Developing Applications for iOS

Lab 2:
RPN Calculator App (1 of 3)

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University of Bucharest

Task 1

Task: Create a new application in Xcode called “Calculator”.

1. Launch Xcode and select the “Create a new Xcode project” option. If you don't see the splash window, you should go to “File > New > New Project...” in Xcode menu.
2. Select the Single View Application template and click Next.
3. Type in “Calculator” for the Product Name.
4. Enter “com.FMI.FirstName.LastName” for the Company Identifier. Notice how Bundle Identifier changes as you type. You should obtain something like “com.FMI.Radu.Ionescu.Calculator” as your bundle identifier.
5. Enter “Calculator” as the Class Prefix for the classes this template is going to generate for us.
6. Select “iPhone” for Device Family. We are going to make this application only for the iPhone (not iPad).

Task 1

Task: Create a new application in Xcode called “Calculator”.

7. Check “Use Storyboard”. Storyboards are a new (iOS 5) way to organize your MVC's Views that we are going to use.

8. Check “Use Automatic Reference Counting”.

9. We won't be creating Unit Tests for this application so we are going to leave the “Include Unit Tests” option unchecked.

10. Click Next.

11. Navigate to “~/Developer/Apps/” folder inside the home directory. If you want to keep your project for later use, please save it in a directory with your name like this: “~/Developer/Apps/<YourName>”.

12. Click Create to create your project directory inside the “~/Developer/Apps” folder.

Task 2

Task: Start building our Calculator’s View by adding a text label to be the Calculator's display.

1. Open up our MVC's View by clicking on MainStoryboard.storyboard in Project Navigator.
2. Hide the Document Outline if it's not already hidden.
3. Click on the “butler” icon on the Toolbar to show up the Assistant Editor. This will by default bring up the View’s Controller.
4. We don’t need the Project Navigator at the far left either, so let’s hide it by using the “Hide or show the Navigator” button available on the Toolbar.
5. Bring up the Utilities area by clicking on the “Hide or show the Utilities” button that is also available on the Toolbar.
6. In Utilities area, click on the Object Library (it might already be selected). Some objects (those appropriate to dragging into your View) should appear in the Object Library.

Task 2

Task: Start building our Calculator’s View by adding a text label to be the Calculator's display.

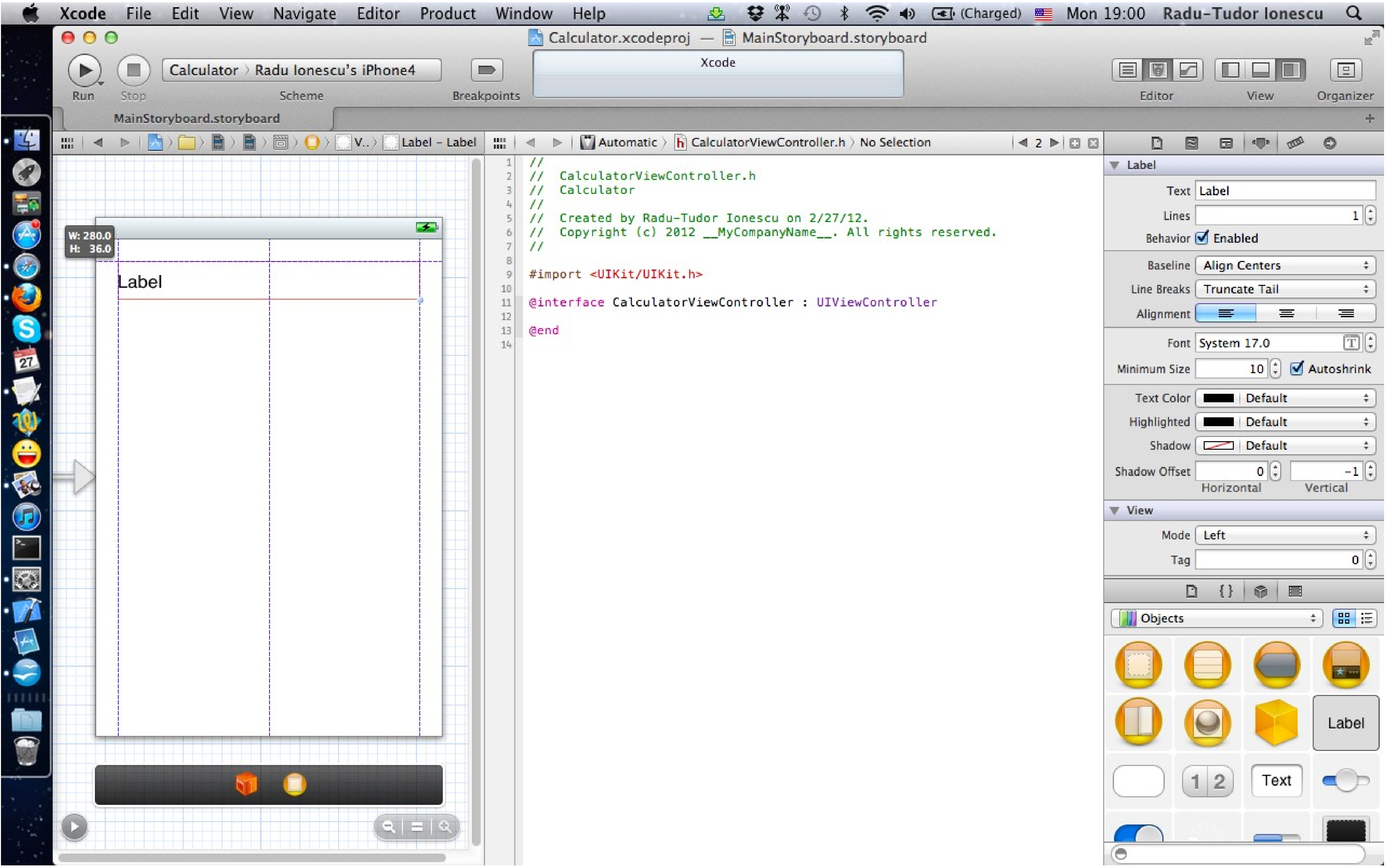
7. Find a `UILabel` object in Object Library.

8. Drag the `UILabel` from the Object Library to your View.

9. In Utilities area, click on the Attributes Inspector. You should see attributes of the Label you just created.

10. Grab the lower right "handle" on the label and resize it to 280 x 36 pixels. Use the dashed blue guidelines to pick a good size. Make sure you align and resize it as in the preview screenshot from the next slide.

11. The numbers in a Calculator's display are never (rarely?) left aligned, so let's change the alignment of the text in our display label to right by clicking on the appropriate button in the inspector.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Mon 19:00 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run Stop Scheme Breakpoints
Calculator › Radu Ionescu's iPhone4
Xcode
Editor View Organizer
MainStoryboard.storyboard
V.. › Label - Label
Automatic › CalculatorViewController.h › No Selection
W: 280.0
H: 36.0
Label
Objects
Label
Text

```
//
//  CalculatorViewController.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <UIKit/UIKit.h>

@interface CalculatorViewController : UIViewController

@end
```

Label

Text: Label
Lines: 1
Behavior: ✓ Enabled
Baseline: Align Centers
Line Breaks: Truncate Tail
Alignment
Font: System 17.0
Minimum Size: 10 ✓ Autoshrink
Text Color: Default
Highlighted: Default
Shadow: Default
Shadow Offset: 0 (Horizontal) -1 (Vertical)

View

Mode: Left
Tag: 0

Task 2

Task: Start building our Calculator’s View by adding a text label to be the Calculator's display.

12. Let's also make the font bigger. Increase the font size to 24 point Helvetica.

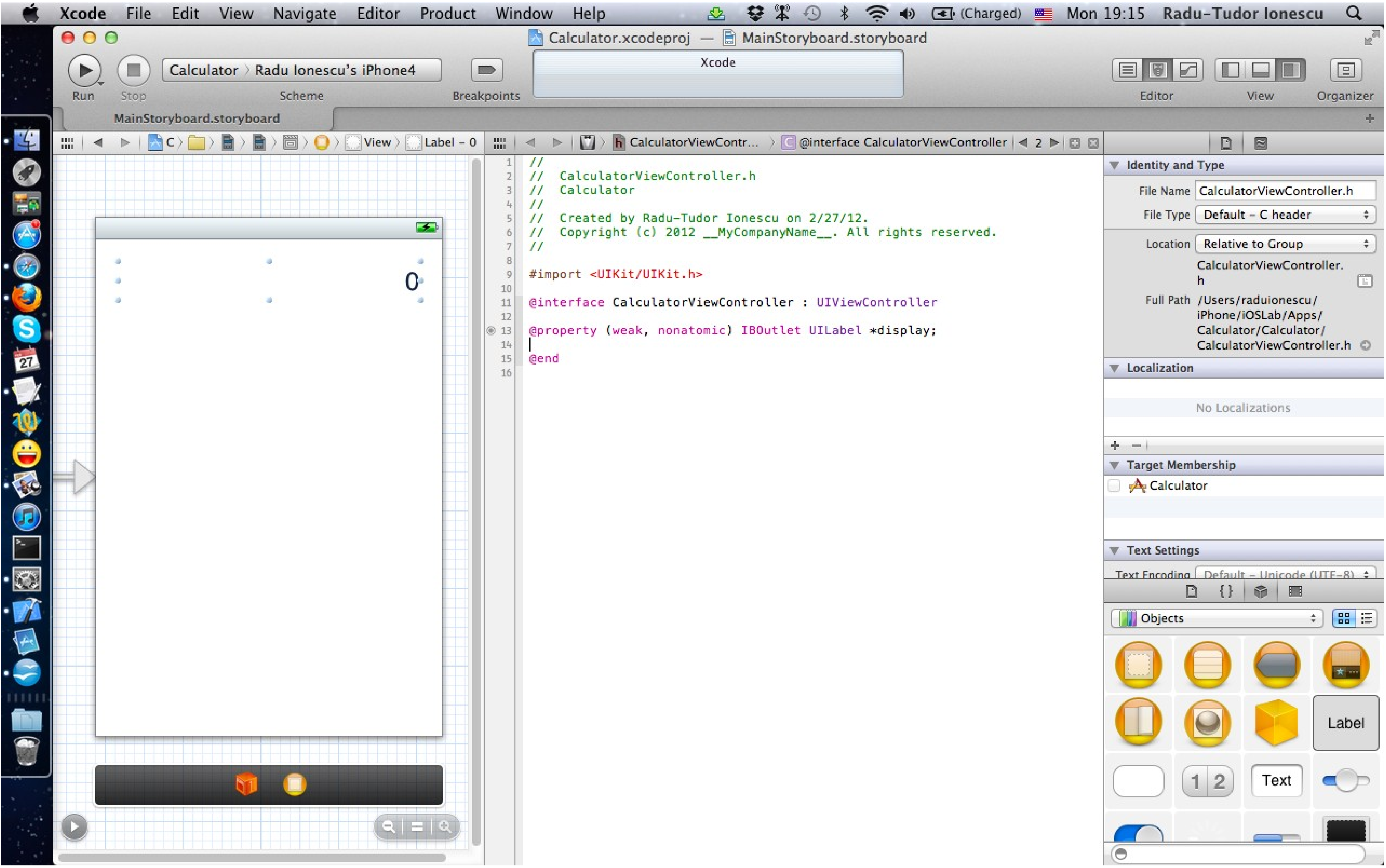
13. We don't want our Calculator to appear with "Label" in its display! So double-click on the label to put it in an editing state then type 0.

14. Hold down CTRL while mousing down and dragging a line from the text label directly into the code of our Controller.

15. We are going to name this outlet display (since it is the display of our Calculator). So type "display" for the outlet name.

16. Select the "Weak" storage type and click Connect to create a property (called `display`) in our Controller which will point to this `UILabel` in our View.

The screenshot from the next slide gives you a hint of how everything should look like.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Mon 19:15 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Xcode
Run
Stop
Calculator › Radu Ionescu's iPhone4
Scheme
Breakpoints
Editor
View
Organizer
MainStoryboard.storyboard
View › Label - 0
CalculatorViewContr… › @interface CalculatorViewController
0
Label
Text

```
//
//  CalculatorViewController.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <UIKit/UIKit.h>

@interface CalculatorViewController : UIViewController

@property (weak, nonatomic) IBOutlet UILabel *display;

@end
```

Identity and Type
File Name: CalculatorViewController.h
File Type: Default - C header
Location: Relative to Group
CalculatorViewController.h
Full Path: /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.h

Localization
No Localizations

Target Membership
Calculator

Text Settings
Text Encoding: Default - Unicode (UTF-8)

Objects

Task 3

Task: Add our Calculator’s keypad buttons.

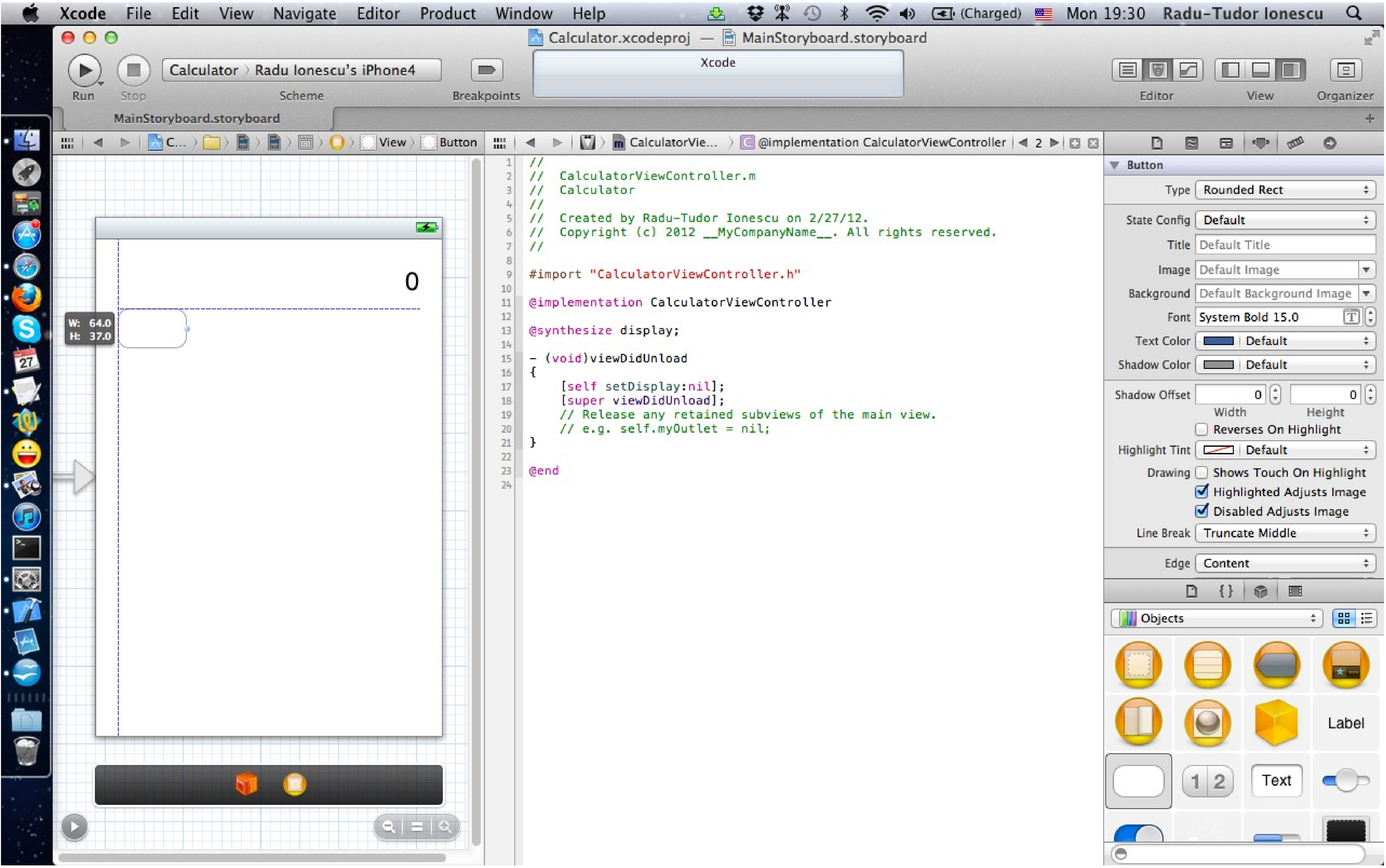
1. Switch Assistant Editor to the Controller's implementation file named “`CalculatorViewController.m`”.

2. Delete the code that we don't need which was automatically added by Xcode. Make sure **NOT** to remove the `@synthesize` declaration and the implementation of the `viewDidUnload` method.

3. Drag a Round Rect Button from the Object Library to your View.

4. Grab the middle-right "handle" on the button and resize it. A width of 64 points works extremely well, so use that. The screenshot from the next slide gives you a hint of how everything should look like after this step.

5. Hold down CTRL while mousing down and dragging a line from the button directly to the text area where your code is.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Mon 19:30 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run Stop Scheme Breakpoints Editor View Organizer
Calculator › Radu Ionescu's iPhone4
Xcode
MainStoryboard.storyboard
C... View Button
CalculatorVie... @implementation CalculatorViewController 2
0
W: 64.0
H: 37.0
Objects
Label
Text

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

@end
```

Button

Type	Rounded Rect
State Config	Default
Title	Default Title
Image	Default Image
Background	Default Background Image
Font	System Bold 15.0
Text Color	Default
Shadow Color	Default
Shadow Offset	Width 0, Height 0
	Reverses On Highlight
Highlight Tint	Default
Drawing	Shows Touch On Highlight
	✓ Highlighted Adjusts Image
	✓ Disabled Adjusts Image
Line Break	Truncate Middle
Edge	Content

Task 3

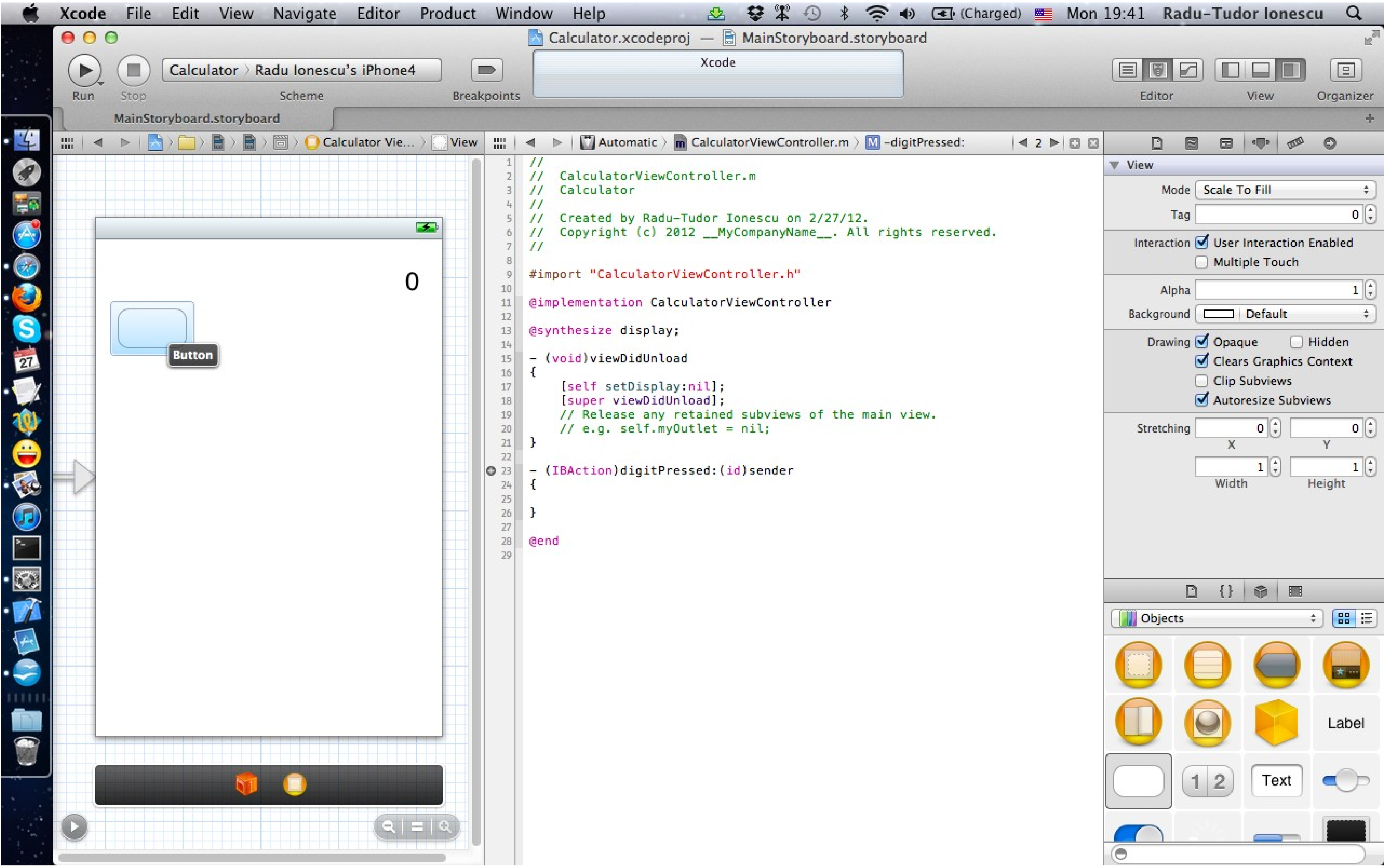
Task: Add our Calculator’s keypad buttons.

6. Enter “digitPressed” as the name of the action message (which makes sense since this button is going to be a digit button in our Calculator’s keypad).

7. You can leave the rest of the fields alone (the defaults are fine for this button). Then press Connect.

8. Similar to an outlet, you can mouse over the little icon on the left of the method implementation and see which object(s) in your View send(s) this message. Notice how the button highlights.

Check out the screenshot from the next slide for a hint of how everything should look like.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Mon 19:41 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › Radu Ionescu's iPhone4
Scheme
Breakpoints
Xcode
Editor
View
Organizer
MainStoryboard.storyboard
Calculator Vie... › View
Automatic › CalculatorViewController.m › -digitPressed:
2
0
Button
Objects
Label
1 2
Text

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(id)sender
{

}

@end
```

View

Mode: Scale To Fill
Tag: 0
Interaction: [✓ User Interaction Enabled] Multiple Touch
Alpha: 1
Background: Default
Drawing: [✓ Opaque] Hidden
[✓ Clears Graphics Context]
Clip Subviews
[✓ Autoresize Subviews]
Stretching: X 0, Y 0, Width 1, Height 1

Task 3

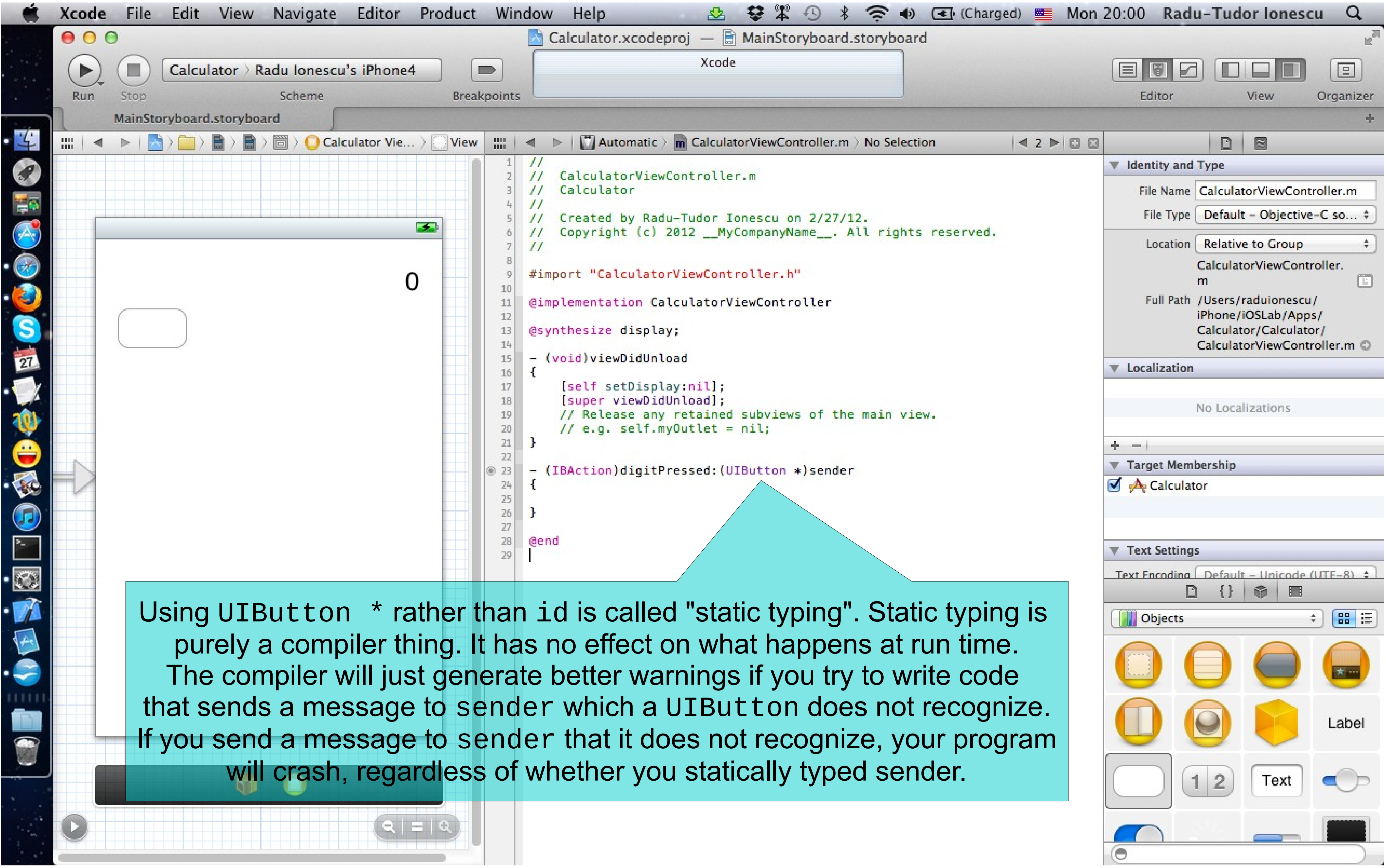
Task: Add our Calculator's keypad buttons.

