Programinng I

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Computer Science Departament
Complutense University of Madrid (UCM)

2 de septiembre de 2026

Objetives

Acquire the essential techniques for developing correct, reusable, and efficient small-scale programs, using basic statements, structured control flow, and sub-programs.

- Understand fundamental concepts of programming.
- Learn to design, implement, and debug small-scale programs.
- Master basic control structures (sequence, selection, iteration).
- Develop skills in modular programming using functions and procedures.
- Familiarize with essential data types (numbers, strings, lists, tuples, dictionaries).
- Practice problem-solving using programming.

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- **Exercises:** made by the students. In class in advance and at home. 2 hours in laboratory
- Evaluation: continuous or final exam

Continuous Evaluation

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- 5 % max of missing.
- Active participation at class (solving problems at the blackboard).

Continuous Evaluation

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- Controlled assistance (QR, small exercise at the end of the class)
- 5 % max of missing.
- Active participation at class (solving problems at the blackboard).
- 10 % of the final grade.

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- a special exercise (practice).

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- 3 people groups.

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- a special exercise (practice).
- 3 people groups.
- Oral presentation.

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Practice

- a special exercise (practice).
- 3 people groups.
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- 20 % of the final grade.

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Partial Exams
- In paper.

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Partial Exams
- In paper.
- 2 partial exams (40 %, 60 %).

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Practice
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- 3 people groups.
- Oral presentation.
- 20 % of the final grade.

Partial Exams
- In paper.
- 2 partial exams (40 %, 60 %).
- Minimal grade each 4 out of 10.

Continuous Evaluation

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- 5 % max of missing.
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- 10 % of the final grade.

Practice
- a special exercise (practice).
- 3 people groups.
- Oral presentation.
- 20 % of the final grade.

Partial Exams
- In paper.
- 2 partial exams (40 %, 60 %).
- Minimal grade each 4 out of 10.
- 70 % of the final grade.

Way to success

My responsability. To teach you the concepts.

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My wish. You to learn.

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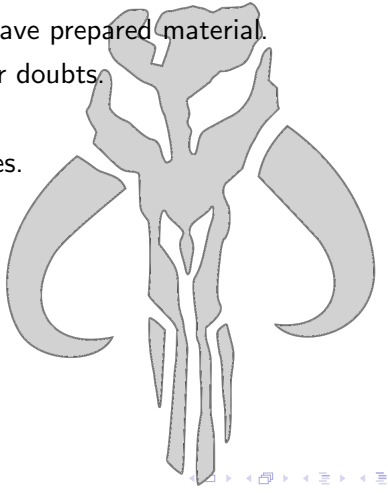

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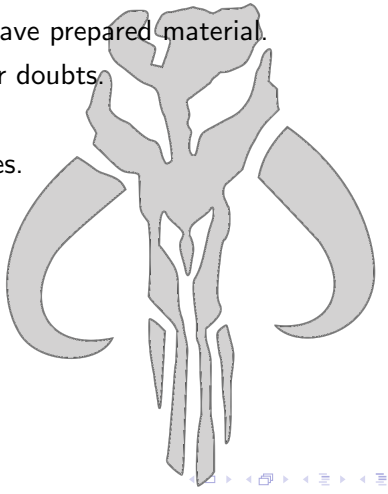

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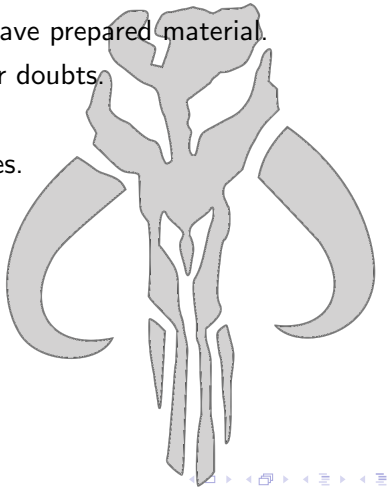

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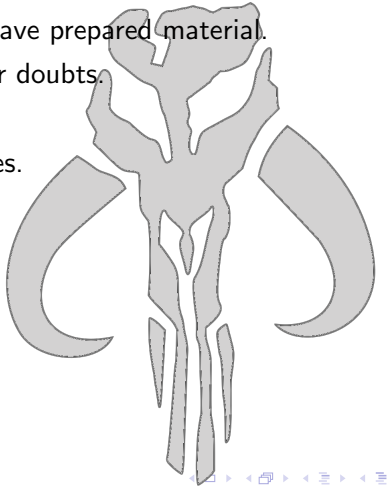

