

Intro

CSCI 334
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Which Programming Language Is Used?

- Unix, Linux C
- PowerPoint and Firefox C++
- OSX, iPhone, iPad Objective-C
- Gmail Client JavaScript
- PeopleSoft JavaScript+Java+SQL+...
- Google Sketchup Ruby
- Google PageRank Indexer Sawzall
- Twitter Message Queue Scala
- Telephone switches Erlang
- Facebook Chat Erlang

Most "Popular Languages", Jan. 2007

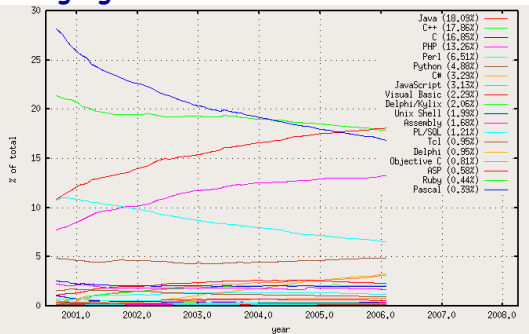
1-10	11-20	21-30	31-40	41-50
Java	SAS	Fortran	RPG	Icon
C	Delphi	Visual FoxPro	ColdFusion	Haskell
C++	PL/SQL	IDL	LabView	Natural
(Visual)Basic	D	Awk	Maple	VBScript
PHP	ABAP	Prolog	REXX	OCaml
Perl	Lisp/Scheme	dBASE	Smalltalk	Q
C#	Ada	MATLAB	Forth	Lua
Python	COBOL	Logo	CL	APL
JavaScript	Pascal	Bash	Tcl/Tk	Lingo
Ruby	Transact-SQL	ActionScript	S-lang	Objective-C

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and the Next 50...

- ABC, Algol, Applescript, AspectJ, Avenue, Beta, Boo, cg, Ch, Clarion, Clean, Clipper, Csh, cT, DC, Dylan, EGL, Eiffel, Erlang, Euphoria, F#, Felix, Focus, Groovy, Inform, Io, LotusScript, MAD, Magic, Mathematica, ML, Modula-2, MOO, MUMPS, Occam, Oz, PILOT, PL/1, Postscript, Powerbuilder, Progress, REALbasic, Rebol, Scala, Seed7, SIGNAL, SPSS, Verilog, VHDL, XSLT

Languages in Common Use



Position Jan 2007	Position Jan 2006	Delta in Position	Programming Language	Ratings Jan 2007	Delta Jan 2006
1	1	=	Java	19.160%	-3.10%
2	2	=	C	15.807%	-3.20%
3	3	=	C++	10.425%	-1.04%
4	5	↑	(Visual) Basic	9.123%	+0.03%
5	4	↓	PHP	7.943%	-1.46%
6	6	=	Perl	6.237%	-0.81%
7	7	=	C#	3.521%	-0.03%
8	8	=	Python	3.502%	+0.90%
9	10	↑	JavaScript	2.845%	+1.31%
10	21	11 * ↑	Ruby	2.519%	+2.15%
11	11	=	SAS	2.343%	+1.18%
12	9	↓ ↓ ↓	Delphi	2.336%	+0.75%
13	12	↓	PL/SQL	1.570%	+0.54%
14	22	8 * ↑	D	1.335%	+0.97%
15	20	5 * ↑	ABAP	1.229%	+0.82%
16	14	2 * ↑	Lisp/Scheme	0.674%	+0.07%
17	18	1 * ↑	Ada	0.638%	+0.17%
18	13	↓ ↓ ↓	COBOL	0.637%	-0.13%
19	15	↓ ↓ ↓	Pascal	0.570%	+0.04%
20	34	14 * ↑	Transact-SQL	0.510%	+0.34%

Course Organization

- Programming in the Small
 - theoretical foundations
 - basic concepts
 - function, imperative
 - new ways of thinking
- Programming in the Large
 - modularity
 - program structure
 - OOP
 - concurrency, security
- Lisp, ML, scripting languages, ...
- Simula, Smalltalk, C++, GJ, Scala, ...