9. The type `id` is a very special type. There are some times when we want to use it because either we allow any class of object to be passed into a method (uncommon) or because the class of the object is opaque (it's like a cookie).

But neither of those cases applies here. In this case, we know that the `sender` to `digitPressed:` is going to be a `UIButton`. Therefore we are going to change this type to be "pointer to a `UIButton`" instead of "pointer to an object of any class".

Select the type of the sender argument to this method and replace it with the type "`UIButton *`".

Check out the screenshot from the next slide.


Xcode File Edit View Navigate Editor Product Window Help
Calculator.xcodeproj — MainStoryboard.storyboard
Run Stop Scheme Breakpoints Editor View Organizer
Calculator Radu Ionescu's iPhone4
Automatic CalculatorViewController.m No Selection
Identity and Type
File Name CalculatorViewController.m
File Type Default - Objective-C so...
Location Relative to Group
Full Path /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.m
Localization
No Localizations
Target Membership
Calculator
Text Settings
Objects
Label
Text

```
//
//  CalculatorViewController.m
//  Calculator
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//  Created by Radu-Tudor Ionescu on 2/27/12.
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//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{

}

@end
```

Using `UIButton *` rather than `id` is called "static typing". Static typing is purely a compiler thing. It has no effect on what happens at run time. The compiler will just generate better warnings if you try to write code that sends a message to `sender` which a `UIButton` does not recognize. If you send a message to `sender` that it does not recognize, your program will crash, regardless of whether you statically typed sender.

Task 3

Task: Add our Calculator’s keypad buttons.

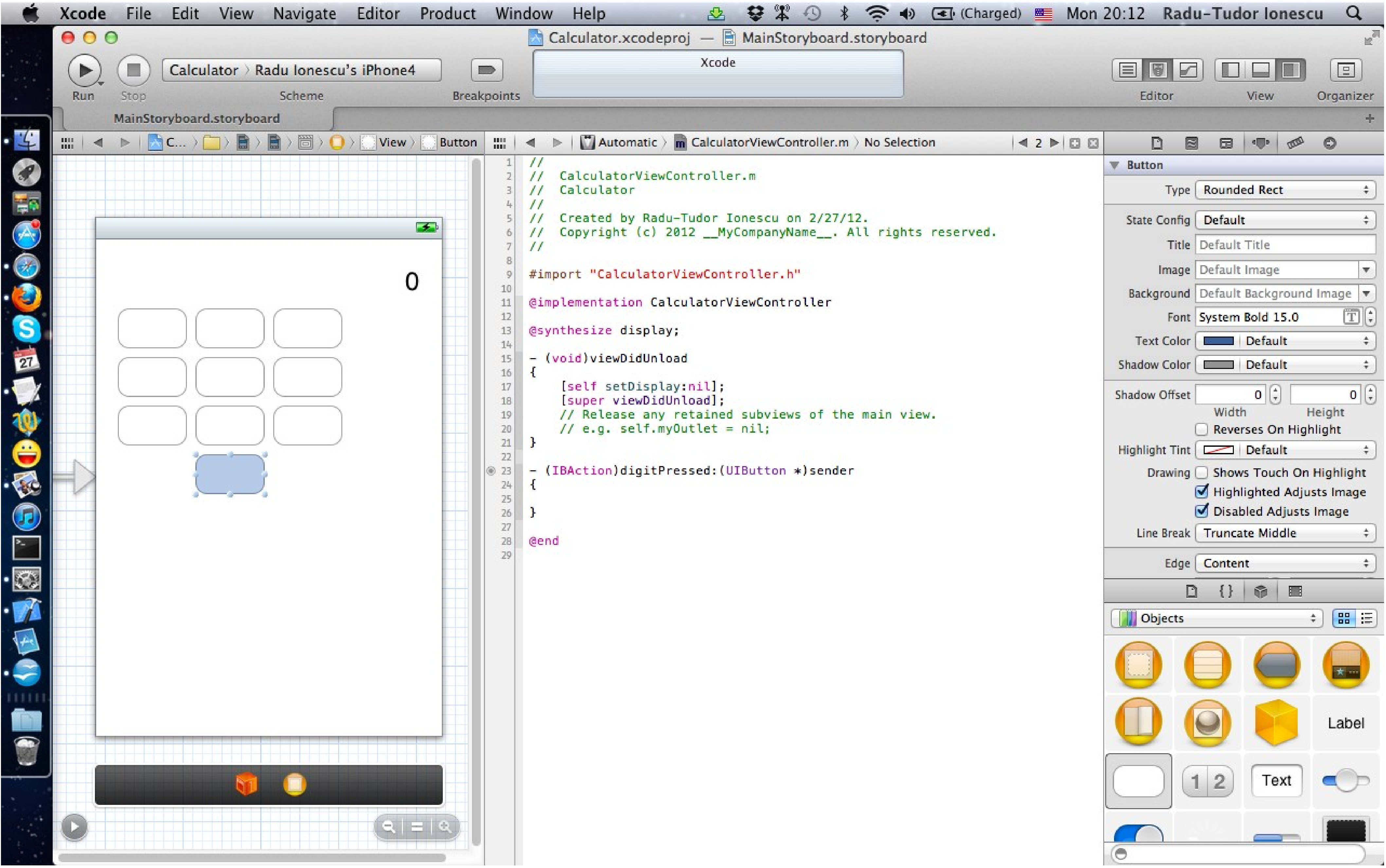
10. Copy and paste our first button to make another button. The copied button will send the same action (`digitPressed:`) as the original.

11. Move the copied button to line up horizontally with the original (the dashed blue lines are awesome here).

12. Copy and paste again to obtain 3 buttons horizontally aligned.

13. Now copy and paste 3 buttons at a time.

14. Using copy and paste and the grid lines, create the entire keypad for the Calculator. It should look like in the screenshot from the next slide.


Xcode File Edit View Navigate Editor Product Window Help
Mon 20:12 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run Stop Scheme Breakpoints Editor View Organizer
Calculator › Radu Ionescu's iPhone4
Xcode
MainStoryboard.storyboard
View Button
Automatic CalculatorViewController.m No Selection
0
Objects
Label
Text

```
//
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//  Calculator
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//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{

}

@end
```

Button

Type	Rounded Rect
State Config	Default
Title	Default Title
Image	Default Image
Background	Default Background Image
Font	System Bold 15.0
Text Color	Default
Shadow Color	Default
Shadow Offset	Width 0, Height 0
	☐ Reverses On Highlight
Highlight Tint	Default
Drawing	☐ Shows Touch On Highlight
	☑ Highlighted Adjusts Image
	☑ Disabled Adjusts Image
Line Break	Truncate Middle
Edge	Content

Task 3

Task: Add our Calculator’s keypad buttons.

15. Double-click on a button to make its text editable. Then type the number that goes in the appropriate spot.

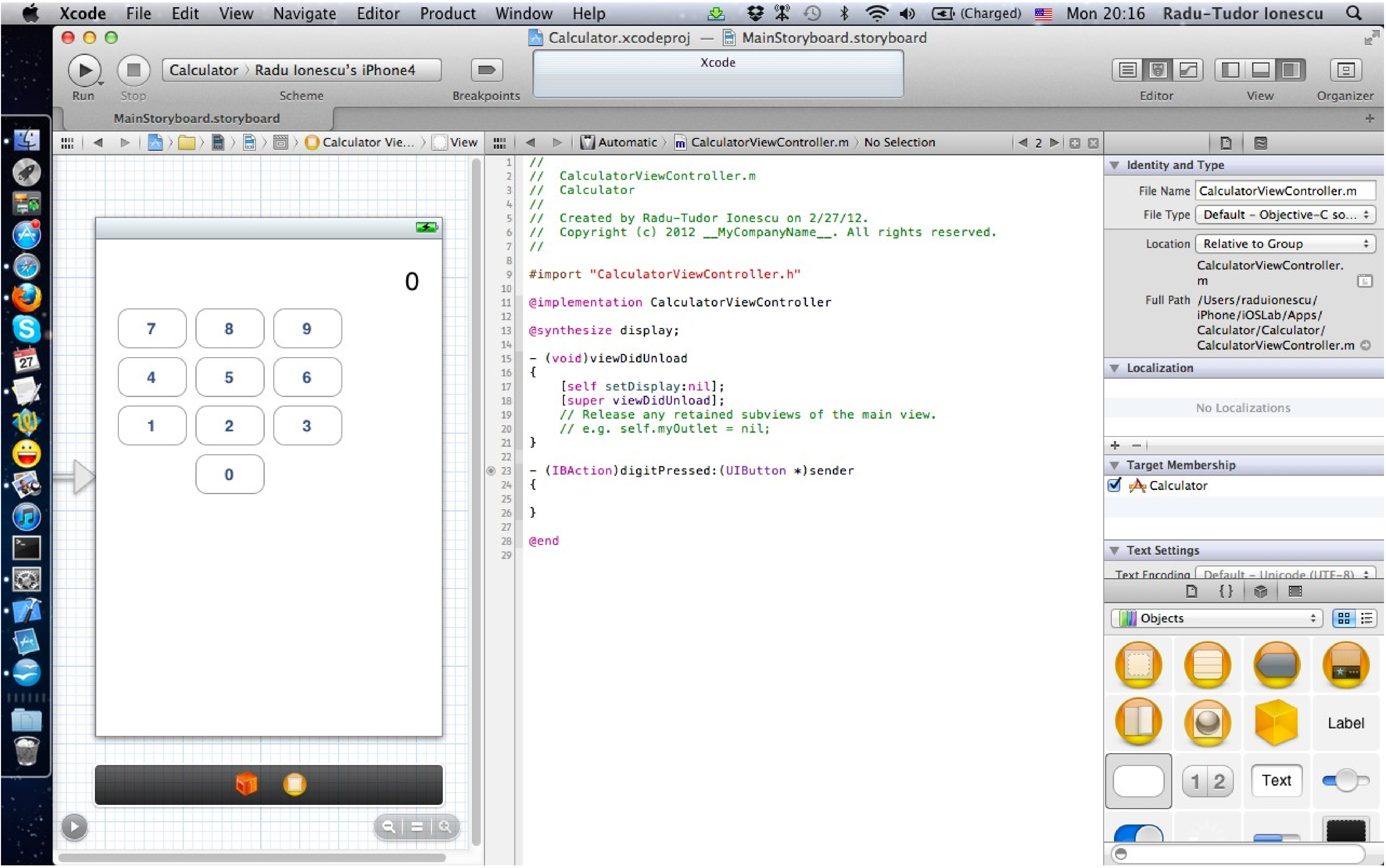
16. Do this for all the buttons. Your keypad should now look like the one in the screenshot from the following slide.

17. Right-click on the nine button.

18. Mouse over the "Touch Up Inside" connection and you will see that the whole View will highlight (that's its way of showing you that this button sends its message to the Controller).

19. Right-click on the icon that represents the Controller (it's under the View).

20. Then mouse over this "Button - 4" entry. Notice how the button highlights.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Mon 20:16 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › Radu Ionescu's iPhone4
Scheme
Breakpoints
Xcode
Editor
View
Organizer
MainStoryboard.storyboard
Calculator Vie... › View
Automatic › CalculatorViewController.m › No Selection
0
7
8
9
4
5
6
1
2
3
0
Objects
Label
1 2
Text

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{

}

@end
```

Identity and Type
File Name: CalculatorViewController.m
File Type: Default - Objective-C so...
Location: Relative to Group
CalculatorViewController.m
Full Path: /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.m

Localization
No Localizations

Target Membership
✓ Calculator

Text Settings
Text Encoding: Default - Unicode (UTF-8)

Task 4

Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

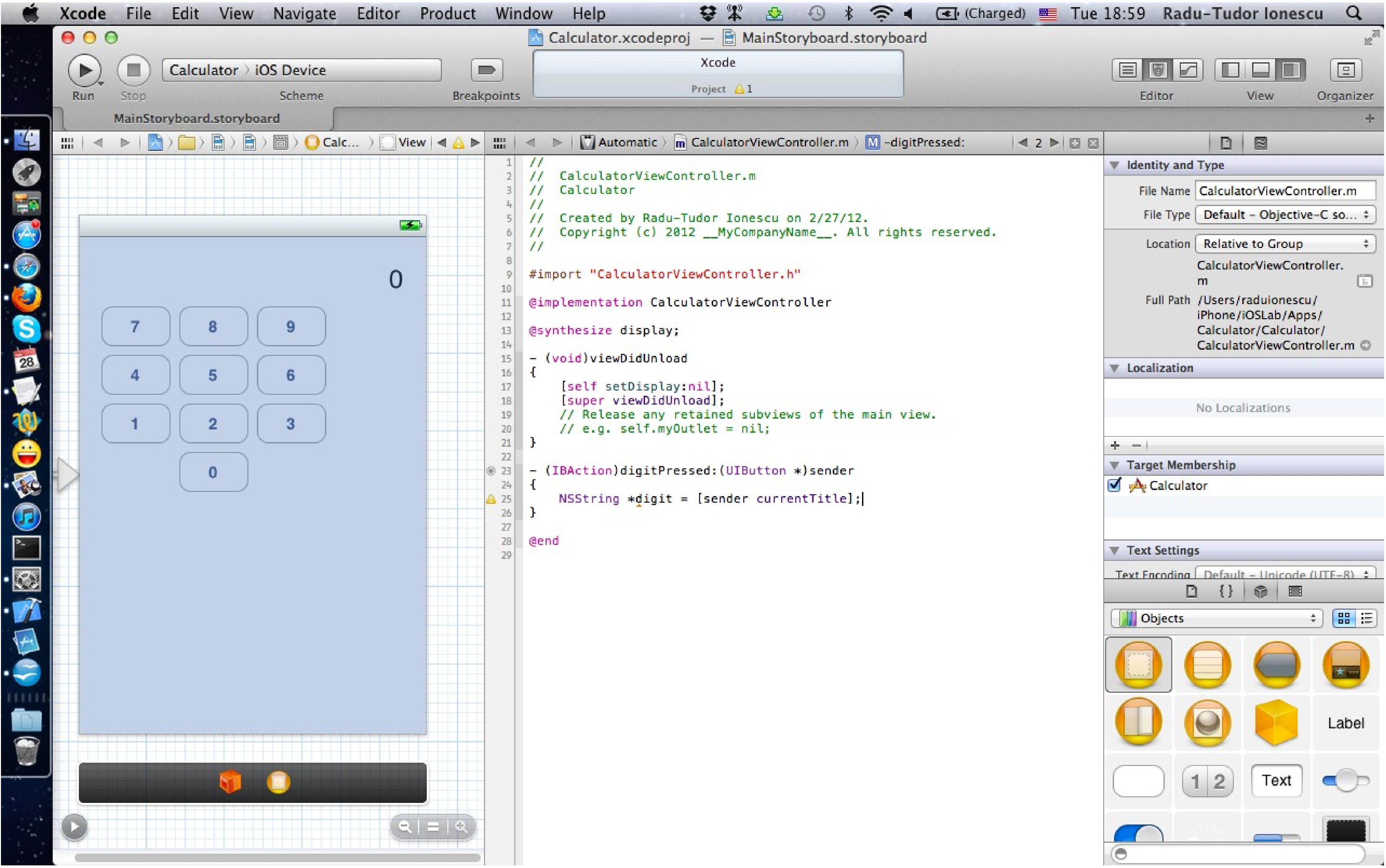
1. We won't need the Utilities area for a while, so close it from the “Hide or show the Utilities” button from the Toolbar.

2. Start by declaring a local variable called `digit` inside the `digitPressed:` method implementation. This local variable will be of type "pointer to an `NSString` object".

3. Since all the buttons send the same action message to our Controller, we have to look at the action message’s argument (`sender`) to find out which one was touched.

`UIButton` objects respond to the message `currentTitle` which returns an `NSString` containing the title of the button. We'll use that to figure out which button was touched.

Make sure your code looks like in the next screenshot.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Tue 18:59 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › iOS Device
Scheme
Breakpoints
Xcode
Project ⚠1
Editor
View
Organizer
MainStoryboard.storyboard
Calc…
View
Automatic
CalculatorViewController.m
-digitPressed:
2
0
7
8
9
4
5
6
1
2
3
0
Objects
Label
1 2
Text

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
}

@end
```

Identity and Type
File Name: CalculatorViewController.m
File Type: Default - Objective-C so…
Location: Relative to Group
CalculatorViewController.m
Full Path: /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.m

Localization
No Localizations

Target Membership
✓ Calculator

Text Settings
Text Encoding: Default - Unicode (UTF-8)

Task 4

Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

4. Add an `NSLog()` to print the digit chosen by the user to the console. Your code should be something like the code in the next screenshot.

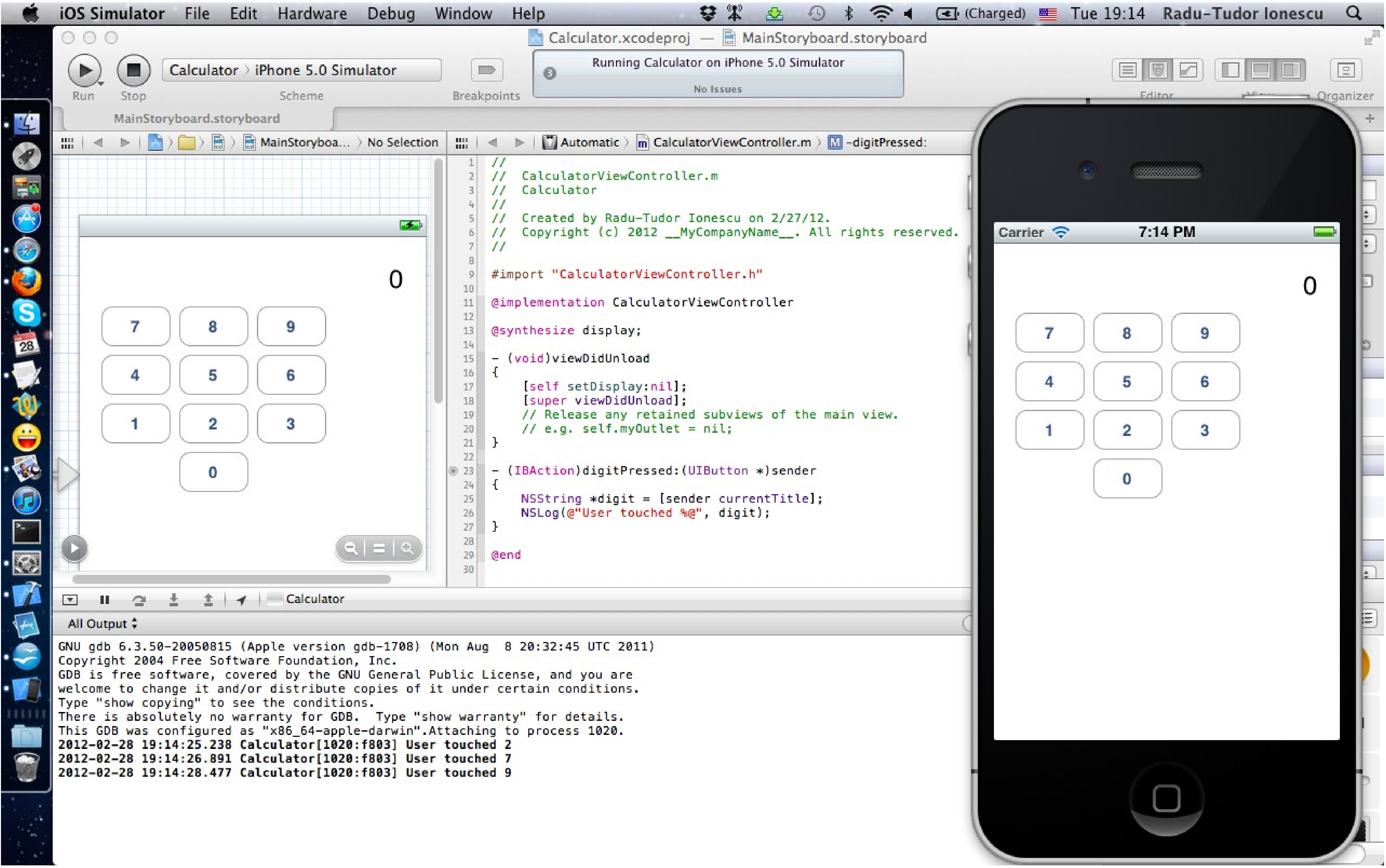
5. Run the application with this `NSLog()` in place.

6. Touch a few keys and check out the console for the messages printed by `NSLog()`.

7. Stop the simulator and delete the line of code with `NSLog()`.

8. Now that we have the `digit` from the button, we need to update our `display` by appending the `digit` onto the end of it. This actually only takes one line of code, but we'll break it down into steps.

