Data Storage

CS 2046

Mobile Application Development

Fall 2010

Announcements

- HW1 due at midnight **tonight**!
  - See newsgroup for ListView/Adapter clarification.
  - Office hours after class.
  - Don't forget to submit to CMS!

- HW2 will be released shortly, due Monday, 11/8.
  - Part 1 based off today's lecture
  - Part 2 based off Wednesday's lecture

Recap

- Simple data storage methods
  - Key/Value pairs: SharedPreferences
  - Read-only files: res/raw, openRawResource()
  - Read/write files:
    - Internal storage: openInputStream(), openOutputStream()
    - Limited in space, but private to application

Other Internal Storage Methods

- getFilesDir()
  - Gets path in filesystem where internal files are stored
- getDir()
  - Creates (or opens) directory in internal storage space
- deleteFile()
- fileList()

External Storage

- Supported on almost every Android device
  - Doesn't mean active and present at all times
    - User can remove SD card

- All files are world-readable/world-writable
  - Can be modified/removed by other applications
  - Can be modified/removed by the user

Prerequisites

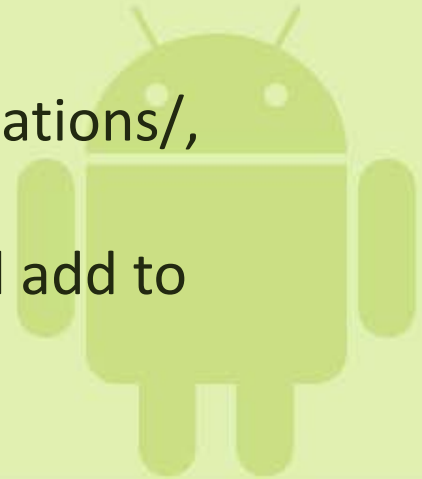
- In Android > 1.5, must declare permission (for writes) in AndroidManifest:

```
<manifest>
  <uses-permision
   android:name="android.permission.WRITE_EXTERNAL_STORAGE" />
  …
</manifest>
```

- Get state with Environment.getExternalStorageState()
  - One of MEDIA_MOUNTED, MEDIA_MOUNTED_READ_ONLY, or other.

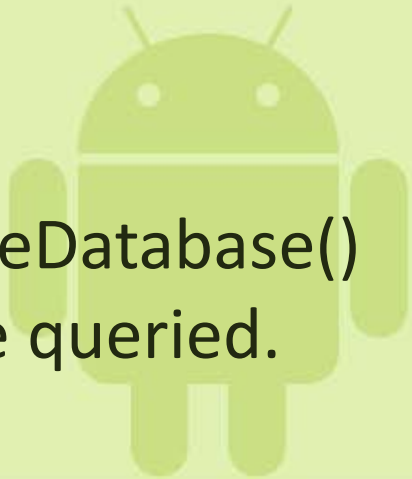
Accessing External Files

- Application specific:
  - File f = new File(getExternalStorageDirectory(), “/Android/data/<package_name>/files/”
  - Automatically deleted on API 8+
- Shared files:
  - new File(getExternalStorageDirectory(), “Dir/”, where Dir is one of:
    - Music/, Podcasts/, Ringtones/, Alarms/, Notifications/, Pictures/, Movies/, Download/
    - Media scanner will automatically scan files and add to appropriate library.



SQLite Databases

- Tabular data
- Don’t worry if you don’t know SQL!
  - You’ll only ever write one full SQL command in this class – creating the initial database.
  - Plenty of sample code if you’re confused
- Easiest method of creation:
  - Extend SQLiteOpenHelper
  - Call getWritableDatabase() and getReadableDatabase() for an SQLiteDatabase object, which can be queried.



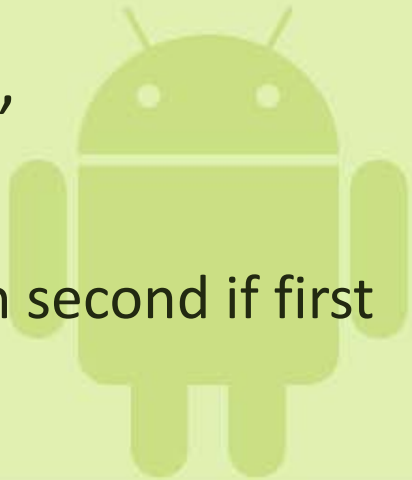
SQLite Datatypes

- Four possibilities
  - INTEGER, REAL, TEXT, BLOB
  - Essentially enough to store anything.
    - Int, long → INTEGER, float, double → REAL
- Most SQL tables have a special ID column to uniquely identify each row
  - Type: INTEGER PRIMARY KEY
- Create tables with the CREATE command:
  - CREATE TABLE table_name (_id INTEGER PRIMARY KEY, col1 TEXT, col2 INTEGER, col3 BLOB);

Other SQL Snippets

- WHERE clauses
  - Specify the rows returned or modified in a query
  - WHERE happy = 1 AND greeting = “hello” OR age > 5
    - In Android, we leave out the “WHERE ”
    - Plenty more operators, but this is the basic idea.

