Coding For Creative Robotics

Week 0: Introduction, Human-Machine Communication & Python Setup

Sonia Litwin
04/10/2024

Agenda

Lecture (90’):

- Introduction
- Get to know you?
- History of the machine language, cybernetics and human-machine communication

Tutorial (90’):

- Introduction to IDE and text editors
- Setup VSCode
- Your first programme
- Can you understand this code?
- Panel open for questions

Course overview

human-machine communication & creative robotics

Coding One: Introduction to Human-Machine Communication & Creative Robotics Coding (20 credits)

Coding Two: Python and Advanced Robotic Applications (20 credits)

Coding Three: Machine Intelligence and Social Robots (20 credits)

Assessment

human-machine communication & creative robotics

Coding One: Introduction to Human-Machine Communication & Creative Robotics Coding (20 credits)

Coding Two: Python and Advanced Robotic Applications (20 credits)

Coding Three: Machine Intelligence and Social Robots (20 credits)

Coding One: Introduction to Human-Machine Communication & Creative Robotics Coding

- Introduction to human-machine communication,
- C++ and Python,
- Programming fundamentals, logical structures, and algorithmic thinking,
- Object-Oriented Programming.

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Get to know you?

The access code **4996 7761**
https://www.menti.com/alwkmq8ev8ay

W0: Say Hello, Very Brief Introduction to Mechanical Automata and Early Computing

Exploring the milestones in mechanical and computational history.

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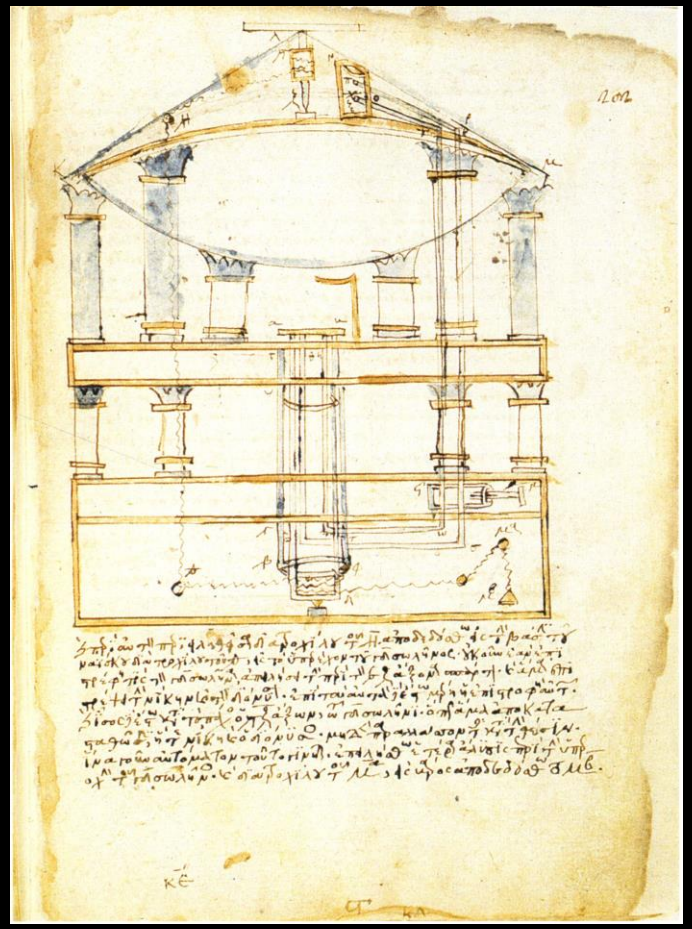
Early Mechanical Automata and Computation

- Fascination with automation dates back to ancient civilizations (Egypt and Greece).
- Ancient Egyptian Automata: Engineers created temple automata for rituals (e.g., opening doors, making sounds).Operated using simple hydraulic systems (water/air pressure).



- Antikythera Mechanism: Ancient Greek device (circa 100 BCE) for predicting astronomical positions. Featured a complex gear system for calculating celestial cycles.

