Intro to Swift

Lecture 2

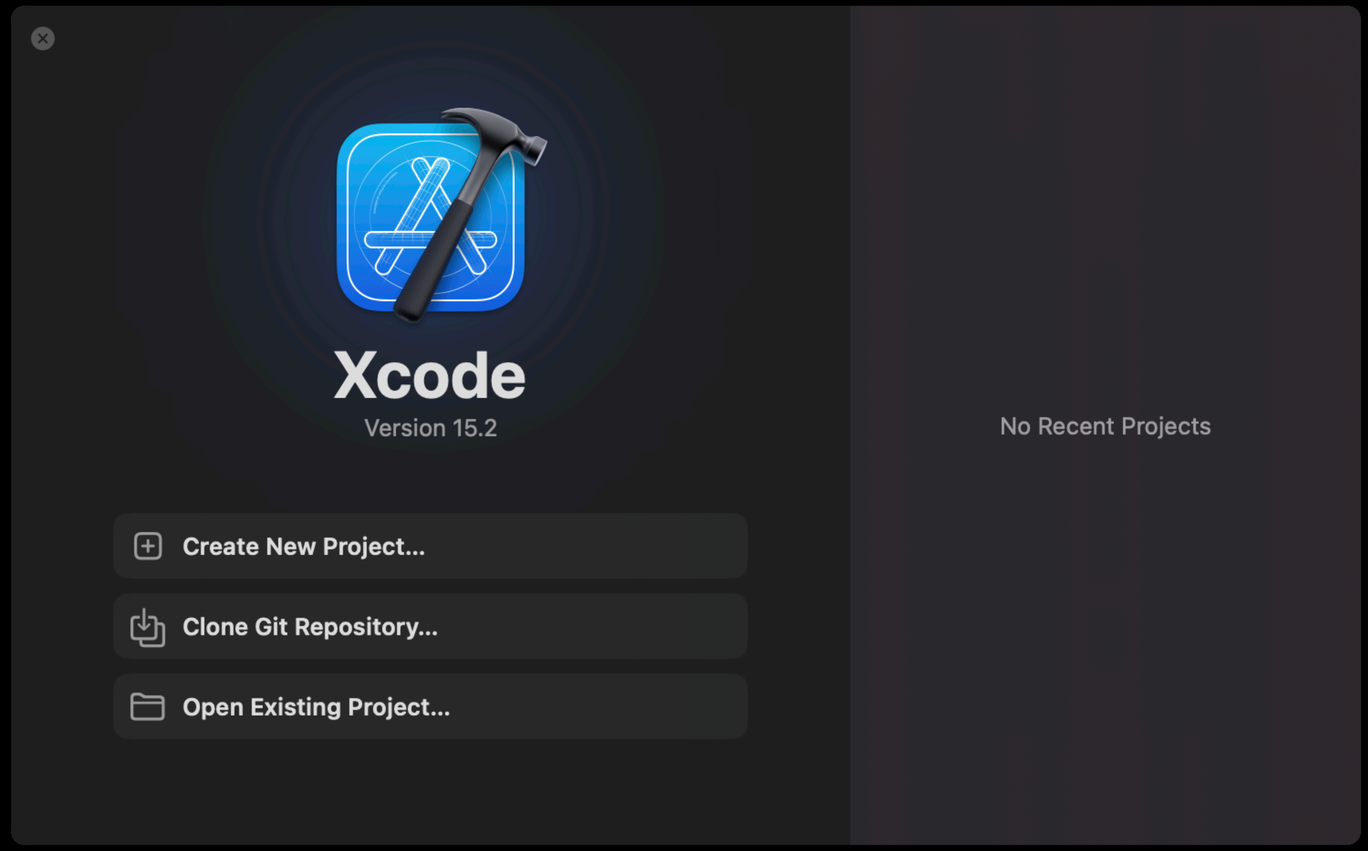
CIS 1951

Any questions, comments, or concerns from last week?

We value your feedback!

