CSC 471 / 371 Mobile Application Development for iOS

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A Swift Primer, Part 3 Class Inheritance

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Outline

- Inheritance relation
- Dynamic typing
- Sub-classing
- Stored and computed properties
- Value types vs. reference types

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The Inheritance Relation

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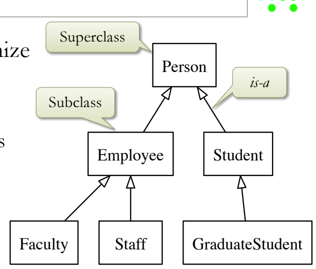
Class Inheritance

- A mechanism to organize classes based on their commonalities
  - Superclass and subclass
    - Code reuse
    - Customize or extend behavior
  - Subtype relation
    - The *is-a* relation
    - Liskov substitution principle



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Subclass and Superclass

- A subclass represents a subtype of the superclass
  - Instances of the subclass is compatible with the superclass
  - **Liskov substitution principle**:
    An instance of the subclass can be substituted for an instance of the superclass
- A subclass can reuse the methods and properties in its superclass
- A subclass can extend the functionality of its superclass
  - adding new properties, and new methods
  - *overriding* existing methods

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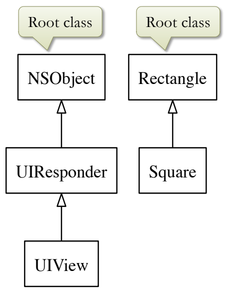
Inheritance in Swift

- A superclass is *not* required for every class
  - A class without a superclass is known as a *root* class
- Swift does not have a common root class
  - Most classes in the *UIKit* and *Foundation* frameworks are subclasses of `NSObject`



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Override Methods

- A subclass *cannot* remove methods or variables declared in its superclass
- A subclass can *override* the method in its superclass
  - Define a method with the same signature but a different implementation in the subclass
  - It replaces the method defined in the superclass
  - The superclass method can be accessed using `super`

The `override` keyword is **required**.

```
override func method() {
  super.method()
   … do something …
}
```

Invoke the method in superclass

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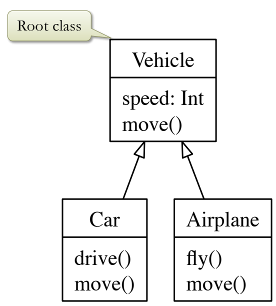
A Simple Class Hierarchy

- The root class:

  Vehicle

```
class Vehicle {
    var speed: Int = 0
    func move() {
        print("Moving")
    }
}
```



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A Simple Class Hierarchy

- A subclass:

  Car

The Superclass

```
class Car : Vehicle {
    func drive() {
        speed = 35
        print("Driving")
    }
    override func move() {
        drive()
    }
}
```

New method in the subclass. Reference variable `speed` declared in its superclass.

Override the same method in its superclass. The `override` keyword is **required**.

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A Simple Class Hierarchy

- Another subclass: Airplane

```
class Airplane : Vehicle {
    func fly() {
        speed = 100
        print("Flying")
    }
    override func move() {
        fly()
    }
}
```

- Instances of vehicles

```
var myCar = Car()
myCar.drive()
myCar.move()

var myAirplane =
    Airplane()
myAirplane.fly()
myAirplane.move()
```

Driving

Flying

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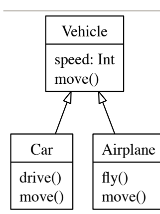
Invoke Methods




```
var myCar = Car()
…
var myAirplane = Airplane()
…
// dynamic binding
var vehicle: Vehicle = myCar
vehicle.move()
vehicle = myAirplane
vehicle.move()
```

Which `move()` is called?

Which `move()` is called?

