

Scala Basics

cont'

Types, Loops, Strings, Reading Files, Data Structures

Lecture Question

- In a package named "lecture" create an object named "LectureQuestion" with a method named "fileSum" that takes a filename as a String and returns an Int which is the sum of the values in the file
- The input file will contain multiple lines each with multiple integer values separated by the '#' character
- Return the sum of all of the integer values in the file
- You may assume that the file exists and is properly formatted

Sample file contents:

```
3#1#8  
12#9#25#10  
-2#12  
1#2
```

Submit a zip file of your project to AutoLab: File > Export to zip file

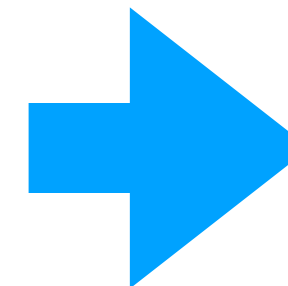
Scala Types

- All values in Scala are objects
 - Objects contain variables and methods
 - No primitive values in Scala
- We'll start with the following types:
 - Int
 - Long
 - Double
 - Boolean
 - Unit
 - String

Int

- A whole number
- 32 bit representation
- -2147483648 to 2147483647
 - Values outside this range will **overflow**
 - Overflow values will wrap around

```
val a: Int = 2147483647  
println(a + 1)
```

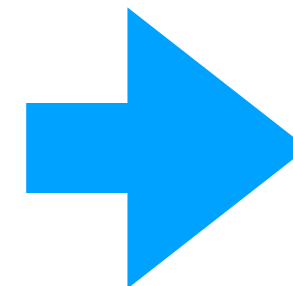


-2147483648

Long

- A whole number (Like Int)
- 64 bit representation
- -9223372036854775808 to 9223372036854775807
- Useful when you expect values that would overflow an Int

```
val a: Long = 2147483647  
println(a + 1)
```

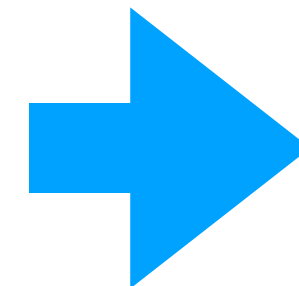


2147483648

Integer Division

- When dividing two Ints the result is always an Int
- Decimal portion is removed
- Effectively returns the floor of the result

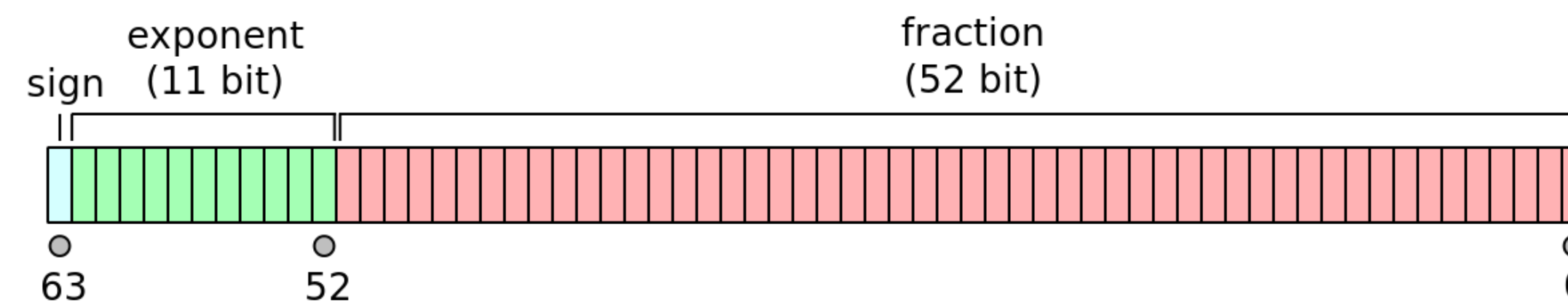
```
val ageInMonths: Int = 245  
val monthsPerYear: Int = 12  
val ageInYears = ageInMonths/monthsPerYear  
println(ageInYears)
```



