(What may now seem) syntax oddities in older programming languages

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Introduction

Looking at old, high level programming languages.

"old" broadly means "before 1980"

although mostly still in use, in one form or another

See the notes for credits for the source code examples, and links to resources.

FORTRAN IV

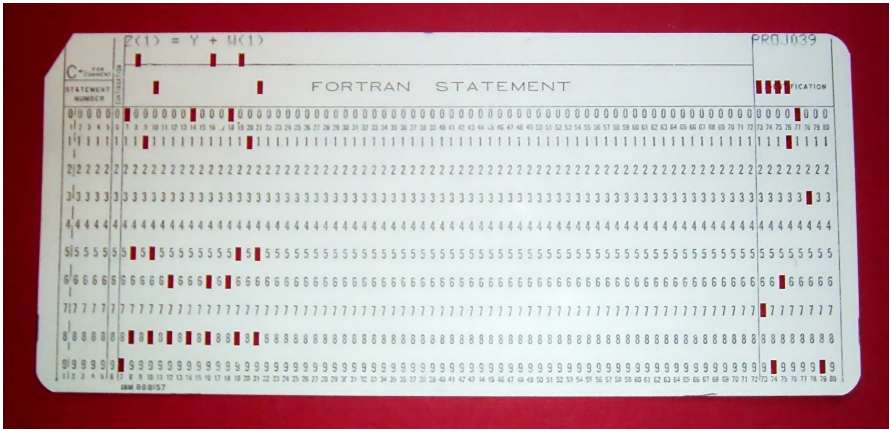
FORTRAN is the first high level language still in use today (in some form)

Early syntax heavily influenced by punch cards.

FORTRAN IV

```
      INTEGER BOTTLS
      DO 50 I = 1, 99
        BOTTLS = 100 - I
        PRINT 10, BOTTLS
        PRINT 20, BOTTLS
        PRINT 30
        BOTTLS = BOTTLS - 1
        PRINT 10, BOTTLS
        PRINT 40
50    CONTINUE
      STOP
10    FORMAT(1X, I2, 31H bottle(s) of beer on the wall.)
20    FORMAT(1X, I2, 19H bottle(s) of beer.)
30    FORMAT(34H Take one down and pass it around,)
40    FORMAT(1X)
      END
```

A (FORTRAN) punched card



Fortran IV and punched cards

Comment Cards - first character is `C`, rest are ignored.

Statement Cards

Data Cards

Fortran IV Statement Cards

Columns:

```
              1         2         3            6         7           8
12345 | 6 | 78901234567890123456789O .. ..  567890123456789012 | 34567890
```

1-5 are spaces or statement numbers ("labels")

6 is the "continuation" character

7-72 are program code

73-80 ignored, but normally used for card sequence

FORTRAN IV continued

Spaces within program code are ignored.

```
G O T O 9 0 0
```

No reserved words, context gives meaning.

```
IF(IF.EQ.PROGRAM)IF=IF*PROGRAM
```

6 character variable names

```
BOTTLS = 99
```

Implicit typing

```
C A variable starting I - N defaults to INTEGER, otherwise REAL
      I = 4
      R = 3.0
```

Arithmetic IF

```
IF (X/Y*Z) 100,300,50
```

FORTRAN procedures: function

```
INTEGER FUNCTION ADD1(I)
  ADD1 = I + 1
END

J = ADD1(3)
```

Returns a single value.

FORTRAN procedures: subroutine

```
SUBROUTINE CALC(A,B,C,SUM,SUMSQ)
  SUM = A + B + C
  SUMSQ = SUM ** 2
END

CALL CALC(1,2,3,SUM1,SUMSQ1)
```

Returns 0 or more values, via its argument list.

LISP

LISP is the second oldest programming language still in common use.

It didn't end up quite how it was initially designed.

M- and S-expressions

S-expressions (Symbolic expressions) were the data representation, and look very much as we'd expect LISP to look.

M-expressions (Meta expressions) were intended as the notation for the writing of recursive functions of S-expressions.