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Dynamic Binding of Methods

- Invoke a method `mtd` of an object `obj`
  `obj.mtd()`
- Which method to be invoked is determined at *runtime*, rather than compile time
- Finding the method to be invoked at *runtime*
  1. Start with the *class* to which the object belongs
     - the *runtime* type, not the *declared* type
  2. If the method is defined in the class, call the method
  3. If the method is not defined, look up in the superclass

  Repeat step 2 and 3 until the method definition is found

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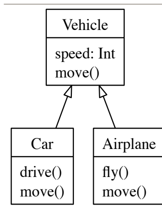
Dynamic Binding




```swift
var myCar = Car()
…
var myAirplane = Airplane()
…
// dynamic binding
var vehicle: Vehicle = myCar
vehicle.move()
vehicle = myAirplane
vehicle.move()
```

Invoke `Car.move()`

Invoke `Airplane.move()`

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Downcasting

- Consider the following

```swift
var myCar = Car()  …
var myAirplane = Airplane() …
var vehicle: Vehicle = myAirplane
vehicle.fly()
```

Type error

Forced downcast: *Expr* `as!` *Type*

- Must downcast to `Airplane`

```swift
(vehicle as! Airplane).fly()
```

Okay, but unsafe. Should be avoided.

```swift
vehicle = myCar
(vehicle as! Airplane).fly()
```

Because, this is also accepted by the compiler, but will crash at runtime

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Safe Downcasting

- Check runtime type before downcast

```swift
if vehicle is Airplane {
    (vehicle as! Airplane).fly()
} else if vehicle is Car {
    (vehicle as! Car).drive()
}
```

Check type: *Expr* `is` *Type*

- Optional downcast, with optional binding

```swift
if let airplane = vehicle as? Airplane {
    airplane.fly()
} else if let car = vehicle as? Car {
    car.drive()
}
```

Optional downcast: *Expr* `as?` *Type*

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Declaring Subclasses

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Another Example: Rectangle – Without Initializer

```swift
class Rectangle {
    var width = 0, height = 0;

    func set(width w: Int, height h: Int) {
        width = w; height = h;
    }
    func area() -> Int { return width * height }
    func perimeter() -> Int { return (width + height) * 2 }
}
```

The default initializer is available, if no initializer is defined.

```swift
var r1 = Rectangle()
```

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Rectangle with Initializers

```
class Rectangle {
    var width = 0, height = 0;

    init(width: Int, height: Int) {
        self.width = width
        self.height = height
    }
    func set(width w: Int, height h: Int) {
        width = w; height = h;
    }
    func area() -> Int { return width * height }
    func perimeter() -> Int { return (width + height) * 2 }
}
```

An initializer is defined.
The default initializer is no longer available.

```
var r1 = Rectangle()
var r2 = Rectangle(
    width: 5, height: 8)
```

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Rectangle with Initializers

```
class Rectangle {
    var width = 0, height = 0;
    init() {}
    init(width: Int, height: Int) {
        self.width = width
        self.height = height
    }
    func set(width w: Int, height h: Int) {
        width = w; height = h;
    }
    func area() -> Int { return width * height }
    func perimeter() -> Int { return (width + height) * 2 }
}
```

It is necessary to explicitly define the default initializer, when other initializers are defined.

```
var r1 = Rectangle()
var r2 = Rectangle(
    width: 5, height: 8)
```

```
r1.set(width: 10, height: 20)
r1.area()
r1.perimeter()
```

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A Subclass: Square – Without Initializer

```
class Square : Rectangle {

}
```

Superclass

```
var s1 = Square()
```

Default initializer is available.

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A Subclass: Square – With Initializers

```
class Square : Rectangle {

    init(side: Int) {
        super.init(width: side, height: side)
    }

}
```

```
var s1 = Square()
var s2 = Square(side: 10)
```

An initializer.
Default initializer is no longer available.

Call the initializer in the superclass

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A Subclass: Square – With Initializers

```
class Square : Rectangle {
    override init() {
        super.init()
    }
    init(side: Int) {
        super.init(width: side, height: side)
    }

}
```

Explicitly define the default initializer
Override the superclass initializer.

```
var s1 = Square()
var s2 = Square(side: 10)
```

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A Subclass: Square – Computed Property

```
class Square : Rectangle {
    override init() {
        super.init()
    }
    init(side: Int) {
        super.init(width: side, height: side)
    }
    var side: Int {
        get { return width }
        set(side) { set(width: side, height: side) }
    }
}
```

```
var s1 = Square()
s1.side = 10
s1.side
```

Computed property with a getter and a setter.

