# SCALA 3



## Daniel Hinojosa

@dhinojosa dhinojosa@evolutionnext.com

# Content and Material

https://github.com/dhinojosa/nfjs-scala-3

# Scala Today

- Enjoyed by many JVM Developers
- Particularly those that desire type discipline and functional programming
- First appeared in 2004
- Designed at École Polytechnique Fédérale de Lausanne
- scala-lang.org

- New Compiler
- Scheduled for Release 2021
- http://dotty.epfl.ch/
- Currently @ 3.0.0-M3
- **Most** Scala 2 code compiles to Scala 3
- Things are still-a-changin'!

# How to Install Scala 3

- Scala 3 currently ***has not been released***
- Best way to "Install Scala 3" is through SBT (Simple Build Tool), version 1.4 and higher.
- Best *IDE* right now is VisualStudioCode with Metals plugin
- Alternate means: You can also download and build Scala 3 by downloading, unzip, and map it in your shell as your preferred Scala.

# Using SBT and Giter8

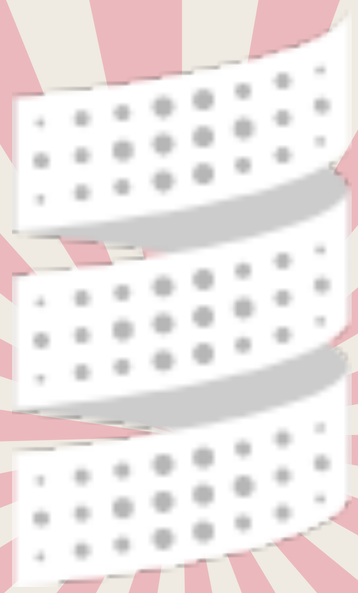
```
> sbt new scala/scala3.g8

name [Scala 3 Project Template]: Scala 3 Demo
```

# Manually Create a Project

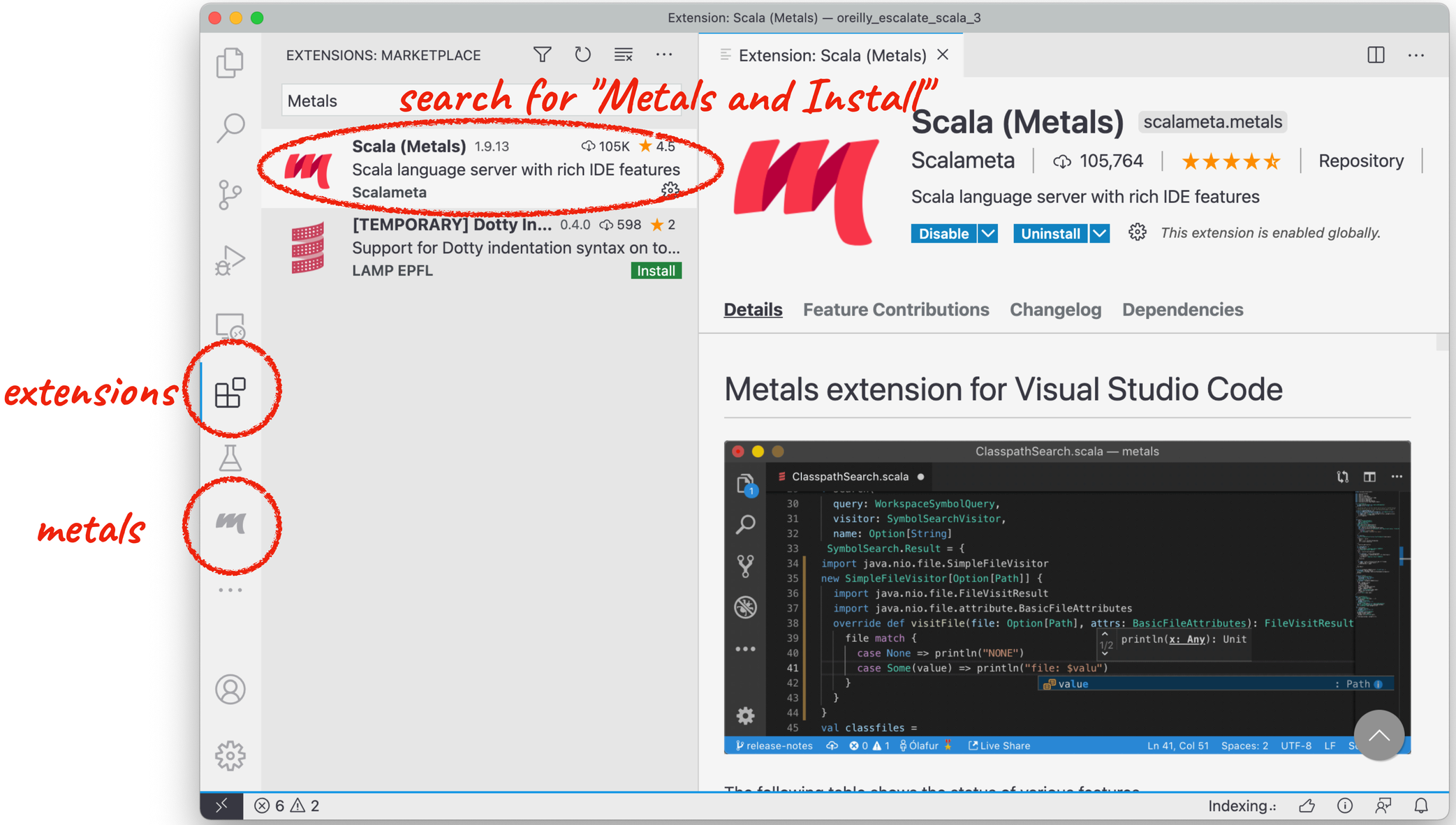
- Create  a *build.sbt* file
- Include `name`, `version`, `description` settings
- Set `scalaVersion` setting to the latest 3 version available (e.g. `3.0.0-M3`)
- Set any `scalacOptions` required and `libraryDependencies`
- Open *project/plugins.sbt* file, and add `addSbtPlugin("ch.epfl.lamp" % "sbt-dotty" % "0.5.1")`

Demo:
build.sbt
project/plugins.sbt



# Scala 3

# Visual Studio Code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EXTENSIONS: MARKETPLACE
Metals
search for "Metals and Install"
Scala (Metals) 1.9.13 105K 4.5
Scala language server with rich IDE features
Scalameta
[TEMPORARY] Dotty In... 0.4.0 598 2
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Scalameta 105,764 Repository
Scala language server with rich IDE features
Disable Uninstall
This extension is enabled globally.
Details Feature Contributions Changelog Dependencies
Metals extension for Visual Studio Code
ClasspathSearch.scala — metals
ClasspathSearch.scala
query: WorkspaceSymbolQuery,
visitor: SymbolSearchVisitor,
name: Option[String]
SymbolSearch.Result = {
import java.nio.file.SimpleFileVisitor
new SimpleFileVisitor[Option[Path]] {
import java.nio.file.FileVisitResult
import java.nio.file.attribute.BasicFileAttributes
override def visitFile(file: Option[Path], attrs: BasicFileAttributes): FileVisitResult
file match {
case None => println("NONE")
case Some(value) => println("file: $valu")
}
}
}
val classfiles =
println(x: Any): Unit
value : Path
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6 2
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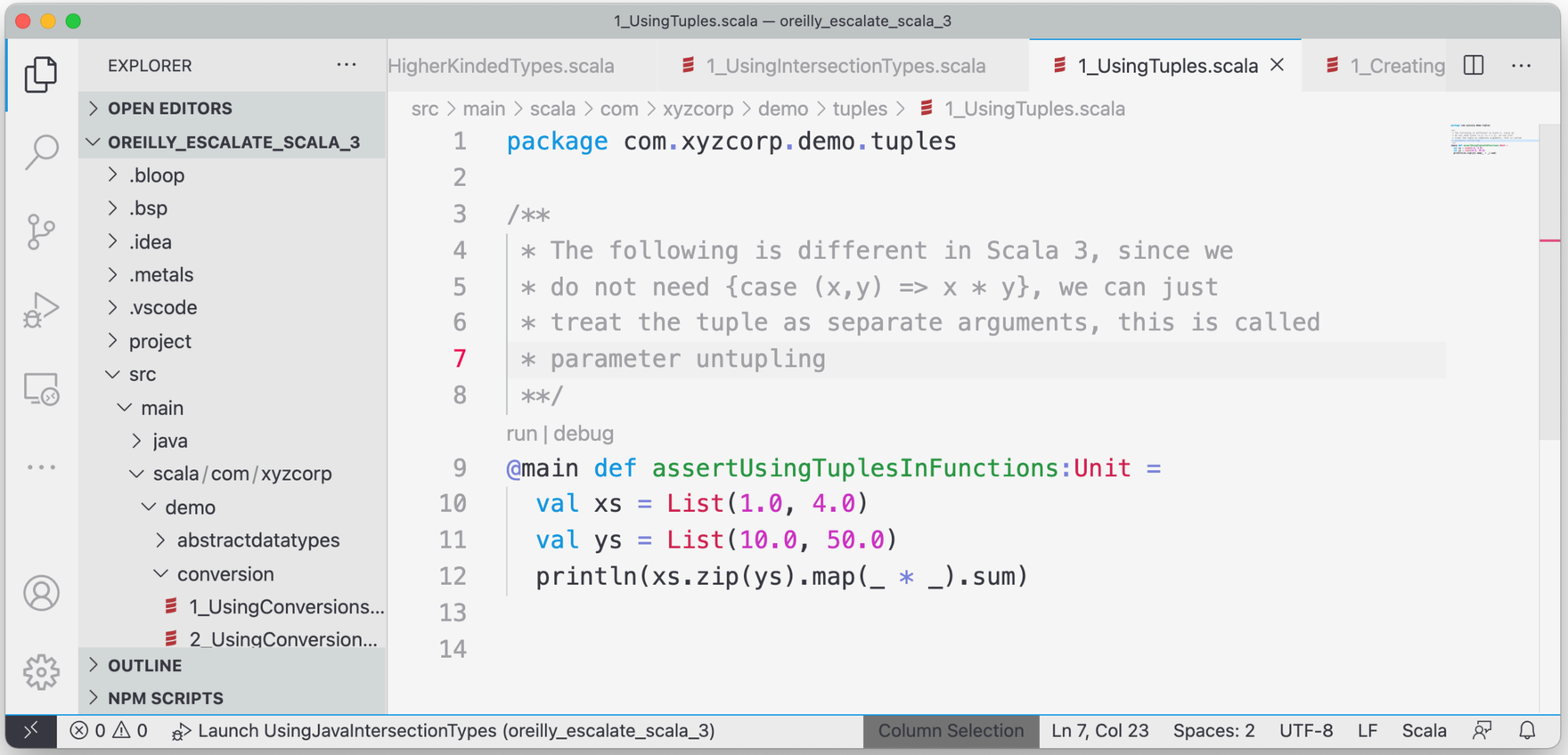


- File | Open | Select Scala Project Root Folder

# Other Editor Alternatives

- IntelliJ IDEA Scala Plugin
- Metals Works with more that just VSCode
    - VIM, Sublime, Emacs, Eclipse
    - https://scalameta.org/metals/docs/editors/overview.html

# Quick! About Scala!

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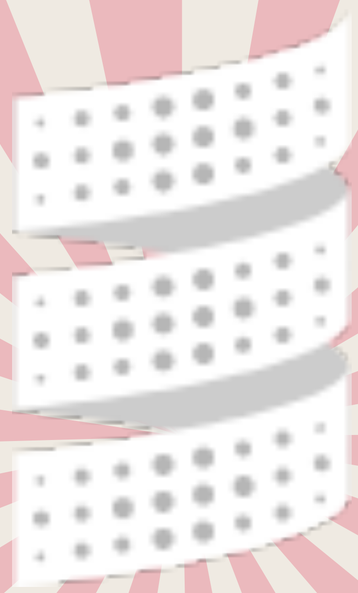

