A Programming Languages Tour

Mother Tongues

Tracing the roots of computer languages through the ages

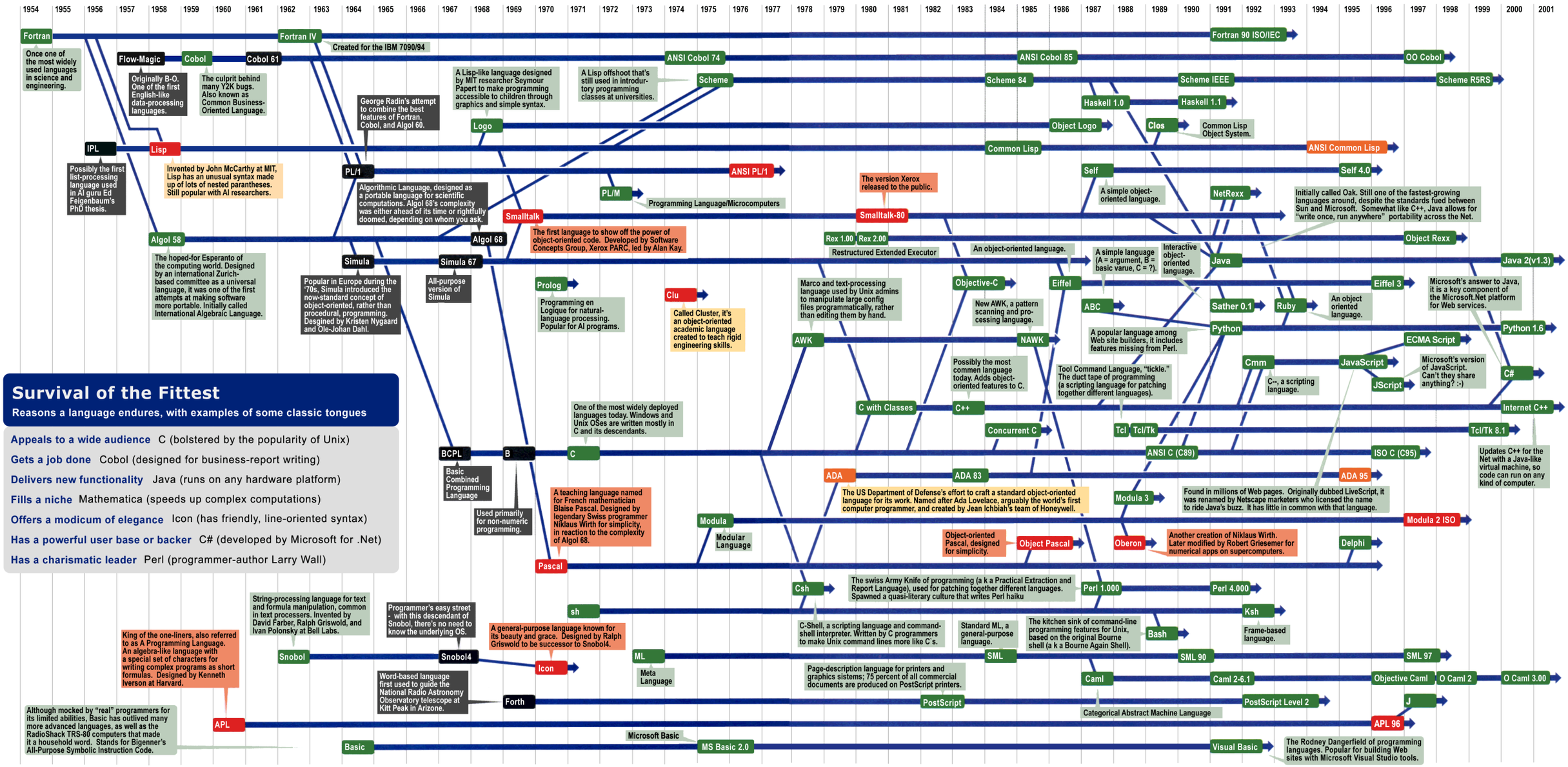
Just like half of the world's spoken tongues, most of the 2,300-plus computer programming languages are either endangered or extinct. As powerhouses C/C++, Visual Basic, Cobol, Java and other modern source codes dominate our systems, hundreds of older languages are running out of life.

