Computer Programming

Lecture 1: Introduction to Computers

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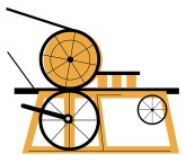
Some materials are partially taken from
Starting Out with Python, 3rd Edition

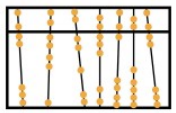
THE EVOLUTION OF COMPUTERS

PC NINJA TRAVELS THROUGH TIME, revealing the history of how computers became our sidekicks. From sliding pebbles on a simple machine to swiping your fingers across a touchscreen, technology has transformed radically!

HISTORIC



2400 BC
The **abacus**, the first known calculator, invented in Babylonia. Decks of beads and rods used to calculate addition, subtraction, division and multiplication, along with being able to extract square and cube roots.



1439
Johannes Gutenberg invents the **printing press**.

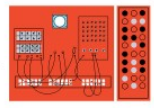
1617
John Napier creates **Napier's Bones**, a manually-operated calculating device consisting of a base board with a rim and rods embedded with multiplication tables, which reduces multiplication to addition and division to subtraction.

1642
Blaise Pascal invents the **Pascaline** (Pascal's Calculator), a mechanical adding machine.

1822
Charles Babbage conceives designs for the **Difference Machine**, a steam-powered calculating machine that is considered one of the first programmable computers, though the technology was too advanced to be built in his time.

MODERN

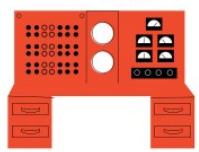
1943–44
The **ENIAC** (Electronic Numerical Integrator and Calculator), the **first noteworthy modern computer**, invented by University of Pennsylvania professors John Mauchly and J. Presper Eckert. A general-purpose digital computer, it could be reprogrammed through a plugboard and switches to solve a full range of computing problems. ENIAC occupied a room 30 by 50 feet in size and weighed 30 tons!



1949
Chester Carlson patents the term **xerography** and releases the Xerox machine Model A photocopier, which required 39 steps to make one copy!

1946
Mauchly and Eckert receive funding from the Census Bureau to build the **UNIVAC** (UNIVersal Automatic Computer), the first commercial computer for business and government applications.

1950
The **SEAC** (Standards Eastern Automatic Computer) demonstrated and produced by the U.S. National Bureau of Standards under a team led by Russell Kirsch. As the first fully functional **stored-program electronic computer**, it could keep programmed instructions and data in read-write, random-access memory (RAM).



1952
The **first computer game**, **"Tic-Tac-Toe,"** designed and created by A.S. Douglas.

1952
The first **mass-produced computer** made and sold by the IBM Company.

1962
J.C.R. Licklider conceives of an **inter-galactic Network** of computers, later known as the **Internet**.

1964
Computer systems that use **icons, windows, and a mouse** designed by Douglas Engelbart, which will take it from a specialized machine for mathematicians to technology more accessible to the general public.

1971
First e-mails sent by Ray Tomlinson on the ARPAnet, the precursor to the Internet, which were able to reach users on different hosts. He used the "@" sign to separate person from machine, which became a standard part of the e-mail address.

1971
IBM introduces the **first floppy disk** that is 8 ¼ inches wide with a capacity of 79.7 kB, and was read-only. A read-write version came in 1972, so that data could be edited and shared between computers.

1975
Bill Gates and Paul Allen founded **Microsoft.**

1975
The IBM 5100 becomes the **first commercially available portable computer.**

1976
The **first Apple computer** invented by **Steve Jobs** and Steve Wozniak.

1977
The **Apple II**, the first personal computer with **color graphics** is demonstrated.

1979
Word processing becomes a reality as MicroPro International releases WordStar.

1981
The **"Personal Computer"** released by the IBM Company, under the name "Acorn." It uses Microsoft's **MS-DOS** operating system, and has an Intel chip, two floppy disks and an optional color monitor.

1983
The **Apple Lisa** personal computer released by the Apple Company, at a base price of $9995. It's the first personal computer with a **GUI** that features a drop-down menu with icons, which can be clicked using a little box with button called a **"mouse."**

1984
The first working **3D printer** created by Chuck Hull of 3D Systems Corp. The printer uses an additive process of laying down successive layers of material in different shapes to create virtually any three-dimensional solid object from a digital model.

1985
Bill Gates and Microsoft release the **Windows operating system**, forever changing desktop computing.

1989
The **"World Wide Web"** invented by Tim Berners-Lee, who develops HyperText Markup Language (HTML) to design webpages.

1990
Release of the **original Microsoft Office 1.0**, featuring Word 1.1, Excel 2.0, and Power Point 2.0.

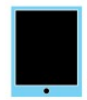
1995
Amazon Bookstore launches, and online shopping becomes popular.

1995
Microsoft releases **Windows 95**, which introduces the web browser **Internet Explorer.**

1999
The term **Wi-Fi** becomes part of computing language and users begin connecting to the Internet without wires.

2001
Apple unveils the **Mac OS X** operating system, which provides protected memory architecture and pre-emptive multi-tasking, among other benefits. Microsoft rolls out **Windows XP**, which has a significantly redesigned GUI.

