# 387: Swift Introduction

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# Introduction

# About Me

- Dr Daniel Goldsmith
- Lecturer in Ethical Hacking and Cyber Security.
- Linux User!

# About Me 2

- Background is Pervasive Computing
    - Security of Wireless Sensor Networks
    - Reverse engineering
    - Radio’s

## Lectures:

- I Don’t Like Lectures!
    - Standing up and talking for hours is boring :(
    - Also Programming is Practical.
- So we have a mix of practical and Talking

# Swift Language

# The Swift Language

- Developed in 2010 by Chris Lattner
- Improves Objective-C
- Swift 3.0 in 2016

# More About Swift

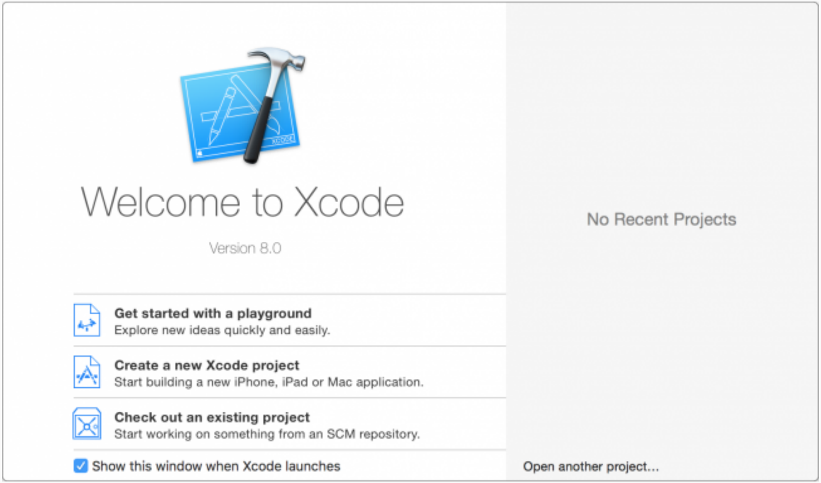
Swift is a new programming language for iOS, macOS, watchOS, and tvOS apps that builds on the best of C and Objective-C, without the constraints of C compatibility.

# Swift and X-Code

- Two Independent things:
    - X-Code is the IDE
    - Swift is the Language.

# Lets Get Started:

- Start X-Code
- Create a new Playground



Welcome to Xcode

Version 8.0

**Get started with a playground**
Explore new ideas quickly and easily.

**Create a new Xcode project**
Start building a new iPhone, iPad or Mac application.

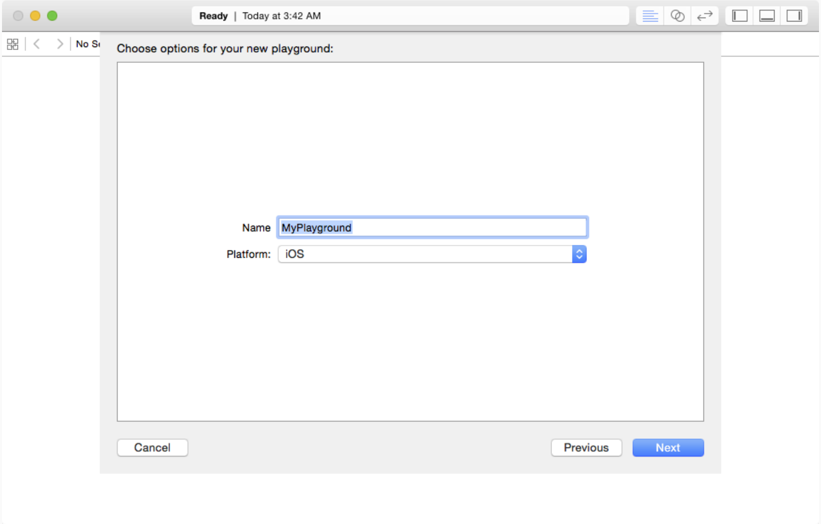
**Check out an existing project**
Start working on something from an SCM repository.