20

Double

- Number with a whole number and a decimal portion
- 64 bit representation
- Values are truncated to fit in 64 bits
- Loss of precision!



https://en.wikipedia.org/wiki/Double-precision_floating-point_format

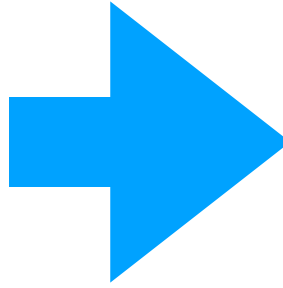
Double

- Values are represented in binary
 - Ex. $0.11 == \frac{1}{2} + \frac{1}{4} == \frac{3}{4}$
- In decimal we have values that cannot be stored without truncation
 - Ex. $\frac{1}{3} != 0.333333333333333333333333$
- Values such as 0.1 cannot be represented as a sum of powers of 2
 - 0.1 (base 10) !=
0.000110011001100110011001100110011001100110011001100110
011001 (base 2)
 - But this the best we can do with Double representations

Double

- We need to be aware of this truncation in our programs
- In the code below, `c == 0.3` is false!

```
val b: Double = 0.1  
val c: Double = b * 3  
println(c)
```

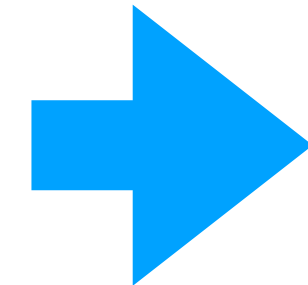


0.30000000000000004

Double

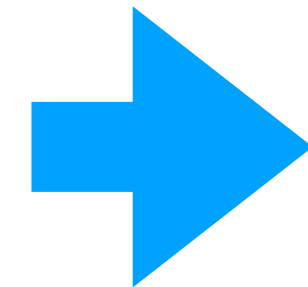
- Checking for equality with Doubles
- Allow a small amount of tolerance when comparing two doubles
- `Math.abs(x - y) < small_value`
 - As long as x and y are within a small value of each other this will be true

```
val b: Double = 0.1
val c: Double = b * 3
val expected: Double = 0.3
println(c == expected)
```



false

```
val epsilon: Double = 0.00000001
val b: Double = 0.1
val c: Double = b * 3
val expected: Double = 0.3
println(Math.abs(c - 0.3) < epsilon)
```



true

Boolean and Unit

- Boolean
 - true or false
- Unit
 - Nothing
 - Used to indicate a method/function that does not return a value
 - Ex: main and println both return Unit

String

- A sequence of characters (type Char)
- Declared with double quotes
 - `val s:String = "valid string literal"`
- Many useful methods. Examples:
 - `startsWith(String)` - check if this String starts with the given String
 - `length()` - number of characters in this String
 - `.split(String)` - Separates this String by the given String

Scala Type Conversions

```
package example

object Types {

  def main(args: Array[String]): Unit = {

    // Declaring variable
    var anInt: Int = 10
    var aDouble: Double = 5.8
    var aBoolean: Boolean = true
    var aString: String = "6.3"

    // Converting variable types
    var anotherDouble: Double = aString.toDouble
    var anotherString: String = anInt.toString

    // Truncates the decimal. anotherInt == 5
    var anotherInt: Int = aDouble.toInt
  }
}
```

Use the to<Type> methods to convert between types

For Loop

For Loop

```
for(<variable_name> <- <data_structure>){  
  <loop_body>  
}
```

Reads:

"for variable_name in data_structure execute

loop_body"

For Loop

```
package example
```

```
object Loop {
```

```
  def printOneTo(n: Int): Unit = {  
    for(i <- 1 to n){  
      println("i == " + i)  
    }  
  }
```

```
  def printOneToAlternate(n: Int): Unit = {  
    val numbers: Range = 1 to n  
    for (i <- numbers) {  
      println("i == " + i)  
    }  
  }
```

```
  def main(args: Array[String]): Unit = {  
    printOneTo(10)  
  }
```

```
}
```

