UFV

UFV.ES

Background and historical perspectives

MODULE 1 / UNIT 1 / 1.1

MOISES M. MARTINEZ

FUNDAMENTALS OF COMPUTER ENGINEERING

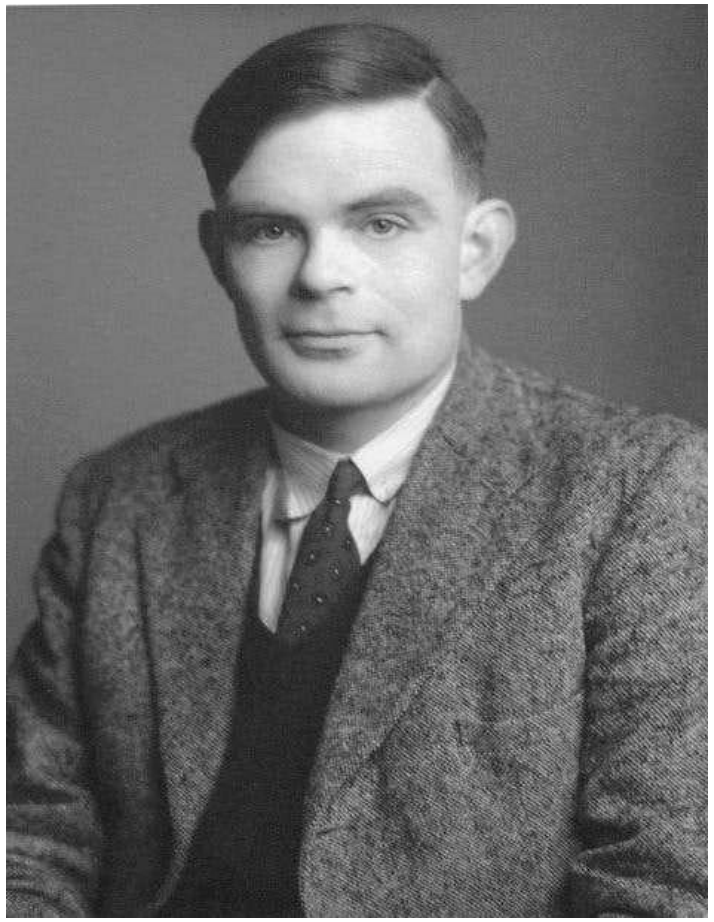
2025/2026

The beginning of Computer Science

01

The begining of Computer Sciences

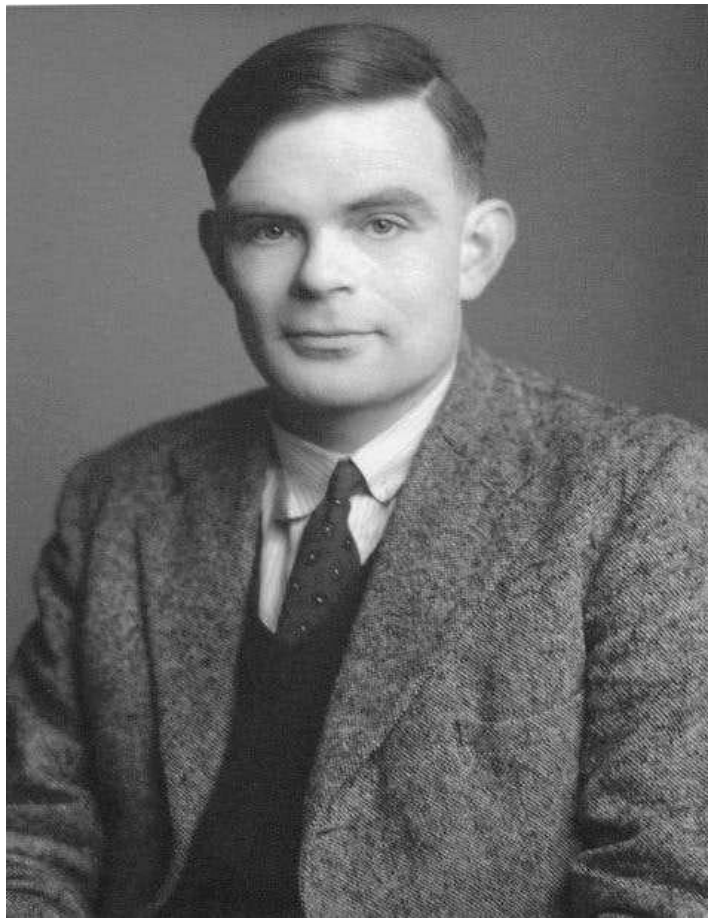
The beginning of everything (Before 1940)



Who is this guy?

The begining of Computer Sciences

The beginning of everything (Before 1940)



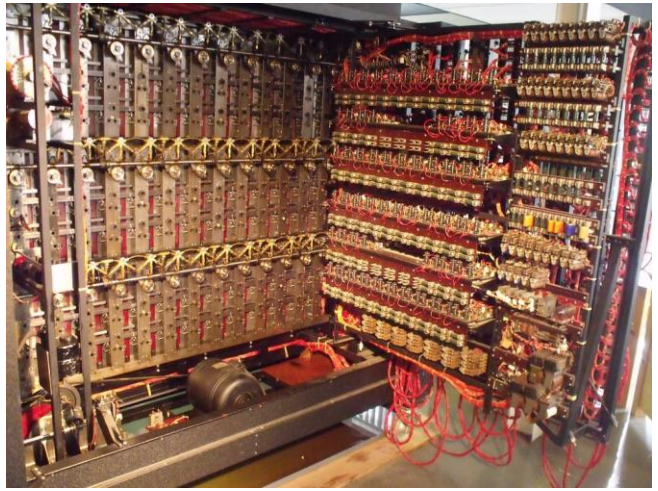
Alan Turing (1912-1954), a British mathematician, is widely regarded as one of the pioneers in the field of modern computing and Artificial Intelligence.

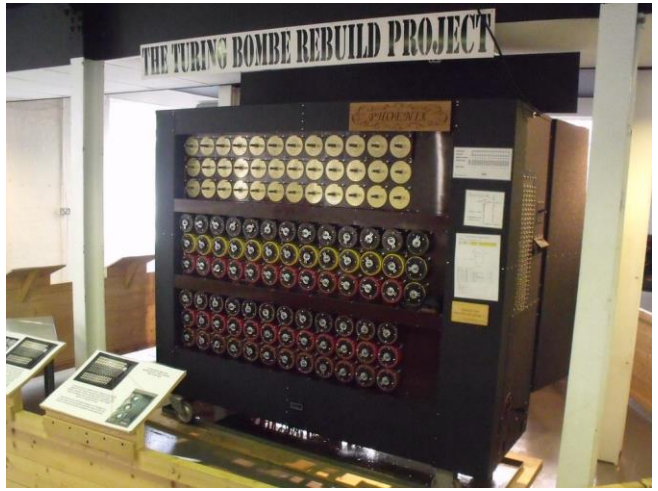
- He engineered the Phoenix, commonly known as the 'bomb,' a crucial apparatus instrumental in deciphering the codes generated by the Enigma machine.
- He formulated the Turing Test in 1950, a benchmark for assessing machine intelligence based on its ability to provide responses indistinguishable from those of a human.
- He conceptualized the Turing Machine, an automaton with the capacity to recognize any formal language.

The begining of Computer Sciences

The beginning of everything (Before 1940)

The Bomba (1940), colloquially referred to as the Phoenix, represented a distinctive mechanical computing device designed for the purpose of ascertaining the rotor configuration of the Enigma machine. Its operation entailed the execution of a sequence of logical deductions for every conceivable combination.





The replication of the bomb device at Bletchley Park, located in England.

Enigma Machine

First generation Programming using punched cards

02

Background and historical perspectives

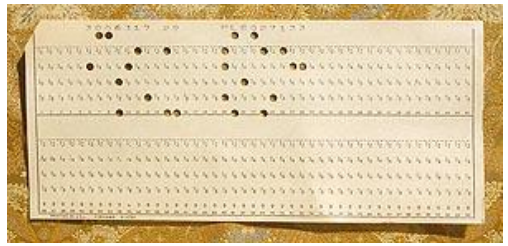
First generation (1940 - 1958)

The thermionic valve, also referred to as a **vacuum valve**, vacuum tube, or electron tube, serves as an electronic component employed for the amplification, switching, or manipulation of an electrical signal. This manipulation occurs through the control of electron flow within a near-vacuum or in the presence of specific gases, thereby operating within a confined space characterized by extremely low pressure.