Let's make another local variable called `myDisplay` (of type "pointer to a `UILabel`") into which we'll just put the value of our `display` outlet. Make sure you express calling the getter of our `display` `@property` using dot notation.


iOS Simulator File Edit Hardware Debug Window Help
Tue 19:14 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Running Calculator on iPhone 5.0 Simulator
No Issues
Editor
Organizer
MainStoryboard.storyboard
MainStoryboa… › No Selection
Automatic › CalculatorViewController.m › -digitPressed:
Calculator
All Output
Carrier
7:14 PM
0
7 8 9
4 5 6
1 2 3
0

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    NSLog(@"User touched %@", digit);
}

@end
```

```
GNU gdb 6.3.50-20050815 (Apple version gdb-1708) (Mon Aug  8 20:32:45 UTC 2011)
Copyright 2004 Free Software Foundation, Inc.
GDB is free software, covered by the GNU General Public License, and you are
welcome to change it and/or distribute copies of it under certain conditions.
Type "show copying" to see the conditions.
There is absolutely no warranty for GDB.  Type "show warranty" for details.
This GDB was configured as "x86_64-apple-darwin".Attaching to process 1020.
2012-02-28 19:14:25.238 Calculator[1020:f803] User touched 2
2012-02-28 19:14:26.891 Calculator[1020:f803] User touched 7
2012-02-28 19:14:28.477 Calculator[1020:f803] User touched 9
```

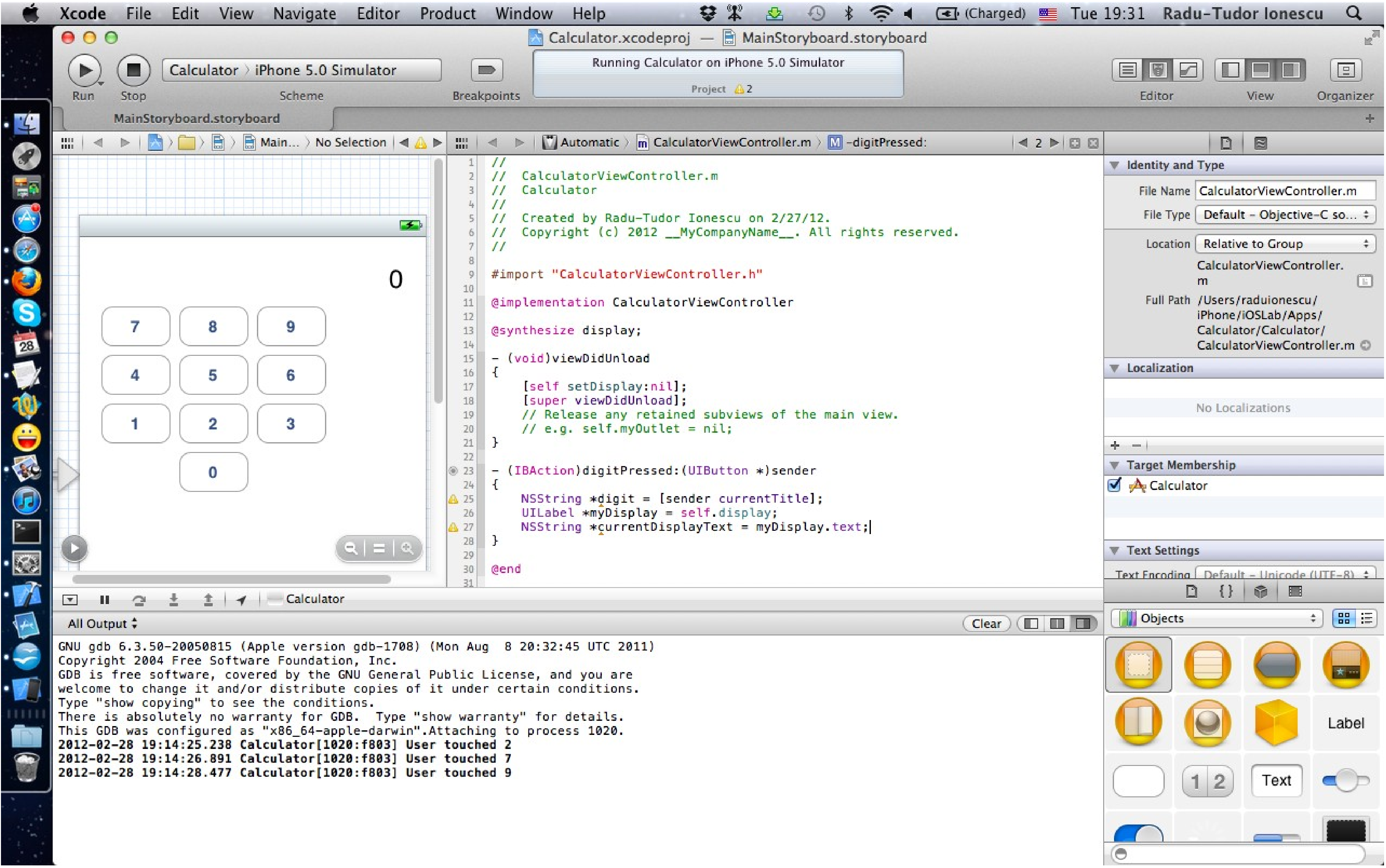
Task 4

Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

9. Now that we have a pointer to our display, let's send it a message to find out what text is currently in it. The message to send is called (appropriately) `text`.

Add a line of code to get the `text` out of our `display` `UILabel` and store it in a local variable (a pointer to an `NSString` object) called `currentDisplayText`. Note that `text` is a property of `UILabel` and you can use dot notation to access it.

Look at the screenshot from the next slide to see how your code should look at this moment.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Tue 19:31 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Running Calculator on iPhone 5.0 Simulator
Project 2
Editor
View
Organizer
MainStoryboard.storyboard
Main… › No Selection
Automatic › CalculatorViewController.m › -digitPressed:
0
7
8
9
4
5
6
1
2
3
0
Calculator
All Output
Clear
Objects
Label
1 2
Text

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    UILabel *myDisplay = self.display;
    NSString *currentDisplayText = myDisplay.text;
}

@end
```

Identity and Type
File Name: CalculatorViewController.m
File Type: Default - Objective-C so…
Location: Relative to Group
CalculatorViewController.m
Full Path: /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.m

Localization
No Localizations

Target Membership
✓ Calculator

Text Settings
Text Encoding: Default - Unicode (UTF-8)

```
GNU gdb 6.3.50-20050815 (Apple version gdb-1708) (Mon Aug  8 20:32:45 UTC 2011)
Copyright 2004 Free Software Foundation, Inc.
GDB is free software, covered by the GNU General Public License, and you are
welcome to change it and/or distribute copies of it under certain conditions.
Type "show copying" to see the conditions.
There is absolutely no warranty for GDB.  Type "show warranty" for details.
This GDB was configured as "x86_64-apple-darwin".Attaching to process 1020.
2012-02-28 19:14:25.238 Calculator[1020:f803] User touched 2
2012-02-28 19:14:26.891 Calculator[1020:f803] User touched 7
2012-02-28 19:14:28.477 Calculator[1020:f803] User touched 9
```

Task 4

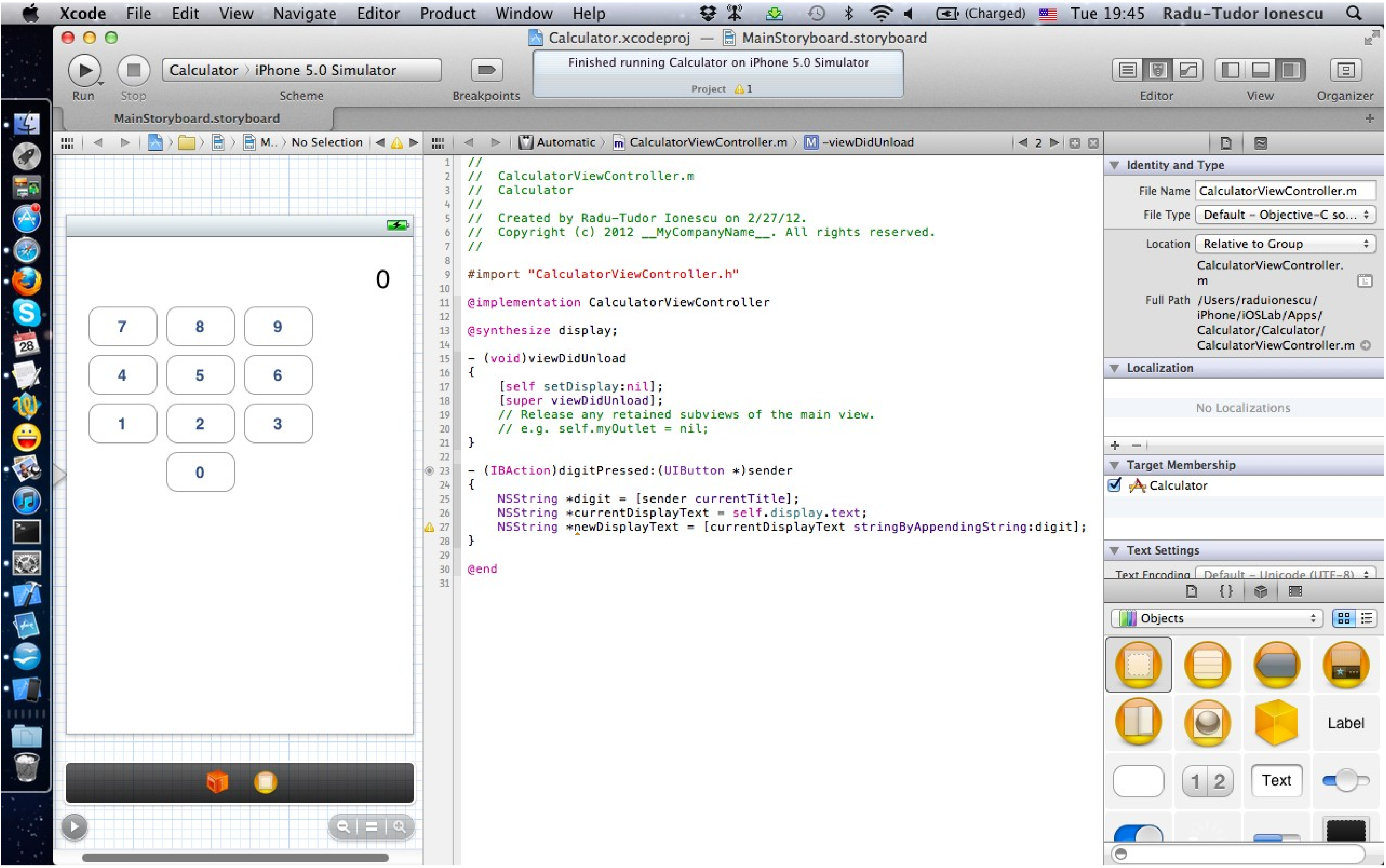
Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

10. There's really no need for the local variable `myDisplay`. So let's select and copy its value (self.display) and paste it where we use it.

11. Now you can delete the line of code that declares the local `myDisplay` variable.

12. Next we need to append the `digit` that the user just touched onto the end of what is currently in the `display`. Create a local variable called `newDisplayText` and assign it with the value returned by messaging the `currentDisplayText` local variable with `stringByAppendingString`: with the argument `digit`.

Look at the screenshot from the next slide to see how your code should look at this moment.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Tue 19:45 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Finished running Calculator on iPhone 5.0 Simulator
Project ⚠1
Editor
View
Organizer
MainStoryboard.storyboard
M.. › No Selection
Automatic › CalculatorViewController.m › -viewDidUnload
0
7 8 9
4 5 6
1 2 3
0
Objects
Label
1 2
Text

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    NSString *currentDisplayText = self.display.text;
    NSString *newDisplayText = [currentDisplayText stringByAppendingString:digit];
}

@end
```

Identity and Type

File Name: CalculatorViewController.m

File Type: Default - Objective-C so...

Location: Relative to Group

CalculatorViewController.m

Full Path: /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.m

Localization

No Localizations

Target Membership

✓ Calculator

Text Settings

Text Encoding: Default - Unicode (UTF-8)

Task 4

Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

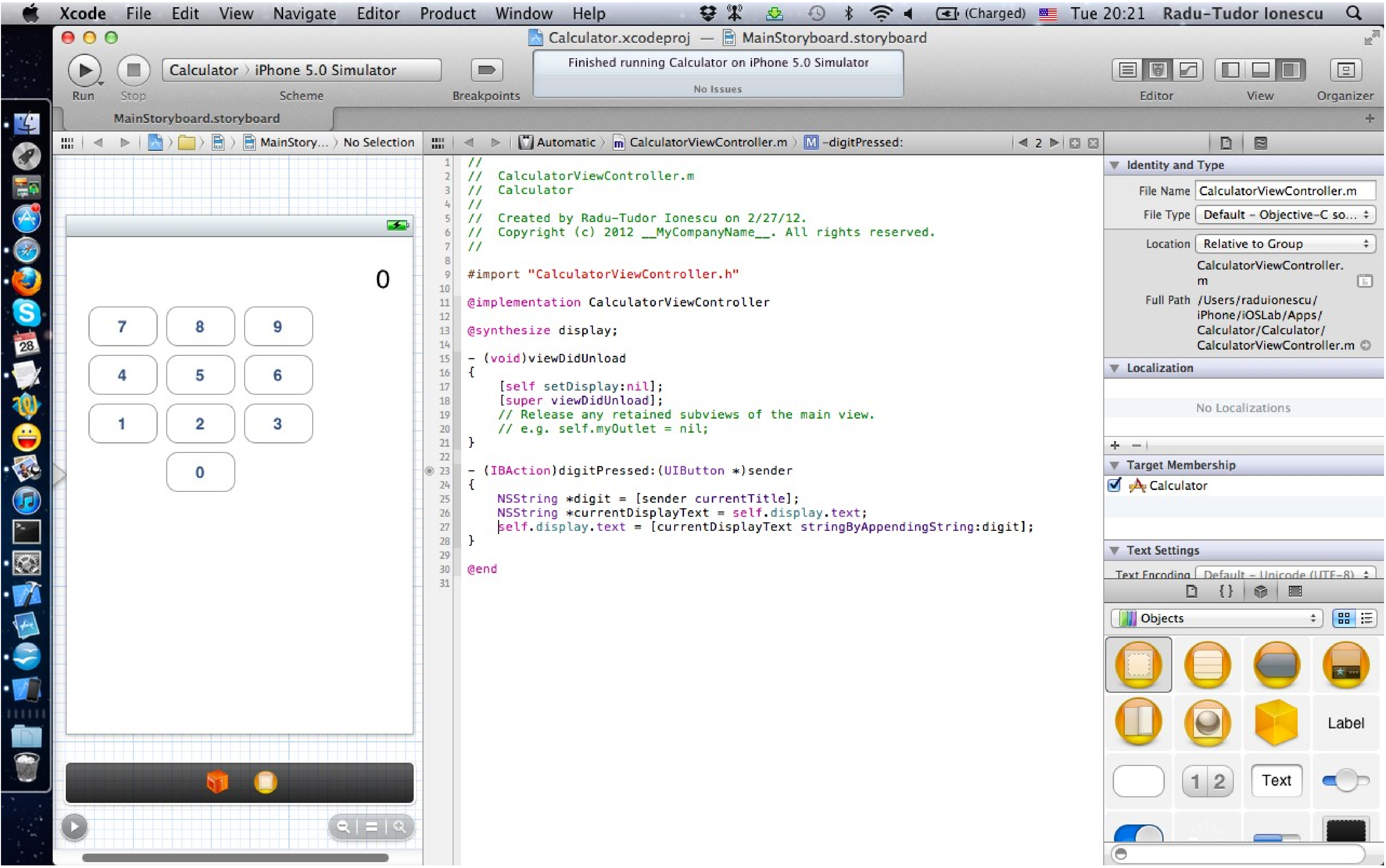
13. We need to set our `display` `UILabel`'s text to the new string with the digit appended to the end.You can use dot notation to set the `self.display.text` property to be the `newDisplayText`.

Note that dot notation for setters is exactly the same as dot notation for getters, it's just that they appear on the left-hand side of equals signs rather than the right-hand side.

14. We don't need the `newDisplay` local variable really, so let's copy its value (the `stringByAppendingString:` message-sending construct) and paste it where it is used.

15. Then we can delete the previous line (that declares the `newDisplayText` variable).

Look at the screenshot from the next slide to see how your code should look at this moment.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Tue 20:21 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Editor
View
Organizer
MainStoryboard.storyboard
MainStory… › No Selection
Automatic › CalculatorViewController.m › -digitPressed:
0
7
8
9
4
5
6
1
2
3
0

Finished running Calculator on iPhone 5.0 Simulator

No Issues

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    NSString *currentDisplayText = self.display.text;
    self.display.text = [currentDisplayText stringByAppendingString:digit];
}

@end
```

Identity and Type

File Name: CalculatorViewController.m

File Type: Default - Objective-C so…

Location: Relative to Group

CalculatorViewController.m

Full Path: /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.m

Localization

No Localizations

Target Membership

☑ Calculator

Text Settings

Text Encoding: Default - Unicode (UTF-8)

Task 4

Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

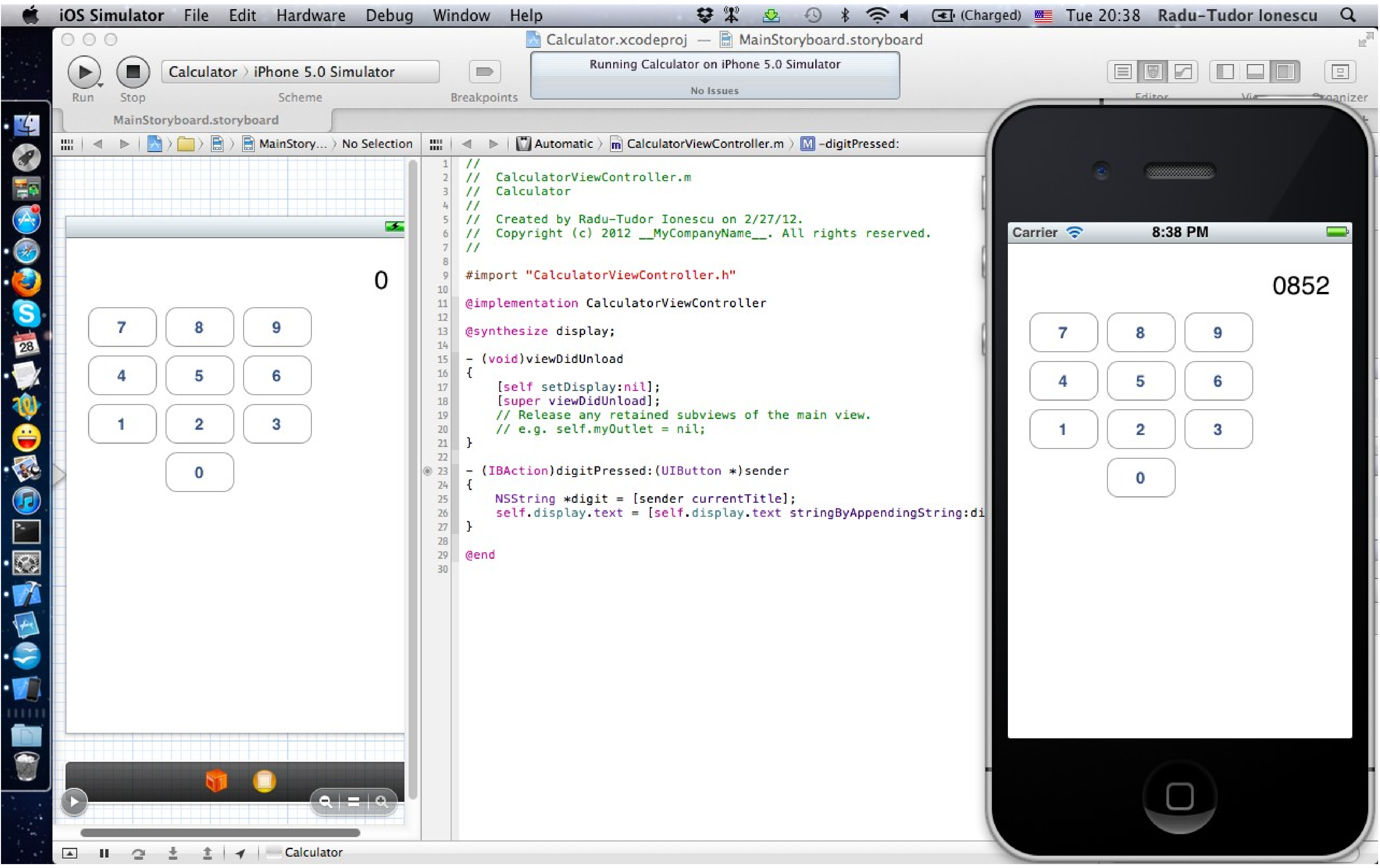
16. The same thing happens for the `currentDisplayText` local variable. It is not really needed. Copy the value of `currentDisplayText` and paste it where it is used.

17. Okay, let’s Run and see if this works!

18. Touch a few keypads. Notice the leading zero that doesn't look right on the display. We should try to fix the problem with the leading zero.

The problem with the leading zero is that we are appending new digits even if the user is not currently in the middle of entering a number. The display should get cleared when the user starts typing a new number instead of appending to whatever happens to be there (like the 0 at the beginning or some operation’s result later on).

Look at the screenshot from the next slide to see how things should look by now.


iOS Simulator File Edit Hardware Debug Window Help
(Charged) Tue 20:38 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Running Calculator on iPhone 5.0 Simulator
No Issues
MainStoryboard.storyboard
MainStory… › No Selection
Automatic › CalculatorViewController.m › -digitPressed:
0
7 8 9
4 5 6
1 2 3
0
Carrier 8:38 PM
0852
7 8 9
4 5 6
1 2 3
0
Calculator

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    self.display.text = [self.display.text stringByAppendingString:di
}

@end
```

Task 4

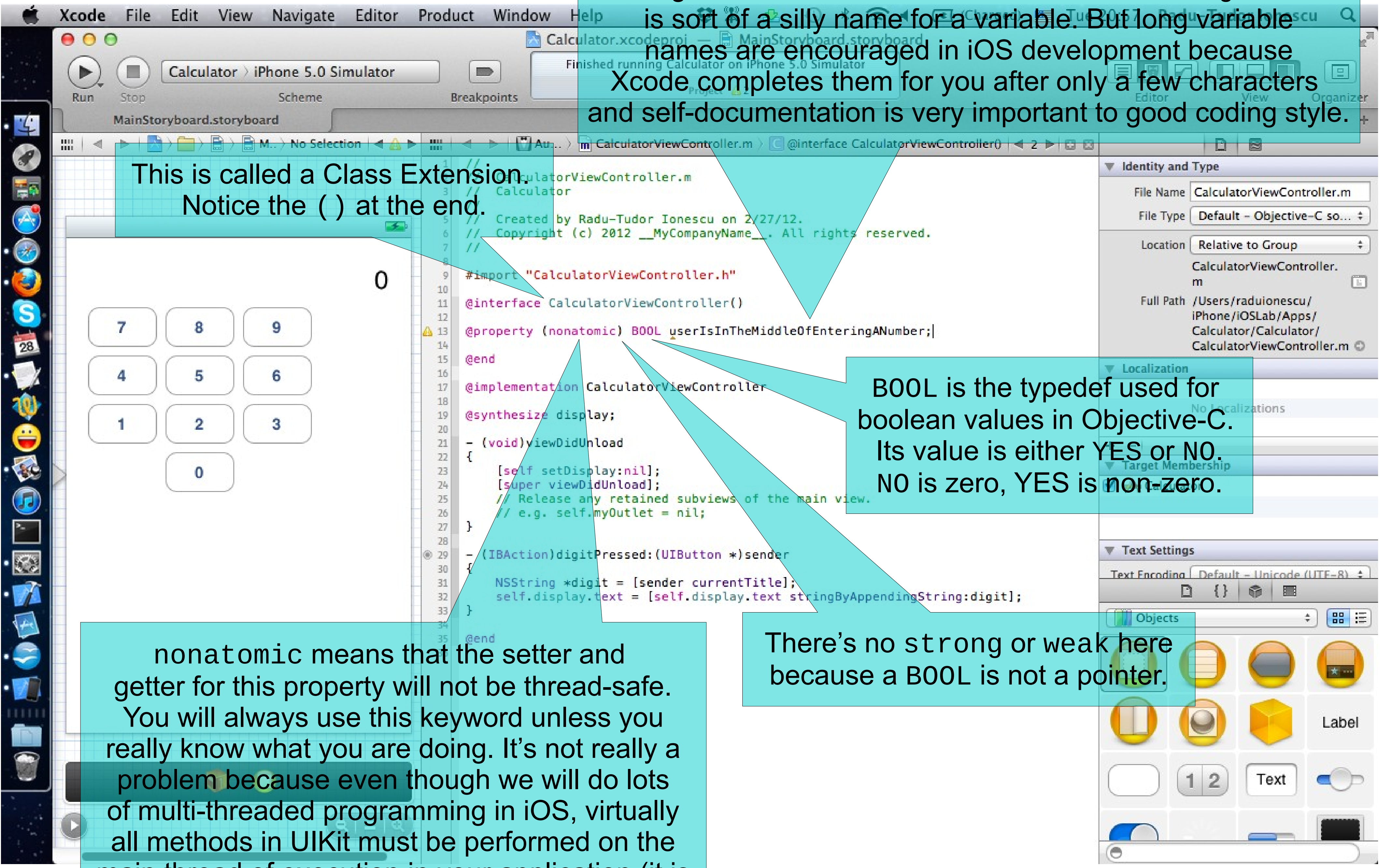
Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

19. To fix this, we are going to need a `@property` to keep track of whether the user is in the middle of entering a number. But we don't want to add the `@property` to our header file because those properties are public.

So where do we add private properties? We need to add a private `@interface` to our implementation file. This is called a Class Extension.

The concept of “public versus private” in Objective-C is done via "header file versus implementation file". You declare public stuff in your header file’s `@interface-@end` block. You declare private stuff in your implementation file’s `@interface-@end` block.

20. Add a private boolean property to track whether the user is in the middle of entering a number. Check out the screenshot in the following slide to understand how to do this.


Xcode File Edit View Navigate Editor Product Window Help
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Finished running Calculator on iPhone 5.0 Simulator
Editor
View
Organizer
MainStoryboard.storyboard
No Selection
CalculatorViewController.m
@interface CalculatorViewController()
0
7 8 9
4 5 6
1 2 3
0
Identity and Type
Localization
No Localizations
Target Membership
Text Settings
Objects
Label
Text

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@interface CalculatorViewController()

@property (nonatomic) BOOL userIsInTheMiddleOfEnteringANumber;

@end

@implementation CalculatorViewController

@synthesize display;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    self.display.text = [self.display.text stringByAppendingString:digit];
}

@end
```

File Name: CalculatorViewController.m
File Type: Default - Objective-C so...
Location: Relative to Group
CalculatorViewController.m
Full Path: /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.m
Text Encoding: Default - Unicode (UTF-8)

You might think `userIsInTheMiddleOfEnteringANumber` is sort of a silly name for a variable. But long variable names are encouraged in iOS development because Xcode completes them for you after only a few characters and self-documentation is very important to good coding style.