2003
Electronic devices that could send e-mails, access the web, and receive phone calls became commercial.

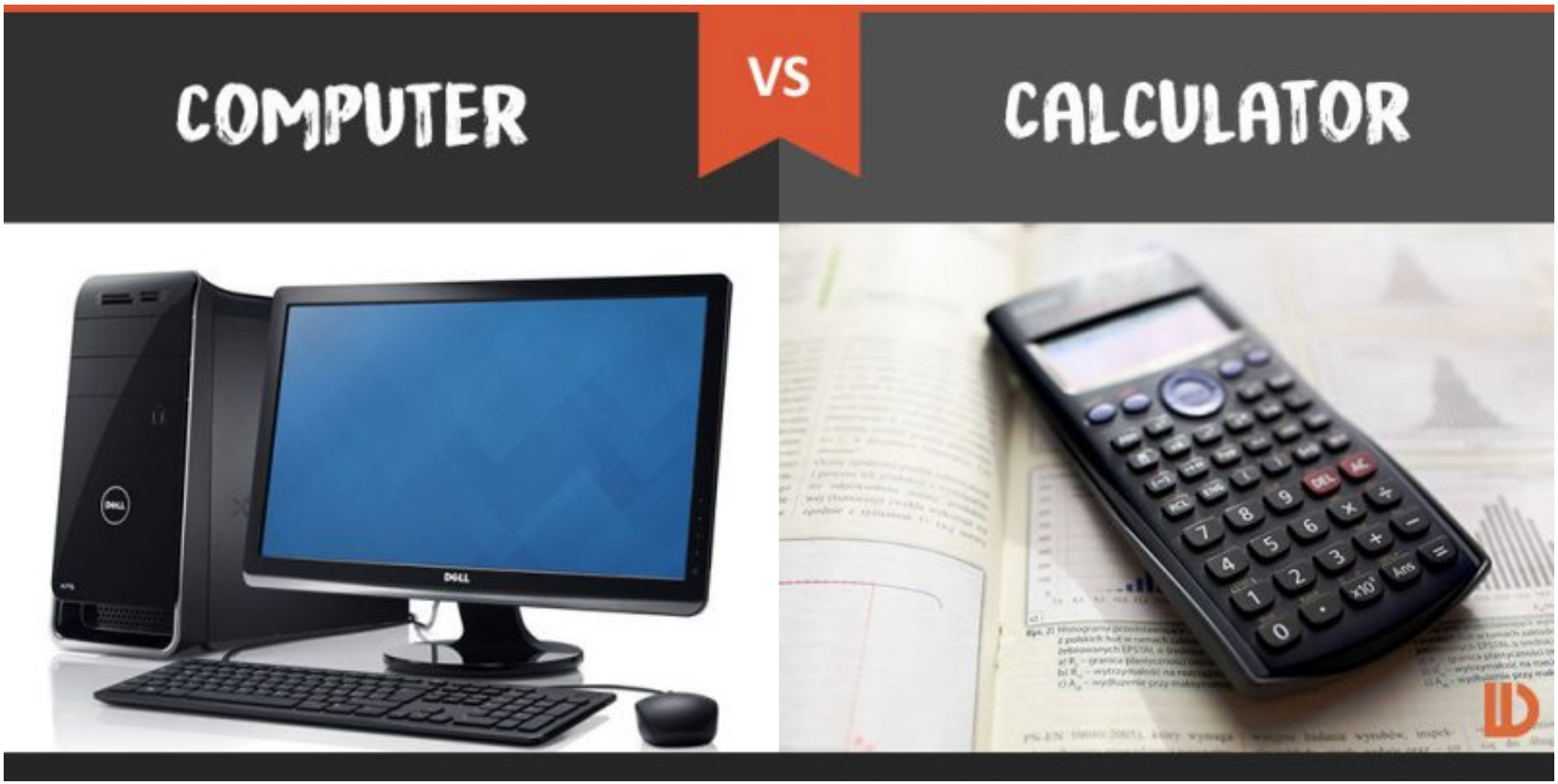


2007
Apple debuts the **iPhone**, both a phone and handheld computer that runs **"apps."**

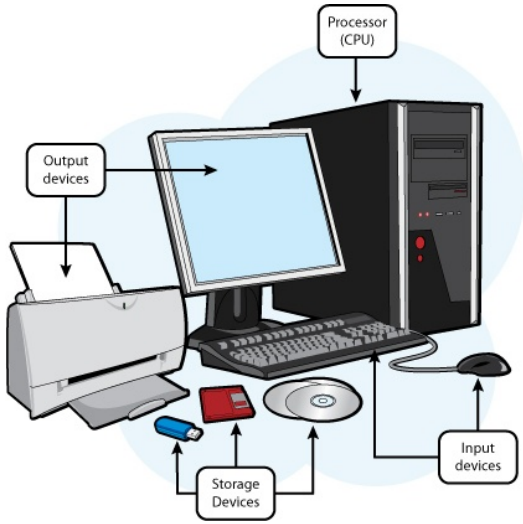
2010
Apple releases the **iPad I**, a tablet computer with a touchscreen that changes the way users view media. 3 million devices sell in 80 days.

2013
Microsoft releases **Windows 8**, a completely reimagined operating system that is tailored toward touchscreens, tablets, and cloud functionality.