Communication Method: Mechanical systems (pulleys, gears)

Machine Language: Fixed physical structures

Leonardo da Vinci's Mechanical Knight

During the Renaissance, Leonardo da Vinci took mechanical design to new heights, imagining machines that could mimic human actions.

- **Communication Method**: Manually operated mechanical systems (cranks, gears, pulleys).
- **Machine Language**: Pre-determined mechanical motion based on physical input.

Leibniz and the Binary System

In the 17th century, the foundation for modern digital computing was laid by Gottfried Wilhelm Leibniz, who introduced the binary number system.

- **Communication Method**: Conceptual binary arithmetic, based on 0 and 1.
- **Machine Language**: Binary code, a system of 1s and 0s, representing on and off states.

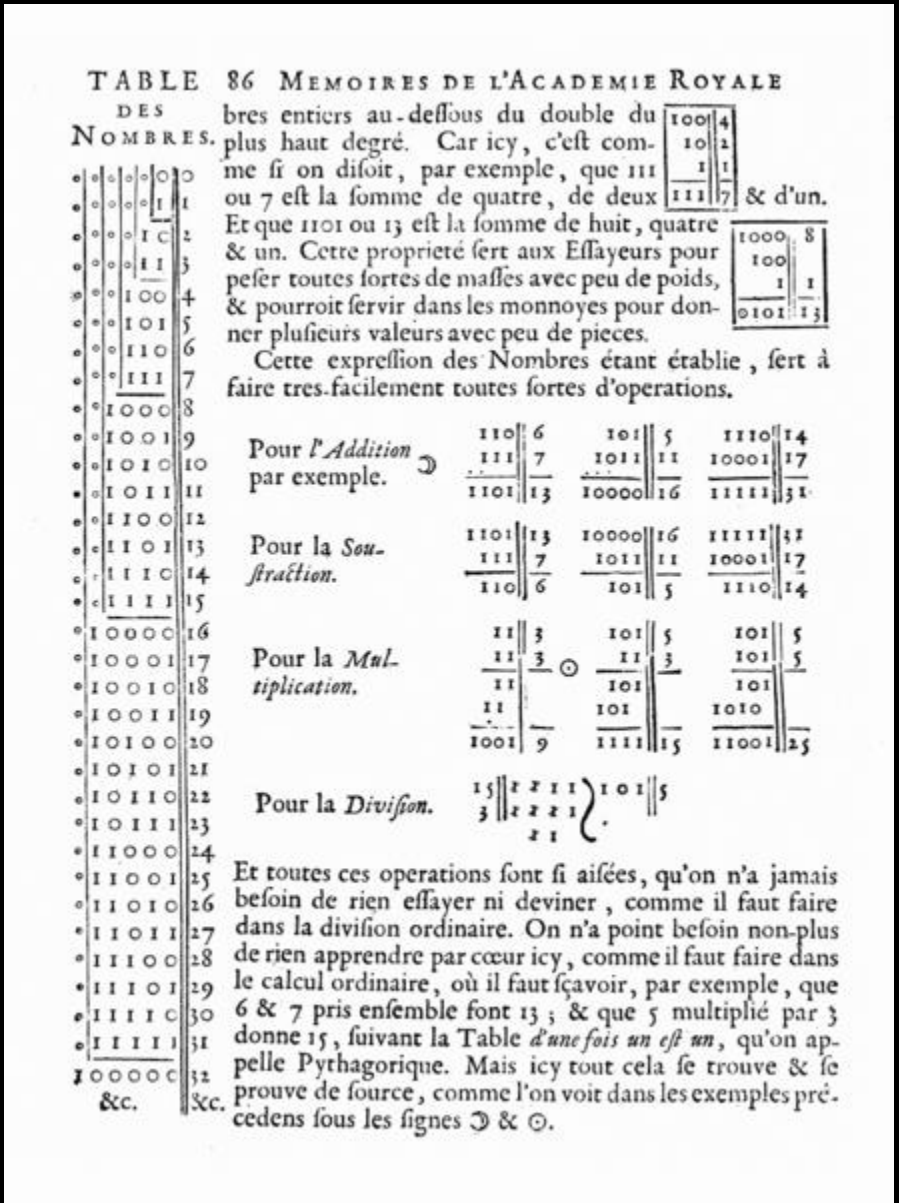


TABLE DES NOMBRES.