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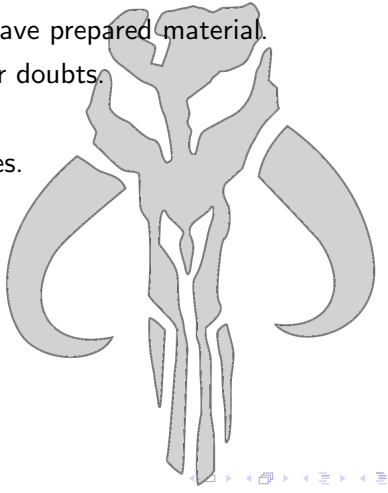

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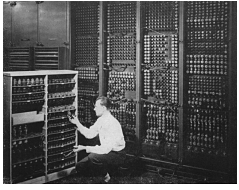
What is a Computer?



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Software Intangible part (programs, data, information, documentation, etc.).

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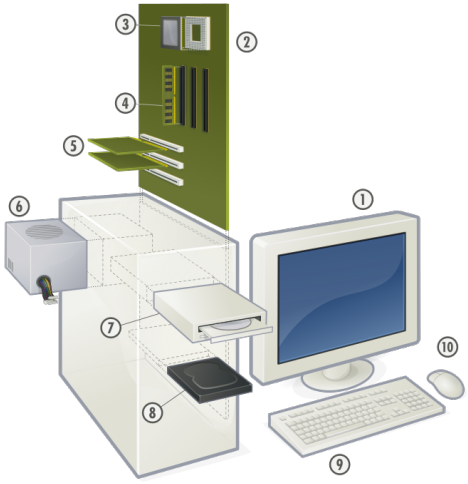
Physical Structure



1. Monitor.
2. Motherboard (Main board).
3. Microprocessor (CPU).
4. RAM Memory.
5. Expansion cards and slots.
6. Power supply.
7. Optical disc drive (CD; DVD; BD).
8. Hard disk drive or Solid-state drive.
9. Keyboard.
10. Mouse.

Computer Capacity and Performance

Number of Cores Indicates how many CPUs it has (parallel processing). A modern personal computer can have 6 cores.

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Memory Capacity

- Internal Memory (RAM)
- Storage Space (Hard Drive, SSD)

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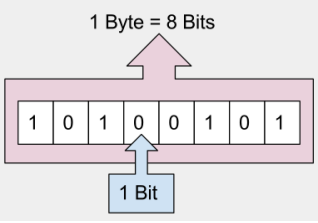
- El Capitan (Current top supercomputer): 1,051,392 cores @ 1.8 GHz.

Storage: Memory Magnitudes



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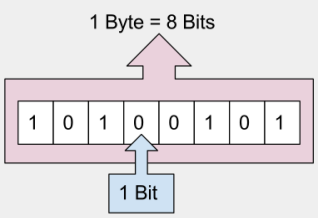

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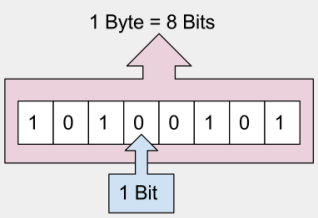

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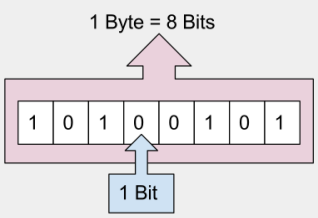

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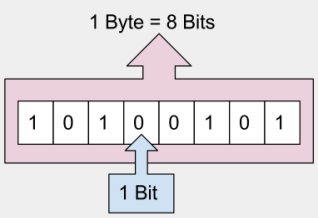

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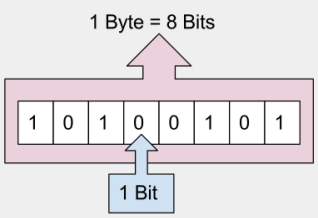

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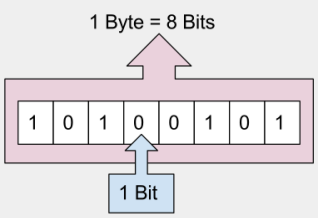