vacuum valve

Mercury tube

Magnetic drum



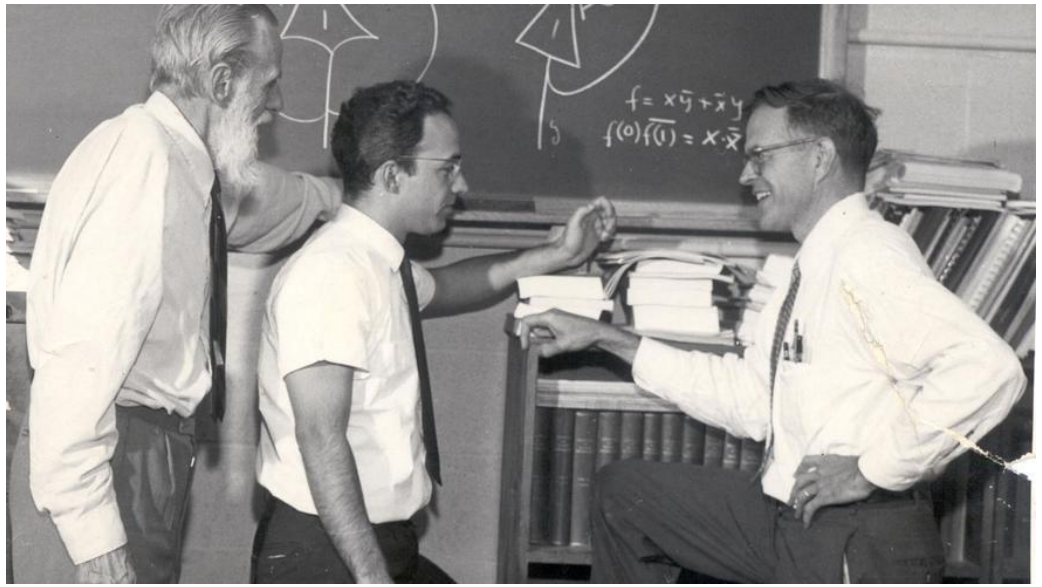
Punched Card

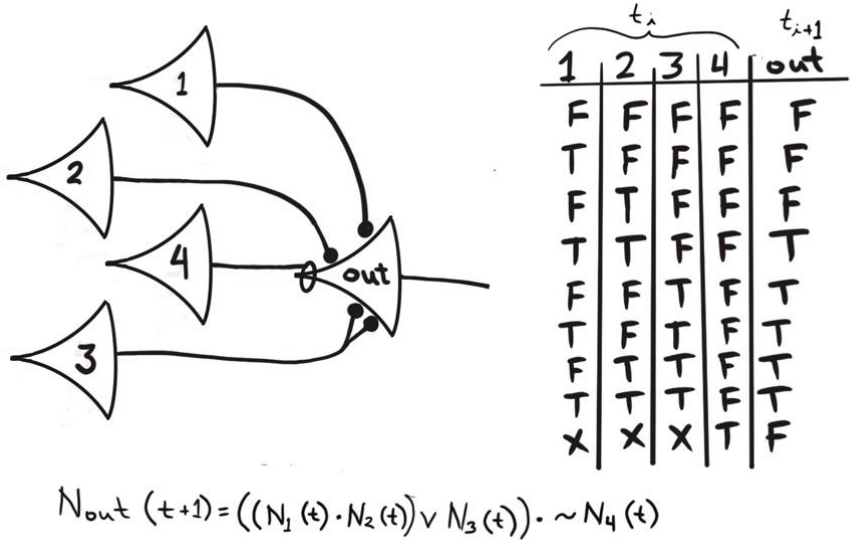
- Memory was constructed using liquid **mercury tubes** and **magnetic drums**.
- The internal storage system featured a high-speed rotating drum, where a read/write device inscribed magnetic markings.
- Programs were loaded into the system using **punched cards**.

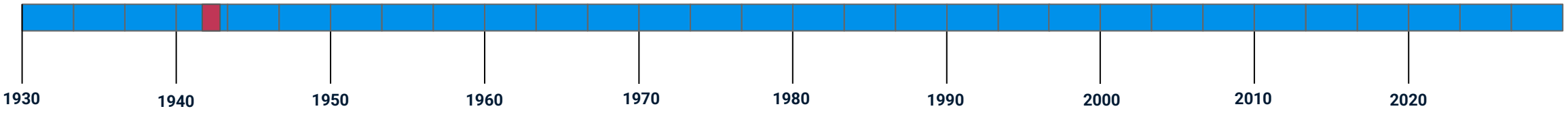
Background and historical perspectives

First generation (1940 - 1958)

The first computational model of a neuron (MCP) was proposed by Warren McCulloch and Walter Pitts in 1943.



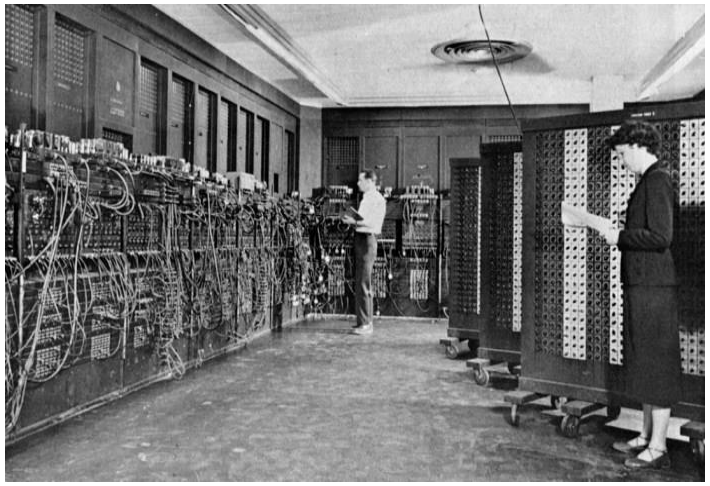




Background and historical perspectives

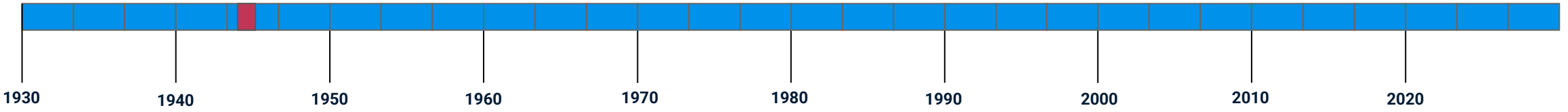
First generation (1940 - 1958)

The ENIAC (Electronic Numerical Integrator And Computer) is recognized as one of the pioneering electromechanical computers with general-purpose capabilities. Its functionality was contingent upon the specific programming instructions it received, allowing it to execute diverse tasks as per the applied programming.



It was designed for the purpose of computing artillery firing tables for the United States Army and occupied a physical footprint of 167 square meters, with a total weight of approximately 27 tons.

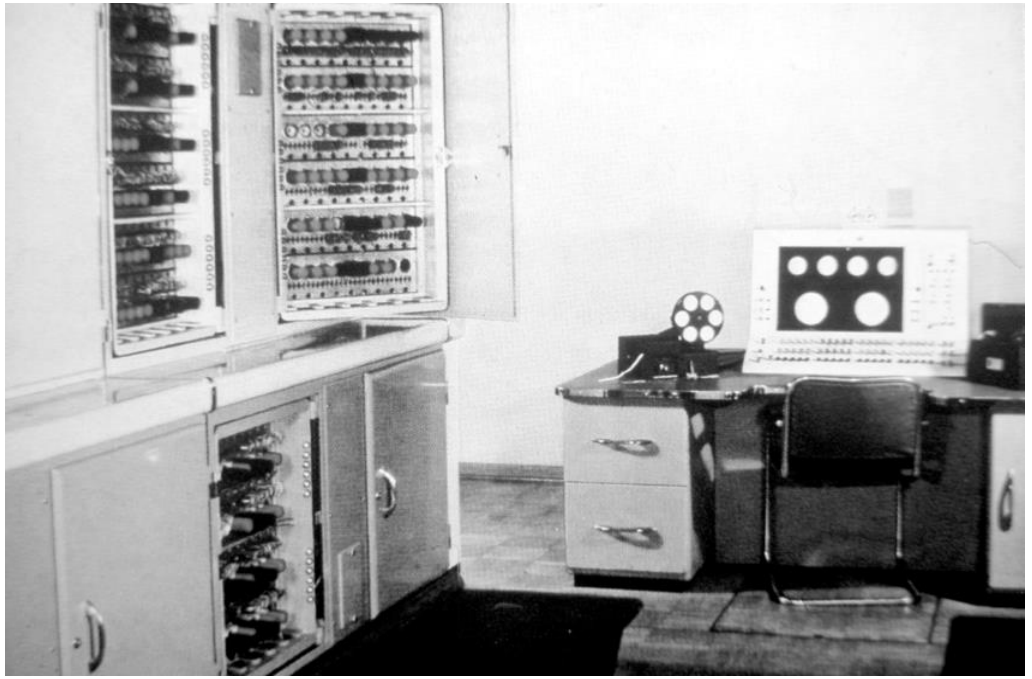
- 5,000 add operations per second.
- 300 multiplication operations per second.



