Class 12

CSC 496: iOS App Development
Swift Fundamentals: Closures and Fetching Data from APIs

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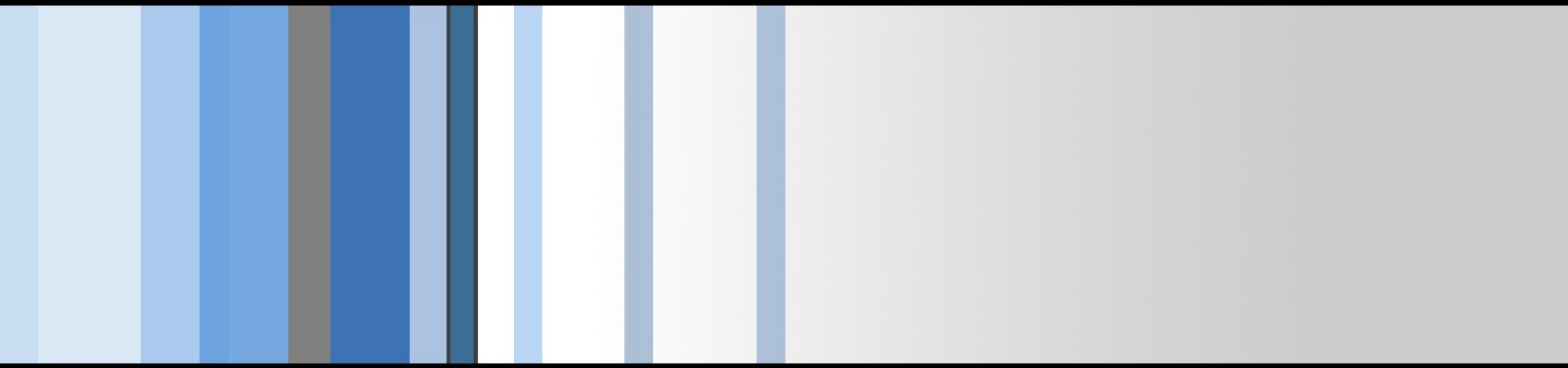


Review

Protocols

- Unlike a class, struct, or enum, a **protocol** is a blueprint of methods, properties, and other requirements that suit a particular action or piece of functionality.
- They're like the rules of the game, setting the standards for how classes, structures, and enumerations should appear and behave.

Protocol Syntax

Swift protocols have a specific syntax, similar to what you would see when defining a class or structure. However, protocols won't provide any implementation for the requirements they define.

```
protocol SomeProtocol {
    // protocol definition goes here
}
```

Adopting Protocols

- A class, structure, or enumeration can adopt a protocol by listing its name after their own, separated by a colon **:**
- Look at this simple example:

```
struct SomeStructure: FirstProtocol, AnotherProtocol {
    // structure definition goes here
}
```

Here, 'SomeStructure' is adopting and conforming to 'FirstProtocol' and 'AnotherProtocol'.

Adopting Protocols: Example

```
protocol Fordable {
    var hasFourWheels: Bool { get }
    func startEngine()
}
```

In this protocol, **Fordable**, there are a variable **hasFourWheels** and a function **startEngine**(). Any type that adopts this protocol will need to implement these two properties.

```
class Car: Fordable {
    var hasFourWheels: Bool = true
    func startEngine() {
        print("Engine started!")
    }
}
```

Protocol Inheritance

- Swift protocols can inherit from one or many protocols. This enables you to build on top of existing protocols to provide more specialized behavior. Let's see how it's done.

```
protocol InheritingProtocol: SomeProtocol, AnotherProtocol {
    // protocol definition goes here
}
```

```
protocol Vehicle {
    var hasWheels: Bool { get }
}
protocol Fordable: Vehicle {
    var hasFourWheels: Bool { get }
}
```

In this scenario, Fordable is inheriting Vehicle protocol. Therefore, anyone who will adopt Fordable protocol will need to fulfill the requirements of Vehicle as well.