An ad hoc collection of engineers-electronic lexicographers, if you will-aim to save, or at least document the lingo of classic software. They're combing the globe's 9 million developers in search of coders still fluent in these nearly forgotten lingua frangas. Among the most endangered are Ada, APL, B (the predecessor of C), Lsp, Oberon, Smalltalk, and Simula.

Code-raker Grady Booch, Rational Software's chief scientist, is working with the Computer History Musuem in Silicon Valley to record and, in some cases, maintain languages by writing new compilers so our ever-changing hardware can grok the code. Why bother? "They tell us about the state of software practice, the minds of their inventors, and the technical, social, and economic forces that shaped history at the time," Booch explains. "They'll provide the raw material for software archaeologists, historians, and developers to learn what worked, what was brilliant, and what was an utter failure." Here's a peek at the strongest branches of programming's family tree. For a nearly exhaustive rundown, check out the Language List at *HTTP://www.informatik.uni-freiburg.de/Java/misc/lang_list.html*. - Michael Mendeno

Key

- 1954 Year Introduced
- **Active:** thousands of users
- **Protected:** taught at universities; compilers available
- **Endangered:** usage dropping off
- **Extinct:** no known active users or up-to-date compilers
- **Lineage continues**



Survival of the Fittest

Reasons a language endures, with examples of some classic tongues

- **Appeals to a wide audience** C (bolstered by the popularity of Unix)
- **Gets a job done** Cobol (designed for business-report writing)
- **Delivers new functionality** Java (runs on any hardware platform)
- **Fills a niche** Mathematica (speeds up complex computations)
- **Offers a modicum of elegance** Icon (has friendly, line-oriented syntax)
- **Has a powerful user base or backer** C# (developed by Microsoft for .Net)
- **Has a charismatic leader** Perl (programmer-author Larry Wall)

Sources: Paul Boutin; Brent Hailpern, associate director of computer science at IBM Research; The Retrocomputing Museum; Todd Proebsting, senior researcher at Microsoft; Gio Wiederhold, computer scientist, Stanford University

Chris Gregg, CS 208E
November 8, 2021

Link to above diagram

How many languages?

https://en.wikipedia.org/wiki/List_of_programming_languages

The above link lists 700 programming languages. We do not have time to discuss all of them.

Most people have never heard of almost all of them, but there are a few that stick out.

Today, we will discuss those languages.

FORTRAN

- Designed in the 1950s by IBM (specifically, John Backus)
- Continuous use since then
  - There are still billions of lines of Fortran, and it is still actively used for scientific computing (and has been modernized significantly)
  - High-level language: reduced the number of programming statements by a factor of 20 over assembly. This was the biggest contributing factor to its widespread acceptance.

FORTRAN

- FORTRAN II came in 1958, and had subroutines (functions), double precision numbers
- No recursion
- No type declarations, although variables whose names started with I, J, K, L, M, or N were integers.
- UPPERCASE only
- In the early days, programs were on punched cards