This is called a Class Extension. Notice the ( ) at the end.

`BOOL` is the typedef used for boolean values in Objective-C. Its value is either `YES` or `NO`. `NO` is zero, `YES` is non-zero.

There's no `strong` or `weak` here because a `BOOL` is not a pointer.

`nonatomic` means that the setter and getter for this property will not be thread-safe. You will always use this keyword unless you really know what you are doing. It's not really a problem because even though we will do lots of multi-threaded programming in iOS, virtually all methods in UIKit must be performed on the main thread of execution in your application (it is non-UI activity that we will put in other threads).

Task 4

Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

21. There are two warnings for the private `@property` declaration. The problem is that we declared the `@property`, but we have not implemented the getter (first warning) or the setter (second warning).

Let's use `@synthesize` (again) to implement both the getter and the setter for us! Note that `@synthesize` doesn't care whether your `@property` is public (declared in the header) or private (declared in the implementation file).

Task 4

Task: Write the code inside `digitPressed:` that will get executed whenever any of the keypad buttons gets touched.

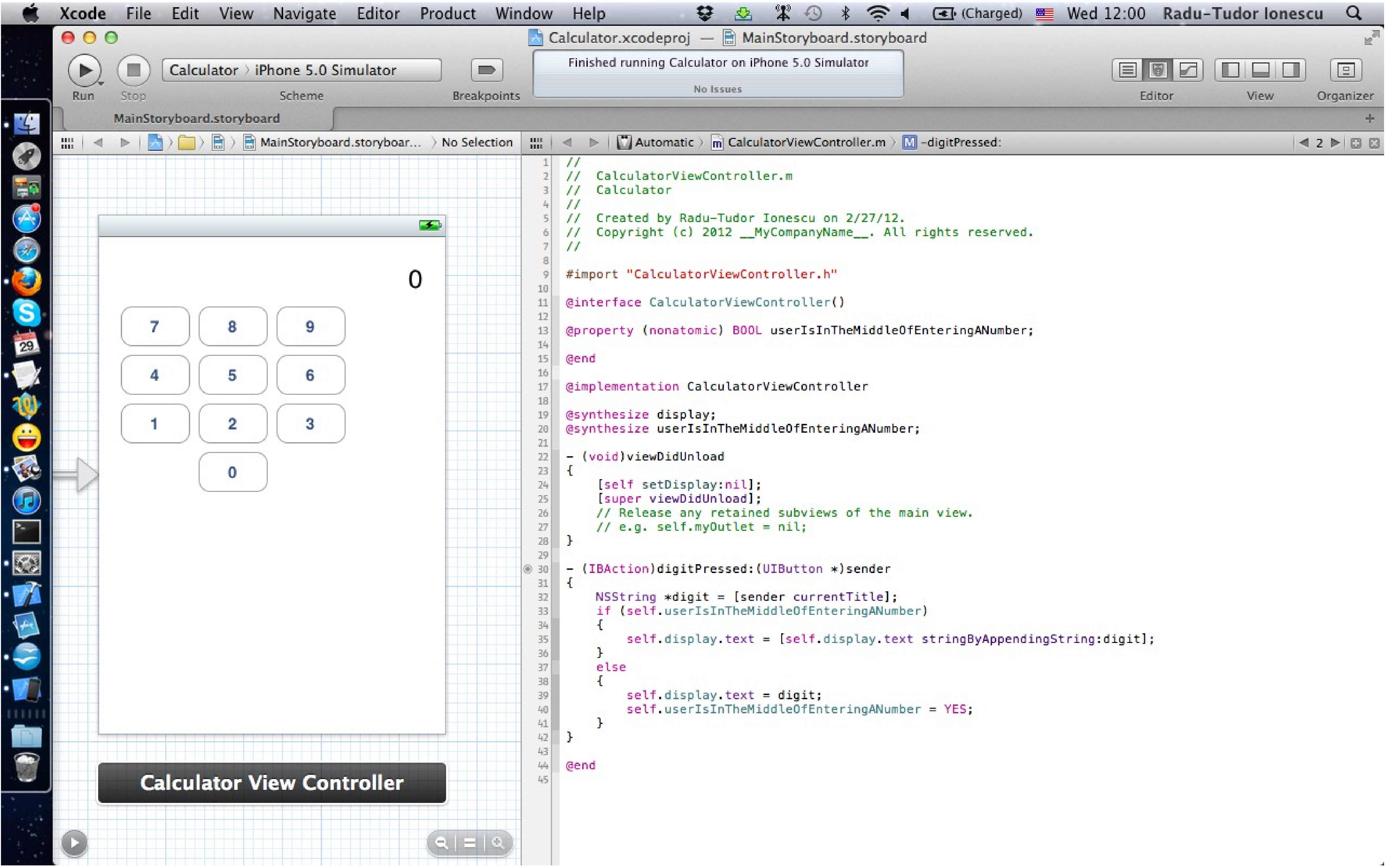
22. Now we just need to only do the appending if the user is in the middle of entering a number.

But what value does `userIsInTheMiddleOfEnteringANumber` start out with? All properties start out with a value of zero. For a pointer to an object (like `display`) zero is called `nil`. Your program will not crash if you send a message to `nil`. It just does nothing in that case (any value the method returns will be zero).

If the user is not in the middle of typing, just start off a new number with the `digit` that was touched. In this case we must set `userIsInTheMiddleOfEnteringANumber` to YES because we are now in the middle of entering a number.

Check out the screenshot from the next slide to see the final implementation of `digitPressed:`.

23. That should do it. Let's run again.



Xcode File Edit View Navigate Editor Product Window Help
(Charged) Wed 12:00 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run Stop Scheme Breakpoints Editor View Organizer
Calculator › iPhone 5.0 Simulator
Finished running Calculator on iPhone 5.0 Simulator
No Issues
MainStoryboard.storyboard
MainStoryboard.storyboar... › No Selection
Automatic › CalculatorViewController.m › -digitPressed:
0
7 8 9
4 5 6
1 2 3
0
Calculator View Controller

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@interface CalculatorViewController()

@property (nonatomic) BOOL userIsInTheMiddleOfEnteringANumber;

@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

@end
```

Task 5

Task: Add some more buttons (for operations *, /, +, - and Enter).

1. Bring back the Utilities area.

2. Drag a Round Rect Button from the Object Library to your View. Do NOT copy and paste a digit button to make this first operation button. Copying and pasting buttons brings the button's action message along with it and we want operation buttons to send a different message than digit buttons!

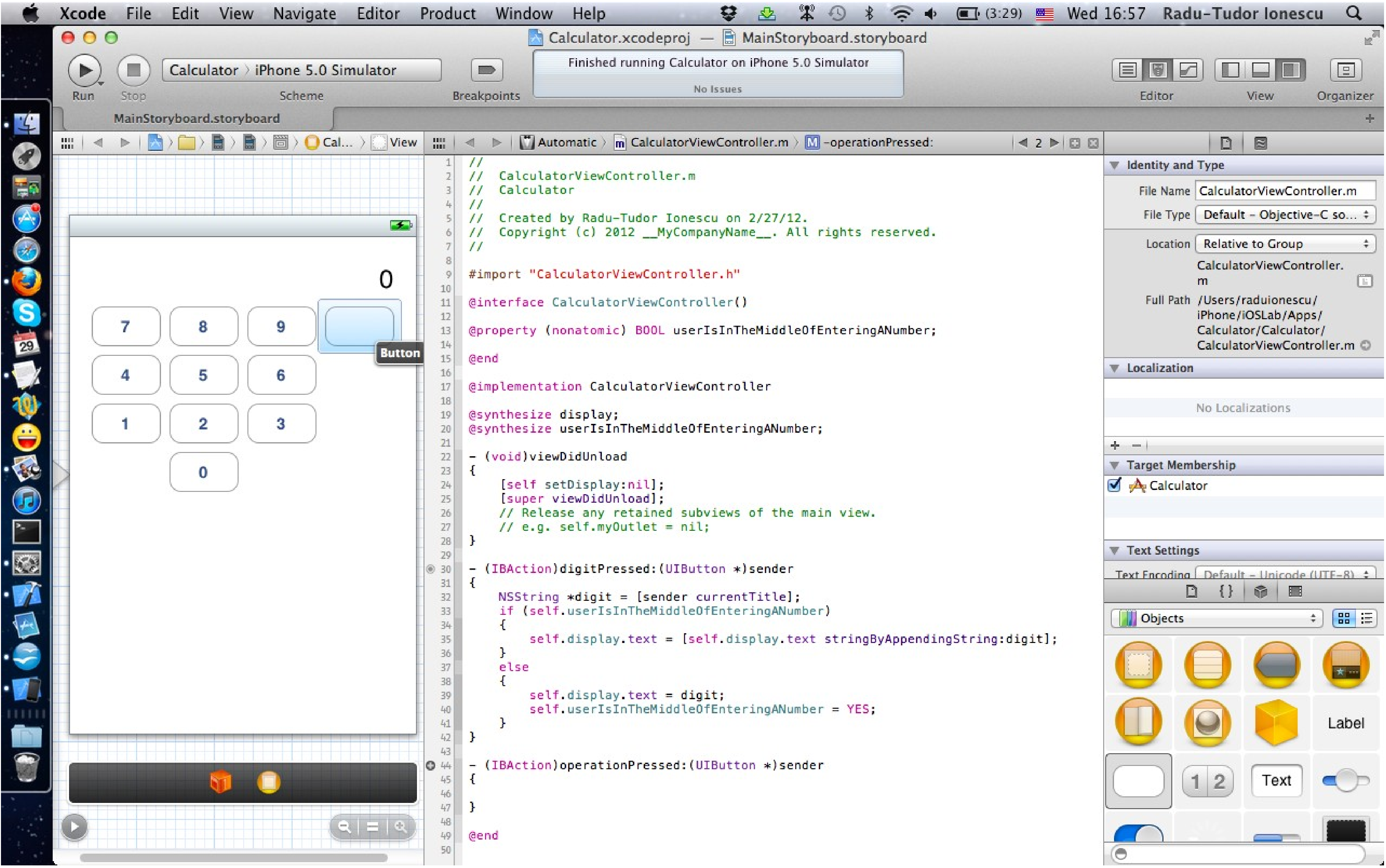
3. Resize the button to 64 x 37 pixels.

4. CTRL-drag to create this button's action.

5. Name the action `operationPressed:` then click Connect.

6. You should statically type the `sender` to `UIButton *`.

Check out the screenshot from the next slide to see how the button and the action should look like.


Xcode File Edit View Navigate Editor Product Window Help
(3:29) Wed 16:57 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Editor
View
Organizer
MainStoryboard.storyboard
Cal… View
Automatic › CalculatorViewController.m › -operationPressed:
0
7
8
9
4
5
6
1
2
3
0
Button
Identity and Type
Localization
Target Membership
Text Settings
Objects
Label
1 2
Text

Finished running Calculator on iPhone 5.0 Simulator

No Issues

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@interface CalculatorViewController()

@property (nonatomic) BOOL userIsInTheMiddleOfEnteringANumber;

@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)operationPressed:(UIButton *)sender
{

}

@end
```

File Name: CalculatorViewController.m

File Type: Default - Objective-C so...

Location: Relative to Group

CalculatorViewController.m

Full Path: /Users/raduionescu/iPhone/iOSLab/Apps/Calculator/Calculator/CalculatorViewController.m

No Localizations

✓ Calculator

Text Encoding: Default - Unicode (UTF-8)

Task 5

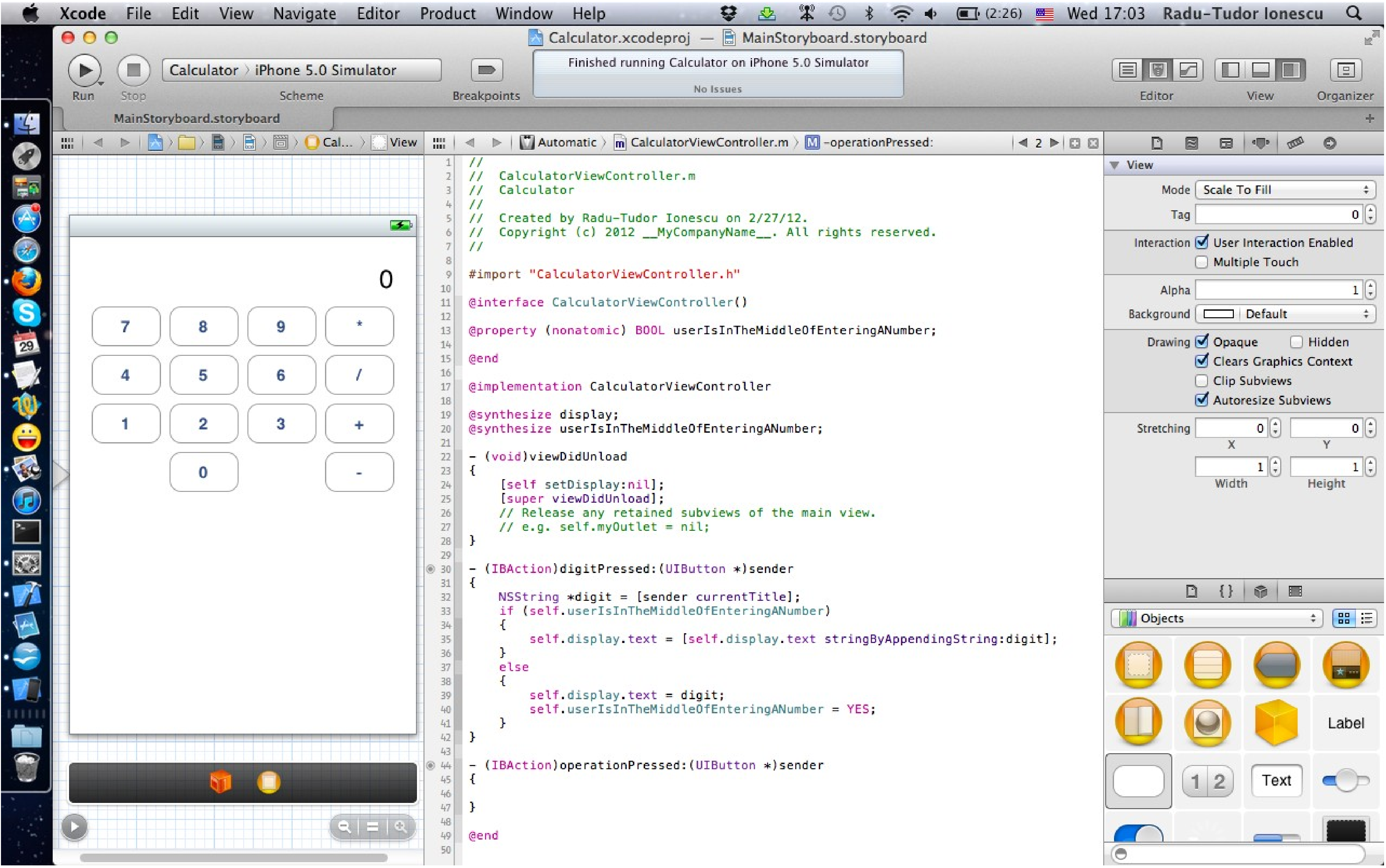
Task: Add some more buttons (for operations *, /, +, - and Enter).

7. Now use copy and paste to create 4 operation buttons. Again, do not copy and paste a digit button to make an operation button!

8. Set the title of each to these four operations to *, /, + and -, respectively. Check out the screenshot from the next slide to see how your view should look like by now.

9. We need an Enter button because an RPN calculator puts all of its operands on a stack and then operates on them. Enter is used to push a number onto the operand stack (e.g. 6 Enter 5 Enter + results in 11).

Drag a Round Rect Button from the Object Library to the View and place it between 0 and - buttons. Do NOT copy and paste either a digit button or an operation button to make an Enter button. The Enter button will have a different action than either digit buttons or operation buttons.


Xcode File Edit View Navigate Editor Product Window Help
(2:26) Wed 17:03 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Editor
View
Organizer
MainStoryboard.storyboard
Cal… › View
Automatic › CalculatorViewController.m › -operationPressed:
0
7
8
9
*
4
5
6
/
1
2
3
+
0
-
Objects
Label
1 2
Text

Finished running Calculator on iPhone 5.0 Simulator

No Issues

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@interface CalculatorViewController()

@property (nonatomic) BOOL userIsInTheMiddleOfEnteringANumber;

@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)operationPressed:(UIButton *)sender
{

}

@end
```

View

Mode: Scale To Fill

Tag: 0

Interaction: [✓] User Interaction Enabled; [ ] Multiple Touch

Alpha: 1

Background: Default

Drawing: [✓] Opaque; [ ] Hidden; [✓] Clears Graphics Context; [ ] Clip Subviews; [✓] Autoresize Subviews

Stretching: X 0, Y 0, Width 1, Height 1

Task 5

Task: Add some more buttons (for operations *, /, +, - and Enter).

10. Resize it to 64 x 37 pixels and set its title to Enter.

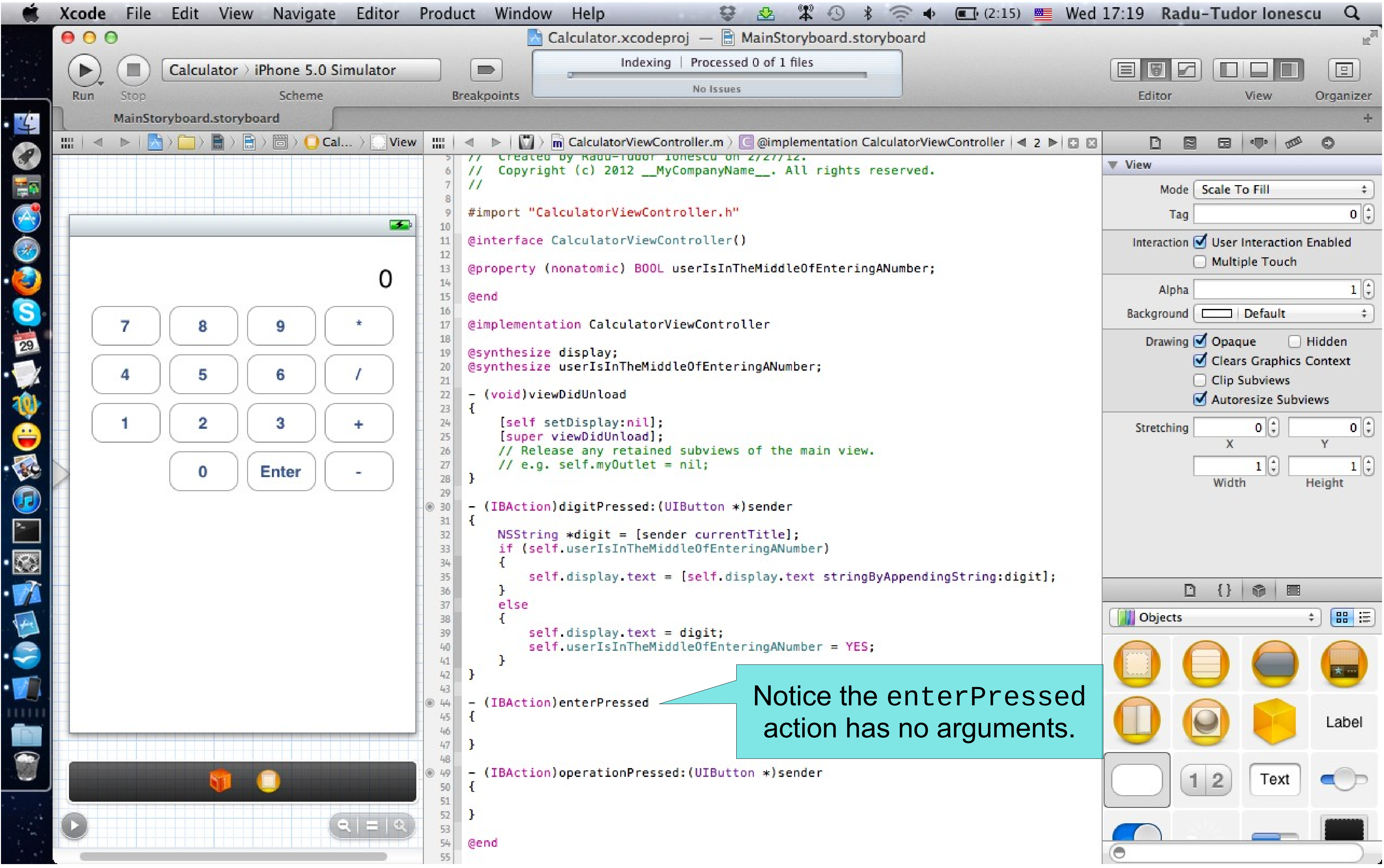
11. CTRL-drag to create this button's action. Put this action before operationPressed: in the file. We are going to call the Enter action from `operationPressed:`, so it needs to be declared earlier in the file. This is not a compiler restriction, but only a good coding practice.

12. Name this action `enterPressed`.

13. There's something a little different about this action method. We don't need the `sender` argument because there's only one Enter key. Note that we can control whether an action message includes the `sender` as an argument.

Change the Arguments to None and click Connect.

Everything should look like in the following screenshot.


Xcode File Edit View Navigate Editor Product Window Help
Calculator.xcodeproj — MainStoryboard.storyboard
Run Stop Scheme Breakpoints Editor View Organizer
Calculator › iPhone 5.0 Simulator
Indexing | Processed 0 of 1 files
No Issues
MainStoryboard.storyboard
CalculatorViewController.m › @implementation CalculatorViewController
0
7 8 9 *
4 5 6 /
1 2 3 +
0 Enter -
Objects
Label
Text

```
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorViewController.h"

@interface CalculatorViewController()

@property (nonatomic) BOOL userIsInTheMiddleOfEnteringANumber;