☑ Show this window when Xcode launches

No Recent Projects

Open another project...

# Playground Options

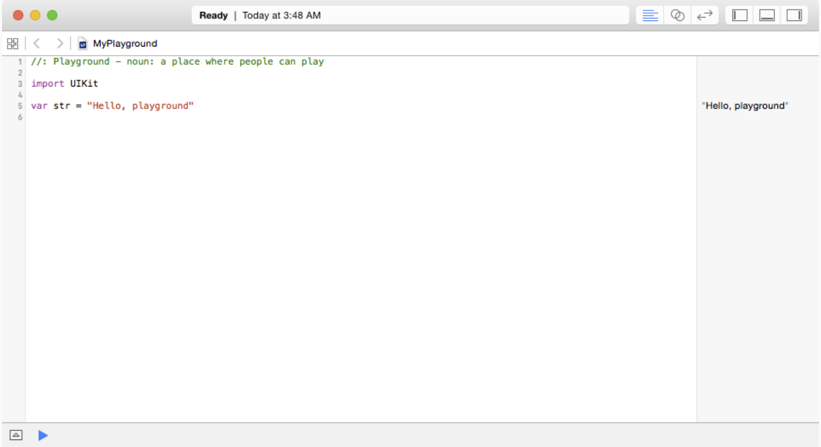


Choose options for your new playground:

Name: MyPlayground

Platform: iOS

# Initial Code



```
//: Playground - noun: a place where people can play

import UIKit

var str = "Hello, playground"
```

```
"Hello, playground"
```

# Writing Code Documentation

# Comments

- Comments are super important
  - Let others understand your code
  - Let YOU understand your code
- Follows the "Principle of Minimal Surprise"

# Comments in Swift

- Single Line Comment

```
// This is a comment
```

- They can also stack

```
// First Line of Comment
// Second Line of comment
```

## Multiline Comments

- But a better way is:

```
/* This is also a comment.
   Over many..
   many...
   many lines. */
```

# Documenting Code

- You do not need to comment every line
  - Some stuff should be self-explanatory
- Try to capture the Logic
  - WHY did you do something
  - WHAT does a particular class / function do.

# Documenting Code: Example

```
// we create a new Todo object
var newList = Todo()
// we now call the addItem method to add two strings to the list
newList.addItem("Cheese")
newList.addItem("Milk")
```

# Documenting Code: Functions

```
/// adds a new item to the list
/// - parameters:
///   - Int: The index of the list item to be returned.
/// - throws: A `TodoError.indexOutOfRange` error, if the index is invalid.
/// - returns: A string containing the list item.
func getItem(atIndex index:Int) throws -> String {
    ...
}
```

# Getting Started

# Hello World!

- The Traditional first program
- Type in the following, and click the run button.

```
//print Hello to the screen
print("Hello, world!")
```

# Some things to note:

- Depending on languages you are familiar with (C,Java,C++):
  - No need to import libraries
  - No Semicolons at the end of each line

# Core Variables

# Constants and Variables:

- Constants: Defined Once, cannot change
- Defined with **let**
- Variables: Can have different values
- Defined with **var**

# Constants and Variables:

```
//A Constant
let pi=3.14

//A Variable
var radius=5.0

//And another
var circumference = 2 * pi * radius
```

# Constants and Variables: 2

- Lets Change some values

```
//Constant
let pi=3.14

//Variable
var radius=5.0

//Change the Variable
radius = 2.0
```

# Constants and Variables: 3

- Lets break something

```
//Constant
let pi=3.14

//Variable
var radius=5.0

//Error when we try to change the constant
pi = 3.1
```

# What about Types?

- If we define an initial value swift is clever enough to work out the type.
- However, some times we need to define it ourselves

## General Types

```
// Round numbers
var number: Int = 10
// Decimal Numbers
var decimal: Double = 3.14

// Text
var text: String = "Hello World"

//Boolean
var status = true
```