Optional Protocol Requirements

- In Swift, protocols can also have optional requirements, which are not required to be implemented by a type in order to conform to the protocol. These optional requirements are marked by the **optional** keyword.

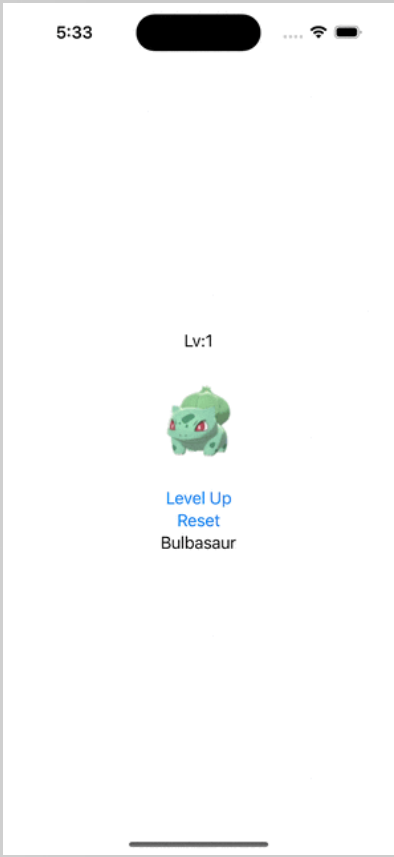
```
@objc protocol Moveable {
    @objc optional func startMoving()
    @objc optional func stopMoving()
}
```

- Here **startMoving**() and **stopMoving**() are not mandatory for any type that adopts **Moveable** protocol.

Understanding SwiftUI's Data Flow - ObservableObject and @Published

Scenario: You have a custom class, and you want your SwiftUI view to update when an attribute of the class changes.

Problem with Bulbasaur Class in SwiftUI: Simply updating the class attribute won't update the UI.



- **ObservableObject**: A protocol that SwiftUI uses to re-render a view when the data it observes changes.
- **@Published**: A property wrapper that marks properties of an ObservableObject to notify the UI of changes.

Understanding SwiftUI's Data Flow - ObservableObject and @Published

- **How to Implement ObservableObject**
  1. Conform your class to the **ObservableObject** protocol.
  2. Use **@Published** to annotate attributes that, when changed, should trigger a UI update.

```
class Bulbasaur: ObservableObject {
    // Attributes
    @Published var id: Int
    @Published var level: Int
```

Use @ObservedObject or @StateObject to bind an instance of your class to the view.

```
@StateObject var b = Bulbasaur()
```

•**@ObservedObject**: Use when your observable object is passed from a parent view.
•**@StateObject**: Use when your observable object is created within the view.

Enums

- Enumerating values with enums
  - Enumerations are a programming construct that lets you define a value type with a finite set of options.
  - Similar to enum type in Java

```
// Enum
enum Title{
    case mr
    case mrs
    case mister
    case miss
    case dr
    case prof
    case other
}
let title1 = Title.dr
```

In many programming languages, including C, enum are defined as a type definition on top of an **integer.**

In Swift, enums **do not need** to represent **integers** --> they do not need to be backed by any type

Enums: Raw Values and Functions

- In Swift, you can assign raw values to enumeration cases when you define the enumeration.

```
enum Rating: Int{
    case worst // Infered as 0
    case bad // Infered as 1
    case average // Infered as 2
    case good // Infered as 3
    case best // Infered as 4
}
let r1 = Rating.good
print(r1)
print(r1.rawValue)
```

```
enum TitleNew: String{
    case mr = "Mr"
    case mrs = "Mrs"
    case mister = "Mister"
    case miss = "Miss"
    case dr = "Dr"
    case prof = "Prof"
    case other // Inferred as "other

    func isProfessional() -> Bool {
        return self == TitleNew.dr || self == TitleNew.prof
    }
    // feels more appropriate as a computed property
    var isProfessional2:Bool{
        return self == TitleNew.dr || self == TitleNew.prof
    }
}
```

- We can also add functions or computed property into enums

Enums: Associated Values

Associated Values Enums in Swift can store associated values, providing additional information about each case. Check out this example:

Example: Dungeon Room Enumeration

Create an enumeration called **DungeonRoom** with cases for different types of rooms: **treasureRoom**, **monsterRoom**, and **emptyRoom**.