FORTRAN

SDS Fortran II Coding Form

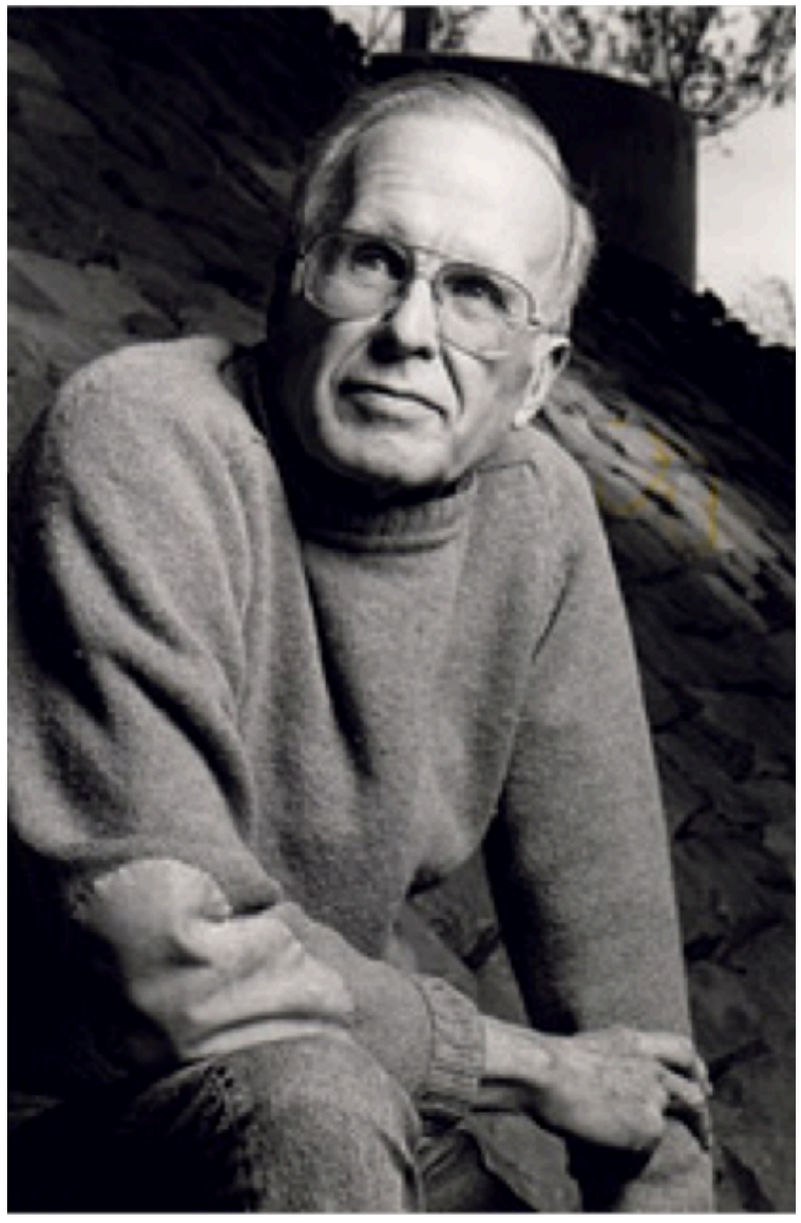
Prepared By _____ Date _____

Problem Identification _____ Page _____ of _____

```
C  CALCULATE AND TYPE THE ROOTS OF A SET OF QUADRATIC EQUATIONS
      DIMENSION A(100),B(100),C(100)
      ACCEPT TAPE 1,N,(A(J),B(J),C(J),J=1,N)
1     FORMAT(I3/(1P3E12.4))
      DO 2 I=1,N
      DISCR=B(I)**2-4.*A(I)*C(I)
C  IF ROOTS ARE COMPLEX GO TO 3 IF NOT GO TO 4
      IF(DISCR)3,4,4
3     ROOT1RL=-B(I)/(2.*A(I))
      ROOT2RL=ROOT1RL
      ROOT1IM=SQRTF(-DISCR)/(2.*A(I))
      ROOT2IM=-ROOT1IM
      GO TO 2
4     ROOT1RL=(-B(I)+SQRTF(DISCR))/(2.*A(I))
      ROOT2RL=(-B(I)-SQRTF(DISCR))/(2.*A(I))
      ROOT1IM=0.
      ROOT2IM=0.
2     TYPE 5,A(I),B(I),C(I),ROOT1RL,ROOT1IM,ROOT2RL,ROOT2IM
5     FORMAT(3H A=1PE11.4,3H B=E11.4,3H C=E11.4/6X,7HROOT1=(
     1E11.4,4H)+I(E11.4,8H) ROOT2=(E11.4,4H)+I(E11.4,1H))
      STOP
      END
```

FORTRAN

“It was our belief that if FORTRAN, during its first months, were to translate any reasonable "scientific" source program into an object program only half as fast as its hand coded counterpart, then acceptance of our system would be in serious danger. [...] To this day I believe that our emphasis on object program efficiency rather than on language design was basically correct. I believe that had we failed to produce efficient programs, the widespread use of languages like FORTRAN would have been seriously delayed.” – John Backus