# More Types

```
//Multiple definions
var decimalOne, decimalTwo: Double

decimalOne = 5.0
decimalTwo = 22.5
```

# Gotchas: Integers

- Integer Only Arithmetic. Drops decimal numbers:
    - What Happens, How do we fix it

```
var number = 22
var value = 7
//This is 3
var output = number / value
```

# Gotchas: Type Safety

- Values types are Locked once defined
    - Swift will not allow you to pass a float to a string etc.
- What happens here, How do we fix it?

```
//Define a string
var text: String
//Try to set a value
text = 3.14
```

# Gotchas: Conversion

- By default no conversion is performed
  - Means we have difficulties combining items and need to **cast** it to the correct type
  - Try the following with and without the conversion.

```
//Define our number
var number = 42
//And build a string from it
var text = "The meaning of Life is " + String(number)
```

# Converting Strings (2)

- These is an even easier way to convert strings
  - Use \(**...**)

```
//Define Number
var number = 42
//Build String
var text = "The Meaning of Life is \(number)"
```

# Arithmatic

- Normal Maths applies

```
//Add Numbers
var number = 4+4
//Subtract
var number = 4-2
//Divide
var number = 4/2
//Multiply
var number = 4*2
```

# Running Totals

- We can also add to existing numbers

```
//Define
var number = 4
//Add 5 to the number
number = number + 5
//Or Shorter version
number += 5
```

# Printing Things

- Sometimes we want output

```
//Define Number
var number = 42
//Build String
var text = "The Meaning of Life is \(number)"
//Print to screen
print(text)
```

# Printing Things (one liner)

- We can also do this without the intermediate Variable

```
//Define number
var number = 42

//Print
print ("The meaning of life is \(number)")
```

# Your Turn:

- Type the basic program below

```
//Constant
let pi = 3.14
//Variable
var radius = 5

//Calculations
var circumference = 2 * pi * radius

//Output
print("Cirumference of Circle with Radius \(radius) is \(circumference)")
```

# Your Turn:

- You have ~20 Minutes to Modify the code to:
    - Store your name as a variable
    - Print the area of the Circle (Pi * $R^2$)
    - Print "Hello <your name>"
    - Print Circumferenace and Area of a circle with radius 10

# Lists and Dictionaries

# Collections of Variables

- So far we have looked at primitive variables
- Lists and Dictionaries allow us to deal with groups of objects

# Lists

- Allow us to store collections of items
- We use Square Brackets **[]**

```
//Define a list
var shoppingList = ["Orange", "Water", "USB Drive"]

//Or an Empty List
var emptyList = [String]()
```

# Getting data from lists

- We use the List Index
  - Starts at 0 (it does make sense in terms of Memory Management)

```
//Define a list
var shoppingList = ["Orange", "Water", "USB Drive"]

//Print the 1st (0th) Item
print(shoppingList[0])

//Change the 2nd value ("water")
shoppingList[1] = "Bottle of Water"
```

# How many Items

- We can use **count**

```
//Define a list
var shoppingList = ["Orange", "Water", "USB Drive"]

//This should print 3
print ("The Size of the shopping list is \(shoppingList.count)")
```

# Adding Items

```
//Define a list
var shoppingList = ["Orange", "Water", "USB Drive"]

//Add an Item
shoppingList.append("Book")

//What happens if we want to add it at a specific place
shoppingList.insert("Beer", at: 0)
```

# Removing Items

```
//Define a list
var shoppingList = ["Orange", "Water", "USB Drive"]

//Remove the First item
shoppingList.remove(at: 0)
```

# Printing all items in an List

- We can also Iterate over the array

```
//Define a list
var shoppingList = ["Orange", "Water", "USB Drive"]

for item in shoppingList {
    print(item)
}
```

# Dictionaries

- Allow us to store items as "Key":"Value" pairs
    - We then access the item using the Key
- Useful for storing named values.