General-Purpose Computers



Hardware and Software



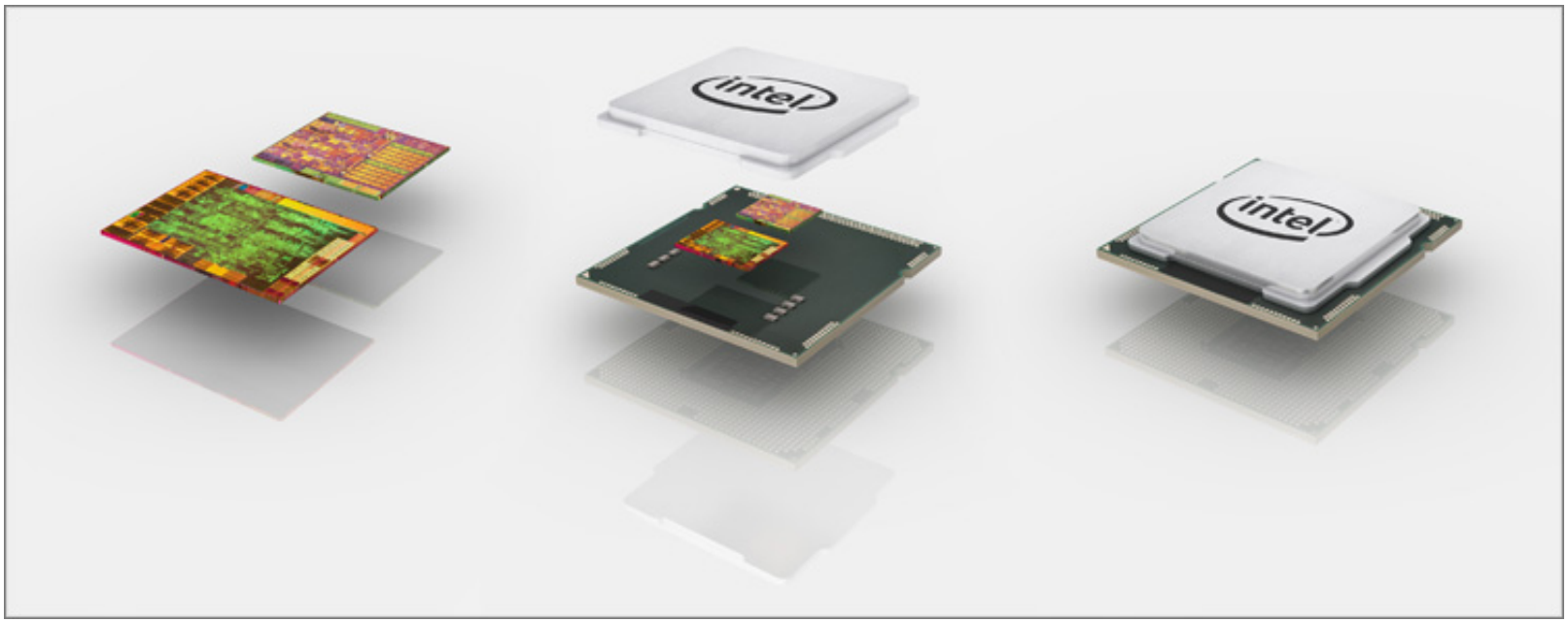
Hardward

- Central processing unit (CPU)
- Main memory (RAM)
- Secondary storage devices
- Input devices
- Output devices

Software

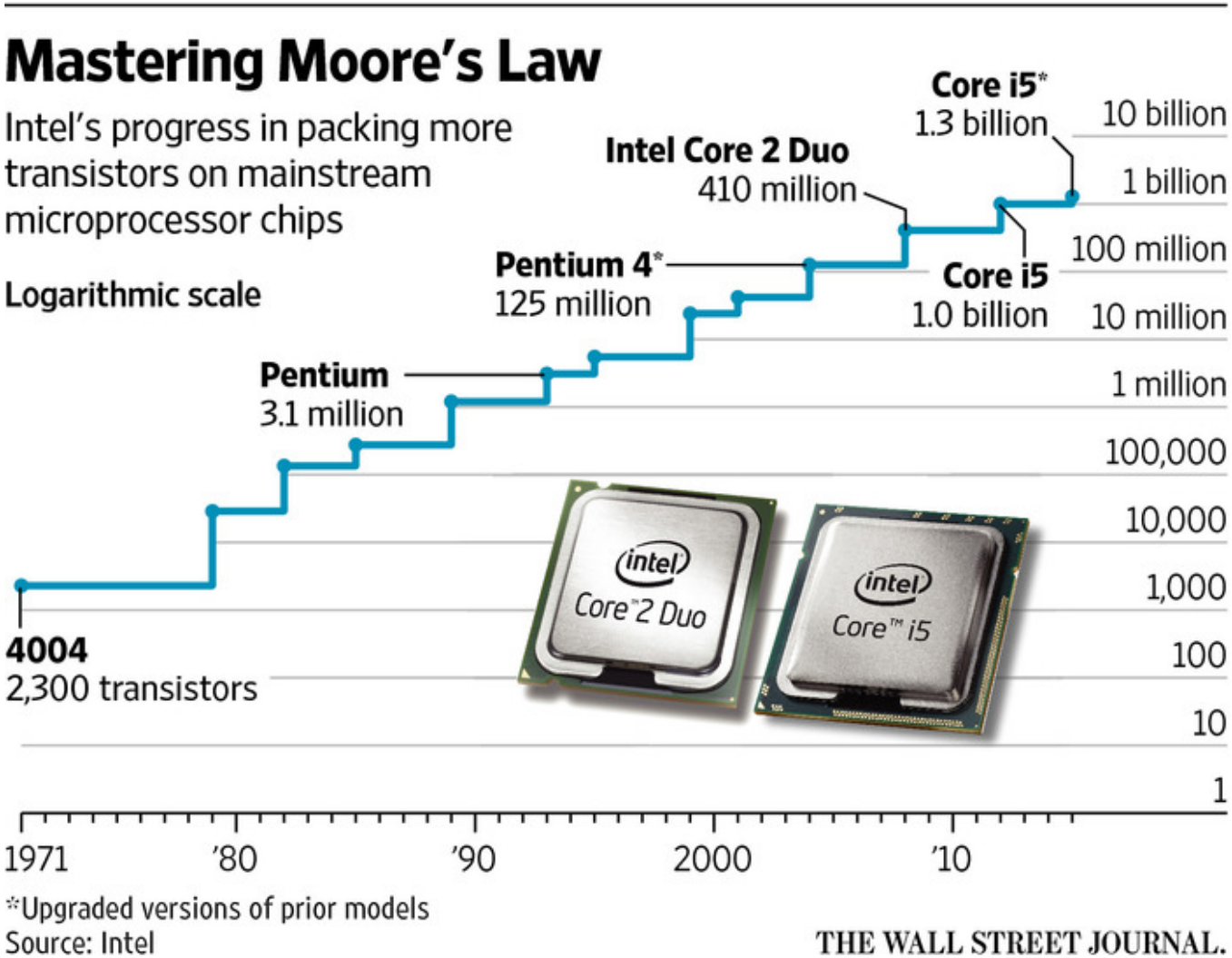
- Operating systems (OS)
- Utility programs
- Software development tools
- Application software