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Stored and Computed Properties

- *Stored* properties
  - Variables or constants *stored* as part of an instance of a class
- *Computed* properties
  - Values are *not stored,* but *computed* from other properties
  - A *getter* and an optional *setter* is provided to retrieve and set values
    - Not regular methods. Different syntax.
    - Have the similar effects of getter/setter methods.
  - Accessed using the same syntax as stored properties
  - Can be read-only: only a getter, no setter

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A Subclass: Square – Computed Read-Only Property

```
class Square : Rectangle {
    override init() {
        super.init()
    }
    init(side: Int) {
        super.init(width: side, height: side)
    }
    var side: Int {
        get { return width }
        set(side) { set(width: side, height: side) }
    }
    var area: Int {
        return side * side
    }
}
```

```
var s1 = Square()
s1.side = 10
"Area = \(square.area)"
"Area = \(square.area())"
```

No conflict with the method with the same name

Computed read-only property with a getter.

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Another Example: Computed Property

```
class Temperature {
    var celsius: Float = 0
    var fahrenheit: Float {
        get { return celsius * 9 / 5 + 32 }
        set { celsius = (newValue - 32) * 5 / 9 }
    }
}
```


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Another Example: Computed Property

```
class Temperature {
    var celsius: Float = 0
    var fahrenheit: Float {
        get { return celsius * 9 / 5 + 32 }
        set { celsius = (newValue - 32) * 5 / 9 }
    }
}
```

Shortened setter syntax. Default argument: `newValue`

```
let temp = Temperature()
temp.celsius = 20
print("The temperature is \(temp.celsius)°C and \(temp.fahrenheit)°F")
```

```
The temperature is 20.0°C and 68.0°F
```

```
temp.fahrenheit = 0
print("The temperature is \(temp.celsius)°C and \(temp.fahrenheit)°F")
```

```
The temperature is -17.7778°C and 0.0°F
```


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Value Types vs. Reference Types

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Setting Temperature

- Let's make the house nice and warm

```
let home = House()
let temp = Temperature()
temp.fahrenheit = 70
home.thermostat.temperature = temp
```

- Let's roast something in the oven too.

```
temp.fahrenheit = 325
home.oven.temperature = temp
home.oven.bake()
```

- **It's really toasty in here! HELP!**

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Value Types vs. Reference Types

- A type in Swift is either a *value* type or a *reference* type
- A variable of a **value type** holds a *value*
  - Assignment to a value typed variable:
    The *value* is copied
- A variable of a **reference type** holds a *reference* to a value
  - Assignment to a reference typed variable:
    The *reference* is copied, but not the value

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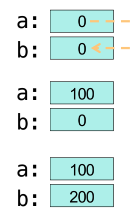
Assignment: Value Type

```
var a = 0
var b = a
a = 100
print(a)
print(b)
```

Output:
100
0

```
b = 200
print(a)
print(b)
```

Output:
100
200



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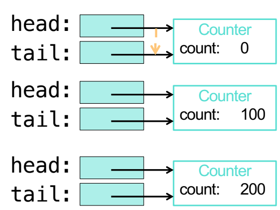
Assignment: Reference Type

```
var head = Counter()
var tail = head
head.count = 100
print(head.count)
print(tail.count)
```

Output:
100
100

```
tail.count = 200
print(head.count)
print(tail.count)
```

Output:
200
200



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A Point Class

- A class representing a point in 2-D space

```
class Point {
    var x = 0, y = 0;
    init() {}
    init(x: Int, y:Int) {
        self.x = x
        self.y = y
    }
    func set(x: Int, y: Int) {
        self.x = x
        self.y = y
    }
}
```

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The Origin of the Rectangle

```
class Rectangle {
    var width = 0, height = 0;
    var origin: Point          // The property origin.
    init() {
        origin = Point()       // Initialize origin.
    }
    init(width: Int, height: Int) {
        origin = Point()       // Initialize origin.
        self.width = width
        self.height = height
    }
    Other methods …
}
```

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The Origin of the Rectangle

```
var rect = Rectangle(width: 5, height: 8)
var p1 = Point(x: 100, y:200)
rect.origin = p1
print("Rectangle origin at: (\(rect.origin.x), (rect.origin.y))")
```

Output:
Rectangle origin at (100, 200)

```
p1.set(x: 50, y: 50)
print("Rectangle origin at: (\(rect.origin.x), (rect.origin.y))")
```