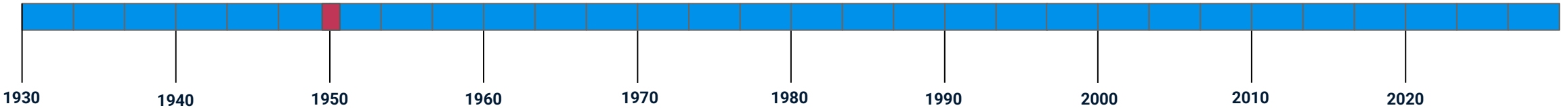
Background and historical perspectives

First generation (1940 - 1958)

UNIVAC (UNIVersal Automatic Computer)



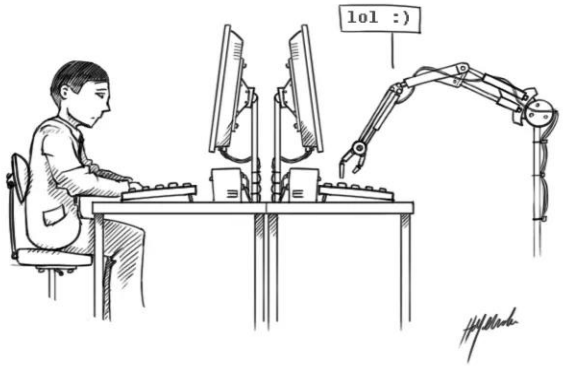
Ferranti Mark I

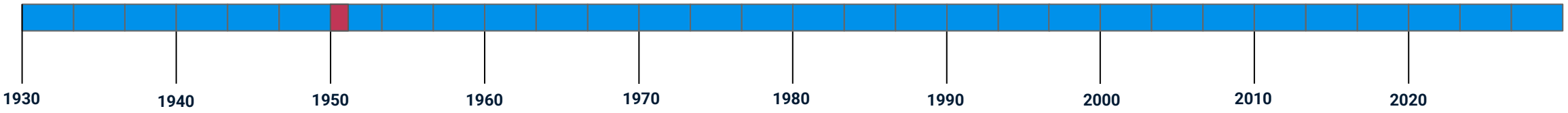


Background and historical perspectives

First generation (1940 - 1958)

Alan Turing authored the publication 'Computing Machinery and Intelligence' in 1950, wherein he expounds upon the renowned concept of the Turing Test.





Background and historical perspectives

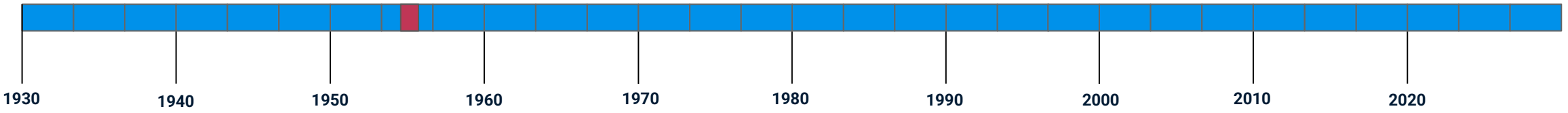
First generation (1940 - 1958)

The Dartmouth Summer Research Conference on Artificial Intelligence in 1956 marked a significant milestone in the emergence of Artificial Intelligence as a field dedicated to delineating applications that endeavoured to replicate the cognitive and behavioural paradigms of human reasoning.


A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence

August 31, 1955

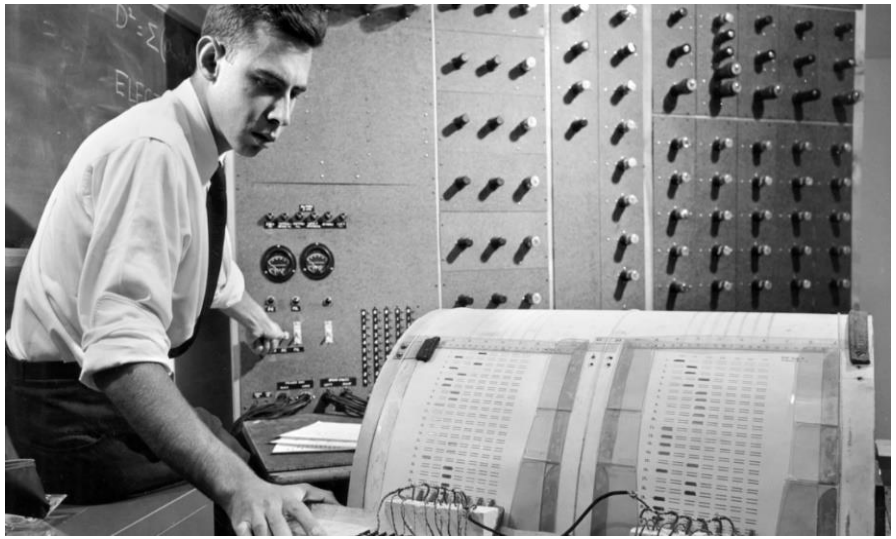

The Dartmouth College Artificial Intelligence Conference: The Next Fifty Years



Background and historical perspectives

First generation (1940 - 1957)

Frank Rosenblatt combined the MCP neuron and the findings of Hebb's Rule creating the **first perceptron** introducing the concept of training (1957).



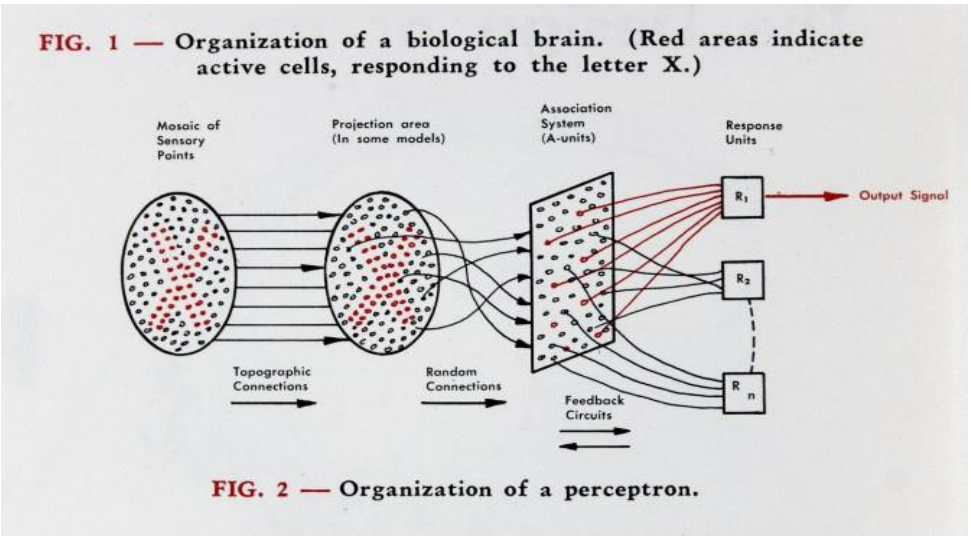
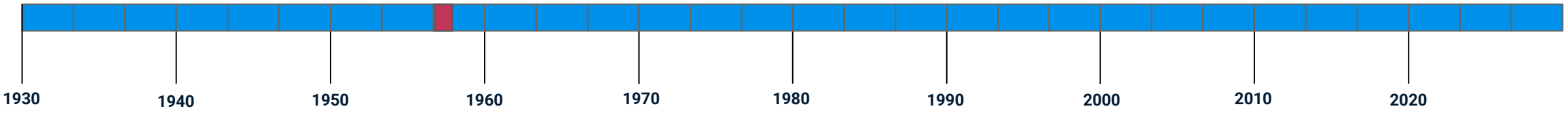


FIG. 1 — Organization of a biological brain. (Red areas indicate active cells, responding to the letter X.)

FIG. 2 — Organization of a perceptron.



Second generation
The arrival of transistors

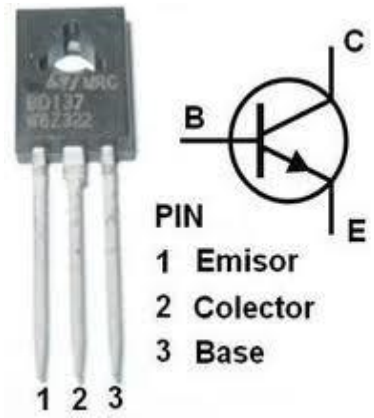
03

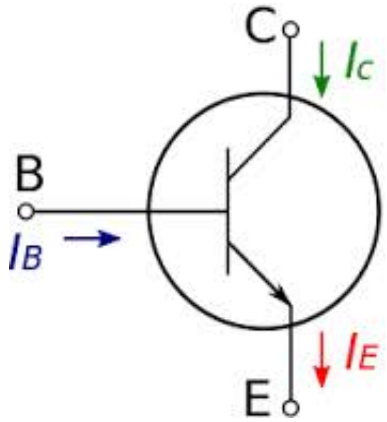
Background and historical perspectives

Second generation (1957 - 1964)

The transistor is a semiconductor electronic device employed for the generation of an output signal in reaction to an input signal, with the capability for amplification, oscillation, switching, or rectification.