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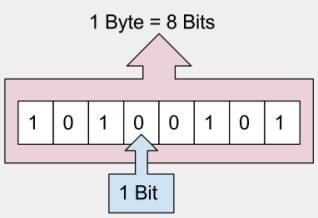

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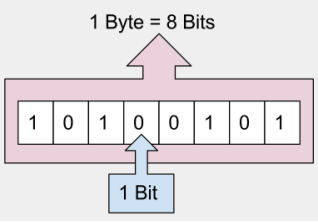

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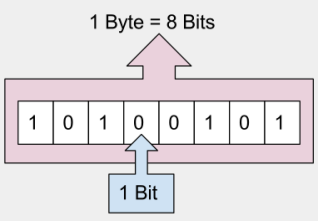

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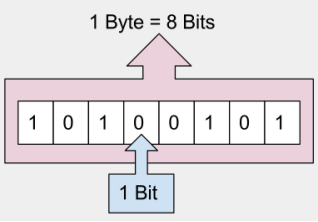

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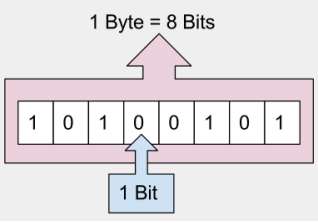

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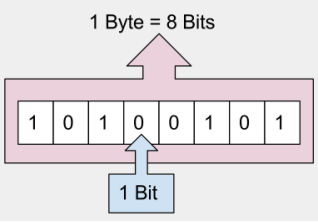

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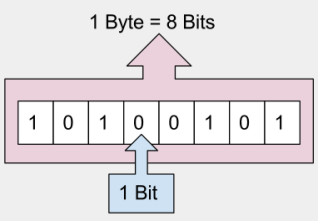

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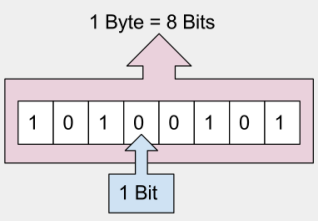
Zettabytes (ZB), Yottabytes (YB)...

Storage: Memory Magnitudes



Kilobyte (KB) $2^{10} \approx 10^3$. Don Quixote (book): 850 KB
Megabyte (MB) $2^{20} \approx 10^6$. Photo: 3 MB (8Mpx). 1 CD: 800 MB
Gigabyte (GB) $2^{30} \approx 10^9$. DVD: 4.7 GB. Wikipedia: 120 GB
Terabyte (TB) $2^{40} \approx 10^{12}$. +200 DVDs. Facebook: 750 TB/day
Petabyte (PB) $2^{50} \approx 10^{15}$. Netflix: 3.14 PB. Google Maps: 20 PB
Exabyte (EB) $2^{60} \approx 10^{18}$. Google: 10 EB on disk
Zettabytes (ZB), Yottabytes (YB)...

`http://www.bluebulbprojects.com/MeasureOfThings/`

Memory Evolution

- Apollo Guidance Computer: 2 KB (RAM), 36 KB (ROM).

Memory Evolution

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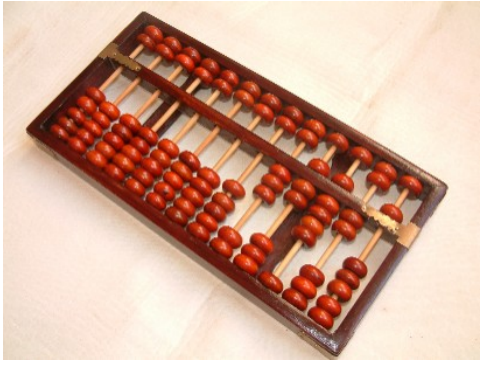
- Commodore 64: 64 KB (RAM), 16 KB (ROM).

