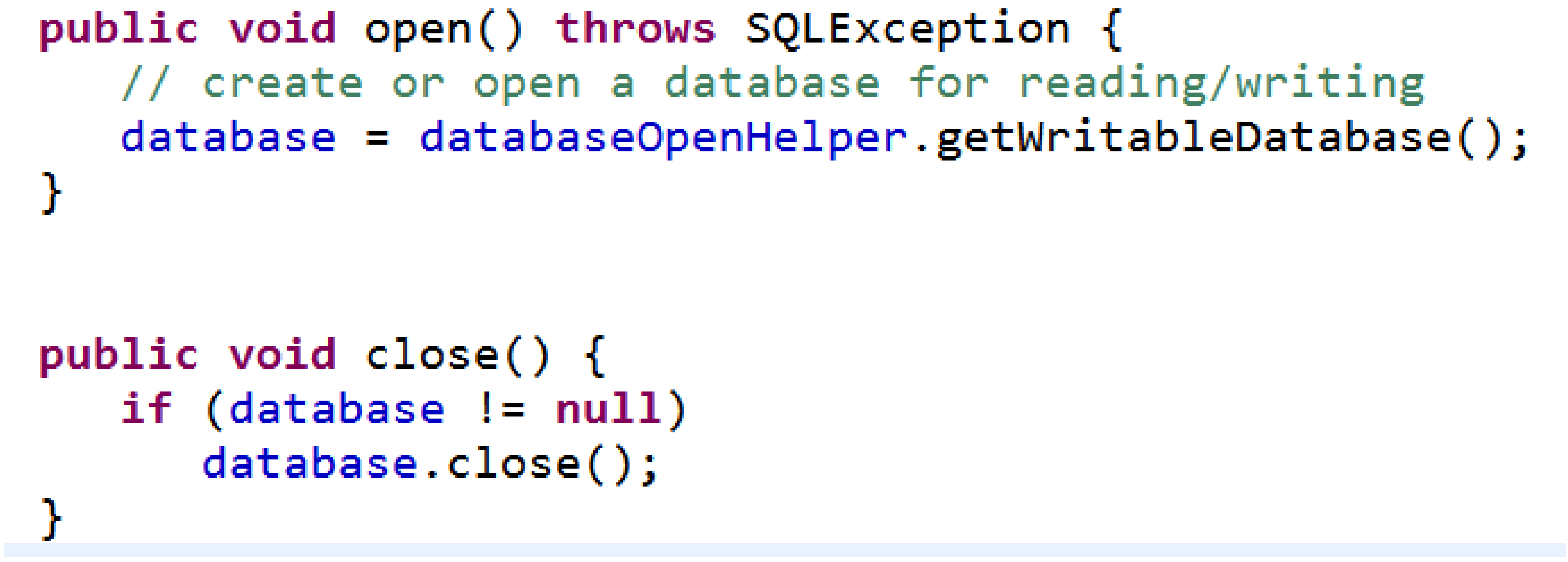
DatabaseConnector Class

- Start of class



```java
public class DatabaseConnector {

    private static final String DATABASE_NAME = "MovieRatings";
    private SQLiteDatabase database;
    private DatabaseOpenHelper databaseOpenHelper;


    public DatabaseConnector(Context context) {
        databaseOpenHelper =
            new DatabaseOpenHelper(context, DATABASE_NAME, null, 1);
    }
```

DatabaseConnector Class



```
public void open() throws SQLException {
   // create or open a database for reading/writing
   database = databaseOpenHelper.getWritableDatabase();
}

public void close() {
   if (database != null)
      database.close();
}
```

Creating Database

- Via an inner class that extends SQLiteOpenHelper
- Used to create database first time app run on a device
- also used to update database if you **update your app** and **alter the structure of the database**

```
private class DatabaseOpenHelper extends SQLiteOpenHelper {

    public DatabaseOpenHelper(Context context, String name,
        CursorFactory factory, int version) {
        super(context, name, factory, version);
    }
```

Creating Database

- The key method in DatabaseOpenHelper

```
// creates the ratings table when the database is created
@Override
public void onCreate(SQLiteDatabase db) {
   // query to create a new table named ratings
   String createQuery = "CREATE TABLE ratings" +
      "(_id INTEGER PRIMARY KEY autoincrement, " +
      "name TEXT, " +
      "genre TEXT, " +
      "dateSeen TEXT, " +
      "tag1 TEXT, " +
      "tag2 TEXT, " +
      "rating INTEGER);";

   db.execSQL(createQuery);
}
```

Creating Database

- The String parameter is a SQLite command
- ratings is name of table
- table has seven columns
  - _id, name, genre, dateSeen, tag1, tag2, rating
- storage classes for columns:
  - TEXT, INTEGER, REAL
  - also NULL and BLOB (Binary Large OBject)
- _id is used as primary key for rows

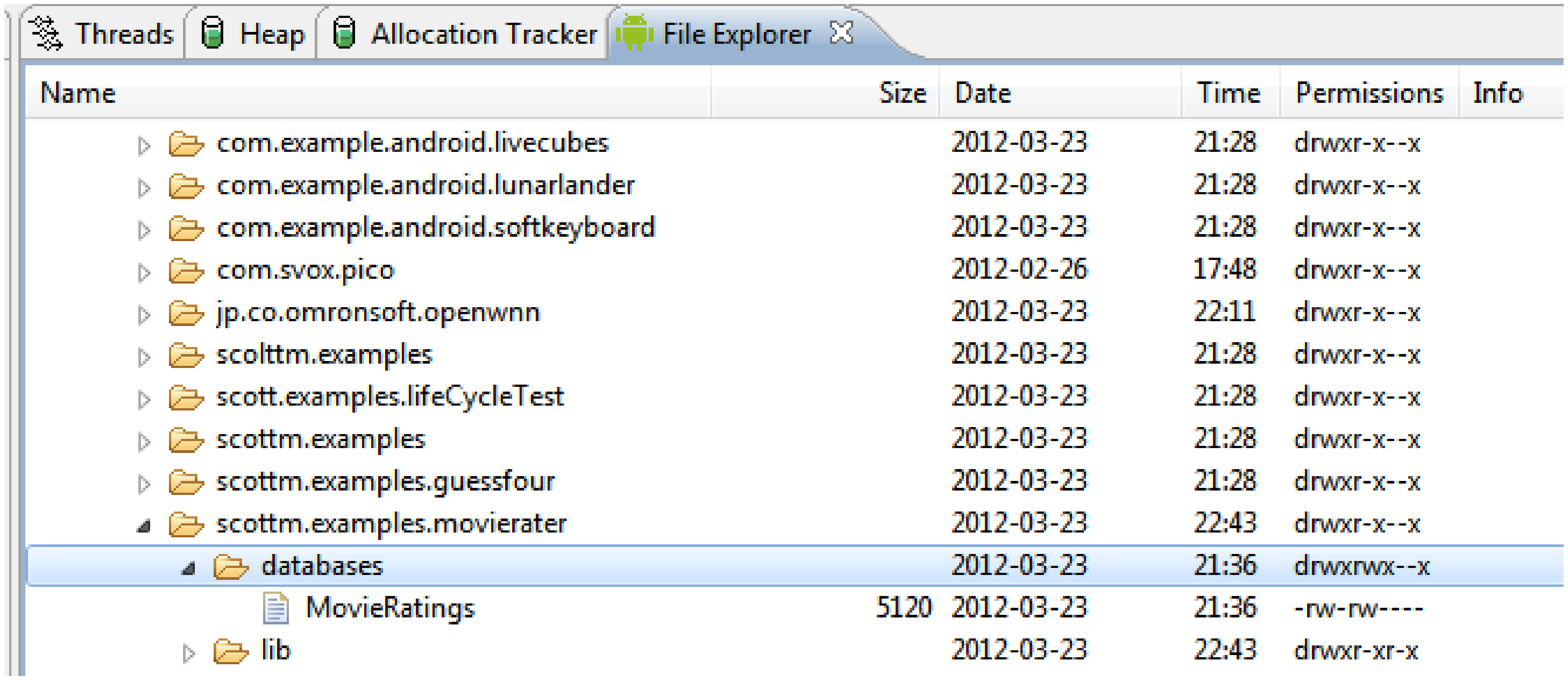
Updating Database

- Quite likely you change the set up of you database over time
  - add tables, add columns, remove tables or columns, reorganize
  - referred to as the *schema* of the database
- onUpgrade method for class that extends SQLiteOpenHelper
  - for converting database on device (from previous version of your app) to scheme used by newer version of app
  - not trivial!