# Dictionaries

```
//Define a dictonary
var occupations = ["Dan" : "Lecturer", "James": "Senior Lecturer"]

//And print some values (Will print "Lecturer")
print(occupation["Dan"])

//Give James a Promotion
occupation["James"] = "Professor"
```

# Adding Items to dictionaries

- NOTE: The change to the layout

```
//Define a dictonary
var occupations = ["Dan" : "Lecturer",
                   "James": "Senior Lecturer",
                  ]
//Add a new person
occupations["Mark"] = "Teaching Assistant"
```

# Iterating over dictionaries

- Returns a tuple by default

```
//Define a dictonary
var occupations = ["Dan" : "Lecturer",
                   "James": "Senior Lecturer",
                  ]

//Either have items returned as a tuple
for value in occupations {
    print("Tuple is \(value)")
}
```

# Iterating over dictionaries

Get each key:value pair.

```
//Or decompose the tuple
for (name, job) in occupations {
    print("\(name): works as a \(job)")
}
```

# Your Turn: Reference Code

```
//Create an empty List
var shoppingList = ["Orange", "Water", "USB-Drive"]
//How many items in the list
print ("List Has \(shoppingList.count) items")
/Add an Item
shoppingList.append("Apple")
//And print it out
for item in shoppingList{
    print ("Item in list \(item)")
}
```

# Your turn: Tasks

- Task 1:
  - Create a new list of numbers **Grades** and populate it with some scores
  - Add a new grade to the list
  - Iterate through the list and print all the grades
  - BONUS: Using another variable, try to calculate the average grade
- Task 2:
  - Convert the list into a dictionary of “Class”: Grade pairs
    - Print the grade for each Class

# Solution

Hopefully you have something like this: - Do Dictonaries together.

```
//Create a grades object
var grades = [70,65,72,50]

//Add a new grade
grades.append(70)

//Something to hold our total (Note its a floating point)
var total = 0

for item in grades{
    total += item
}

print("Average grade is \(Double(total) / Double(grades.count))")
```

# Selection and Iteration

# Selection and Iteration

- So far we have introduced variables, and some more complex data structures
- To write useful programs we need to do something with them
  - Selection: Choosing what to do based on an input
  - Iteration: Doing something many times

# Conditions

- We have several conditions we can evaluate against
    - == Equal To
    - **!=** Not Equal To
    - > Greater Than
    - < Less Than
    - >= Greater or Equal to
    - <= Less or Equal to

# Conditions

```
5 == 5  //True
4 == 5  //False
10 > 5  //True
10 < 5  //False
5 >= 5  //True
```

# Selection

- **If** condition is met, then do something

```
var value = 10

if value > 5 {
    print("Value is Greater than 5")
}
```

# Selection: Providing an alternative

- We can use **Else**

```
var value = 10

if value > 5 {
     print("Value is Greater than 5")
}
else {  //Otherwise
     print("Value is less than 5")
}
```

# Selection, Multiple Choice

- Note Order is important here

```
value = 10
if value == 5 {
    print("Value is equal to 5")
}
else if value > 5 {
    print("Value is greater than 5")
}
else {
    print("Value is less than 5")
}
```

# Selection Task

- Lets write a (broken) grade calculator
  - Try running with different values for grade, what happens?
  - Can you fix the code to work correctly

# Selection Task

```
var grade = 55

//Fail
if grade < 40 {
     print ("Sorry, you failed")
} else if grade > 70 {
     print ("Congratulations you got a 1st")
} else if grade >= 40{
     print ("That sucks, a 3rd")
} else if grade >= 50 {
     print ("OK, a 2:2")
} else if grade >= 60 {
     print ("Not bad, a 2:1")
} else { //Catch things outside of expected range
     print ("Grade outside of boundries")
}
```

# More Selection

- We can also use **Switch** statements to achieve the same aim
    - Again, try the code. Does it need fixing.

```
var grade = 55

switch grade{
    case 0..<40:
        print ("Sorry, you failed")
    case 70..100:
        print ("Congratulations, a 1st")
    case 60..<70:
        print ("Not bad, a 2:1")
    case 40..<50:
        print ("That Sucks, a 3rd")
    case 50..<60:
        print ("OK, a 2:2")
    default:  //Catch all
        print ("Grade outside of boundries")
}
```

# Iteration:

- Allows us to do things many times.
    - Go through the items in a list
    - repeat a task a given number of times
    - repeat a task until a condition is met

# For and While Loops:

- **FOR** when we know how many items there are
  - Items in a list
  - Do things a set number of times
- **WHILE** stop when a condition is met
  - While we are still getting user input
  - To keep doing something until told to stop.