From the LISP 1.5 Programmer's Manual

M-expression

```
[atom[x] → x; T → ff[car[x]]]
```

becomes S-expression:

```
(COND ((ATOM X) X)
    ((QUOTE T) (FF (CAR X))))
```

LISP 2

```
% SUMSQUARE COMPUTES THE SUM OF THE SQUARES OF THE
% COMPONENTS OF AN ARBITRARY VECTOR

REAL SECTION COMPUTE, LISP;

REAL FUNCTION SUMSQUARE(X(I));
   BEGIN INTEGER J; REAL Y;
           FOR J ← STEP 1 UNTIL I DO
               Y ← Y + X(J) ↑ 2;
           RETURN Y;
   END;

SUMSQUARE (2, 7, 4); STOP
```

```
69.0
```

Modern Lisps

Common Lisp

```
(defun sum-of-squares (vector)
  (loop for x across vector sum (expt x 2)))
```

Scheme

```
(define (sum-of-squares l)
  (apply + (map * l l)))
```

Common Lisp 99 bottles

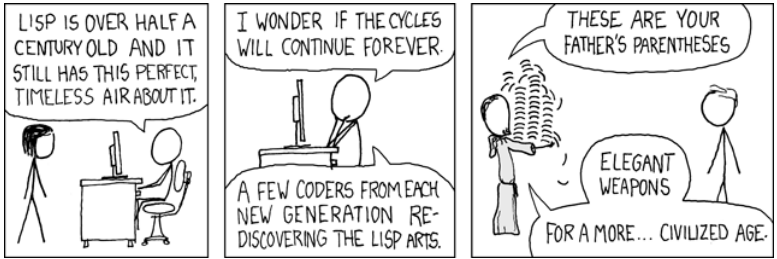
```
(defun bottles (x)
  (loop for bottles from x downto 1
        do (format t "~a bottle~:p of beer on the wall~@
                      ~:*~a bottle~:p of beer~@
                      Take one down, pass it around~@
                      ~V[No more~:;~:*~a bottle~:p of~] beer on the wall~2%"
                   bottles (1- bottles))))

(bottles 99)
```

Scheme 99 bottles

```
(define bottles
  (lambda (n)
    (cond ((= n 0) (display "No more bottles"))
          ((= n 1) (display "One bottle"))
          (else (display n) (display " bottles")))
    (display " of beer")))
(define beer
  (lambda (n)
    (if (> n 0)
        (begin
          (bottles n) (display " on the wall") (newline)
          (bottles n) (newline)
          (display "Take one down, pass it around") (newline)
          (bottles (- n 1)) (display " on the wall") (newline)
          (newline)
          (beer (- n 1))))))
(beer 99)
```

...the inevitable xkcd cartoon



https://xkcd.com/297/ (Randall Monroe)

IF-THEN-ELSE

According to https://en.wikipedia.org/wiki/Lisp_(programming_language

> A conditional using an if–then–else syntax was invented by McCarthy in a Fortran context. He proposed its inclusion in ALGOL, but it was not made part of the Algol 58 specification. For Lisp, McCarthy used the more general cond-structure. Algol 60 took up if–then–else and popularized it.

IF .. THEN .. ELSE appeared in FORTRAN in FORTRAN 77.

COBOL

The third oldest programming language still in common use.

An attempt to make something suitable for business use.

COBOL 2002

```
program-id. ninety-nine.
data division.
working-storage section.
01  cnt       pic 99.

procedure division.

  perform varying cnt from 99 by -1 until cnt < 1
    display cnt " bottles of beer on the wall"
    display cnt " bottles of beer"
    display "Take one down, pass it around"
    subtract 1 from cnt
    display cnt " bottles of beer on the wall"
    add 1 to cnt
    display space
  end-perform.
```

COBOL old school (5 slides abbreviated)