Aside - Contract Class

- If you plan to use the database in multiple activities and components of your app
  - consider creating a *Contract Class*
- A class with constants that define table names and columns
  - instead of hard coding in multiple places
- Android has built in ContactsContract and CalendarContract classes

Databases on Device

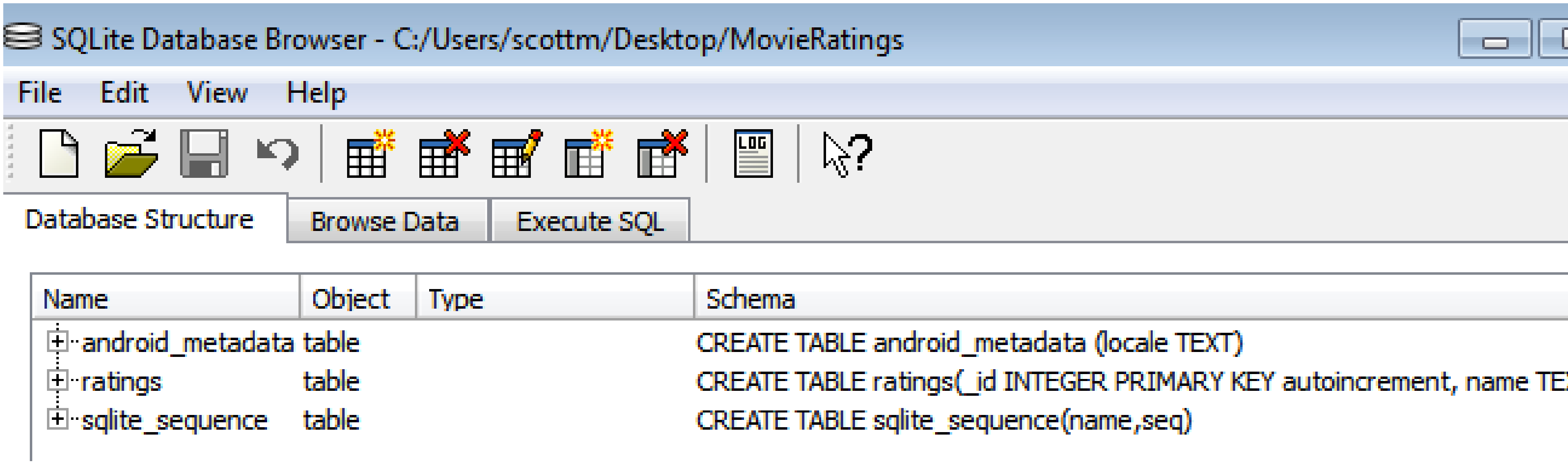


Name	Size	Date	Time	Permissions	Info
com.example.android.livecubes		2012-03-23	21:28	drwxr-x--x	
com.example.android.lunarlander		2012-03-23	21:28	drwxr-x--x	
com.example.android.softkeyboard		2012-03-23	21:28	drwxr-x--x	
com.svox.pico		2012-02-26	17:48	drwxr-x--x	
jp.co.omronsoft.openwnn		2012-03-23	22:11	drwxr-x--x	
scolttm.examples		2012-03-23	21:28	drwxr-x--x	
scott.examples.lifeCycleTest		2012-03-23	21:28	drwxr-x--x	
scottm.examples		2012-03-23	21:28	drwxr-x--x	
scottm.examples.guessfour		2012-03-23	21:28	drwxr-x--x	
scottm.examples.movierater		2012-03-23	22:43	drwxr-x--x	
databases		2012-03-23	21:36	drwxrwx--x	
MovieRatings	5120	2012-03-23	21:36	-rw-rw----	
lib		2012-03-23	22:43	drwxr-xr-x	

- can pull database and view
- data/data/app package/database
- sqlitebrowser is a decent tool

sqlite browser

- Entire Database:
  - Recall, we created a single table


SQLite Database Browser - C:/Users/scottm/Desktop/MovieRatings
File Edit View Help
LOG
Database Structure
Browse Data
Execute SQL

Name	Object	Type	Schema
android_metadata	table		CREATE TABLE android_metadata (locale TEXT)
ratings	table		CREATE TABLE ratings(_id INTEGER PRIMARY KEY autoincrement, name TE
sqlite_sequence	table		CREATE TABLE sqlite_sequence(name,seq)

