Programming languages in general, in particular, and at Bloomberg

Bloomberg Frankfurt
March 19, 2019

Sergey Sitov: C++
Matthias Kleiber: Java / JavaScript
Danica Fine: Scala

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Programming Languages and C++

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Sergey Sitov
Tead Lead, Connectivity Infrastructure
s.sitov@Bloomberg.net

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Programming Languages

- How many programming languages are there?

  Active: ~250 (TIOBE)

  Notable: ~700 (Wikipedia, non-markup)

  HOPL: 8,945 (Online Historical Encyclopaedia of Programming Languages)

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Programming Languages

- Why are there so many?

“We do not need so many languages, but we want them”

We choose to use different tools for different jobs

We choose what we like and know

Variety is beneficial for the industry

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Programming Languages

- Why there are so many?

  Because there are:

  - different domains with different requirements
  - different problems to solve
  - different levels of abstraction / paradigms
  - different execution environments / hardware
  - developers with different experience

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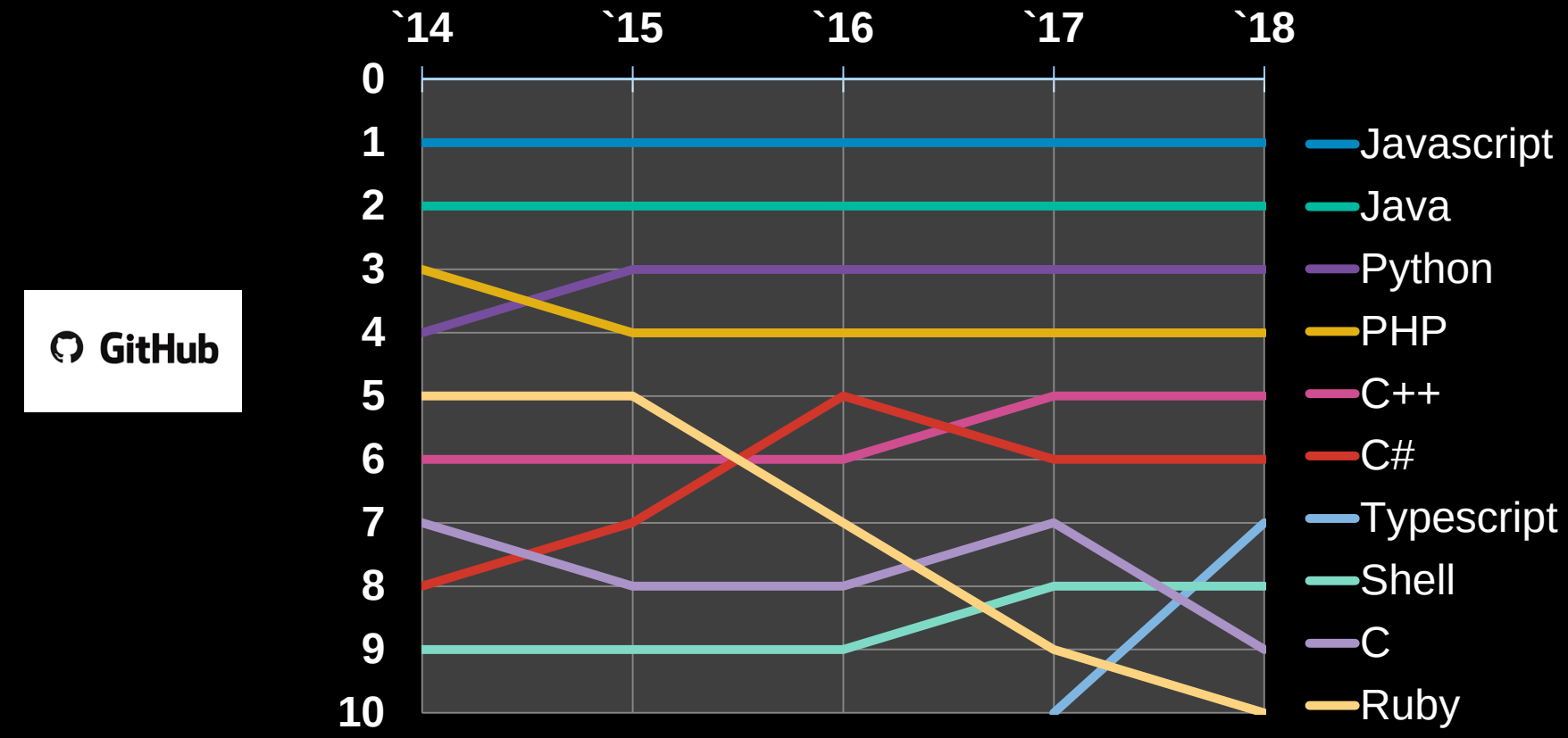
Programming Languages

- What languages are the most popular?



https://github.blog/2018-11-15-state-of-the-octoverse-top-programming-languages/

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Programming Languages

- What languages are the most popular?