0	0
1	1
10	2
11	3
100	4
101	5
110	6
111	7
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15
10000	16
10001	17
10010	18
10011	19
10100	20
10101	21
10110	22
10111	23
11000	24
11001	25
11010	26
11011	27
11100	28
11101	29
11110	30
11111	31
100000	32
&c.	&c.

86 MEMOIRES DE L'ACADEMIE ROYALE

bres entiers au-dessous du double du plus haut degré. Car icy, c'est comme si on disoit, par exemple, que 111 ou 7 est la somme de quatre, de deux & d'un. Et que 1101 ou 13 est la somme de huit, quatre & un. Cette proprieté sert aux Essayeurs pour peser toutes sortes de masses avec peu de poids, & pourroit servir dans les monnoyes pour donner plusieurs valeurs avec peu de pieces.

100	4
10	2
1	1
111	7

1000	8
100	
1	1
1101	13

Cette expression des Nombres étant établie, sert à faire tres-facilement toutes sortes d'operations.

Pour *l'Addition* par exemple. ☽

110	6	101	5	1110	14
111	7	1011	11	10001	17
1101	13	10000	16	11111	31

Pour la *Soustraction.*

1101	13	10000	16	11111	31
111	7	1011	11	10001	17
110	6	101	5	1110	14

Pour la *Multiplication.*

11	3	101	5	101	5
11	3 ⊙	11	3	101	5
11		101		101	
11		101		1010	
1001	9	1111	15	11001	25

Pour la *Division.*

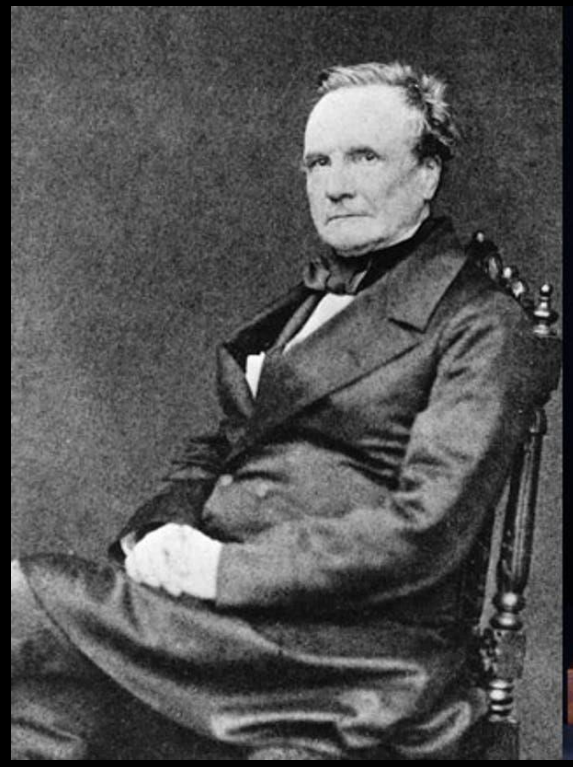
15	2 2 1 1	101	5
3	2 2 2 1		
	2 1		

Et toutes ces operations sont si aisées, qu'on n'a jamais besoin de rien essayer ni deviner, comme il faut faire dans la division ordinaire. On n'a point besoin non-plus de rien apprendre par cœur icy, comme il faut faire dans le calcul ordinaire, où il faut sçavoir, par exemple, que 6 & 7 pris ensemble font 13; & que 5 multiplié par 3 donne 15, suivant la Table *d'une fois un est un*, qu'on appelle Pythagorique. Mais icy tout cela se trouve & se prouve de source, comme l'on voit dans les exemples précedens sous les signes ☽ & ⊙.

