CSE 250
Data Structures

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Scala

Announcements

- AI Quiz on Autolab available now.
  - Due Mon Feb 6 @ 11:59 PM
  - Submit as many times as you want
  - To pass the class, your final submission must indicate that you have satisfied the requirement (1.0 out of 1.0 score)
  - If you don’t have access to CSE-250 on Autolab, let course staff know.

- Recitations and Office Hours start next week
- JOIN THE PIAZZA!

Why Scala?

- Strongly Typed Language
  - The compiler helps you make sure you mean what you say.
- JVM-based, Compiled Language
  - Run anywhere, but also see the impacts of data layout.
- Interactive REPL Interpreter
  - It’s easy to test things out quickly (more on this later).
- Well Thought-Out Container Library
  - Clearly separates data structure role and implementation.

Environment

- IntelliJ
  - Ubuntu Linux
  - MacOS
  - Windows
- Emacs/Vim + SBT
  - Ubuntu Linux
  - MacOS
  - Windows / WSL

Labs will come with an IntelliJ workspace and an SBT build.sbt file

Coding Style is Important!

Indentation

Names

Comments

Consistency

Braces

Return values

```
def doThings() = {
                val someString = 42
        val xyz = for (i <- 1 to 5) yield i
val   QQ = xyz.map(_+someString)
    // This is a for loop.
    for (q <- QQ) println(q)
       // this is also a for loop
    for (i <- 0 until 14) println(i)
5
}
```

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- Indentation
- Names
- Comments
- **Consistency**
- Braces
- Return values

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Coding Style is Important!

Indentation - indent bracketed code uniformly

Names - give variables *semantically* meaningful names

Useful comments - convey the “why” not the “what”

Consistency - *many* ways to express concepts, pick one and be consistent

Braces - like indentation, braces are not required, but can help avoid bugs

Return values - clearly indicate them

Coding Style is Important!

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This isn't just for our benefit...you will be reading your code more than anyone! Help yourself out!

Some Best Practices

- **Never** start with code!
  - Plan out what you are trying to do
  - Think about the bigger picture first
- Figure out what you have. How is it structured?
  - Draw (on real paper) diagrams
  - Construct examples
- What do you want to get, and how should that be structured?
  - Same as above
- How do you get from one to the other?
  - Connect the diagrams
  - Pseudocode!!! (break the big problem down into smaller ones)

What if you get stuck?

- Explain *exactly* what you have tried
  - Which test cases fail? How do they fail? Have you written your own?
  - What other things have you tried which don't work?
- Explain what you are trying to accomplish and why
  - Context matters
  - Sometimes figuring out the what and the why can already uncover misunderstandings
- Follow coding style guidelines! It will be easier to help you.
- WRITE TESTS!!!

Still stuck?

- **Guarantee**: If you bring us (mostly working) pseudocode, the TAs and I will help you translate it to Scala.
- Translation Challenges:
  - Syntax (e.g., “I don’t know how to break out of a for loop”)
    - Ask on Piazza, Office Hours, Recitation; We will help you!
  - Semantics (e.g., “I don’t know how to insert into a linked list”)
    - Ask, but we’ll ask you to be more precise
- Oftentimes questions about syntax are actually asking about semantics.

Still stuck?

- **Guarantee**: If you bring us (mostly working) pseudocode, the TAs and I
-
-
- tics.

Ultimately, you aren't here to learn Scala. You are here to learn about data structures.

If Scala is tripping you up, we want to help.

Now…onto some Scala

Type	Description	Examples
`Boolean`	Binary value	`true, false`
`Char`	16-bit unsigned integer	`'x', 'y'`
`Byte`	8-bit signed integer	`42.toByte`
`Short`	16-bit signed integer	`42.toShort`
`Int`	32-bit signed integer	`42`
`Long`	64-bit signed integer	`42l`
`Float`	Single-precision floating-point number	`42.0f`
`Double`	Double-precision floating-point number	`42.0`
`Unit`	No value	`()`