Replica first transistor





Background and historical perspectives

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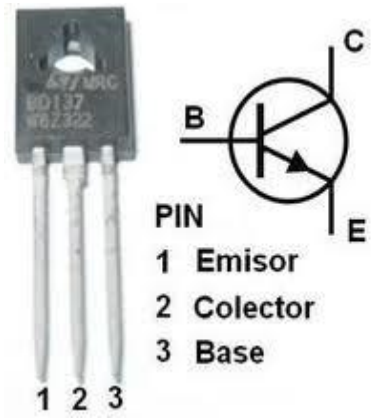
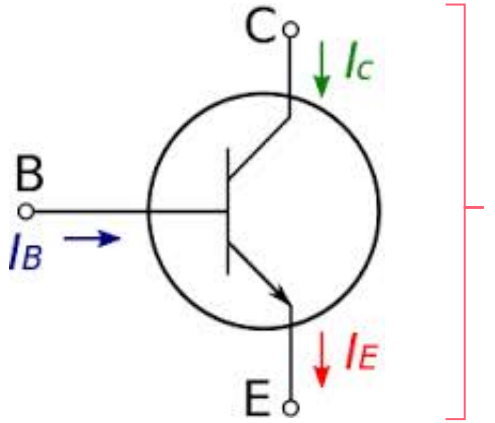
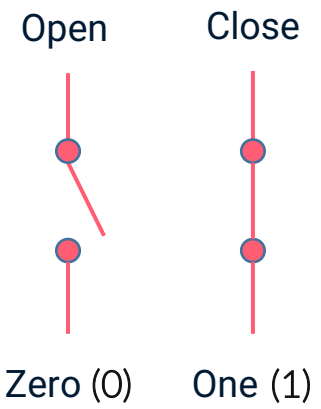






It serves as a switch in digital electronics, enabling the modulation of current conduction between the collector and the emitter by utilizing a low-intensity current through the base (IB) to either enable or disable the flow of current between the collector (IC) and emitter (IE).

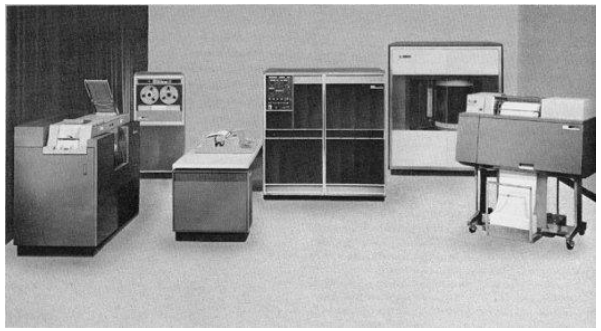
Background and historical perspectives

Second generation (1957 - 1964)

Central computers, commonly known as **mainframes** or **iron**, are centralized electronic systems used by large organizations for critical functions, such as processing Big Data, enterprise resource planning, and managing substantial transaction volumes.

- They support time-sharing systems by centralizing resources and enabling user access through simple terminals.
- Their interfaces are less user-friendly, central computers provide the advantage of independent programming with high-level languages, regardless of the underlying hardware infrastructure.

PDP 1



IBM 1401

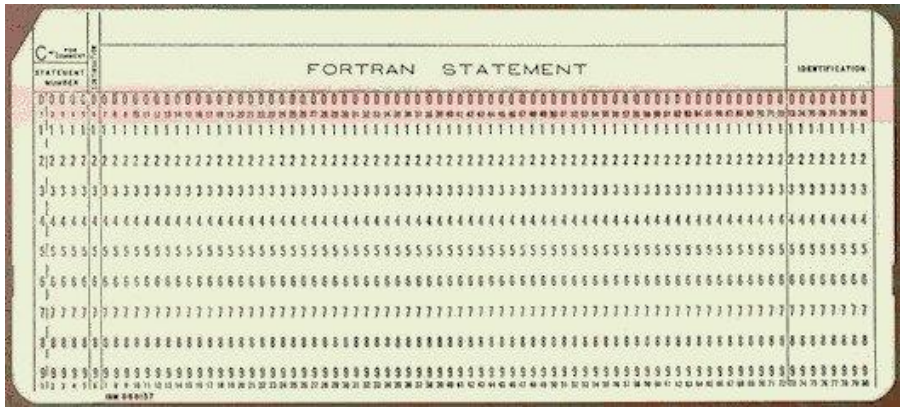
IBM 1621

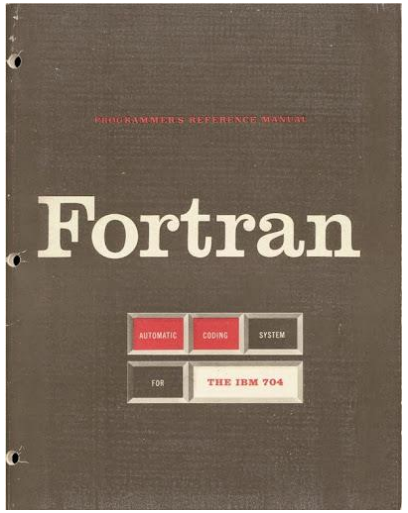
IBM 360

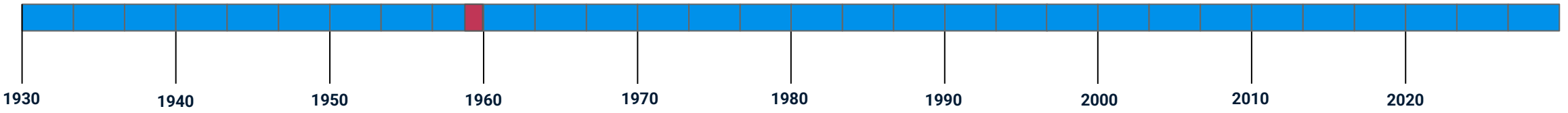
Background and historical perspectives

Second generation (1957 - 1964)

FORTRAN (**For**mula **Tran**slation) emerged as a pioneering high-level programming language, widely used for scientific and engineering applications due to its efficiency in numerical and mathematical computations.



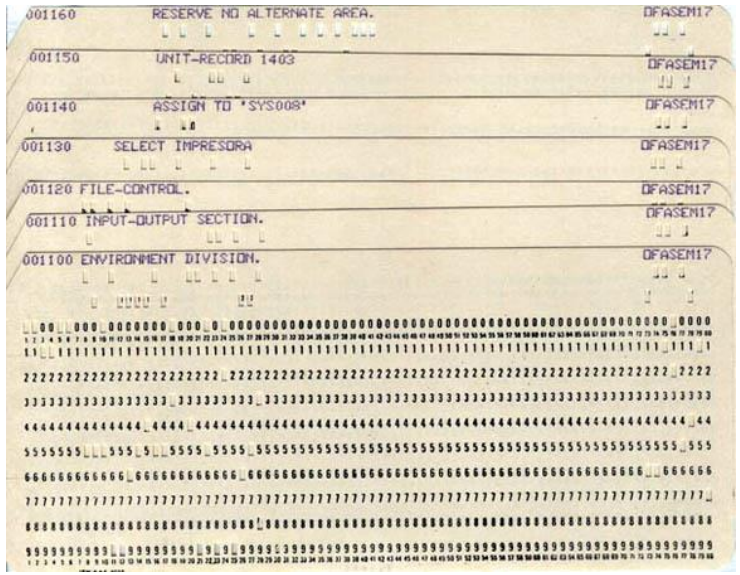




Background and historical perspectives

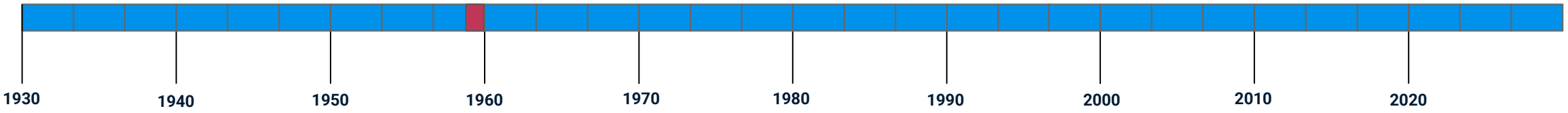
Second generation (1957 - 1964)

COBOL, an acronym for 'COmmon Business-Oriented Language,' was introduced in 1959. It was specifically designed to be executed on a wide range of computers using a compiler.



```
COMMAND ===>                                              SCROLL ===> CSR
000974        PROC-REG-ENTRADA.
000975            MOVE  CLI-TIPCTA-ENT    TO  CLI-TIPCTA-SAL.
000976            MOVE  NUMCTA-ENT        TO  NUMCTA-SAL.
000977            MOVE  NOMREF-ENT        TO  NOMREF-SAL.
000978            MOVE  NOMCLIE-ENT       TO  NOMCLIE-SAL.
000979            MOVE  DOMIC-CLI-ENT     TO  DOMIC-CLI-SAL.
000980            MOVE  SALDOMAX-ENT      TO  SALDOMAX-SAL.
000981        *
000982            MOVE  EL-FECHA-ENT (IND-FECHA-ENT-FIN)  TO  FECHA-ENTRADA.
000983        *
000984            IF  NUM-MOVS-ENT  GREATER  SALDOMAX-ENT
000985                MOVE  0       TO  IND-VALOR-1
000986            ELSE
000987                COMPUTE  IND-VALOR-1   ROUNDED  =  1  -
000988                         (NUM-MOVS-ENT  /  SALDOMAX-ENT).
000989        *
000990            MOVE  FEC-VALOR-ENT     TO  FEC-VALOR-SAL.
000991            MOVE  FEC-OPER-ENT      TO  FEC-OPER-SAL.
000992            IF    FEC-OPER-ENT      =   FEC-VALOR-ENT
000993                  MOVE  ZERO        TO  NUM-DIAS-DIF
000994            ELSE
000995                  CALL  'DIFERDIA' USING  FEC-VALOR-ENT.
```

Mathematician **Grace Hopper** was a leading advocate for the adoption of COBOL in both the private sector and the United States military.