FORTRAN

```
C AREA OF A TRIANGLE WITH A STANDARD SQUARE ROOT FUNCTION
C INPUT - TAPE READER UNIT 5, INTEGER INPUT
C OUTPUT - LINE PRINTER UNIT 6, REAL OUTPUT
C INPUT ERROR DISPLAY ERROR OUTPUT CODE 1 IN JOB CONTROL LISTING
      READ INPUT TAPE 5, 501, IA, IB, IC
  501 FORMAT (3I5)
C IA, IB, AND IC MAY NOT BE NEGATIVE OR ZERO
C FURTHERMORE, THE SUM OF TWO SIDES OF A TRIANGLE
C MUST BE GREATER THAN THE THIRD SIDE, SO WE CHECK FOR THAT, TOO
      IF (IA) 777, 777, 701
  701 IF (IB) 777, 777, 702
  702 IF (IC) 777, 777, 703
  703 IF (IA+IB-IC) 777, 777, 704
  704 IF (IA+IC-IB) 777, 777, 705
  705 IF (IB+IC-IA) 777, 777, 799
  777 STOP 1
C USING HERON'S FORMULA WE CALCULATE THE
C AREA OF THE TRIANGLE
  799 S = FLOATF (IA + IB + IC) / 2.0
      AREA = SQRTF( S * (S - FLOATF(IA)) * (S - FLOATF(IB)) *
     +     (S - FLOATF(IC)))
      WRITE OUTPUT TAPE 6, 601, IA, IB, IC, AREA
  601 FORMAT (4H A= ,I5,5H  B= ,I5,5H  C= ,I5,8H  AREA= ,F10.2,
     +        13H SQUARE UNITS)
      STOP
      END
```

FLOW-MATIC / COBOL

- In the mid-1950s, Grace Hopper created a language called “FLOW-MATIC” that greatly influenced COBOL, which is an acronym for “common business-oriented language”
- FLOW-MATIC was the first programming language to express operations using English-like statements.

FLOW-MATIC

```
 (0)  INPUT INVENTORY FILE-A PRICE FILE-B ; OUTPUT PRICED-INV FILE-C UNPRICED-INV
      FILE-D ; HSP D .
 (1)  COMPARE PRODUCT-NO (A) WITH PRODUCT-NO (B) ; IF GREATER GO TO OPERATION 10 ;
      IF EQUAL GO TO OPERATION 5 ; OTHERWISE GO TO OPERATION 2 .
 (2)  TRANSFER A TO D .
 (3)  WRITE-ITEM D .
 (4)  JUMP TO OPERATION 8 .
 (5)  TRANSFER A TO C .
 (6)  MOVE UNIT-PRICE (B) TO UNIT-PRICE (C) .
 (7)  WRITE-ITEM C .
 (8)  READ-ITEM A ; IF END OF DATA GO TO OPERATION 14 .
 (9)  JUMP TO OPERATION 1 .
(10)  READ-ITEM B ; IF END OF DATA GO TO OPERATION 12 .
(11)  JUMP TO OPERATION 1 .
(12)  SET OPERATION 9 TO GO TO OPERATION 2 .
(13)  JUMP TO OPERATION 2 .
(14)  TEST PRODUCT-NO (B) AGAINST ; IF EQUAL GO TO OPERATION 16 ;
      OTHERWISE GO TO OPERATION 15 .
(15)  REWIND B .
(16)  CLOSE-OUT FILES C ; D .
(17)  STOP . (END)
```

COBOL

```
Command ===>                                                  Scroll ===> CSR
=COLS> ----+----1----+----2----+----3----+----4----+----5----+----6----+----7--
******* ******************************** Top of Data ********************************
000100          IDENTIFICATION DIVISION.
000200          PROGRAM-ID.    COBOL1.
000300          ENVIRONMENT DIVISION.
000400          DATA DIVISION.
000500          WORKING-STORAGE SECTION.
000600        * Comment Line - MainframeGurukul.com
000700          01  WS-A                    PIC  9(3).
000800          01  WS-B                    PIC  9(3).
000900          01  WS-C                    PIC  9(4).
001000          PROCEDURE DIVISION.
                    MOVE  100 TO WS-C.
                    MOVE  200 TO WS-B.
                    COMPUTE WS-A =WS-B + WS-C.
001310              DISPLAY "C VALUE " , WS-C.
                    DISPLAY "B VALUE " , WS-B.
                    DISPLAY "A VALUE " , WS-A.
                    STOP RUN.
```

Program name

Data items declaration. WS-A data item defined with size 9(3), which means program can store up to 3 digits of numeric data into this field

Initializing WS-C with value 100. Next statement, initializes WS-B with value 200