Memory Evolution

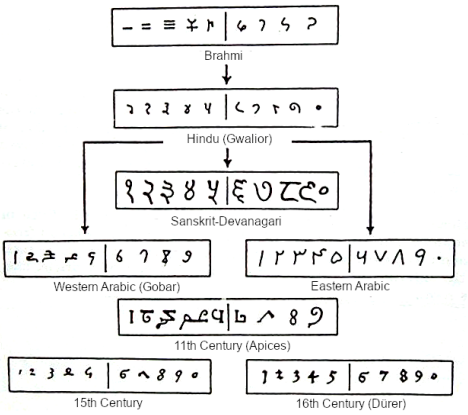
- Apollo Guidance Computer: 2 KB (RAM), 36 KB (ROM).
- Commodore 64: 64 KB (RAM), 16 KB (ROM).
- Modern PC: 32 GB RAM, 1 TB (Hard Drive/SSD).

Historical Perspective I



- More than 5,000 years ago.
- Addition, subtraction, multiplication, division, and square roots.

Historical Perspective II



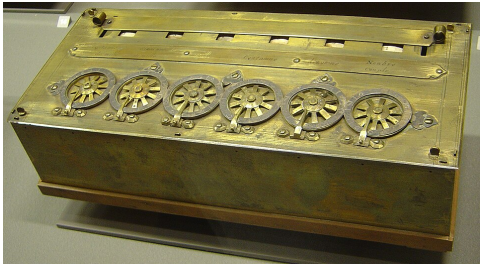
- Indo-Arabic numerals.
- Facilitated mathematical operations.
- Faster and more reliable.

Number one story: `https://youtu.be/jrLQW1vQklE?si=Rv_RwWJzURBCMNpV`

Historical Perspective III

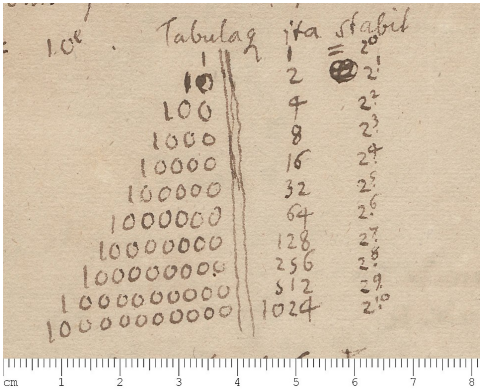
- Muḥammad Al-Khwarizmi, Latinized as Algorithmi.
- 9th-century Persian mathematician.
- Father of Algebra.
- Precursor to modern algorithms.

Historical Perspective IV



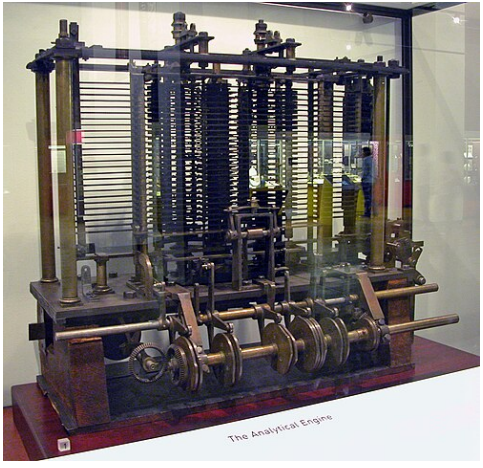
- The Pascaline.
- Blaise Pascal (at age 19), 17th Century.
- Mechanical addition using gear wheels.

Historical Perspective V



- Binary System.
- Leibniz, 17th Century.
- Influenced by ancient systems in India and China (I-Ching).

Historical Perspective VI

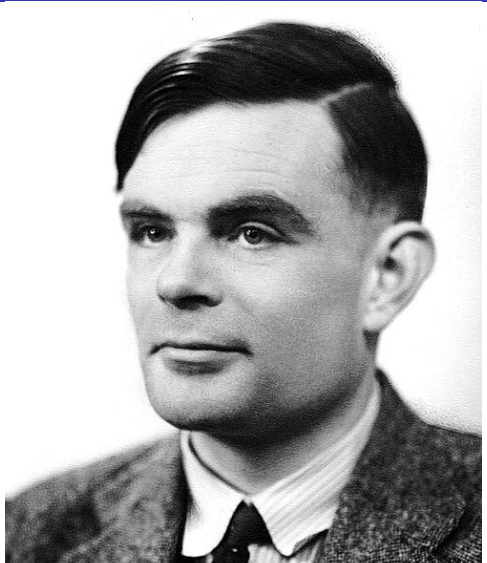


- Charles Babbage's Analytical Engine, 19th Century.
- Never fully built due to the technical complexity of the era.

