Android Application Programming

Challenge: Graphics and Sound

Introduction

In the previous tic-tac-toe tutorial, your game used buttons for displaying the game board. In this tutorial, we'll use a custom View for displaying the board which will give us more control over the board's visual appearance. The View will draw a game board using rectangles and use bitmaps to represent X's and O's. We'll also use the Android `MediaPlayer` to play sound effects when making moves.

Creating a Custom View

We will first create a custom View control that will represent the game board. We'll perform our own painting, drawing the game grid and images representing X and O.

1. Add a new Java class to your project, and name it **BoardView**. The class needs to extend `android.view.View`. This View will replace the buttons that are currently used to represent the game board.

2. In the `BoardView` class, create a constant to represent the thickness of the game board lines:

```
public class BoardView extends View  {

   // Width of the board grid lines
   public static final int GRID_WIDTH = 6;
```

3. Next, create two `Bitmap` data members which will be used to store the X and O images:

```
private Bitmap mHumanBitmap;
private Bitmap mComputerBitmap;
```

4. Create two images using your favorite graphic editor, or find two images off the Web that you'd like to use in your game. Images should be in an Android supported format: JPEG, GIF, PNG, or BMP. The size of the images should be no wider or taller than about 100 pixels. You will shrink the images down to the appropriate size when drawing them onto the View, so you don't have to worry about the precise size of the images. Just make sure the two images have roughly the same width and height. Also make sure the name of the files follow all the rules for naming variables as the filenames will be used to create variables to access the images (no spaces, and only use lowercase alpha, numeric, and underscore characters).

5. Add the two images to your Eclipse project's **res/drawable** folder by dragging and dropping the files onto the drawable folder. The res/drawable folder is where you previously placed the menu's images.

6. Create an `initialize()` function that will load the two images. In the code below, the images are called `x_img` and `o_img`, so you will need to adjust the code to match your image names.

```
public void initialize() {
    mHumanBitmap = BitmapFactory.decodeResource(getResources(), R.drawable.x_img);
    mComputerBitmap = BitmapFactory.decodeResource(getResources(), R.drawable.o_img);
}
```

7. Call `initialize()` in the `BoardView`'s three constructors:

```
public BoardView(Context context) {
    super(context);
    initialize();
}

public BoardView(Context context, AttributeSet attrs, int defStyle) {
    super(context, attrs, defStyle);
    initialize();
}

public BoardView(Context context, AttributeSet attrs) {
   super(context, attrs);
    initialize();
}
```

8. Before we start drawing on the View, define a class-level variable `Paint` object:

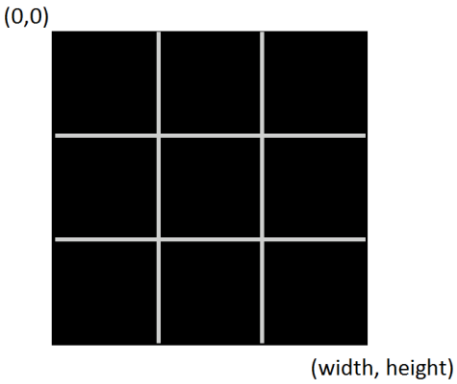
```
private Paint mPaint;
```

and initialize it in the `initialize()` method:

```
mPaint = new Paint(Paint.ANTI_ALIAS_FLAG);
```

We'll use the `mPaint` object later to control the color and thickness of the lines we draw for the game board.

9. Before we start drawing on the `BoardView`, it's important to understand *what* we want to draw and *where* we want to draw it. Let's first start with the game board. Below is a conceptual drawing of the `BoardView` as we want it to appear. The upper-left coordinate of the View is (0,0). The bottom right coordinate is (300,300) in dp units which will vary from device to device in terms of actual pixels. The actual width and height in pixels can be determined by calling `View.getWidth()` and `View.getHeight()`, which we will do momentarily.