Feb 2019	Feb 2018	Change	Programming Language	Ratings	Change
1	1		Java	15.876%	+0.89%
2	2		C	12.424%	+0.57%
3	4	↑	Python	7.574%	+2.41%
4	3	↓	C++	7.444%	+1.72%
5	6	↑	Visual Basic .NET	7.095%	+3.02%
6	8	↑	JavaScript	2.848%	-0.32%
7	5	↓	C#	2.846%	-1.61%
8	7	↓	PHP	2.271%	-1.15%
9	11	↑	SQL	1.900%	-0.46%
10	**20**	⇈	**Objective-C**	**1.447%**	**+0.32%**

https://www.tiobe.com/tiobe-index/

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Programming Languages

- What languages will make you competitive on the market and earn you money?

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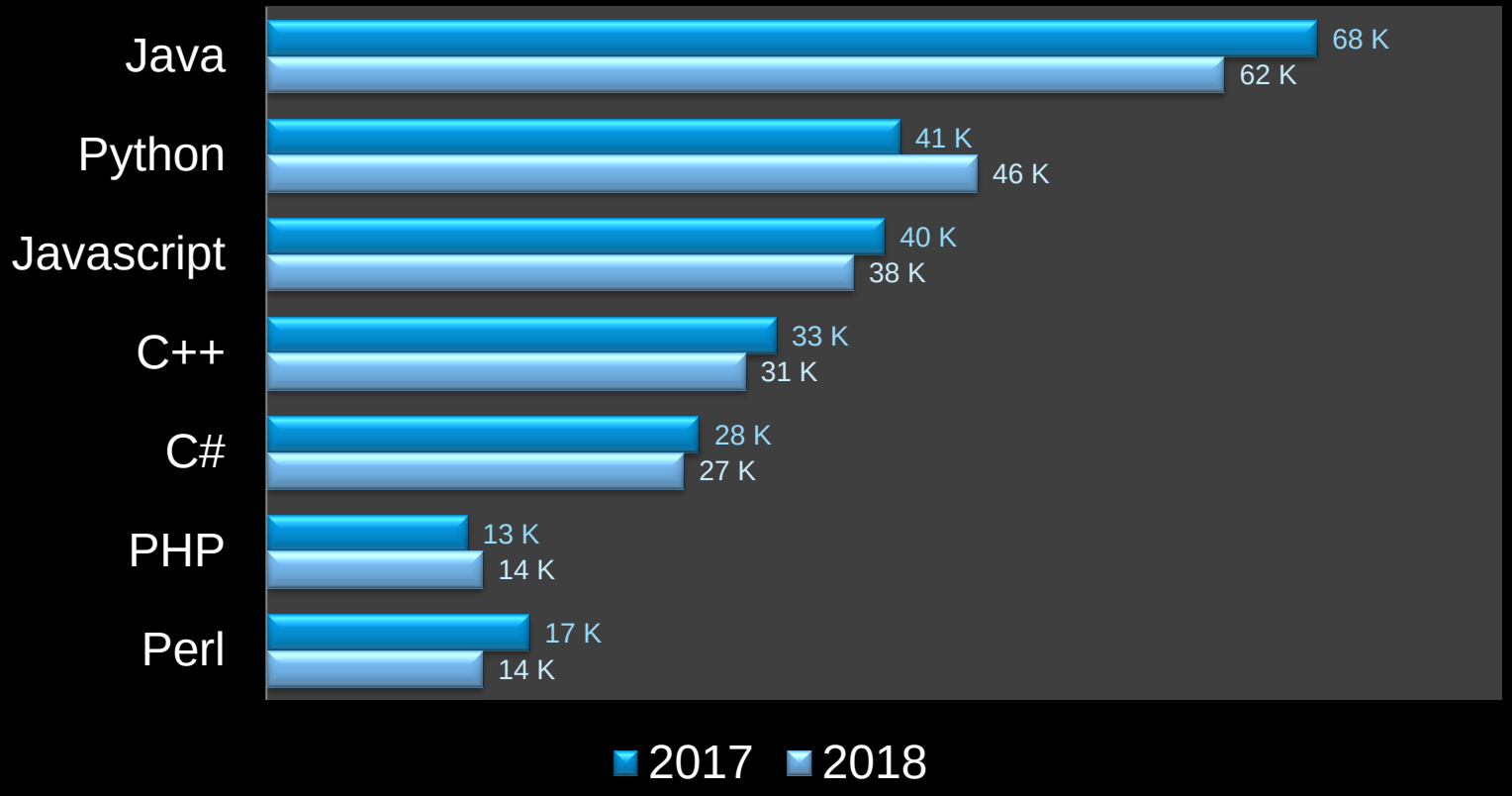
Programming Languages