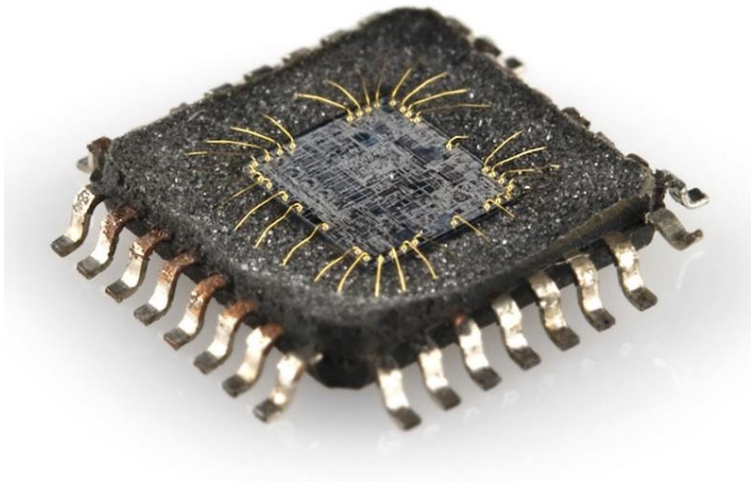
Third generation
Combining transistors to form integrated circuits

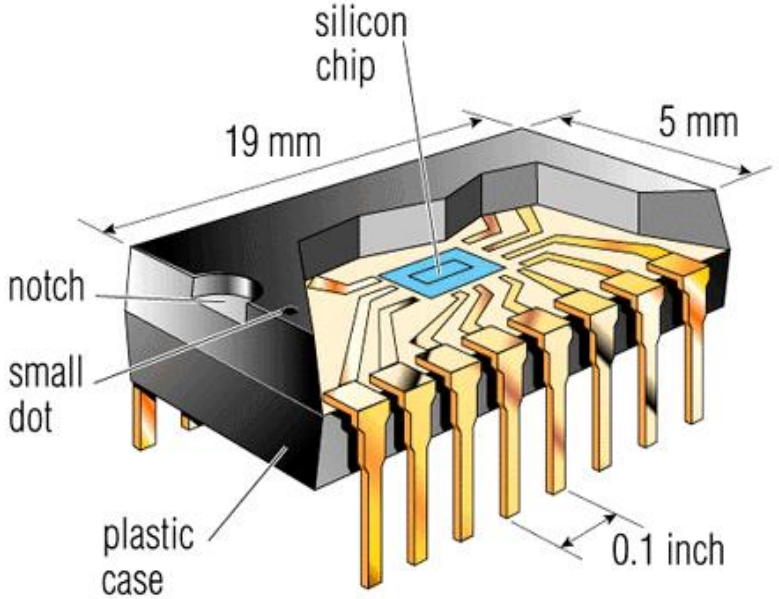
04

Background and historical perspectives

Third generation (1965 - 1971)

The Integrated Circuit (1959), often referred to as a chip or microchip, represents an electronic device designed to execute particular functions, such as signal amplification. These circuits are constructed using semiconductor materials, notably Silicon, which exhibit characteristics reminiscent of those observed in vacuum tubes.





Background and historical perspectives

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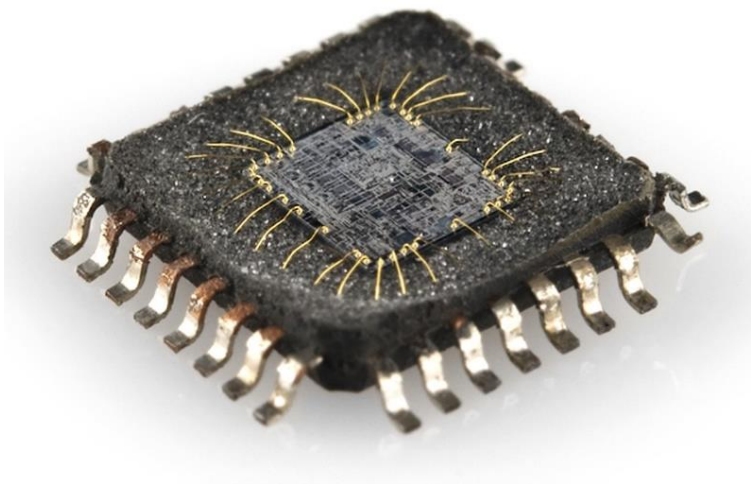
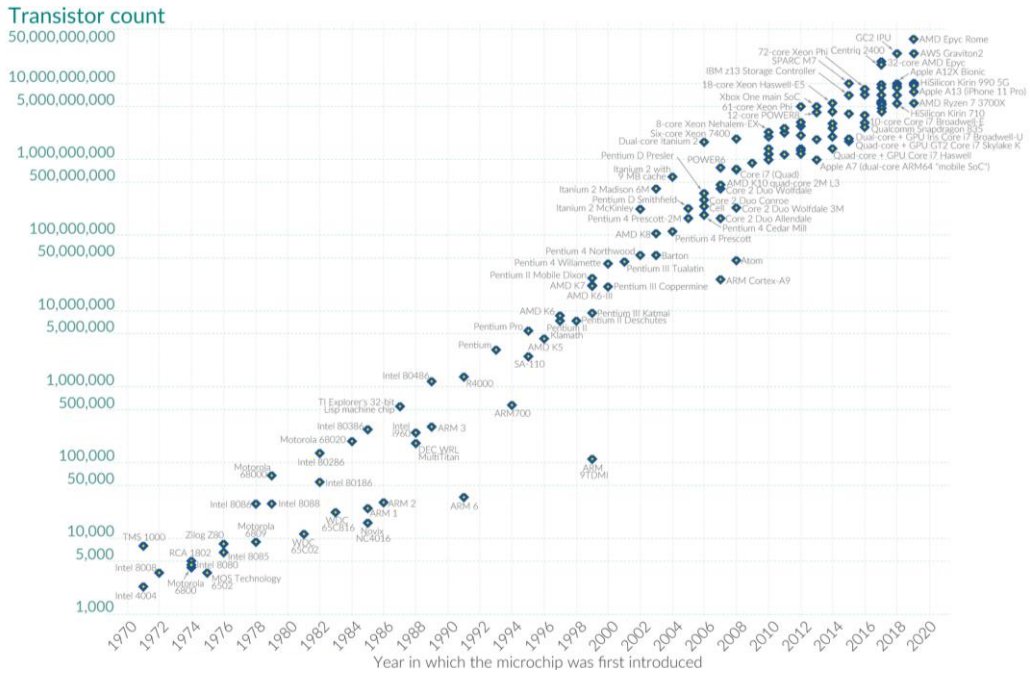


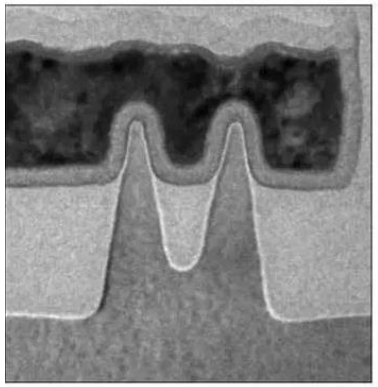
- Analog integrated circuits are constructed through the encapsulation of transistors, which collectively serve as amplifiers or signal oscillators.
- Digital integrated circuits are assembled using encapsulated transistors that operate as fundamental logic gates (And, Not, Or, Xor), designed to manipulate binary values.

Background and historical perspectives

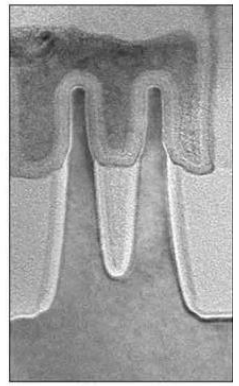
Third generation (1965 - 1971)

Moore's Law, introduced in 1971, is an empirical principle that posits that the quantity of transistors on an integrated circuit will roughly double approximately every two years. Initially, this law was articulated with the expectation of an annual doubling of transistor counts.





