Introduction to Python Programming

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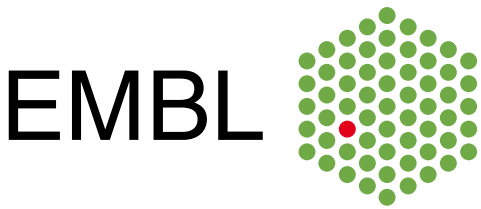
November 14, 2014



Python

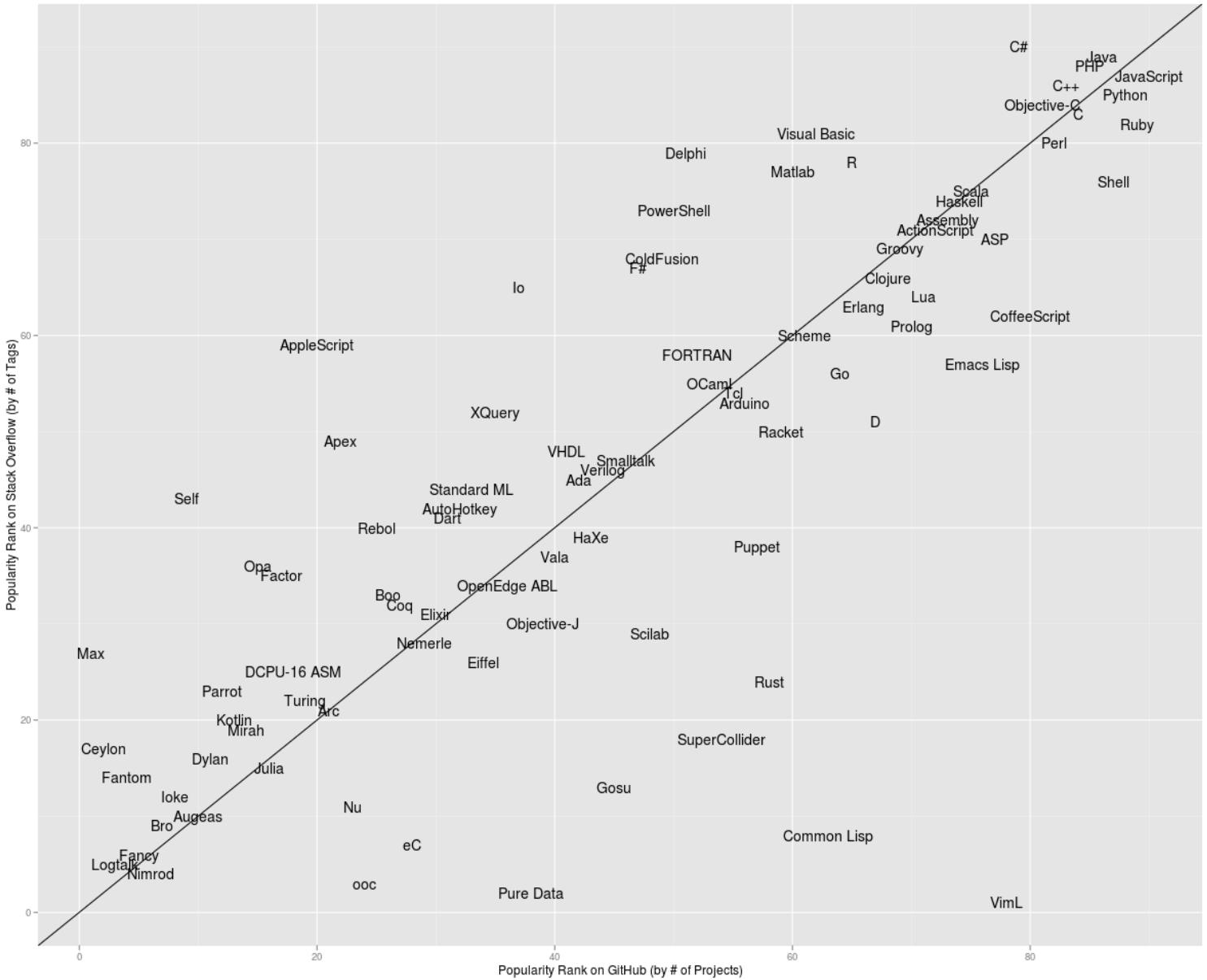
Let's digress for a moment discussing the language...