@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)enterPressed
{

}

- (IBAction)operationPressed:(UIButton *)sender
{

}

@end
```

View
Mode: Scale To Fill
Tag: 0
Interaction: [✓] User Interaction Enabled, [ ] Multiple Touch
Alpha: 1
Background: Default
Drawing: [✓] Opaque, [ ] Hidden, [✓] Clears Graphics Context, [ ] Clip Subviews, [✓] Autoresize Subviews
Stretching: X 0, Y 0, Width 1, Height 1

Notice the `enterPressed` action has no arguments.

Task 6

Task: Create the Model of our MVC for the calculator brain.

1. We cannot proceed any further with our implementation without the Model of our MVC. So we're going to take a time-out from implementing our MVC's Controller to go implement our MVC's Model. Hide the Utilities area again.

2. Before we switch to our writing our Model, it would be nice to capture the setup on the screen (i.e.View and Controller) so that we can easily return to it later. We can do that using Tabs in Xcode (just like Tabs in a Browser).

In Xcode menu go to "File > New > New Tab" (or use the CMD + T shortcut) to open a new tab.

Notice the new tab starts out as a snapshot of the old tab. Once we start changing it, we can get back to the old arrangement by clicking the other tab.

Task 6

Task: Create the Model of our MVC for the calculator brain.

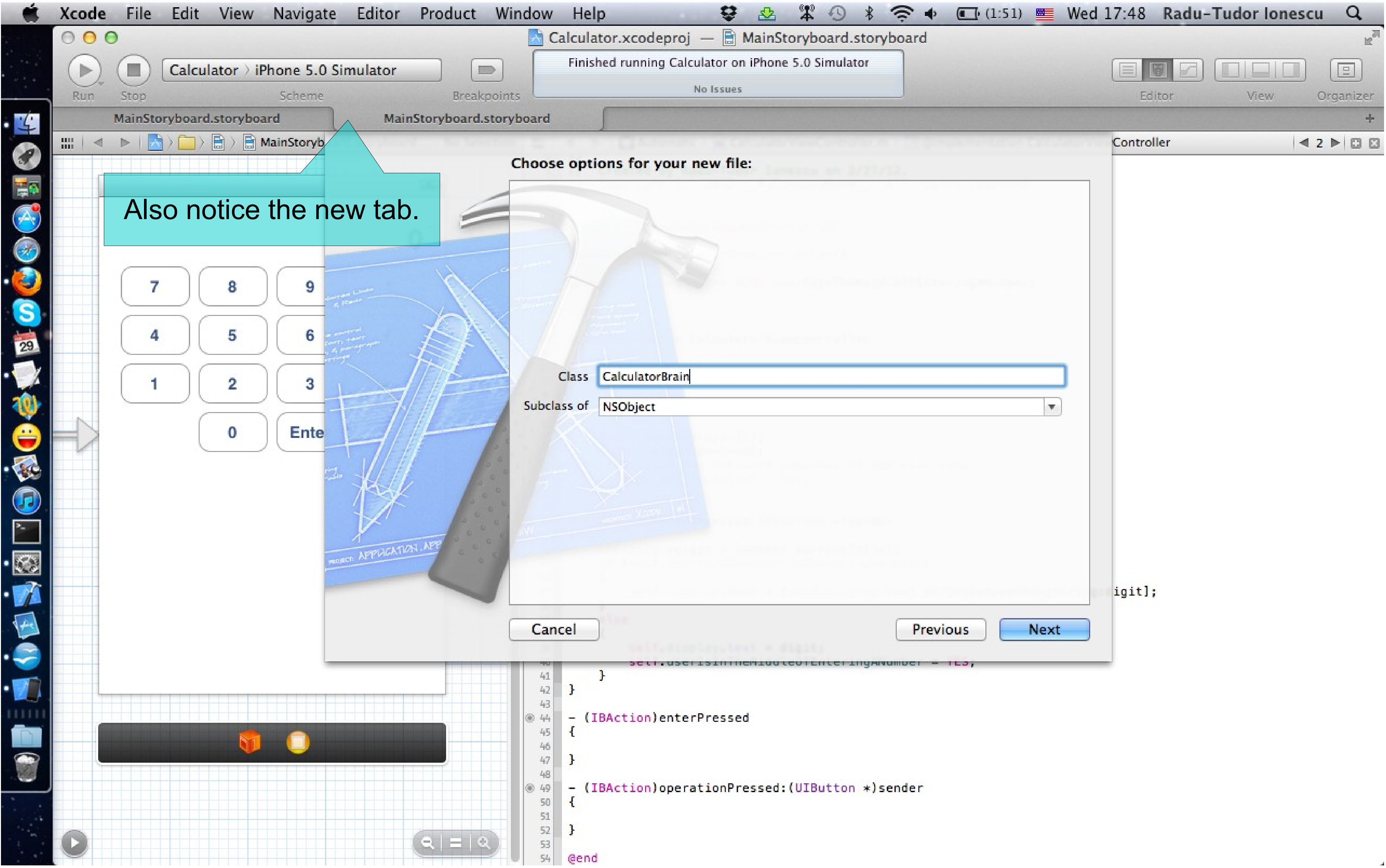
3. Time to create our Model. Do this by selecting “New File” from the File menu.

The File menu's “New File...” item is the gateway to creating a wide variety of things in an application. Including not only new classes (as in this case), but also user-interface elements, database schema, and more.

4. Select the “Objective-C class” option and click Next.

5. We are going to call our Model's class “CalculatorBrain”, so type that in the Class field. Check out the following screenshot.

Our Model is going to be a direct subclass of `NSObject`, so this is correctly selected. `NSObject` is the root superclass of all objects in iOS. Classes inherit some nice generic functionality from `NSObject` including the method called `description` which returns an `NSString` representation of the object which is useful for debugging with `NSLog()`.



Also notice the new tab.

Xcode File Edit View Navigate Editor Product Window Help
Wed 17:48 Radu-Tudor Ionescu
Calculator.xcodeproj — MainStoryboard.storyboard
Run Stop Scheme Breakpoints
Calculator › iPhone 5.0 Simulator
Finished running Calculator on iPhone 5.0 Simulator
No Issues
Editor View Organizer
MainStoryboard.storyboard
MainStoryboard.storyboard
Controller
7 8 9 4 5 6 1 2 3 0 Enter
Cancel
Previous
Next

Choose options for your new file:

Class CalculatorBrain

Subclass of NSObject

```
    }
}

- (IBAction)enterPressed
{

}

- (IBAction)operationPressed:(UIButton *)sender
{

}

@end
```

Task 6

Task: Create the Model of our MVC for the calculator brain.

6. Then click Next to choose where to put your Model’s .m and .h files.

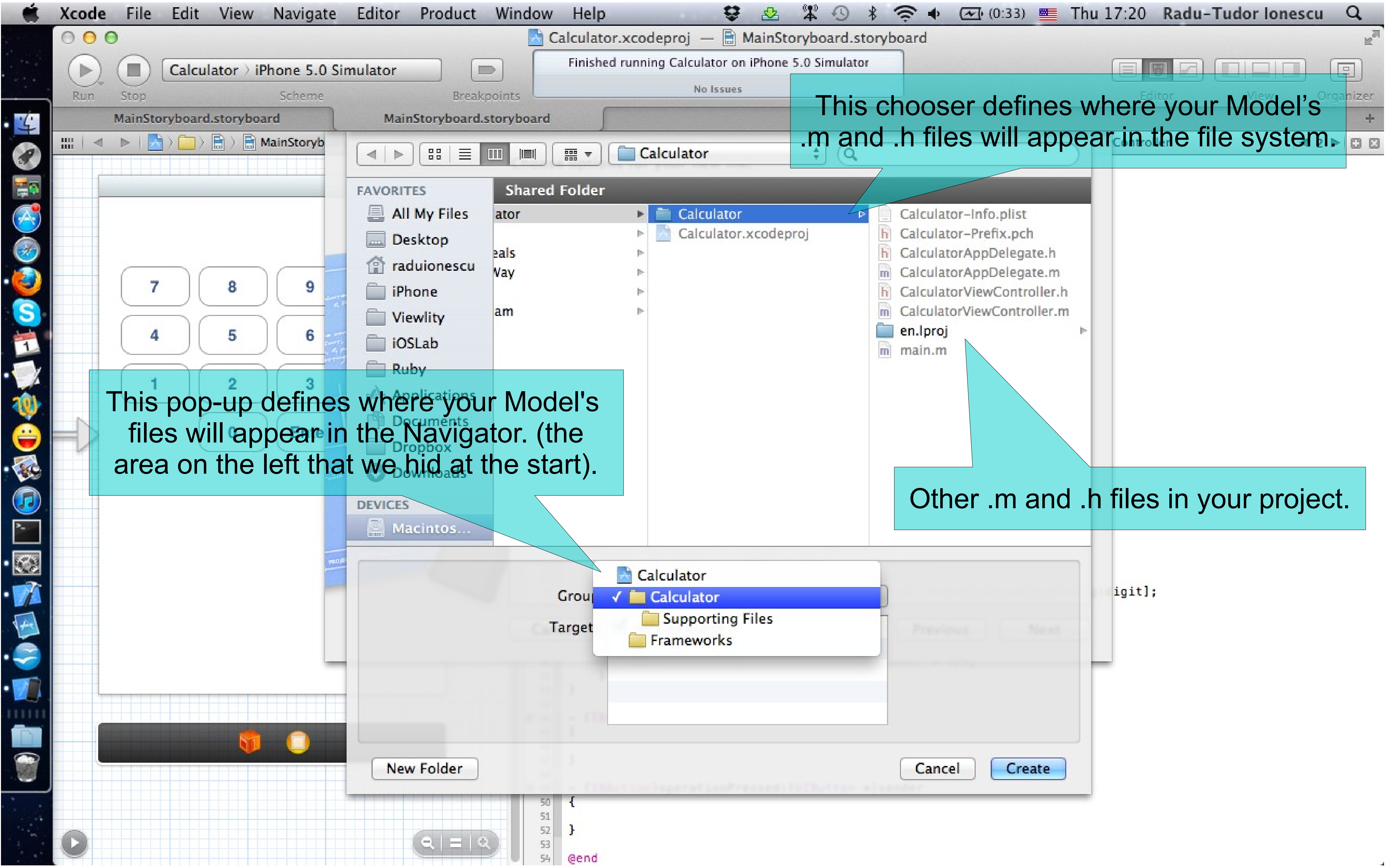
7. Make sure you put your Model’s .m and .h files in the same place as all of your other .m and .h files, that is in the "Calculator" subfolder.

8. Don’t put your Model’s .m and .h files in the top-level group in the Navigator either. Put them in this group one level down.

Check out the screenshot from the following slide to understand how to set things up.

9. Click Create. Notice the Navigator shows up after you create your Model. Also notice that Xcode has created stubs for both the header and implementation of our MVC’s Model and it has automatically renamed the current tab. You can name it yourself by double-clicking on it if you wish.

10. Close the Navigator to make space.



This chooser defines where your Model's .m and .h files will appear in the file system.

This pop-up defines where your Model's files will appear in the Navigator. (the area on the left that we hid at the start).

Other .m and .h files in your project.

Task 6

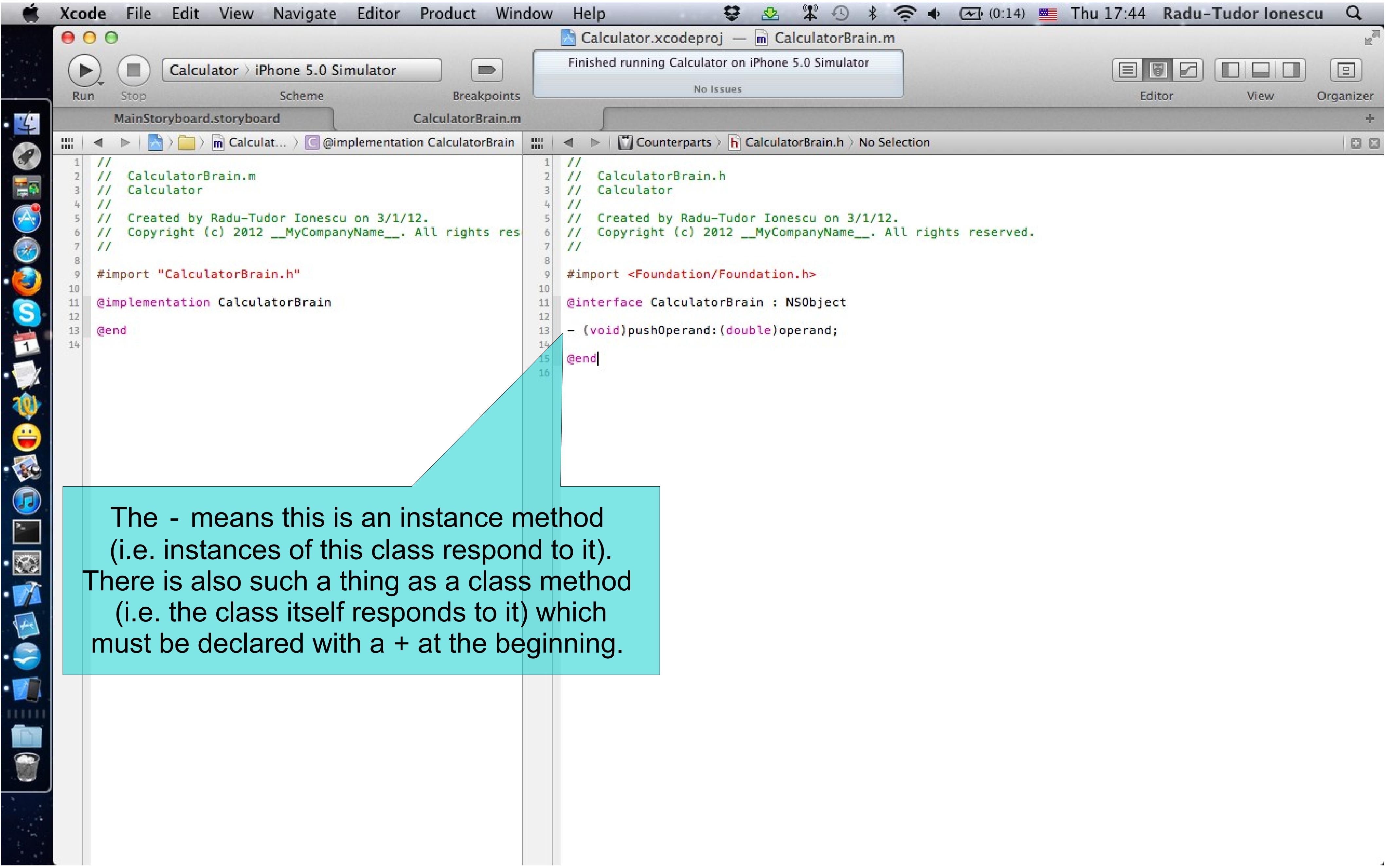
Task: Create the Model of our MVC for the calculator brain.

11. We're going to start by defining the public API of our Model. All of our public API lives in the header file (that's what makes it public). Public API are method and properties other objects (besides our Model itself) are allowed to invoke.

First add the `pushOperand:` which will provide a way to push operands onto our Calculator's stack of operands. This method must return nothing (`void`). The argument must be a double-precision floating point number called `operand`.

Notice the warning that was introduced by declaring this method. It says "Incomplete implementation". This makes sense because we have not yet implemented `pushOperand:`.

The following screenshot will show you how to declare this method.


Xcode File Edit View Navigate Editor Product Window Help
Thu 17:44 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Finished running Calculator on iPhone 5.0 Simulator
No Issues
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorBrain.m
Calculat… › @implementation CalculatorBrain
Counterparts › CalculatorBrain.h › No Selection

```
//
//  CalculatorBrain.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights res
//

#import "CalculatorBrain.h"

@implementation CalculatorBrain

@end
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;

@end
```

The - means this is an instance method (i.e. instances of this class respond to it). There is also such a thing as a class method (i.e. the class itself responds to it) which must be declared with a + at the beginning.

Task 6

Task: Create the Model of our MVC for the calculator brain.

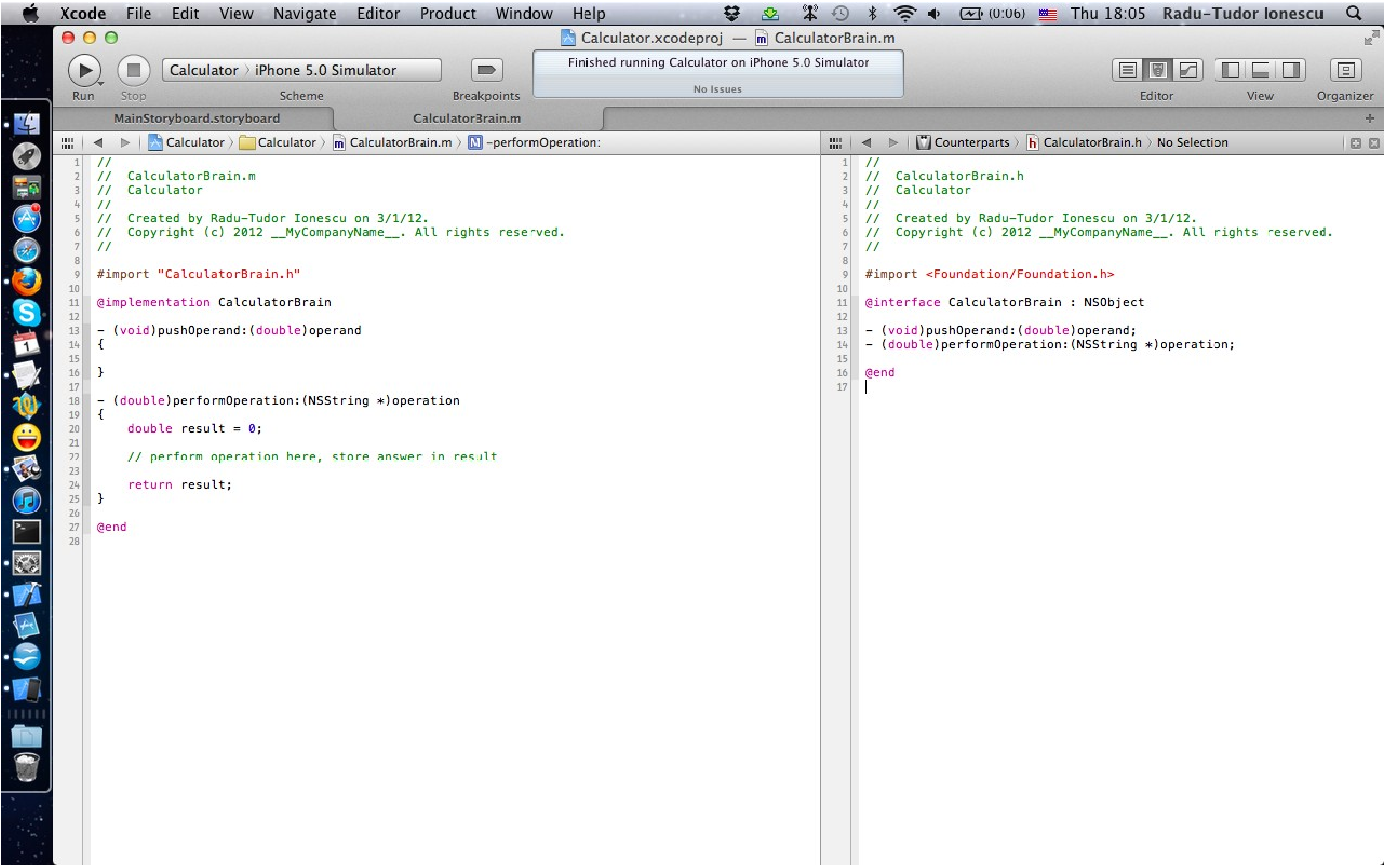
12. Now add the `performOperation:` method that performs a given operation using the operands on the stack. We are going to use a string to describe the operation (the same string that is on the operation buttons in our UI). This is pretty bad design to have strings in the UI also have meaning in your Model, but it's simple and so we'll go with it for this demo.

This method returns a `double` (the result of performing the operation). The argument to this method is a pointer to an `NSString` object called `operation`.

13. Let's stub out both of our methods in our implementation.

14. Let's have the `performOperation:` method return a default value of zero for now.

The .m and .h files of our model should like in the next screenshot.


Xcode File Edit View Navigate Editor Product Window Help
Thu 18:05 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run
Stop
Calculator 〉 iPhone 5.0 Simulator
Scheme
Breakpoints
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorBrain.m
Calculator 〉 Calculator 〉 CalculatorBrain.m 〉 -performOperation:
Counterparts 〉 CalculatorBrain.h 〉 No Selection

Finished running Calculator on iPhone 5.0 Simulator

No Issues

```
//
//  CalculatorBrain.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"

@implementation CalculatorBrain

- (void)pushOperand:(double)operand
{

}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    // perform operation here, store answer in result

    return result;
}

@end
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Task 6

Task: Create the Model of our MVC for the calculator brain.

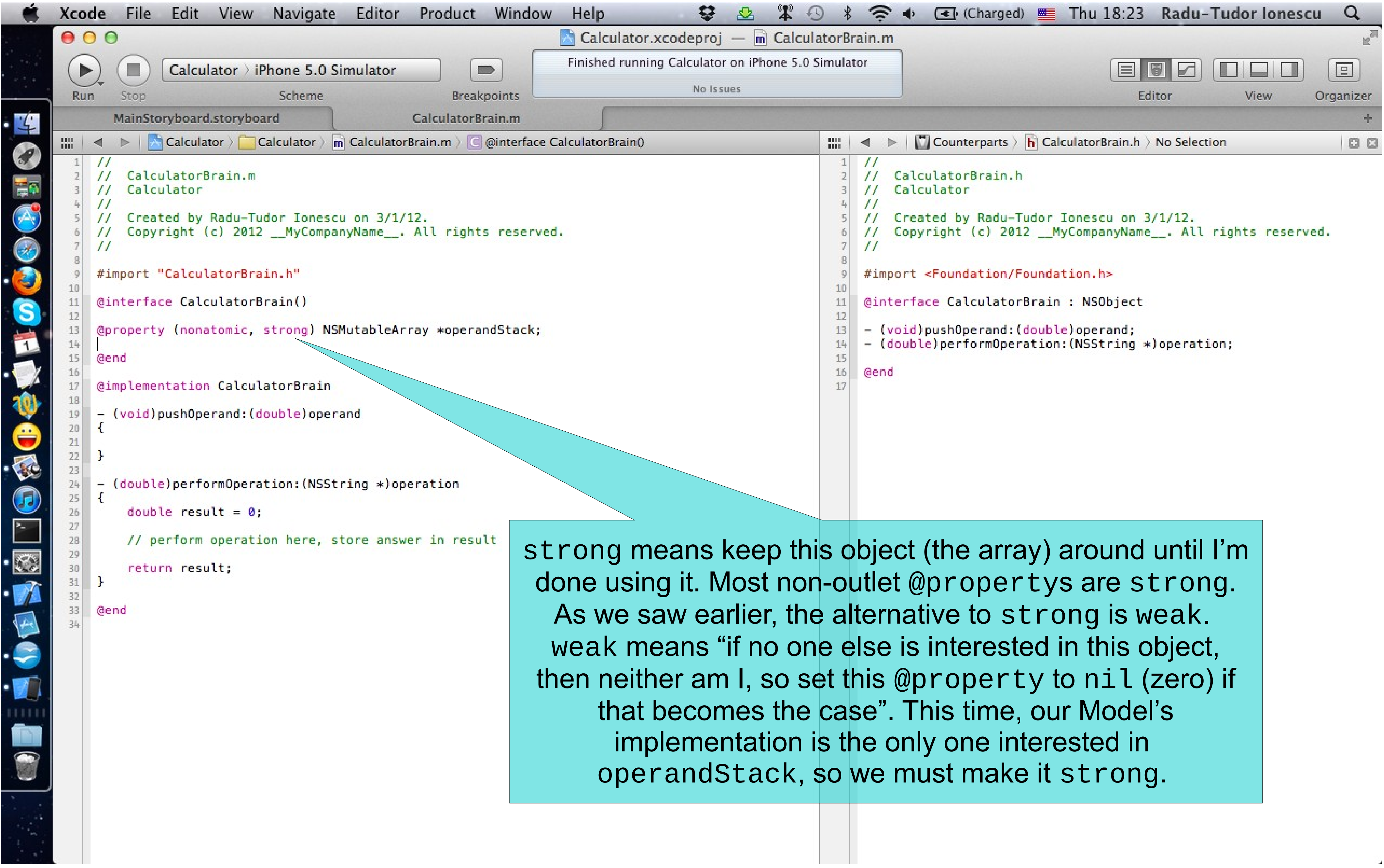
15. How are we going to store our stack of operands? We are going to use an array. “Pushing” onto our stack will just add an item to the end of the array. “Popping” will grab the last item in the array, then remove that item from the array.

Add a private `@interface` so that we can declare the array we need to store the operand stack.

16. Add a `nonatomic` and `strong` `@property` called `operandStack` of type “pointer to `NSMutableArray` object”.

We will cover much more later about arrays, strings, etc., but notice that this array’s class name is `NSMutableArray`. The base array class (`NSArray`) is not modifiable. Clearly that wouldn’t work for this class’s implementation.