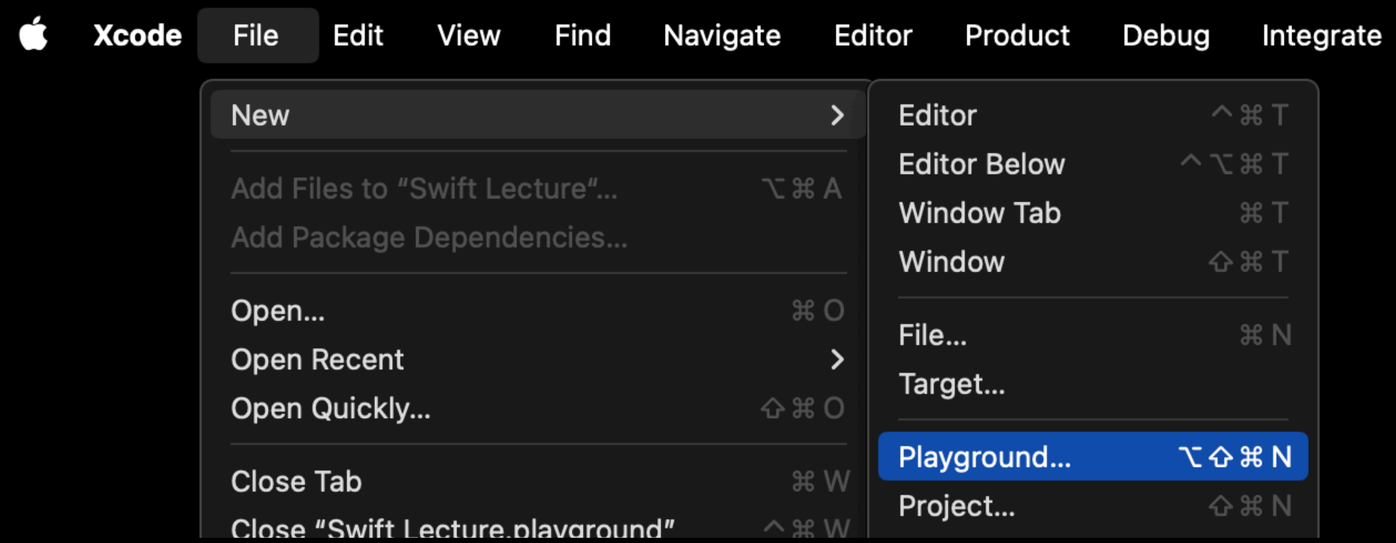
(please)

