

Android:
n-Puzzle
Walkthrough

Tommy
MacWilliam

The n-Puzzle
Dynamic GUIs
Bitmaps
Saving State
Menus

Android: n-Puzzle Walkthrough

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Announcements

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- ▶ Lecture videos: <https://www.cs76.net/Lectures>
- ▶ Section videos: <https://www.cs76.net/Sections>
- ▶ Walkthrough videos: <https://www.cs76.net/Projects>

Today

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- ▶ The n-Puzzle
- ▶ Dynamic GUIs
- ▶ Bitmaps
- ▶ Saving State
- ▶ Menus

Section Feedback

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- ▶ <http://tommymacwilliam.com/e76/feedback>
 - ▶ let me know how I'm doing!
- ▶ I don't like long surveys either, so give me feedback via an anonymous (I promise) 140-character tweet!

Game Plan

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- ▶ break apart a large image and display tiles
- ▶ gameplay logic (moving tiles)
- ▶ connecting gameplay to UI
- ▶ dynamic image selector list
- ▶ saving/retrieving state
- ▶ congratulatory activity

Solving the n-Puzzle

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- ▶ half the fun of this project is learning to solve an n-Puzzle
 - ▶ <http://www.chessandpoker.com/fifteen-puzzle-solution.html>
- ▶ the puzzle is solved when all tiles are placed in increasing order, left to right, top to bottom

Creating the n-Puzzle

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- ▶ shuffled state: all tiles in decreasing order
 - ▶ odd number of tiles = even number of rows/columns = swap last two tiles
- ▶ associate each tile with a number in $[1, n^2 - 1]$
 - ▶ blank tile gets a sentinel value (like 0)
 - ▶ but remember, we're showing images to the user, not numbers

MVC

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- ▶ we'll see this design pattern a lot more once we get into iOS
- ▶ application divided into 3 distinct components
 - ▶ model: representation/storage of internal data
 - ▶ view: display of data to the end-user
 - ▶ controller: bridge between the model and the view

MVC

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- ▶ good design decision: keep model separate from the view
 - ▶ model: internal representation of the board state
 - ▶ view: presentation of tiles
- ▶ model can be as complicated as a class or as simple as an array

Creating the n-Puzzle

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- ▶ board is two dimensional, so we could use a Java 2D array
 - ▶ `int board[][];`
 - ▶ remember, arrays are fixed-size in Java
- ▶ `java.util.ArrayList` is more flexible and dynamically sizable (as another option)
 - ▶ get/set notation is much more verbose than an array
 - ▶ `java.util.Vector` is very similar, but slower

Manipulating the n-Puzzle

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- ▶ tap a tile to move it into the blank space
 - ▶ swap `Views` in view and elements in model
- ▶ many corner cases (yes, we will try them all)
 - ▶ tile is not next to blank
 - ▶ tapping two tiles at once
 - ▶ holding down a tile
- ▶ get someone to `monkey` around with your app

Displaying the n-Puzzle

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- ▶ many different ways to display the tiles of the n-Puzzle
 - ▶ `LinearLayouts` within a `LinearLayout`
 - ▶ `TableLayout`
- ▶ attach an event handler to each tile to handle tap
 - ▶ determine the position of the button on the board and make swap if applicable

Dynamic GUIs

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- ▶ we can also create GUIs using purely Java, not XML
 - ▶ necessary when you don't know what your GUI will be until runtime
- ▶ **make sure to** `import android.widget.*; etc.`
 - ▶ wildcard puts a small hit on the compiler, so you best to import elements individually

Dynamic GUIs

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▶ XML

```
<LinearLayout>  
    <Button />  
</LinearLayout>
```

▶ Java:

```
LinearLayout layout = new  
LinearLayout(this);  
Button button = new Button(this);  
layout.addView(button);
```

Dynamic GUIs

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- ▶ `R.id.<id>` no longer applies
 - ▶ we need to maintain IDs now
- ▶ `view.setId(int id);`
 - ▶ set the numerical ID of a view
 - ▶ `id`: unique numerical integer

Event Handling

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- ▶ `setOnClickListener(View view);`
 - ▶ attaches an event handler that will fire on a tap
 - ▶ `view`: the object that was tapped
 - ▶ `view.getId()` will return the equivalent of `R.id.<id>`

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- ▶ `view.getParent () ;`
 - ▶ get the parent element of a view
 - ▶ so we can get the layout containing this element
- ▶ `layout.getChildCount ()`
 - ▶ get the number of children of a layout
- ▶ `layout.getChildAt (int index)`
 - ▶ **index: numerical index of element**

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- ▶ `layout.addView(View view)`
 - ▶ **add a subview to a view**
 - ▶ **view: view to add**
- ▶ `layout.removeView(View view)`
 - ▶ **remove a subview from a view**
 - ▶ **view: view to remove**
- ▶ `layout.removeViewAt(int index)`
 - ▶ **remove a subview from a view**
 - ▶ **index: index of child to remove**

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▶ example time!