Central Processing Unit (CPU)



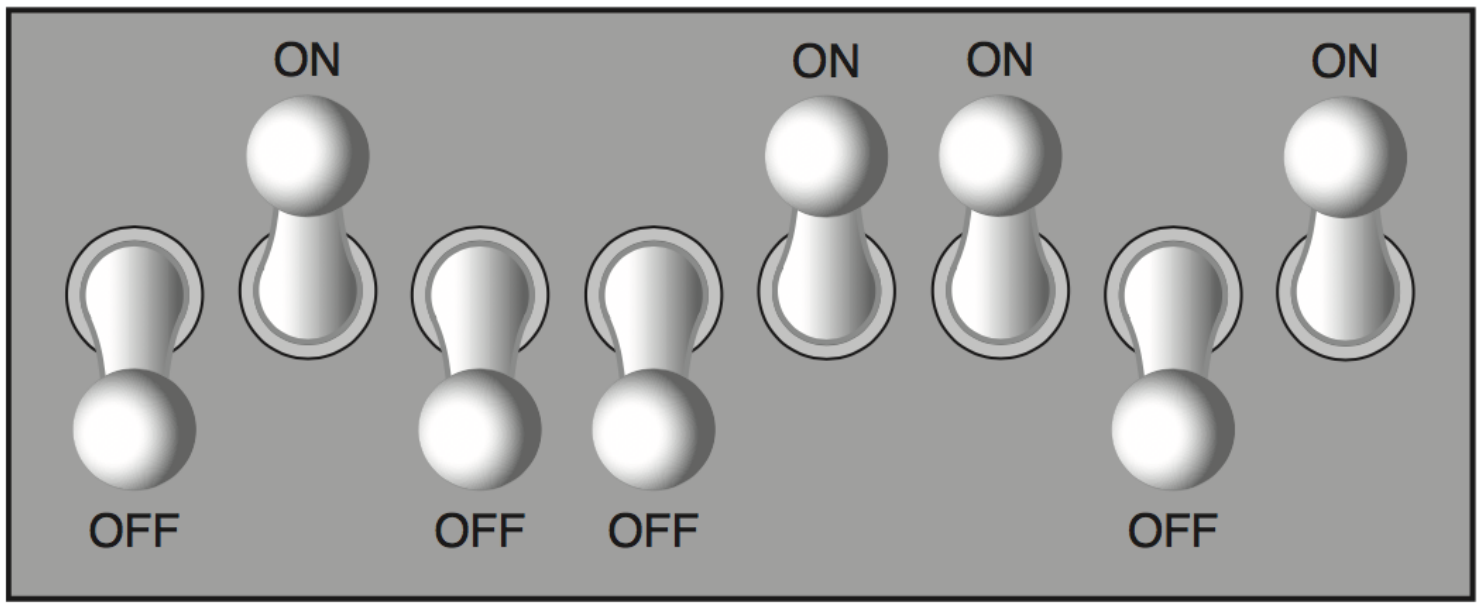
Central Processing Unit (CPU)

Moore's Law


Mastering Moore's Law
Intel's progress in packing more transistors on mainstream microprocessor chips
Logarithmic scale
4004
2,300 transistors
Pentium
3.1 million
Pentium 4*
125 million
Intel Core 2 Duo
410 million
Core i5
1.0 billion
Core i5*
1.3 billion
10 billion
1 billion
100 million
10 million
1 million
100,000
10,000
1,000
100
10
1
1971
'80
'90
2000
'10
intel
Core 2 Duo
intel
Core i5
*Upgraded versions of prior models
Source: Intel
THE WALL STREET JOURNAL.

Storing Numbers

All data stored in a computer is converted to sequences of 0s and 1s.



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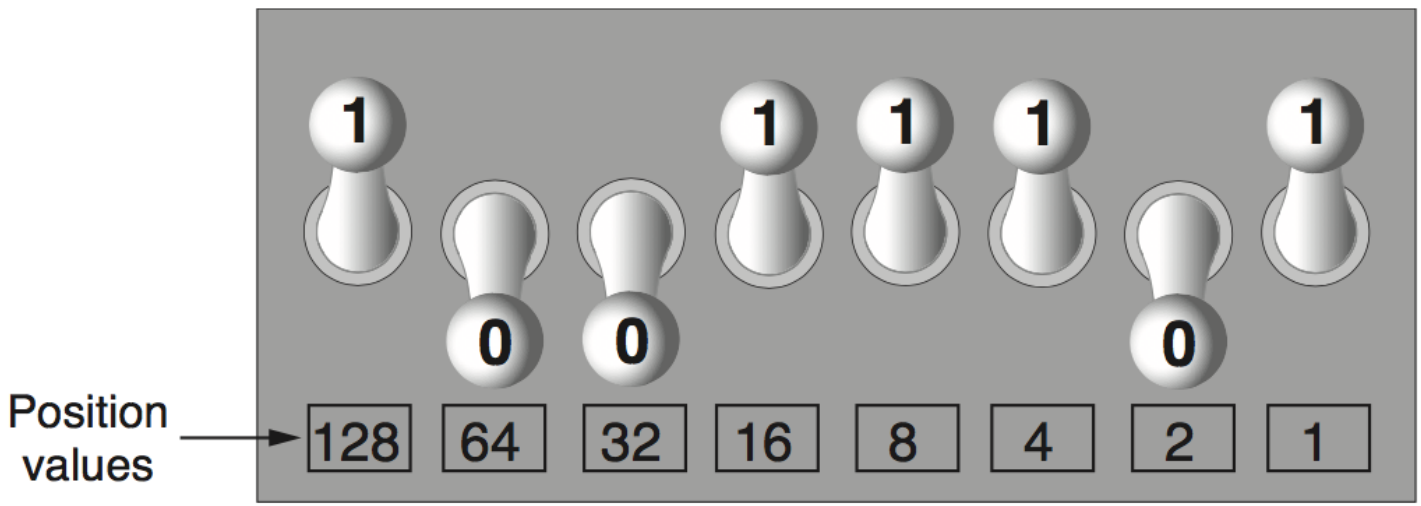
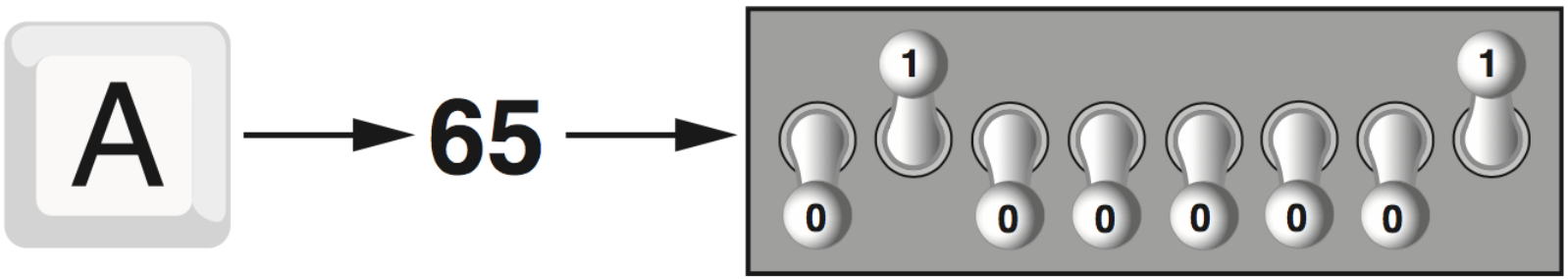


