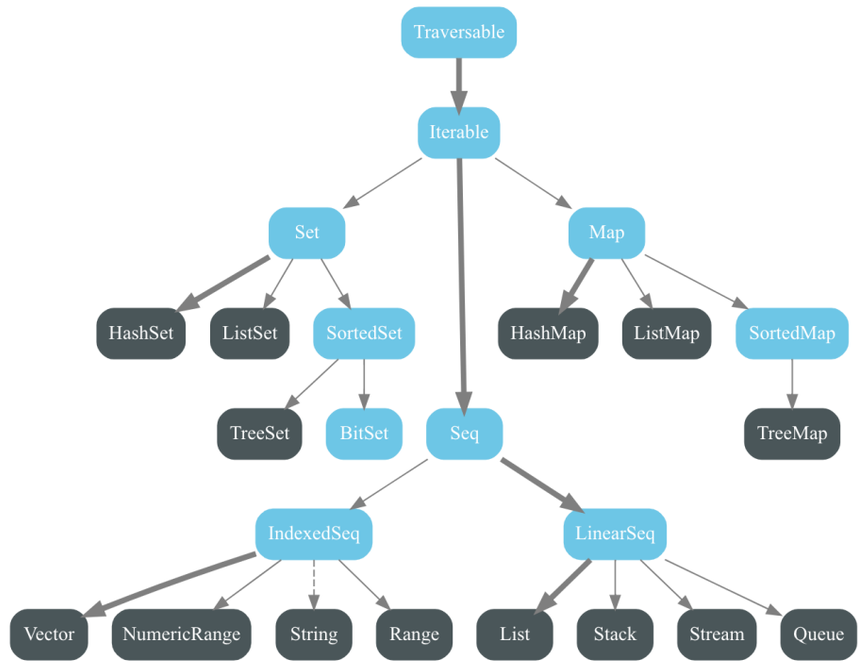
Data Structures

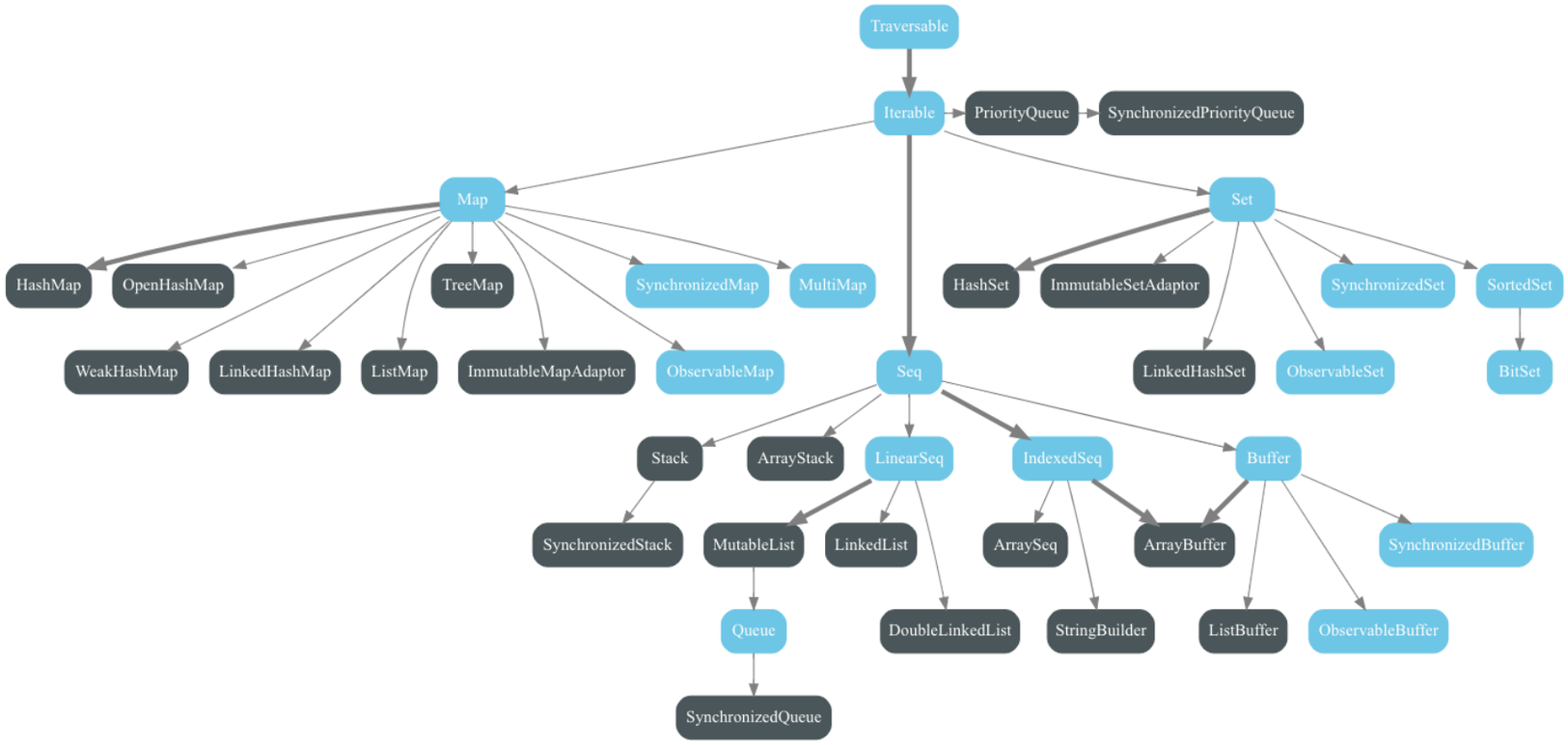
Data Structures

- Wide variety of Data Structures in Scala

Graph for immutable hierarchy:



Graph for mutable hierarchy:



https://docs.scala-lang.org/tutorials/FAQ/collections.html

Data Structures

- Let's keep it simple and focus on 3 for now
- Array
  - Sequential
  - Fixed Size
- List
  - Sequential
- Map
  - Key-Value Store

Array

- Sequential
  - One continuous block of memory
  - Random access based on memory address
    - address = first_address + (element_size * index)
- Fixed Size
  - Since memory adjacent to the block may be used
  - Efficient when you know how many elements you'll need to store

Array

```scala
def arrayExample(): Unit = {
  // Create new Array of Int
  val arr: Array[Int] = Array(2, 3, 4)

  // Change a value by index
  arr(1) = 20

  // Access a value by index
  val x: Int = arr(1)

  // Iterate over elements
  for (element <- arr) {
    println(element)
  }

  // Iterate over indices
  for (index <- 0 to arr.length) {
    println(index)
  }
}
```

List

- Sequential
  - Spread across memory
  - Each element knows the memory address of the next element
    - Follow the addresses to find each element
- Variable Size
  - Store new element anywhere in memory
  - Add store the memory address in the last element
    - or new element stores address of first element
- Values cannot change

List

```scala
def listExample(): Unit = {
  // Create new Array of Int
  var list: List[Int] = List(2, 3, 4)

  // Access the first element
  val x: Int = list.head

  // Access a value by position
  val y: Int = list.apply(1)

  // Add an element to the end of the list (append)
  list = list :+ 50

  // Add an element to the beginning of the list (prepend)
  list = 70 :: list

  // Iteration
  for(element <- list){
    println(element)
  }
}
```

Map

- Key-Value Store
  - Values stored at keys instead of indices
  - Multiple different implementations
    - Default is HashMap (CSE250 topic)
- Variable Size
- Variable Values

Map

```
def mapExample(): Unit = {