sqlite browser

- ratings table

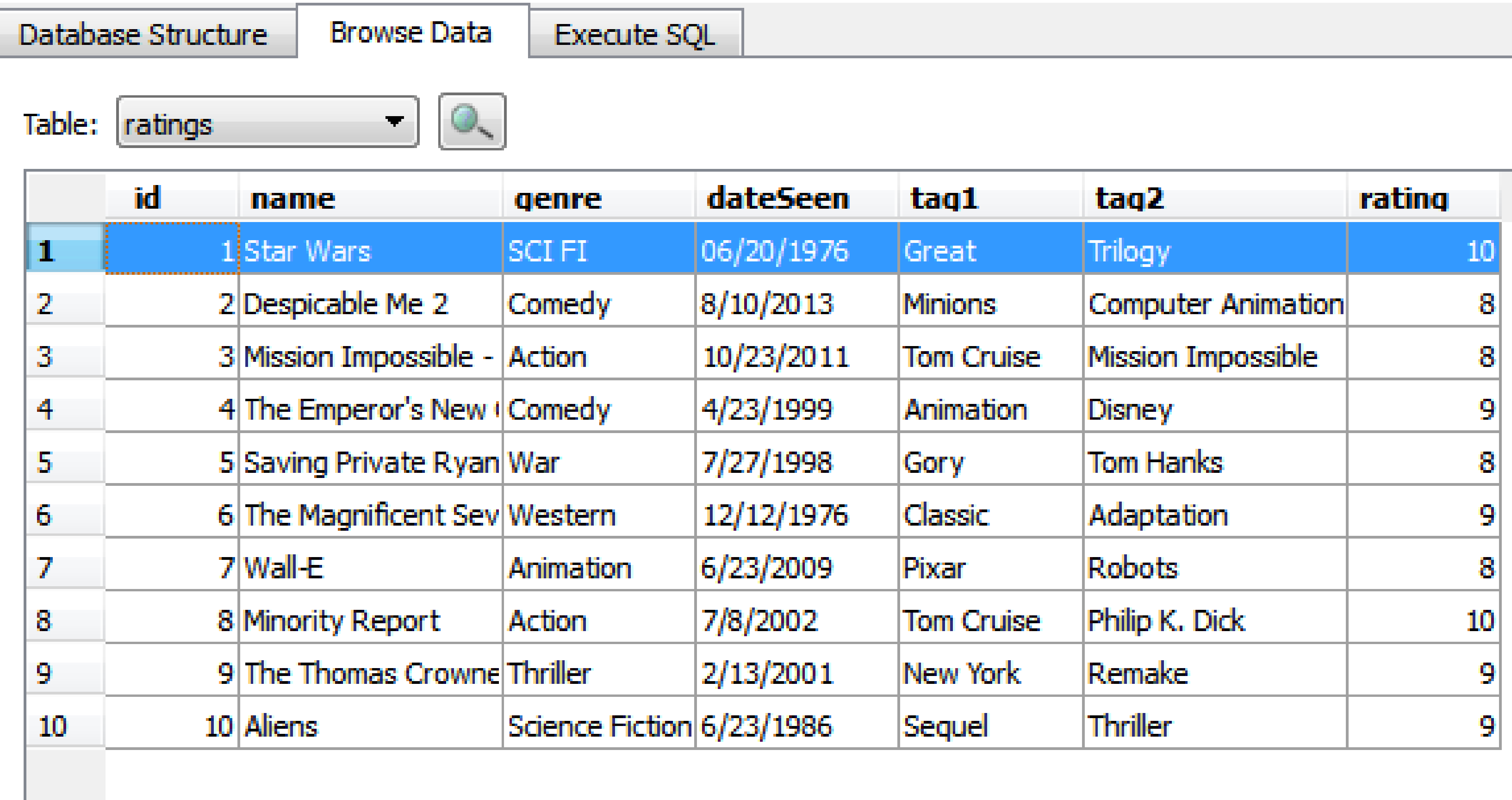
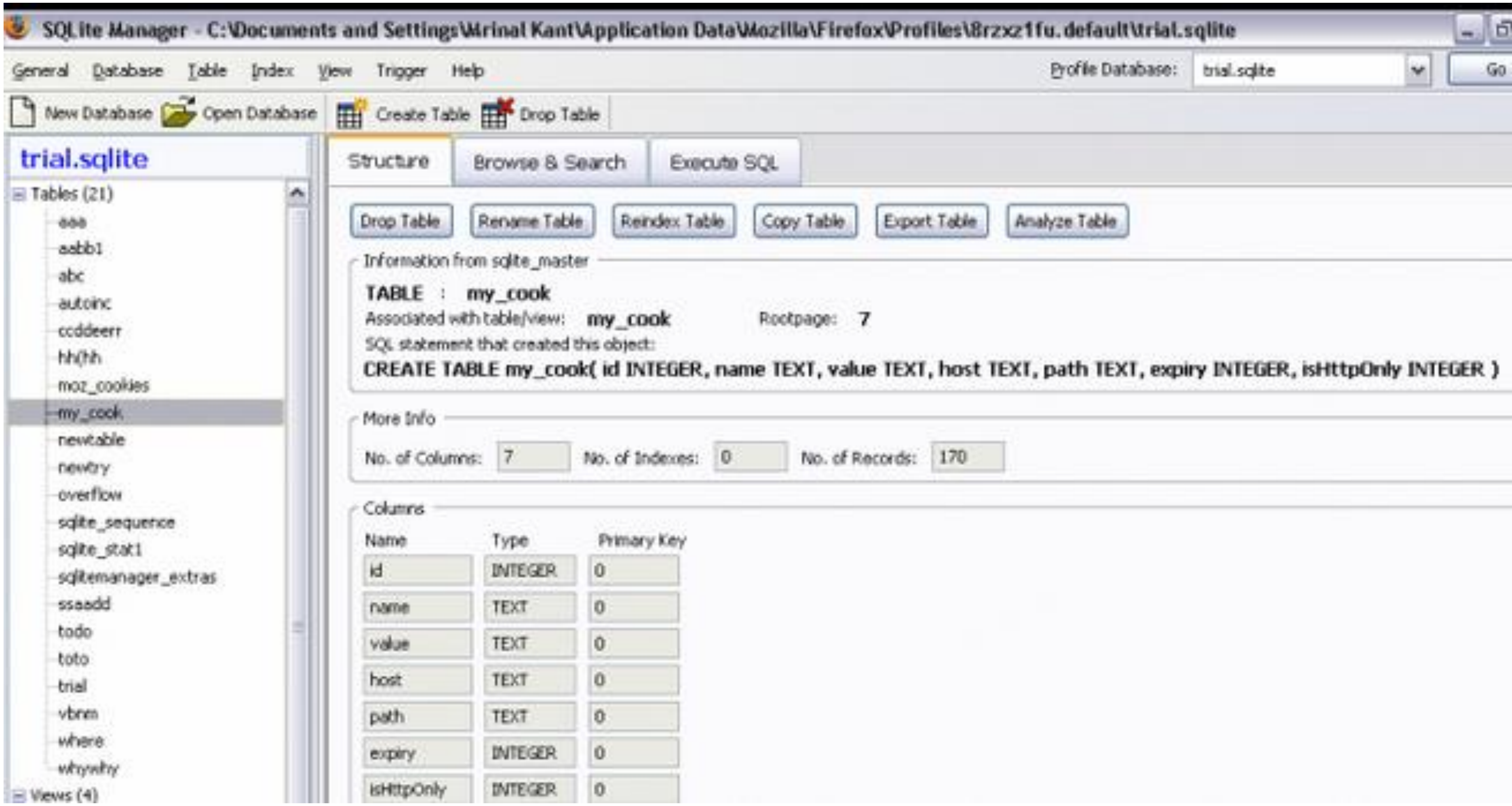


Table: ratings

	id	name	genre	dateSeen	tag1	tag2	rating
1	1	Star Wars	SCI FI	06/20/1976	Great	Trilogy	10
2	2	Despicable Me 2	Comedy	8/10/2013	Minions	Computer Animation	8
3	3	Mission Impossible -	Action	10/23/2011	Tom Cruise	Mission Impossible	8
4	4	The Emperor's New	Comedy	4/23/1999	Animation	Disney	9
5	5	Saving Private Ryan	War	7/27/1998	Gory	Tom Hanks	8
6	6	The Magnificent Sev	Western	12/12/1976	Classic	Adaptation	9
7	7	Wall-E	Animation	6/23/2009	Pixar	Robots	8
8	8	Minority Report	Action	7/8/2002	Tom Cruise	Philip K. Dick	10
9	9	The Thomas Crowne	Thriller	2/13/2001	New York	Remake	9
10	10	Aliens	Science Fiction	6/23/1986	Sequel	Thriller	9

sqlite Manager for Firefox

- Alternative to sqlite Viewer



SQLite Manager - C:\Documents and Settings\Mrinal Kant\Application Data\Mozilla\Firefox\Profiles\8rzxz1fu.default\trial.sqlite

trial.sqlite

Tables (21)
- aaa
- aabb1
- abc
- autoinc
- ccddeerr
- hh(hh
- moz_cookies
- my_cook
- newtable
- newtry
- overflow
- sqlite_sequence
- sqlite_stat1
- sqlitemanager_extras
- ssaadd
- todo
- toto
- trial
- vbnm
- where
- whywhy

Views (4)

Information from sqlite_master

TABLE : my_cook

Associated with table/view: my_cook Rootpage: 7

SQL statement that created this object:

```
CREATE TABLE my_cook( id INTEGER, name TEXT, value TEXT, host TEXT, path TEXT, expiry INTEGER, isHttpOnly INTEGER )
```