- Sort orders
  - Order in which results should be returned
  - String formatted like “age ASC happy DESC”
    - ASC goes low to high, DESC high to low
    - Can have multiple columns – sorts by first, then second if first is equal.



SQLiteOpenHelper Example

```
private static class DatabaseHelper extends SQLiteOpenHelper {
    DatabaseHelper(Context context) {
        super(context, DATABASE_NAME, null, DATABASE_VERSION);
    }

    @Override
    public void onCreate(SQLiteDatabase db) {
        db.execSQL("CREATE TABLE " + NOTES_TABLE_NAME + " ("
            + Notes._ID + " INTEGER PRIMARY KEY,"
            + Notes.TITLE + " TEXT,"
            + Notes.MODIFIED_DATE + " INTEGER"
            + ");");
    }

    @Override
    public void onUpgrade(SQLiteDatabase db, int oldVersion, int newVersion) {
        db.execSQL("DROP TABLE IF EXISTS " + NOTES_TABLE_NAME);
        onCreate(db);
    }
}
```

ContentProvider

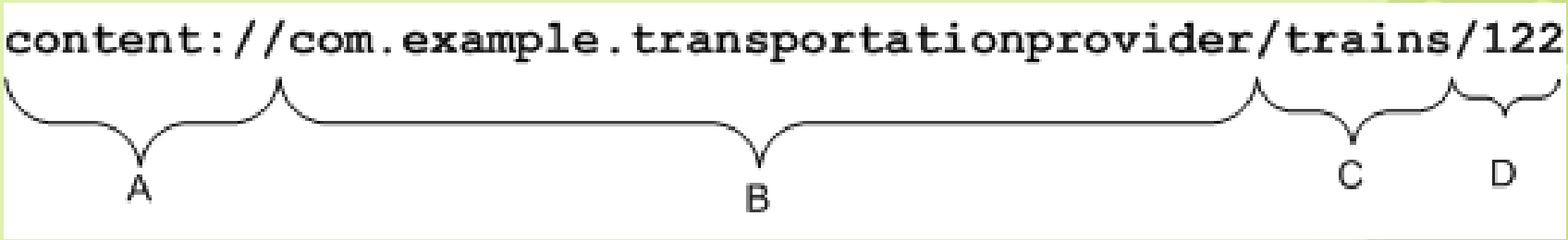
- Could just use raw commands of SQLiteDatabase class to access this database.

- Cons:
  - Accessing raw SQL database isn't simple
  - Other applications won't be able to access data

- So, we usually wrap the database in a ContentProvider to make access smoother.

Accessing a ContentProvider

- Use Context.getContentResolver() to get a ContentResolver object.
- Has query, insert, update, delete methods.
- Takes a content URI as input:



ContentProvider Queries

- query() method takes these arguments:
  - Content URI for the content to return
  - Projection – which columns to return
    - String[] array of column names
  - Where clause – which rows to return
  - WhereArgs – don't worry for now
  - Sort order – order in which to return results

Cursors

- Query returns a Cursor object containing the rows.
- Suppose we made a query with the projection, new String[] { “Col1”, “Col2” }
  - Col1 = INTEGER, Col2 = TEXT

```
while (cursor.moveToNext()) {
  int col1 = cursor.getInt(0);
  String col2 = cursor.getString(1);
  ...
}
```

Inserts

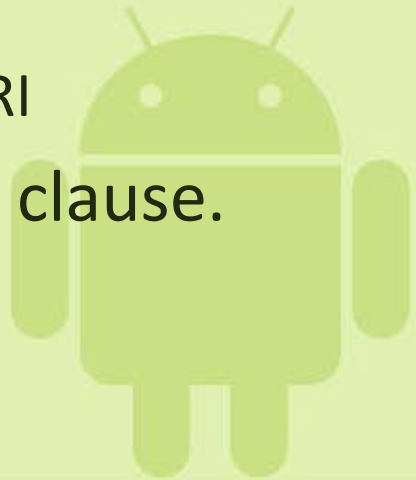
- ContentValues: object containing key-value pairs
  - Key: column name in table
  - Value: value to insert or update

- Insert: Call ContentResolver.insert() on the content URI for the table to insert into, and values to insert

Updates, Deletes

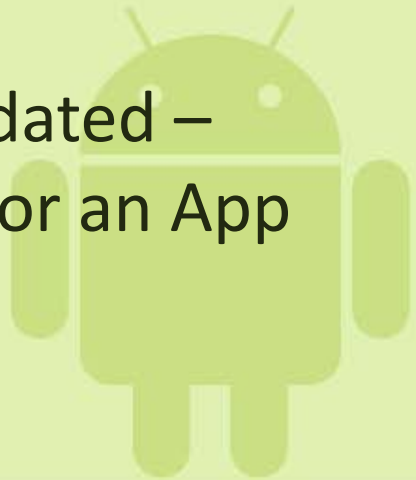
- Updates and deletes are essentially identical
  - Only difference – update includes the values being updated, delete doesn't since rows are just being removed.