Let’s get started



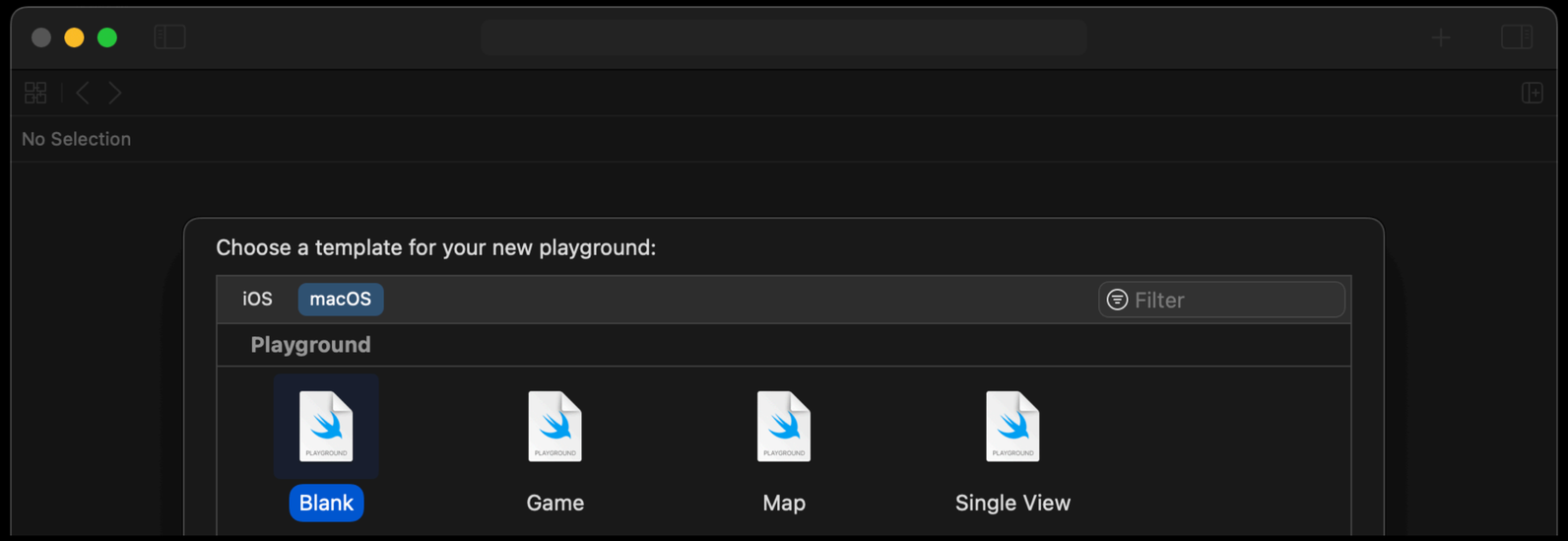
Fire up Xcode

Let’s get started



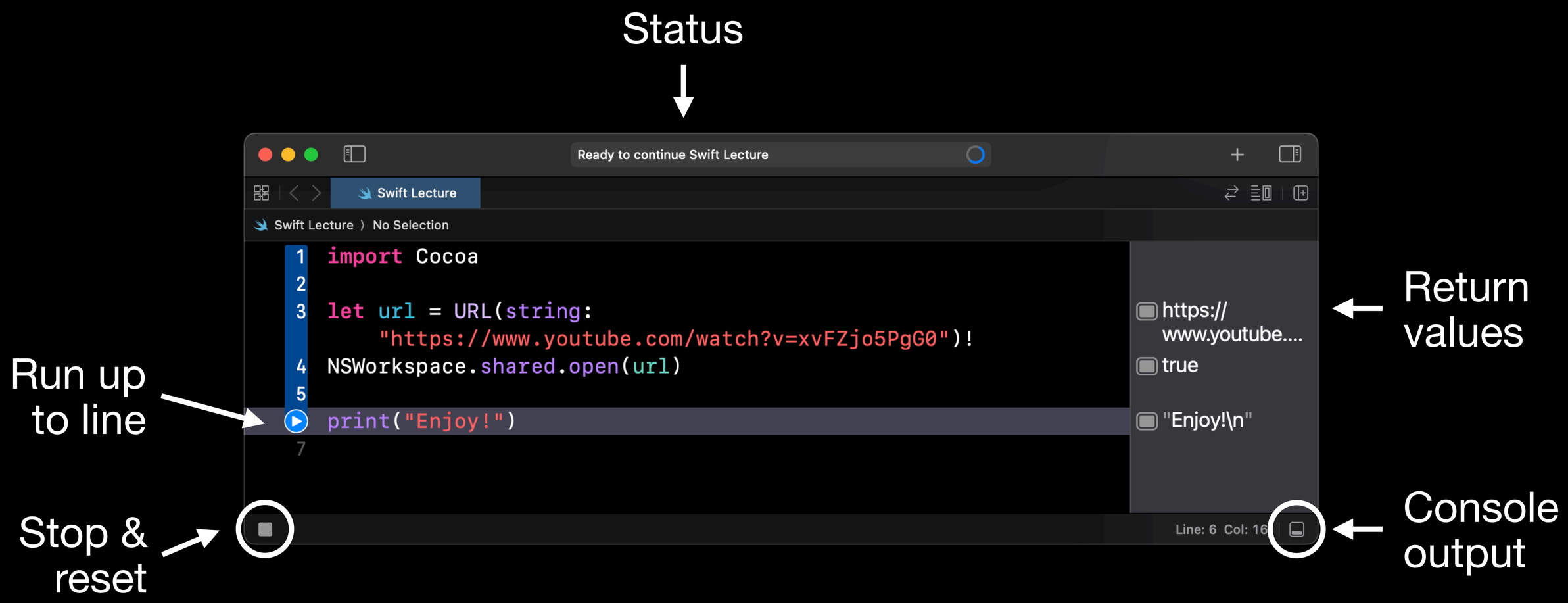
Create a new **playground**

Let’s get started



Choose **Blank**

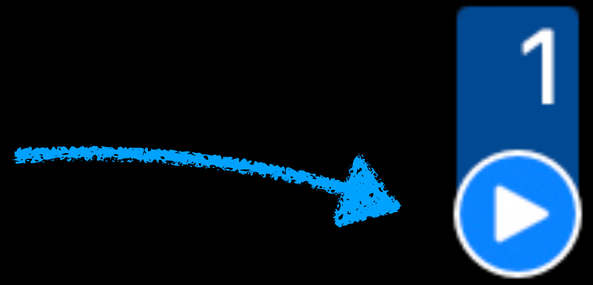
Your new playground



First things first

```
// The obligatory first line
print("Hello, world!")
```

When you’re ready to run your code, click **here**



The Basics

Variables

let and var

```
let name = "Anthony"
var section = 201
```

Variables

let and var

```
let name = "Anthony"
name = "Yuying"
```

Cannot assign to value: ‘name’ is a ‘let’ constant

```
var section = 201
section = 202
```

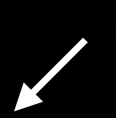
Type Inference

What's wrong with this code?

```
var x = 5
x = 5.9
```

Type Inference

What's wrong with this code?



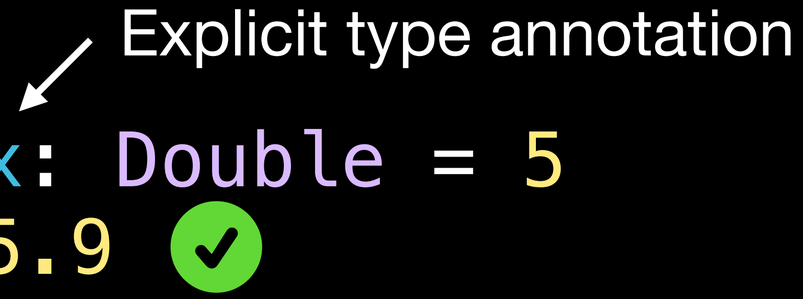
Compiler **infers** that x is an Int

```
var x = 5
x = 5.9
```

Cannot assign value of type 'Double' to type 'Int'

Type Inference

Specifying Types Explicitly



⚠ This is not the same as *casting* an Int to a Double!