# Scala 3

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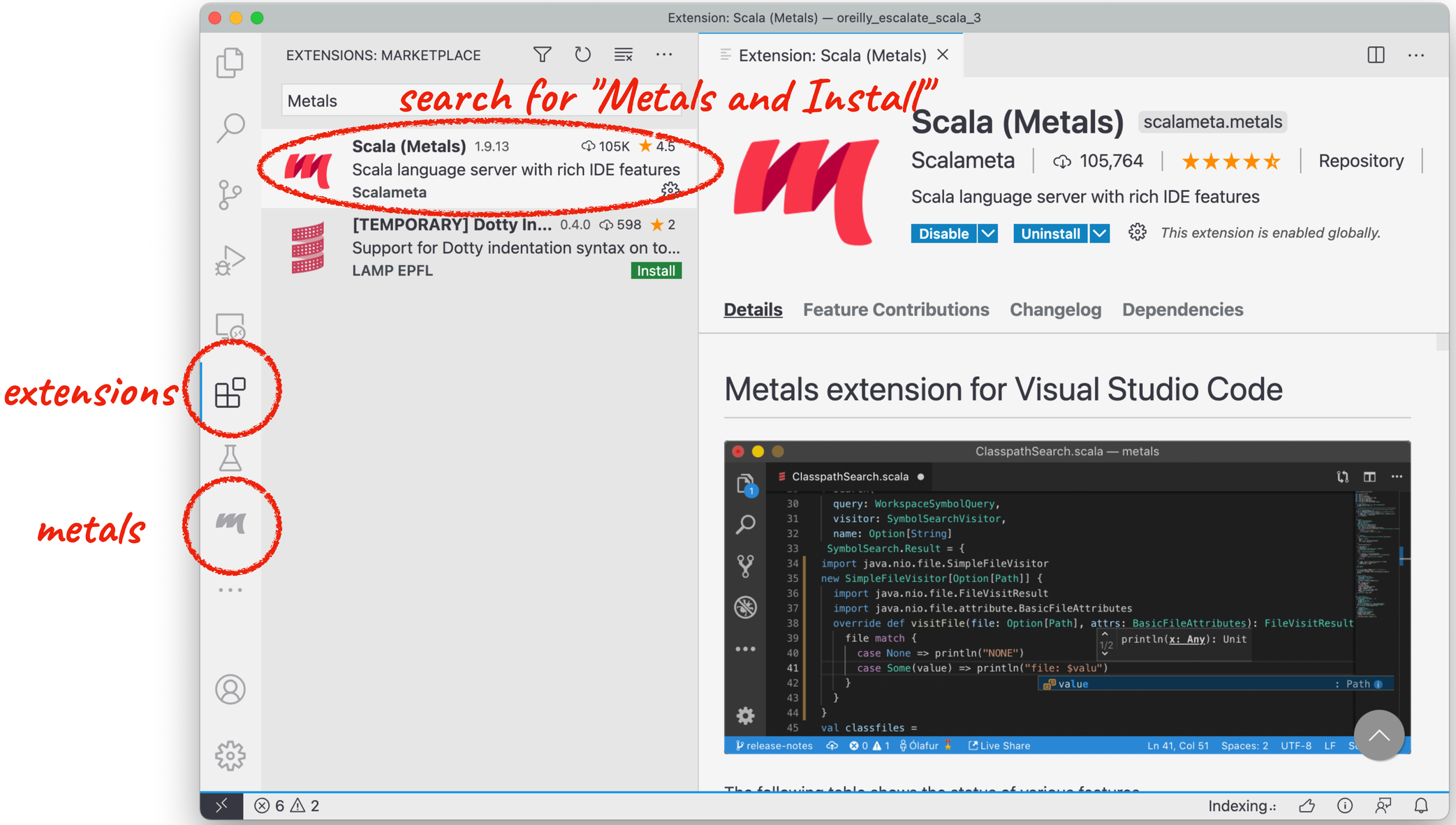
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Details Feature Contributions Changelog Dependencies
Metals extension for Visual Studio Code
ClasspathSearch.scala — metals
ClasspathSearch.scala
query: WorkspaceSymbolQuery,
visitor: SymbolSearchVisitor,
name: Option[String]
SymbolSearch.Result = {
import java.nio.file.SimpleFileVisitor
new SimpleFileVisitor[Option[Path]] {
import java.nio.file.FileVisitResult
import java.nio.file.attribute.BasicFileAttributes
override def visitFile(file: Option[Path], attrs: BasicFileAttributes): FileVisitResult
file match {
case None => println("NONE")
case Some(value) => println("file: $valu")
}
}
}
val classfiles =
println(x: Any): Unit
value : Path
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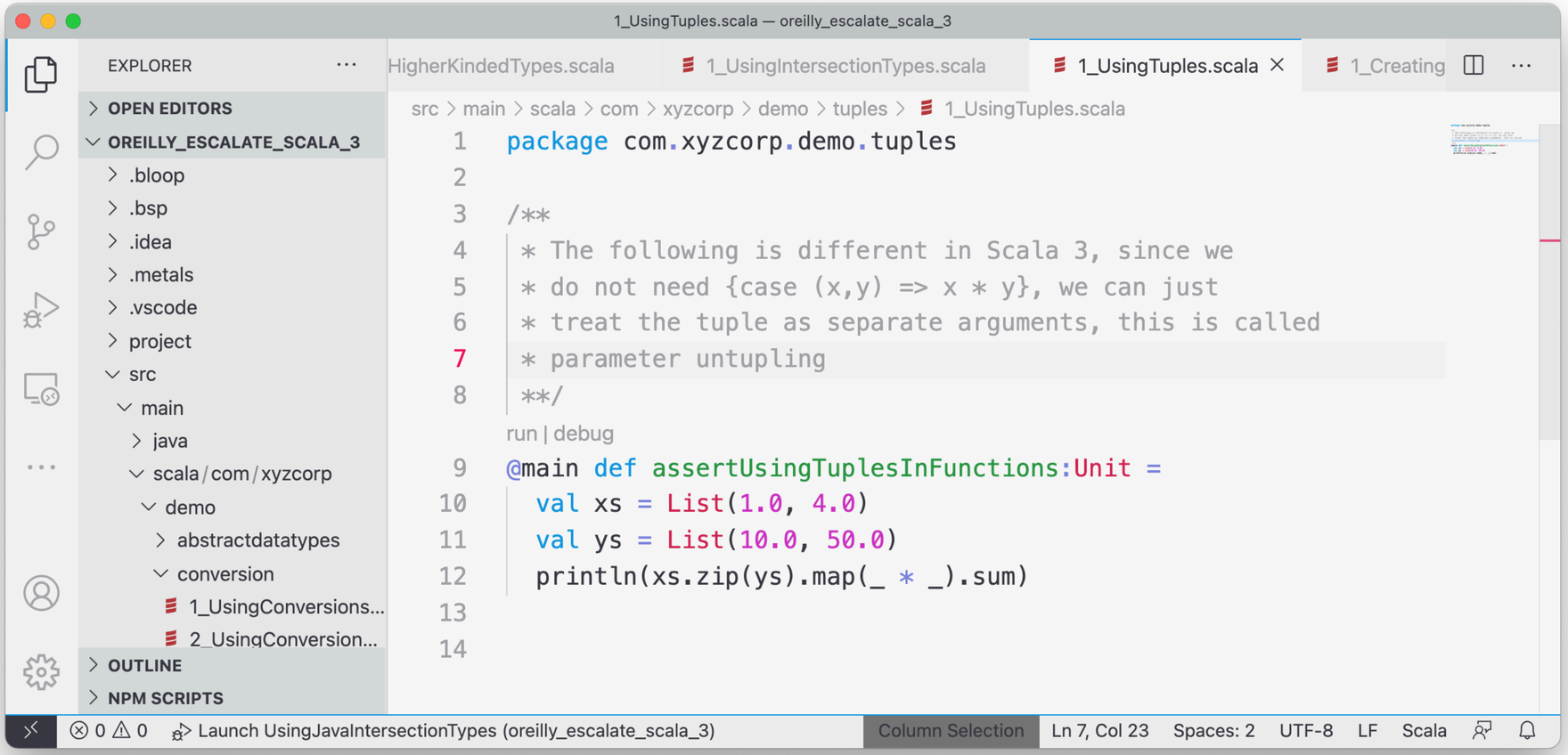


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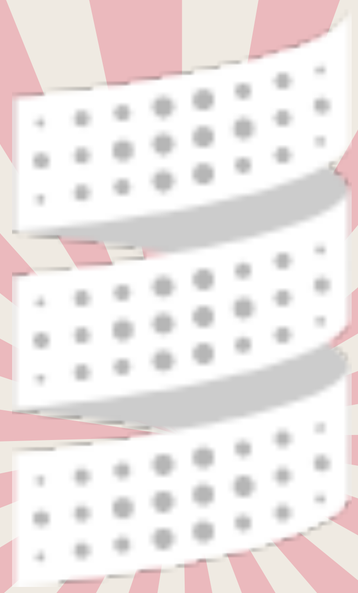
# What's new in Scala 3?



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# Aesthetic Changes

- Optionally, now we can write our code without brackets/braces. Think Python, or don't, if it will cause you acid reflux
- Violations are flagged as *warnings*
- Internally, compiler will insert `<indent>` and `<outdent>` tags
- Can be turned off with `-noindent` flag
- Indentations and Braces can be intermingled

`Demo: src/main/scala/com.xyzcorp.demo.optionalbraces.*`

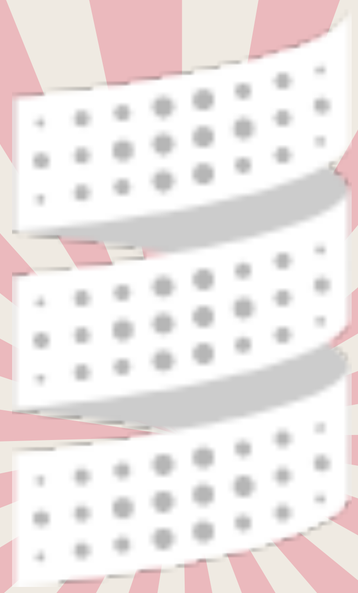
- `@main` annotations marks a method as a main method
- Situated either at the top-level or in a statically accessible object
- App will be deprecated, maybe.
- Arguments to the main method will be converted to parameters if there is a `scala.util.FromString` type
- If enough arguments aren't provided or wrong quality, then your app will terminate with an error message

Demo:
`src/main/scala/com.xyzcorp.demo.mainmethod.*`

- `if`, `else`, `else if` doesn't need a condition wrapped in a parenthesis but can be followed by `then`.
- for "loops" (not comprehensions) will make use of `do` keyword if the condition is not wrapped in parenthesis
- `for` comprehension where the condition has no parenthesis can use the `yield` keyword
- `while` loops do not need parenthesis, and would also would use `do` keyword

Demo:
`src/main/scala/com.xyzcorp.demo.newcontrolsyntax.*`

# Creating Data Types



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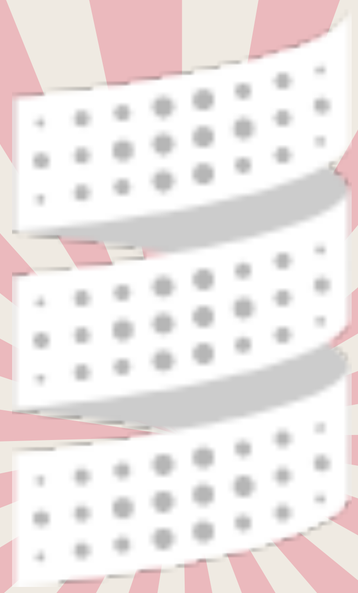
# Intersection Types