- In-demand programming languages



https://www.codingdojo.com/blog/7-most-in-demand-programming-languages-of-2018/

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Programming Languages

- The highest paying programming languages
  - Go
  - Python
  - R
  - Java
  - Ruby on rails
  - C++
  - C#
  - Swift
  - Kotlin

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Programming Languages at Bloomberg

- What do we use at Bloomberg?
  - One of the primary language is C++ (by lines of code in version control)
  - JavaScript is for the Terminal front-end
  - Python for automation
- Also: Scala, Java, Lua, Haskell, Perl, Fortran, C#, Rust, Erlang, Golang, Lisp, PHP, …

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C++ Programming Language

- Created by Bjarne Stroustrup in 1985
- Standardized only in 1998
- Originally intended to include Object-Oriented paradigm into C language (“C with classes”)
- Now it is a statically-typed, imperative, generic, multi-paradigm, multi-purpose programming language

```
#include <iostream>
int main() {
    std::cout << "Hello, World!";
    return 0;
}
```

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C++ Programming Language

- At Bloomberg, we have a massive C++ code base

- C++ is mostly used for back-end implementations
- For all mission-critical and performance sensitive applications
- It powers the Bloomberg Terminal

- Maintaining open source **BDE** (Basic Development Environment) (https://github.com/bloomberg/bde)
- Representation on the WG21 (ISO C++ Committee)

- Actively participate at large C++ conferences

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C++ Programming Language

- Why do engineers want and like to use C++?
  - C++ offers ways of abstraction that have – unlike **all** other languages – no performance overhead at runtime
  - It allows one to write very efficient code that still has a very high abstraction level – compile time vs. runtime trade-offs
  - Direct mapping to hardware features – feeling of coding to `bare-metal` rather than to an interpreter or virtual machine

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C++ Programming Language

- Generic Programming with C++

- Freedom from data types by templates

```
template <typename T>
const T& max(const T &a, const T &b) {
    return a > b ? a : b;
}
```

- Freedom to manipulate data using comparators/predicates
- Abstraction of access to data structures using iterators or ranges

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C++ Programming Language

- Generic Programming with C++
- You can write libraries of reusable code with templates, which can be specialized by a user's own types and policies
- Standard Templates Library (STL)
-

- Bloomberg BDE

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C++ Programming Language

- Generic Programming with C++
- Templates in C++ are Turing complete (meta-programming)
- It is possible to write code executed at compile time (constant expressions)

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C++ Programming Language

- It is still primarily an Object-Oriented Programming language, but it also now has idioms from functional programming: auto, lambdas, ranges, combinators, filters, …

Generate an infinite list of integers starting at 1, square them, take the first 10, and sum them:

```
using namespace ranges;
auto sum = accumulate(view::ints(1)
                    | view::transform([](int i){return i*i;})
                    | view::take(10), 0);
```


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C++ Programming Language

- Low-latency trading with C++
  - Cache-aware programming
  - Lock-free algorithms
  - Bypass calls to kernel
  - Directly use special CPU instruction set (SSE2, SSE3, AVX ...)
  - Use GPU hardware (OpenCL, CUDA)
  - High-performance computing with OpenMP