- Each **treasureRoom** contains an integer value representing the amount of gold. Each **monsterRoom** contains a string representing the type of monster.
- Write a function **describeRoom** that takes a **DungeonRoom** as an argument and returns a string describing the room.

Enums: Associated Values

```swift
enum DungeonRoom {
    case treasureRoom(Int)
    case monsterRoom(String)
    case emptyRoom
}

func describeRoom(room: DungeonRoom) -> String {
    switch room {
    case .treasureRoom(let goldAmount):
        return "This is a treasure room with \(goldAmount) gold coins."
    case .monsterRoom(let monsterType):
        return "This is a monster room with a \(monsterType)."
    case .emptyRoom:
        return "This is an empty room."
    }
}

// Usage:
let description = describeRoom(room: .monsterRoom("Dragon"))
print(description)  // Output: "This is a monster room with a Dragon."
```

Exercise: Direction Enumeration

Direction Enumeration:

- Create an enumeration called Direction with four possible cases: north, south, east, and west.
- Assume a player is at position (0, 0) on a 2D grid. Write a function **movePlayer** that takes a Direction and a distance as arguments and returns the new position of the player.

Exercise: Player Action Enumeration

Player Action Enumeration:

Create an enumeration called PlayerAction with cases for different player actions: attack, defend, heal, and escape.

- Each attack action has an associated integer value representing the attack power. Each defend action has an associated integer value representing the defense power.
- Write a function performAction that takes a PlayerAction as an argument and prints a description of the action performed.

```swift
enum Direction {
    case north
    case south
    case east
    case west
}

func movePlayer(direction: Direction, distance: Int) -> (Int, Int) {
    var x = 0
    var y = 0

    switch direction {
    case .north:
        y += distance
    case .south:
        y -= distance
    case .east:
        x += distance
    case .west:
        x -= distance
    }

    return (x, y)
}
```

```swift
enum PlayerAction {
    case attack(Int)
    case defend(Int)
    case heal
    case escape
}

func performAction(action: PlayerAction) {
    switch action {
    case .attack(let power):
        print("Player attacks with \(power) power.")
    case .defend(let defense):
        print("Player defends with \(defense) defense.")
    case .heal:
        print("Player heals.")
    case .escape:
        print("Player escapes.")
    }
}
```

Closures

- Closures are also referred to as **anonymous functions**
  - Closures are **functions without a name**
    - Can take a set of input parameters
    - Can return an output
    - Can be assigned, stored, passed around, and used as input and output to functions

Closure Full Form:

- In Swift, closures have a very flexible syntax that allows for a range of shorthand or simplified forms. This flexibility often enhances code readability and conciseness.

In its **full form**, a closure **specifies the names and types of its parameters, as well as its return type**. Here is a basic example:

```
let fullForm: (Int, Int) -> Int = { (a: Int, b: Int) -> Int in
    return a + b
}
```

Closure Simplified Form:

- In Swift, closures have a very flexible syntax that allows for a range of shorthand or simplified forms. This flexibility often enhances code readability and conciseness.

In a **simplified form**, Swift can infer the types of parameters and the return type from context, and thus you can omit them. Here is the simplified version of the above closure:

```
let simplifiedForm: (Int, Int) -> Int = { a, b in
    return a + b
}
```

Simplified Form

```
let fullForm: (Int, Int) -> Int = { (a: Int, b: Int) -> Int in
    return a + b
}
```

Full Form

Closure Simplified Form:

- **Features of the Simplified Form:**

1. **Type Inference**: In the simplified form, we've omitted the types of a and b, as well as the return type. Swift's type inference is smart enough to figure these out based on the closure's expected type (Int, Int) -> Int.

```
let typeInferred: (Int, Int) -> Int = { a, b in a + b }

let typeInferred2 = { (a: Int, b: Int) in a + b }
```