Output:

i == 1

i == 2

i == 3

i == 4

i == 5

i == 6

i == 7

i == 8

i == 9

i == 10

"1 to n" creates a Range of integers that can be iterated over with a for loop

-Similar to range(n) in Python

For Loop + String Example

```
package example

object StringSplitter {

  def computePercentTrue(line: String): Double = {
    val splits: Array[String] = line.split(";")
    var totalCount: Double = 0
    var trueCount: Double = 0
    for (value <- splits) {
      val valueAsBoolean: Boolean = value.toBoolean
      if (valueAsBoolean) {
        trueCount += 1
      }
      totalCount += 1
    }
    trueCount / totalCount
  }

  def main(args: Array[String]): Unit = {
    val testInput = "true;false>true>true>true"
    val percentTrue = computePercentTrue(testInput) // expecting 0.8
    println("Percentage true == " + percentTrue)
  }
}
```

Given a String containing boolean values separated by semicolons, return the percentage of values that are true

For Loop + String Example

```
package example

object StringSplitter {

  def computePercentTrue(line: String): Double = {
    val splits: Array[String] = line.split(";")
    var totalCount: Double = 0
    var trueCount: Double = 0
    for (value <- splits) {
      val valueAsBoolean: Boolean = value.toBoolean
      if (valueAsBoolean) {
        trueCount += 1
      }
      totalCount += 1
    }
    trueCount / totalCount
  }

  def main(args: Array[String]): Unit = {
    val testInput = "true;false;true;true;true"
    val percentTrue = computePercentTrue(testInput) // expecting 0.8
    println("Percentage true == " + percentTrue)
  }
}
```

Split the String on semicolons
-Returns a data structure of Strings

For Loop + String Example

```
package example

object StringSplitter {

  def computePercentTrue(line: String): Double = {
    val splits: Array[String] = line.split(";")
    var totalCount: Double = 0
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    for (value <- splits) {
      val valueAsBoolean: Boolean = value.toBoolean
      if (valueAsBoolean) {
        trueCount += 1
      }
      totalCount += 1
    }
    trueCount / totalCount
  }

  def main(args: Array[String]): Unit = {
    val testInput = "true;false>true>true>true"
    val percentTrue = computePercentTrue(testInput) // expecting 0.8
    println("Percentage true == " + percentTrue)
  }
}
```

Iterate over each value

For Loop + String Example

```
package example

object StringSplitter {

  def computePercentTrue(line: String): Double = {
    val splits: Array[String] = line.split(";")
    var totalCount: Double = 0
    var trueCount: Double = 0
    for (value <- splits) {
      val valueAsBoolean: Boolean = value.toBoolean
      if (valueAsBoolean) {
        trueCount += 1
      }
      totalCount += 1
    }
    trueCount / totalCount
  }

  def main(args: Array[String]): Unit = {
    val testInput = "true;false>true>true>true"
    val percentTrue = computePercentTrue(testInput) // expecting 0.8
    println("Percentage true == " + percentTrue)
  }
}
```

Convert the Strings to Booleans

For Loop + String Example

```
package example

object StringSplitter {

  def computePercentTrue(line: String): Double = {
    val splits: Array[String] = line.split(";")
    var totalCount: Double = 0
    var trueCount: Double = 0
    for (value <- splits) {
      val valueAsBoolean: Boolean = value.toBoolean
      if (valueAsBoolean) {
        trueCount += 1
      }
      totalCount += 1
    }
    trueCount / totalCount
  }

  def main(args: Array[String]): Unit = {
    val testInput = "true;false>true>true>true"
    val percentTrue = computePercentTrue(testInput) // expecting 0.8
    println("Percentage true == " + percentTrue)
  }
}
```