Some Basic Types

Int

```
2 + 2 // 4

2 * 4 // 8

7 / 3 // 2

Int.min // -2^(63)

Int.max // 2^(63) - 1
```

Some Basic Types

Double

```
2.0 + 5.5 // 7.5

2.0 * 5.5 // 11.0

7.0 / 3.0 // 2.33333...

let num: Int = 3
7.0 / Double(num) // 2.33333...
```

Some Basic Types

String

```
"This is a string!"

let name = "Jordan"
“Hello, " + name + "!" // "Hello, Jordan!"
"Hello, \(name)!"      // "Hello, Jordan!"
```

Interpolation

Some Basic Types

Array

```
var foods: [String] = ["Penn Dining", "Allegro's"]
foods.count // 2
foods[0]    // "Penn Dining"
foods[0] = "🤮"

foods.append("Terakawa")
foods.count // 3
foods[2]    // "Terakawa"

foods       // ["🤮", "Allegro's", "Terakawa"]
```

Some Basic Types

Dictionary

```
let violations = [
    "1920 Commons": 38,
    "Hill House": 21
]

violations["1920 Commons"]     // 38
violations["Not Penn Dining"] // nil
```

More on this later…

Some Basic Types

Empty Arrays & Dictionaries

```
let array1 = [String]()
let array2: [String] = []

let dict1 = [String: Int]()
let dict2: [String: Int] = [:]
```

Why do we need this?