2. **Implicit Returns**: If the closure contains just a single return statement, you can omit the return keyword.

```
let implicitReturn: (Int, Int) -> Int = { a, b in a + b }
```

1. **Shorthand Argument Names**: Swift automatically provides shorthand names for the closure's parameters, which you can refer to as $0, $1, $2, etc. Here, $0 refers to the first argument a, and $1 refers to the second argument b.

```
let shorthandArgs: (Int, Int) -> Int = { $0 + $1 }
```

Closures

```
// 1. No input, no output
let printProfDetails: () -> Void = {
    let name = PersonName(givenName: "Si", middleName: "", familyName: "Chen")
    print(name.fullName())
}
printProfDetails()
```

```
// 2. No input, String output
let createProf: () -> String = {
    let name = PersonName(givenName: "Si", middleName: "", familyName: "Chen")
    return name.fullName()
}
let prof1 = createProf()
print(prof1)
```

```
// 3. Double input, Circle output
let createACircle: (Double) -> Circle = {
    r1 in
    let c = Circle(r: r1)
    return c
}
let c2 = createACircle(100)
print(c2.getCircumference())
```

Closures

- **Capture Lists:** Closures can "capture", or store, references to variables and constants. This is useful when you want a closure to remember those values and use them later even if the original value has been destroyed or changed.
- Here's how it looks:

```
var number = 5
let incrementer = { [number] in
    print(number + 1)
}
number = 6
incrementer()
```

Even though number changed after the incrementer closure was created, the closure still prints 6 because it captured the original value of number when the closure was created.

Closures

- **Capture Lists:** Closures can "capture", or store, references to variables and constants. This is useful when you want a closure to remember those values and use them later even if the original value has been destroyed or changed.

```
func makeIncrementer() -> () -> Int {
    var counter = 0
    let incrementer: () -> Int = {
        counter += 1
        return counter
    }
    return incrementer
}
```

In this case, every call to **makeIncrementer**() would return a new **incrementer** closure that has its own counter capture list.

Closures

- **Escaping Closures** Closures that are passed as arguments to a function, but are called after the function is done executing are known as **escaping closures**. Escaping closures are written with a **@escaping** annotation.

```
func doSomething(escapingClosure: @escaping () -> Void) {
    DispatchQueue.main.async {
        escapingClosure()
    }
}
```

In this function, the escapingClosure might be called after doSomething() returns. Hence, it escapes the function's scope.

Closures

- **Escaping Closures** often use as method parameters
  - Can be really useful when we want to be notified when a long-running task is completed
- Example: We want to save the details of our **Circle** object to a remote database.
  - We may want to be notified when this process has completed.
    - Execute some additional code → Printing a completion message, update UI, …etc
  - Passing a closure to execute on completion

```
var saveHandler: ((Bool) -> Void)? // closure, take a Bool to indicate whether the save was a success

func saveToRemoteDatabase(handler: @escaping (Bool) -> Void){ // @escaping, a modifier, tells the compiler rather than using the closure within this method,
                                                              // we intend to store the closure and use it later, the closure will be *escaping* the scope of
                                                                  this method
    saveHandler = handler
    // send circle object to remote database
    // once remote save is complete, it calls saveComplete(Bool)
    saveComplete(success: true)
}
func saveComplete(success: Bool)
{
    saveHandler?(success)
}
```

Closures Examples

- Imagine we are developing an iOS App for a restaurant, and we need a piece of code that can handle food orders. A customer can tap on a food item to place an order.
- Now, how would you write this code using closures in Swift?

```
var orderFood: (String) -> Void = { foodItem in
    print("Order received for \(foodItem)")
}
```

Now, whenever a customer taps on a food item, you could execute this closure:

```
orderFood("Pizza")
```

In the console, you would then see: "Order received for Pizza".