- Combination of two or more types
- "And" relationship
- Very akin to how they are implemented in Java

Demo:
src/main/java/com.xyzcorp.demo.intersectiontypes.*
src/main/scala/com.xyzcorp.demo.intersectiontypes.*



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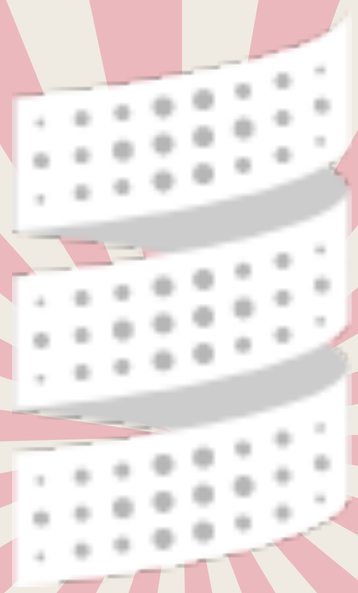
# Union Types

- Combination of two or more types
- "Or" relationship
- Very akin to how they are implemented in Haskell or Elm

```
data Bool = False | True
```

Demo:
src/main/scala/com.xyzcorp.demo.uniontypes.*



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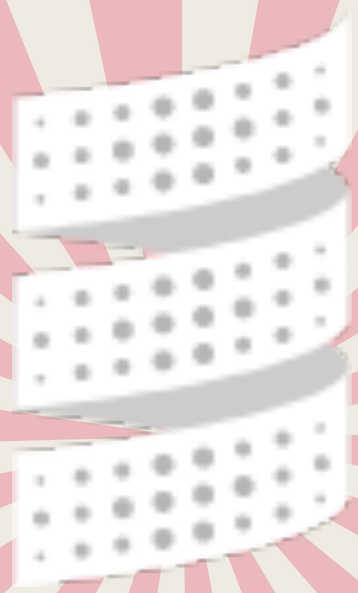
# Enumerations

- Enumerations in Scala 2 originally ***were*** kind of terrible and ignored
- Redesigned with simplicity in mind
- *union types* can model an enumeration
- Compatible with Java Enumerations

Demo:
`src/main/scala/com.xyzcorp.demo.enums.*`
`src/main/java/com.xyzcorp.demo.enums.*`



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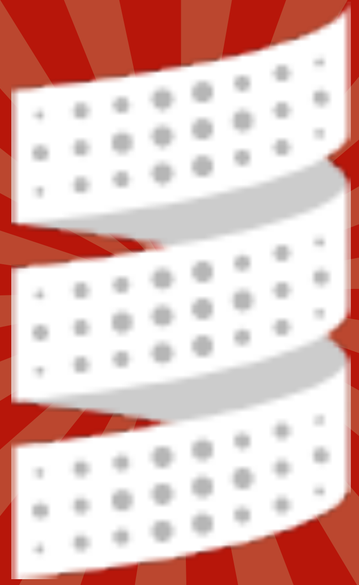
# Algebraic Data Types

- Enumerations and their ease of use makes it the best choice now for Algebraic Data Types
- Algebraic Data Types is a type associated operations but whose representation is hidden
- Also great for Generalized Algebraic Data Types to represent expressions

Demo:
`src/main/scala/com.xyzcorp.algebraicdatatypes.*`

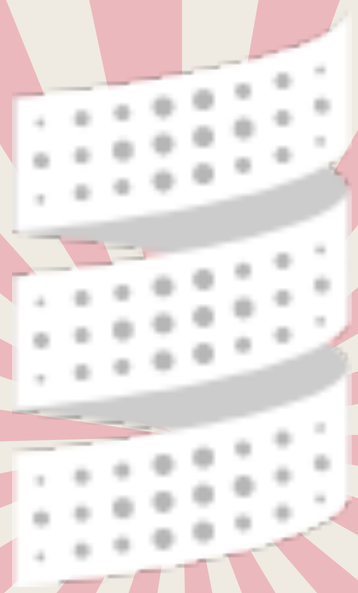
# Lab: Creating Domains

# The New Implicits



- `implicit` is a defining feature in Scala
- Binds a type to an object that can be used within a scope
- When a type is required it will retrieve that object, this has the following advantages and disadvantages
  - **Advantage -** Lessens boilerplate and cruft making your code lean
  - **Disadvantage -** Higher Learning Curve; Can be tough to chase down definition

- It is the means by which Scala programmers:
  - Create typeclasses
  - Create context values
  - Extends functionality
  - Perform Dependency Injection



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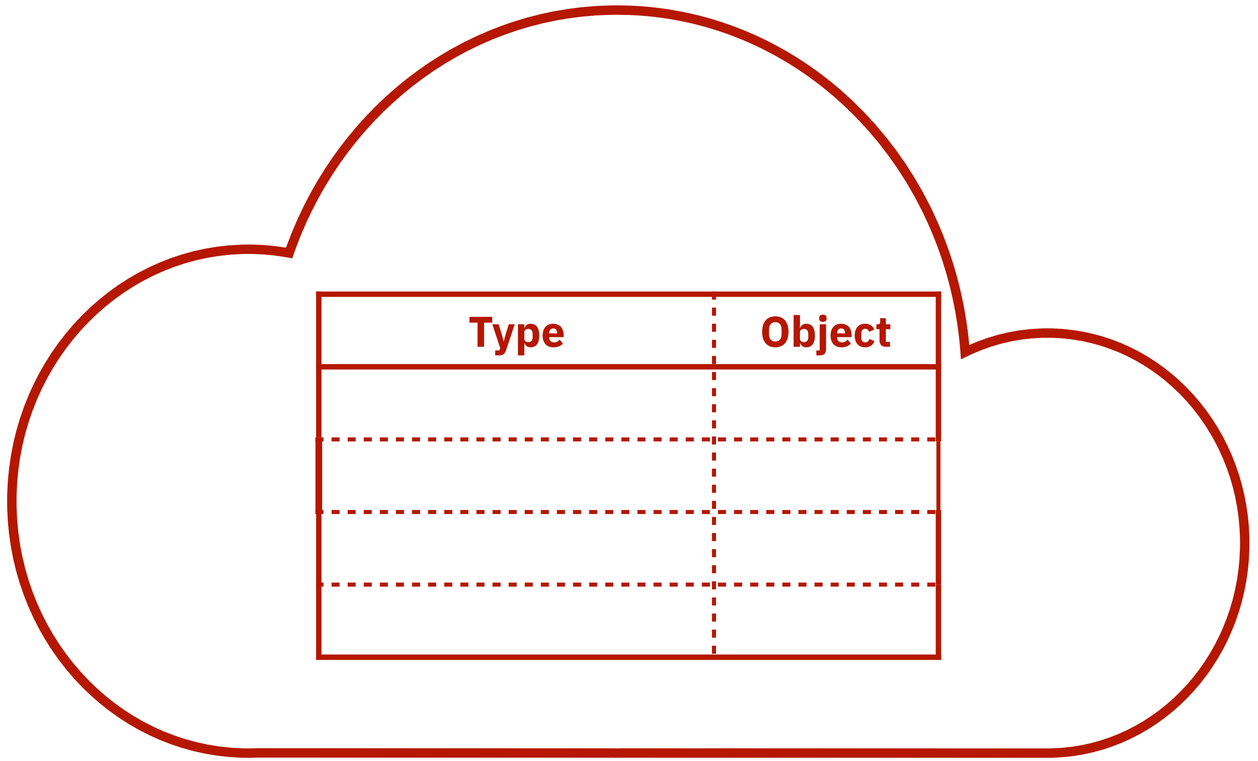
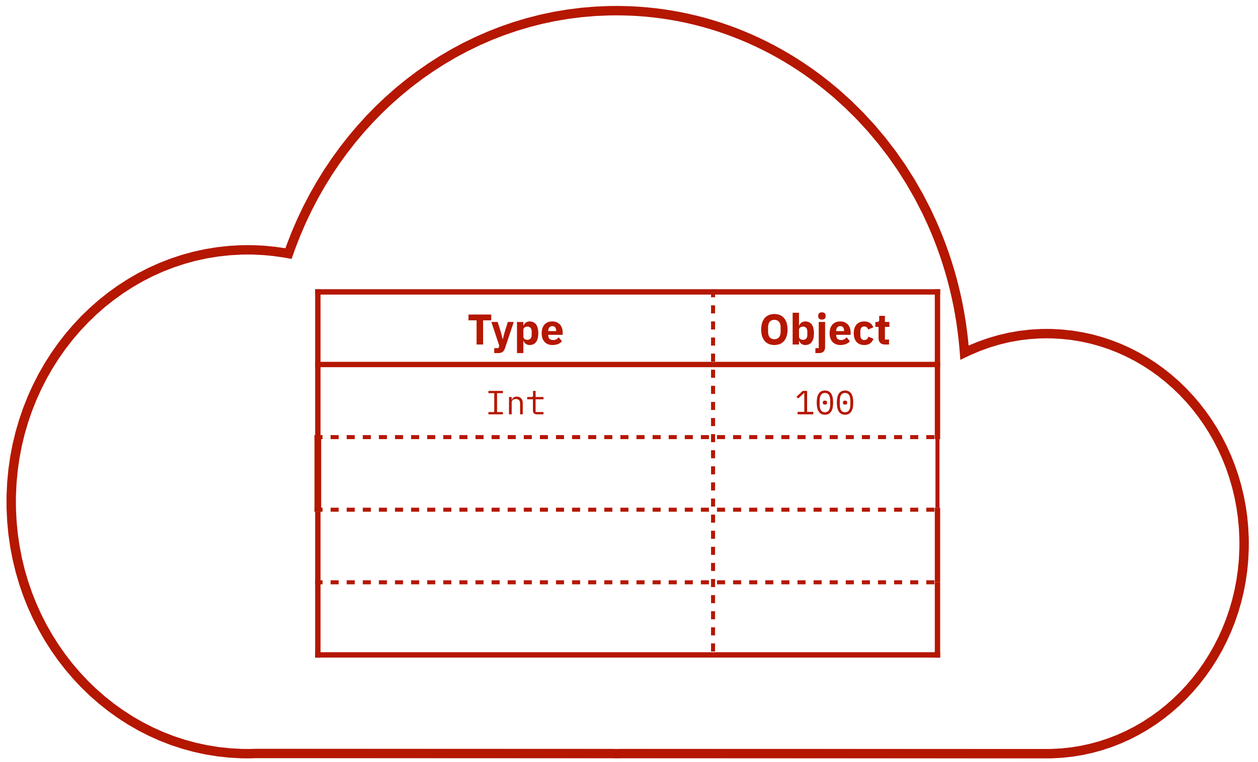
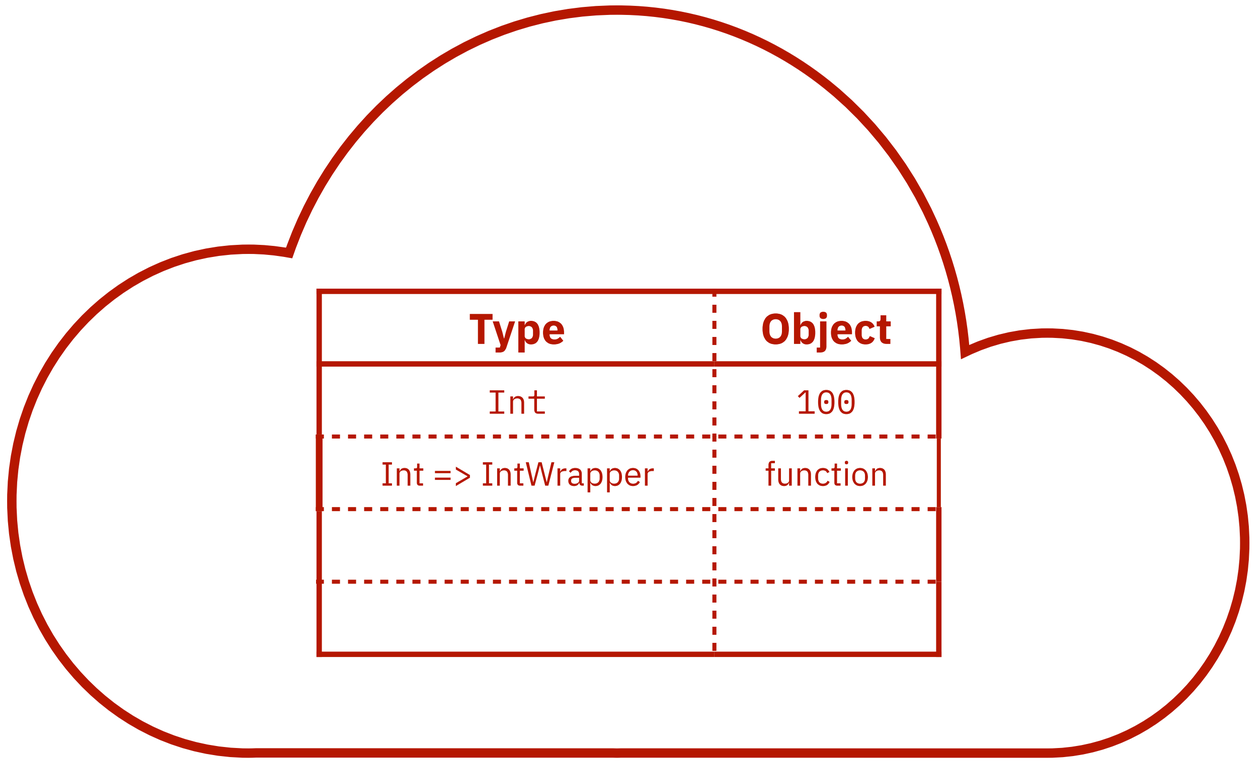
# Implicits in Scala 2