Python Language History

History

- Python was started in the late 80's.
- It was intended to be both easy to teach and industrial strength.
- It is (has always been) open-source.
- In the last 10 years, it has become one of the most widely used languages (top 10).

Popularity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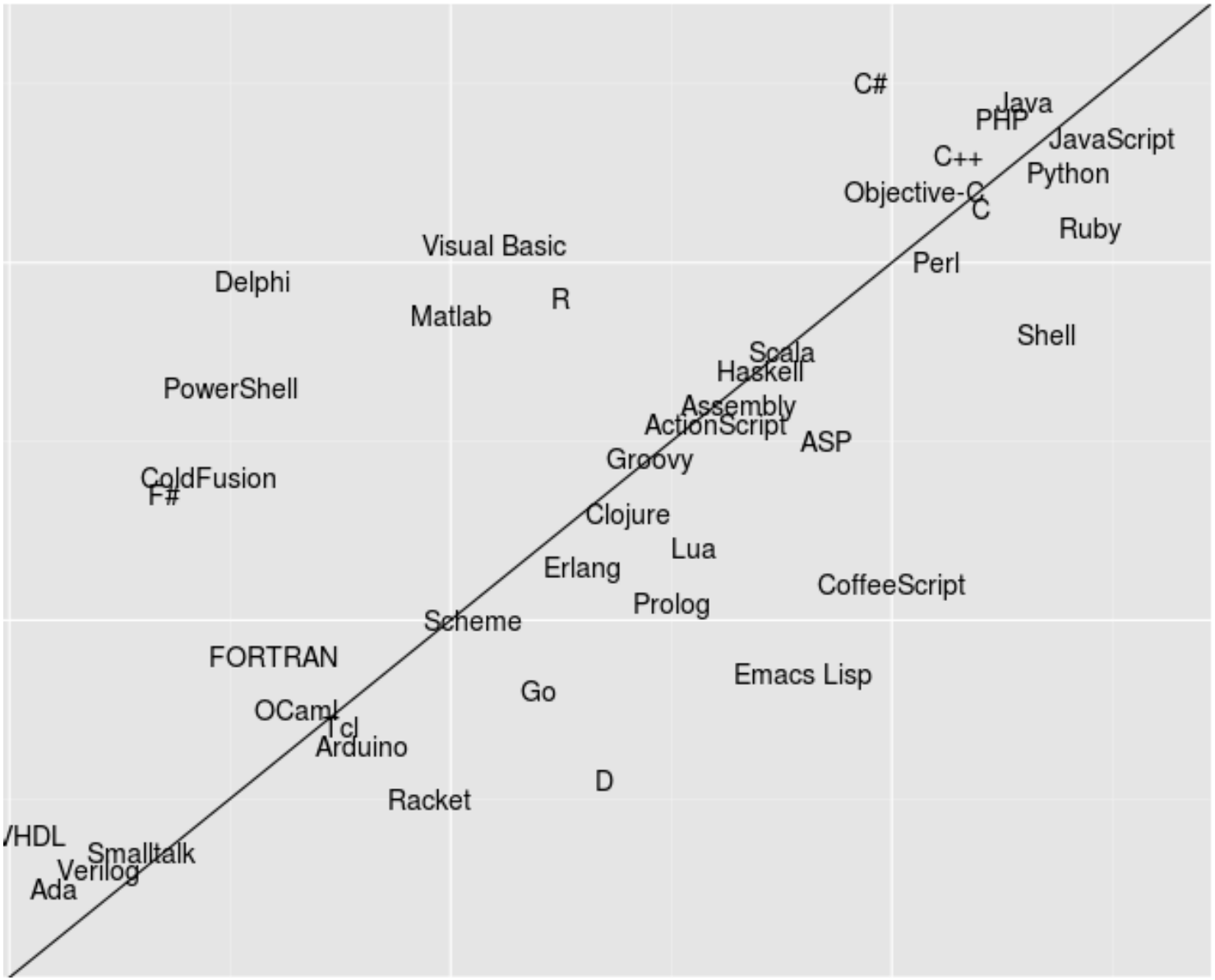
Java
PHP
JavaScript
C++
Python
Objective-C
C
Ruby
Visual Basic
Perl
Delphi
R
Matlab
Shell
Scala
Haskell
PowerShell
Assembly
ActionScript
ASP
Groovy
ColdFusion
F#
Clojure
Io
Lua
Erlang
CoffeeScript
Prolog
Scheme
AppleScript
FORTRAN
Emacs Lisp
Go
OCaml
Tcl
Arduino
XQuery
D
Racket
Apex
VHDL
Smalltalk
Verilog
Ada
Standard ML
Self
AutoHotkey
Dart
Rebol
HaXe
Puppet
Vala
Ona
Factor
OpenEdge ABL
Boo
Coq
Elixir
Objective-J
Scilab
Nemerle
Max
Eiffel
DCPU-16 ASM
Rust
Parrot
Turing
Arc
Kotlin
Mirah
SuperCollider
Ceylon
Dylan
Julia
Fantom
Gosu
Ioke
Nu
Augeas
Bro
Common Lisp
eC
Fancy
Logtalk
Nimrod
ooc
Pure Data
VimL
Popularity Rank on Stack Overflow (by # of Tags)
Popularity Rank on GitHub (by # of Projects)
0
20
40
60
80