10. To draw the board, we will draw two vertical lines and two horizontal lines. You will now override the View's `onDraw()` method which will use `mPaint` when drawing on the View's canvas. The `onDraw()` function is called automatically any time the view needs to be painted, like when the View is first displayed. You should never call this method directly yourself.

```
@Override
public void onDraw(Canvas canvas) {
    super.onDraw(canvas);

    // Determine the width and height of the View
    int boardWidth = getWidth();
    int boardHeight = getHeight();

    // Make thick, light gray lines
    mPaint.setColor(Color.LTGRAY);
    mPaint.setStrokeWidth(GRID_WIDTH);

    // Draw the two vertical board lines
    int cellWidth = boardWidth / 3;
    canvas.drawLine(cellWidth, 0, cellWidth, boardHeight, mPaint);
    canvas.drawLine(cellWidth * 2, 0, cellWidth * 2, boardHeight, mPaint);
}
```

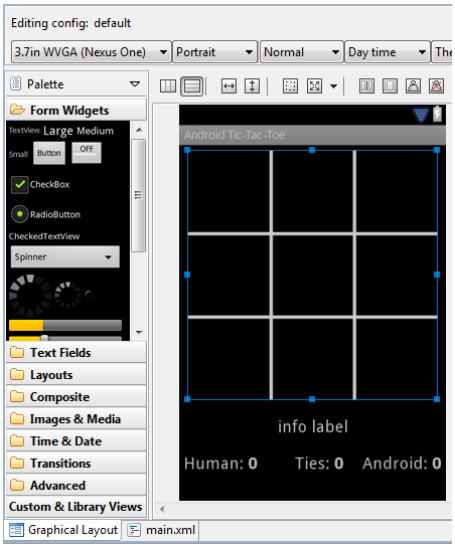
The code above only draws the two vertical lines. **It is left to you** to draw the two horizontal lines.

11. In order to test your code and see what it is actually drawing, we need to replace the previous game board which was made of buttons with our `BoardView`. Open the **layout/main.xml** file and **replace** the `TableLayout` XML containing the buttons with the following:

```
<edu.harding.tictactoe.BoardView
       android:id="@+id/board"
      android:layout_width="300dp"
      android:layout_height="300dp"
      android:layout_marginTop="5dp"/>
```

You may need to also adjust the relative placement of your other TextViews which relied on the name of the game board.

12. Now click on the Graphical Layout tab of main.xml to see what the `BoardView` will look like. If you have successfully drawn the two horizontal lines in the correct location, the `BoardView`'s `onDraw()` method should make the View look like the image below:



13. The `BoardView` must also display the X and O images as they appear on the board. Add the following code directly underneath the code which is drawing the board lines in the `onDraw()` method:

```
// Draw all the X and O images
for (int i = 0; i < TicTacToeGame.BOARD_SIZE; i++) {
    int col = i % 3;
    int row = i / 3;

    // Define the boundaries of a destination rectangle for the image
    int left = TODO
    int top = TODO
    int right = TODO
    int bottom = TODO

    if (mGame != null && mGame.getBoardOccupant(i) == TicTacToeGame.HUMAN_PLAYER) {
          canvas.drawBitmap(mHumanBitmap,
                    null,  // src
                    new Rect(left, top, right, bottom),  // dest
                    null);
    }
    else if (mGame != null && mGame.getBoardOccupant(i) == TicTacToeGame.COMPUTER_PLAYER) {
          canvas.drawBitmap(mComputerBitmap,
                    null,  // src
                    new Rect(left, top, right, bottom),  // dest
                    null);
    }
}
```

The code above uses `canvas.drawBitmap()` to draw the human/computer bitmaps in a rectangle that is just wide enough to fit in a board's cell. **It's left to you** to set the `left`, `top`, `right`, and `bottom` variables to define this destination rectangle appropriately. You'll want to use the `row`, `col`, `cellWidth`, and `GRID_WIDTH` variables in your calculations. To get you started on the right path, you could draw an X or O in the upper-left square of the board by setting `left = 0`, `top = 0`, `right = cellWidth`, and `bottom = cellWidth`.