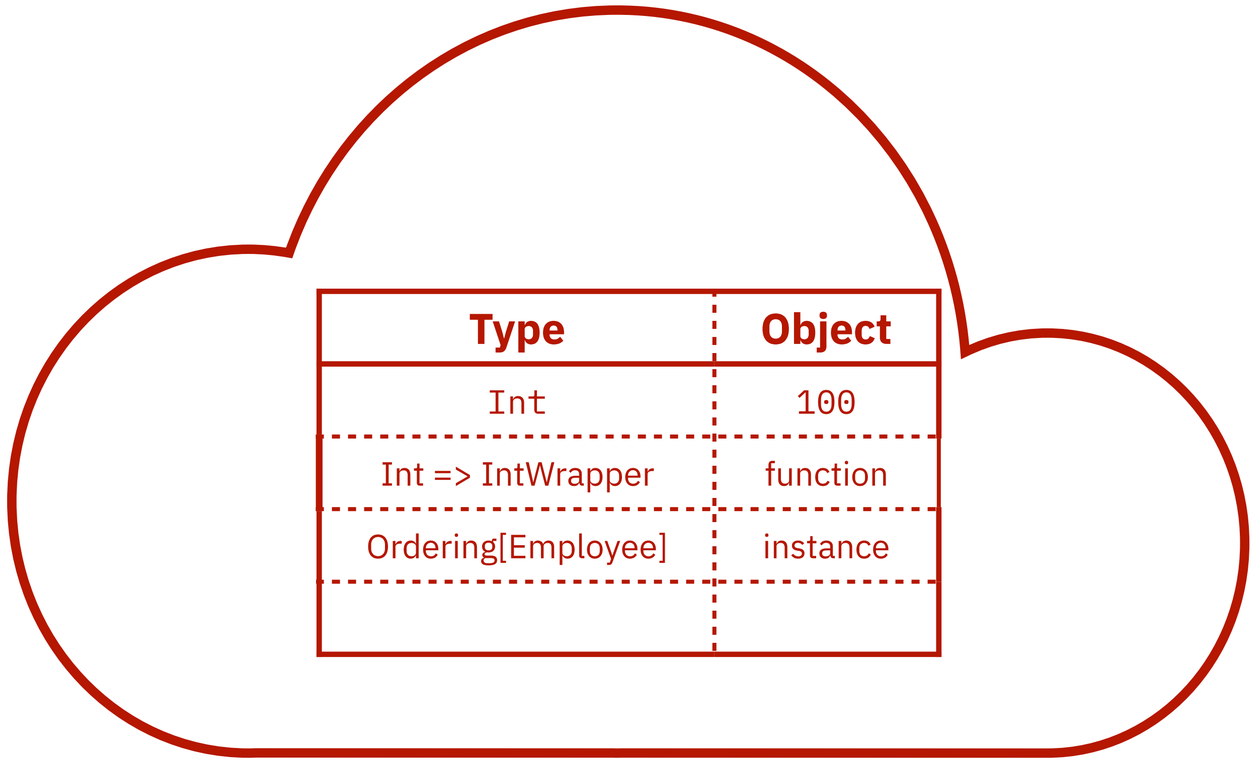

Type
Object



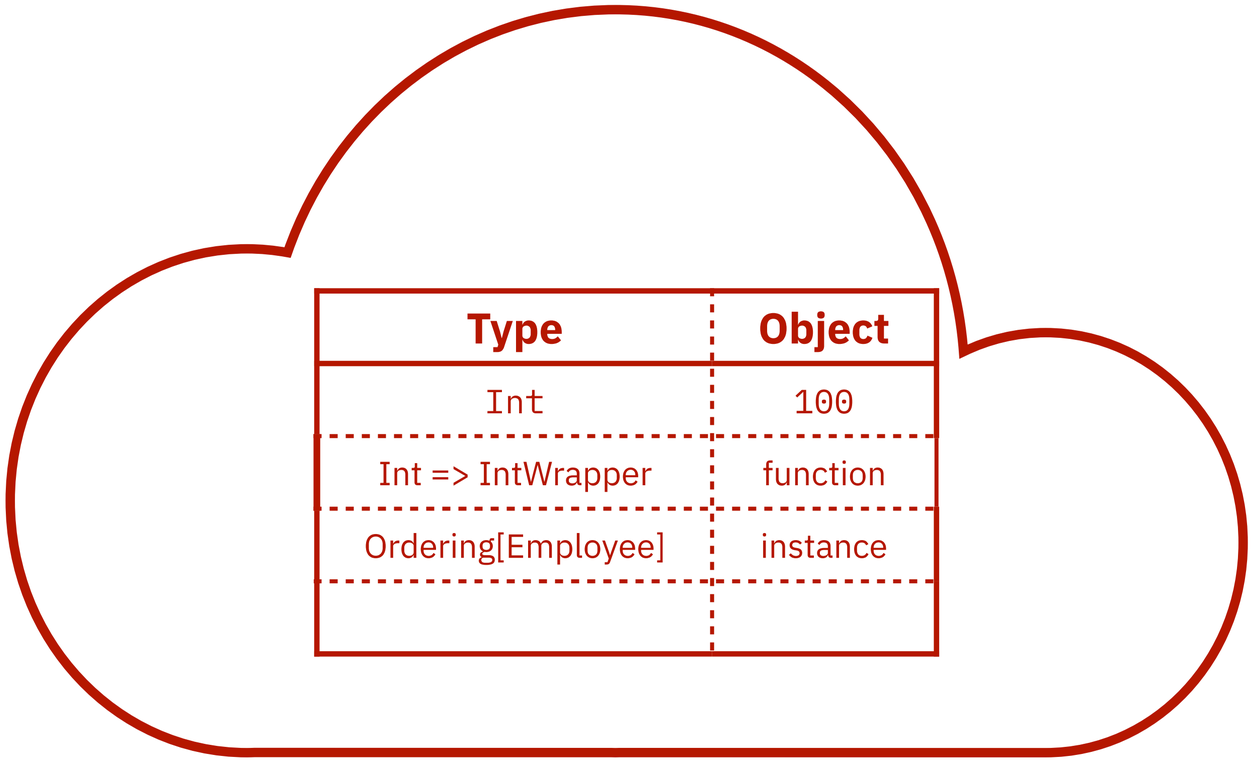

```
implicit val x:Int = 100
```




```
implicit val x = i => new IntWrapper(i)
```

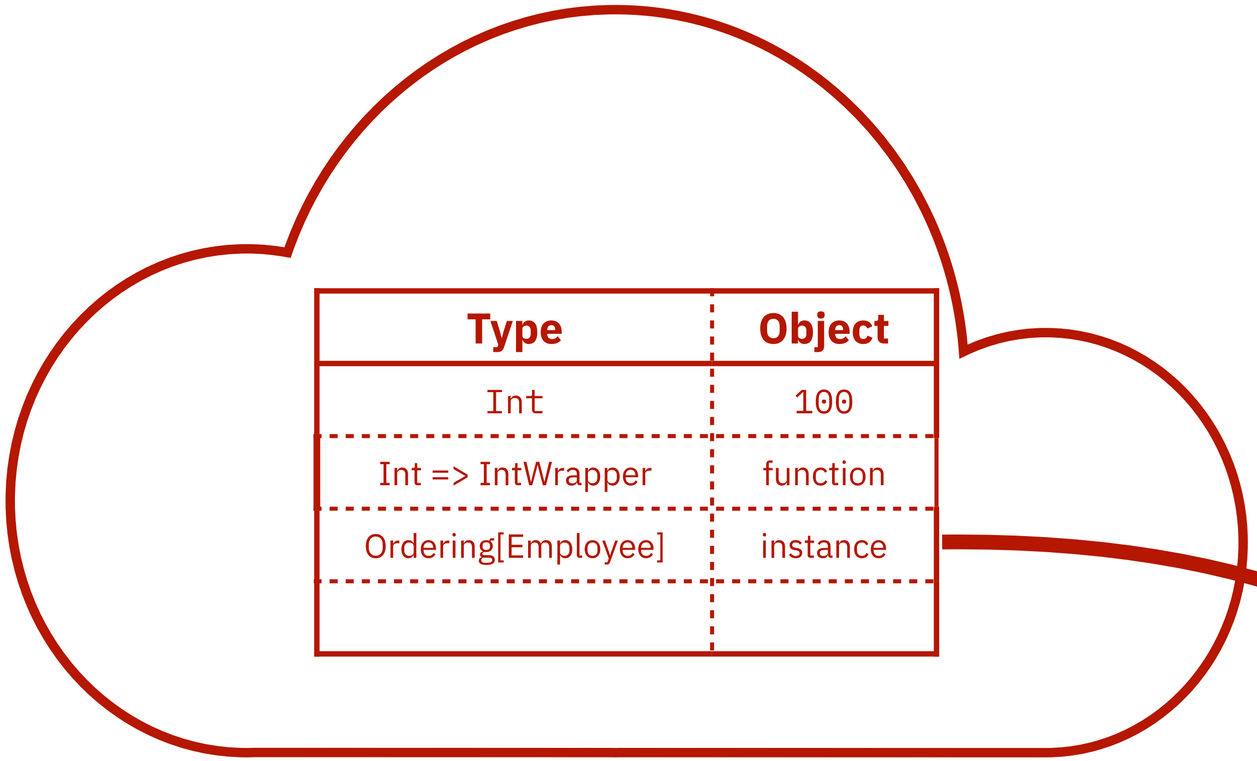



```
implicit ord:Ordering[Employee] = new Ordering[Employee]{...}
```




?

```
def mySortingMethod(list:List[Employee])(implicit o:Ordering[Employee])
```