# For Loops (1)

- We have already met some for loops (called for-in loops):
  - Iterate through items in the list

```
//Define List
var thelist = ["foo","bar","baz"]
//For - In loop
for item in thelist {
    print(item)
}
```

# For Loops (2)

- We can also define a **range** of numbers to use

```
//A Range between 0 and 5
for index in 0..<5 {
    print ("Index is \(index)")
}
```

# For Loops (3)

- We can use the index to access items in a list
    - This is the longhand version of the for-in loop

```
//Define List
var thelist = ["foo","bar","baz"]

//Indexed For loop

for index in 0..<thelist.count {
    print ("Item at Index \(index) is \(thelist[index])")
}
```

# While Loops:

- Sometimes we dont know the number of items we need to deal with
- In this case we use a **WHILE** loop
  - **WHIlE** something is true, continue looping
- It is **REALLY IMPORTANT** to remember to change the condition otherwise you can get infinite loops.

# While Loops (2):

- So Lets keep doubling a number

```
//Initialise Variable
var total=1
while total < 25 {
   print("Total is \(total)")
   //And add it to iteslf
   total += total
}
```

## While Loops (3):

- Using a **While** as a **For**
  - Question: Why not <= ?

```
//Define List
var thelist = ["foo","bar","baz"]

//and an index
var index = 0

while index < thelist.count {
    print("Item at index \(index) is \(thelist[index])")
    index += 1
}
```

# Your Turn

- Remember the List of Grades?
- Remember the Classification Calculator
- Combine the two:
    - Print the score for each grade
    - Print the final grade classification

# Functions / Methods

# Functions and Methods:

- So far we have been writing all the code in the global namespace
    - This is a BadThing(TM) as it reduces modularity
    - We have to keep copying chunks of code
    - Leads to the potential for lots of mistakes.

# Functions

- Allow us to break the code into "Logical" blocks
- We can then call the function from the code, to make use of it.
- For example, good candidates for functions are:
    - The **calculate grade** code we used before.
    - The Math we did to calculate parts of a circle.

# Defining Functions

- We use the **func** syntax.
- **name** of function
- **parameters** (optional) that the function accepts
- **return** (optional) value type

```
func <name>(<parameters>) -> <return> {
  ...
}
```

# Defining the grade function

- We know that the grade function:
  - Takes a value as input
  - Prints the grade message

# Defining the grade function (1)

- The first cut of the grade function looks like this.

```
func grade(mark: Double) {
    if mark < 40 {
        print ("Sorry, you failed")
    } else if mark > 70 {
        print ("Congratulations you got a 1st")
    } else if mark >= 60 {
        print ("Not bad, a 2:1")
    } else if mark >= 50 {
        print ("OK, a 2:2")
    }else if mark >= 40{
        print ("That sucks, a 3rd")
    } else { //Catch things outside of expected range
        print ("Mark outside of boundries")
}
```

# Calling the grade function

- We can then call the function, including any parameters

```
var score = 55

grade(mark: score)
```

# Improving the Grade function

- But there are some issues here:
    - Except for debugging Functions shouldnt really print things
    - It is more appropriate to have the function return a value (as it can be used anywhere)

# Improving the Grade function

```
func grade(mark: Double) -> String {
    if mark < 40 {
        return "Sorry, you failed"
    } else if mark > 70 {
        return "Congratulations you got a 1st")
    } else if mark >= 60 {
       return "Not bad, a 2:1"
    } else if mark >= 50 {
        return "OK, a 2:2"
    }else if mark >= 40{
        return "That sucks, a 3rd"
    } else { //Catch things outside of expected range
        return "Mark outside of boundries"
}
```