Primitive Types in Scala

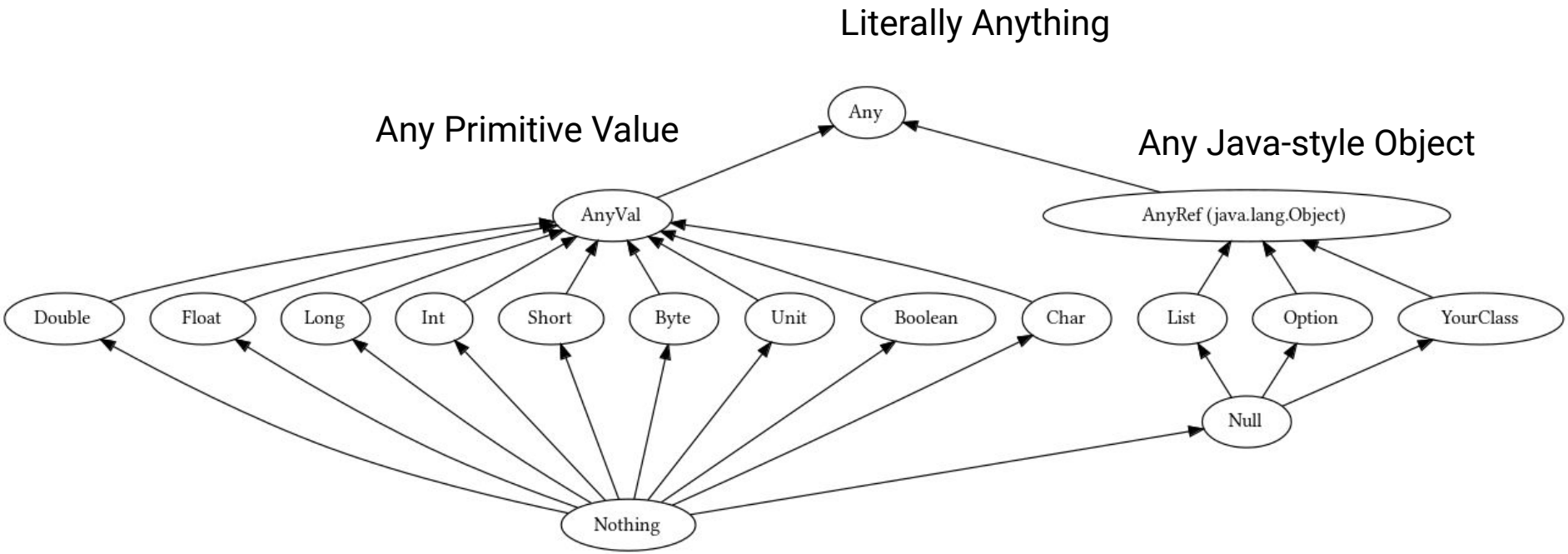

image: Scala-Lang Tour, Scala Type Hierarchy [https://docs.scala-lang.org/tour/unified-types.html]

Every Expression has a Type

Optionally, you can annotate anything with “ : type”

- Variables (declare the type)
- Functions (declare the return type)
- Parenthesized arithmetic

Anything you don’t annotate, Scala will try to infer

```
val cost: Float = (7 / 2.0).toFloat

val income = 15 + 10.2 * 9.3f

def howCute(x: Int) = “Aw” + “w” * x
```

Every Expression has a Type

Optionally, you can annotate anything with “ : type”

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Anything you don’t annotate, Scala will try to infer

`val cost: Float = (7 / 2.0).toFloat`	**Float**
`val income = 15 + 10.2 * 9.3f`	**Double**
`def howCute(x: Int) = “Aw” + “w” * x`	**Int => String**

Inconsistent Types

```
val indicator = if (x > 0) { “positive” * x }
                else { -1}
```

What is the type of `indicator`?
A: String
B: Int
C: Any
D: AnyRef

Inconsistent Types

```
val indicator = if (x > 0) { “positive” * x }
                else { -1 }
```

What is the type of `indicator`?
A: String
B: Int
C: Any
D: AnyRef

Answer: C
The if clause is a String (AnyRef)
The else clause is an int (AnyVal)

Inconsistent Types

```
val indicator = if (x > 0) { “positive” * x }
                else { -1.toString }
```