More Info

No. of Columns: 7 No. of Indexes: 0 No. of Records: 170

Columns

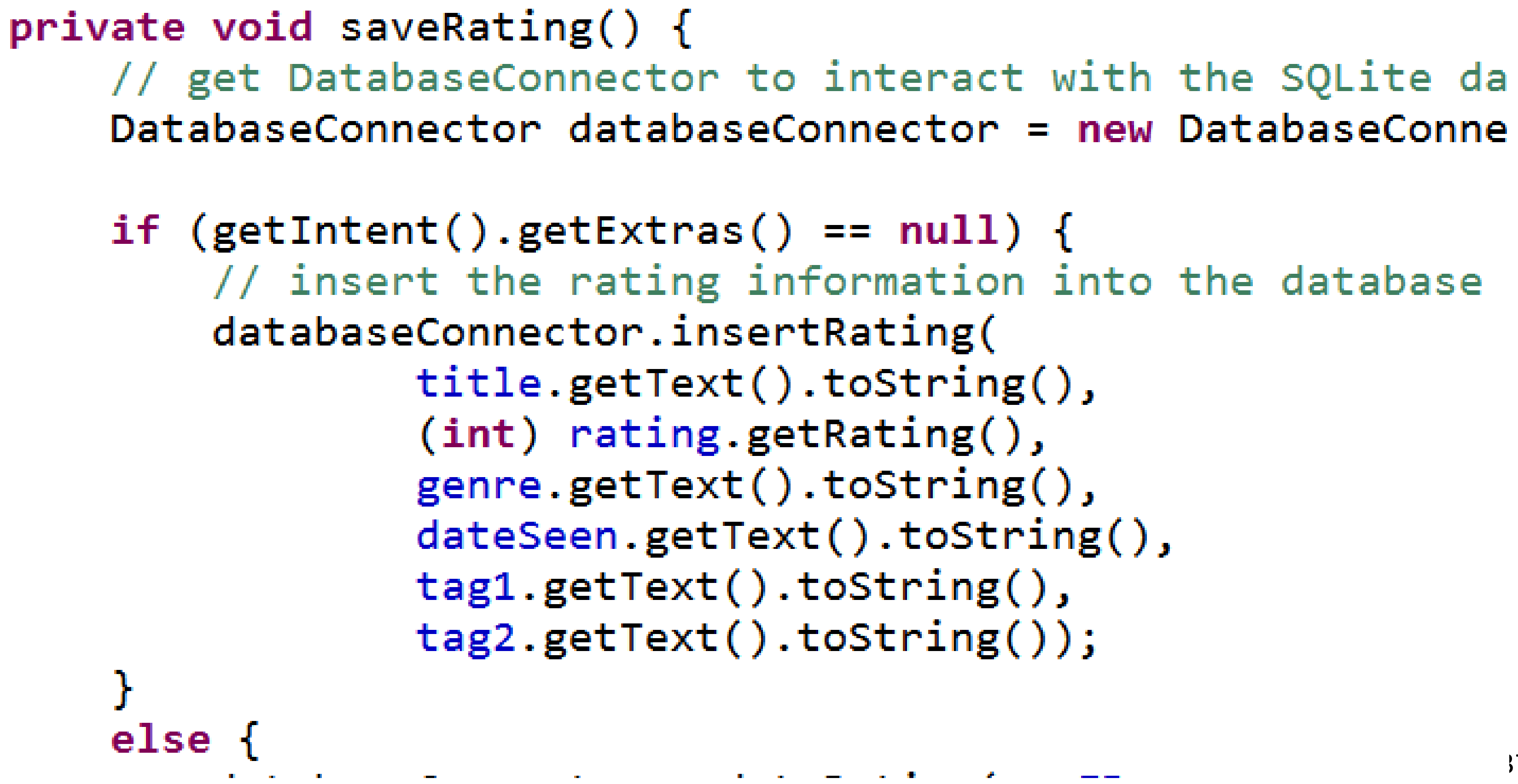
Name	Type	Primary Key
id	INTEGER	0
name	TEXT	0
value	TEXT	0
host	TEXT	0
path	TEXT	0
expiry	INTEGER	0
isHttpOnly	INTEGER	0

Inserting Data

- ContentValues: object with key/value pairs that are used when inserting/updating databases
- Each ContentValue object corresponds to one row in a table
- _id being added and incremented automatically

Inserting Data

- In AddEditRating
- When save button clicked



```
private void saveRating() {
    // get DatabaseConnector to interact with the SQLite da
    DatabaseConnector databaseConnector = new DatabaseConne

    if (getIntent().getExtras() == null) {
        // insert the rating information into the database
        databaseConnector.insertRating(
                title.getText().toString(),
                (int) rating.getRating(),
                genre.getText().toString(),
                dateSeen.getText().toString(),
                tag1.getText().toString(),
                tag2.getText().toString());
    }
    else {
```

Inserting Data

- Key method in DatabaseConnector

```java
// inserts a new rating into the database
public void insertRating(String title, int rating,
   String genre, String dateSeen, String tag1, String tag2) {
   ContentValues newRating = new ContentValues();
   newRating.put("name", title);
   newRating.put("rating", rating);
   newRating.put("genre", genre);
   newRating.put("dateSeen", dateSeen);
   newRating.put("tag1", tag1);
   newRating.put("tag2", tag2);

   open();
   database.insert("ratings", null, newRating);
   close();
}
```

nullColumnHack, for inserting empty row

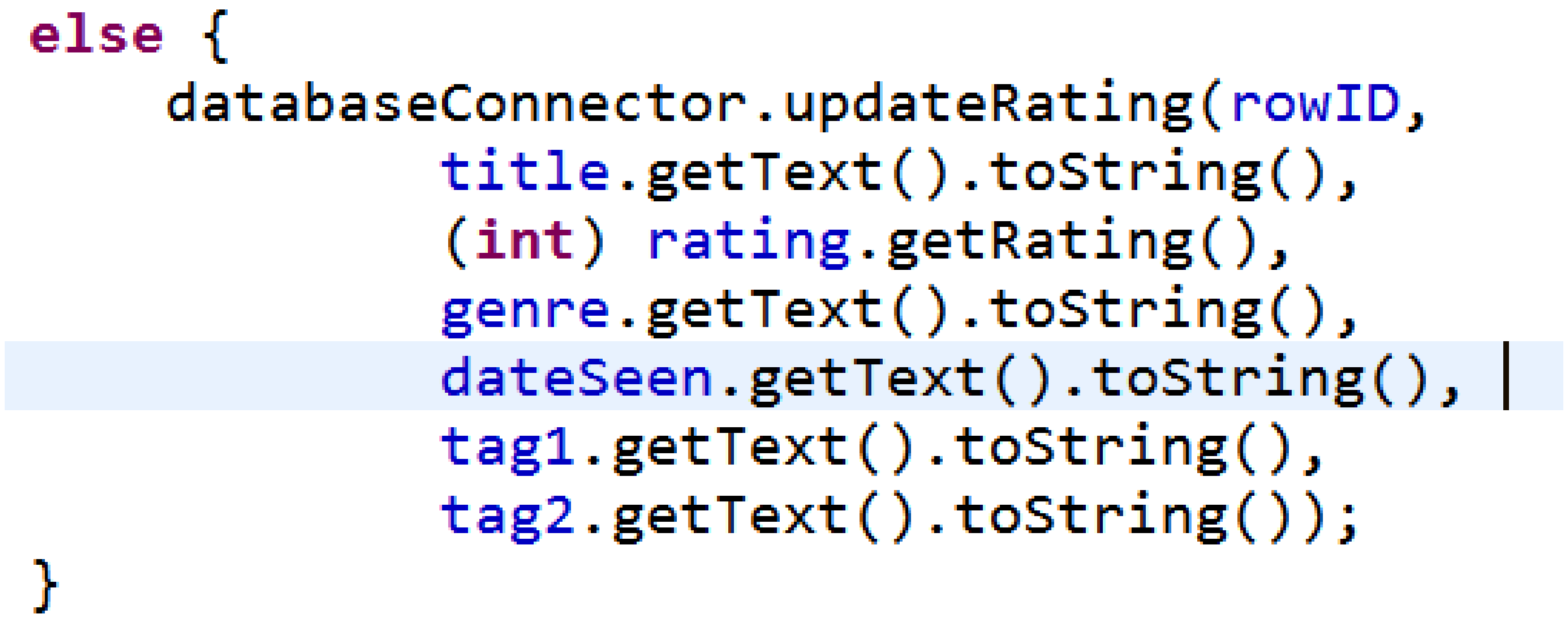
More on insert

- The second parameter
- nullColumnHack
  - that's the parameter identifier
- "optional; may be null. SQL doesn't allow inserting a completely empty row without naming at least one column name. If your provided values (second parameter) is empty, no column names are known and an empty row can't be inserted. If not set to null, the nullColumnHack parameter provides the name of nullable column name to explicitly insert a NULL into in the case where your values is empty."