Popularity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D
Racket
VHDL
Smalltalk
Verilog
Ada

Python Versions

- The current versions of Python are 2.7 and 3.4
- This class assumes you have 2.6–2.7
- There are some small differences when compared to version 3.x

What is a Computer?

1. Memory
2. Processor
3. Magic

Python Model

1. Objects
2. Operations on objects
3. Magic

Python Example

```
print "Hello World"
```

Running Python

1. From a file
2. Interactively

Computer Program

helloword.py

```
print 'Hello World'
```

Running a Program

1. Shell
2. IDE

Let me show you a demonstration...

More Complex Example

What is 25 times 5?

More Complex Example

What is 25 times 5?

```
print 25 * 5
```

More Complex Example

```
name = 2
other = 3
yetanother = name + other
name = 5
print yetanother + name
```

Blackboard demonstration

Conditionals

```
if <condition>:
    <statement 1>
    <statement 2>
else:
    <statement 3>
```

Conditionals (Example)

```
print 'Before testing...'
if 3.3*9.2 > 30:
    print 'Greater than 30'
else:
    print 'Smaller or equal'
print 'After'
```

Conditionals (Example)

```
print 'Before testing. . .'
if 3.3*9.2 > 31:
    print 'Greater than 31'
elif 3.3*9.2 > 30:
    print 'Greater than 30'
else:
    print 'Smaller or equal'
print 'After'
```

Conditionals (Example)

```
print 'Before testing...'
v = 3.3*9.2
if v > 31:
    print 'Greater than 31'
elif v > 30:
    print 'Greater than 30'
else:
    print 'Smaller or equal'
print 'After'
```

Lists

```
students = ['Luis','Mark','Rita']

print students[0]
print students[1]
print students[2]
```

Loops

```
students = ['Luis','Mark','Rita',...]

for st in students:
    print st
```