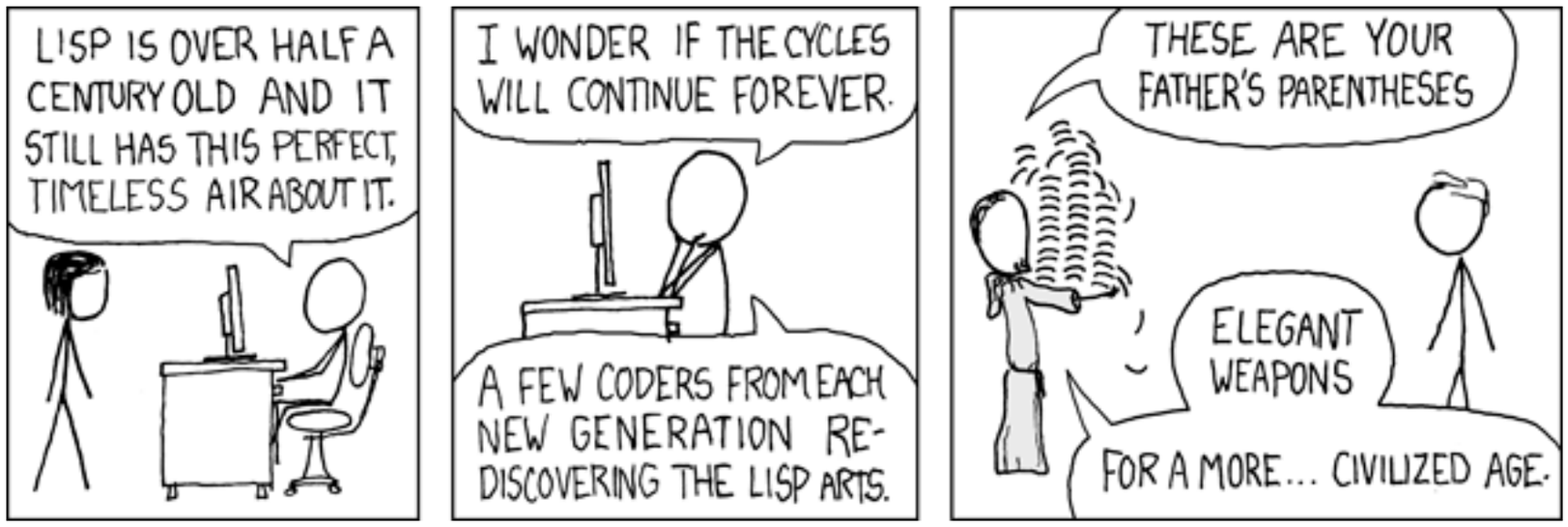
Adding values of WS-B & WS-C data-items and moving the value to WS-A data item using COMPUTE Verb.

Displaying values to output / spool.

STOP RUN will stop execution of program

Lisp

- 1958 — designed by John McCarthy
- Originally created as a practical mathematical notation for computer programs, influenced by the notation of Alonzo Church's lambda calculus.
- Quickly became the favored programming language for artificial intelligence (AI) research.
- Has a distinct, *fully parenthesized* format.



https://xkcd.com/297/

Lisp

- Lisp lends itself naturally to recursion

```
(defun factorial (n &optional (acc 1))
  (if (= n 0) acc
      (factorial (- n 1) (* acc n))))
```

- Machines were designed in the 1970s and 1980s that were designed specifically to efficiently run Lisp as their main software and programming language.
- They never had much traction because, well, it is hard to run Lisp efficiently.
- Today, the Scheme language (a dialect of Lisp) is still taught as an introductory language

ALGOL

- Developed by committee in the late 1950s
- Greatly influenced many other languages, such as C, Pascal, Python, etc.
- Introduced code blocks, and “begin” “end” semantics
- First language to implement nested function definitions
- Had “call-by-value” and “call-by-name” semantics
- The original language did not have I/O — implementations were free to define their own I/O (not a great idea…)
- Allowed recursion (there was a debate about whether this was a good idea — they chose wisely)

Algol

```
procedure Absmax(a) Size:(n, m) Result:(y) Subscripts:(i, k);
    value n, m; array a; integer n, m, i, k; real y;
comment The absolute greatest element of the matrix a, of size n by m
    is transferred to y, and the subscripts of this element to i and k;
begin
    integer p, q;
    y := 0; i := k := 1;
    for p := 1 step 1 until n do
        for q := 1 step 1 until m do
            if abs(a[p, q]) > y then
                begin y := abs(a[p, q]);
                    i := p; k := q
                end
end Absmax
```