Closures Examples

- Imagine we are developing a food delivery app and need a function to calculate the **total cost** of an order.
- This includes the **sum of the prices of each food item, plus a delivery fee**.
  - The sum and fee will vary, so we want to use a closure to perform this calculation.
- We can visualize this as follows:

How to implement this closure?

```
var foodPrices = [10, 15, 20]
var deliveryFee = 5

var totalCost: (([Int], Int) -> Int)?
```

Here, we have an array of food prices foodPrices, a fixed delivery fee deliveryFee, and a closure totalCost that takes an array of integers and an integer, and returns an integer.

Closures Examples

- **Here's how we can solve it:**
  - Step 1: We assign a block of code that performs the necessary calculation to totalCost.

```
totalCost = {
    prices, fee in
    var sum = 0
    for price in prices {
        sum += price
    }
    return sum + fee
}
```

  - Step 2: We can now use this closure to calculate the total cost of an order.

```
let cost = totalCost?(foodPrices, deliveryFee)

print("The total cost of the order is: \(cost)")
```

Exercise: Calculating Damage

- Create a closure named **calculateDamage** that takes two arguments: an integer representing the player's attack power, and a float representing the enemy's defense factor (a number between 0 and 1). The closure should return an integer representing the damage dealt to the enemy.

```
let calculateDamage: (Int, Float) -> Int = { attackPower, defenseFactor in
    // Your code here
}
```

Exercise: Checking Level Up

Checking Level Up:

- Create a closure named **checkLevelUp** that takes two arguments: an integer representing the player's current level, and an integer representing the player's current experience points. Assume 100 points are needed to level up. The closure should return a **boolean** indicating whether the player levels up.

```
let checkLevelUp: (Int, Int) -> Bool = { currentLevel, currentXP in
    // Your code here
}
```

Exercise: High Score Tracker

High Score Tracker

- You are developing a simple game where players can achieve high scores. You need a way to track the highest score achieved so far even after a new game starts. Create a closure that can update and provide the highest score whenever called.

```
var highestScore = 0

let trackHighScore: (Int) -> Int = { newScore in
    // Your code here to compare and possibly update the highest score
}

// Usage:
// Assume these calls happen at different times during game play
let newHighScore1 = trackHighScore(100)  // Highest score so far: 100
let newHighScore2 = trackHighScore(150)  // Highest score so far: 150
let newHighScore3 = trackHighScore(120)  // Highest score remains 150
```

Fetching data from APIs

- Most iOS app needs to interact with the internet, whether it's fetching images from a server, communicating with a database, or accessing various services. You do all of these via APIs (Application Programming Interfaces)

API Example: https://pokemon.wcpc.fun/id/1


```
{"base_experience":64,"base_happiness":70,"capture_rate":45,"color_id":5,"conquest_order":null,"evolution_chai
ender_differences":0,"hatch_counter":20,"height":7,"id":1,"identifier":"bulbasaur","is_baby":0,"is_default":1,
```


URL and URLComponents

- A URL (Uniform Resource Locator) is basically the address of a particular resource on the internet.
- In Swift, we have the **URL** and **URLComponents** classes that let's us work with URLs.
- **URL** is straightforward, and you typically use it to create a URL from a String like so:

```
let url = URL(string: "https://someapi.com/data")
```

- **URLComponents**, however, is more flexible. It represents the components of a URL and allows you to construct and manipulate URLs more granularly.

```
var urlComponents = URLComponents()
urlComponents.scheme = "https"
urlComponents.host = "api.swaggerhub.com"
urlComponents.path = "/apis/swagger-api/school/1.0.0"

let url = urlComponents.url
print(url!)
```

URL and URLComponents

```
var urlComponents = URLComponents()
urlComponents.scheme = "https"
urlComponents.host = "api.swaggerhub.com"
urlComponents.path = "/apis/swagger-api/school/1.0.0"

let url = urlComponents.url
print(url!)
```

Note: In the Swift programming language, the ! symbol is used for force-unwrapping an optional value.