- Where clause
  - If blank, modify all records at URI
    - Either entire table or specific ID if present in URI
  - If not blank, only modifies record matching clause.



Creating a ContentProvider

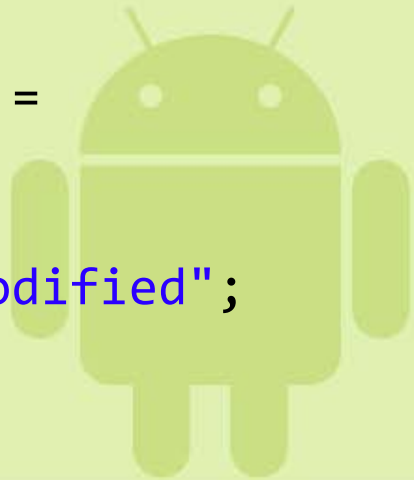
- Somewhat boilerplate
  - This sample code is fairly close to the solution to Part 1 of Assignment 2.
- But ContentProviders are very useful for storing application information.
  - Moreover, can have special queries
  - e.g. content://com.example.notes/last_updated – could return note which was last updated for an App Widget.



Initial Setup - Constants

- Useful to define a class of constants
  - Establishes the interface used to access provider

```
public final class Notes implements BaseColumns {
    public static final String AUTHORITY =
       "com.google.provider.NotePad";
    public static final Uri CONTENT_URI =
       Uri.parse("content://" + AUTHORITY + "/notes");
    public static final String CONTENT_TYPE =
       "vnd.android.cursor.dir/vnd.google.note";
    public static final String CONTENT_ITEM_TYPE =
       "vnd.android.cursor.item/vnd.google.note";
    public static final String DEFAULT_SORT_ORDER =
       "modified DESC";
    public static final String TITLE = "title";
    public static final String MODIFIED_DATE = "modified";
}
```



Initial Setup - Provider

- DatabaseHelper class for accessing SQLite DB
- Static constants:

```
private static final String DATABASE_NAME = "note_pad.db";
private static final int DATABASE_VERSION = 1;
private static final String NOTES_TABLE_NAME = "notes";

private static final int NOTES = 1;
private static final int NOTE_ID = 2;

private static final UriMatcher sUriMatcher;

static {
    sUriMatcher = new UriMatcher(UriMatcher.NO_MATCH);
    sUriMatcher.addURI(Notes.AUTHORITY, "notes", NOTES);
    sUriMatcher.addURI(Notes.AUTHORITY, "notes/#", NOTE_ID);
}
```

ContentProvider – onCreate & getType

```
@Override
public boolean onCreate() {
    mOpenHelper = new DatabaseHelper(getContext());
    return true;
}

@Override
public String getType(Uri uri) {
    switch (sUriMatcher.match(uri)) {
      case NOTES:
          return Notes.CONTENT_TYPE;
      case NOTE_ID:
          return Notes.CONTENT_ITEM_TYPE;
      default:
          throw new IllegalArgumentException("Unknown URI " + uri);
    }
}
```

ContentProvider - query

```
public Cursor query(Uri uri, String[] projection, String where,
        String[] whereArgs, String sortOrder) {
    SQLiteQueryBuilder qb = new SQLiteQueryBuilder();
    qb.setTables(NOTES_TABLE_NAME);

    switch (sUriMatcher.match(uri)) {
        case NOTE:
            break;
        case NOTE_ID:
            qb.appendWhere(Notes._ID + "=" +
                    uri.getPathSegments().get(1));
            break;
        default:
            throw new IllegalArgumentException("Unknown URI " + uri);
    }

    SQLiteDatabase db = mOpenHelper.getReadableDatabase();
    Cursor c = qb.query(db, projection, where, whereArgs,
            null, null, sortOrder);
    c.setNotificationUri(getContext().getContentResolver(), uri);
    return c;
}
```

ContentProvider - insert

```
public Uri insert(Uri uri, ContentValues values) {
    // Validate the requested uri
    if (sUriMatcher.match(uri) != NOTES) {
        throw new IllegalArgumentException("Unknown URI " + uri);
    }

    SQLiteDatabase db = mOpenHelper.getWritableDatabase();
    long rowId = db.insert(NOTES_TABLE_NAME, Notes.NOTE, values);

    if (rowId > 0) {
        Uri noteUri = ContentUris.withAppendedId(Notes.CONTENT_URI,
                rowId);
        getContext().getContentResolver().notifyChange(noteUri,
                null);
        return noteUri;
    }

    throw new SQLException("Failed to insert row into " + uri);
}
```