Check out the next screenshot.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Thu 18:23 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run Stop Scheme Breakpoints Editor View Organizer
Calculator › iPhone 5.0 Simulator
Finished running Calculator on iPhone 5.0 Simulator
No Issues
MainStoryboard.storyboard
CalculatorBrain.m
Calculator › Calculator › CalculatorBrain.m › @interface CalculatorBrain()
Counterparts › CalculatorBrain.h › No Selection

```
//
//  CalculatorBrain.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"

@interface CalculatorBrain()

@property (nonatomic, strong) NSMutableArray *operandStack;

@end

@implementation CalculatorBrain

- (void)pushOperand:(double)operand
{

}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    // perform operation here, store answer in result

    return result;
}

@end
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

`strong` means keep this object (the array) around until I'm done using it. Most non-outlet `@propertys` are `strong`. As we saw earlier, the alternative to `strong` is `weak`. `weak` means "if no one else is interested in this object, then neither am I, so set this `@property` to `nil` (zero) if that becomes the case". This time, our Model's implementation is the only one interested in `operandStack`, so we must make it `strong`.

Task 6

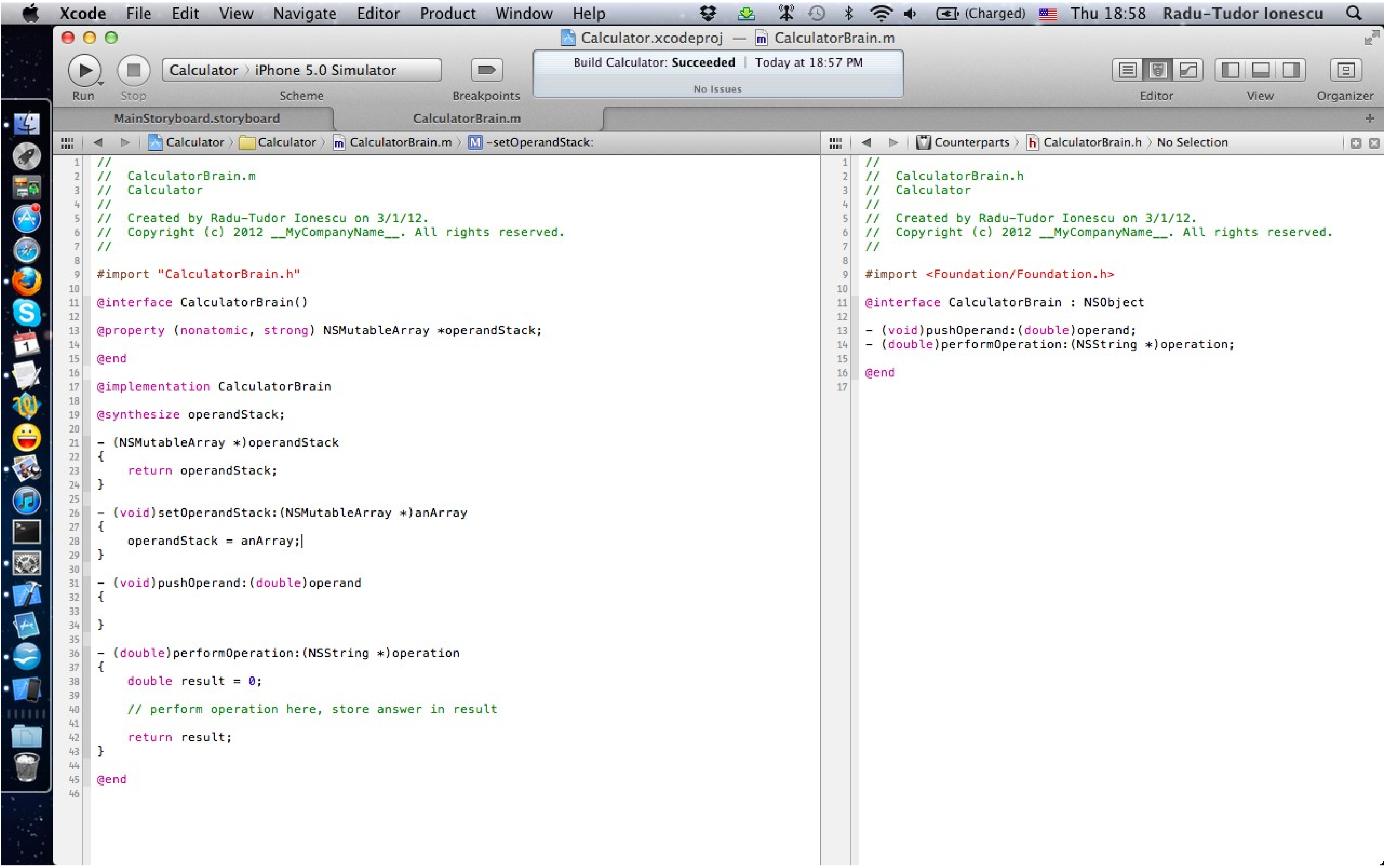
Task: Create the Model of our MVC for the calculator brain.

17. Check the warnings for the previously declared property.

As we saw last time we added a `@property`, the compiler warns us that we need to create its getter (`operandStack`) and setter (`setOperandStack:`). It’s even suggesting that we use `@synthesize` to generate the getter and the setter.

Add an `@synthesize` for the `operandStack` in the implementation.

18. And then, as an exercise, let's type in exactly what `@synthesize` would generate. Check out the next screenshot to make sure you did this right.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Thu 18:58 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Build Calculator: Succeeded | Today at 18:57 PM
No Issues
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorBrain.m
Calculator › Calculator › CalculatorBrain.m › -setOperandStack:
Counterparts › CalculatorBrain.h › No Selection

```
//
//  CalculatorBrain.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"

@interface CalculatorBrain()

@property (nonatomic, strong) NSMutableArray *operandStack;

@end

@implementation CalculatorBrain

@synthesize operandStack;

- (NSMutableArray *)operandStack
{
    return operandStack;
}

- (void)setOperandStack:(NSMutableArray *)anArray
{
    operandStack = anArray;
}

- (void)pushOperand:(double)operand
{

}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    // perform operation here, store answer in result

    return result;
}

@end
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

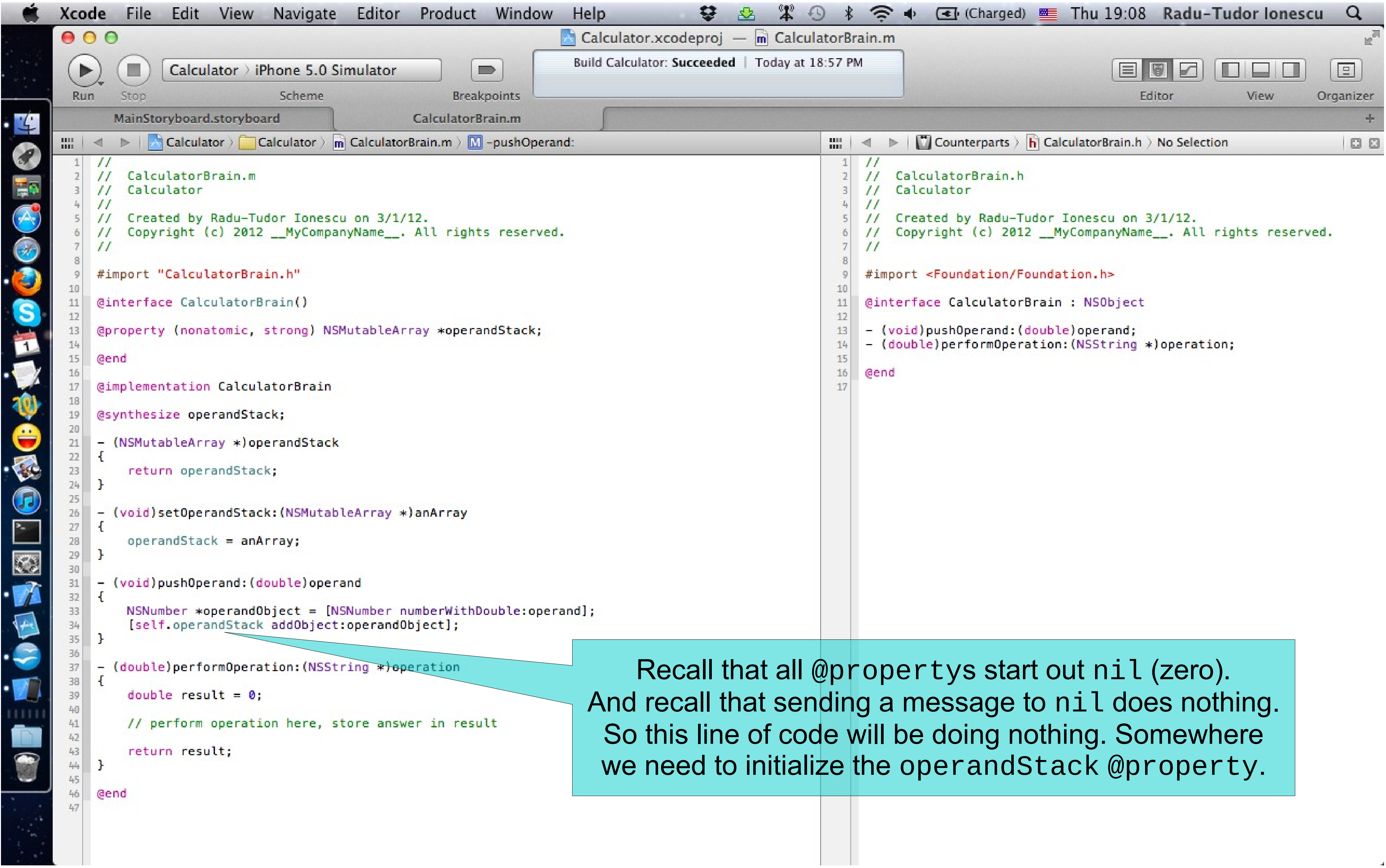
Task 6

Task: Create the Model of our MVC for the calculator brain.

19. Now that we have a stack, let's try to push an operand onto it. Note that `NSMutableArray` is an array of **objects** and a `double` is a primitive type, not an object. But there is a class called `NSNumber` which can be used to wrap primitive types into an object.

Wrap the operand with an `NSNumber` by using the `NSNumber`'s class method `numberWithDouble:` and store it into a "pointer to `NSNumber`" object called `operandObject`.

20. Then, add the `operandObject` to the stack with the `addObject:` method. Again, check out the next screenshot to make sure you did this right.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Thu 19:08 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run Stop Scheme Breakpoints
Calculator › iPhone 5.0 Simulator
Build Calculator: Succeeded | Today at 18:57 PM
Editor View Organizer
MainStoryboard.storyboard
CalculatorBrain.m
Calculator › Calculator › CalculatorBrain.m › -pushOperand:
Counterparts › CalculatorBrain.h › No Selection

```
//
//  CalculatorBrain.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"

@interface CalculatorBrain()

@property (nonatomic, strong) NSMutableArray *operandStack;

@end

@implementation CalculatorBrain

@synthesize operandStack;

- (NSMutableArray *)operandStack
{
    return operandStack;
}

- (void)setOperandStack:(NSMutableArray *)anArray
{
    operandStack = anArray;
}

- (void)pushOperand:(double)operand
{
    NSNumber *operandObject = [NSNumber numberWithDouble:operand];
    [self.operandStack addObject:operandObject];
}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    // perform operation here, store answer in result

    return result;
}

@end
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Recall that all `@propertys` start out `nil` (zero).
And recall that sending a message to `nil` does nothing.
So this line of code will be doing nothing. Somewhere
we need to initialize the `operandStack` `@property`.

Task 6

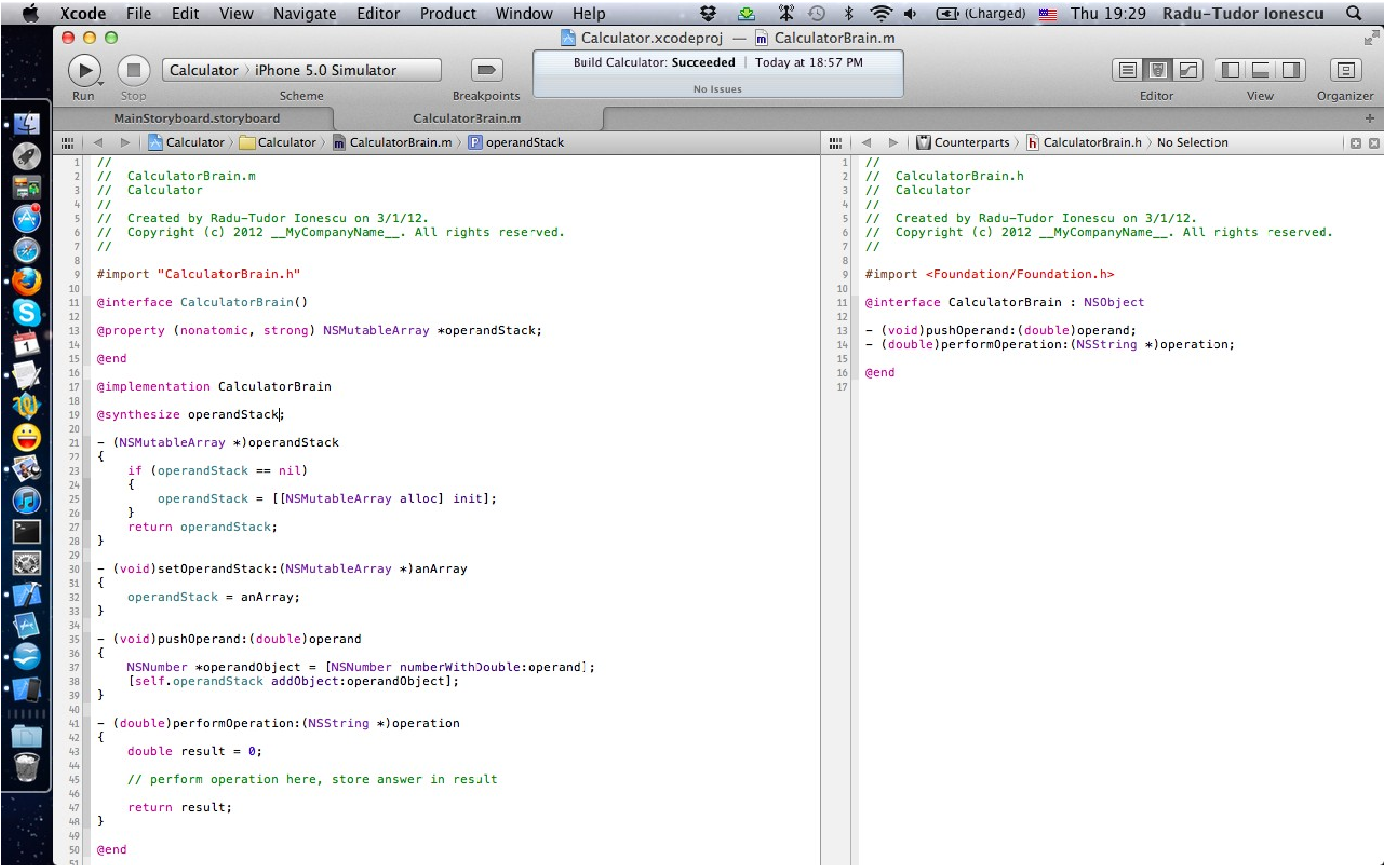
Task: Create the Model of our MVC for the calculator brain.

21. There is a perfect place to initialize `operandStack`. Its getter!

If someone tries to get `operandStack` and it is not initialized, initialize it before returning it. This sort of initialization is called “lazy instantiation” and is a common paradigm in iOS.

To create a mutable array (or any object in general) you should use the `[[NSMutableArray alloc] init]` construct. But first you must test if the operand stack is `nil`. Notice the implicit testing of a pointer (to see if it is `nil`) is `if (operandStack == nil)`. You could also say `if (!operandStack)`.

Check out the next screenshot to make sure you did everything right.



```objc
//
//  CalculatorBrain.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"

@interface CalculatorBrain()

@property (nonatomic, strong) NSMutableArray *operandStack;

@end

@implementation CalculatorBrain

@synthesize operandStack;

- (NSMutableArray *)operandStack
{
    if (operandStack == nil)
    {
        operandStack = [[NSMutableArray alloc] init];
    }
    return operandStack;
}

- (void)setOperandStack:(NSMutableArray *)anArray
{
    operandStack = anArray;
}

- (void)pushOperand:(double)operand
{
    NSNumber *operandObject = [NSNumber numberWithDouble:operand];
    [self.operandStack addObject:operandObject];
}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    // perform operation here, store answer in result

    return result;
}

@end
```

```objc
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Xcode File Edit View Navigate Editor Product Window Help
(Charged) Thu 19:29 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run Stop Scheme Breakpoints
Calculator › iPhone 5.0 Simulator
Build Calculator: Succeeded | Today at 18:57 PM
No Issues
Editor View Organizer
MainStoryboard.storyboard
CalculatorBrain.m
Calculator › Calculator › CalculatorBrain.m › operandStack
Counterparts › CalculatorBrain.h › No Selection

Task 6

Task: Create the Model of our MVC for the calculator brain.

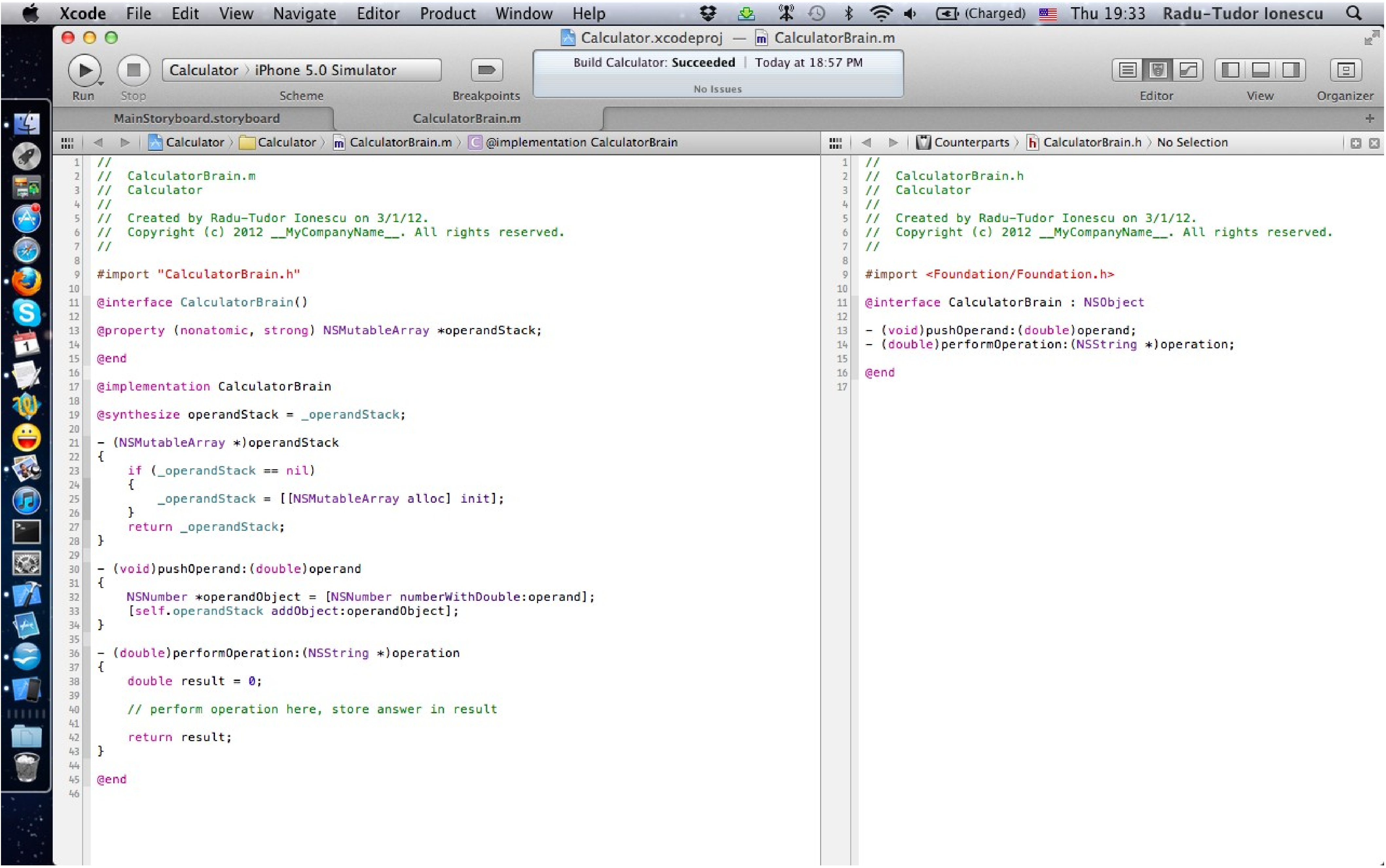
22. Recall the fact that `@synthesize` creates an instance variable with the same name as the property is dangerous. We can avoid this potential accident by having `@synthesize` use a different name for its instance variable than the name of the property.

Prefix the instance variable with an underscore (`_operandStack`).

23. Only setters and getters should access the instance variable directly. Fix the setter and getter to access the instance variable by its new name, `_operandStack`.

24. We are not going to do anything with the setter, so you can delete it. Remember that `@synthesize` will always create whichever setter and/or getter that you do not.

Check out the next screenshot to make sure you did everything right.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Thu 19:33 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run Stop Scheme Breakpoints
Calculator › iPhone 5.0 Simulator
Build Calculator: Succeeded | Today at 18:57 PM
No Issues
Editor View Organizer
MainStoryboard.storyboard
CalculatorBrain.m
Calculator › Calculator › CalculatorBrain.m › @implementation CalculatorBrain
Counterparts › CalculatorBrain.h › No Selection

```
//
//  CalculatorBrain.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"

@interface CalculatorBrain()

@property (nonatomic, strong) NSMutableArray *operandStack;

@end

@implementation CalculatorBrain

@synthesize operandStack = _operandStack;

- (NSMutableArray *)operandStack
{
    if (_operandStack == nil)
    {
        _operandStack = [[NSMutableArray alloc] init];
    }
    return _operandStack;
}

- (void)pushOperand:(double)operand
{
    NSNumber *operandObject = [NSNumber numberWithDouble:operand];
    [self.operandStack addObject:operandObject];
}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    // perform operation here, store answer in result

    return result;
}

@end
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

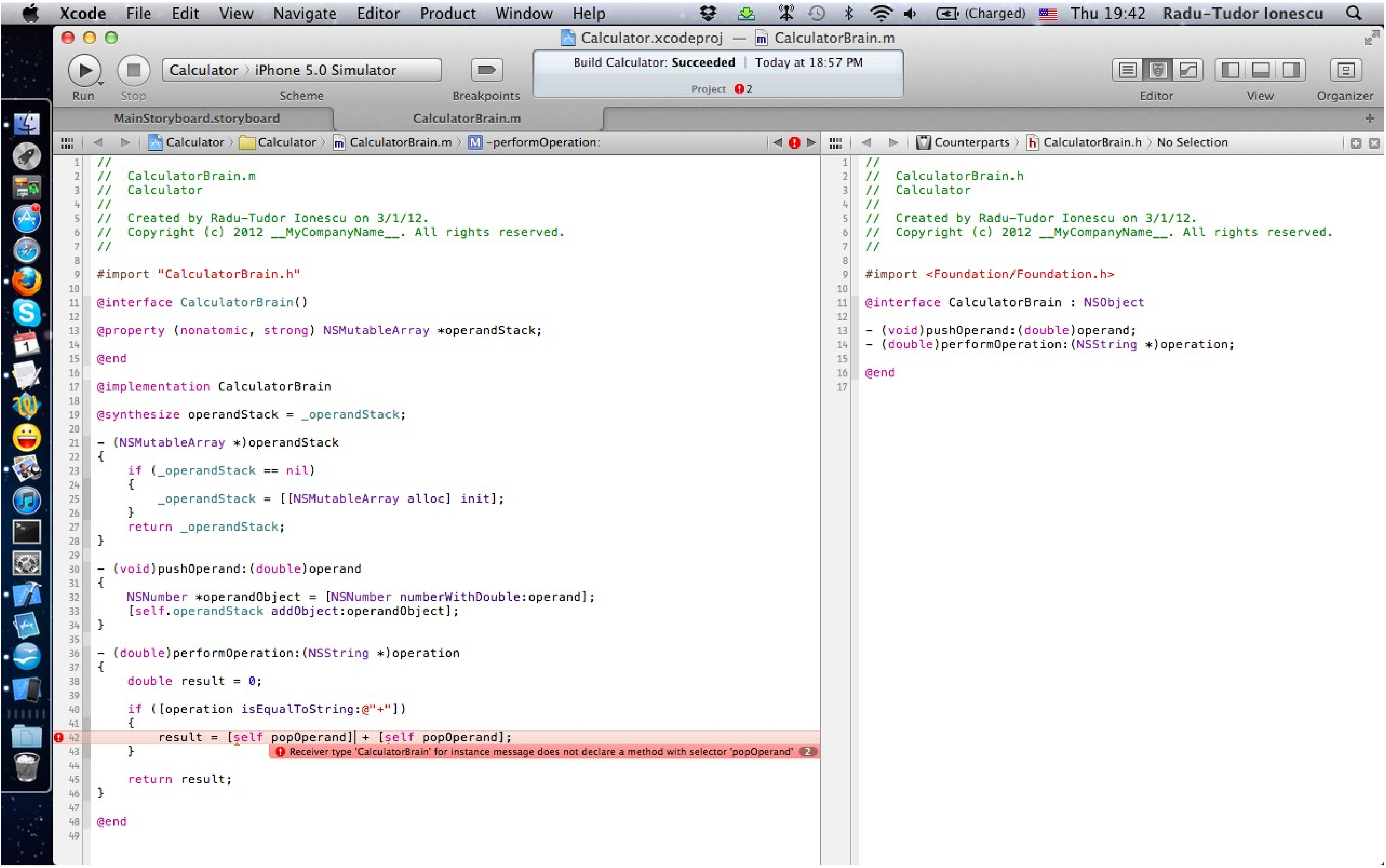
Task 6

Task: Create the Model of our MVC for the calculator brain.

25. It is time to implement the `performOperation:` method. Let's start by implementing the + operation.

First, we should verify that the operation is `@”+”` with the `isEqualToString:` method. Then we must pop two operands and add them into the `result`. Let's write this.

Check out the next screenshot to make sure you did everything right.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Thu 19:42 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Build Calculator: Succeeded | Today at 18:57 PM
Project 2
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorBrain.m
Calculator › Calculator › CalculatorBrain.m › -performOperation:
Counterparts › CalculatorBrain.h › No Selection

```objc
//
//  CalculatorBrain.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"

@interface CalculatorBrain()

@property (nonatomic, strong) NSMutableArray *operandStack;

@end

@implementation CalculatorBrain

@synthesize operandStack = _operandStack;

- (NSMutableArray *)operandStack
{
    if (_operandStack == nil)
    {
        _operandStack = [[NSMutableArray alloc] init];
    }
    return _operandStack;
}

- (void)pushOperand:(double)operand
{
    NSNumber *operandObject = [NSNumber numberWithDouble:operand];
    [self.operandStack addObject:operandObject];
}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    if ([operation isEqualToString:@"+"])
    {
        result = [self popOperand] + [self popOperand];
    }

    return result;
}

@end
```

Receiver type 'CalculatorBrain' for instance message does not declare a method with selector 'popOperand' 2

```objc
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Task 6

Task: Create the Model of our MVC for the calculator brain.