Transistor
22 NM



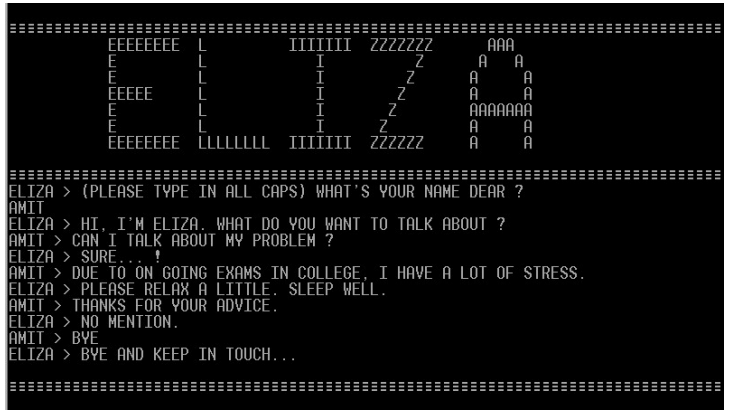
Transistor
14 NM

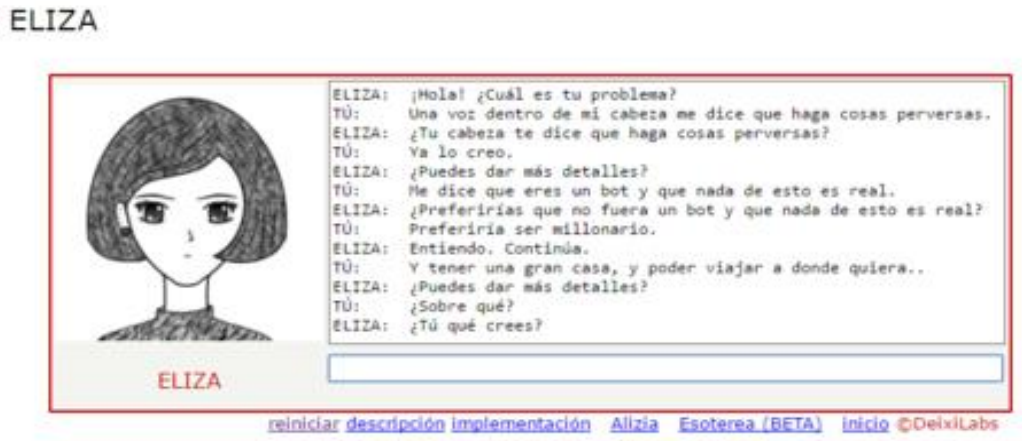
A nanometer corresponds to 10^{-7} centimeters, which is equivalent to 0.0000001 centimeters.

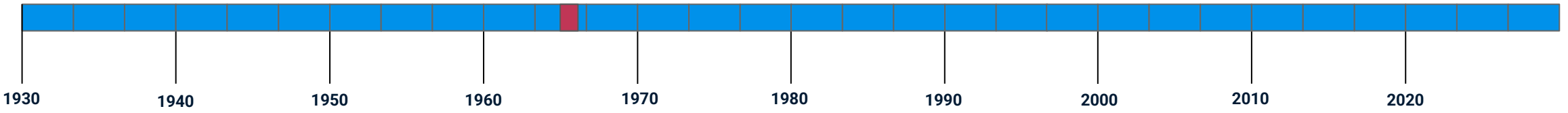
Background and historical perspectives

Third generation (1965 - 1971)

The inception of the first chatbot, named ELIZA, in 1965 marks a pivotal milestone as it is widely recognized as the inaugural conversational bot. ELIZA's functioning was predicated on the identification of keywords within input sentences, generating responses based on pre-registered model phrases within its database.



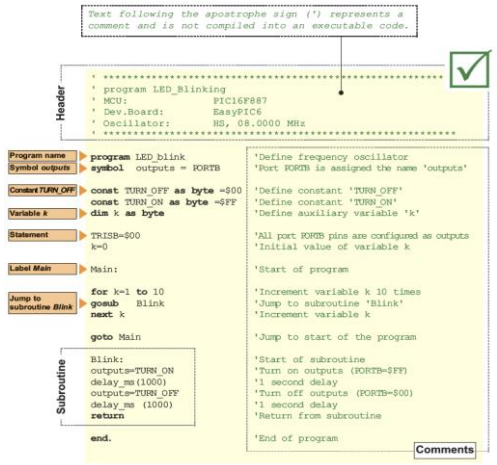




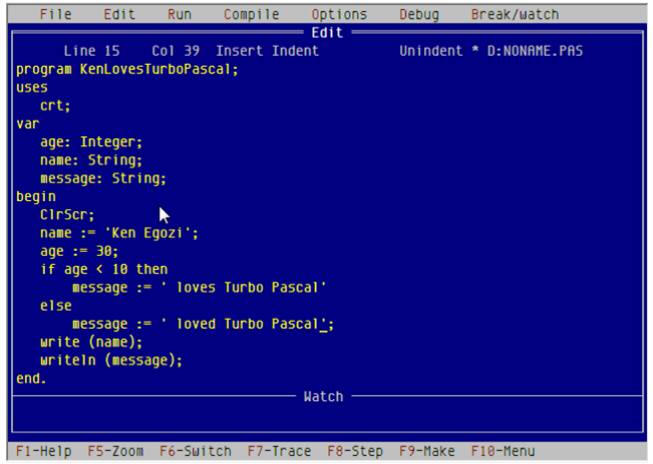
Background and historical perspectives

Third generation (1965 - 1971)

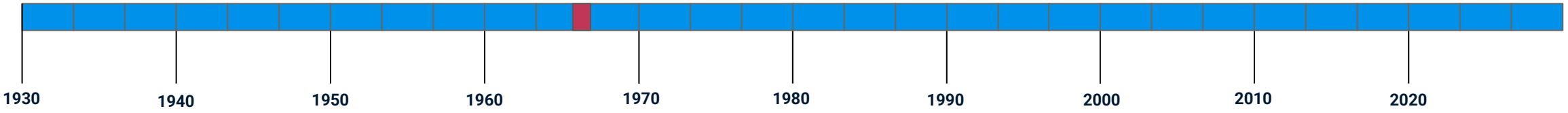
The emergence of imperative, pedagogically-oriented programming languages, exemplified by BASIC (Beginner's All-purpose Symbolic Instruction Code, 1964) and Pascal (1971), occurred with the specific intent of serving as educational tools for training prospective programmers.



Source code example in BASIC



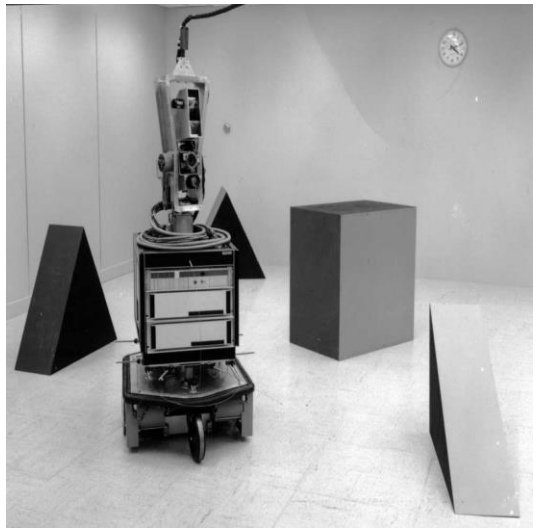
Source code example in Pascal

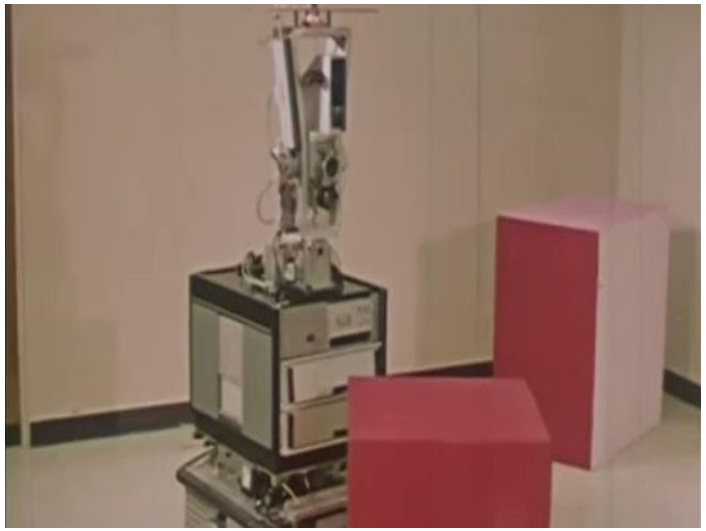


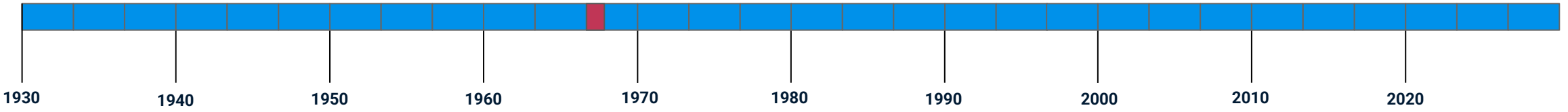
Background and historical perspectives

Third generation (1965 - 1971)

The Shakey robot, developed in 1966, stands as a pioneering example of a robot with the ability to engage in deliberative reasoning regarding its actions. This capacity was facilitated through the application of the General Problem Solver (GPS) system and the implementation of Automated Planning.



