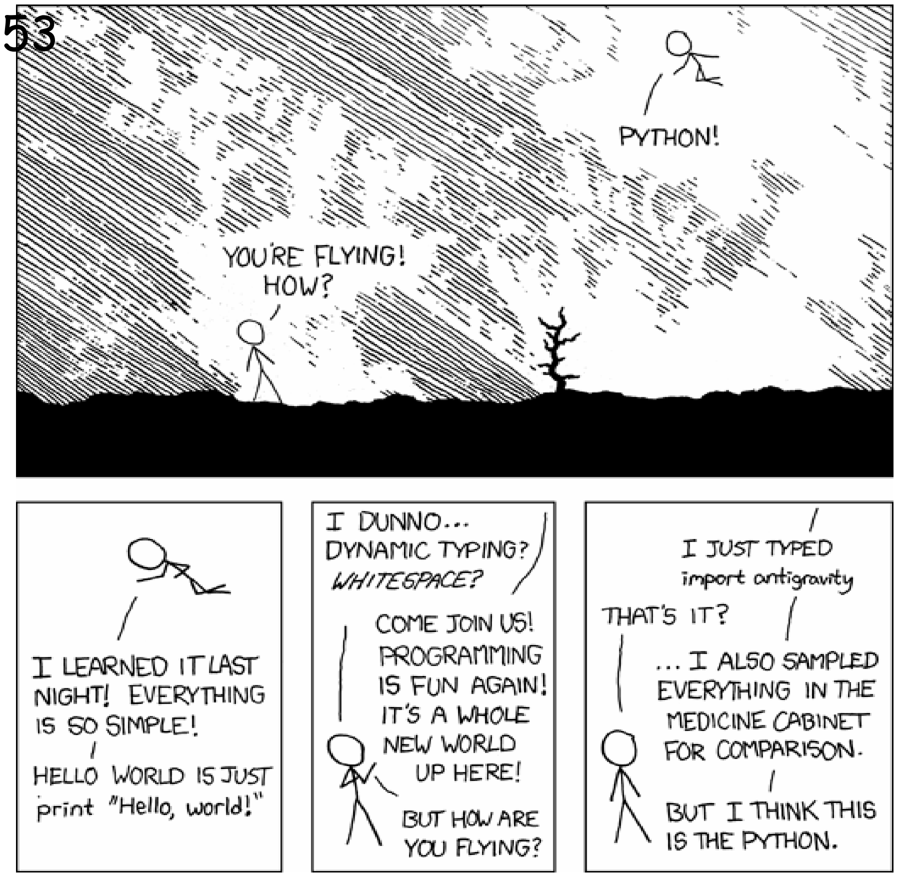
## Python

- **developed ~1991 by Guido van Rossum**
  - *CWI, Amsterdam => ... => Google*
- **for scripting but very interactive**

```
% python
>>> print "hello, world"
hello, world
>>> print 355.0/113
3.14159292035
>>> import math
>>> print math.pi
3.14159265359
```

- **Disclaimer: I am NOT a Python expert**
- **see `www.python.org`**

## xkcd.com/353


PYTHON!
YOU'RE FLYING! HOW?
I LEARNED IT LAST NIGHT! EVERYTHING IS SO SIMPLE!
HELLO WORLD IS JUST print "Hello, world!"
I DUNNO... DYNAMIC TYPING? WHITESPACE?
COME JOIN US! PROGRAMMING IS FUN AGAIN! IT'S A WHOLE NEW WORLD UP HERE!
BUT HOW ARE YOU FLYING?
I JUST TYPED import antigravity
THAT'S IT?
... I ALSO SAMPLED EVERYTHING IN THE MEDICINE CABINET FOR COMPARISON.
BUT I THINK THIS IS THE PYTHON.

## World's most boring example (yet again)

```
for fahr in range(0, 300, 20):
    print "%3d %6.1f" % (fahr, 5.0/9*(fahr-32))
```

- **grouping by indentation**
- **if elif else; while; for i in list**
- **constants: numbers, strings**
  - \ escapes interpreted in '...' and "..." but not in r'...' or r"..."
- **variables hold strings or numbers as in Awk**
  - interpretation determined by operators & context; have to be initialized
- **operators:**
  - arithmetic operators like C but no `++`, `--`, `?:`     = is not an operator
  - string concatenation uses `+`
  - relational operators are the same for string and numeric comparisons
  - format with `"fmt string" % (list of exprs)`
- **mostly uses class libraries for operations**
  - many fewer operators than Perl
  - class libraries ("modules") instead, e.g., string, re, sys, os, math, ...