Now the type of `indicator` is `String`

Every Block has a Return Value/Type

What is the return value of this horrific block of code?

```
def doThings() = {
                val someString = 42
        val xyz = for (i <- 1 to 5) yield i
val   QQ = xyz.map(_+someString)
    // This is a for loop.
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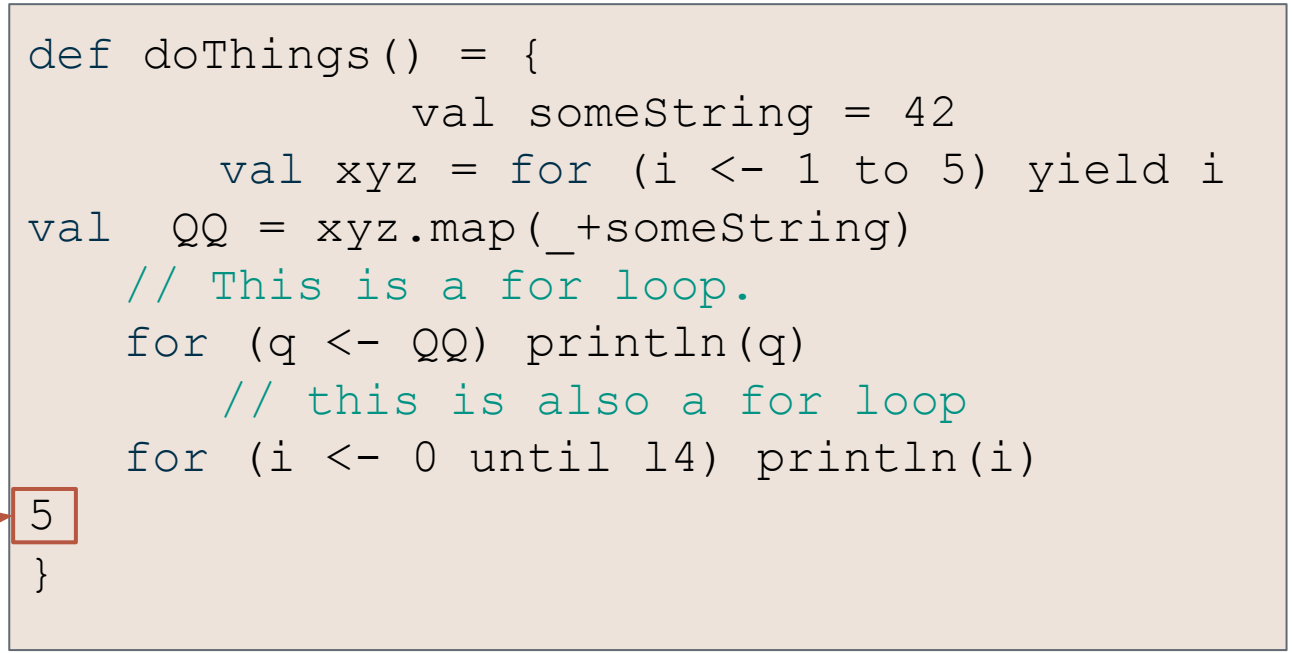
5
}
```

Every Block has a Return Value/Type

What is the return value of this horrific block of code?

The *last line* of every block is its value



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```

Assignments using Blocks

```
val point = { val x = 10; val y = 20; (x,y) }


val name = {
    val first = “Eric”
    val last = “Mikida”
    first + “ “ + last
}
```

Assignments using Blocks

```
val point = { val x = 10; val y = 20; (x,y) }
```

Value of `point`: (10, 20)

```
val name = {
    val first = "Eric"
    val last = "Mikida"
    first + " " + last
}
```

Value of `name`: “Eric Mikida”

Assignments using Blocks

```
val point = { val x = 10; val y = 20; (x,y) }
```

(notice the semicolons for the single-line assignment)

```
val name = {
    val first = "Eric"
    val last = "Mikida"
    first + " " + last
}
```

Mutable vs Immutable

Mutable	Immutable
Can be changed	Cannot be changed
`var` **var**iable that can be reassigned	`val` **val**ue that cannot be reassigned

Mutable state is more flexible (can but updated), but it is harder to reason about!

Will this work?

```
val set = mutable.Set(1,2,3)

set += 4
```

Will this work?

```
val set = mutable.Set(1,2,3)

set += 4
```

Yes!

After executing this code, `set` will *point to* a mutable set containing 1, 2, 3 and 4!
The key here is “points to”.
`set` was assigned a reference that points to a mutable set
We did not change that reference (we followed the rules, `set` is immutable)
What we changed was the object being referenced

Scala Class Types

- `class`
  - Normal OOP type (instantiate with ‘new’)
- `object`
  - A ‘singleton’ class; Only one instance
- `trait`
  - A ‘mixin’ class; Can not be instantiated directly
- `case class`
  - Like class, but provides bonus features

Companion Objects

An object with the same name as a class (in the same file)

- Defines global (static) methods for that class
- Useful, for example, to avoid directly using '`new`'

```
class Register(val x: Int) {
    def addValue(y: Int) = x + y
}
object Register {
    def apply(x: Int) = new Register(x)
}
val reg = Register(10)
```

← **Creates a new register instance**

Syntactic sugar: In Scala `foo(x)` *is the same as* `foo.apply(x)`