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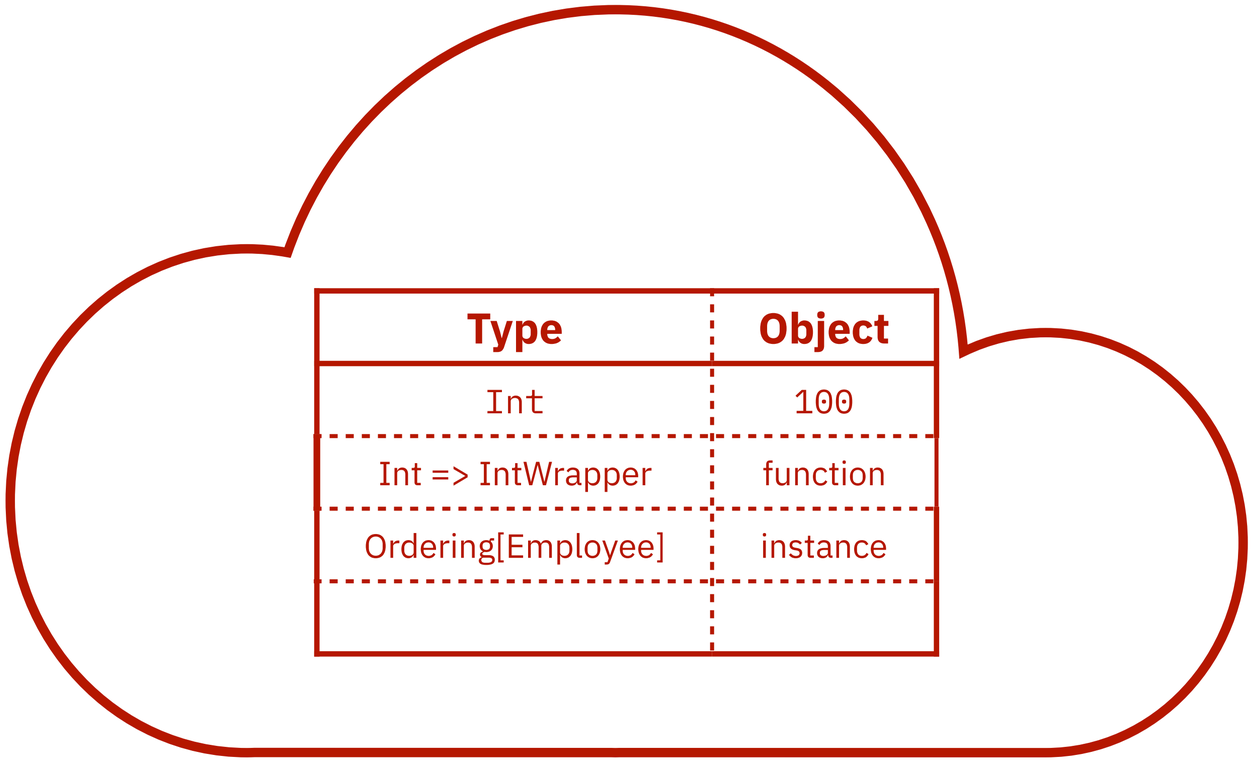
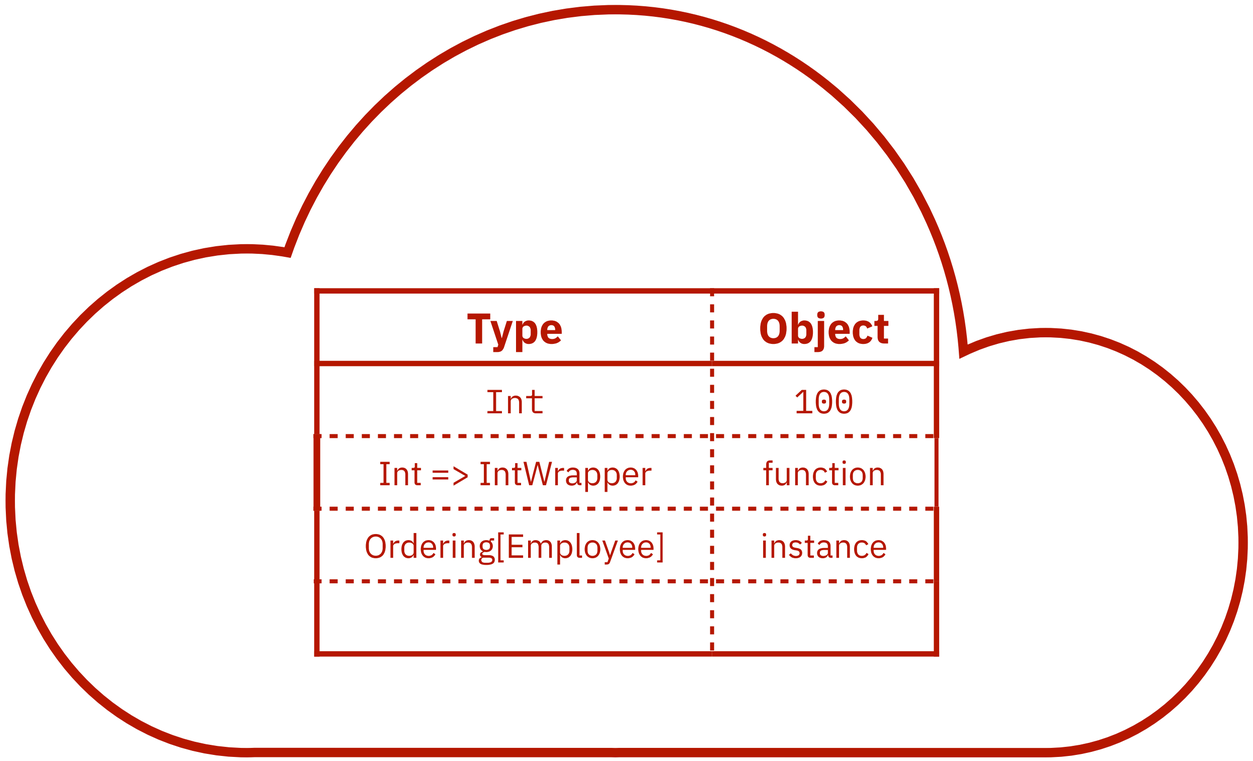
```



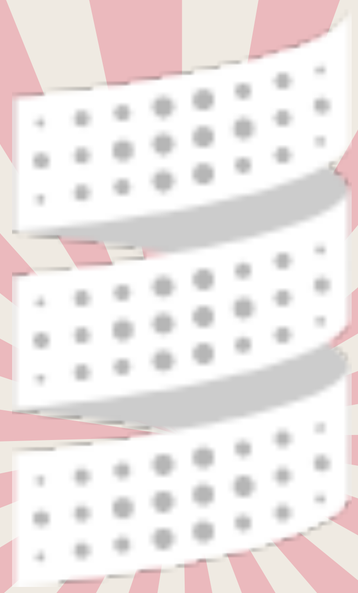

?

```
def mySortingMethod(list:List[Employee])(implicit o:Ordering[Department])
```




```
def mySortingMethod(list:List[Employee])(implicit o:Ordering[Department])
```

*No implicit ordering found for implicit*



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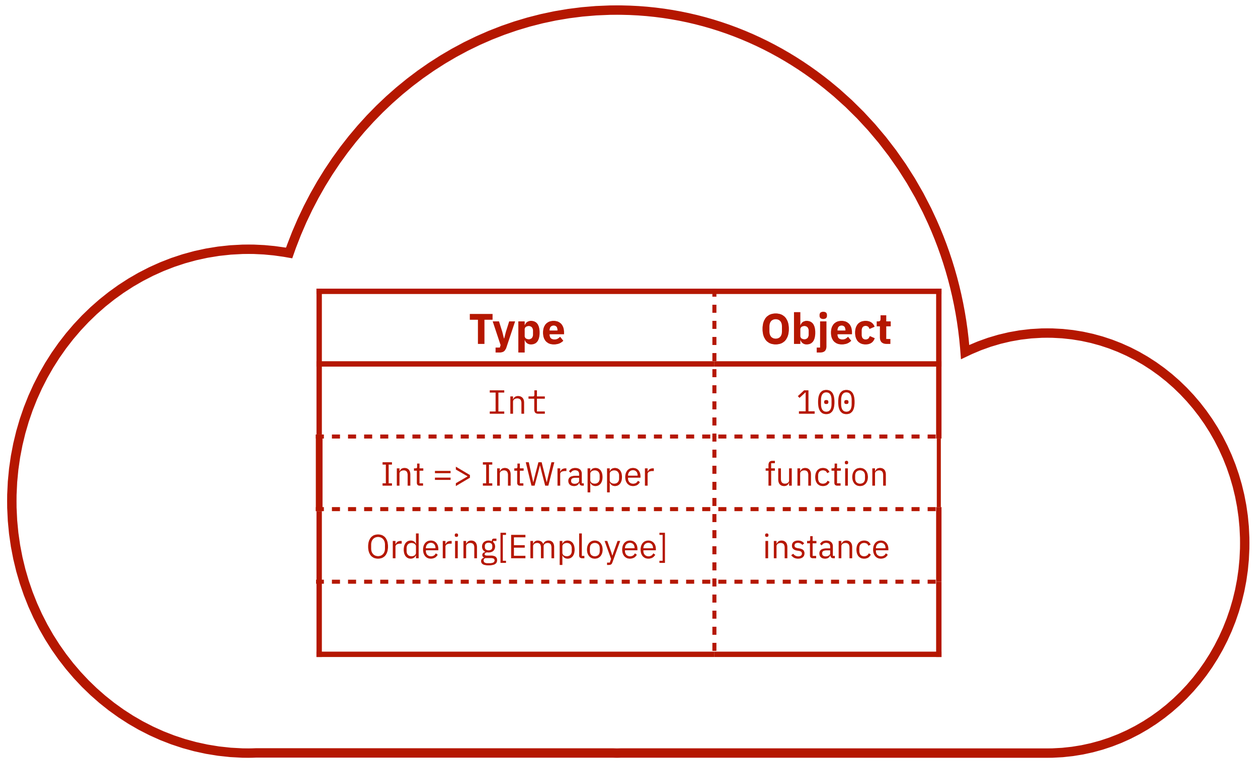
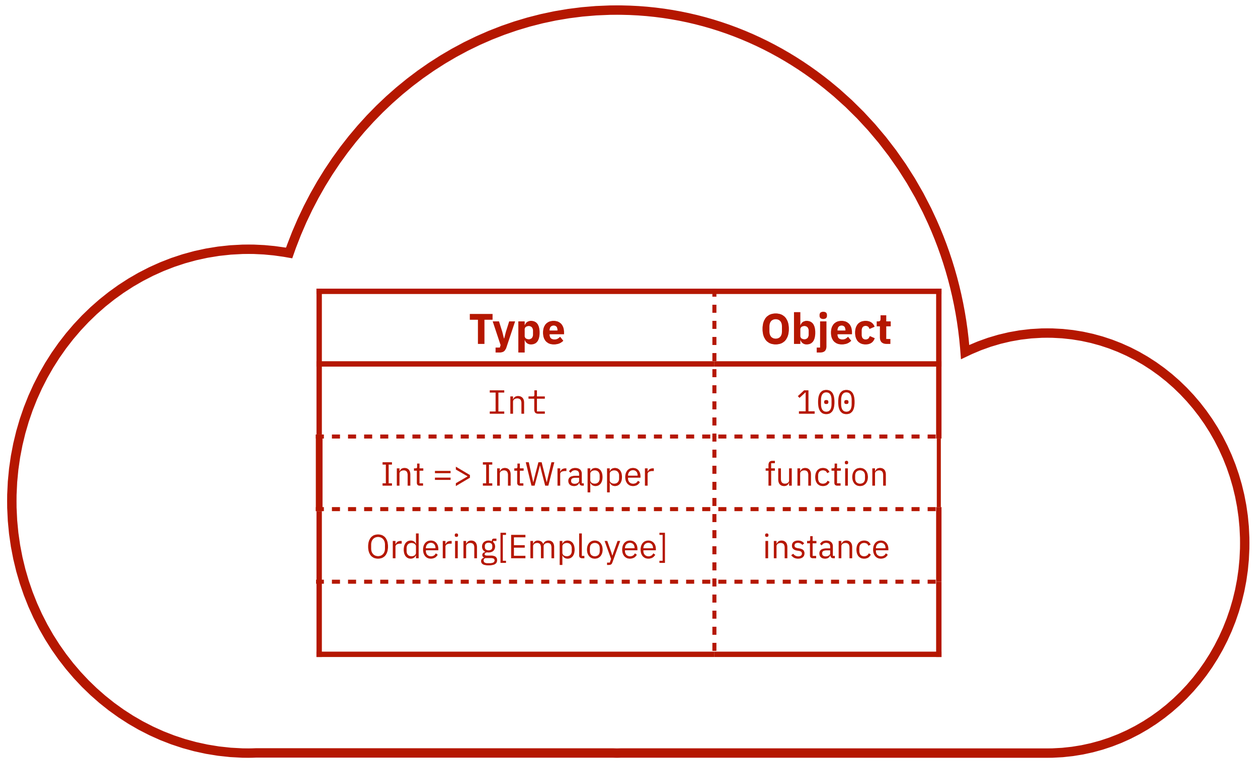
# Given and Using

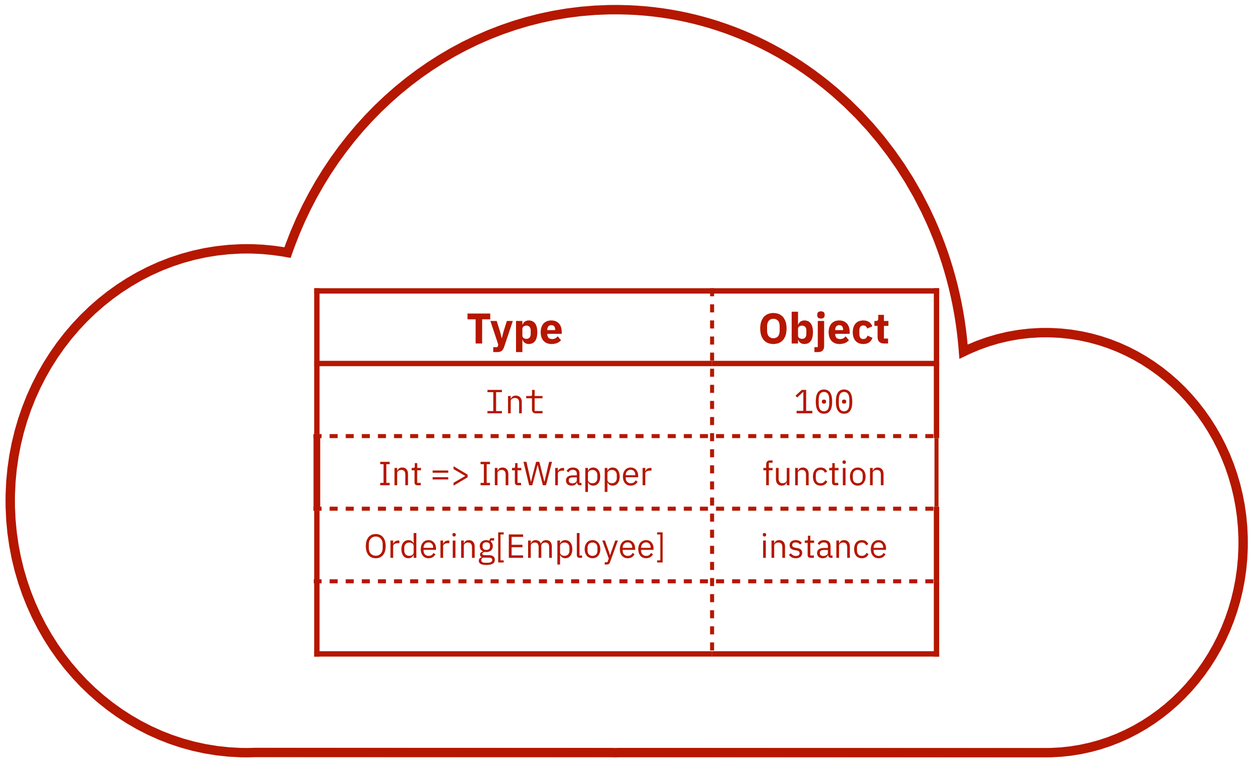
## The New "Implicits"