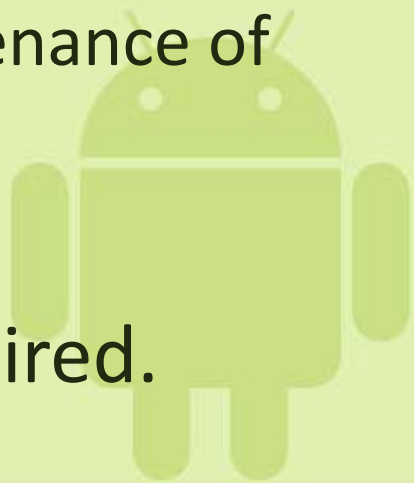
ContentProvider – update/delete

- Delete = update except for values

```
public int update(Uri uri, ContentValues values, String where,
        String[] whereArgs) {
    SQLiteDatabase db = mOpenHelper.getWritableDatabase();
    int count;
    switch (sUriMatcher.match(uri)) {
        case NOTES:
            count = db.update(NOTES_TABLE_NAME, values, where,
                    whereArgs);
            break;
        case NOTE_ID:
            String noteId = uri.getPathSegments().get(1);
            count = db.update(NOTES_TABLE_NAME, values, Notes._ID +
                    "=" + noteId + (!TextUtils.isEmpty(where) ? " AND
                    (" + where + ')' : ""), whereArgs);
            break;
        default:
            throw new IllegalArgumentException("Unknown URI " + uri);
    }
    getContext().getContentResolver().notifyChange(uri, null);
    return count;
}
```

ContentProviders - Recap

- That's all of the code necessary for a basic SQL-backed ContentProvider.
  - Don't forget to add entry to AndroidManifest file!
- For more features, you can modify the basic framework.
  - Example – Assignment 2, automatic maintenance of LAST_MODIFIED column.
- Could also use a non-SQL backend if desired.



Storage Methods Summary

Data	Visibility	Size	Method
Key-Value Pairs	Private	Small	SharedPreferences
File	Private, Read-only	Small	res/raw
File	Private, Read/Write	Small-Medium	Internal Storage
File	Public, Read/Write	Any	External Storage
Table	Private	Any	SQLite
Table	Public	Any	ContentProvider

Intro of the Day - Live Folders

- Displays application data on the Home Screen outside of your application.

- Data source: ContentProvider
  - Display will automatically update if a change is made in background

- From article at:
  http://developer.android.com/resources/articles/live-folders.html

Live Folder Activity

- First step: Have an Activity which tells Android what to do
  - Can just reuse existing Activity
  - Specify an Intent Filter with:
    - action=android.intent.action.CREATE_LIVE_FOLDER
    - category=android.intent.category.DEFAULT

Activity Code

```
if(LiveFolders.ACTION_CREATE_LIVE_FOLDER.equals(
        getIntent().getAction())  {
    Intent i = new Intent();
    i.setData(CONTENT_URI);
    i.putExtra(LiveFolders.EXTRA_LIVE_FOLDER_NAME, “Example”);
    i.putExtra(LiveFolders.EXTRA_LIVE_FOLDER_ICON,
        Intent.ShortcutIconResource.fromContext(this,
        R.drawable.<live_folder_icon>);
    i.putExtra(LiveFolders.EXTRA_LIVE_FOLDER_DISPLAY_MODE,
        LiveFolders.DISPLAY_MODE_LIST);
    setResult(RESULT_OK, i);
    finish();
}
```

Changes to ContentProvider

- Provider must obey certain rules for the URI passed by Activity:
  - Must return at least two columns, LiveFolders._ID and LiveFolders.NAME
    - Optional columns for things like icon, description, Intent to run when item is clicked
- Add URI for LiveFolder queries
- Use a projection map to “rename” columns

Provider Code

```
private static final HashMap<String, String> LIVE_FOLDER_PROJECTION_MAP;

static {
    LIVE_FOLDER_PROJECTION_MAP = new HashMap<String, String>();
    LIVE_FOLDER_PROJECTION_MAP.put(LiveFolders._ID, Notes._ID +
        " AS " + LiveFolders._ID);
    LIVE_FOLDER_PROJECTION_MAP.put(LiveFolders.NAME, Notes.TITLE +
        " AS " + LiveFolders.NAME);
}
```

In query:

```
SQLiteQueryBuilder qb = new SQLiteQueryBuilder();
switch(sUriMatcher.match(uri)) {
    case LIVE_FOLDER:
        qb.setProjectionMap(LIVE_FOLDER_PROJECTION_MAP);
    ...
}
```