Charles Babbage's Analytical Engine

Charles Babbage envisioned a machine that could be programmed to perform any calculation, creating the world's first concept of a general-purpose computer.

- **Communication Method:** Punch cards, mechanical input via gears and wheels.
- **Machine Language:** Punched card system that dictated operations (e.g., addition, subtraction, multiplication).



Ada Lovelace—The First Programmer

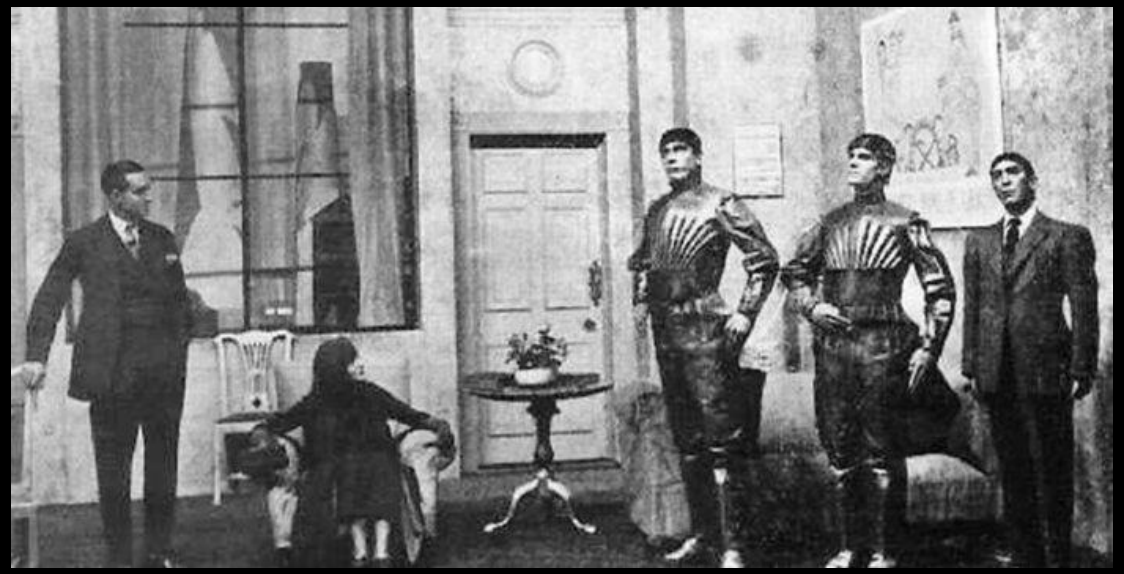
Ada Lovelace, collaborating with Babbage, took the concept of programming further by designing the first algorithm intended for a machine.

- **Communication Method:** Punch cards encoded with specific instructions.
- **Machine Language:** Algorithmic input via punch cards (early programming language).

The Term 'Robot' is Born

In 1920, Czech playwright Karel Čapek introduced the word 'robot' in his play R.U.R. (Rossum's Universal Robots).