$128 + 16 + 8 + 4 + 1 = \mathbf{157}$

Storing Characters



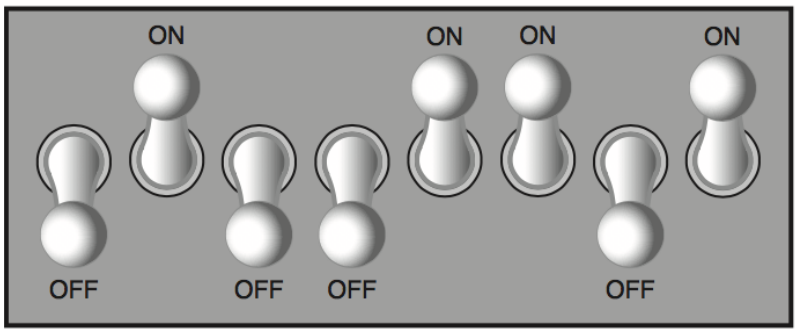
American Standard Code for Information Interchange (ASCII)

A	B	C	D	E	F	G	H	I	J	K	L	M
↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕
65	66	67	68	69	70	71	72	73	74	75	76	77

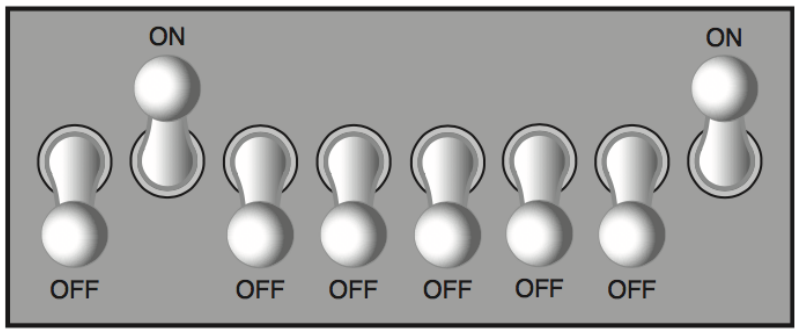
N	O	P	Q	R	S	T	U	V	W	X	Y	Z
↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕	↕
78	79	80	81	82	83	84	85	86	87	88	89	90

Table 1: ASCII encodings of English capital letters.

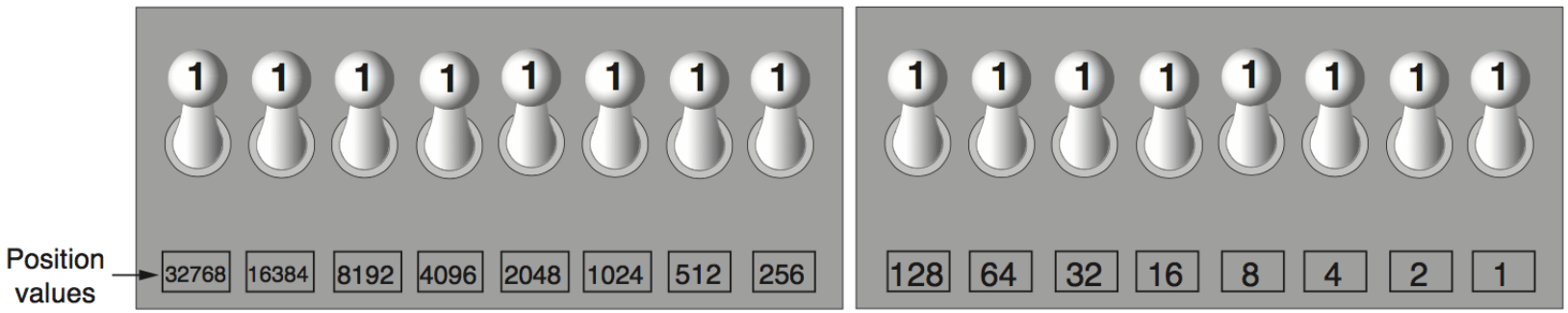
Stroing Characters



The number 77 stored in a byte.