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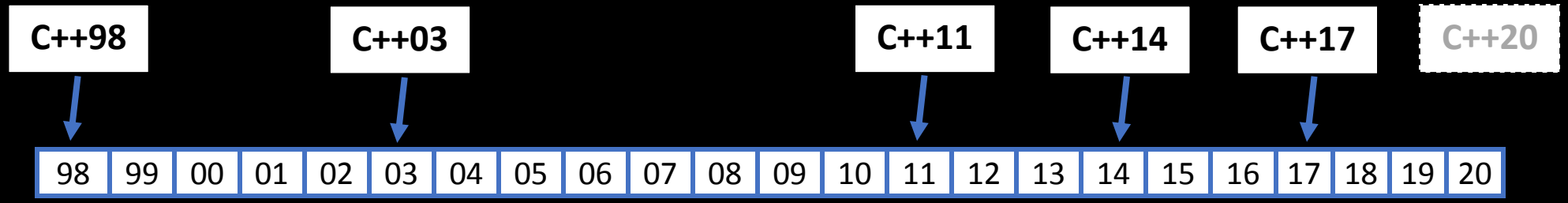
C++ Programming Language

- C++ language is still evolving



- Try the language and all its new features
  - godbolt.org
  - wandbox.org

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Thank you!

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Programmiersprachen im Allgemeinen, im Speziellen und bei Bloomberg: Java/JavaScript

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Bloomberg Frankfurt
March 19, 2019

Matthias Kleiber
Software Architect & Developer
m.kleiber@bloomberg.net

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Programmiersprachen: Java

- Warum ist Java NICHT die beste Programmiersprache?
  - Ausschließlich dynamische Funktionsaufrufe (performance)
  - Java-Runtime JVM wird zur Laufzeit benötigt
  - Keine direkten Funktions-Aufrufe zum Betriebssystem
  - Keine Unterstützung für Speicherstrukturen des Betriebssystems
  - Geräte-Treiber sind de facto unmöglich

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Programmiersprachen: Java

- Muss ich Java sprechen können?
  - Nein, aber lesen!
  - Nein, aber die JVM verstehen
  - Nein, aber Interfaces verstehen
  - Nein, aber warum eigentlich nicht?

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Programmiersprachen: Java

- OO und EE
  - Klassen sind die Basis...
  - ...aber nicht für alles!
  - Java Enterprise Edition
  - JSF, JAX-RS, JPA, EJB

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Programmiersprachen: Java

- Wann geht Java in Rente?
  - Wann ging Assembler in Rente?
  - Sind IoT, Social Media und mobile Apps das Ende von Java?
  - Kotlin – mindestens die JVM überlebt

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Programmiersprachen: JavaScript

- Ist JavaScript eine Programmiersprache?
  - Programmierst Du noch oder skriptest Du schon?
  - Warum ein Interpreter weder Compiler, noch VM ist
  - (zu) viel Dynami(k/t)?

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Programmiersprachen: JavaScript

- Warum spricht das Internet nur JavaScript?
  - Als das Internet Laufen lernte und das erste DOM entstand
  - Die ScriptEngine - der Motor des Internets
  - Transpilieren

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Programmiersprachen: JavaScript

- Das JavaScript-Engine Oligopol
  - Warum sieht die gleiche Internetseite in jedem Browser anders aus?
  - jQuery – jQuery – jQuery 97.3%
  - Kleine Scripte – große Wirkung

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Programmiersprachen: JavaScript

- Frameworks und kein Ende
  - AngularJS
  - React
  - Vue.js
  - Node.js

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Danke!

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Scala at Bloomberg and Beyond

Bloomberg Engineering

Bloomberg Frankfurt
March 19, 2019

Danica Fine
Software Engineer
dfine17@bloomberg.net

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Agenda

- What is Scala?
- Why Scala?
  - Functional Features
  - Embracing Functional Programming
- Scala at Bloomberg
- Takeaways
- Questions

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What is Scala?