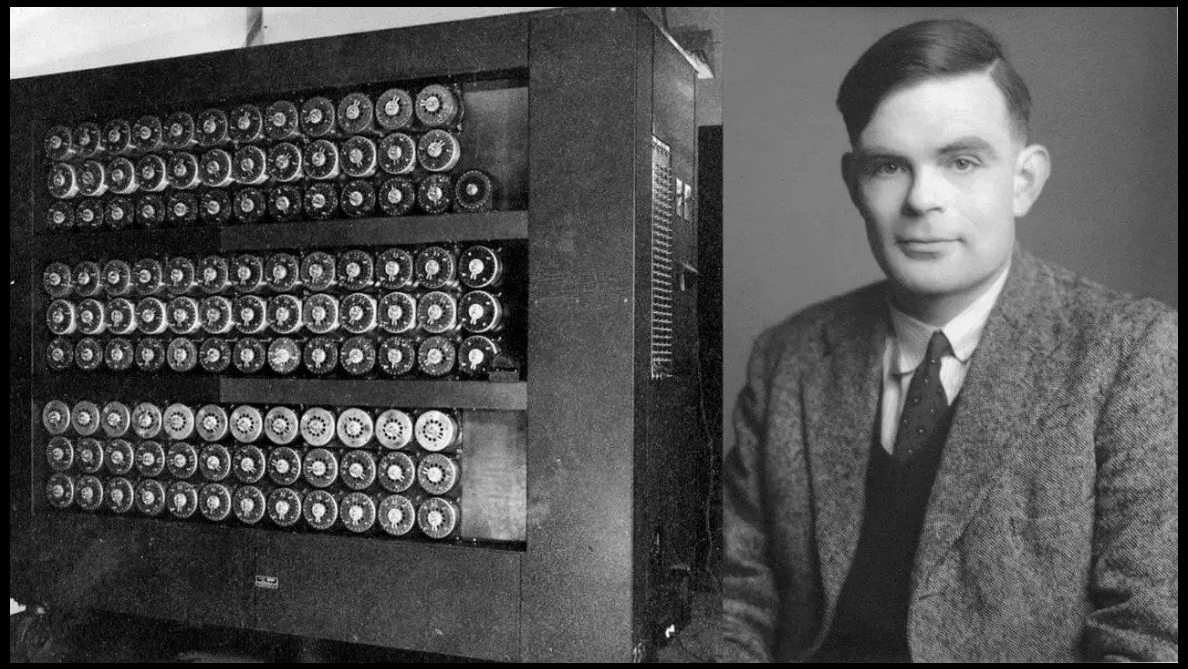
- **Communication Method:** Conceptual.
- **Machine Language:** None (fictional portrayal of autonomous action).



Alan Turing and the Universal Machine

In the 1930s, Alan Turing formalized the concept of a machine that could solve any computational problem, given the right instructions.

- **Communication Method:** Input tape with symbols and a set of rules.
- **Machine Language:** Symbols (binary-like) encoding instructions for computation



Claude Shannon and the Mathematical Theory of Communication

- Building on the theoretical foundations laid by Turing, Claude Shannon made significant strides in understanding how information could be processed and communicated by machines.

- **Communication Method:** Electrical signals representing binary digits (bits) in digital circuits.