  // Create new Map of Int to Int
  var myMap: Map[Int, Int] = Map(2 -> 4, 3 -> 9, 4 -> 16)

  // Add an key-value pair
  myMap = myMap + (5 -> 25)

  // Access a value by key (Crashes if key not in map)
  val x: Int = myMap(3)

  // Access a value by key with default value if key not in map
  val y: Int = myMap.getOrElse(100, -1)

  // Iteration
  for((key, value) <- myMap){
    println("value " + value + " stored at key " + key)
  }
}
```

Nested Data Structures

- Example using an object variable

Scala Unit Testing

```scala
// return the maximum value that can be computed by multiplying two
//  different elements from the input list
//  -Two elements with the same value are considered different
// If the list only contains 1 element, return that element squared
// If the list is empty, return -1
def maxMultiply(input: List[Int]): Int = {

  if (input.isEmpty) {
    -1
  } else if (input.length == 1) {
    // round to avoid truncation errors
    Math.round(Math.pow(input.head, 2)).toInt
  } else {
    var maxFound = input.head * input.apply(1)
    var ix = 0
    var iy = 0
    for (x <- input) {
      iy = 0
      for (y <- input) {
        if (iy != ix) {
          if (x * y > maxFound) {
            maxFound = x * y
          }
        }
        iy += 1
      }
      ix += 1
    }
    maxFound
  }
}
```

Lecture Question

In a package named "lecture" there is an object named "DataStructures" with a method named "maxMultiply" attempting to solve the question from lecture. There will be a correct solution and 3 incorrect solutions in AutoLab:

```
// Return the maximum value that can be computed by multiplying two
//  different elements from the input list
//  -Two elements with the same value are considered different
// If the list only contains 1 element, return that element squared
// If the list is empty, return -1
```

Unit Testing: In a package named "tests" create a class named "TestDataStructures" as a test suite that tests the maxMultiply method

Suggestion: It is helpful to store test cases in a Map with inputs as keys and expected outputs as values

* This question will be open until midnight