Some Basic Types

What's the type?

```
let a = [1, 2, 3, 4, 5]

let b = [1: "one", 2: "two", 3: "three"]

let c = [[1, 3], [2, 4]]

let d = [1: ["one", "1"], 2: ["two", "2"]]
```

Control Flow

Control Flow

If

```
let quantity = 1

if quantity > 0 {
    print("Thanks for your purchase!")
} else if quantity == 0 {
    print("Look, at least buy *something*.")
} else {
    print("Nice try. Now please leave the store.")
}
```

Control Flow

Switch

```
let course = "CIS 3200"
switch course {
case "CIS 1600":
    print("Oh no")
case "CIS 1210":
    print("Oh nooooo")
case "CIS 3200":
    print("Time to drop out")
default:
    print("Course not found")
}
```

Control Flow

While

```
var i = 0
while i < 5 {
    print(i)
    i += 1
}
```

```
0
1
2
3
4
```

Control Flow

For

```
for i in 0..<5 {
    print(i)
}
```

```
0
1
2
3
4
```

Control Flow

For

```
let names = ["Anthony", "Jordan", "Yuying"]
for name in names {
    print("Hello, \(name)!")
}
```

```
Hello, Anthony!
Hello, Jordan!
Hello, Yuying!
```

Optionals

```
violations["Not Penn Dining"] // nil
```

What's *nil*?

Optionals

Remember CIS 1200?

```
type 'a option =
  | None
  | Some of 'a
```

Optionals

A wrapper type

`Int?`

`nil`

OR

`38`

A concrete value

Optionals
Motivation

I call it **my billion-dollar mistake**. It was the invention of the null reference in 1965… This has led to **innumerable errors, vulnerabilities, and system crashes**, which have probably caused a billion dollars of pain and damage in the last forty years.

- Sir Charles Anthony (Tony) Hoare

Optionals
Defining & Unwrapping

```
let optional: String? = "hi"
```

“Force unwrapping”
```
optional!          // 2
```

“Optional chaining”
```
optional?.count // Optional(2)
```

“Optional binding”
```
if let str = optional {
    str.count   // 2
}
```

Optionals
Defining & Unwrapping

```
let optional: String? = nil
```

“Force unwrapping”

```
optional!          // FATAL ERROR
```

“Optional chaining”

```
optional?.count // nil
```

“Optional binding”

```
if let str = optional {
    str.count   // Doesn’t run
}
```

Optionals

Optional or not?

```
dictionary["generic key"]

Int.random(in: 1...3)

array.randomElement()
```

Optionals

A word of warning

`array[0]`

does **not** return an optional!

It will crash if `array` is empty.

Functions

Functions

The Basics

```
func greet(name: String) -> String {
    return "Hello, \(name)!"
}

greet(name: "Anthony") // Hello, Anthony!
```

Arguments are ***labelled***!

Functions

Omitting Labels

Add an underscore

```
func greet(_ name: String) -> String {
    return "Hello, \(name)!"
}

greet("Anthony") // Hello, Anthony!
```

Functions

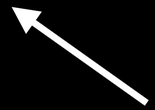
First-Class Functions

```
func greet(name: String) -> String {
    return "Hello, \(name)!"
}

let names = ["Anthony", "Jordan", "Yuying"]

// ["Hello, Anthony!", "Hello, Jordan!", "Hello, Yuying!"]
names.map(greet)
```

Like `transform` from CIS 1200



Treated like a value

Functions

First-Class Functions

```
func greet(name: String) -> String {
    return "Hello, \(name)!"
}
```

What type is `greet`?

```
(String) -> String
```

Functions

Closures

```
let names = ["Anthony", "Jordan", "Yuying"]

names.map({ (name: String) in
    return "Hello, \(name)!"
})
```

Functions

Closure Shorthand

```
names.map({ (name: String) in
    "Hello, \(name)!"
})
```

For simple closures, we can **leave out the return**

```
names.map({ name in
    "Hello, \(name)!"
})
```

The compiler can **infer parameter types** for us

```
names.map({ "Hello, \($0)!" })
```