Historical Perspective VII

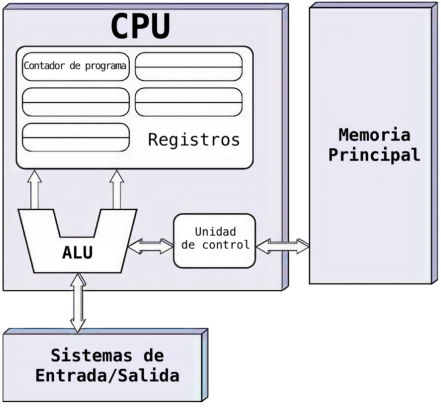
- Ada Lovelace (Augusta Ada Byron).
- The world's first computer programmer.
- Wrote programs for Babbage's machine.

Historical Perspective VIII



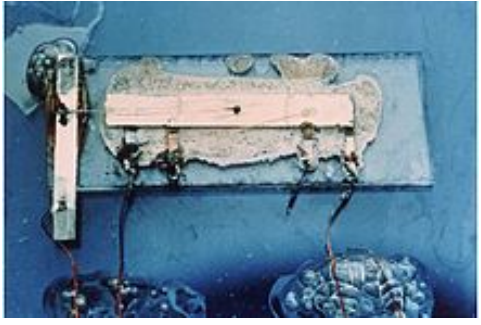
- Mathematician, Father of Modern Computing.
- Cracked the Enigma (Nazi's encrypting machine, II World World) code with the Bombe machine.
- Convicted for his sexual orientation; pardoned decades after his death.

Historical Perspective IX



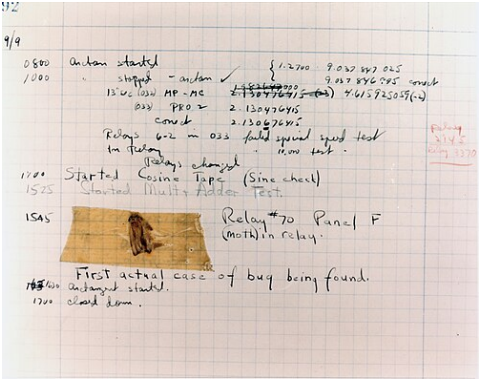
- John von Neumann (1945).
- Defined the architecture used in current computers.

Historical Perspective X



- The Integrated Circuit (IC).
- Jack S. Kilby, 1958.

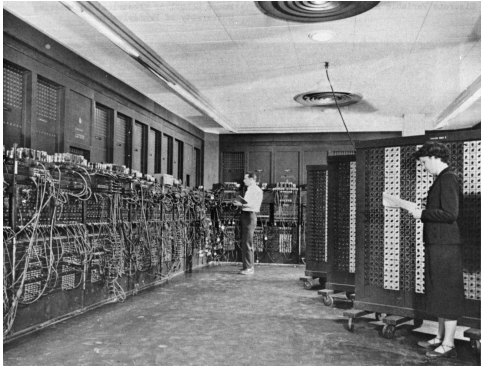
Historical Perspective XI



- The first documented "Bug" was a literal moth.
- 1947: A hardware failure caused by an insect.

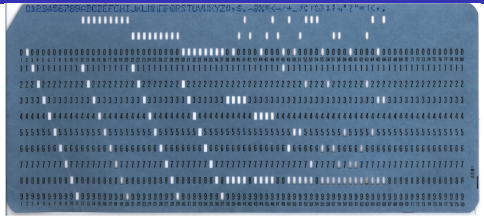
Historical Perspective XII

ENIAC



- 1945: First general-purpose programmable electronic computer.
- Turing Complete: Capable of solving any computable problem.
- Cost $487,000 (approx. $6.9 million today).
- Size: 2m x 1m x 30m. Weight: 20 Tons.
- Speed: 5 kHz.
- Storage: Punched cards. Output: Printer.

Historical Perspective XIII



- Each card represents a line of 80 characters.
- A program is a stack of these punched cards.