“Scala combines object-oriented and functional programming in one concise, high-level language. Scala's static types help avoid bugs in complex applications, and its JVM and JavaScript runtimes let you build high-performance systems with easy access to huge ecosystems of libraries.”

www.scala-lang.org

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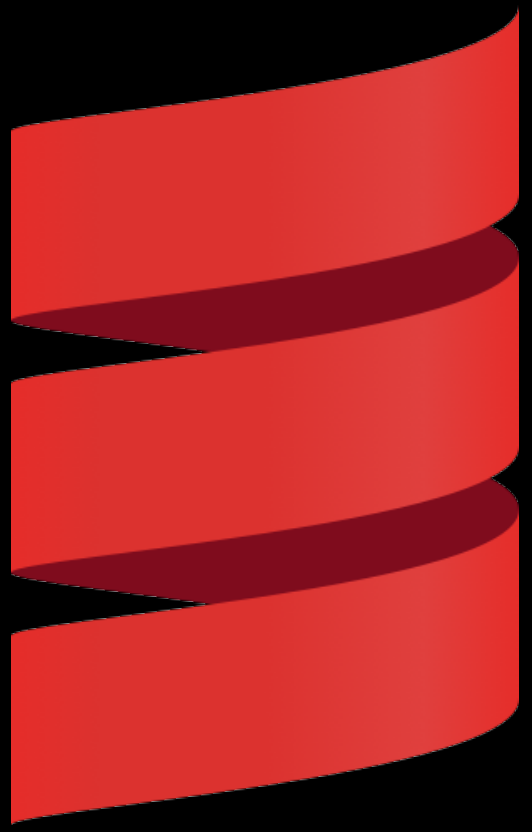
Scala Overview

- “Scalable Language”
- Blend of functional and object-oriented paradigms
- More specifically…
  - Type-safe
  - Built on the JVM
  - Wide support of Java collections and other popular libraries



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Why Functional?

- Higher predictability
- Compile-time optimizations
- Avoid concurrency problems
- Reduce verbosity (in most cases)

Type fewer characters!

“You only have a finite number of keystrokes in your lifetime. Don’t waste them on unnecessarily verbose code.”

- Afzal Mazhar

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Other Features

To convince you to love Scala…

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Type Inference

- Compiler infers types of expressions

```
>> val mult = (x: Int, y:Int) => x * y
   mult: (Int, Int) => Int
>> val bbg = "Bloomberg"
   bbg: String = Bloomberg
```

- Safer Code

```
def userExistsIn(userIds: Set[Long]): Boolean = {
  var userId = getCurrentUserId() // returns Long
  userIds.contains(userId)
}
```

- Convenient, less verbose

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Functions as First-Class Citizens

- Values can be a function type

```
>> val f1 = (s: String) => s.length
   f1: String => Int = $$Lambda$162/1654@4a7fd0c9
```

- Passed as arguments

```
>> val l1 = Seq("a", "ab", "abc")
   l1: Seq[String] = List(a, ab, abc)
>> l1.map(f1)
   res0: Seq[Int] = List(1, 2, 3)
```


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Functions as First-Class Citizens (cont.)

- Returned as results

```
>> def add(x: Int) = (y: Int) => x + y
   add: (x: Int)Int => Int
>> val addTwo = add(2)
   addTwo: Int => Int = $$Lambda$107/7037@7d401cdc
>> addTwo(3)
   res0: Int = 5
```

- Partial application/currying

```
>> val l = Seq(1, 2, 3)
>> val init0 = l.foldLeft(0)(_)
   init0: ((Int, Int) => Int) => Int = $$Lambda$17/89@77f3c1
```


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Option Type

- Handling objects that may or may not exist
- Compiler forces programmer to deal with this possibility

Offers a solution to the “Billion-dollar mistake!”

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Option Type (cont.)

```
def toInt(s: String): Option[Int] = {
  try {
    Some(Integer.parseInt(s.trim))
  } catch {
    case e: NumberFormatException => None
  }
}
```

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Case Classes

- Good for modelling immutable data
- Similar to regular classes, but with some extras
  - Built-in “apply” method for instantiation
  - Shallow copying ability
  - Structure comparison
- Boilerplate code done for you

```
>> case class User(uuid: Int, name: String, . . .)
   defined class User
```

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Case Classes (cont.)

```
>> case class User(uuid: Int, name: String)
   defined class User
>> val bob = User(0, "Bob")
   bob: User = User(0, "Bob")
>> bob.name
   res1: String = Bob
>> bob.name = "New Bob”
   <console>:12: error: reassignment to val
>> val newBob = bob.copy(name = "New Bob")
   newBob: User = User(0, "New Bob")
>> bob == newBob
   res3: Boolean = false
```

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Pattern Matching

- Used to deconstruct values that match against a pattern
- Patterns include:
  - Values

```
(l1.size, l2.size) match {
  case (0,0) => “Both are empty.”
  case (0,_) => “First is empty.”
  case (_,0) => “Second is empty.”
  case (a,b) => “Total ” + (a + b)
}
```