```
given Ordering[Employee] = new Ordering[Employee]{
    def compare (x:Employee,y:Employee)
}
```

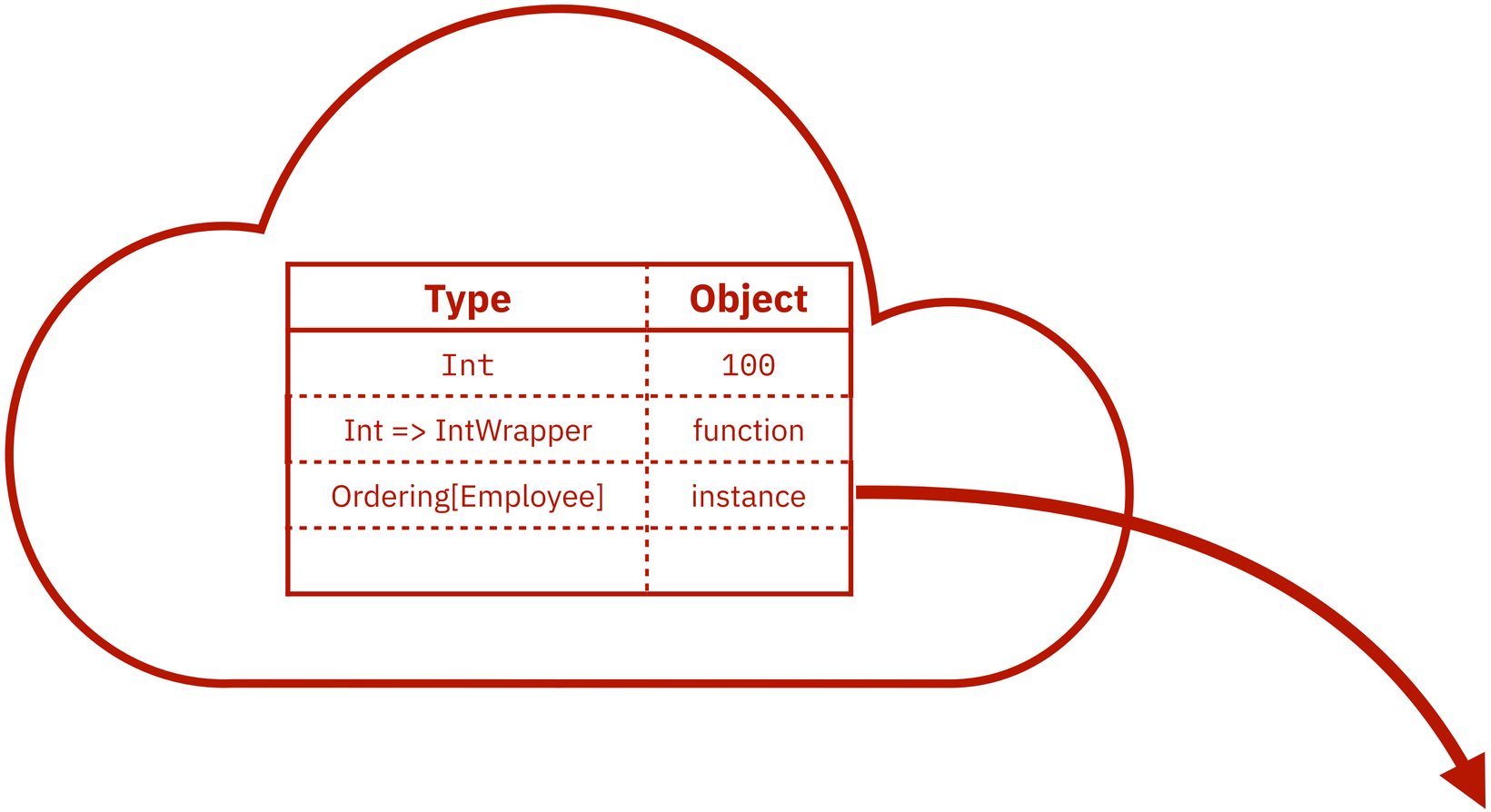



```
given Ordering[Employee] with {
    def compare(x:Employee,y:Employee)
}
```




?

```
def mySortingMethod(list:List[Employee])(using o:Ordering[Employee])
```




```
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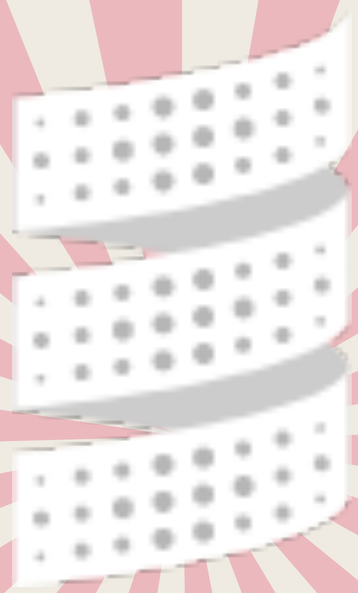
```

- What's the difference?
  - `implicits` are an overused term for multiple purpose
  - Not intuitive except for seasoned developers.
  - Conflicts with in many code instances; for example, below requires an `apply` method