Dynamic Image List

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- ▶ we can use `ListAdapters` from lecture4
- ▶ create a custom list item in `res/layout`
 - ▶ e.g. `custom_menu_item.xml` that contains Views
- ▶ create an `ArrayAdapter` from `R.layout.<custom_menu_item>`
- ▶ `setListAdapter(arrayAdapter)` to add to View
 - ▶ `getListView().setOnClickListener()` will attach an event handler to each item

Breaking up an image

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- ▶ **Google is so helpful**
- ▶ `http://lmgtfy.com?q=android+break+up+image`

Bitmaps

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- ▶ must be able to create a background from:
 - ▶ image smaller than n-Puzzle board
 - ▶ image larger than n-Puzzle board
 - ▶ image with portrait orientation
 - ▶ image with landscape orientation
 - ▶ image with square orientation

Bitmaps

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- ▶ the `Bitmap` class allows us to work with images in `res/drawable`
- ▶ `BitmapFactory.decodeResource (Resources r, int id)`
 - ▶ `r: getResources () ;`
 - ▶ `id: ID of drawable (i.e. R.drawable.<image>)`

Resizing Bitmaps

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- ▶ images we load into our app might not fit on the screen
- ▶ `Bitmap.createScaledBitmap(Bitmap bitmap, int width, int height, boolean filter);`
 - ▶ `bitmap`: image to scale
 - ▶ `width`: desired width of image
 - ▶ `height`: desired height of image

Maintaining Aspect Ratio

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- ▶ simply modifying the width and height to fit the device will distort the image
- ▶ need to modify width/height at the same rate
 - ▶ equivalently of resizing a photo by dragging a corner, not an edge

Cropping Bitmaps

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- ▶ image also might not be square
- ▶ `Bitmap.createBitmap(Bitmap bitmap, int x, int y, int width, int height);`
 - ▶ `bitmap`: image to crop
 - ▶ `x, y`: origin for cropped image
 - ▶ `width, height`: dimensions for cropped image, in pixels

Getting screen size

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- ▶ `getResources().getDisplayMetrics()` returns an object containing properties corresponding to screen size
 - ▶ `getResources().getDisplayMetrics().pixelHeight`
 - ▶ `getResources().getDisplayMetrics().pixelWidth`

Error-Checking

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Menus

- ▶ `Bitmap` objects can be pretty memory intensive
- ▶ surround code in `try {} catch {}` blocks to avoid `OutOfMemoryError`
- ▶ `bitmap.recycle()` when an image is no longer needed
 - ▶ garbage collects the `Bitmap`, freeing up memory

Bitmaps

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▶ example time!

Saving State

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Saving State

Menus

- ▶ per the spec, we need to save:
 - ▶ the state of the board
 - ▶ number of moves made
 - ▶ difficulty

Saving State

- ▶ remember the `Activity` lifecycle
- ▶ `onPause()` called whenever `Activity` is removed from foreground state
 - ▶ seems like a good place to save state
- ▶ `onCreate()` called when `Activity` is first created
 - ▶ seems like a good place for `View` setup, can retrieve saved state here
- ▶ `onResume()` called immediately before `Activity` is put into foreground state
 - ▶ state retrieval also possible here
- ▶ be sure to call `super.onPause()`, `super.onResume()`, and `super.onCreate()`!

Retrieving State

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- ▶ `SharedPreferences` allows us to retrieve saved state
 - ▶ preferences for app retrieved via
`getPreferences(int mode);`
 - ▶ get saved key/value pairs via
`sharedPreferences.get<type>(String name,
int value)`
 - ▶ where `<type>` can be `Boolean`, `String`, `Int`, etc.
 - ▶ name: key corresponding to desired value
 - ▶ value: value to return if name is not found

Saving State

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Saving State

Menus

- ▶ `SharedPreferences.Editor` **used to save state**
 - ▶ **created via** `getPreferences(int mode).edit()`
- ▶ **save key/value pairs via**
`sharedPreferencesEditor.put<type>(String name, int value)`
 - ▶ **where** `<type>` **can be** `Boolean`, `String`, `Int`, **etc.**
 - ▶ **name:** **key corresponding to desired value**
 - ▶ **value:** **value to associate with name**
- ▶ `sharedPreferencesEditor.commit()` **writes changes**

Saving/Retrieving State

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Menus

▶ example time!

Menus

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Menus

- ▶ per the spec, menu should appear when we press the menu button
- ▶ menus go in `res/menu`
- ▶ `<menu>` has multiple `<item>` children
 - ▶ `<group>` can be used to organize `<item>` elements
- ▶ accessed just like other resources, via `R.menu.<filename>`

Menus

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Menus

- ▶ `onCreateOptionsMenu(Menu menu)` **fires when user requests to open menu**
 - ▶ `MenuInflater` used to display menu
- ▶ `onOptionsItemSelected(MenuItem item)` **fires when user selects a menu item**
 - ▶ `item.getItemId()` returns an ID that can be used with `R.id.<id>`

Menus

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- ▶ Android has lots of built-in icons for menus and in general
- ▶ <http://androiddrawableexplorer.appspot.com/>
 - ▶ menu icons start with `ic_menu_`
- ▶ attribute value: `@android:drawable/<icon name>`

Menus

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Menus

▶ example time!