Historical Perspective XIV

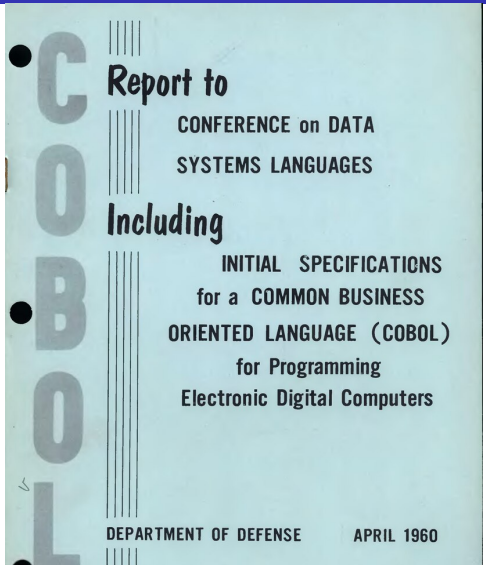
IBM 360 (1964)

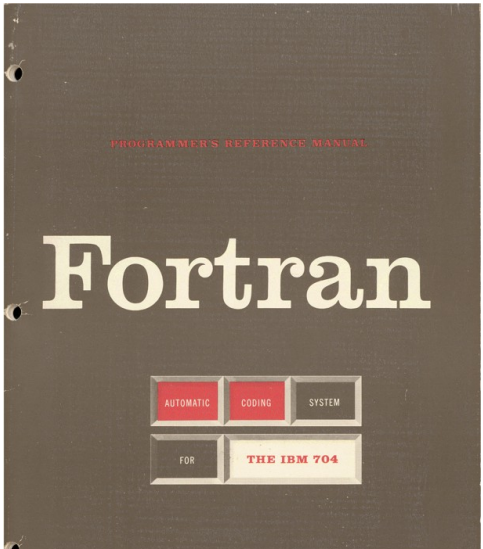
- First large-scale commercial computers.
- Speed: 34.5 kHz. Memory: 8–64 KB.

Historical Perspective XV

Languages of the 60s: COBOL, FORTRAN

Historical Perspective XVI





What is Programming?

Programming is the process of designing, writing, testing, debugging, and maintaining the source code of computer programs.

- **Algorithm:** A finite, ordered sequence of well-defined instructions that solves a problem.
- **Source Code:** The set of instructions written in a programming language.
- **Programming Language:** A formal language designed to communicate instructions to a machine.

Why Python?

- **Easy to learn and read:** Clear and concise syntax.
- **Versatile:** Wide range of applications (Web, AI, Data Science, Automation, etc.).
- **Large community:** Extensive support and resources.
- **Multi-paradigm:** Supports Object-Oriented, Functional, and Structured programming.
- **Extensive libraries:** A rich ecosystem of modules.

Your First Program: "Hello World"

```
print("Hello World")
```

- The `print()` function is used to display text on the console.
- Text strings are enclosed in either double (") or single (') quotes.

Comments

```
# This is a single-line comment
print("Hello") # This is a comment at the end of a line

"""
This␣is␣a␣multi-line
comment␣(docstring).
It␣is␣used␣to␣explain␣blocks␣of␣code.
"""
print("World")
```

- Comments are ignored by the Python interpreter.
- They help make the code more readable and understandable.

Variables

```
name = "Alice"
age = 30
height = 1.75
is_student = True

print(name)
print(age)
print(height)
print(is_student)
```

- Variables are containers for storing data values.
- Python is dynamically typed: you do not need to declare the variable type.

Basic Data Types

- **Integers (`int`):** Whole numbers, positive or negative (e.g., `10`, `-5`).
- **Floats (`float`):** Numbers with a decimal point (e.g., `3.14`, `-0.5`).
- **Strings (`str`):** Sequences of characters (e.g., `"Hello"`, `'Python'`).
- **Booleans (`bool`):** Truth values (`True`, `False`).

Comparison Operators

```
x = 10
y = 12

print(f"x == y: {x == y}")   # False
print(f"x != y: {x != y}")   # True
print(f"x > y: {x > y}")     # False
print(f"x < y: {x < y}")     # True
print(f"x >= y: {x >= y}")   # False
print(f"x <= y: {x <= y}")   # True
```

Logical Operators

```
p = True
q = False

print(f"p and q: {p and q}") # False
print(f"p or q: {p or q}")   # True
print(f"not p: {not p}")     # False
```

Entrada de Datos

```
nombre = input("Ingresa␣tu␣nombre:␣")
edad_str = input("Ingresa␣tu␣edad:␣")
edad = int(edad_str) # Convertir a entero

print(f"Hola,␣{nombre}.␣Tienes␣{edad}␣ñaos.")
```

- La función `input()` lee una línea de texto del usuario.
- Siempre devuelve una cadena de texto (`str`).
- Es necesario convertir a otros tipos de datos si se requiere (ej. `int()`, `float()`).