14. The code above knows to draw the human or computer pieces based on the call to `mGame.getBoardOccupant(i)` which indicates if an X, O, or empty is present at that location. We have not yet declared the `mGame` variable, so you need to create an `mGame` data member of type `TicTacToeGame` for the `BoardView` class and create a setter for it that you will later call to give the `BoardView` access to the

internal representation of the game board.

```
private TicTacToeGame mGame;

public void setGame(TicTacToeGame game) {
    mGame = game;
}
```

15. Finally, write some accessors which will later be helpful to the AndroidTicTacToeActivity to determine which cell the user has touched on the BoardView:

```
public int getBoardCellWidth() {
    return getWidth() / 3;
}

public int getBoardCellHeight() {
    return getHeight() / 3;
}
```

Using the BoardView

1. Earlier you added the `BoardView` to the main.xml file. Now go to the `AndroidTicTacToeActivity` class and declare a class-level variable for the `BoardView`. Inside `onCreate()`, set the `mBoardView` variable to the board you just created in main.xml, and call `setGame()` so the `BoardView` has access to the game board. You should also remove any code that is initializing buttons.

```
private BoardView mBoardView;

public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.main);

        mGame = new TicTacToeGame();
        mBoardView = (BoardView) findViewById(R.id.board);
        mBoardView.setGame(mGame);

snip...
}
```

2. When starting a new game, we no longer have buttons that need to be cleared. Instead we need to just tell the `BoardView` to re-draw itself. This is done by "invalidating" the View. Modify the `startNewGame()` method by replacing the button code with a call to the View's `invalidate()` method:

```
private void startNewGame() {

      mGame.clearBoard();
      mBoardView.invalidate();   // Redraw the board

snip...
}
```

Now whenever `startNewGame()` is called, the `BoardView`'s `onDraw()` method will re-draw the game board.

Listen for Touches

If you run your application as it stands, you'll be able to see the game board, but you will not be able to make a move. We need our app to sense touches on the game board to determine where the human is wanting to place his/her X. We'll do this by adding a `TouchListener` to the `BoardView`.

1. First, create an inner class for `AndroidTicTacToe` called `mTouchListener` that implements the `OnTouchListener` interface as shown below. The `onTouch()` method will be called when the user first puts her finger on the device, when her finger moves locations while still touching the device, and when her finger is removed from the device. However, returning `false` from this method causes the move and up events not to be reported back to this event handler. Our app only needs to know when the finger is first placed on the device, so we'll return `false` from `onTouch()`.

   `mTouchListener` will work much like the `onClickListener` used for the buttons in our last app except that we must now convert the touched (x,y) coordinate into a cell location to determine where the move should be placed. Note that some of the code is snipped out which handles checking for a win and making the computer move; all this code can be found in the existing `onClickListener`.

```
// Listen for touches on the board
private OnTouchListener mTouchListener = new OnTouchListener() {
   public boolean onTouch(View v, MotionEvent event) {

       // Determine which cell was touched
       int col = (int) event.getX() / mBoardView.getBoardCellWidth();
       int row = (int) event.getY() / mBoardView.getBoardCellHeight();
       int pos = row * 3 + col;

       if (!mGameOver && setMove(TicTacToeGame.HUMAN_PLAYER, pos)){

          // If no winner yet, let the computer make a move
snip...
       }

       // So we aren't notified of continued events when finger is moved
       return false;
   }
};
```

2. In the `onCreate()` method, attach the `TouchListener` to the `BoardView`:

```
// Listen for touches on the board
mBoardView.setOnTouchListener(mTouchListener);
```