I orginally had 5 slides of COBOL doing 99 bottles here. It started:

```
IDENTIFICATION DIVISION.
PROGRAM-ID.BOTTLES_OF_BEER.
AUTHOR.DONALD FRASER.
```

and ended:

```
WRITE-ROUTINE.
        MOVE BOTTLES TO NUMBER-OF-BEERS-1, NUMBER-OF-BEERS-2.
        COMPUTE BOTTLES = BOTTLES - 1.
        WRITE BEERS-OUT FROM LINE1.
        MOVE BOTTLES TO NUMBER-OF-BEERS-3.
        WRITE BEERS-OUT FROM LINE2.
```

Forth

Stack based language

Very little syntax

A very simple Forth example

From https://www.whoishostingthis.com/resources/forth-programming/

```
: OUTMATH             Output a mathematical calculation
  ." We will now calculate: (2 + 3) * 5" CR
  2 3 + 5 *
  ." This equals: " . CR ;

OUTMATH
```

```
We will now calculate: (2 + 3) * 5
This equals: 25
```

99 bottles in Forth

```
:noname   dup . ." bottles" ;
:noname       ." 1 bottle"  ;
:noname ." no more bottles" ;
create bottles , , ,

: .bottles  dup 2 min cells bottles + @ execute ;
: .beer     .bottles ."  of beer" ;
: .wall     .beer ."  on the wall" ;
: .take     ." Take one down, pass it around" ;
: .verse    .wall cr .beer cr
       1- .take cr .wall cr ;
: verses    begin cr .verse ?dup 0= until ;

99 verses
```

or create a beer language (slide 1)

```
DECIMAL
: BOTTLES ( n -- )
        DUP
        CASE
        1 OF    ." One more bottle " DROP ENDOF
        0 OF    ." NO MORE bottles " DROP ENDOF
                . ." bottles "    \ DEFAULT CASE
        ENDCASE ;

: ,   [CHAR] , EMIT  SPACE 100 MS CR ;
: .   [CHAR] . EMIT  300 MS  CR CR CR ;
: OF       ." of "   ;     : BEER     ." beer " ;
: ON       ." on "   ;     : THE      ." the "  ;
: WALL     ." wall" ;      : TAKE     ." take " ;
: ONE      ." one "  ;     : DOWN     ." down, " ;
: PASS     ." pass " ;     : IT       ." it "   ;
: AROUND   ." around" ;
```

(slide 2)

```
: POPONE    1 SWAP CR ;
: DRINK     POSTPONE DO ; IMMEDIATE
: ANOTHER   S" -1 +LOOP" EVALUATE ; IMMEDIATE
: HOWMANY   S" I " EVALUATE ; IMMEDIATE
: ONELESS   S" I 1- " EVALUATE ; IMMEDIATE
: HANGOVER    ." :-("  CR QUIT ;

: BEERS ( n -- )   \ Usage:  99 BEERS
     POPONE
     DRINK
       HOWMANY BOTTLES OF BEER ON THE WALL ,
       HOWMANY BOTTLES OF BEER ,
       TAKE ONE DOWN PASS IT AROUND ,
       ONELESS BOTTLES OF BEER ON THE WALL .
     ANOTHER
     HANGOVER ;
```

The Algols - a selection

ALGOL 60 - Tony Hoare said "Here is a language so far ahead of its time that it was not only an improvement on its predecessors but also on nearly all its successors."

ALGOL 68 - seen at the time as a very complex language

ALGOL W - Wirth's proposed successor to ALGOL 60, ancestor of PASCAL and Modula-2

Simula 67 - ALGOL 60 with classes

Ada - designed for safety and developing large systems

Stropping

In the older ALGOL languages, bold text would be used for keywords in documentation:

    int a real int = 3;

but that didn't work in actual source code.

Stropping (from "apostrophe") uses extra characters to mark keywords.