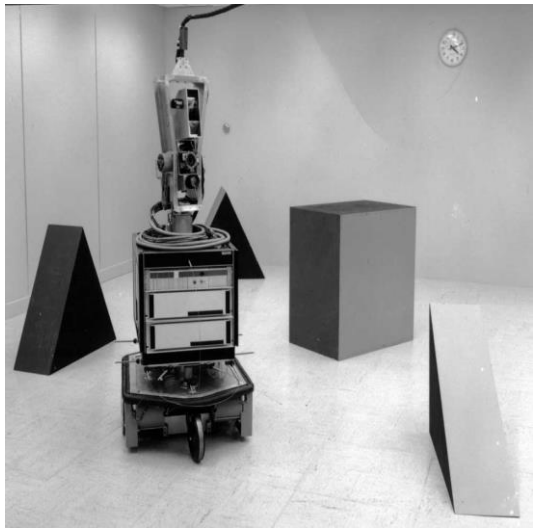




Background and historical perspectives

Third generation (1965 - 1971)

The A* algorithm, conceived in 1968, represents a seminal development that gave birth to the field of informed heuristic search. This algorithm has since been instrumental in addressing a wide array of challenges related to search, optimization, and reasoning problems.



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4	3	2	3	4	5	6	7	8		16	17	18	19
3	2	1	2	3	4	5	6	7		15	16	17	18
2	1	0	1	2	3	4	5	6		14	15	16	17
3	2	1	2	3	4	5	6	7		13	14	15	16
4	3	2	3	4	5	6	7	8		12	13	14	15
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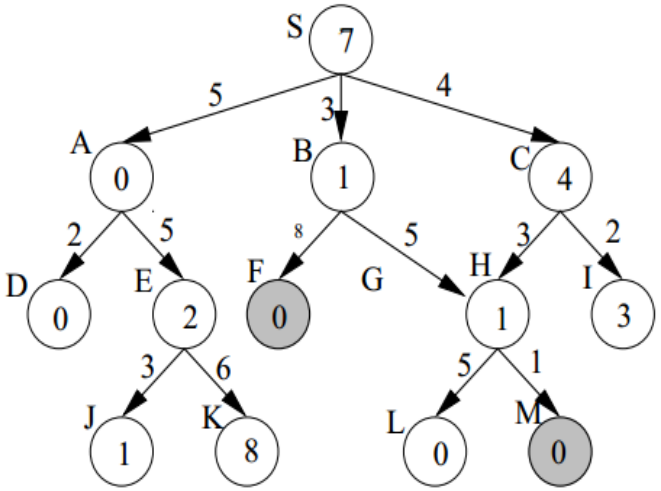
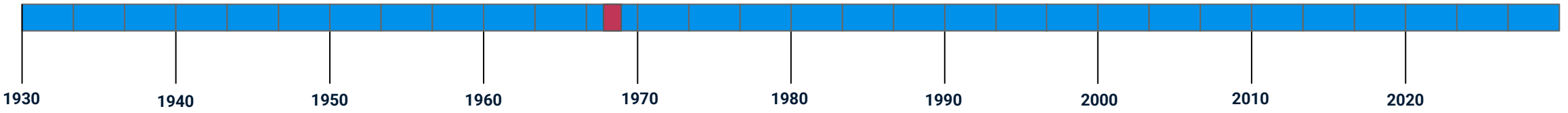
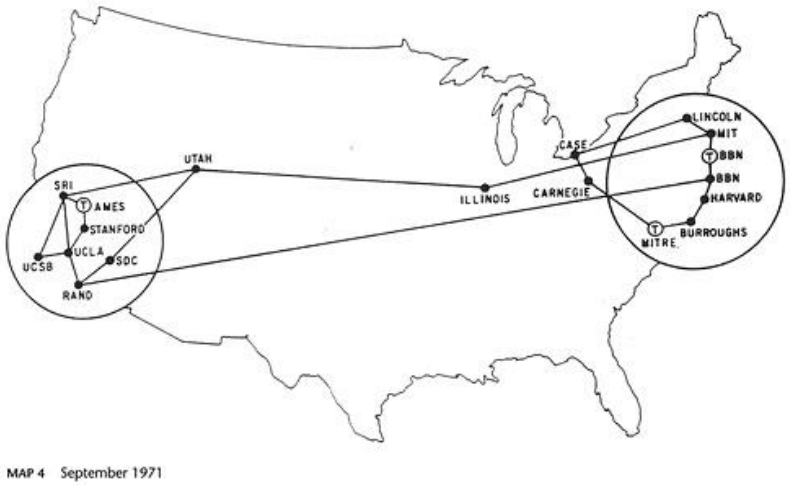




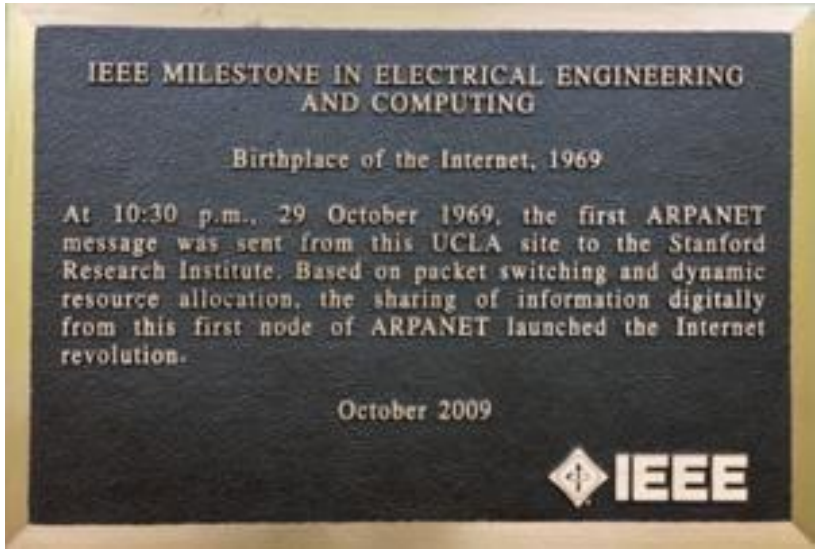
Background and historical perspectives

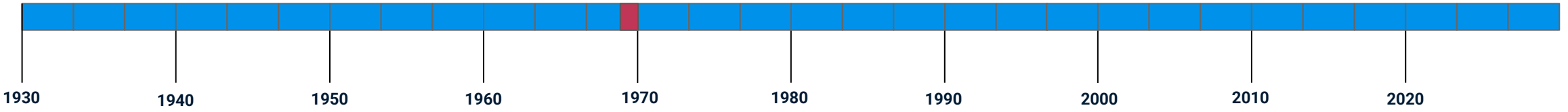
Third generation (1965 - 1971)

The U.S. Advanced Research Projects Agency Network (ARPANET), developed in 1969, was the first public packet-switched computer network between three universities in California, pioneering the fundamental technologies that would later form the backbone of the modern Internet.



MAP 4 September 1971





Fourth generation
Microprocessors and computer networks

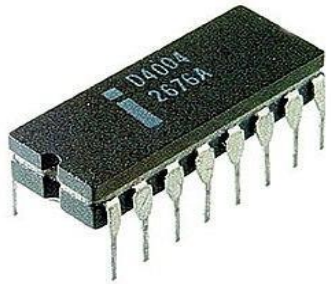
05

Background and historical perspectives

Fourth generation (1971 - 1981)

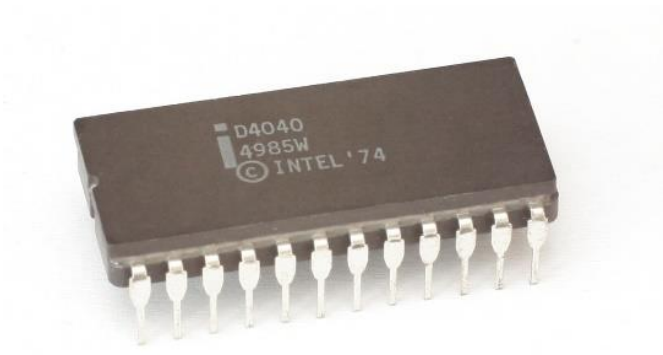
The Microprocessor, introduced in 1971, is an integrated circuit endowed with the capability to execute instructions encoded in binary language. It performs elementary arithmetic and logical operations, including addition, subtraction, multiplication, division, binary logic (such as 'and' and 'or' operations), and memory access functions. This pivotal component comprises at least two fundamental elements:

- Arithmetic Logic Unit (ALU): This digital circuit facilitates the execution of arithmetic and logical operations between values stored within the registers of the register bank.
- Register Bank: It comprises a collection of high-speed, small-capacity memory registers intended for the storage of operands and their corresponding results.