```
def currentMap(implicit ctx: Context): Map[String, Int]
```

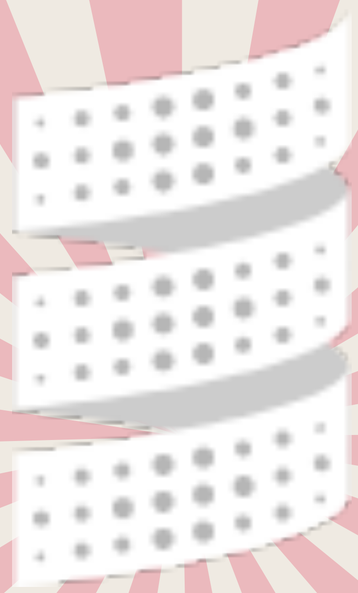


Scala 3

# Implicit Values

- An implicit value is bound per scope
- It is available when required
- Can always be overridden with your own implementation
- The binding is after the `given` keyword

Demo:
`src/main/scala/com.xyzcorp.givenusing.*`



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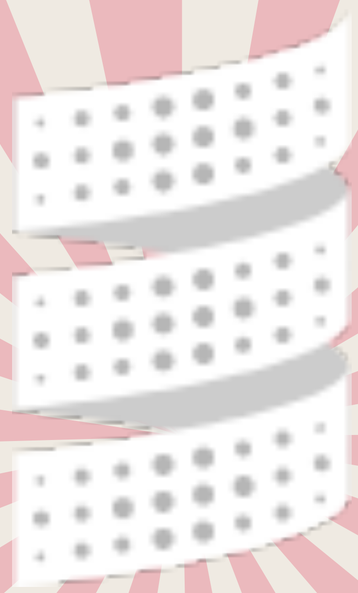
# Extension Methods

- Can we add methods to a type that already exist?
- Can we add `isOdd` and `isEven` to `Integer`
- Many languages have this mechanism, under different terms
- Scala has used it with implicits, but is now under a different identity

Demo:
`src/main/scala/com.xyzcorp.extensions.*`

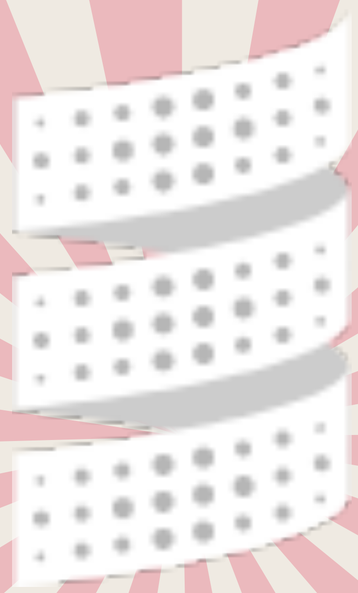


# Scala 3

# Conversions

- Previously in Scala 2 conversions can be performed by either implicitly defining:
  - A function of the conversion
  - A method of the conversion
- Scala 3 Dotty used a type `Conversion` that uses an `apply` much like `Function1`, and are automatically converted to the `Conversion` values.

Demo:
`src/main/java/com.xyzcorp.conversions.*`



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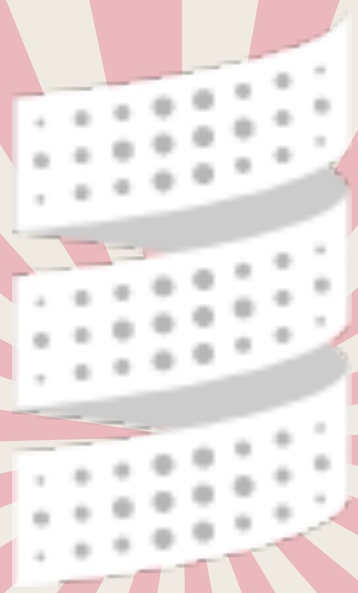
# Type Classes

- TypeClasses are implicit behaviors used in functional programming languages
- Think of a behavior that would like to work for varying types.  (e.g. folding, mapping, flatMapping, producing Strings, determining equality, effects, side-effects, etc.)
- Ad-hoc polymorphism - ***polymorphism*** *in which* ***polymorphic*** *functions can be applied to arguments of different types*

`Demo:`
`src/main/scala/com.xyzcorp.typeclasses.*`

# Lab: Creating a Typeclass



Scala 3

# Type Lambdas

- Defines a function of types to types
- They may carry bounds and variances
- Allows us to compose to a higher kinded type
- Avoids `{type λ[α] = List[Option[α]]})#λ`
- Translated with TypeLambdas: `[A] =>> List[Option[A]]`

- Higher Kinded Types?
  - What if the `List` in `List[A]` can be generic? `T[A]` or `M[A]`?
  - That's a higher kinded type and they are useful, particularly in functional programming

Demo:
`src/main/scala/com.xyzcorp.higherkindedtypes.*`

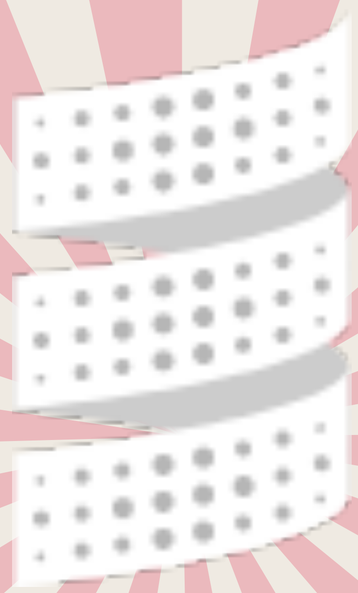
# Lab: Creating a Monad

**Step 0:** If you are using scastie, be sure to use Scala 3

**Step 1:** In `src/main/scala/exercises` in the project or using scastie, open `monads.1_Monads`, there you will see the definition for `Monad`, and `MyBox`.

**Step 2:** In the `object MyBox` create a "given" Monad definition for MyBox

**Step 3:** Create a main method that will test that it works. For example `Monad[MyBox].flatMap(MyBox(123))(a => MyBox(a + 20)` should be equal to a `MyBox(143)`



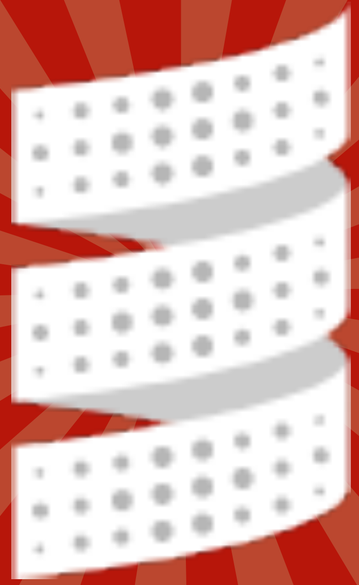
# Scala 3

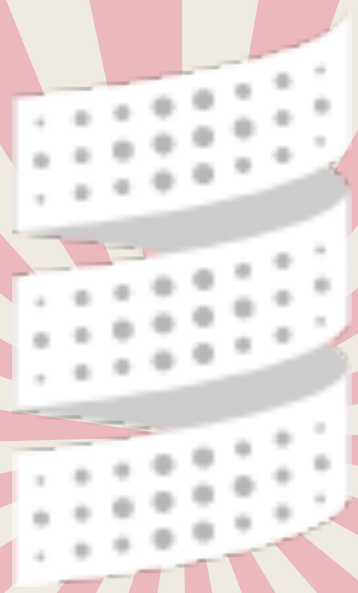
"I still don't get this Type-Fu"

- It's intellectually satisfying stuff
- It's safe
- Referentially Transparent
- But it is not easy

- Draw some inspiration, in some projects
  - Typelevel Cats
  - Shapeless
  - ScalaZ
  - ZIO

# Other Cool Features



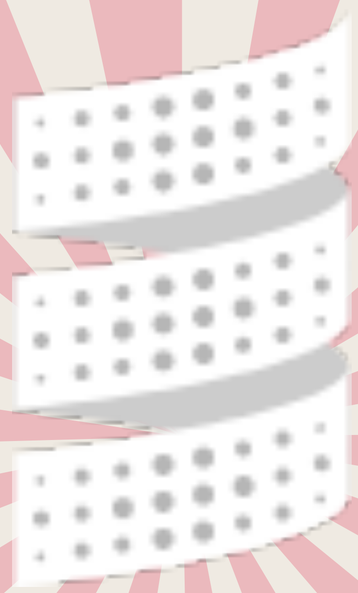


Scala 3

# Trait Parameters

- Traits are analogous to interfaces in Scala
- Like interfaces they do not have state or constructors
- With Dotty, they can,  so we can declare a variable and that will be mixed in with a type.
- Arguments are evaluated immediately
- Strict rules apply as how inheritance of these traits will work

Demo:
src/main/scala/com.xyzcorp.traitparameters.*

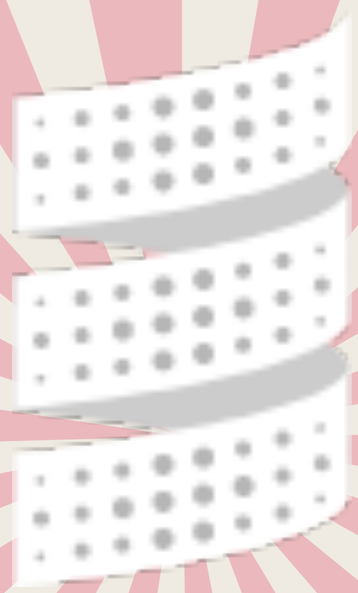


Scala 3

# Match Types

- Important to know that the type system in Scala has it's own language.
- A match type operates almost like Pattern Matching.
- The distinction is rather than extract values; we will be extracting types.

Demo:
`src/main/scala/com.xyzcorp.matchtypes.*`

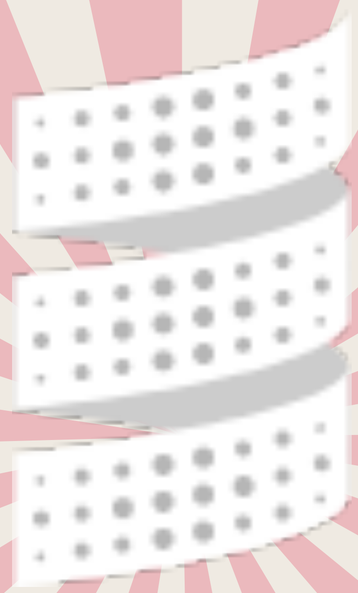


Scala 3