However, if urlComponents.url is nil, attempting to force-unwrap it will result in a runtime error. Typically, using optional binding or other safer methods of unwrapping is a better choice. For instance, you could do the following:

```
if let url = urlComponents.url {
    print(url)
} else {
    print("Invalid URL components")
}
```

URLSession

- **URLSession** is Swift's primary API for networking. With it, you can send and receive data, upload and download files, and do much more. Here's how you can fetch data from a URL:

```
let session = URLSession.shared
let task = session.dataTask(with: url!) { (data, response, error) in
    if let error = error {
        print("Error: \(error)")
    } else if let data = data {
        let str = String(data: data, encoding: .utf8)
        print("Received data:\n\(str!)")
    }
}
task.resume()
```

HTTP Methods (GET, POST, PUT, DELETE)

- HTTP methods define what action we want to perform to the resource. The most common methods you'll interact with are GET, POST, PUT, and DELETE.
  - **GET**: To fetch data.
  - **POST**: To send data.
  - **PUT**: To update existing data.
  - **DELETE**: To remove data.
- You can specify the HTTP method of your request like so:

```
var request = URLRequest(url: url!)
request.httpMethod = "POST" // or GET, PUT, DELETE
```

HTTP Status Codes

```
let session = URLSession.shared
let task = session.dataTask(with: url!) { (data, response, error) in
    if let error = error {
        print("Error: \(error)")
    } else if let httpResponse = response as? HTTPURLResponse {
        print("HTTP Status Code: \(httpResponse.statusCode)")
        if let data = data {
            let str = String(data: data, encoding: .utf8)
            print("Received data:\n\(str!)")
        }
    }
}
task.resume()
```

- HTTP status codes are three-digit numbers returned by servers to indicate the status of a web activity. These status codes are divided into five classes:
  - 2xx (Success): The action was received, understood and accepted.
  - 3xx (Redirection): Further action must be taken to complete the request.
  - 4xx (Client Error): The request contains bad syntax or cannot be fulfilled.
  - 5xx (Server Error): The server failed to fulfill a seemingly valid request.
- For example, a commonly seen status code is 200, which means the request has succeeded, or 404, which means the requested resource could not be found.

JSON

- **JSON** (JavaScript Object Notation) is a lightweight data-interchange format.
  - Other options: XML, YAML,…
- JSON is built on two structures:
  - A collection of name/value pairs. In various languages, this is realized as an *object*, record, struct, dictionary, hash table, keyed list, or associative array.
  - An ordered list of values. In most languages, this is realized as an *array*, vector, list, or sequence.

```
{
    "title": "Design Patterns",
    "subtitle": "Elements of Reusable Object-Oriented Software",
    "author": [
        "Erich Gamma",
        "Richard Helm",
        "Ralph Johnson",
        "John Vlissides"
    ],
    "year": 2009,
    "weight": 1.8,
    "hardcover": true,
    "publisher": {
        "Company": "Pearson Education",
        "Country": "India"
    },
    "website": null
}
```

Parsing JSON with Codable

- To parse JSON in Swift, we'd use something called 'Codable'. It's a type alias for the Decodable & Encodable protocols.
- So when something is Codable, that means it can be encoded to or decoded from a JSON structure. Here's a simple example:

```
struct User: Codable {
    var name: String
    var email: String
}

let data = ...// some JSON data
let decoder = JSONDecoder()

do {
    let user = try decoder.decode(User.self, from: data)
    print(user.name)
} catch {
    print(error)
}
```

How to fetch and parse data from the API with Swift

- 1. Build a data model (based on the structure of the JSON)

```
import Foundation

struct PokemonData: Decodable{
  //
      {"base_experience":270,"base_happiness":100,"capture_rate":45,"color_id":6
      ,"conquest_order":null,"evolution_chain_id":78,"evolves_from_species_id":null
      ,"forms_switchable":0,"gender_rate":-1,"generation_id":1,"growth_rate_id":4
      ,"habitat_id":5,"has_gender_differences":0,"hatch_counter":120,"height":4
      ,"id":151,"id:1":151,"identifier":"mew","is_baby":0,"is_default":1,"name":"Mew"
      ,"order":182,"order:1":182,"shape_id":6,"species_id":151,"weight":40}

    var name: String

}
```