http://tinyurl.com/kpl3ow7

Updating Data

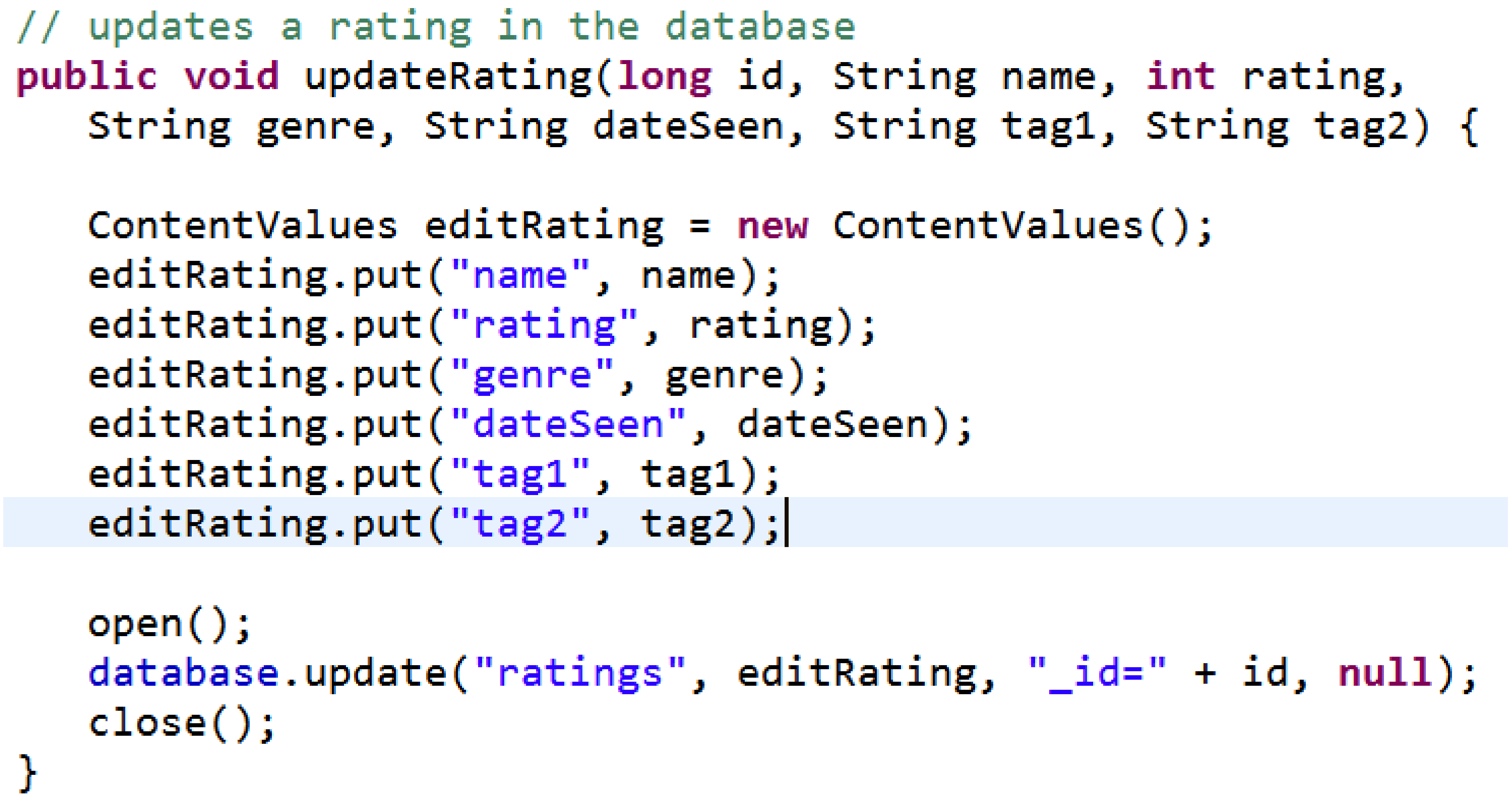
- In AddEditRating
- When save button clicked
- notice id added



```
else {
    databaseConnector.updateRating(rowID,
            title.getText().toString(),
            (int) rating.getRating(),
            genre.getText().toString(),
            dateSeen.getText().toString(),
            tag1.getText().toString(),
            tag2.getText().toString());
}
```

Updating Data

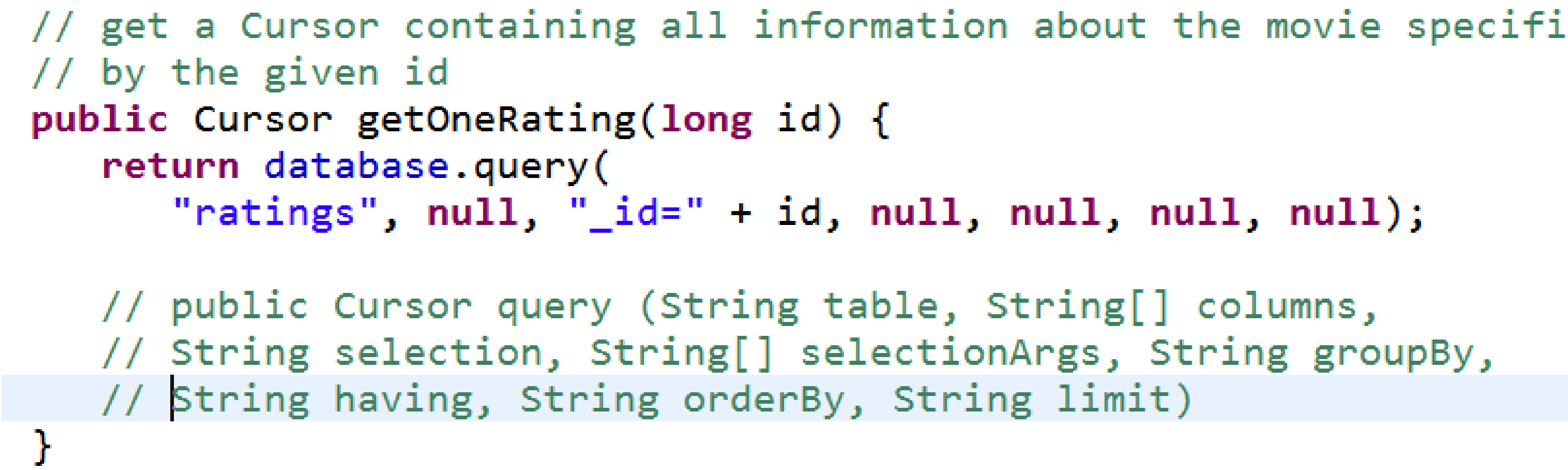
- In DatabaseConnector



```java
// updates a rating in the database
public void updateRating(long id, String name, int rating,
   String genre, String dateSeen, String tag1, String tag2) {

   ContentValues editRating = new ContentValues();
   editRating.put("name", name);
   editRating.put("rating", rating);
   editRating.put("genre", genre);
   editRating.put("dateSeen", dateSeen);
   editRating.put("tag1", tag1);
   editRating.put("tag2", tag2);

   open();
   database.update("ratings", editRating, "_id=" + id, null);
   close();
}
```

Query Data

- Getting a single row by _id
  - in order to populate ViewRating
  - In DatabaseConnector



```
// get a Cursor containing all information about the movie specifi
// by the given id
public Cursor getOneRating(long id) {
    return database.query(
        "ratings", null, "_id=" + id, null, null, null, null);

    // public Cursor query (String table, String[] columns,
    // String selection, String[] selectionArgs, String groupBy,
    // String having, String orderBy, String limit)
}
```

Query Data

- Get all rows
  - still In DatabaseConnector
- To populate the ListView in the MovieRaterActivity
- only getting id and name columns

```
public Cursor getAllRatings() {
    return database.query("ratings", new String[] {"_id", "name"},
        null, null, null, null, "name");
    // query(String table,
    // String[] columns, String selection, String[] selectionArgs,
    // String groupBy, String having, String orderBy)
}
```

Cursors

- When you execute a query on a database in Android …
- you get a Cursor back
- http://developer.android.com/reference/android/database/Cursor.html
- "Cursor provided random [access] read-write access to the result of a query"
- Commonly used in other database implementations / models

Cursor

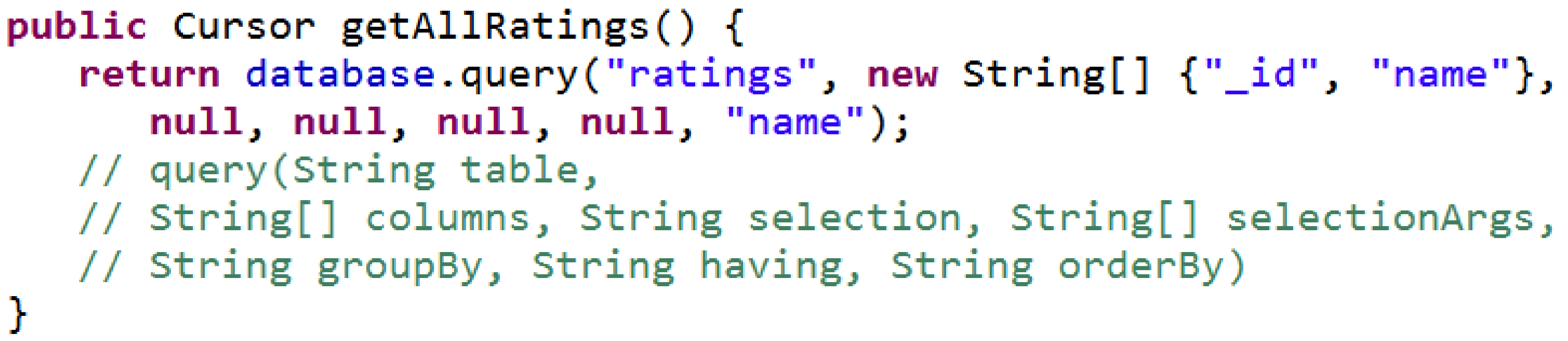
- find out number of rows in result with getCount()
- iterate over rows
  - moveToFirst(), moveToNext()
- determine column names with getColumnNames()
- get values for current row