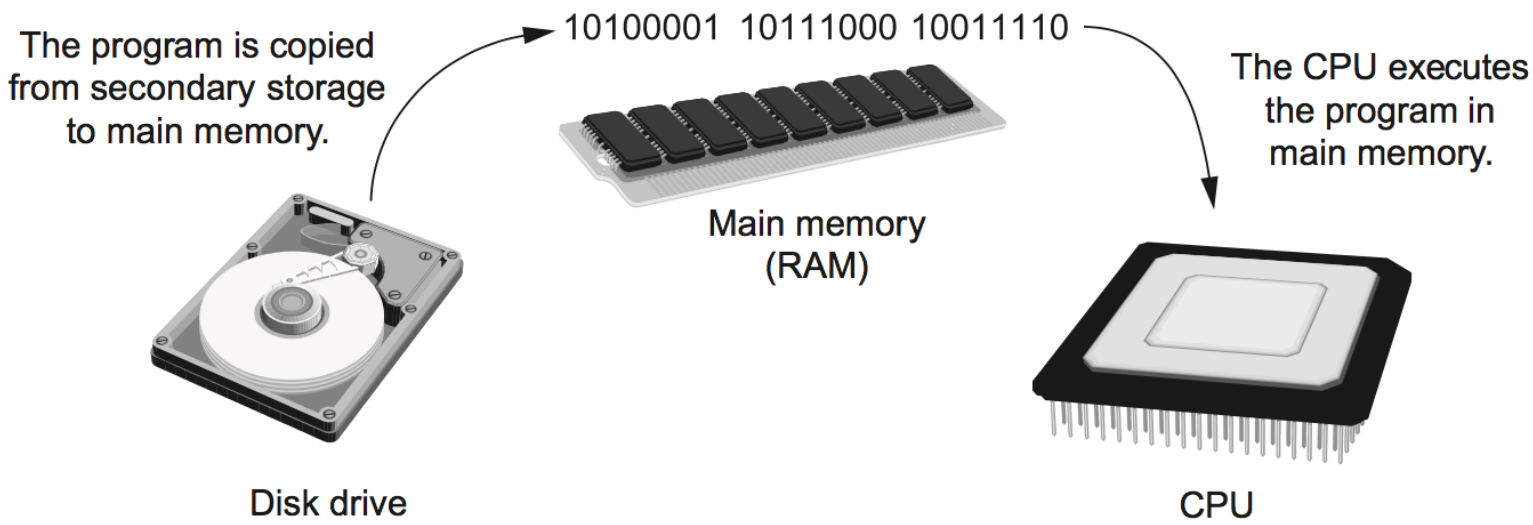


The letter A stored in a byte.



32768 + 16384 + 8192 + 4096 + 2048 + 1024 + 512 + 256 + 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 = **65535**

Fetch-Decode-Execute Cycle



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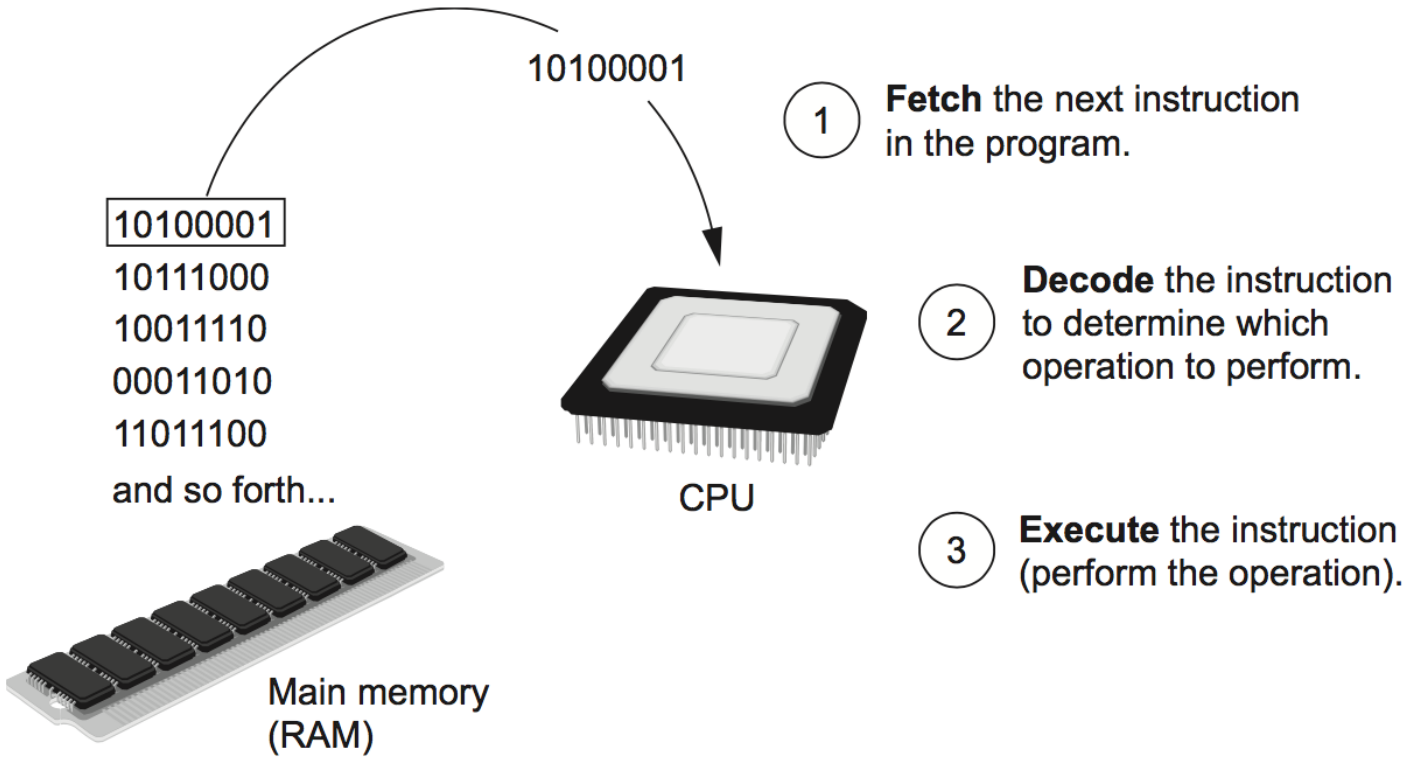


Programming Languages

?