ALGOL 60 used QUOTE stropping

```
'int' intval = 3;
```

ALGOL 68 typically used UPPER stropping

```
INT a real int = 3;
```

or POINT stropping when working with 6 bit characters (no lower-case characters)

```
.INT A REAL INT = 3;
```

Algol 68 could also use RES "stropping"; reserved words, as we'd expect

```
int a_real_int = 3;  # there are 61 accepted reserved words #
```

Algol 68: UPPER stropping

```
# Add an element to the end of the list #
PROC append = ( REF LIST list, ELEMENT val ) VOID:
BEGIN
  IF list IS empty
  THEN
    list := HEAP NODE := ( val, empty )
  ELSE
    REF LIST tail := list;
    WHILE next OF tail ISNT empty
    DO
      tail := next OF tail
    OD;
    next OF tail := HEAP NODE := ( val, empty )
  FI
END;
```

APL and J

Originally a mathematical notation for use in describing systems.

An implementation of an interpreted for "Iverson Notation", using English reserved words instead of symbols, was available in 1965.

The first APL system to use the APL character set went live in 1966.

Kenneth E. Iversion received the Turing Award for his work on APL in 1979.

J is a version of APL using digraphs instead of the special symbols.

For printing programs, Iverson and Falkoff got IBM to design a special type ball for their 1050 and 2741 terminals.

99 bottles in APL and J

```
bob  ←  { (⍕⍵), ' bottle', (1=⍵)↓'s of beer'}
bobw ←  {(bob ⍵) , ' on the wall'}
beer ←  { (bobw ⍵) , ', ', (bob ⍵) , '; take one down and pass it around, ', bobw ⍵-1}
↑beer¨ ⌽(1-⎕IO)+⍳99
```

and its equivalent in J

```
bob =: ": , ' bottle' , (1 = ]) }. 's of beer'"_
bobw=: bob , ' on the wall'"_
beer=: bobw , ', ' , bob , '; take one down and pass it around, ' , bobw@<:
beer"0 >:i.-99
```

Snobol

Pattern matching as the basis for a programming language.

Snobol

Command lines are made up of the *optional* parts:

```
<label> <subject> <pattern> = <object> : <transfer>
```

The `<subject>` is matched against the `<pattern>`

Any matched portion of `<subject>` is replaced with `<object>`

`<transfer>` is an absolute or conditional branch (to a `<label>`)

A simple Snobol example

```
          OUTPUT = "What is your name?"
          Username = INPUT
          Username "J"                                          :S(LOVE)
          Username "K"                                          :S(HATE)
MEH       OUTPUT = "Hi, " Username                              :(END)
LOVE      OUTPUT = "How nice to meet you, " Username            :(END)
HATE      OUTPUT = "Oh. It's you, " Username
END
```

Snobol 99 bottles

```
* 99 BOTTLES OF BEER IN SNOBOL (UNTESTED)
        BEER = 99
MOREBEER OUTPUT = BEER ' BOTTLES OF BEER ON THE WALL'
        OUTPUT = BEER ' BOTTLES OF BEER'
        OUTPUT = 'TAKE ONE DOWN, PASS IT AROUND'
        BEER = BEER - 1
        OUTPUT = BEER ' BOTTLES OF BEER ON THE WALL'
        GT(BEER,0)   : S(MOREBEER)
        OUTPUT = 'NO MORE BOTTLES OF BEER ON THE WALL'
        OUTPUT = 'NO MORE BOTTLES OF BEER'
        OUTPUT = 'GO TO THE STORE AND BUY SOME MORE'
        OUTPUT = '99 BOTTLES OF BEER'
END
```

BCPL

A small language designed to be easy to bootstrap, and for use in writing compilers.

The ancestor of C.

Some things about BCPL

Only one type: the word.