Cursor

- To use all the data …
- wrap the Cursor in a SimpleCursorAdapter
- pass the Adapter to a ListView or other view to handle lots of data
- NOTE: result must contain an integer column named _ID that is unique for the result set
  - used as id for row in ListView

Database Connection

- Recall:



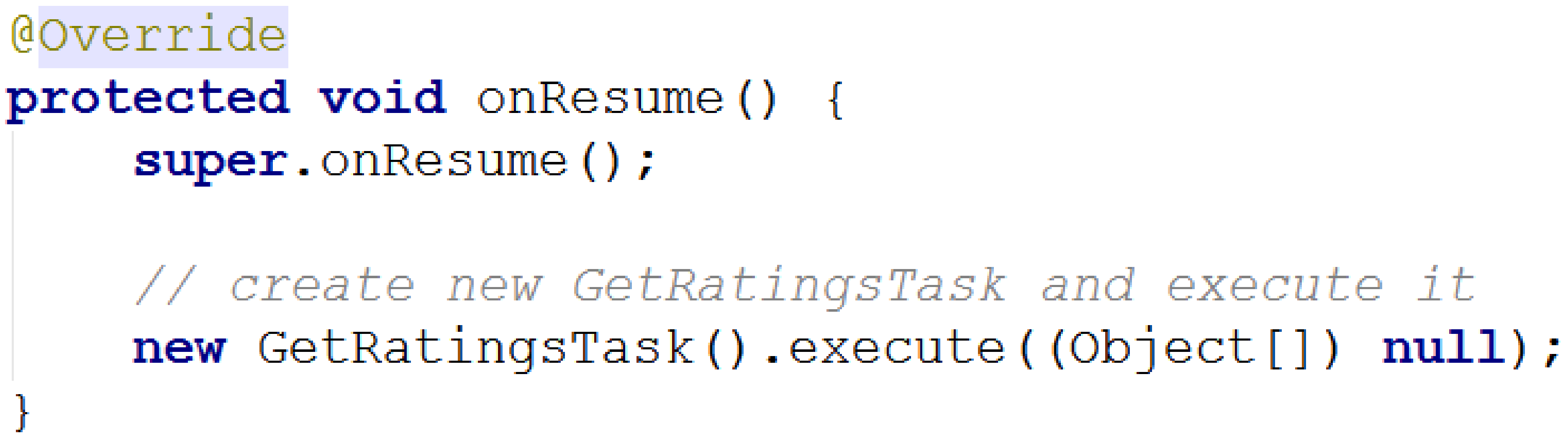
```
public Cursor getAllRatings() {
   return database.query("ratings", new String[] {"_id", "name"},
      null, null, null, null, "name");
   // query(String table,
   // String[] columns, String selection, String[] selectionArgs,
   // String groupBy, String having, String orderBy)
}
```

MovieRaterActivity

- Rating Adapter is a SimpleCursorAdapter
  - recall ArrayAdapter from CountryList
- from onCreate method

```
// map each ratings's name to a TextView
// in the ListView layout
String[] from = new String[] { "name" };
int[] to = new int[] { R.id.ratingTextView };
ratingAdapter = new SimpleCursorAdapter(
        MovieRaterActivity.this,
        R.layout.rating_list_item, null,
        from, to);
// public SimpleCursorAdapter (Context context,
// int layout, Cursor c,
// String[] from, int[] to)

setListAdapter(ratingAdapter);
```

Populate List in MovieRater



```
@Override
protected void onResume() {
    super.onResume();

    // create new GetRatingsTask and execute it
    new GetRatingsTask().execute((Object[]) null);
}
```

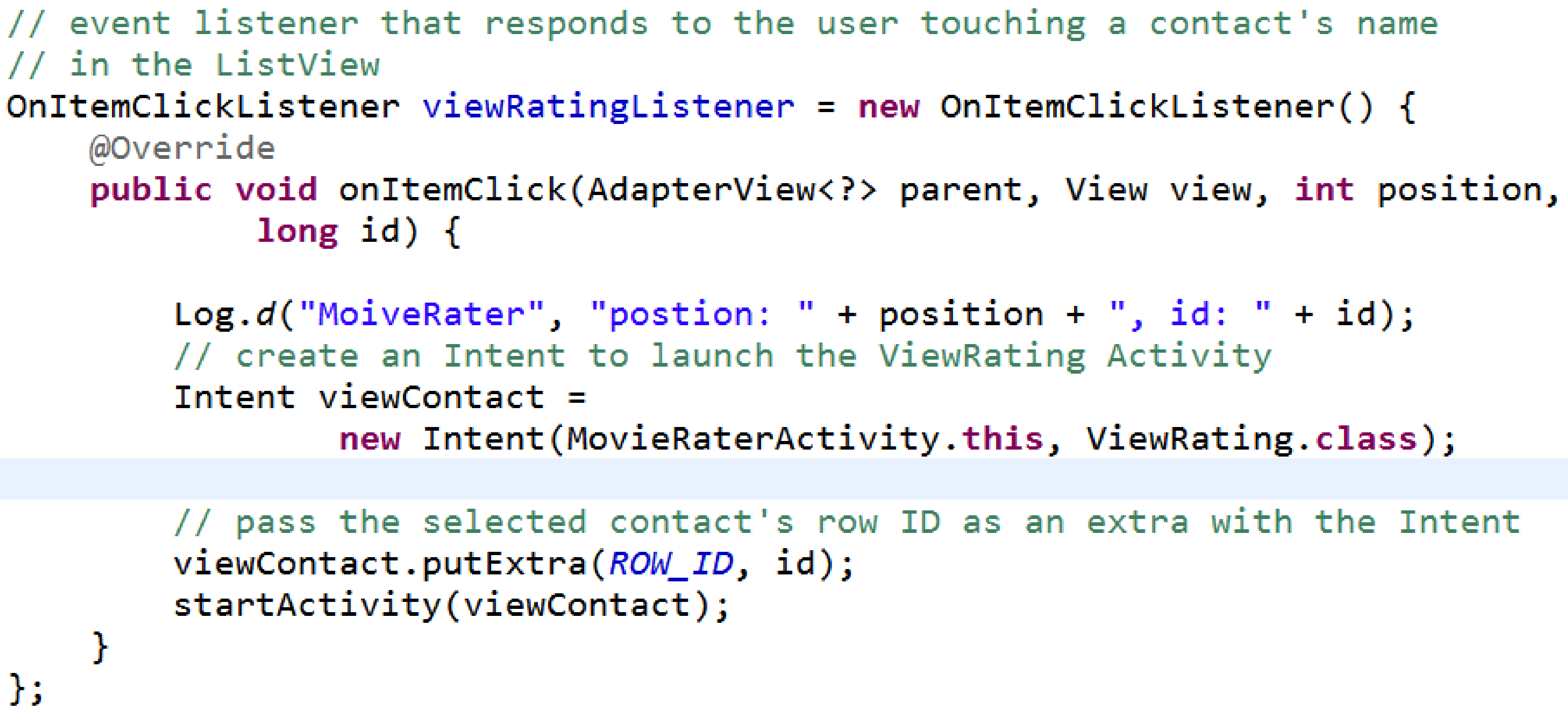
- Recall, accessing a database may block the UI thread