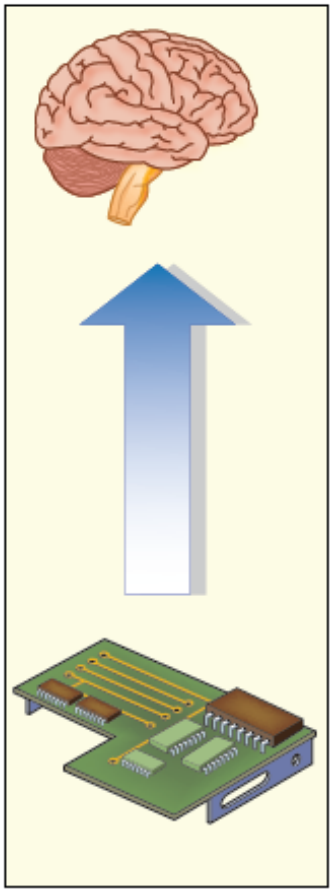
declarative languages (Haskell, ML, Prolog...)

OO languages (C++, Java, Python...)

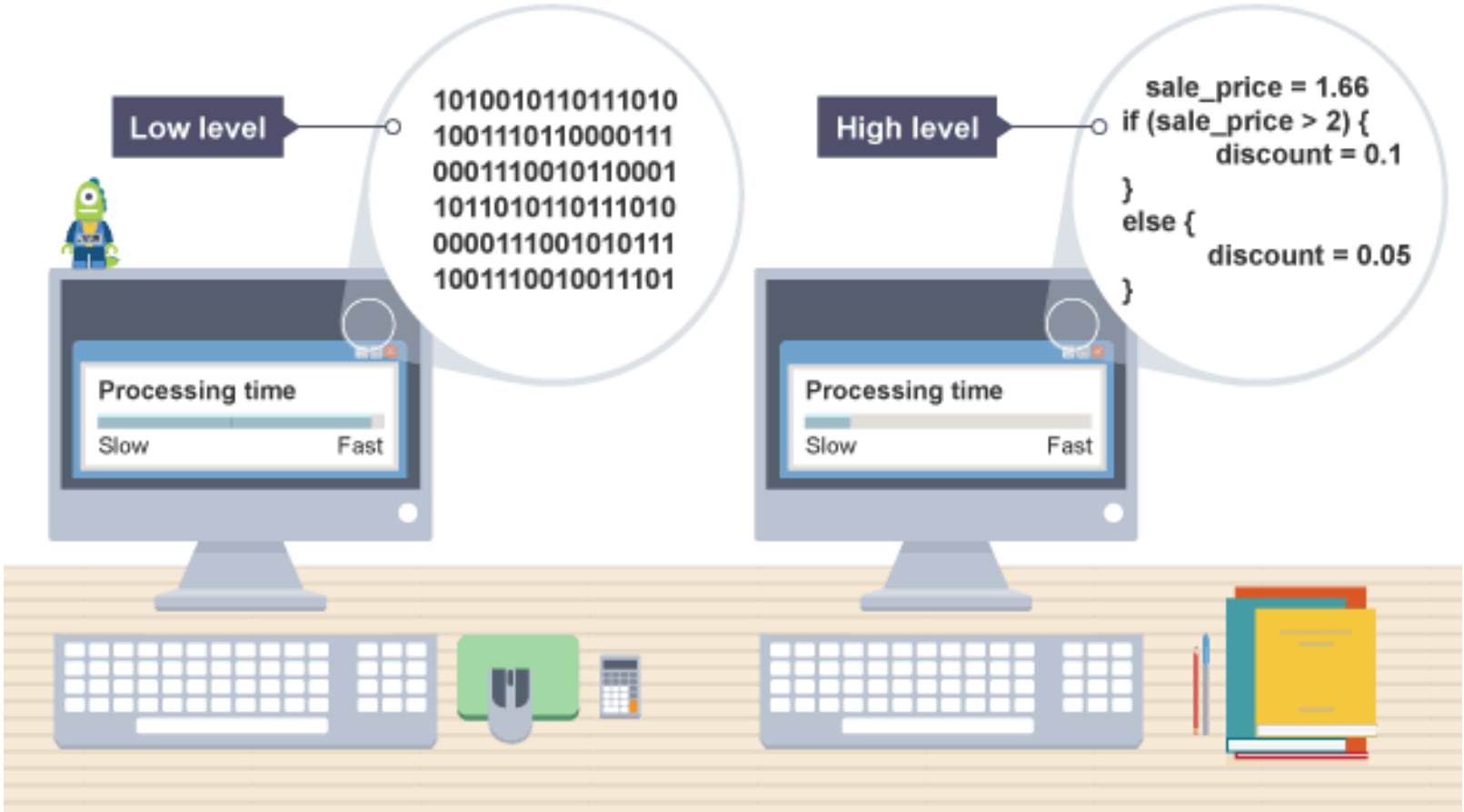
procedural languages (C, Fortran, COBOL...)

assembly languages

binary code



Programming Languages



Programming Languages

Machine code

```
89 F8 A9 01 00 00 00 75 06 6B C0 03 FF C0 C3 C1 E0 02 83 E8 03 C3
```