# Calling the improved grade function

```
score = 55

var result = grade(mark: score)
print (result)
```

# Documenting the Grade Function

- We should also document our grade function

```
func grade(mark:Double) -> String{
    /* Convert a students grade into textual feedback
       - parameters:
           - mark:  Double representing the students numerical mark
       - returns: A String representing text based feedback
    */
    if mark < 40
        ...
}
```

# Dealing with multiple parameters

- We can specify multiple parameters to a function

```
func area(pi: Double, radius: Double) -> Double {
    /* Calculate the Area of a circle
       - parameters:
         - pi:  Value of Pi
         - radius: Radius of cicle
       - return:  The circles area
       */
```

# Functions: Your Turn

```
//Value for Pi
let pi = 3.14

//A List of Circles
var circles = [1.0, 2.0, 5.0, 10.0]

func area(pi: Double, radius: Double) -> Double {
    /* Calculate the Area of a circle
       - parameters:
         - pi:  Value of Pi
         - radius: Radius of cicle
       - return:  The circles area
       */
    return pi * (radius * radius)
}
```

# Functions: Your turn

- Create a function to calculate and return the Circumference ($2pi$r)
- Get the program to calculate and print the Area and Radius for each of the circles

# Classes

# Classes

- So Far our code has had no Class :)
- Classes are a way of abstracting behaviour and are core to OO programming.
- Classes represent a "thing" in our program
    - People
    - Shapes
    - Courses

# Defining Classes

- We can use the **class** keyword

```
class Person {
  ...
}
```

# Creating Objects

- Instances of each class are known as Objects
- We can create them by putting parenthesis after the name

```
var Dan = Person()
```

# Class Variables

- Class's also have attributes,
- These are the variables that make the class unique
- For example a person could have:
    - First (Given) Name
    - Last (Family) Name
    - Age

# Adding Class Variables

```
class Person{
    /* Defines a Person */
    var givenName: String
    var familyName: String
    var age: Int
}
```

# Accessing Class Variables

- Use Dotted Syntax

```
class Person{
    /* Defines a Person */
    var givenName: String
    var familyName: String
    var age: Int
}

//Create a person object
var Dan = Person()
//Set variables
Dan.givenName = "Daniel"
Dan.familyName = "Goldsmith"

//Print my Name
print("Full Name is \(Dan.givenName) \(Dan.familyName)")
```

# Constructors

- Using Dotted syntax is clumsy when creating objects
- Instead we use Constructors
  - The special **init** method.
  - Takes parameters and is used to set variables

# Constructors

```
class Person{
    /* Defines a Person */
    var givenName: String
    var familyName: String
    var age: Int

    init(givenName: String, familyName: String){
        //Create a new Person with provided names
        //Note the use of Self to differentiate between class and param
        self.givenName = givenName
        self.familyName = familyName
    }

var Dan = Person("Daniel","Goldsmith")
```

# Constructors without the self

```
class Person{
    /* Defines a Person */
    var givenName: String
    var familyName: String
    var age: Int

    init(given: String, family: String){
        //Create a new Person with provided names
        //Note the parameters are less readable
        givenName = given
        familyName = family
    }

var Dan = Person("Daniel","Goldsmith")
```

# Class Functions

- Each class will have a set of functions associate with it
- These can access the class variables to perform tasks
- Defined in a similar way to normal functions
- BUT within the scope of the class.

# Class Functions

```
class Person{
    /* Defines a Person */
    var givenName: String
    var familyName: String
    var age: Int

    init(given: String, family: String){
        //Create a new Person with provided names
        //Note the parameters are less readable
    givenName = given
    familyName = family
    }

    func getName() -> String {
        //No parameters,  Return full name as string
        return "\(givenName) \(familyName)"
    }
```

# Calling Functions

- Call the function by using <object>.<function>

```
var Dan = Person("Daniel", "Goldsmith")

var theString = Dan.getName()
print(theString)
```

# Your Turn

- Its time to make some Shapes
    - Create Classes for three different shapes (ie Square, Rectangle, Triangle)
    - Each Shape should have functions that return its Area, and Circumference.
    - Test the Shape functions out. Make sure they work.