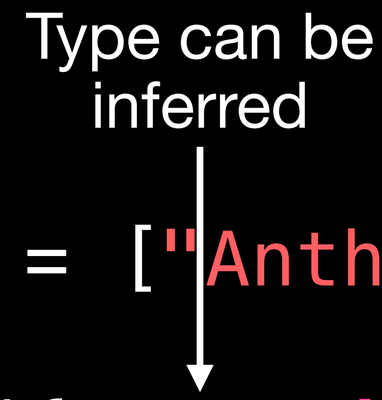
$0 is shorthand for “argument 0”

```
names.map { "Hello, \($0)!" }
```

Trailing closure syntax lets us omit the parentheses

Functions

Closures




```
let names = ["Anthony", "Jordan", "Yuying"]

names.map({ name in
    return "Hello, \(name)!"
})
```

Functions

Closures

```
let names = ["Anthony", "Jordan", "Yuying"]
names.map({ "Hello, \($0)!" })
```


Shorthand for
“argument 0”

Functions

Closures

```
let names = ["Anthony", "Jordan", "Yuying"]
names.map { "Hello, \($0)!" }
```

“Trailing closure syntax”

Classes, Structs, Enums

Classes

A Basic Class

```
class Receipt {
    // ...
}
```

Classes

Properties

```
class Receipt {
    var items: [String]
    var amount: Int
}
```

Classes

Initializers/Constructors

```
class Receipt {
    var items: [String]
    var price: Double

    init(items: [String], price: Double) {
        self.items = items
        self.price = price
    }
}

Receipt(items: ["🍎 Polishing Cloth"], price: 19.00)
```

Classes

Methods

```
class Receipt {
    // ...
    func applyDiscount(percent: Int) {
        price *= 1 - Double(percent) / 100
    }
}

let oops = Receipt(items: ["Polishing Cloth"], price: 19.00)
oops.applyDiscount(percent: 20)
oops.price // 15.2
```

Classes

Computed Properties

```
class Receipt {
    // ...
    var numberOfItems: Int {
        items.count
    }
}

let oops = Receipt(items: ["Polishing Cloth"], price: 19.00)
oops.numberOfItems // 1
```

Classes

Computed Properties ≈ Methods

```
let oops = Receipt(items: ["Polishing Cloth"], price: 19.00)
oops.numberOfItems // 1

oops.items.append("Polishing Cloth Travel Case")
oops.numberOfItems // 2
```

Structs

Enter `struct`

```
class Receipt {
    var items: [String]
    var price: Double
    // ...
}
```

Pass by reference

```
struct Receipt {
    var items: [String]
    var price: Double
    // ...
}
```

Pass by value

Classes vs. Structs

Classes

```
class Receipt {
    var items: [String]
    var price: Double
    // ...
}

let a = Receipt(items: ["Polishing Cloth"], price: 19.00)
let b = a

a.price = 1999.00
b.price // 1999.00
```

Classes vs. Structs

Structs

```
struct Receipt {
    var items: [String]
    var price: Double
    // ...
}

var a = Receipt(items: ["Polishing Cloth"], price: 19.00)
let b = a

a.price = 1999.00
b.price // 19.00
```

Something to think about: Why did we have to change `let` to `var`?

Structs

Sidenote: `mutating`

Needed when modifying a struct inside one of its methods

```
struct Receipt {
    // ...
    mutating func applyDiscount(percent: Int) {
        price *= 1 - Double(percent) / 100
    }
}
```