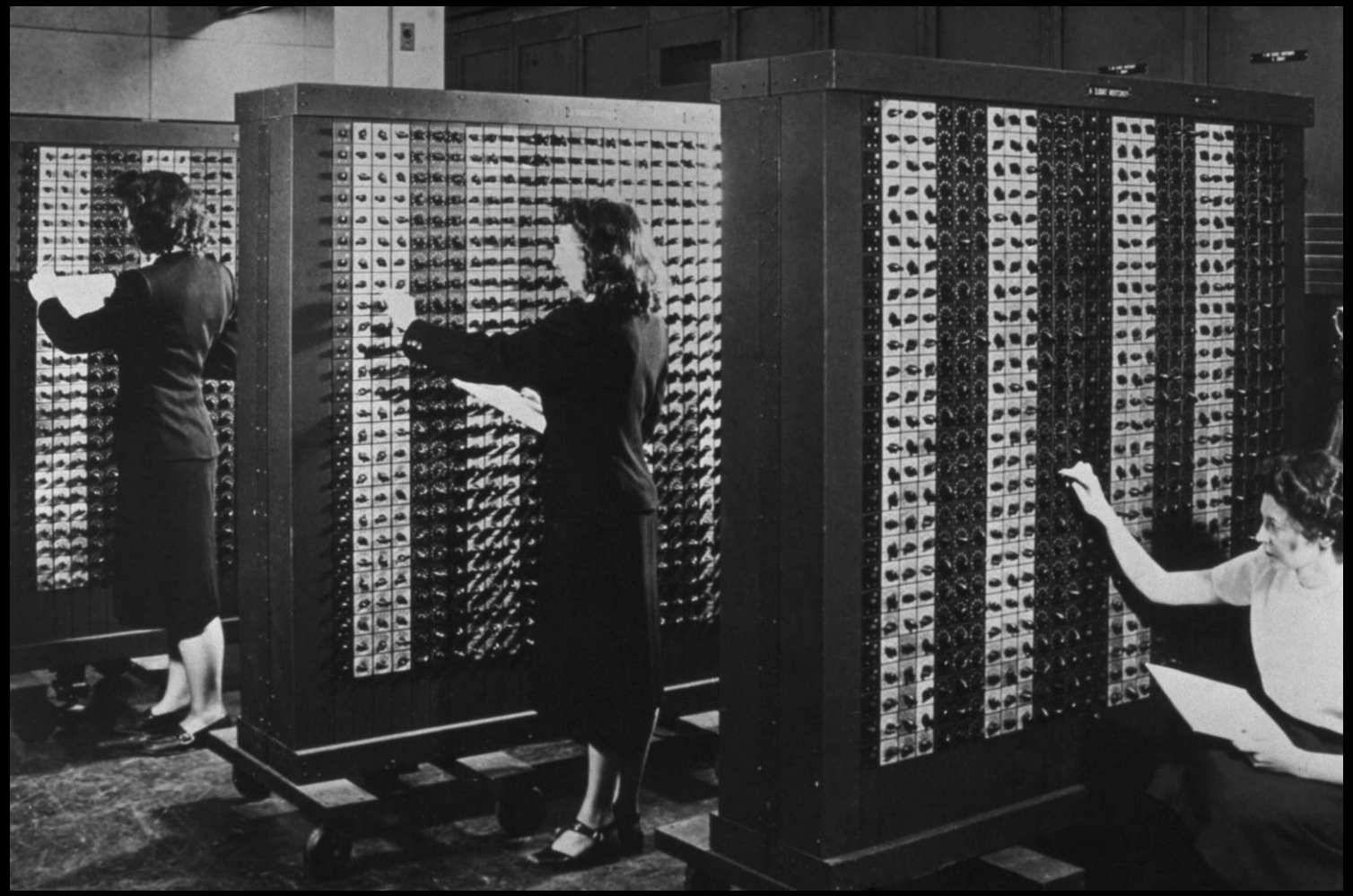
- **Machine Language:** Binary code implemented through logical gates and circuits.

ENIAC and Programming with Machine Language

- The development of electronic computers like ENIAC brought theoretical concepts into practical reality but introduced new challenges in communicating with these machines.

- **Communication Method**: Manual hardware configuration

- **Machine Language**: Unlike modern binary computers, ENIAC used a decimal system for computation



The Advent of Assembly Language

- To simplify programming, assembly language was introduced, serving as a bridge between human-readable instructions and machine code.

- **Communication Method**: Text-based mnemonic codes (assembly instructions) written by programmers.
- **Machine Language**: Binary machine code generated by the assembler from assembly instructions.

Grace Hopper and the First Compiler

- Seeking to further simplify programming, Grace Hopper pioneered the development of the compiler, transforming how humans communicate with machines.

- **Compiler**: A software tool that translates code from a high-level programming language into machine code executable by a computer.

- **Communication Method**: High-level programming language code written by humans.

- **Machine Language**: Machine code generated by the compiler from high-level code.

Unimate—The First Industrial Robot

Extending the principles of programming to the physical world, Unimate became the first industrial robot to work alongside humans in manufacturing.

- **Communication Method**: Programming via numerical codes stored on magnetic media.
- **Machine Language**: Specific control codes interpreted by the robot's controller to perform actions.