Obtaining Cursor in MovieRater

```
// performs database query outside GUI thread
private class GetRatingsTask extends AsyncTask<Object, Object, Cursor> {
    DatabaseConnector databaseConnector =
            new DatabaseConnector(MovieRaterActivity.this);

    // perform the database access
    @Override
    protected Cursor doInBackground(Object... params) {
        databaseConnector.open();

        return databaseConnector.getAllRatings();
    }

    // use the Cursor returned from the doInBackground method
    @Override
    protected void onPostExecute(Cursor result) {
        ratingAdapter.changeCursor(result);
        databaseConnector.close();
    }
} // end class GetContactsTask
```

Clicking on Item in List

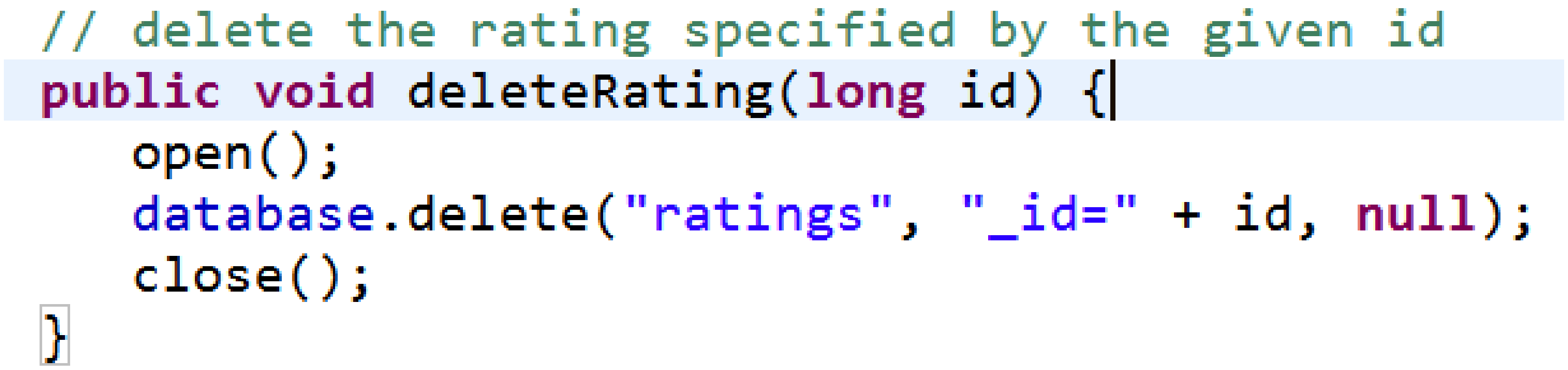
- _id not displayed but still part of entry in list -> use _id to get back to database row



```java
// event listener that responds to the user touching a contact's name
// in the ListView
OnItemClickListener viewRatingListener = new OnItemClickListener() {
    @Override
    public void onItemClick(AdapterView<?> parent, View view, int position,
            long id) {

        Log.d("MoiveRater", "postion: " + position + ", id: " + id);
        // create an Intent to launch the ViewRating Activity
        Intent viewContact =
                new Intent(MovieRaterActivity.this, ViewRating.class);

        // pass the selected contact's row ID as an extra with the Intent
        viewContact.putExtra(ROW_ID, id);
        startActivity(viewContact);
    }
};
```

Deleting Data

- Menu Option in ViewRating



```java
// delete the rating specified by the given id
public void deleteRating(long id) {
    open();
    database.delete("ratings", "_id=" + id, null);
    close();
}
```

Other Cursor Options

- moveToPrevious
- getCount
- getColumnIndexOrThrow
- getColumnName
- getColumnNames
- moveToPosition
- getPosition

Possible Upgrades

- Add functionality to
  - show all movies that share a particular genre
  - movies from a date range
  - shared tags
  - table for the genres (predefined)
- Simply more complex data base queries

ALTERNATIVES TO SQLITE
- MOVING HIGHER UP THE FOOD CHAIN

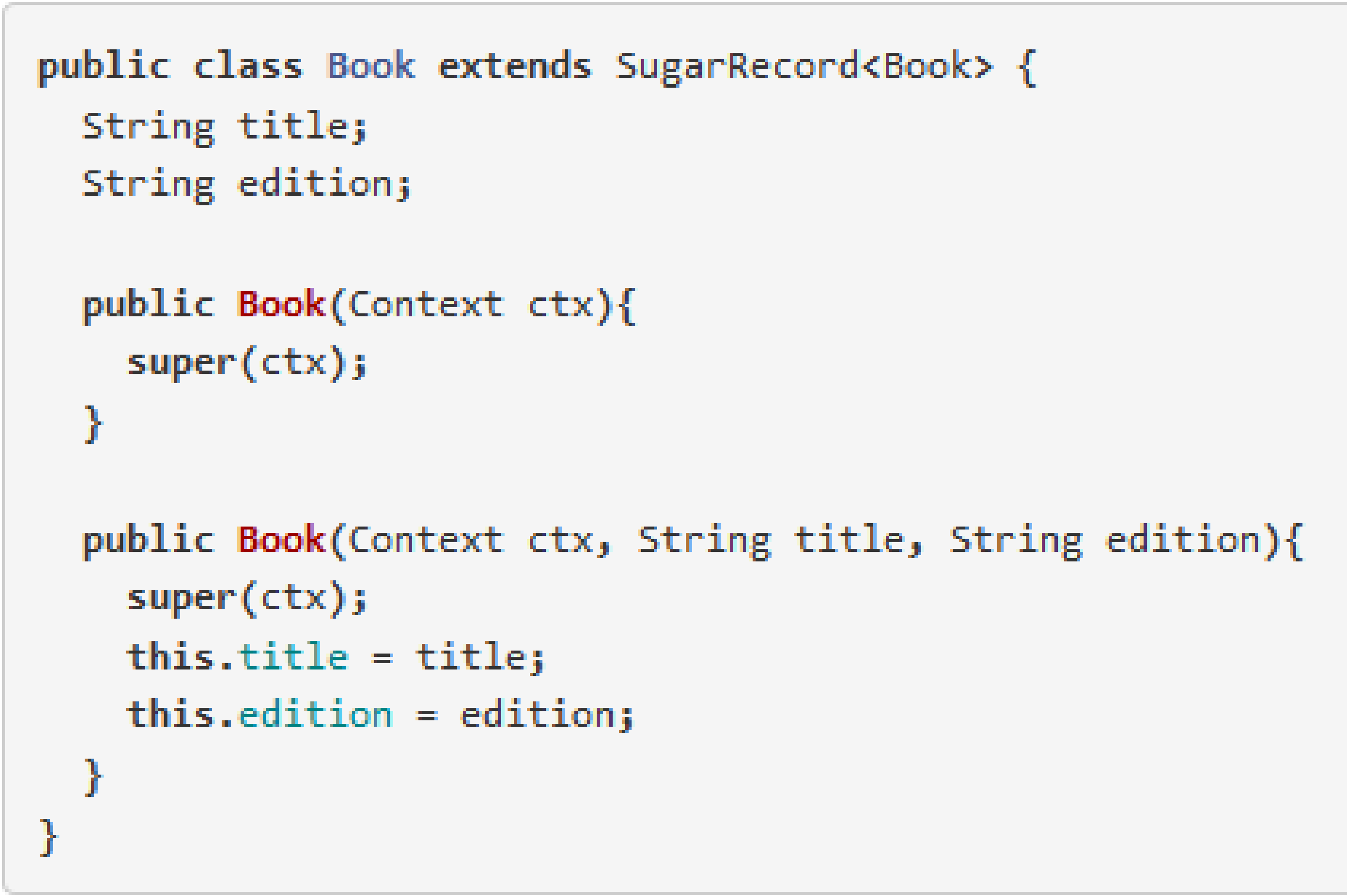
Alternatives to sqlite

- When using SQLite you may feel like you are "Down in the weeds"
- Various alternatives to work higher up the food chain
  - in other words at a higher level of abstraction
- Object Relational Mappers - ORM
- Higher level wrappers for dealing with sql commands and sqlite databases
- Many ORMs exist