Structs

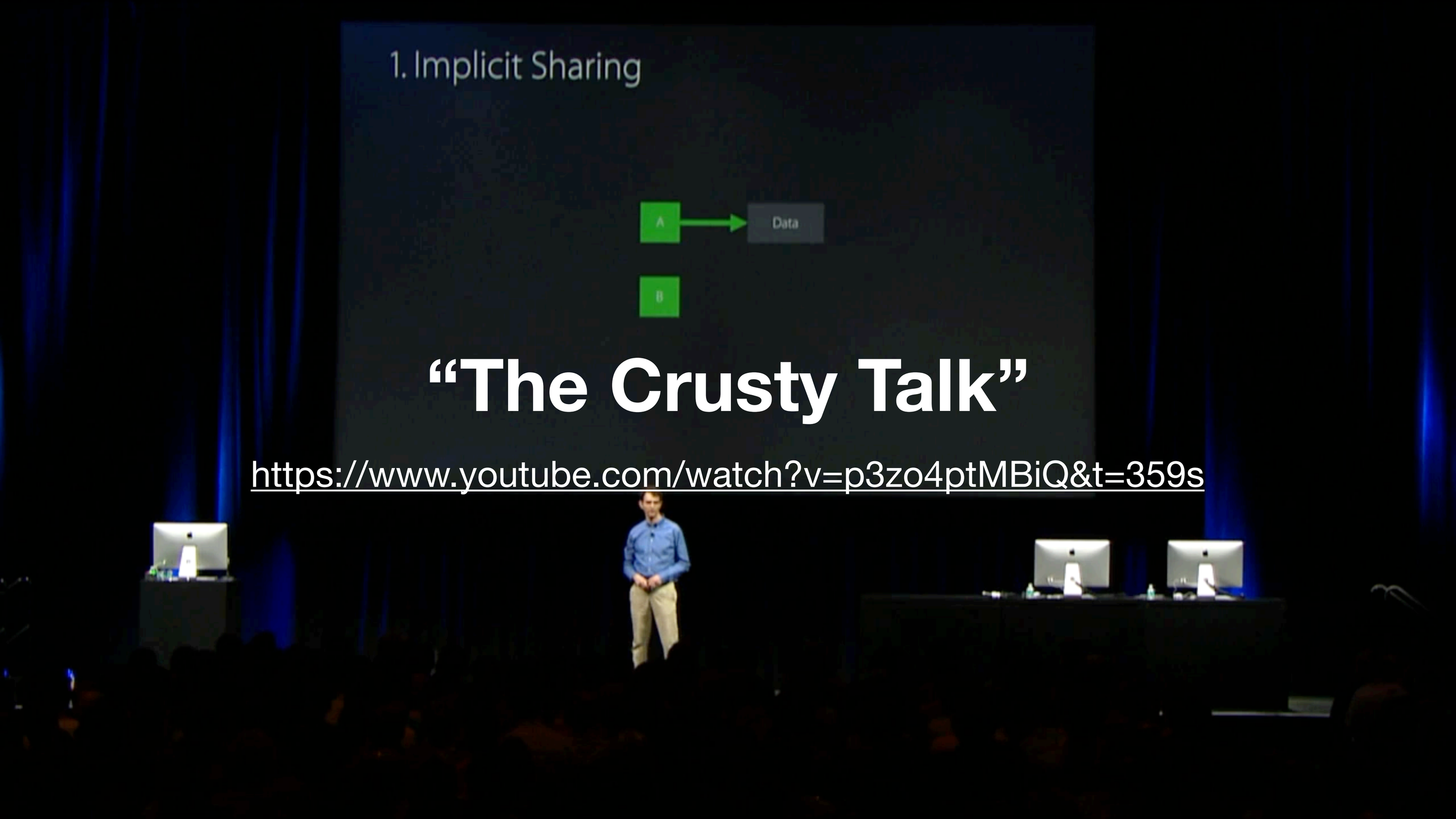
Sidenote: Auto-Generated Initializers

```
struct BankAccount {
    var funds: Int
}

var alice = BankAccount(funds: 0)
var bob = BankAccount(funds: 100)
```

That's it!

Why do we need structs?



“The Crusty Talk”

https://www.youtube.com/watch?v=p3zo4ptMBiQ&t=359s

Enumerations

Remember CIS 1200?

```
type cat_state =
  | Sleeping
  | Eating
  | Playing
  | Hunting
```

Enumerations

```
enum CatState {
    case sleeping
    case eating
    case playing
    case hunting
    case slappingTheDog
    case meowingAtYouToOpenTheDoor
    case giftingYouALiveMouse
}

var myCat = CatState.eating
myCat = .slappingTheDog
```

Protocols and Extensions

Protocols

Declaration

```
protocol ComputerStore {
    var name: String { get }
    func buyComputer() -> Receipt
}
```