The Rise of Human-Computer Interaction

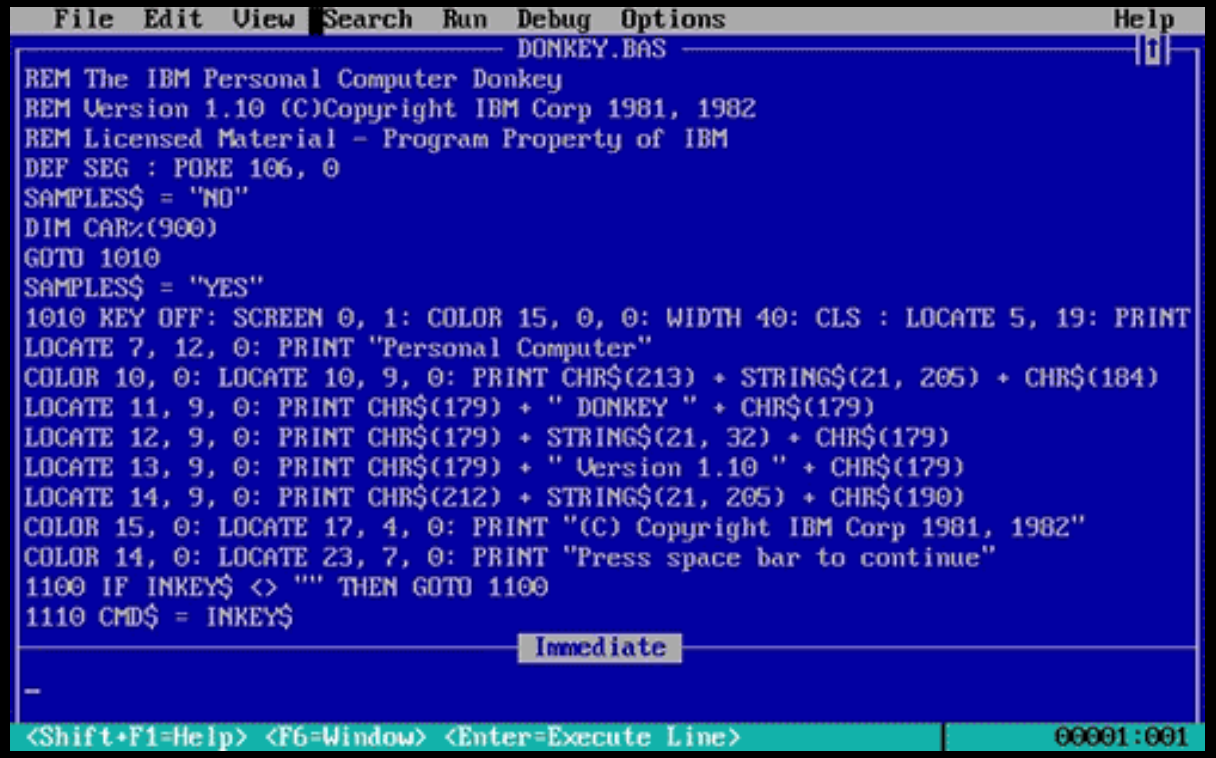
Douglas Engelbart's 1968 'Mother of All Demos' showcased revolutionary HCI technologies, including the mouse, graphical user interfaces (GUIs), hypertext, and real-time collaborative editing.

- **Communication Method**: Visual and interactive interfaces using devices like the mouse.

- **Machine Language**: GUI actions translated by the operating system into machine-level instructions.