`$( .. )$` to mark blocks

`IF .. THEN` and `TEST .. THEN .. ELSE`

A statement continues to the next line if it can't have ended (so, for instance, if the last character was the + of an arithmetic expression

Labels are values, and since everything is a word, you can do arithmetic on them.

```
GET "LIBHDR"
MANIFEST $(
    BOTTLES = 99
$)
LET START() BE $(
    LET BEERS(N, S) BE $(
        TEST N = 0 THEN WRITEF("No more bottles")
                   ELSE WRITEF("%N bottle%S", N, (N = 1) -> "", "s")
        WRITEF(" of beer%S", S)
    $)
    FOR I = BOTTLES TO 1 BY -1 DO $(
            BEERS(I, " on the wall, ")
            BEERS(I, ".*NTake one down, pass it around.*N")
            BEERS(I - 1, " on the wall.*N")
    $)
    FINISH
$)
```

Prolog

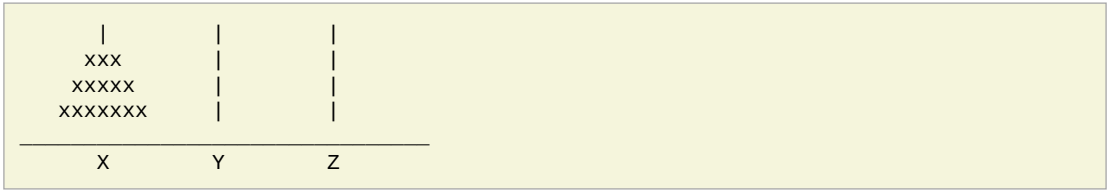
Logic language, declarative

Specify *relations* (facts and rules), and run a *query* over those relations

Uses full stop to end expressions/statements, not semicolon

Tower of Hanoi

We want to define `move(N,X,Y,Z)` to move *n* disks from peg X to peg Y, using peg Z as an intermediary:



Prolog solution from
http://www.cs.toronto.edu/~sheila/384/w11/simple-prolog-examples.html

The description

To transfer a stack containing 1 disc from peg X to peg Y:

Move that disc from X to Y

To transfer a stack containing *n* discs (recursively):

Transfer the first *n-1* discs to peg Z

Move the last disc on X to Y

Transfer the *n-1* discs from Z to peg Y

The code

```
move(1,X,Y,_) :-
    write('Move top disk from '),
    write(X),
    write(' to '),
    write(Y),
    nl.
move(N,X,Y,Z) :-
    N>1,
    M is N-1,
    move(M,X,Z,Y),
    move(1,X,Y,_),
    move(M,Z,Y,X).
```

Running the code

```
?-  move(3,left,right,center).
Move top disk from left to right
Move top disk from left to center
Move top disk from right to center
Move top disk from left to right
Move top disk from center to left
Move top disk from center to right
Move top disk from left to right

yes
```

Prolog 99 bottles

```
bottles :-
    bottles(99).

bottles(1) :-
    write('1 bottle of beer on the wall, 1 bottle of beer,'), nl,
    write('Take one down, and pass it around,'), nl,
    write('Now they are alle gone.'), nl.
bottles(X) :-
    X > 1,
    write(X), write(' bottles of beer on the wall,'), nl,
    write(X), write(' bottles of beer,'), nl,
    write('Take one down and pass it around,'), nl,
    NX is X - 1,
    write(NX), write(' bottles of beer on the wall.'), nl, nl,
    bottles(NX).
```

S and R

Statistical programming

R is an implementation of S with some extensions. Much S code should run unaltered in R.

Simple looping solution in R

```
# a naive function to sing for N bottles of beer...
song = function(bottles){
  for(i in bottles:1){ #for every integer bottles, bottles-1 ... 1
    cat(bottles," bottles of beer on the wall \n",bottles,
        " bottles of beer \nTake one down, pass it around \n",
        bottles-1, " bottles of beer on the wall \n"," \n" ,sep="")
        bottles = bottles - 1 #take one down...
  }
}
song(99)
```

```
for (b in 99:1){
  print(b)
  print(" bottle(s) of beer on the wall,")
  print(b)
  print(" bottle(s) of beer.")
  print("Take one down, pass it around,")
  print(b-1)
  print(" bottle(s) of beer on the wall.")
  print("")
}
```