User Input

```
name = input("Enter your name: ")
age_str = input("Enter your age: ")
age = int(age_str) # Convert to integer

print(f"Hello, {name}. You are {age} years old.")
```

- The `input()` function reads a line of text from the user.
- It always returns a string (`str`).
- You must convert it to other data types if needed (e.g., `int()`, `float()`).

Control Structures: `if-elif-else`

```
temperature = 25

if temperature > 30:
    print("It is very hot.")
elif temperature > 20:
    print("The temperature is pleasant.")
else:
    print("It is cold.")
```

- Allows executing different blocks of code based on conditions.
- Indentation is crucial in Python to define code blocks.

Estructuras de Control: `while` Loop

```
contador = 0
while contador < 5:
  print(f"Contador: {contador}")
  contador += 1 # contador = contador + 1
```

- Repite un bloque de código mientras una condición sea verdadera.
- Es importante asegurarse de que la condición eventualmente se vuelva falsa para evitar bucles infinitos.

Control Structures: `while` Loop

```
counter = 0
while counter < 5:
    print(f"Counter: {counter}")
    counter += 1 # equivalent to counter = counter + 1
```

- Repeats a block of code as long as a condition is true.
- It is important to ensure that the condition eventually becomes false to avoid infinite loops.

Estructuras de Control: `for` Loop

```
frutas = ["manzana", "banana", "cereza"]
for fruta in frutas:
  print(fruta)

for i in range(5): # i toma valores 0, 1, 2, 3, 4
  print(f"úNmero: {i}")
```

- Itera sobre elementos de una secuencia (listas, cadenas, rangos, etc.).
- La función `range(n)` genera una secuencia de números desde 0 hasta n-1.

Control Structures: `for` Loop

```
fruits = ["apple", "banana", "cherry"]
for fruit in fruits:
    print(fruit)

for i in range(5): # i takes values 0, 1, 2, 3, 4
    print(f"Number: {i}")
```

- Iterates over elements of a sequence (lists, strings, ranges, etc.).
- The `range(n)` function generates a sequence of numbers from 0 to n-1.

Functions

```
def greet(name):
    print(f"Hello, {name}!")

def add(a, b):
    return a + b

greet("Alice")
result = add(5, 3)
print(f"The sum is: {result}")
```

- Functions are reusable blocks of code that perform a specific task.
- `def` is used to define a function.
- `return` is used to send back a value.

Lists

```
numbers = [1, 2, 3, 4, 5]
fruits = ["apple", "banana", "cherry"]

print(f"First fruit: {fruits[0]}") # apple
print(f"Last number: {numbers[-1]}") # 5

fruits.append("orange") # Add to the end
print(f"Fruits: {fruits}")

fruits[1] = "blueberry" # Modify an element
print(f"Modified fruits: {fruits}")

print(f"Length of fruits: {len(fruits)}")
```

- Lists are ordered and mutable collections of items.
- They are defined using square brackets `[]`.
- Elements are accessed by index (starting at 0).

Strings

```
greeting = "Hello, "
name = "World"
message = greeting + name + "!" # Concatenation

print(message) # Hello, World!
print(f"Length: {len(message)}")

print(message.upper()) # HELLO, WORLD!
print(message.lower()) # hello, world!
print(message.replace("World", "Python")) # Hello, Python!
```

- Strings are immutable.
- String methods can be used for manipulation (e.g., `upper()`, `lower()`, `replace()`).
- f-strings (`f`) are a convenient way to format strings.

Modules and Packages

```
import math
import random

print(f"PI: {math.pi}")
print(f"Square root of 16: {math.sqrt(16)}")

from random import randint
# Since we imported 'randint' directly, we don't need 'random.'
print(f"Random number between 1 and 10: {randint(1, 10)}")
```

- Modules are Python files (`.py`) that contain functions, classes, and variables.
- They allow you to organize and reuse code.
- `import` is used to include modules.
- `from ... import ...` is used to import specific elements from a module.