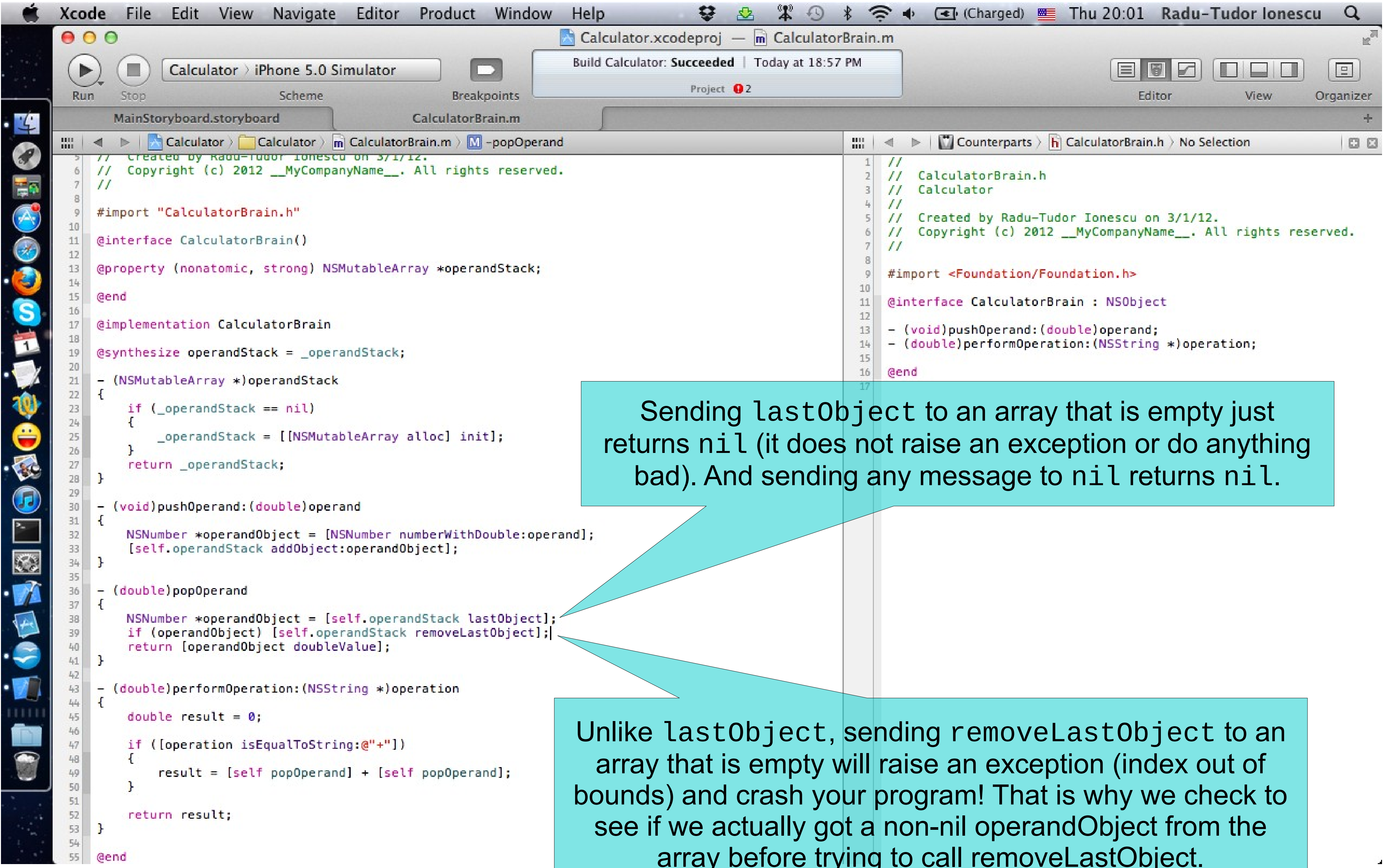
26. Notice the error that tell us that popOperand is not implemented.

Implement popOperand method by getting the lastObject in our operandStack array, then returning that last object's doubleValue.

Note that lastObject is a method that NSMutableArray inherits from NSArray which returns the last object in the array. All the objects in our operandStack array are NSNumbers and NSNumber responds to the method doubleValue (which returns a double).

27. We got the value off the end of the array, but we also need to "pop" it off by removing it. We have to send the removeLastObject message to the operandStack, but not before testing if the lastObject is not nil.

The next slide shows you a screenshot with the popOperand method implementation.


Xcode File Edit View Navigate Editor Product Window Help
Calculator.xcodeproj — CalculatorBrain.m
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Build Calculator: Succeeded | Today at 18:57 PM
Project 2
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorBrain.m
Calculator › Calculator › CalculatorBrain.m › -popOperand
Counterparts › CalculatorBrain.h › No Selection

```objc
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"

@interface CalculatorBrain()

@property (nonatomic, strong) NSMutableArray *operandStack;

@end

@implementation CalculatorBrain

@synthesize operandStack = _operandStack;

- (NSMutableArray *)operandStack
{
    if (_operandStack == nil)
    {
        _operandStack = [[NSMutableArray alloc] init];
    }
    return _operandStack;
}

- (void)pushOperand:(double)operand
{
    NSNumber *operandObject = [NSNumber numberWithDouble:operand];
    [self.operandStack addObject:operandObject];
}

- (double)popOperand
{
    NSNumber *operandObject = [self.operandStack lastObject];
    if (operandObject) [self.operandStack removeLastObject];
    return [operandObject doubleValue];
}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    if ([operation isEqualToString:@"+"])
    {
        result = [self popOperand] + [self popOperand];
    }

    return result;
}

@end
```

```objc
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Sending `lastObject` to an array that is empty just returns `nil` (it does not raise an exception or do anything bad). And sending any message to `nil` returns `nil`.

Unlike `lastObject`, sending `removeLastObject` to an array that is empty will raise an exception (index out of bounds) and crash your program! That is why we check to see if we actually got a non-nil operandObject from the array before trying to call removeLastObject.

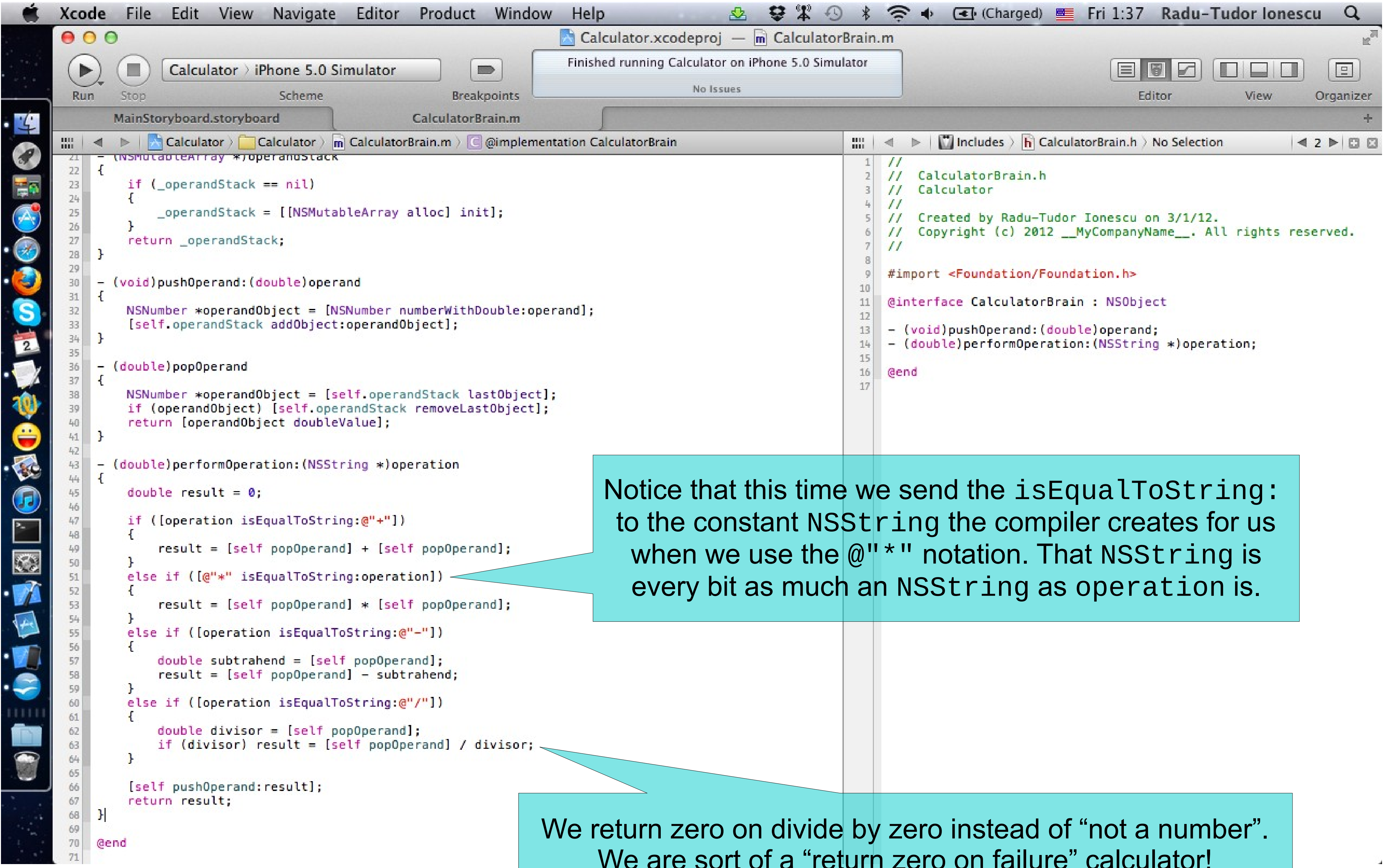
Task 6

Task: Create the Model of our MVC for the calculator brain.

28. Implement the *, -, and / operantions. Make sure to get the order of operands correct for the - and / operations! For example, the input “6 Enter 2 -” should be 4, not -4.

29. Finally, we must be sure to push the `result` back onto the stack so that the next operation we are asked to do will use it.

The screenshot from the next slide shows the final implementation of our CalculatorBrain Model.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Fri 1:37 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorBrain.m
Run Stop Scheme Breakpoints Editor View Organizer
Calculator › iPhone 5.0 Simulator
MainStoryboard.storyboard
CalculatorBrain.m
Calculator › Calculator › CalculatorBrain.m › @implementation CalculatorBrain
Includes › CalculatorBrain.h › No Selection

Finished running Calculator on iPhone 5.0 Simulator

No Issues

```objc
- (NSMutableArray *)operandStack
{
    if (_operandStack == nil)
    {
        _operandStack = [[NSMutableArray alloc] init];
    }
    return _operandStack;
}

- (void)pushOperand:(double)operand
{
    NSNumber *operandObject = [NSNumber numberWithDouble:operand];
    [self.operandStack addObject:operandObject];
}

- (double)popOperand
{
    NSNumber *operandObject = [self.operandStack lastObject];
    if (operandObject) [self.operandStack removeLastObject];
    return [operandObject doubleValue];
}

- (double)performOperation:(NSString *)operation
{
    double result = 0;

    if ([operation isEqualToString:@"+"])
    {
        result = [self popOperand] + [self popOperand];
    }
    else if ([@"*" isEqualToString:operation])
    {
        result = [self popOperand] * [self popOperand];
    }
    else if ([operation isEqualToString:@"-"])
    {
        double subtrahend = [self popOperand];
        result = [self popOperand] - subtrahend;
    }
    else if ([operation isEqualToString:@"/"])
    {
        double divisor = [self popOperand];
        if (divisor) result = [self popOperand] / divisor;
    }

    [self pushOperand:result];
    return result;
}

@end
```

```objc
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Notice that this time we send the `isEqualToString:` to the constant `NSString` the compiler creates for us when we use the `@"*"` notation. That `NSString` is every bit as much an `NSString` as `operation` is.

We return zero on divide by zero instead of “not a number”. We are sort of a “return zero on failure” calculator!

Task 7

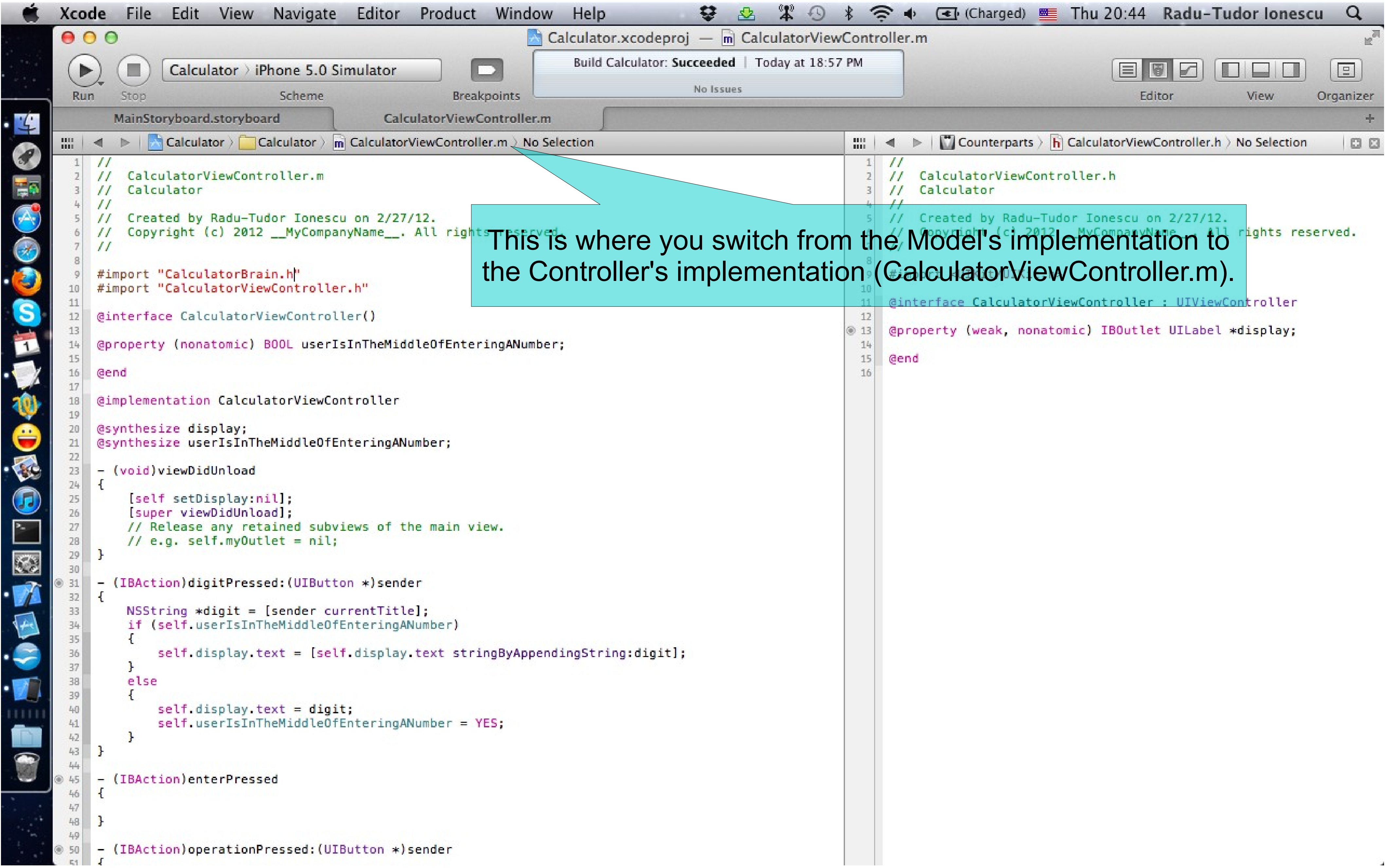
Task: Finish the Controller implementation by connecting it to the Model.

1. Switch back to our Controller to finish it off. Click on the name of the file in the top bar and use it to navigate to your Controller’s implementation (CalculatorViewController.m).

2. Your Controller’s implementation (.m) file should appear on the left. Note that the Automatic Assistant switched the right-hand side to our Controller’s header file (instead of our Model’s). But actually, we want our Model’s header file on the right because we are going to use it in our Controller. But to have our Model’s header file on the right-side in Automatic mode, we need to create the relationship between our Controller and the Model in our code. We do that by `#import`ing our Model into our Controller’s implementation.

`#import` the Model’s header file into our Controller’s implementation. Make sure you save the implementation at this moment.

The screenshot from the next slide shows the project configuration at this moment.


Xcode File Edit View Navigate Editor Product Window Help
Calculator.xcodeproj — CalculatorViewController.m
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Build Calculator: Succeeded | Today at 18:57 PM
No Issues
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorViewController.m
Calculator › Calculator › CalculatorViewController.m › No Selection
Counterparts › CalculatorViewController.h › No Selection

This is where you switch from the Model's implementation to the Controller's implementation (CalculatorViewController.m).

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved
//

#import "CalculatorBrain.h"
#import "CalculatorViewController.h"

@interface CalculatorViewController()

@property (nonatomic) BOOL userIsInTheMiddleOfEnteringANumber;

@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)enterPressed
{

}

- (IBAction)operationPressed:(UIButton *)sender
{
```

```
//
//  CalculatorViewController.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <UIKit/UIKit.h>

@interface CalculatorViewController : UIViewController

@property (weak, nonatomic) IBOutlet UILabel *display;

@end
```

Task 7

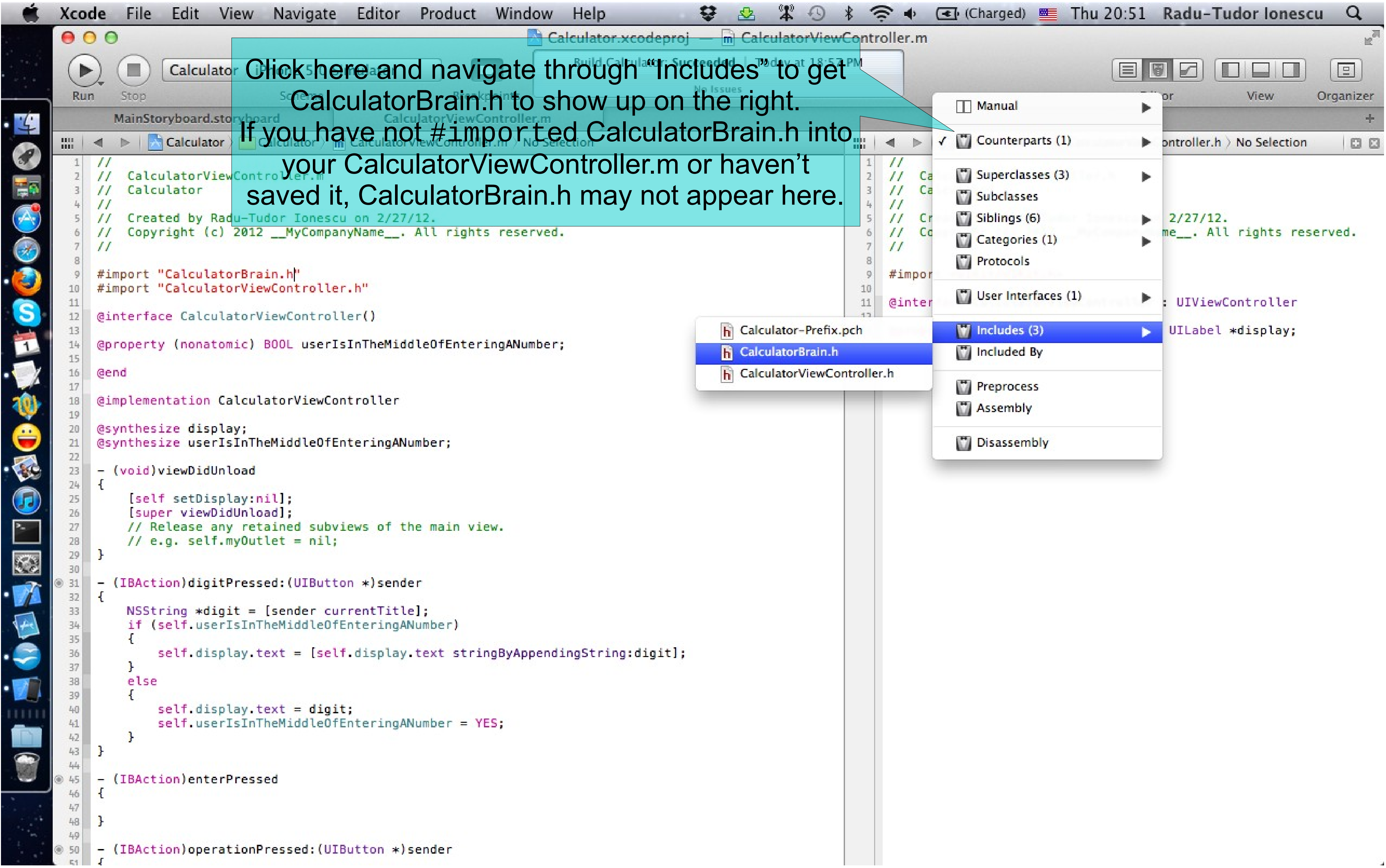
Task: Finish the Controller implementation by connecting it to the Model.

3. Put the CalculatorBrain header file on the right in Assistant Editor. Check the next slide to understand how to do this.

Your Model’s header file should appear on the right. It is common to put the header file (public API) of a class on the right-hand side of the screen as you are working in your implementation on the left.

4. All we need to do next is to add a private `@property` in our Controller that points to our Model. And then use an instance of our Model to implement `operationPressed:` and `enterPressed`.

Add a `@property` (called `brain`) to hold a pointer from our Controller to our Model.



Click here and navigate through "Includes" to get CalculatorBrain.h to show up on the right.
If you have not `#imported` CalculatorBrain.h into your CalculatorViewController.m or haven't saved it, CalculatorBrain.h may not appear here.