APL

- Named after a book called “A Programming Language”
- Developed in the 1960s
- Used a large range of mathematical symbols, which was best programmed using a specialized keyboard

IBM 2741 APL keyboard

- It is very terse! Here is the Game of Life program (some of you may have done this in 106B):

```
life←{↑1 ⍵∨.∧3 4=+/,¯1 0 1∘.⊖¯1 0 1∘.⌽⊂⍵}
```

APL

- It is pretty wacky to see someone program efficiently in APL: https://www.youtube.com/watch?v=DmT80OseAGs&t=23s

```
      ∇DET[⎕]∇
     ∇ Z←DET A;B;P;I
[1]    I←⎕IO
[2]    Z←1
[3]   L:P←(|A[;I])⍳⌈/|A[;I]
[4]    →(P=I)/LL
[5]    A[I,P;]←A[P,I;]
[6]    Z←-Z
[7]   LL:Z←Z×B←A[I;I]
[8]    →(0 1 ∨.=Z,1↑⍴A)/0
[9]    A←1 1 ↓A-(A[;I]÷B)∘.×A[I;]
[10]   →L
[11] ⍝EVALUATES A DETERMINANT
     ∇
```

BASIC

- BASIC was created in 1964 at Dartmouth as a beginner's programming language.
- It became the *de facto* standard for personal computers of the 1970s and 1980s to boot directly into a BASIC interpreter, which meant that millions of people (adults and kids) were exposed to BASIC and programming.
- Bill Gates launched his career writing a BASIC interpreter, for the Altair 8800 computer.
- BASIC has its detractors: it does not have a block structure (though newer versions do), and relies on line numbers and GOTO statements. Edsger Dijkstra said, "It is practically impossible to teach good programming style to students that have had prior exposure to BASIC: as potential programmers they are mentally mutilated beyond hope of regeneration."

BASIC


VICE: C64 emulator
10 PRINT "I ♥ CS208E"
20 GOTO 10
READY.
RUN
I ♥ CS208E
I ♥ CS208E
I ♥ CS208E
I ♥ CS208E
I ♥ CS208E
I ♥ CS208E
I ♥ CS208E
I ♥ CS208E
I ♥ CS208E
I ♥ CS208E
BREAK IN 10
READY.

Simula

- Simula was a simulation language written in the late 1960s
- It is a *superset* of ALGOL 60
- Simula introduced classes and inheritance, and is considered the first object oriented programming language.
- In that vein, it begat C++, Objective-C, Java, C#, etc.

Simula

```
Begin
   Class Glyph;
      Virtual: Procedure print Is Procedure print;;
   Begin
   End;
   Glyph Class Char (c);
      Character c;
   Begin
      Procedure print;
        OutChar(c);
   End;
   Glyph Class Line (elements);
      Ref (Glyph) Array elements;
   Begin
      Procedure print;
      Begin
         Integer i;
         For i:= 1 Step 1 Until UpperBound (elements, 1) Do
            elements (i).print;
         OutImage;
      End;
   End;
   Ref (Glyph) rg;
   Ref (Glyph) Array rgs (1 : 4);
   ! Main program;
   rgs (1):- New Char ('A');
   rgs (2):- New Char ('b');
   rgs (3):- New Char ('b');
   rgs (4):- New Char ('a');
   rg:- New Line (rgs);
   rg.print;
End;
```

Pascal

- Pascal was created in 1970 by Niklaus Wirth at least in part while he was an Assistant Professor at Stanford.
- Pascal was widely used as a teaching language, particularly in the 1980s, when people wanted a beginner-friendly, structured language that had a block structure, functions, etc.
- Borland's *Turbo Pascal* was a predominant development environment in the late 1980s for commercial software, and one of the first integrated IDEs available.
- Pascal had pointers, arrays, and many of the features in C (it was largely replaced by C as a teaching language in the early 1990s)

Pascal

```pascal
while a <> b do  WriteLn('Waiting');

if a > b then WriteLn('Condition met')    {no semicolon allowed!}
    else WriteLn('Condition not met');

for i := 1 to 10 do  {no semicolon for single statements allowed!}
    WriteLn('Iteration: ', i);

repeat
    a := a + 1
until a = 10;

case i of
    0 : Write('zero');
    1 : Write('one');
    2 : Write('two');
    3,4,5,6,7,8,9,10: Write('?')
end;
```