  - Types

```
v match {
  case (s: String) => . . .
  case (i: Int)    => . . .
  case _           => . . .
}
```

  - Case Classes

```
v match {
  case User(i, _) if (i < 10) => . . .
  case User(i, n) => . . .
}

v match {
  case Some(s) => . . .
  case None    => . . .
}
```

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Tips to Embracing the Functional Mindset

- Avoid mutating variables; opt for immutable values instead
- Take advantage of collections and higher-order functions (e.g., map, filter, and fold)
- Pass all required data as arguments; avoid relying state

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Scala at Bloomberg

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Derivatives Data Use Case

- Low-latency application pipeline
- Streaming infrastructure
- Scala is a player in big data processing (Spark)

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Other Projects within the Company

- Apache Spark
- Support Scala code generation for our in-house application layer

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Things to Consider

According to Stack Overflow's 2018 Developer Survey…

https://insights.stackoverflow.com/survey/2018

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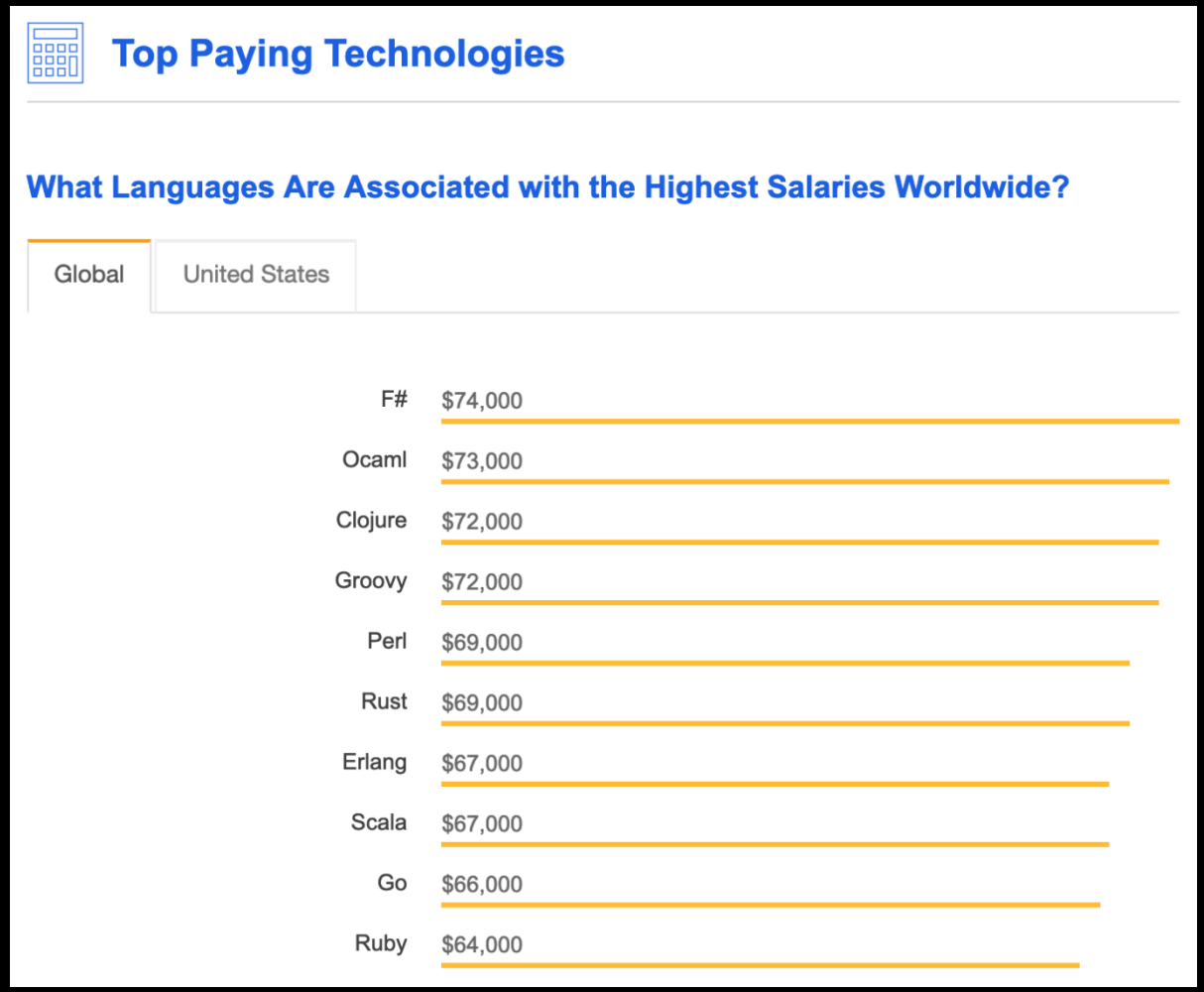
Salary