Count the total number of values and the number that are true

For Loop + String Example

```
package example

object StringSplitter {

  def computePercentTrue(line: String): Double = {
    val splits: Array[String] = line.split(";")
    var totalCount: Double = 0
    var trueCount: Double = 0
    for (value <- splits) {
      val valueAsBoolean: Boolean = value.toBoolean
      if (valueAsBoolean) {
        trueCount += 1
      }
      totalCount += 1
    }
    trueCount / totalCount
  }

  def main(args: Array[String]): Unit = {
    val testInput = "true;false>true>true>true"
    val percentTrue = computePercentTrue(testInput) // expecting 0.8
    println("Percentage true == " + percentTrue)
  }
}
```

Compute the average

-Note: If these values were Ints this would be integer division

Reading Files

Reading Files

```
package example

import scala.io.Source

object FileReader {

  def convertFileToString(filename: String): String = {
    var contents: String = ""
    val file: BufferedSource = Source.fromFile(filename)
    for (line <- file.getLines()){
      contents += line + "\n"
    }
    contents
  }

  def main(args: Array[String]): Unit = {
    val filename = "data/testFile.txt"
    val contents = convertFileToString(filename)
    println(contents)
  }
}
```

Read the contents of a file into a String line-by-line
-Assumes "data/testFile.txt" exists in the project

Reading Files

```
package example
```

```
import scala.io.Source
```

```
object FileReader {
```

```
  def convertFileToString(filename: String): String = {  
    var contents: String = ""  
    val file: BufferedSource = Source.fromFile(filename)  
    for (line <- file.getLines()){  
      contents += line + "\n"  
    }  
    contents  
  }
```

```
  def main(args: Array[String]): Unit = {  
    val filename = "data/testFile.txt"  
    val contents = convertFileToString(filename)  
    println(contents)  
  }
```

```
}
```

Import the Source object from the standard library

Reading Files

```
package example

import scala.io.Source

object FileReader {

  def convertFileToString(filename: String): String = {
    var contents: String = ""
    val file: BufferedSource = Source.fromFile(filename)
    for (line <- file.getLines()){
      contents += line + "\n"
    }
    contents
  }

  def main(args: Array[String]): Unit = {
    val filename = "data/testFile.txt"
    val contents = convertFileToString(filename)
    println(contents)
  }
}
```

Call `scala.io.Source.fromFile(filename: String): BufferedSource`

Reading Files

```
package example

import scala.io.Source

object FileReader {

  def convertFileToString(filename: String): String = {
    var contents: String = ""
    val file: BufferedSource = Source.fromFile(filename)
    for (line <- file.getLines()){
      contents += line + "\n"
    }
    contents
  }

  def main(args: Array[String]): Unit = {
    val filename = "data/testFile.txt"
    val contents = convertFileToString(filename)
    println(contents)
  }
}
```

Call `BufferedSource.getLines()` to get the lines in a data structure of Strings

Reading Files

```
package example

import scala.io.Source

object FileReader {

  def convertFileToString(filename: String): String = {
    var contents: String = ""
    val file: BufferedSource = Source.fromFile(filename)
    for (line <- file.getLines()){
      contents += line + "\n"
    }
    contents
  }

  def main(args: Array[String]): Unit = {
    val filename = "data/testFile.txt"
    val contents = convertFileToString(filename)
    println(contents)
  }
}
```

Do whatever you need to do with the content of the file (Just printing to the screen in this example)