# Multiversal Equality

- `==` and `!=` uses Java's `equals()` in objects
- `equals` is not type safe
- Multiversal Equality is an opt-in Haskell style way for determining equality
- Based on trait `Eql[-L, -R]`
- Uses type classes to determine the equality

Demo:
`src/main/scala/com.xyzcorp.multiversalequality.*`

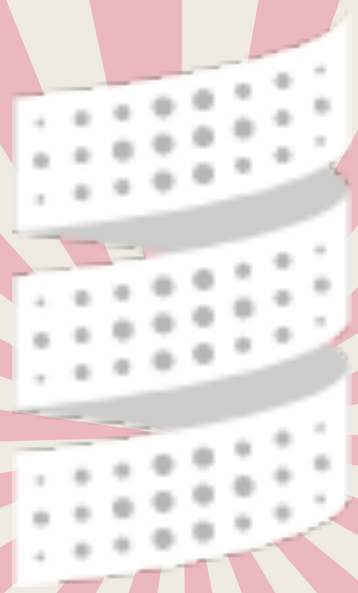


Scala 3

# Opaque Types

- Provides a completely new type based on the previous one, but...
  - They are not synonymous or an alias
  - Information hiding, we can treat

Demo:
`src/main/scala/com.xyzcorp.opaquetypes.*`

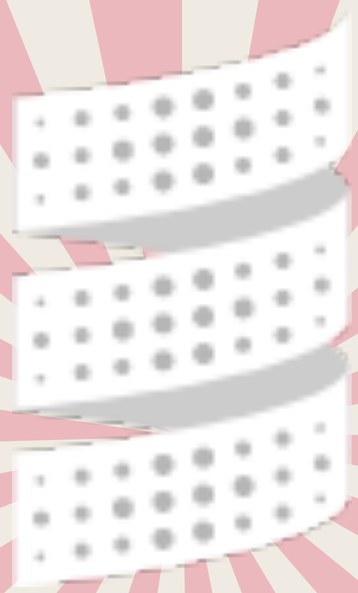


Scala 3

# Parameter Untupling

- One pain point with Scala is the use of a partial function to destructure what is inside of a tuple.
- Scala 3 all that will disappear so you can express yourself without any extra ceremony

Demo:
`src/main/scala/com.xyzcorp.parameteruntupling.*`

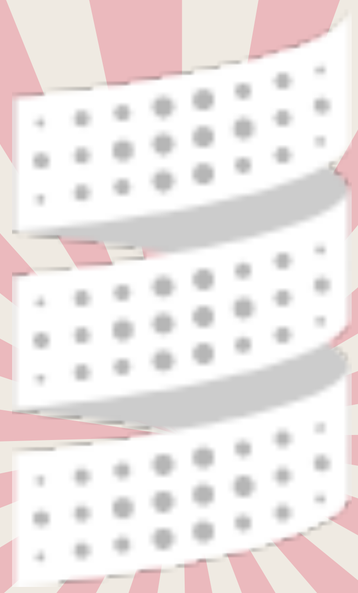


Scala 3

# Tupled Functions

- In Scala 2, Functions were declared using `Function1`, `Function2`, `Function3`, ..., `Function22`
- In Scala 3, there is no limit due to fancy programming with the new implicits and type handling.
- Important to remember, types are important and if you get the 33rd element of a homogenous tuple the type should be consistent

Demo:
`src/main/scala/com.xyzcorp.tupledfunction.*`

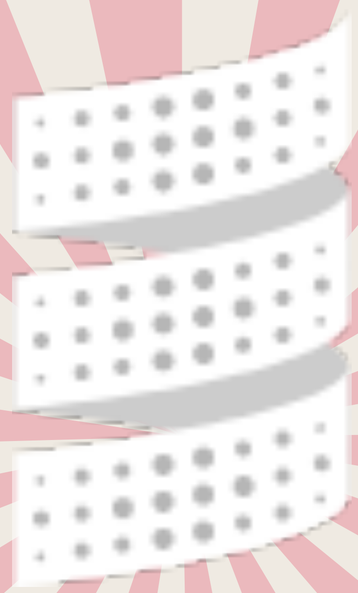


Scala 3

# Universal Apply

- Instantiate a class without a `new`
- Makes the language more unified as to how to instantiate or create objects
- Compliments `apply`.
- Done internally via the compiler using a technique called *constructor proxies*

Demo:
`src/main/scala/com.xyzcorp.universalapply.*`



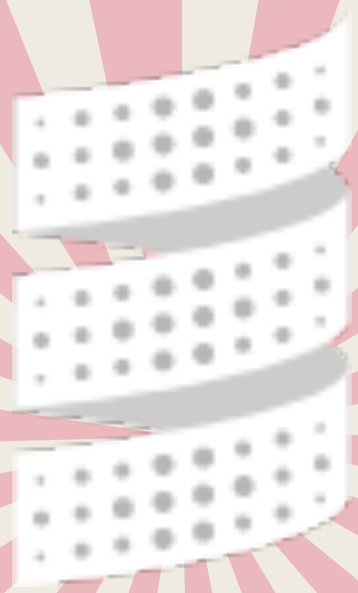
Scala 3

# Structural Types

- In dynamic typed or optional typed languages, it is great to express oneself with more of a linguistic syntax.
  - `db.findById(..).name`
- Static typed languages particularly those that have a rigorous typed system becomes harder.

- This is where the `Selectable` trait comes in
- Allows the language to convert `obj.name` into something searchable rather than expecting name to be a method in `obj`.

Demo:
`src/main/scala/com.xyzcorp.structuraltypes.*`

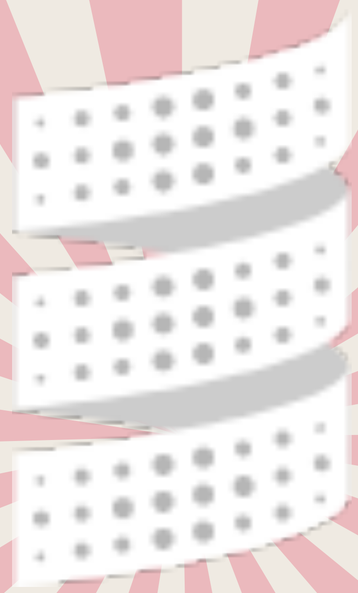


Scala 3

# TargetName

- `@targetName` defines an alternate, usually linguistic, name for a function or method, and more.
- `import scala.annotation.targetName`
- Backticked method names are no longer necessary
- Very useful to disambiguate two methods with the same signature usually due to erasure

Demo:
`src/main/scala/com.xyzcorp.demo.targetname.*`

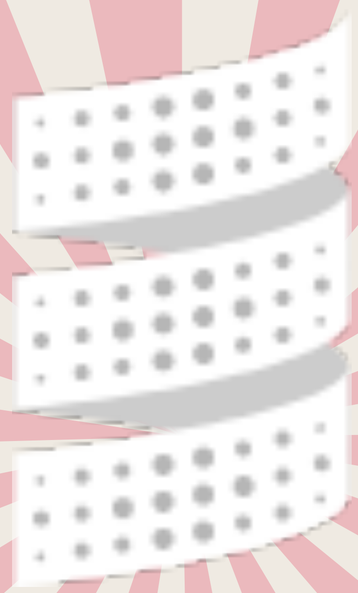


# Scala 3

## Infix

- `infix` operators or methods can be situated between the object and the parameter
- Include the keyword `infix` to state intent that the method or function is meant to be used in an infix fashion.
- Will produce a warning if you use a method as infix without declaring it as such
- Not necessary for symbolic operators (e.g +)

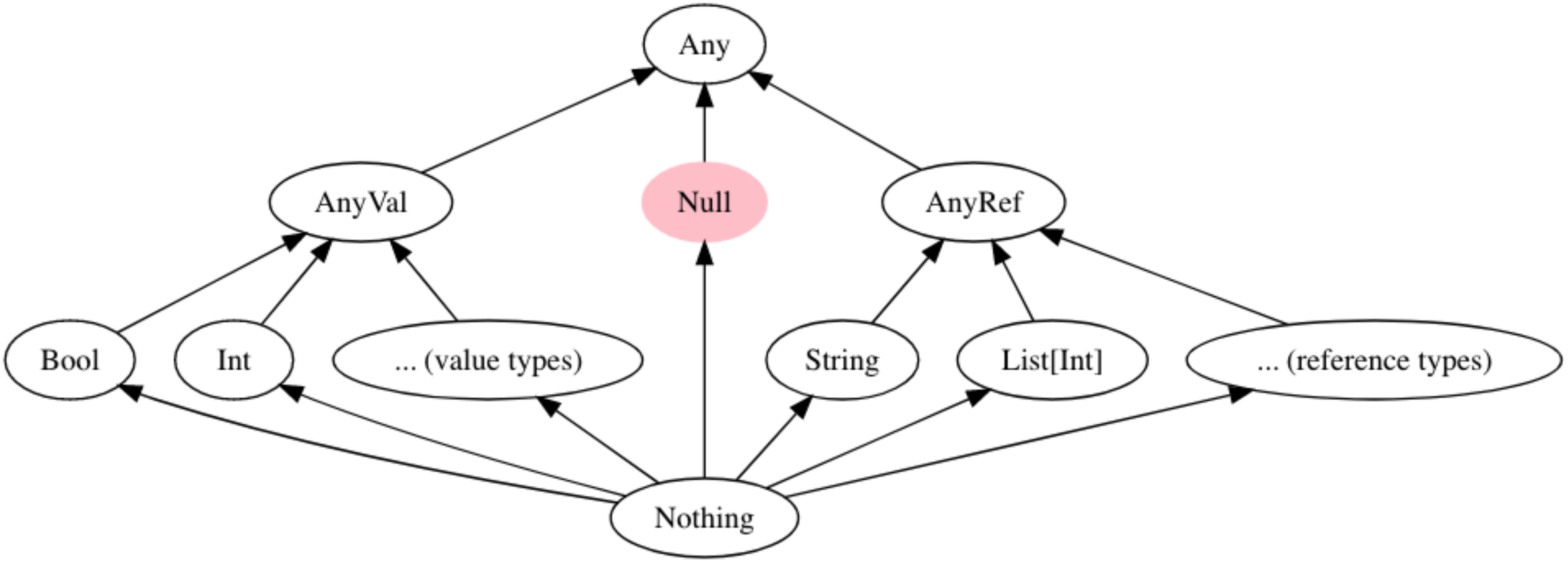
Demo:
`src/main/scala/com.xyzcorp.infix.*`



# Scala 3

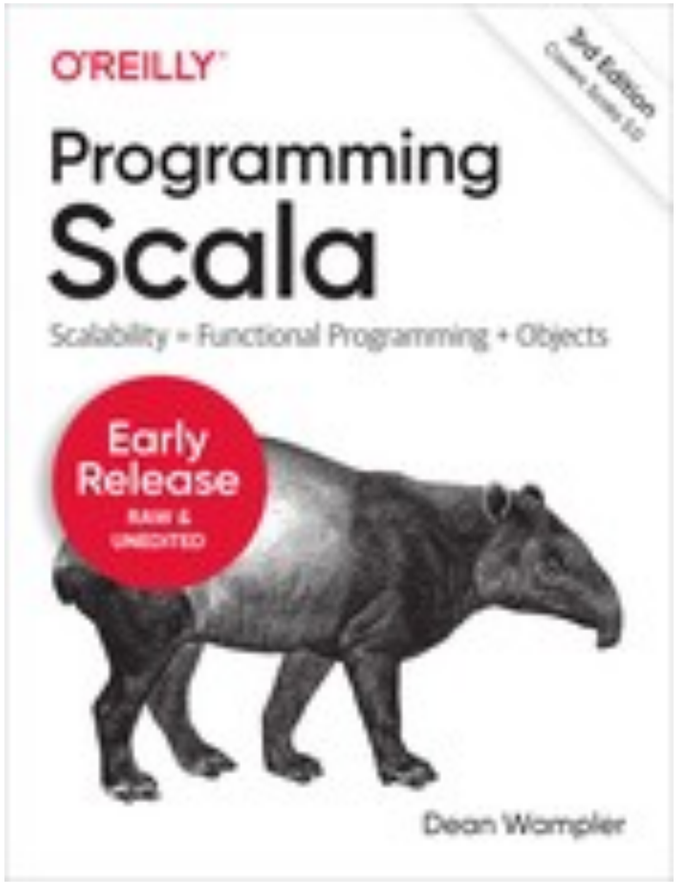
# Explicit Nulls

- Union Type of `A | Null`
  - Type meaning: Either `A` or `Null`
- Can be the type used when calling Java that has the potential to be a null
  - Requires switch `-Yexplicit-nulls`
  - Aggressive null checking
- The Union Type can be carried forward from a Java API call.




Demo: com.xyzcorp.explicitnulls.*

# References (For Now)




# Programming Scala, 3rd Edition

by Dean Wampler

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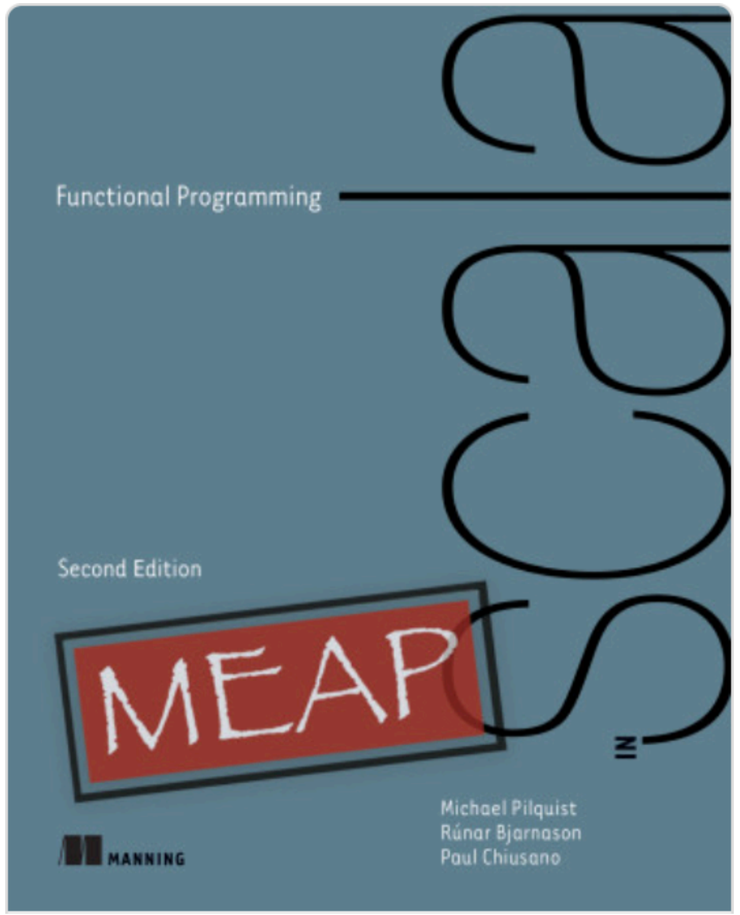


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Michael Pilquist, Rúnar Bjarnason, and Paul Chiusano

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# Thank You

Daniel Hinojosa
Twitter: @dhinojosa
Email: dhinojosa@evolutionnext.com