## Lists

- **list, initialized to empty** `food = []`
- **list, initialized with 3 elements**

```
food = [ 'beer', 'pizza', "coffee" ]
```

- **elements accessed as `arr[index]`**
  - indices from 0 to `len(arr)-1` inclusive
  - add new elements with list.append(value) : `food.append('coke')`
  - slicing: `list[start:end]` is elements `start..end-1`
- **echo command:**

```
for i in range(1, len(sys.argv)):
    if i < len(sys.argv):
        print argv[i],    # suppresses newline
    else:
        print argv[i]
```

- **tuples are like lists, but are constants**

```
soda = ( 'coke', 'pepsi' )
soda.append('dr pepper')
```
is an error

## Dictionaries (== associative arrays)

- **dictionaries are a separate type from arrays**
  - subscripts are arbitrary strings
  - elements initialized with `dict = {'pizza':200, 'beer':100}`
  - accessed as `dict[str]`
- **example: add up values from name-value input**

| | |
|---|---|
| pizza | 200 |
| beer | 100 |
| pizza | 500 |
| coke | 50 |

```
import sys, string, fileinput
val = {}   # empty dictionary
line = sys.stdin.readline()
while (line != ""):
  (n, v) = line.strip().split()
  if val.has_key(n):
    val[n] += string.atof(v)
  else:
    val[n] = string.atof(v)
  line = sys.stdin.readline()
for i in val:
  print "%s\t%g" % (i, val[i])
```

**AWK version:**

```
     { val[$1] += $2 }
 END {
   for (i in val)
     print i, val[i] }
```

## Regular expressions and substitution

- **underlying mechanisms like Perl: libraries, not operators, less syntax**

| | |
|---|---|
| re.search(pat, str) | find first match |
| re.match(pat, str) | test for <u>anchored</u> match |
| re.split(pat, str) | split into list of matches |
| re.findall(pat, str) | list of all matches |
| re.sub(pat, repl, str) | replace all pat in str by repl |

- **shorthands in patterns**

  \d = digit, \D = non-digit

  \w = "word" character [a-zA-Z0-9_], \W = non-word character

  \s = whitespace, \S = non-whitespace

  \b = word boundary, \B = non-boundary
- **substrings**
  - matched parts are saved for later use in \1, \2, ...

  `s = re.sub(r'(\S+)\s+(\S+)', r'\2 \1', s)` flips 1st 2 words of s
- **watch out**
  - re.match is anchored (match must start at beginning)
  - patterns are not matched leftmost longest

## Functions

```
def name(arg, arg, arg):
    statements of function

def div(a, b):
    ''' computes quotient & remainder. b had better be > 0'''
    q = a / b
    r = a % b
    return (q, r)  # returns a list
```

- **functions are objects**
  - can assign them, pass to functions, return from fcns
- **parameters are passed call by value**
  - can have named arguments and default values and arrays of name-value pairs
- **variables are local unless declared `global`**
- **EXCEPT if you only read a global, it's visible**

```
      x = 1; y = 2
      def foo(): y=3; print x,y
      foo()
        1 3
     print y
        2
```

## Classes and objects

```
class Stack:
   def __init__(self):  # constructor
      self.stack = []   # local variable
   def push(self, obj):
      self.stack.append(obj)
   def pop(self):
      return self.stack.pop()    # list.pop
   def len(self):
      return len(self.stack)

stk = Stack()
stk.push("foo")
if stk.len() != 1: print "error"
if stk.pop() != "foo": print "error"
del stk
```

- **always have to use `self` in definitions**
- **special names like `__init__`  (constructor)**
- **information hiding only by convention?**

## Review: Formatter in AWK

```
/./  { for (i = 1; i <= NF; i++)
            addword($i)
     }
/^$/ { printline(); print "" }
END  { printline() }

function addword(w) {
    if (length(line) + length(w) > 60)
        printline()
    line = line space w
    space = " "
}

function printline() {
    if (length(line) > 0)
        print line
    line = space = ""
}
```

## Formatter in Python (version 1)

```
import sys, string
line=""; space = ""

def main():
    buf = sys.stdin.read()
    for word in string.split(buf):
        addword(word)
    printline()

def addword(word):
    global line, space
    if len(line) + len(word) > 60:
        printline()
    line = line + space + word
    space = " "

def printline():
    global line, space
    if len(line) > 0:
        print line
    line = space = ""

main()
```

## Surprises, gotchas, etc.

- **indentation for grouping, ":" always needed**
- **no implicit conversions**
  - often have to use class name (string.atof(s))
- **elif, not else if**
- **no ++, --, ?:**
- **assignment is not an expression**
- **% for string formatting**
- **`global` declaration to modify non-local variables in functions**
- **no uninitialized variables**

```
    if v != None:
    if arr.has_key():
```

- **regular expressions not leftmost longest**
  - re.match is anchored, re.sub replaces all
- **function call needs parens**
  - `foo` is not the same as `foo()`

## What makes Python successful?

- **comparatively small, simple but rich language**
  - regular expressions, strings, tuples, assoc arrays
  - clean (though limited) object-oriented mechanism
  - reflection, etc.
- **efficient enough**
  - seems to be getting better
- **large set of libraries**
  - extensible by calling C or other languages
- **embeddings of major libraries**
  - e.g., TkInter for GUIs
- **open source with large and active user community**
- **standard: there is only one Python**
  - but watch out for Python 3000, which is not backwards compatible
- **a reaction to the complexity and general ugliness of Perl?**

## Perl vs. Python

- **most tradeoffs in Awk made to keep it small and simple**
- **most tradeoffs in Perl made to make it powerful and expressive**
- **most tradeoffs in Python made to make it small and interactive**
- **domain of applicability**
  - Perl does system stuff well
  - Python is a lot simpler
  - Python is more extensible?
- **efficiency**
  - seem close to the same now
- **standardization**
  - there's only one Perl but it evolves
  - there's only one Python but it evolves
- **program size, installation, environmental assumptions**
  - both are big, use a big configuration script, take advantage of the environment
  - Python is somewhat smaller