Output:
Rectangle origin at (50, 50)

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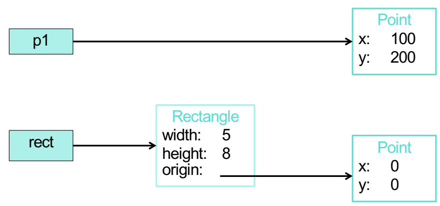
The Origin of the Rectangle

- Class is a *reference* type



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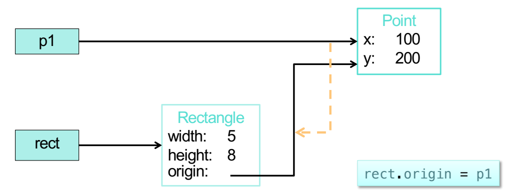
The Origin of the Rectangle

- Class is a *reference* type



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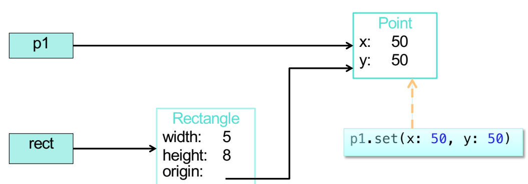
The Origin of the Rectangle

- Class is a *reference* type



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A Point Struct

- Define Point as a *struct*
- The `mutating` keyword is necessary, since it *mutates* the value, i.e., one of its properties, of the struct

```
struct Point {
    var x = 0, y = 0;
    init() {}
    init(x: Int, y:Int) {
        self.x = x
        self.y = y
    }
    mutating func set(x: Int, y: Int) {
        self.x = x
        self.y = y
    }
}
```

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Class vs. Structure

- Struct (for short) – a type very similar to class
  - Defined using the same syntax as class, except the `struct` keyword
    - Properties, methods, initializers
    - No inheritance
  - A value type
    - Not managed by ARC
- Class
  - Supports inheritance, type casting
  - A reference type
    - Managed by ARC

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The Origin of the Rectangle – Using Struct

```
class Rectangle {
    var width = 0, height = 0;
    var origin: Point
    init() {
        origin = Point()
    }
    init(width: Int, height: Int) {
        origin = Point()
        self.width = width
        self.height = height
    }
    Other methods …
}
```

The Rectangle class is identical.

Point is a struct.

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The Origin of the Rectangle – Using Struct

```
var rect = Rectangle(width: 5, height: 8)
var p1 = Point(x: 100, y:200)
rect.origin = p1
print("Rectangle origin at: (\(rect.origin.x), (rect.origin.y))")
```

Output:
`Rectangle origin at (100, 200)`

```
p1.set(x: 50, y: 50)
print("Rectangle origin at: (\(rect.origin.x), (rect.origin.y))")
```

Output:
`Rectangle origin at (100, 200)`

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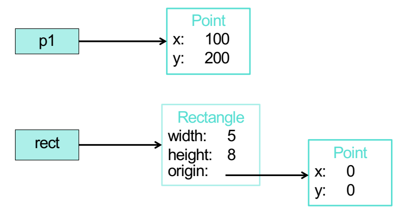
The Origin of the Rectangle – Using Struct

- Struct is a value type



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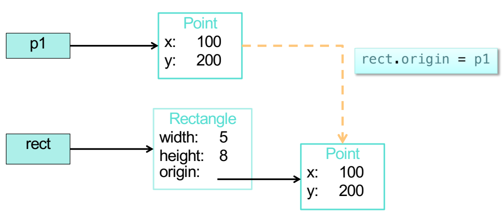
The Origin of the Rectangle – Using Struct

- Struct is a value type



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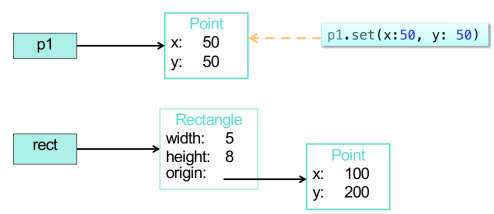
The Origin of the Rectangle – Using Struct

- Struct is a value type



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Next …

- Swift collections and libraries
- More UI views and controls
- Images and scroll views
- Switches, sliders, segmented controls, steppers
- Text input
- Auto layout

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