- Scala is associated with high-earning jobs
- ~€60,000
- Half of the top 10 highest earning programming jobs use functional languages



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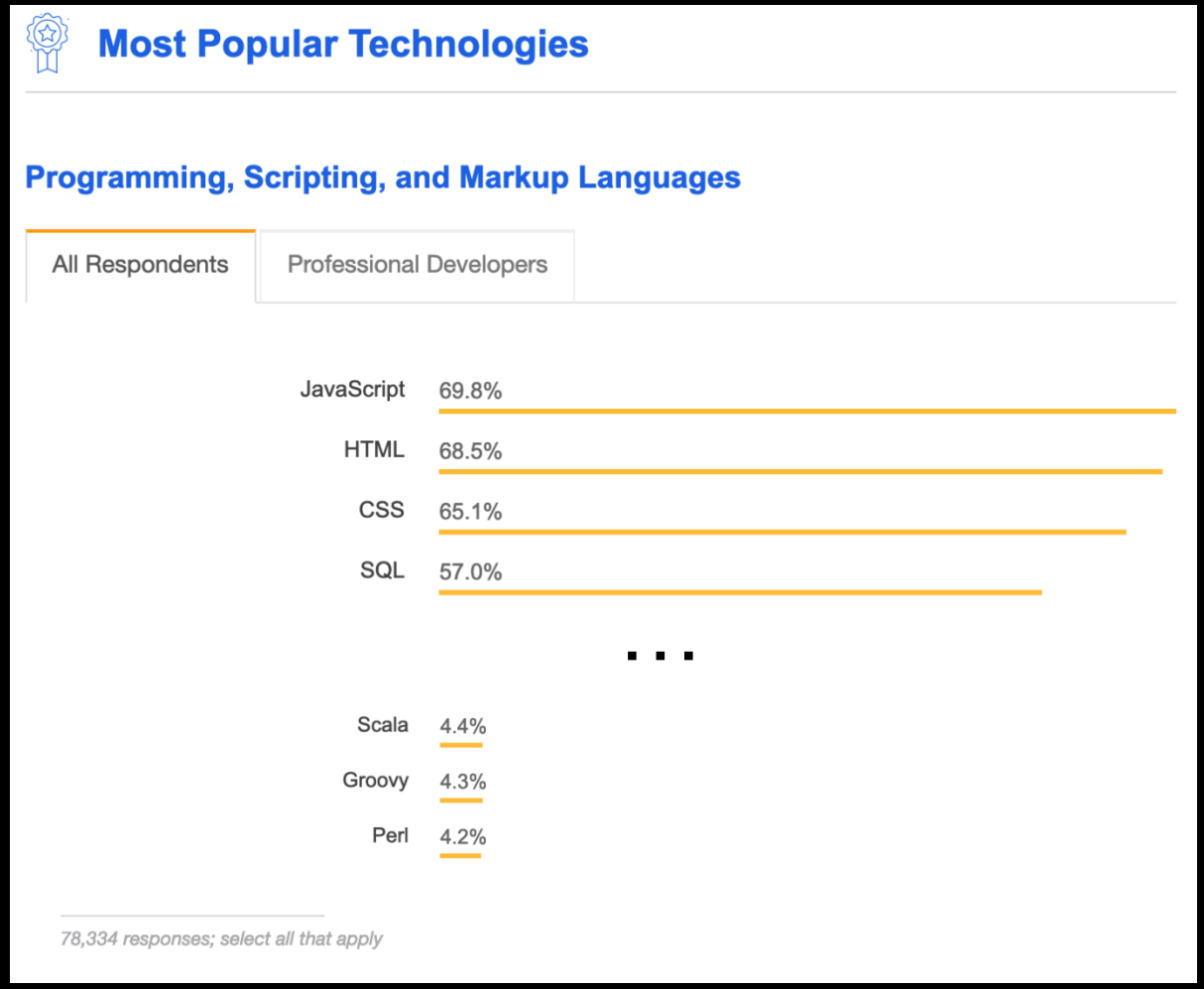
Popularity