Partial And Total Functions

- Total function $f:A \rightarrow B$ is a subset $f \subseteq A \times B$ with
 - For every $x \in A$, there is some $y \in B$ with $\langle x, y \rangle \in f$ (total)
 - If $\langle x, y \rangle \in f$ and $\langle x, z \rangle \in f$ then $y = z$ (single-valued)
- Partial function $f:A \rightarrow B$ is a subset $f \subseteq A \times B$ with
 - If $\langle x, y \rangle \in f$ and $\langle x, z \rangle \in f$ then $y = z$ (single-valued)
- Programs define partial functions for two reasons
 - partial operations (like division)
 - nontermination
$$f(x) = \text{if } x=0 \text{ then } 1 \text{ else } f(x-2)$$

Computability

- Definition

A function f is *computable* if there is a program P that computes f , i.e., for any input x , the computation $P(x)$ halts with output $f(x)$
- Terminology

Partial recursive functions
= partial functions (integers to integers) that are computable

Halting Problem

- Decide whether program halts on input
 - Given program P and input x to P ,
- $Halt(P, x) = \begin{cases} \text{"halts"} & \text{if } P(x) \text{ halts} \\ \text{"does not halt"} & \text{otherwise} \end{cases}$
- Clarifications
 - Assume program P requires one string input x
 - Write $P(x)$ for output of P when run on input x
 - Program P is string input to $Halt$
- Fact: There is no program for $Halt$

Proof

- Suppose $Q(P, x)$ is a program that:
 - returns "halts" if $P(x)$ halts
 - returns "does not halt" if $P(x)$ does not halt
 - Construct program

$$D(P) = \text{if } Q(P, P) = \text{"halts"} \text{ then run forever} \\ \text{else halt}$$
- $D(P)$ will halt if $P(P)$ runs forever.
- $D(P)$ will run forever if $P(P)$ halts.

Proof (2)

- What does $D(D)$ do?
 - If $D(D)$ halts, then $D(D)$ will run forever.
 - If $D(D)$ runs forever, then $D(D)$ halts.
- This is a contradiction!
- Therefore, our assumption that Q solves the halting problem is not valid.

Implications of Halting Problem

- There are useful program properties we cannot determine:
 - will a program run forever or not?
 - will a program eventually cause an error? (compilers do conservative checking- more on this later)
 - will a program touch a specific piece of memory again?

Ruby

- From Wikipedia:

Ruby is a reflective, dynamic, object-oriented programming language. It combines syntax inspired by Perl with Smalltalk-like object-oriented features, and also shares some features with Python, Lisp, Dylan and CLU.

- Web Services (wiki's, webmail, shopping, ...), Data Processing

The Scala Programming Language

- **Scala is object-oriented.**
- **Scala is functional**
- **Scala is statically typed**
- Scala is equipped with an expressive type system that enforces statically that abstractions are used in a safe and coherent manner. In particular, the type system supports:
 - generic classes,
 - variance annotations,
 - upper and lower type bounds,

Languages in common use (II)

Position	Delta 1 Year	Programming Language	Ratings	Delta 1 Year
1	↑	C	17.122%	-0.65%
2	↓	Java	15.896%	-6.35%
3	=	C++	14.916%	-2.62%
4	↑	(Visual) Basic	11.650%	+4.47%
5	↓	Perl	8.968%	-0.87%
6	=	PHP	8.231%	+2.80%
7	↑↑↑↑	Delphi/Pascal/Kylix	5.865%	+4.28%
8	↑↑↑↑	Python	5.597%	+4.17%
9	↓	SQL	2.693%	-0.55%
10	↓	C#	1.634%	-0.43%

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50 Most "Widely-Used" Languages, 2004

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C++	COBOL	VB.NET	ActionScript	VHDL
(Vis.) Basic	ABAP	Prolog	LabView	Objective-C
Perl	IDL	Postscript	S-Lang	VBScript
PHP	Pascal	Scheme	Tcl/Tk	ML
Delphi	Lisp	ColdFusion	Icon	Lingo
Python	Fortran	Awk	Bash	Csh
SQL	Ada	Ruby	PL/1	Groovy
C#	RPG	REXX	Clipper	Dylan

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