C

- C was originally developed at Bell Labs by Dennis Ritchie in 1972.
- It was designed to make utilities for Unix, and was specifically designed to be both low-level and portable.
- It is a direct descendent of Algol, then BCPL, and then B, and it has influenced many, many languages.
- Compilers for many languages translate to C before compiling with a C compiler to binary, because C compilers are so efficient.
- Compilers for other languages are often also *implemented* in C.
- C is widely used for systems and embedded programming, and the Linux kernel is in C (and will never be in C++, if Linus Torvalds has anything to do with it).

C

- Instead of showing some C code (you likely have seen it many times) take a look at the Obfuscated C Code Contest.

C++ / Objective-C / C#

- C++, Objective-C, and C# are all more or less supersets of C, and all have classes and are object oriented.
- C++ was developed in 1985 by Bjarne Stroustrup, and was originally called “C with Classes”. It is widely used today for big programs, and particularly for video games. It is a complicated language with many, many features, but is also fast and can handle low-level tasks.
- Objective-C was developed in the early 1980s and was adopted by the NeXT computer company (owned by Steve Jobs) as its core language. It was used as the core language for Mac’s OS X and iOS development, and is still used primarily at Apple (it has been largely superseded by Swift for user applications).
- C# is Microsoft’s answer to Java, and part of the .NET platform. It is “managed” C, meaning that it, in general, does *not* recommend using C# for low-level access (to raw pointers, for instance), and programmers have to use the keyword “unsafe” for such parts of the code.

Postscript

- Postscript is a *page description language* developed in the early 1980s for use in the desktop publishing arena.
- It was designed by programmers who left Xerox PARC to found Adobe.
- The Apple Laserwriter was the first printer to use Postscript, in 1985. Because Postscript required high performance, the LaserWriter had a processor that was more powerful than most of the Macs it was connected to.
- The PDF language is a direct descendent of Postscript.

Postscript

```
gsave
1 0.5 scale
70 100  48  0 360 arc
fill
grestore
/Helvetica-Bold 14 selectfont
1.0 setgray
29 45 moveto
(Hello, world!) show
showpage
```

Hello World, in Postscript

Java

- Java is an object oriented programming language, written by James Gosling, in 1995 that was specifically designed to “write once, run anywhere” with portability being an utmost concern.
- It is managed (no low-level access)
- Java programs are compiled to *Java Bytecode*, which is then interpreted by a *Java Virtual Machine*.
- Java has a robust garbage collector, so memory management is handled for the programmer, to a large extent.
- Java *applets* were very popular in the late 1990s as web-based programs.
- Java was never known to be fast (because of the byte code interpretation, primarily), but it is an excellent choice for cross-platform applications.
- Java is used for many Android applications, although this is being eclipsed by the use of the Kotlin language.