Like **interfaces** in Java

Protocols

Implementation


```
struct MicrosoftStore: ComputerStore {
    let name = "Microsoft Experience Center"
    func buyComputer() -> Receipt {
        return Receipt(
            items: ["Spyware"],
            price: 1000.00
        )
    }
}
```

Protocols

Implementation

```
struct LinuxStore: ComputerStore {
    let name = "???"
    func buyComputer() -> Receipt {
        return Receipt(
            items: ["IBM ThinkPad"],
            price: 200.00
        )
    }
}
```

Protocols

Implementation

```
struct AppleStore: ComputerStore {
    let name = "Apple Store"
    func buyComputer() -> Receipt {
        fatalError("Bank account overdrawn")
    }
}
```

Protocols

Another Example

```
public protocol AdventureGame {
    init()

    var title: String { get }

    mutating func start(context: AdventureGameContext)
    mutating func handle(input: String, context: AdventureGameContext)
}
```

Protocols

Built-in Protocol: `Equatable`

```
public protocol Equatable {
    /// Returns a Boolean value indicating whether two values are equal.
    static func == (lhs: Self, rhs: Self) -> Bool
}
```

Extensions

Making Receipt Equatable

```
extension Receipt: Equatable {
    static func ==(_ left: Receipt, _ right: Receipt) -> Bool {
        return left.items == right.items &&
               left.price == right.price
    }
}

let a = Receipt(items: ["Water"], price: 1)
let b = Receipt(items: ["Water"], price: 1)
a == b // Now works!
```

Error Handling

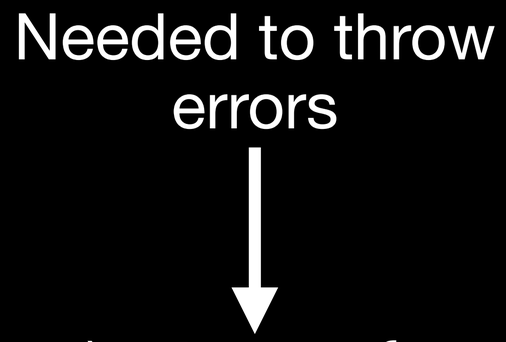
Error Handling

Defining Errors

```
enum BankError: Error {
    case insufficientFunds
}
```

Error Handling

Throwing Errors




```
struct BankAccount {
    var funds: Int

    mutating func transfer(amount: Int,
                           to destination: inout BankAccount) throws {
        if funds < amount {
            throw BankError.insufficientFunds
        }

        destination.funds += amount
        funds -= amount
    }
}
```

Disclaimer: If you are programming for an actual bank, please do not use this code

Error Handling

Handling Errors

```
var alice = BankAccount(funds: 0)
var bob = BankAccount(funds: 200)

do {
    try alice.transfer(amount: 100, to: &bob)
} catch {
    print("Couldn't transfer money: \(error)")
}
```

Error Handling

Other Ways of Handling Errors

```
func somethingThatCouldFail() throws -> Int {
    /* ... */
}
```

Crashes on error

```
try! somethingThatCouldFail()
```

Returns nil on error

```
try? somethingThatCouldFail()
```

Review

- Declaring constants and variables is easy with **type inference**
- **Optionals** make handling nil/null much safer
- **Functions and closures** are first-class types
- **Classes, structs, and enums** let us organize code and data
- **Protocols and extensions** make defining and standardizing behavior easy

This is barely scratching the surface!

Protocol extensions
Sequence and collection methods
Generic types
Hash sets
Type casting
Associated types
guard and defer
Option sets
Result builders
Unsafe pointers
Observation
Mirrors
Key path expressions
Dynamic member lookup
Macros
C/C++/Objective-C interop
Generic constraints
Regex support

And much more!

Check out the resources at https://www.seas.upenn.edu/~cis1951/resources/

Homework 1

Text Adventure Game

- Make an adventure game using Swift language constructs
- We'll provide the UI, you bring the gameplay
- Will be released **Monday, 1/29**
- Due after 2 weeks on **Monday, 2/12**
- Be creative!