Reading Files

Example in IntelliJ

Data Structures

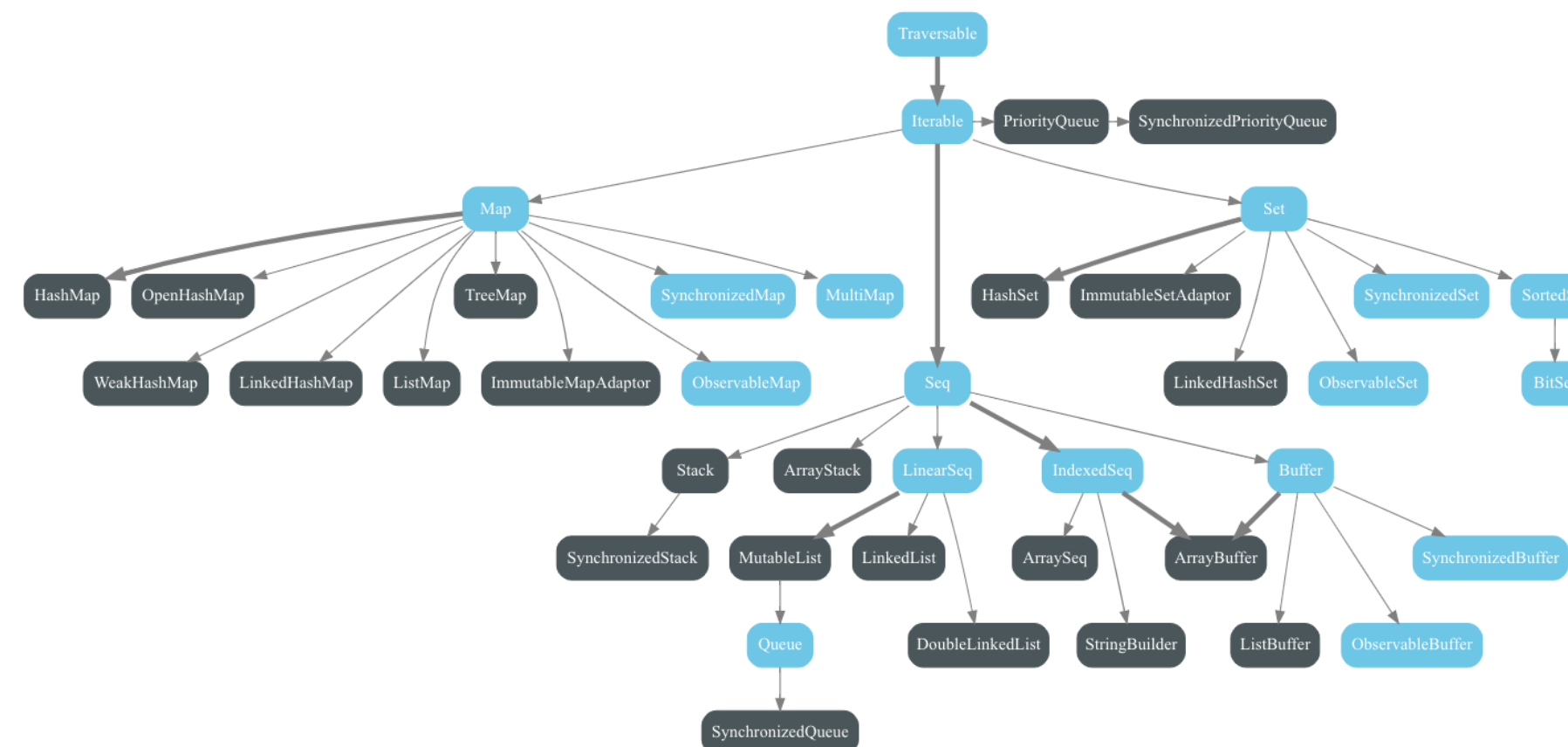
Data Structures

- 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
 - $\text{address} = \text{first_address} + (\text{element_size} * \text{index})$
- Fixed Size
 - Since memory adjacent to the block may be used
 - Efficient when you know how many elements you'll need to store

Array

```
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 - 1)) {  
    println(index)  
  }  
  
  // Iterate over indices - alternate  
  for (index <- arr.indices) {  
    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 the new memory address to the last element
 - Or new element stores address of first element
- Values cannot change [In Scala]

List

```
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 a 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)  
  }  
}
```

Lecture Question

- In a package named "lecture" create an object named "LectureQuestion" with a method named "fileSum" that takes a filename as a String and returns an Int which is the sum of the values in the file
- The input file will contain multiple lines each with multiple integer values separated by the '#' character
- Return the sum of all of the integer values in the file
- You may assume that the file exists and is properly formatted

Sample file contents:

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```

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