Javascript

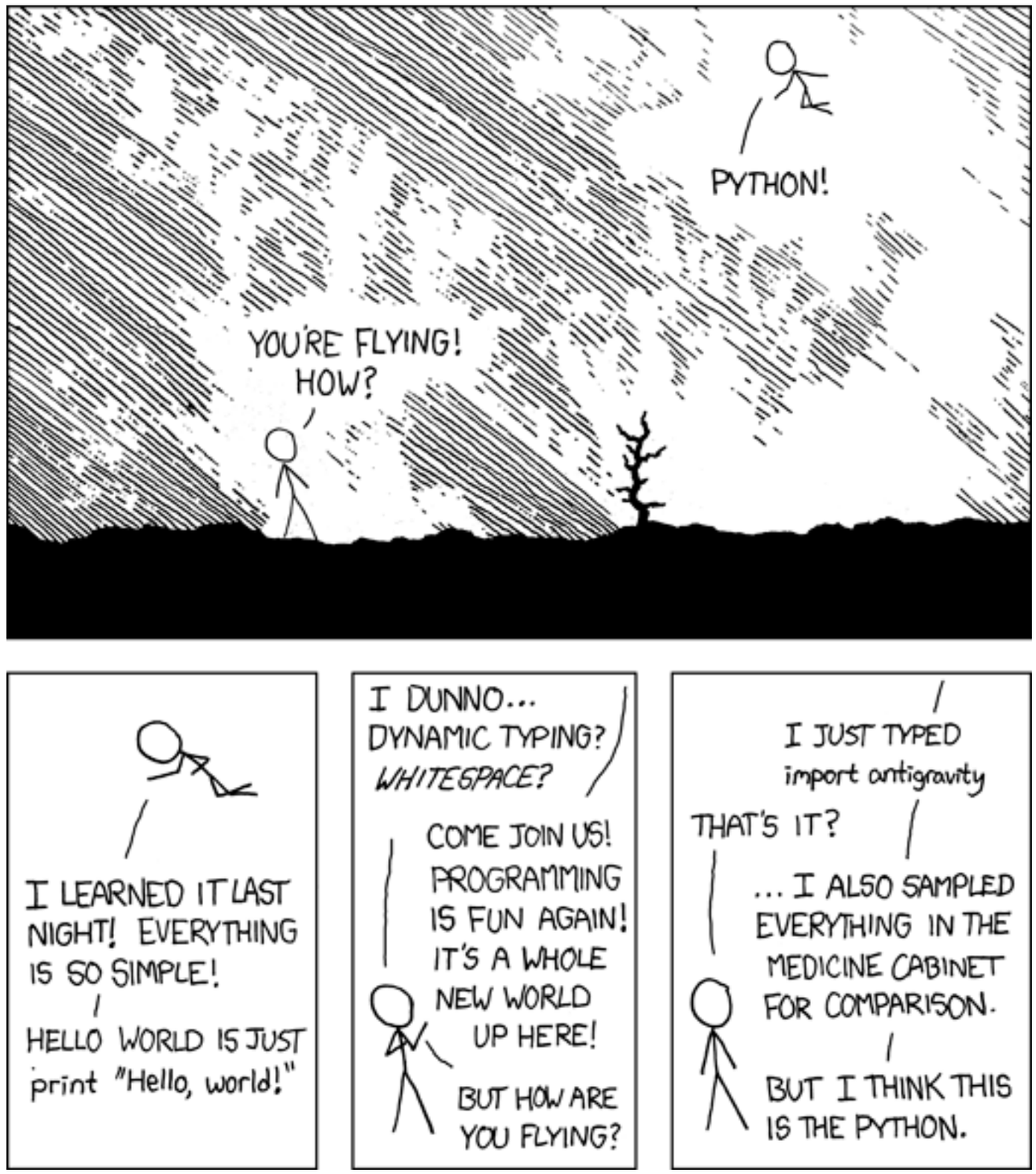
- Javascript is the *language de jure* of the Internet.
- Developed (famously) in a bit over a week at Netscape in 1995, and was called Javascript to capitalize on the popularity of Java. It is not related to Java except for the C-like structure and general syntax.
- It was influenced by Scheme, and does have some interesting properties, such as closures.
- In 2008, Douglas Crockford (who invented JSON) wrote a book called *Javascript: the Good Parts*. Crockford wrote the book to show that while Javascript has some terrible parts, it can be a very nice language if you only use a subset of the language.

https://www.destroyallsoftware.com/talks/the-birth-and-death-of-javascript

Python

- Created in 1990 by Guido van Rossum (B*enevolent Dictator for Life)*, Python is one of the most widely used languages in the world.
- It was designed for code readability, and has the interesting property of requiring whitespace to be correct.
- Python famously has “batteries included” which has contributed to its success.

Python



https://xkcd.com/353/

Perl / Ruby / SNOBOL / AWK / PHP

Swift / Kotlin / Rust / Go

Haskell / OCaml / Scala

Old languages fade away, and new languages are created all the time — the top row are languages were once very popular in their own right. The middle row are languages that have superseded (to some extent) other languages.
The bottom row is a group of *functional* languages that stress “pure” functions that have no side effects.

Esoteric Languages

https://en.wikipedia.org/wiki/Esoteric_programming_language

```
HAI 1.0
CAN HAS STDIO?
I HAS A VAR
IM IN YR LOOP
    UP VAR!!1
    VISIBLE VAR
    IZ VAR BIGGER THAN 10? KTHX
IM OUTTA YR LOOP
KTHXBYE
```

LOLCODE

This Amazing Quine Relay

https://github.com/mame/quine-relay

The End