

# SpaceAdventure

## Lesson 12

### Description

Implement the ability to travel to a random planet, and troubleshoot a runtime error.

Welcome to the Solar System.

There are 8 planets to explore.

What is your name?

Jane

Nice to meet you, Jane. My name is Eliza, I'm an old friend of Siri.

Let's go on an adventure!

Shall I randomly choose a planet for you to visit? (Y or N)

Y

Traveling to Neptune...

Arrived at Neptune. A very cold planet, furthest from the sun.

### Learning Outcomes

- Discover the `arc4random_uniform` C function, and apply the function to obtain a pseudo-random number within a range.
- Discover the Swift data type conversion idiom, and apply initializers to convert a value to another data type.
- Discover the `UInt32` datatype and describe what an unsigned integer is.
- Discuss subtle flaws in a computer program, and paraphrase a problem and solution.

### Vocabulary

pseudo-random number	<code>arc4random_uniform</code>	unsigned integer
data type conversion	<code>UInt32</code>	return value
subscripting	runtime error	

## Materials

- SpaceAdventure Lesson 12 Xcode project

## Opening

How can we get the program to select a random planet to travel to?

## Agenda

- Discuss how one might select a random integer, use that integer to subscript the `planetarySystem.planets` array, and pass the value of the retrieved planet's `name` property to the existing `visit:` method.
- Using the Xcode Documentation and API Reference (⇧⌘0), investigate the `arc4random_uniform` function.
- In the `SpaceAdventure.determineDestination` method, replace the `println` call and `TODO` in the first branch of the `if` statement with a naive implementation.

```
...
if decision == "Y" {
    let upperBound = planetarySystem.planets.count
    let index = Int(arc4random_uniform(UInt32(upperBound)))
    visit(planetarySystem.planets[index].name)
} else if decision == "N" {
    ...
}
```

- Explain the use of the C function `arc4random_uniform` to obtain a pseudo-random number between 0 and its argument; the conversion of `upperBound` to a `UInt32` to satisfy the `arc4random_uniform` parameter type; and the conversion of the return value of `arc4random_uniform` to an `Int`, in order to subscript the `planets` array.
- Run the program (⌘R), enter a name, choose Y, and observe the results displayed in the console (⇧⌘C).
- Discuss what might happen if the `planets` array is empty.
- In the `SpaceAdventure` initializer, comment out (⌘/) the adding of each `Planet` object to the `planets` array.

```
init() {  
    ...  
    // planetarySystem.planets.append(mercury)  
    ...  
    // planetarySystem.planets.append(neptune)  
}
```

- Run the program (⌘R), enter a name, choose Y, witness the program crash, and observe the "Array index out of range" runtime error displayed in the console (⇧⌘C). Stop the program with a keyboard shortcut (⌘.) or the stop button in the Xcode Toolbar.

## Closing

Why is our program crashing with a runtime error? Can you think of a way we can improve the code, to handle cases where the array of planets is empty?

## Modifications And Extensions

- Investigate pseudo-random numbers, the `arc4random` function, and different ways of generating random numbers with C and Swift. Explain why random number generation is difficult for a computer, and investigate algorithms that increase the quality of pseudo-random number generation, such as Mersenne Twister.
- Use the Debug Navigator (⌘6) to select different points in the call stack related to the runtime error, and investigate the meaning of the non-Swift code displayed for some of the items.
- Observe how the console displays the `(lldb)` prompt, and investigate the commands you can type to interact with the debugger.

## Resources

The Swift Programming Language: About Swift [https://developer.apple.com/library/prerelease/ios/documentation/Swift/Conceptual/Swift\\_Programming\\_Language/](https://developer.apple.com/library/prerelease/ios/documentation/Swift/Conceptual/Swift_Programming_Language/)

The Swift Programming Language: A Swift Tour [https://developer.apple.com/library/prerelease/ios/documentation/Swift/Conceptual/Swift\\_Programming\\_Language/GuidedTour.html](https://developer.apple.com/library/prerelease/ios/documentation/Swift/Conceptual/Swift_Programming_Language/GuidedTour.html)

The Swift Programming Language: The Basics [https://developer.apple.com/library/prerelease/ios/documentation/Swift/Conceptual/Swift\\_Programming\\_Language/TheBasics.html](https://developer.apple.com/library/prerelease/ios/documentation/Swift/Conceptual/Swift_Programming_Language/TheBasics.html)  
BSD Library Functions Manual: ARC4RANDOM(3) [https://developer.apple.com/library/mac/documentation/Darwin/Reference/ManPages/man3/arc4random\\_uniform.3.html](https://developer.apple.com/library/mac/documentation/Darwin/Reference/ManPages/man3/arc4random_uniform.3.html)

The Swift Programming Language: Integers [https://developer.apple.com/library/ios/documentation/Swift/Conceptual/Swift\\_Programming\\_Language/TheBasics.html#apple\\_ref/doc/uid/TP40014097-CH5-ID317](https://developer.apple.com/library/ios/documentation/Swift/Conceptual/Swift_Programming_Language/TheBasics.html#apple_ref/doc/uid/TP40014097-CH5-ID317)

The Swift Programming Language: Collection Types [https://developer.apple.com/library/ios/documentation/Swift/Conceptual/Swift\\_Programming\\_Language/CollectionTypes.html](https://developer.apple.com/library/ios/documentation/Swift/Conceptual/Swift_Programming_Language/CollectionTypes.html)

The Swift Programming Language: Subscripts [https://developer.apple.com/library/ios/documentation/Swift/Conceptual/Swift\\_Programming\\_Language/Subscripts.html](https://developer.apple.com/library/ios/documentation/Swift/Conceptual/Swift_Programming_Language/Subscripts.html)

Xcode Overview: Debug Your App [https://developer.apple.com/library/ios/documentation/ToolsLanguages/Conceptual/Xcode\\_Overview/DebugYourApp.html](https://developer.apple.com/library/ios/documentation/ToolsLanguages/Conceptual/Xcode_Overview/DebugYourApp.html)

LLDB Quick Start Guide [https://developer.apple.com/library/ios/documentation/IDEs/Conceptual/gdb\\_to\\_lldb\\_transition\\_guide/document/Introduction.html](https://developer.apple.com/library/ios/documentation/IDEs/Conceptual/gdb_to_lldb_transition_guide/document/Introduction.html)