Smalltalk

Almost no syntax

Everything is an object

Messages get sent to objects:

```
'Hello, world' printNl !
```

```
1 to: 20 by: 2 do: [:x| x printNl ] !
```

http://www.info.univ-angers.fr/pub/gh/hilapr/beers/schade/s.html#SmallTalk

```
"Programmer: patrick m. ryan - pryan@access.digex.net
"http://www.access.digex.net/~pryan

99 to: 1 by: -1 do: [ :i |
        i print. ' bottles of beer on the wall, ' print.
        i print. ' bottles of beer. ' print.
        'take one down, pass it around, ' print.
        (i-1) print. ' bottles of beer on the wall, ' print.
```

I think that's rather elegant.

https://rosettacode.org/wiki/99_Bottles_of_Beer#Smalltalk

A straightforward approach

```
Smalltalk at: #sr put: 0 ; at: #s put: 0 !
sr := Dictionary new.
sr at: 0 put: ' bottle' ;
  at: 1 put: ' bottles' ;
  at: 2 put: ' of beer' ;
  at: 3 put: ' on the wall' ;
  at: 4 put: 'Take one down, pass it around' !
99 to: 0 by: -1 do: [:v | v print.
        ( v == 1 ) ifTrue: [ s := 0. ]
                   ifFalse: [ s := 1. ].
        Transcript show: (sr at:s) ; show: (sr at:2) ; show: (sr at:3) ; cr.
                   v print.
        Transcript show: (sr at:s) ; show: (sr at:2) ; cr.
                   (v ~~ 0) ifTrue: [ Transcript show: (sr at:4) ; cr. ].
  ].
```

ABC - Python's inspirational ancestor

Just for the sake of it

```
HOW TO RETURN verse n:
  SELECT:
      n = 0:
        PUT "no more bottles of beer" IN s
      n = 1:
        PUT "1 bottle of beer" IN s
      ELSE:
        PUT "`n` bottles of beer" IN s
  RETURN s
```

```
HOW TO DRINK:
  PUT 99 IN num
  WHILE num > 0:
      WRITE verse num, " on the wall, ", verse num, "," /
      WRITE "take one down, pass it around," /
      PUT num - 1 IN num
      WRITE verse num, " on the wall." /

DRINK
```

Python

I suppose I had to include this, just for comparison

```
def sing(b, end):
    print(b or 'No more','bottle'+('s' if b-1 else ''), end)

for i in range(99, 0, -1):
    sing(i, 'of beer on the wall,')
    sing(i, 'of beer,')
    print('Take one down, pass it around,')
    sing(i-1, 'of beer on the wall.\n')
```

(mainly included to show how one should not necessarily judge a language from the examples given!)

Although I'm actually very fond of

```
"""Pythonic 99 beer song (maybe the simplest naive implementation in Python 3)."""

REGULAR_VERSE = """\
{n} bottles of beer on the wall, {n} bottles of beer.
Take one down and pass it around, {n_minus_1} bottles of beer on the wall.
"""
ENDING_VERSES = """\
2 bottles of beer on the wall, 2 bottles of beer.
Take one down and pass it around, 1 bottle of beer on the wall.\n
1 bottle of beer on the wall, 1 bottle of beer.
Take one down and pass it around, no more bottles of beer on the wall.\n
No more bottles of beer on the wall, no more bottles of beer.
Go to the store and buy some more, 99 bottles of beer on the wall.
"""
for n in range(99, 2, -1):
    print(REGULAR_VERSE.format(n=n, n_minus_1=n - 1))
print(ENDING_VERSES)
```

Source of examples

The "99 bottles of beer" examples were from one of:

- https://rosettacode.org/wiki/99_Bottles_of_Beer/Lisp
- http://www.info.univ-angers.fr/pub/gh/hilapr/beers/schade/

Sum of squares (LISP) was from:

- https://rosettacode.org/wiki/Sum_of_squares

Full acknowledgements for everything are in the notes.

Fin

Written in reStructuredText.

Converted to PDF slides using rst2pdf.

Source and extended notes at
https://github.com/tibs/old-proglang-syntaxes-talk