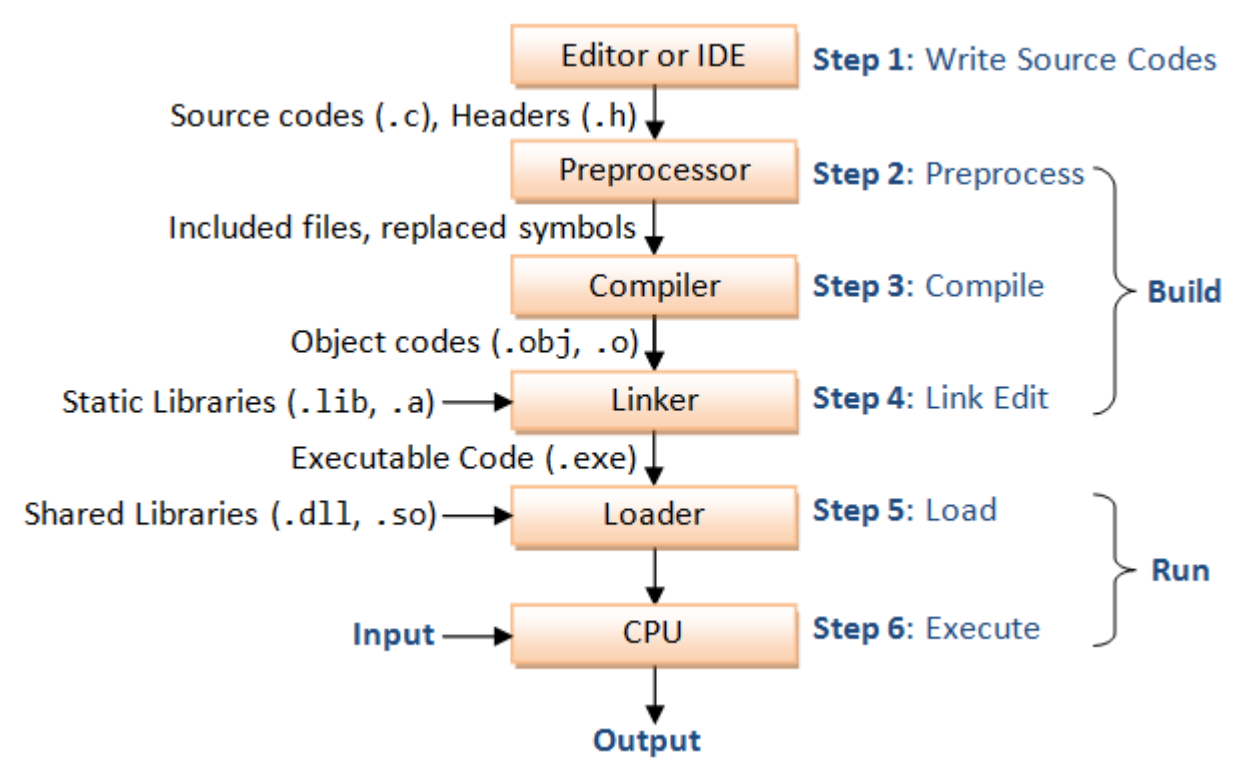
The Personal Computer Revolution and User-Friendly Programming

The advent of personal computers in the 1970s and 1980s democratized computing, making it accessible to individuals and small businesses.



The Development of C and Object-Oriented Languages

As software complexity increased, new programming paradigms and languages emerged to manage this complexity effectively.



The Development of Python and Its Impact

- Created by Guido van Rossum in the late 1980s.
- Emphasizes readability and simplicity, making it accessible for beginners.
- "Python is an experiment in how much freedom programmers need." - Guido van Rossum

Date: 1980s
Communication Method: High-level scripting language with clear syntax
Machine Language: Interpreted code executed by the Python interpreter

Advantages of Python in Robot Programming

- Readable and maintainable code facilitates collaboration among developers.
- Extensive libraries (e.g., NumPy, OpenCV) support rapid development and complex tasks.
- Easy integration with hardware and sensors using libraries like PySerial and GPIO.
- Building the ground for the AI revolution we experience today ->

Artificial Intelligence and Machine Learning in Robotics

- Artificial intelligence and machine learning have become integral to advancing robotics, enabling machines to learn from data and improve over time.

- **Machine Language:** We can increasingly communicate with the machines using text and voice commands. But there is more ->

Brain-Computer Interfaces—Direct Communication

- Emerging technologies like brain-computer interfaces (BCIs) are pushing the boundaries of how we communicate with machines.

- **Machine Language:** Not only coding, vision and audio but now also the biosensors can be used to communicate with the machines.

The Future of Human-Machine Communication?

- Advancements in AI, natural language processing, augmented reality, and other fields are leading toward more natural and intuitive interactions with machines. The goal is to create technology that seamlessly integrates with human activities, enhancing capabilities without imposing barriers.

Your thoughts?