How to fetch and parse data from the API with Swift

- 2. Create a Class to fetch API Data and decode it based on the model

```
// Method to fetch Pokémon data from API.
// completionHandler is called when data is successfully fetched and decoded.
private func fetchAPIData(completionHandler: @escaping (PokemonData) -> Void, pokemonID: Int) {
    let url = URL(string: "https://pokemon.wcpc.fun/id/\(pokemonID)")!

    URLSession.shared.dataTask(with: url) { (data, response, error) in
        guard let data = data else { return }

        do {
            let pokemonData = try JSONDecoder().decode(PokemonData.self, from: data)

            // Move to the main thread
            DispatchQueue.main.async {
                completionHandler(pokemonData)
            }
        } catch {
            print(error.localizedDescription)
        }
    }.resume()
}
```

Pokédex Version 3

Task: Build the Pokédex Version 3

Pokédex version 3

API Address: https://pokemon.wcpc.fun/id/1

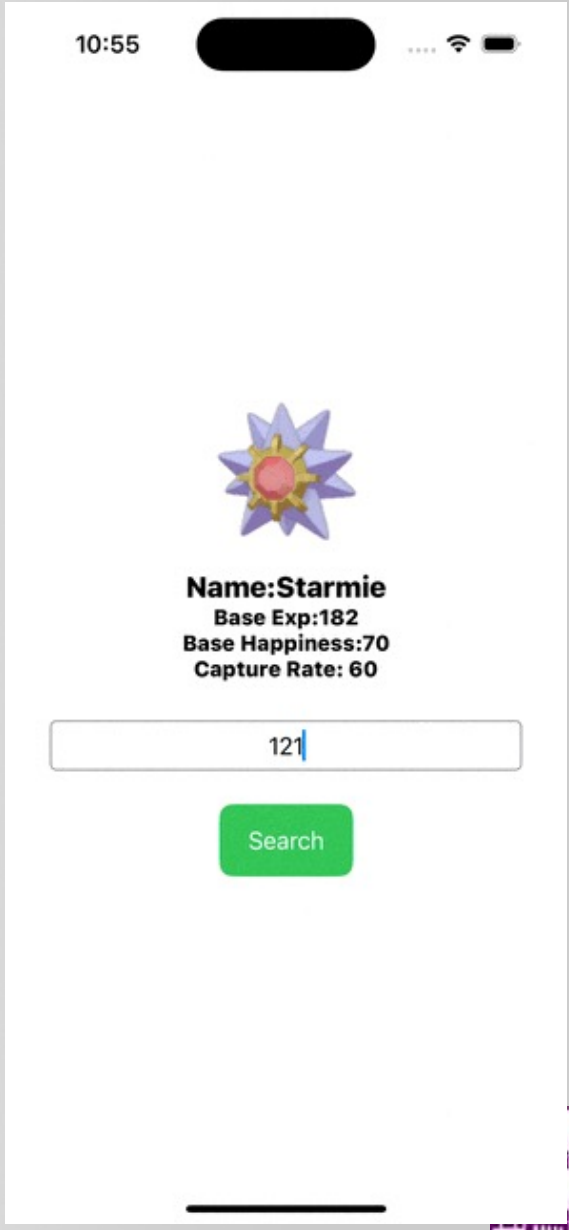
Task: Develop a Pokédex Application

Objective:

Create a user-friendly mobile application to serve as a Pokédex. The app should display crucial attributes of each Pokémon, including a profile picture.

Requirements:

- **Core Attributes**: Integrate at least four attributes from the Pokémon API, with "name" being a mandatory field. Other attributes may include weight, height, base experience, etc.
- **User Interface**: Develop an intuitive and visually appealing user interface that displays the Pokémon's profile picture alongside its attributes.
- **Search Functionality**: Implement a search feature that allows users to input a Pokémon ID and retrieve corresponding information.
- **UI Design**: Prioritize aesthetics and user experience. Aim to make the interface polished and visually engaging.



Q & A