Example

```
values = [0.11, -0.23, -0.16, 0.18, 0.23, 0.19]
```

Example

```
values = [0.11, -0.23, -0.16, 0.18, 0.23, 0.19]

sum = 0
for v in values:
    sum = sum + v
print sum
```

Exercise

- How do you obtain the number of elements in a list?
- Use this to compute the mean of a list of numbers

Example

```
values = [0.11, -0.23, -0.16, 0.18, 0.23, 0.19]

sum = 0.0
sum2 = 0.0
for v in values:
    sum = sum + v
    sum2 = sum2 + v * v

mu = sum/len(values)
mu2 = sum2/len(values)
print 'Average: {0}'.format(mu)
print 'Std Dev: {0}'.format(mu2 - mu*mu)
```

Example

```
values = [0.11, -0.23, -0.16, 0.18, 0.23, 0.19]

sum = 0.0
sum2 = 0.0
for v in values:
    sum += v
    sum2 += v * v

mu = sum/len(values)
mu2 = sum2/len(values)
print 'Average: {0}'.format(mu)
print 'Std Dev: {0}'.format(mu2 - mu*mu)
```

Example

```
values = [0.11, -0.23, -0.16, 0.18, 0.23, 0.19]

mu = 0.0
mu2 = 0.0
for v in values:
    mu += v
    mu2 += v * v

mu /= len(values)
mu2 /= len(values)
print 'Average: {0}'.format(mu)
print 'Std Dev: {0}'.format(mu2 - mu*mu)
```

Example

```
values = [0.11, -0.23, -0.16, 0.18, 0.23, 0.19]

mu = 0.0
mu2 = 0.0
for v in values:
    mu += v
    mu2 += v * v

mu /= len(values)
mu2 /= len(values)
print 'Average: {0}'.format(mu)
print 'Std Dev: {0}'.format(mu2 - mu*mu)
```

Exercise

Adapt the code to ignore negative numbers.

Exercise

Adapt the code to ignore negative numbers.

```
values = [0.11, -0.23, -0.16, 0.18, 0.23, 0.19]

mu = 0.0
mu2 = 0.0
n = 0.0
for v in values:
    if v >= 0.0:
        mu += v
        mu2 += v * v
        n += 1

mu /= n
mu2 /= n
print 'Average: {0}'.format(mu)
print 'Std Dev: {0}'.format(mu2 - mu*mu)
```

Loops (II)

Greatest Common Divisor (Euclid's Method)

$$\gcd(a, b) = \begin{cases} a & \text{if } b = a \\ \gcd(a - b, b) & \text{if } a > b \\ \gcd(a, b - a) & \text{o.w.} \end{cases}$$

Loops (II)

Greatest Common Divisor (Euclid's Method)

$$\gcd(a, b) = \begin{cases} a & \text{if } b = a \\ \gcd(a - b, b) & \text{if } a > b \\ \gcd(a, b - a) & \text{o.w.} \end{cases}$$

```
a = 9344
b = 6497

while a != b:
    if a > b:
        a,b = a-b,b
    else:
        a,b = a,b-a
print a
```

Python So Far

Python

1. Basic types: int, float, list
2. Control flow: for, while, if, else, elif

List Indexing

```
students = ['Luis','Rita','Sabah','Grace']
print students[0]
print students[1:2]
print students[1:]
print students[-1]
print students[-2]
```

Tuples (I)

```
A = (0,1,2)
B = (1,)

print A[0]
print len(B)
```

Tuples (II)

Tuples are like immutable lists.

Dictionaries

- Dictionaries are associative arrays.

```
gene2ensembl = {}
gene2ensembl['SMAD9'] = 'ENSG00000120693'
gene2ensembl['ZNF670'] = 'ENSG00000135747'

print gene2ensembl['SMAD9']
```

Dictionary Methods

```
gene2expression = {
      'SMAD9' : 12.3,
      'ZNF670' : 4.3,
}

print len(gene2ensembl)
print gene2ensembl.keys()
```