- Not at the bottom of the list…



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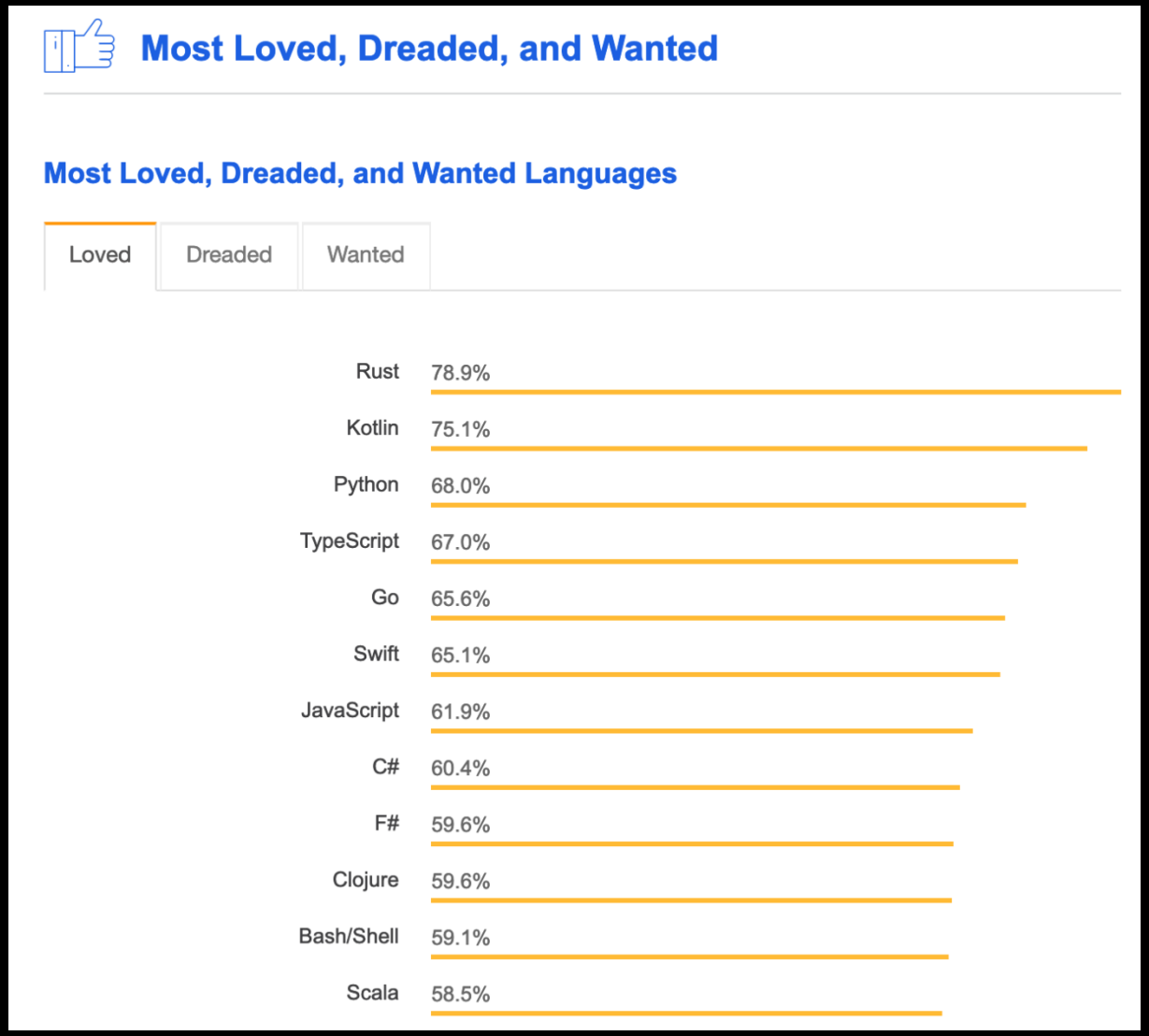
A Loved Language

- 12th most loved!
- Did not make the “Most Dreaded” list



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We are hiring!

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