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Assembly language

```
        .globl  f
        .text
f:
        mov     %edi, %eax      # Put first parameter into eax register
        test    $1, %eax        # Examine least significant bit
        jnz     odd             # If it's not a zero, jump to odd
        imul    $3, %eax        # It's even, so multiply it by 3
        inc     %eax            # and add 1
        ret                     # and return it
odd:
        shl    $2, %eax         # It's odd, so multiply by 4
        sub    $3, %eax         # and subtract 3
        ret                     # and return it
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Programming Languages

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```
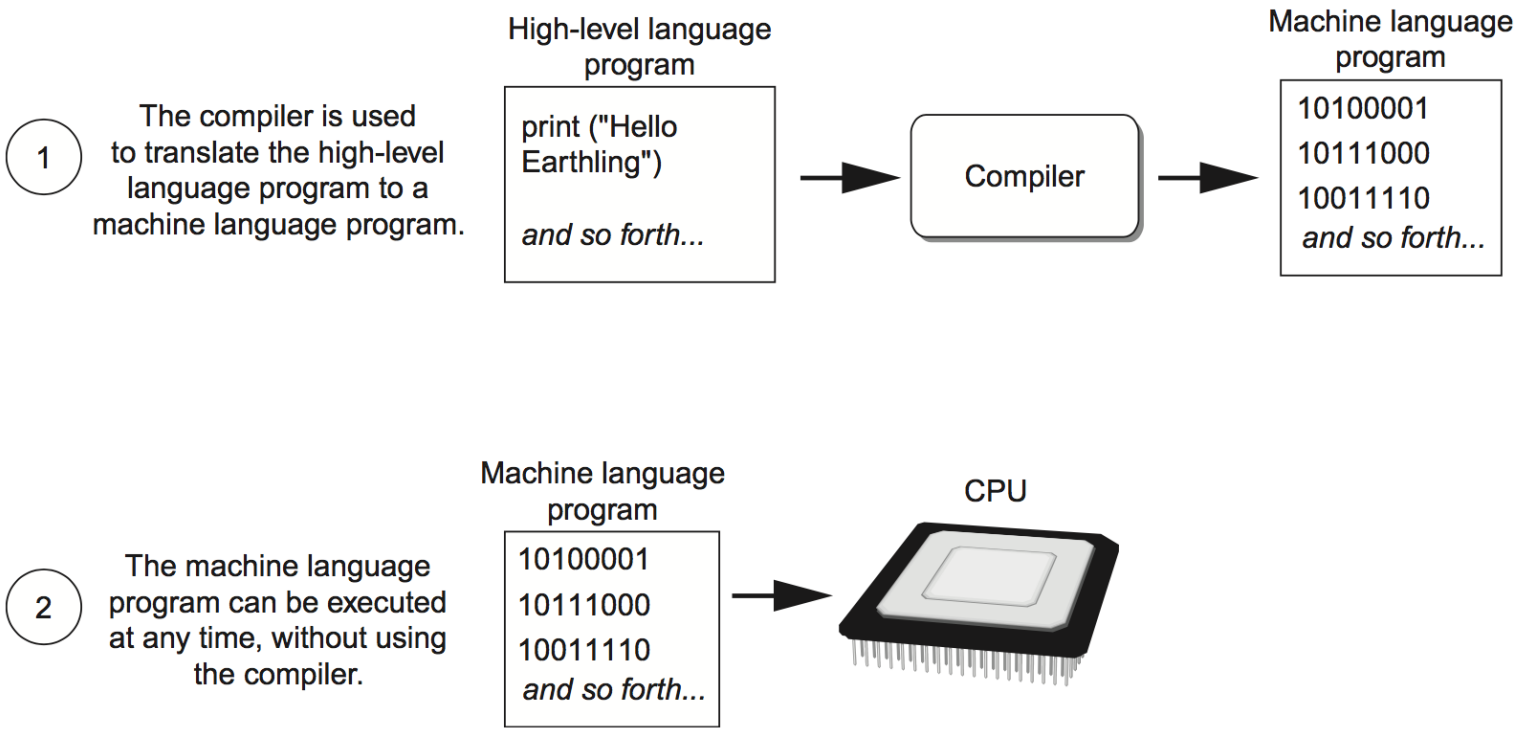

High-level language (Python)

```
def f(n):
    return 3 * n + 1 if n % 2 == 0 else 4 * n - 3
```

Compiler vs Interpreter



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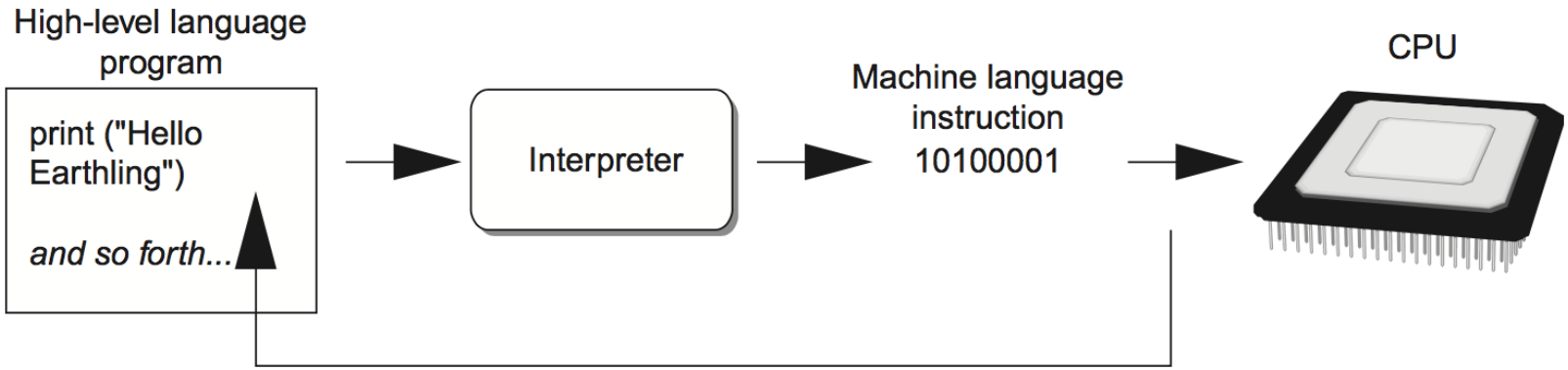

The interpreter translates each high-level instruction to its equivalent machine language instructions and immediately executes them.

This process is repeated for each high-level instruction.