3. Modify the `setMove()` function so it invalidates the `BoardView` when a legal move has been made; this causes the `BoardView`'s `onDraw()` method to fire which will display the user's bitmap in the correct cell.

```
private boolean setMove(char player, int location) {
   if (mGame.setMove(player, location)) {
       mBoardView.invalidate();   // Redraw the board
       return true;
   }
   return false;
}
```

4. Run your program and verify that your game works by touching the location on the game board where you'd like to move. As soon as you have touched an empty square in the board, your X image should appear in that square, and then the O image should appear in another square. You may want to click in all 9 location to verify that your earlier rectangle coordinates were calculated correctly. If you are not seeing your images anywhere on the screen, you may want to output to LogCat the `left`, `top`, `right`, and `bottom` variables after you have set them so you can debug your code. The `right` and `bottom` variables should be larger than the `left` and `top` variables.

Adding Sound

Adding sound to a game can make it much more fun and appealing. Of course you should also allow users to turn off the sounds since not everyone likes to hear your game while in a public location.

1. You need to create or obtain two mp3 files. One will be played when the human makes a move and the other when the computer makes a move, so they should only be a second or two in duration. If you search Google for "free sound effects", you'll find many websites that offer free mp3 sound files to download. You can also use .wav files, but I have personally had problems getting them to work properly. Make sure that both filenames are composed only of lowercase letters, underscores, and digits since the file names will be converted into variable names.

2. In Eclipse, create a `raw` folder under `res` just like you did earlier in this assignment when creating a `menu` folder. The `raw` folder is where you should store sound files and other binary resources.

3. Drag and drop your mp3 files into the `raw` folder. You should see both files listed under `raw` in your project.

4. Crate two class-level `MediaPlayer` variables for the sound effects:

```
MediaPlayer mHumanMediaPlayer;
MediaPlayer mComputerMediaPlayer;
```

5. Media players consume resources that are shared by other Android processes, so special care should be taken to release the resources held by the media player when your application is not in use. We will load the sound effects into our media players when the Activity goes into the Resume state, and we will release the media players when the Activity goes into the Pause state. This could happen, for example, if another Activity comes to the foreground. We will discuss more about `onResume` and `onPause` in the next tutorial.

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

    mHumanMediaPlayer = MediaPlayer.create(getApplicationContext(), R.raw.sword);
   mComputerMediaPlayer = MediaPlayer.create(getApplicationContext(), R.raw.swish);
}

@Override
protected void onPause() {
   super.onPause();

    mHumanMediaPlayer.release();
    mComputerMediaPlayer.release();
}
```

Note that the code above assumes the mp3 files were named sword.mp3 and swish.mp3; you will need to use the names of your mp3 files.

6. When the human makes a move (in the `setMove()` function), call the `MediaPlayer`'s `start()` method to play the human's sound effect:

```
mHumanMediaPlayer.start();    // Play the sound effect
```

In a similar fashion, update `setMove()` to play the computer's sound effect when the computer makes a move.

Extra Challenge

Right now the computer moves immediately after the human which doesn't leave enough time to see the "Android's turn" message, and it causes the computer's sound effect to be played immediately after the human's sound effect, if at all. Fix these problems by making the computer wait one second before making its move.

Although you could create a loop that blocks the UI thread for a second, this would make your app unresponsive during the delay. A better solution is to use the `android.os.Handler`'s `postDelay()` method. This method takes two arguments: 1) a `Runnable` (an interface representing an executable command), and 2) a delay in milliseconds before the `Runnable` is executed on the `Handler`'s thread. Here's an example that outputs "Hello" to LogCat after 4 seconds has passed:

```
Handler handler = new Handler();
handler.postDelayed(new Runnable() {
   public void run() {
      Log.v(LOG_TAG, "Hello");
   }
}, 4000);
```

To use the `Handler` correctly, you'll need to re-organize the code that is responsible for making the computer move after the human moves. You'll find it helpful to use a class-level variable to indicate whose turn it is because you do not want to allow the human to make a move when it's the computer's turn; right now this is not an issue because the computer moves immediately after the human moves.