```
//
//  CalculatorViewController.m
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 2/27/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import "CalculatorBrain.h"
#import "CalculatorViewController.h"

@interface CalculatorViewController()

@property (nonatomic) BOOL userIsInTheMiddleOfEnteringANumber;

@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)enterPressed
{

}

- (IBAction)operationPressed:(UIButton *)sender
{
```

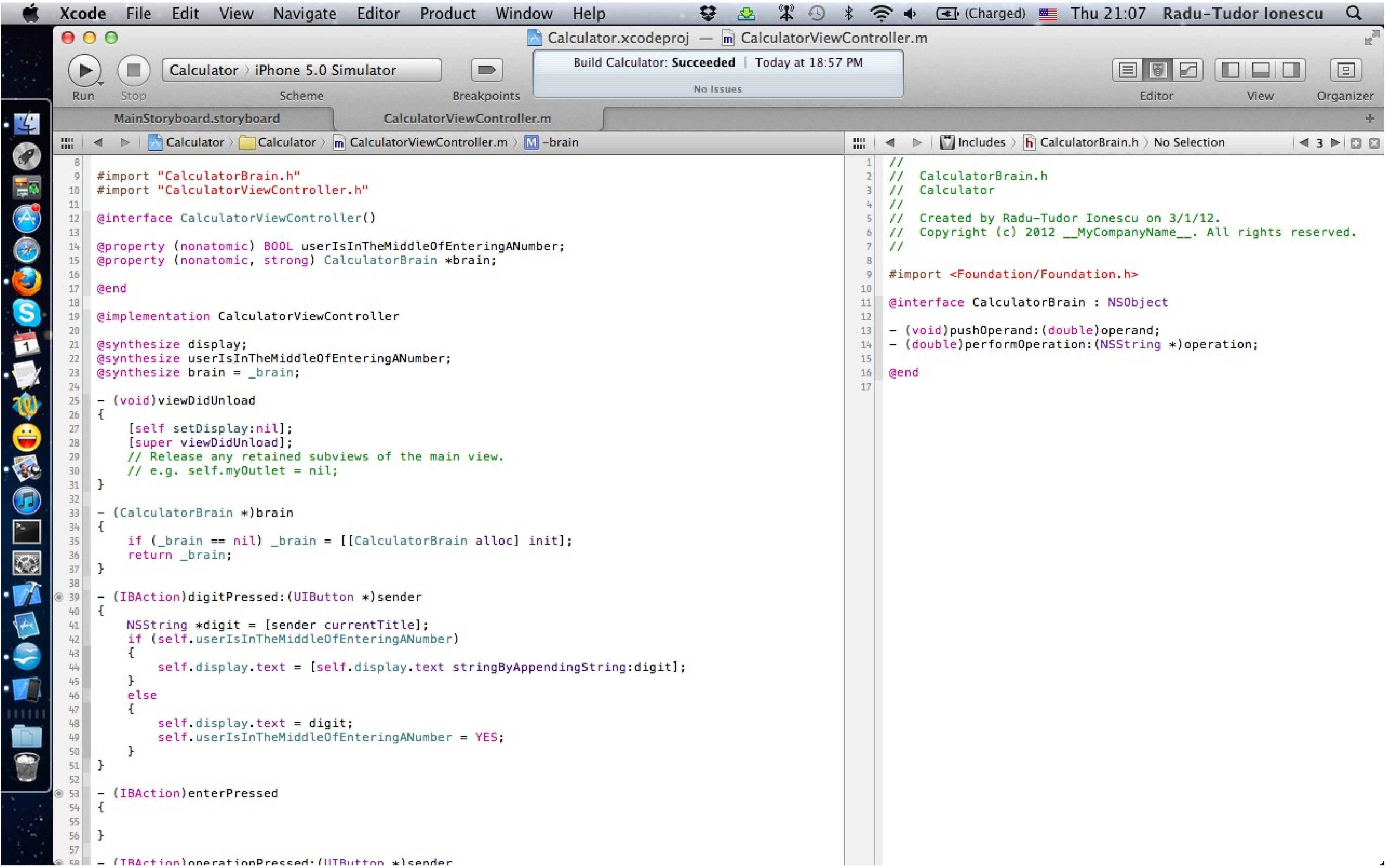
Task 7

Task: Finish the Controller implementation by connecting it to the Model.

5. Add a `@synthesize` to create the brain setter & getter. Again, we will use the most common naming convention for the corresponding instance variable (underscore plus property name).

6. We need to implement the getter of the `brain` `@property` in order to lazily instantiate the `brain` (in its getter method).

See how to set things up in the next screenshot.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Thu 21:07 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorViewController.m
Run
Stop
Calculator › iPhone 5.0 Simulator
Scheme
Breakpoints
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorViewController.m
Calculator › Calculator › CalculatorViewController.m › -brain
Includes › CalculatorBrain.h › No Selection
3

Build Calculator: **Succeeded** | Today at 18:57 PM

No Issues

```
#import "CalculatorBrain.h"
#import "CalculatorViewController.h"

@interface CalculatorViewController()

@property (nonatomic) BOOL userIsInTheMiddleOfEnteringANumber;
@property (nonatomic, strong) CalculatorBrain *brain;

@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;
@synthesize brain = _brain;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (CalculatorBrain *)brain
{
    if (_brain == nil) _brain = [[CalculatorBrain alloc] init];
    return _brain;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)enterPressed
{

}

- (IBAction)operationPressed:(UIButton *)sender
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Task 7

Task: Finish the Controller implementation by connecting it to the Model.

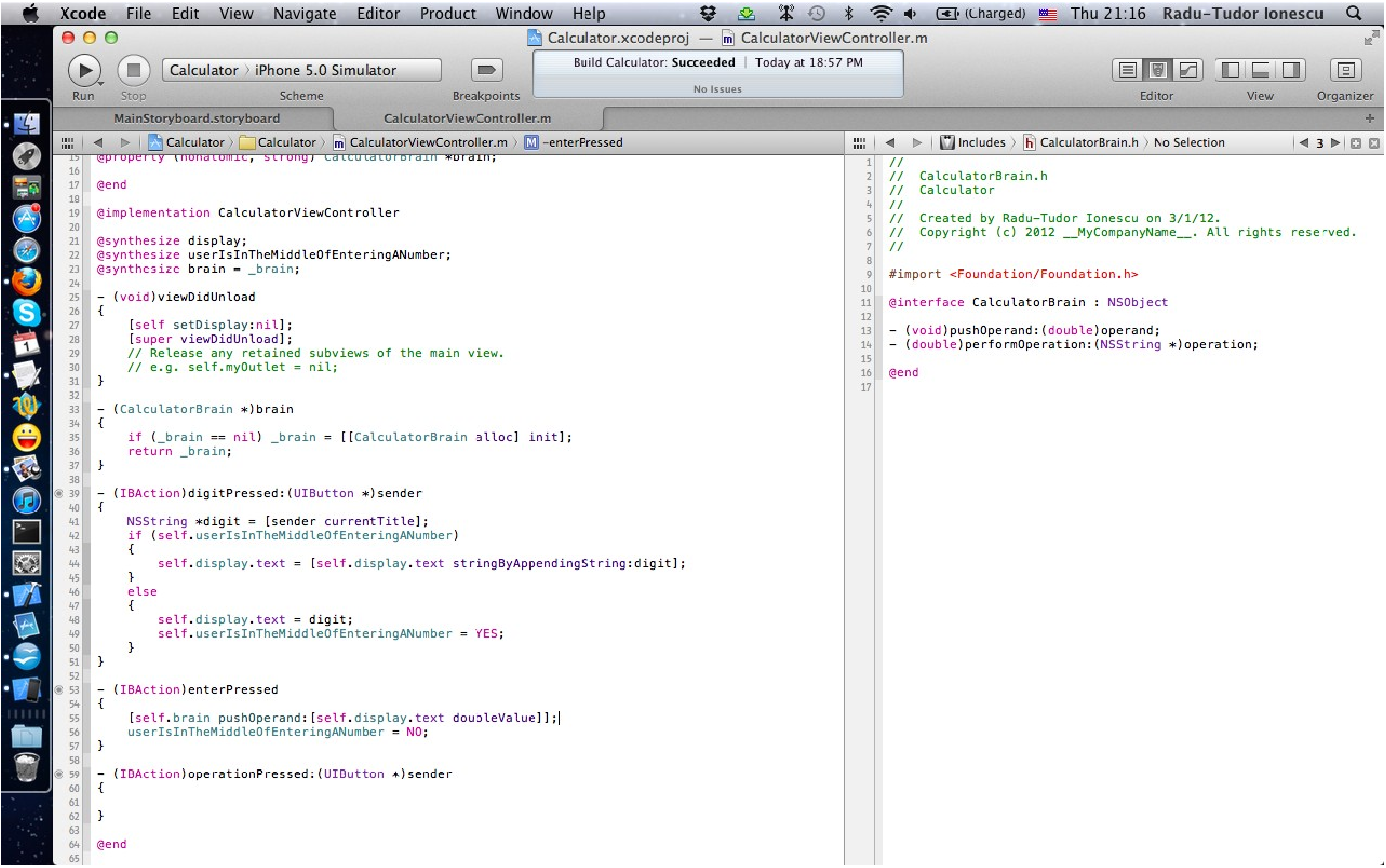
7. Next let's handle the Enter button being touched. All we need to do is push the double value of the `display` into our Model (`self.brain`).

Note that `NSString` responds to `doubleValue` as well. It tries to parse a double out of whatever is in the string. Luckily, there is no way to put anything but a number into our Calculator’s `display`.

8. Of course, touching Enter means we are no longer in the middle of typing a number.

We need to set `userIsInTheMiddleOfEnteringANumber` to `NO`.

See how to set things up in the next screenshot.


Xcode File Edit View Navigate Editor Product Window Help
(Charged) Thu 21:16 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorViewController.m
Run
Stop
Calculator 〉 iPhone 5.0 Simulator
Scheme
Breakpoints
Build Calculator: Succeeded | Today at 18:57 PM
No Issues
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorViewController.m
Calculator 〉 Calculator 〉 CalculatorViewController.m 〉 -enterPressed
Includes 〉 CalculatorBrain.h 〉 No Selection
3

```objc
@property (nonatomic, strong) CalculatorBrain *brain;

@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;
@synthesize brain = _brain;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (CalculatorBrain *)brain
{
    if (_brain == nil) _brain = [[CalculatorBrain alloc] init];
    return _brain;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)enterPressed
{
    [self.brain pushOperand:[self.display.text doubleValue]];
    userIsInTheMiddleOfEnteringANumber = NO;
}

- (IBAction)operationPressed:(UIButton *)sender
{

}

@end
```

```objc
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Task 7

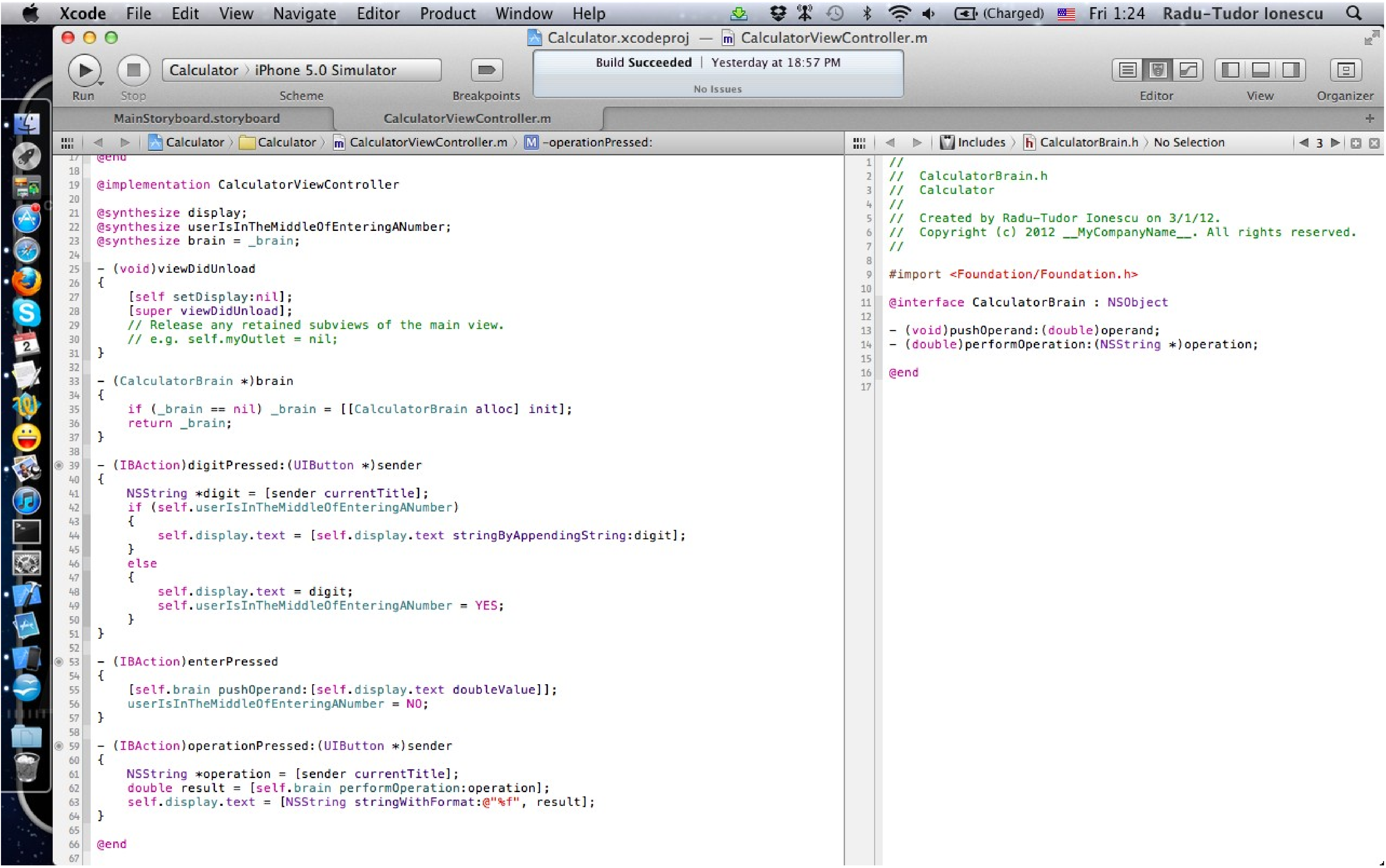
Task: Finish the Controller implementation by connecting it to the Model.

9. To implement `operationPressed:` we have to look at the button that sent us the action to determine which operation to perform. As for digits, we look at the `sender`'s `currentTitle`.

10 .Then we just perform the operation using our Model and store the `result` in local variable of `double` type.

11. We also need to update the `display` with the `result` of the operation. We can use the `NSString`'s `stringWithFormat:` class method to convert the `double` `result` into a string object.

See how to implement the `operationPressed:` method on the next slide.



Xcode File Edit View Navigate Editor Product Window Help
(Charged) Fri 1:24 Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorViewController.m
Run Stop Scheme Breakpoints
Calculator › iPhone 5.0 Simulator
Build Succeeded | Yesterday at 18:57 PM
No Issues
Editor View Organizer
MainStoryboard.storyboard
CalculatorViewController.m
Calculator › Calculator › CalculatorViewController.m › -operationPressed:
Includes › CalculatorBrain.h › No Selection
3

```
@end

@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;
@synthesize brain = _brain;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (CalculatorBrain *)brain
{
    if (_brain == nil) _brain = [[CalculatorBrain alloc] init];
    return _brain;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)enterPressed
{
    [self.brain pushOperand:[self.display.text doubleValue]];
    userIsInTheMiddleOfEnteringANumber = NO;
}

- (IBAction)operationPressed:(UIButton *)sender
{
    NSString *operation = [sender currentTitle];
    double result = [self.brain performOperation:operation];
    self.display.text = [NSString stringWithFormat:@"%f", result];
}

@end
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Task 7

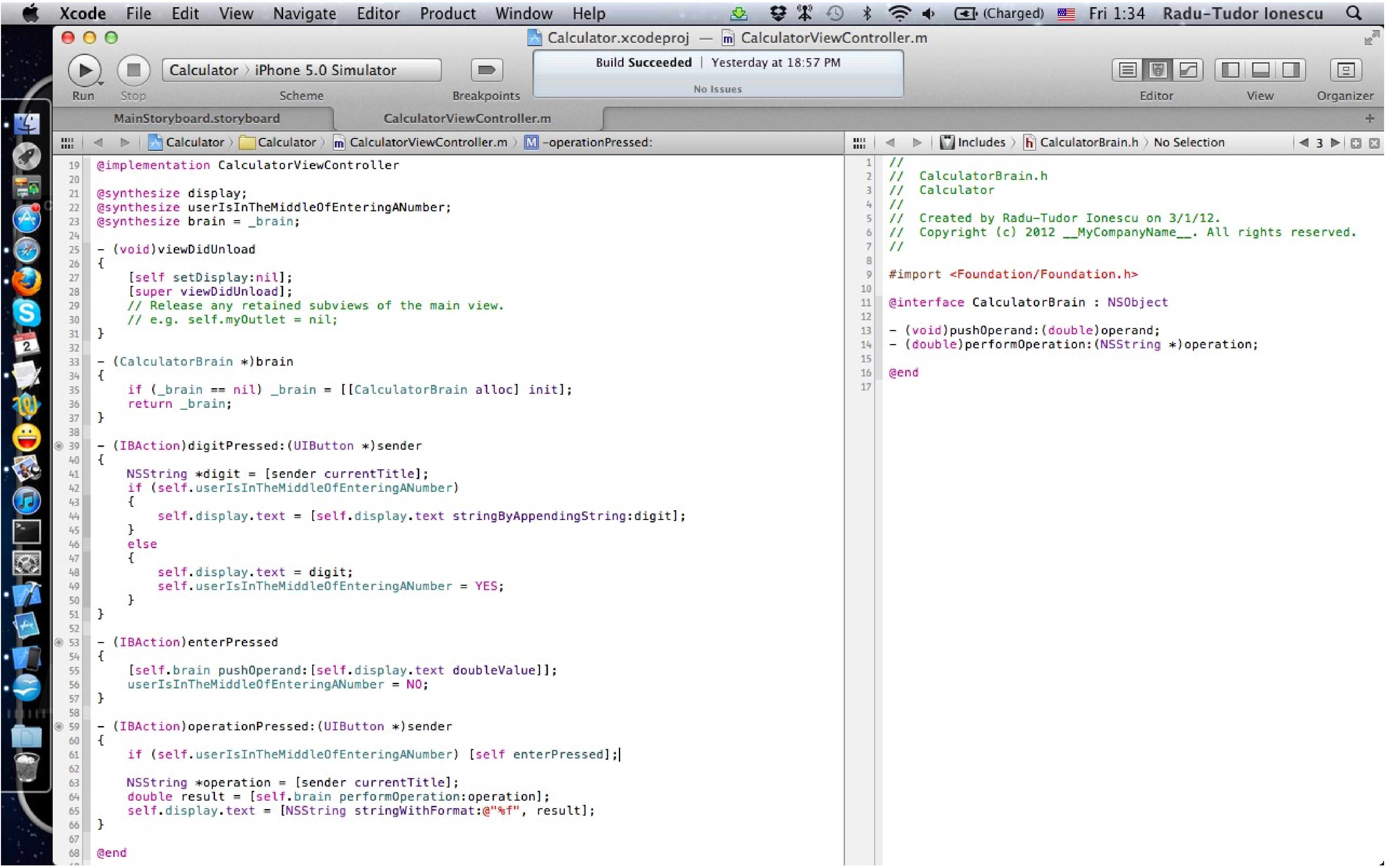
Task: Finish the Controller implementation by connecting it to the Model.

12. By the way, when an operation is pressed and the user is in the middle of typing a number, let's do an implicit Enter. For example, 6 Enter 4 - would be the same as 6 Enter 4 Enter -.

The screenshot from the next slide shows the final implementation of the `operationPressed:` method.

13. All done! Hit Run again. Touch 360 Enter 9 /. The result should be 40.

14. Then touch 77 +. The result should be 360 / 9 + 77 = 117.



Xcode
File
Edit
View
Navigate
Editor
Product
Window
Help
(Charged)
Fri 1:34
Radu-Tudor Ionescu
Calculator.xcodeproj — CalculatorViewController.m
Run
Stop
Calculator 〉 iPhone 5.0 Simulator
Scheme
Breakpoints
Build Succeeded | Yesterday at 18:57 PM
No Issues
Editor
View
Organizer
MainStoryboard.storyboard
CalculatorViewController.m
Calculator 〉 Calculator 〉 CalculatorViewController.m 〉 -operationPressed:
Includes 〉 CalculatorBrain.h 〉 No Selection
3

```
@implementation CalculatorViewController

@synthesize display;
@synthesize userIsInTheMiddleOfEnteringANumber;
@synthesize brain = _brain;

- (void)viewDidUnload
{
    [self setDisplay:nil];
    [super viewDidUnload];
    // Release any retained subviews of the main view.
    // e.g. self.myOutlet = nil;
}

- (CalculatorBrain *)brain
{
    if (_brain == nil) _brain = [[CalculatorBrain alloc] init];
    return _brain;
}

- (IBAction)digitPressed:(UIButton *)sender
{
    NSString *digit = [sender currentTitle];
    if (self.userIsInTheMiddleOfEnteringANumber)
    {
        self.display.text = [self.display.text stringByAppendingString:digit];
    }
    else
    {
        self.display.text = digit;
        self.userIsInTheMiddleOfEnteringANumber = YES;
    }
}

- (IBAction)enterPressed
{
    [self.brain pushOperand:[self.display.text doubleValue]];
    userIsInTheMiddleOfEnteringANumber = NO;
}

- (IBAction)operationPressed:(UIButton *)sender
{
    if (self.userIsInTheMiddleOfEnteringANumber) [self enterPressed];

    NSString *operation = [sender currentTitle];
    double result = [self.brain performOperation:operation];
    self.display.text = [NSString stringWithFormat:@"%f", result];
}

@end
```

```
//
//  CalculatorBrain.h
//  Calculator
//
//  Created by Radu-Tudor Ionescu on 3/1/12.
//  Copyright (c) 2012 __MyCompanyName__. All rights reserved.
//

#import <Foundation/Foundation.h>

@interface CalculatorBrain : NSObject

- (void)pushOperand:(double)operand;
- (double)performOperation:(NSString *)operation;

@end
```

Assignment 1

Assignment: Your calculator already works with floating point numbers (e.g. if you touch the buttons 3 Enter 4 / it will properly show the resulting value of 0.75), however, there is no way for the user to enter a floating point number. Remedy this. Allow only legal floating point numbers to be entered (e.g. “192.168.0.1” is not a legal floating point number).

Hint: Add another button for “.” and the action `pointPressed`. There’s an `NSString` method which you might find quite useful. It’s called `rangeOfString:`. Check it out in the documentation. It returns an `NSRange` which is just a normal C struct which you can access using normal C dot notation. For example, consider the following code:

```
NSString *greeting = @"Hello There Joe, how are ya?";

NSRange range = [greeting rangeOfString:@"Bob"];

if (range.location == NSNotFound) { ... /* no Bob */ }
```

Be careful of the case where the user starts off entering a new number by pressing the decimal point, e.g., they want to enter the number “.5” into their calculator. Handle this case properly.

Assignment 2

Assignment: Add a “C” button that clears everything (for example, the display in your View, the operand stack in your Model, any state you maintain in your Controller, etc.). Make sure 3 7 C 5 results in 5 showing in the display.

Hint: Add another button for “C” and the action `clearPressed`. You will have to add API to your Model to support this feature. To be more precise you will have to declare and implement another method in CalculatorBrain to `emptyOperandStack`. Note that you can remove all objects from an `NSMutableArray` by calling a single method. Look into the `NSMutableArray` documentation for this.

Congratulations!