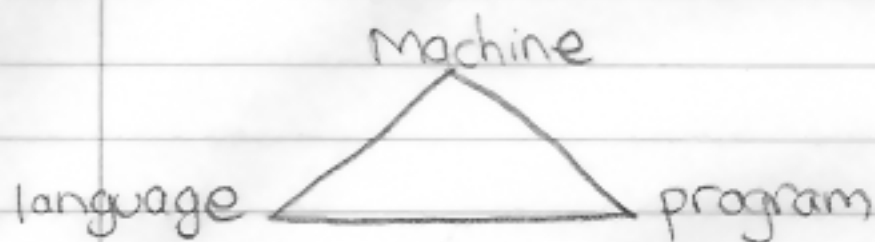


Study of Computer Architecture Cannot Be In Isolation



In Early 50's

Design implementation of a Computer

- proof of existence : A mechanical system which will execute orders

Stored programmed machine

Programming : Brute = Machine
Force = Program

There was no concept of "High Level Language" — Closer to the Human

Hardware cost was the dominant cost

↓
Minimize the Hardware Cost

↓
Circuit minimization

(No attention paid to other issues
or Regularity
or Simplicity
or Comprehension).

Variables minimize storage elements

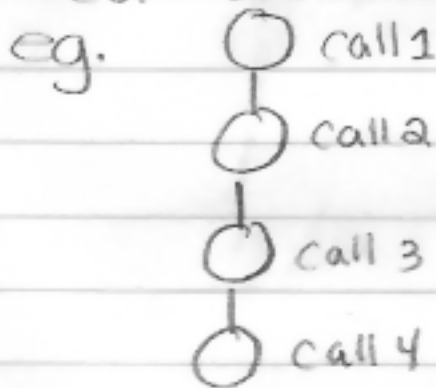
↓
Reduce the number of variables in a program

Complexity

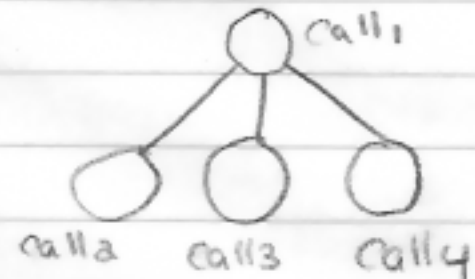
Space \equiv Hardware

Time \equiv minimize circuits (calls, code optimization)

② Why not reduce the # of calls?



contrasts



② what mimics the ALU?

$B * C$
↑
ALU

③ Assignment Store / Load

$A = B \leftarrow C$
↑
Load / Store

④ GOTO
IF-THEN-ELSE
DO-WHILE
etc

} mimicing PC and
manipulation of PC

Storage manipulation gives rise to "absurd" concepts!

$$\text{eg. } A = A + 1$$

Location Value

NOT TRUE IN MATHEMATICS

Programming \Leftrightarrow Mimicing the Computer

Implications:

Difficult to

① Proof of Correctness

② Axiomatic } very difficult (unnatural)

Operational } to give the semantics

Denotational } of even a simple concept

eg. GOTO Difficult to describe using denotational semantic or CRITICAL SECTION PROBLEM



Published "solutions" did not work for years!

x GOTO

↓ "Goto considered harmful"

↓ Structured Program

(All programming constructs are "Single-Entry Single Exit")

70's they found:

- ① Programs cannot be written easily
- ② Cannot be read easily
- ③ High maintenance cost
- ④ Hard to debug
- ⑤ Hard to prove

Bad for business

Fortran

Basic

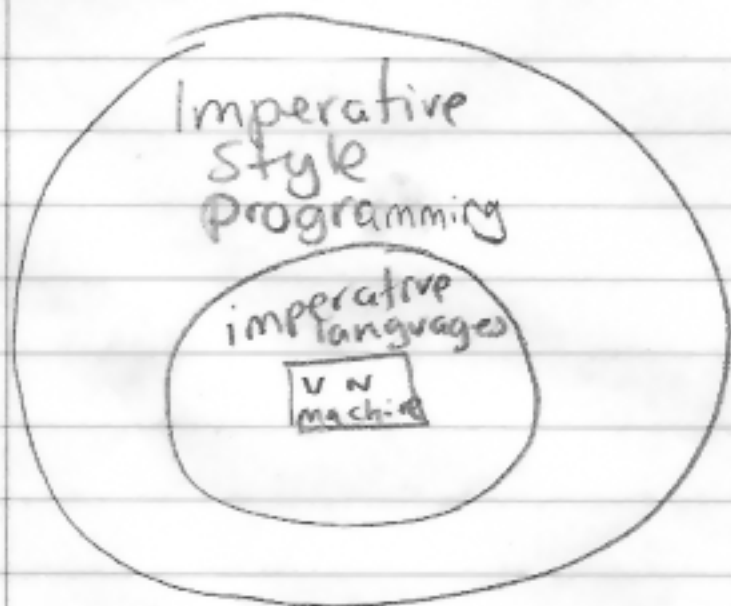
C

Pascal

Java

...

F#



Some architectural innovations:

- ① Index Register eg. $A[I]$
- ② General purpose registers
eg. Holding intermediate values
- ③ Floating Point Data (representation)
- ④ Direct Addressing
- ⑤ Program interrupts and handling
- ⑥ Asynchronous/parallel operations

Q: why is it difficult to detect parallelism?

- ⑦ Virtual Storage D-Units
- ⑧ Multiprocessing