ORM Example - Sugar ORM

- Syntactic Sugar?
  - what does that mean?
- Install package
- Add to manifest file
- Classes you want stored in database must extend SugarRecord

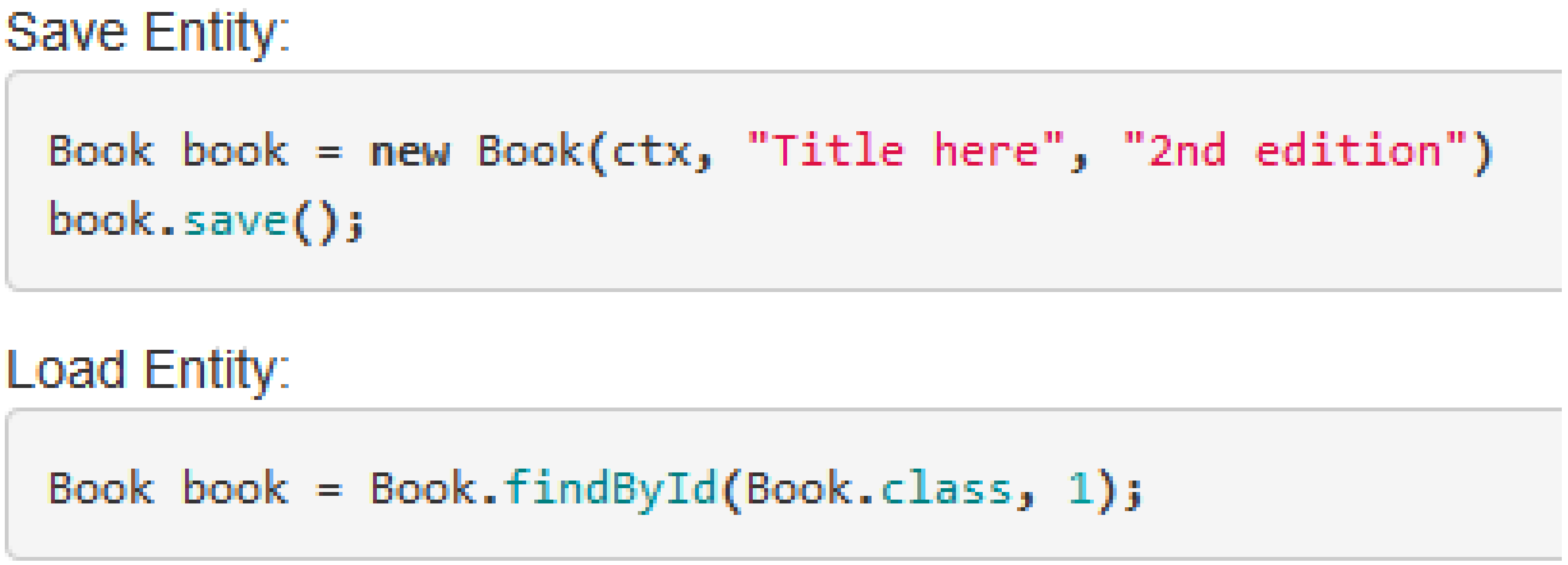
Example ORM - Sugar ORM



```
public class Book extends SugarRecord<Book> {
  String title;
  String edition;

  public Book(Context ctx){
    super(ctx);
  }

  public Book(Context ctx, String title, String edition){
    super(ctx);
    this.title = title;
    this.edition = edition;
  }
}
```

Example ORM - Sugar ORM

- CRUD operations
  - create, read, update, destroy
  - working with the data



Save Entity:

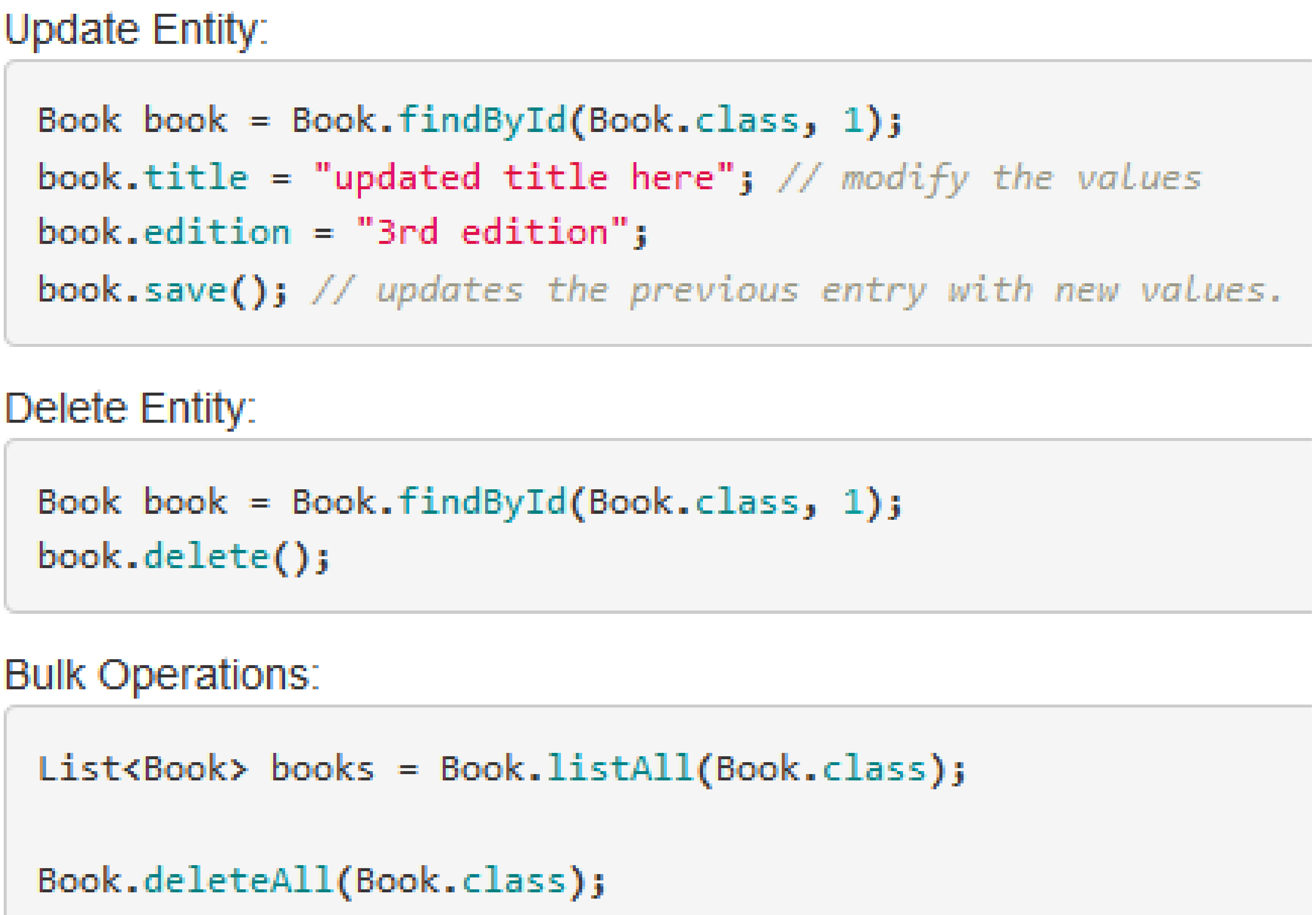
```
Book book = new Book(ctx, "Title here", "2nd edition")
book.save();
```

Load Entity:

```
Book book = Book.findById(Book.class, 1);
```

http://satyan.github.io/sugar/getting-started.html

Example ORM - Sugar ORM



Update Entity:

```
Book book = Book.findById(Book.class, 1);
book.title = "updated title here"; // modify the values
book.edition = "3rd edition";
book.save(); // updates the previous entry with new values.
```

Delete Entity:

```
Book book = Book.findById(Book.class, 1);
book.delete();
```

Bulk Operations:

```
List<Book> books = Book.listAll(Book.class);

Book.deleteAll(Book.class);
```

Implications for Movie Rater

- Simple syntax and method calls to make queries on the database
- In the demo app, Movie Rating should be its own class
- Could use Sugar ORM to simplify dealing with the sqlite database