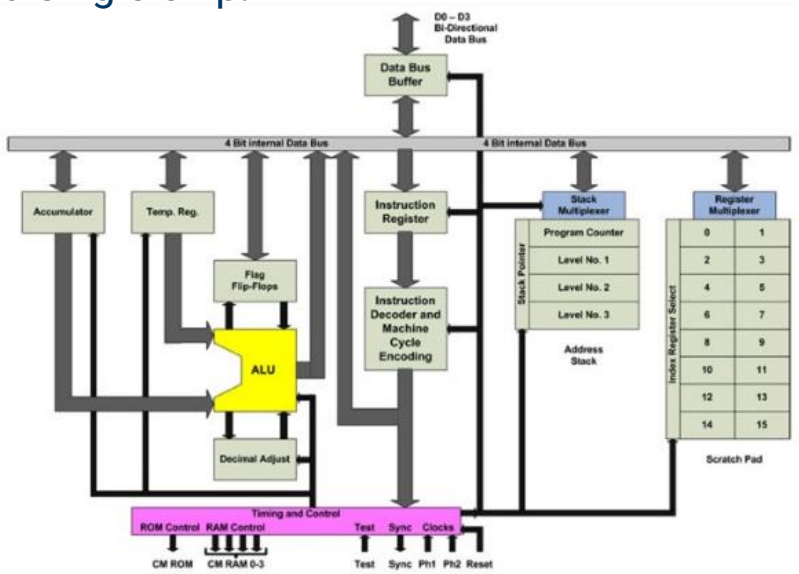


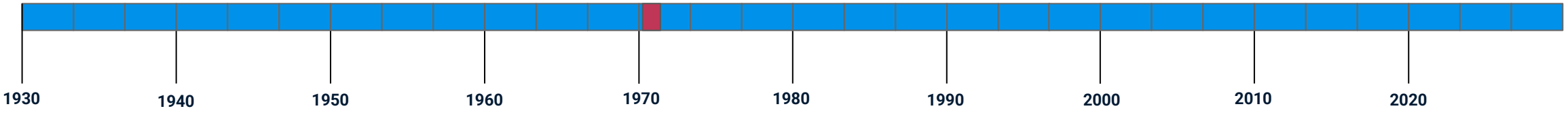
Fourth generation (1971 - 1981)

In 1971, Intel developed the inaugural microprocessor, known as the **Intel 4040**, specifically designed for a calculator featuring a 4-bit Central Processing Unit (CPU). This pioneering microprocessor incorporated an Arithmetic Logic Unit (ALU), a register bank, and a 4-bit Bus, all integrated onto a single chip.



INTEL 4040





Background and historical perspectives

Fourth generation (1971 - 1981)

High-speed computer networks serve as infrastructures facilitating data exchange and resource sharing among diverse systems. They enable the interconnection of numerous machines within a confined space, whether within a building, campus, or urban area, allowing the rapid transmission of small data packets between them in a matter of microseconds.

- Local Area Network (LAN): A LAN constitutes a wired network tailored for a limited number of systems, typically confined to a small geographical area.
- Metropolitan Area Network (MAN): MANs function as a 'metropolitan' network type, enabling the interconnection of LANs or WLANs at high-speed rates. MANs are typically deployed to link regions within the same city or smaller municipalities.
- Wide Area Network (WAN): WANs encompass expansive network architectures that interconnect LANs, WLANs, and MANs. Such networks are commonly established and managed by Internet Service Providers (ISPs).
- Wireless Local Area Network (WLAN): WLANs are wireless networks designed to facilitate access for a restricted number of systems through wireless access points.

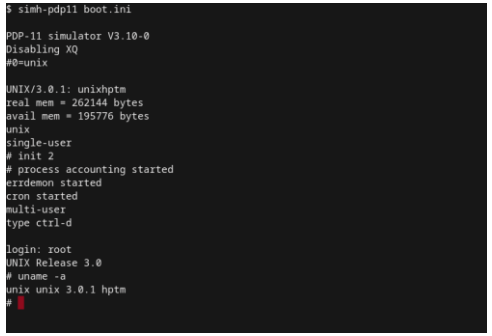
Background and historical perspectives

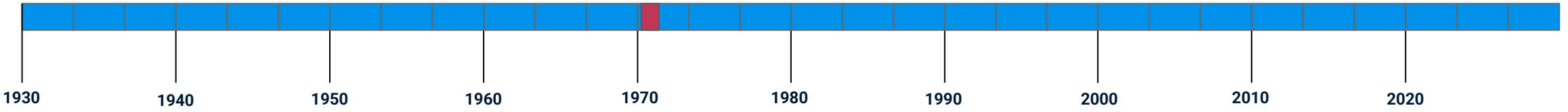
Fourth generation (1971 - 1981)

UNIX operative system, established in 1971, comprises a lineage of multitasking, multiuser computer operating systems. Unix systems are distinguished by their modular design, often referred to as the 'Unix philosophy,' which encompasses the following key components:

- A unified, inode-based filesystem known as the Unix filesystem.
- A primary mode of inter-process communication based on pipes.
- Shell scripting and command language, embodied in the Unix shell, are utilized to amalgamate various tools, enabling the execution of intricate workflows.

Dennis Ritchie (C) and Ken Thompson (UNIX).





Background and historical perspectives

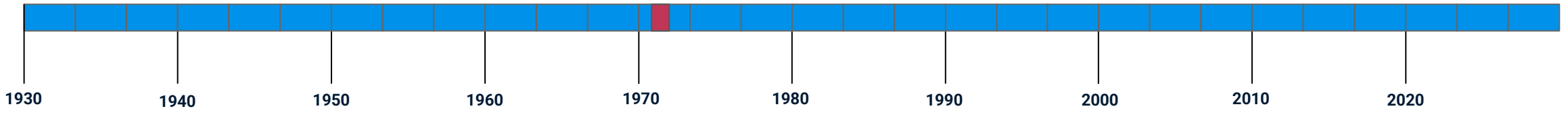
Fourth generation (1971 - 1981)

The C++ language, introduced in 1979, is an object-oriented, imperative-type general-purpose programming language that builds upon the foundation of C. Its creation aimed to augment the capabilities of the C programming language by introducing an object-oriented approach, thus rendering it a hybrid paradigm language.

```
template <class Derived, bool containerMode, class... Args>
template <class Output>
void BaseFormatter<Derived, containerMode, Args...>::appendOutput(Output& out)
    const {
  auto p = str_.begin();
  auto end = str_.end();

  // Copy raw string (without format specifiers) to output;
  // not as simple as we'd like, as we still need to translate "}}" to "}"
  // and throw if we see any lone "}"
  auto outputString = [&out] (StringPiece s) {
    auto p = s.begin();
    auto end = s.end();
    while (p != end) {
      auto q = static_cast<const char*>(memchr(p, '}', end - p));
      if (!q) {
        out(StringPiece(p, end));
        break;
      }
```

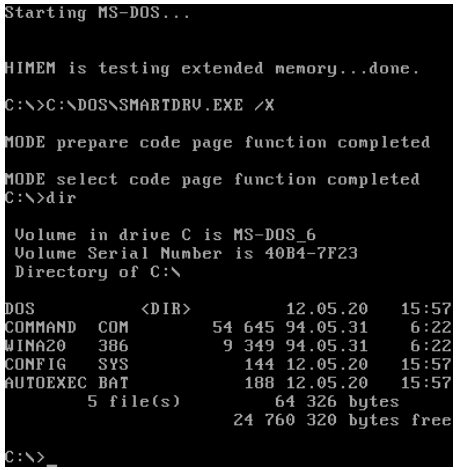
The nomenclature “C++” derives from its syntax, signifying an increment over C, underscoring the fact that C++ serves as an extension of the C programming language.

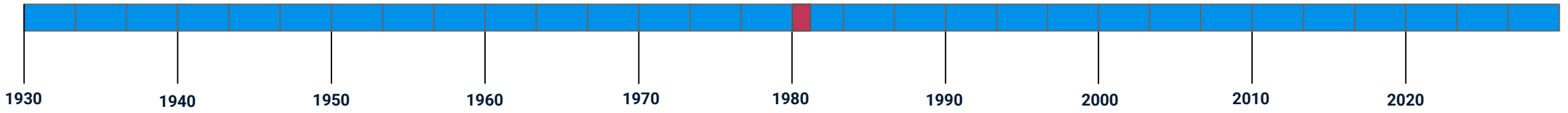


Background and historical perspectives

Fourth generation (1971 - 1981)

MS-DOS (Microsoft Disk Operating System) was created and first released in 1981, based on an operating system called QDOS (Quick and Dirty Operating System), which was developed by Seattle Computer Products. Microsoft acquired the rights to QDOS, refined it, and rebranded it as MS-DOS.





Fifth generation
The rise of Internet

06

Background and historical perspectives

Fifth generation (1981 - 1995)

A personal computer (PC), short for Personal Computer, is a programmable digital apparatus that executes a sequence of instructions to process input data, resulting in the generation of information subsequently routed to output devices

- PCs are powered by microprocessors that integrated the CPU onto a single chip, enabling compact design and sufficient processing power for general tasks.
- PCs includes essential peripherals like a keyboard for input, a monitor for display, and often a printer or floppy disk drives for output and storage.
- PCs uses floppy disks for data storage and program loading, which were easy to use and portable.

Apple II

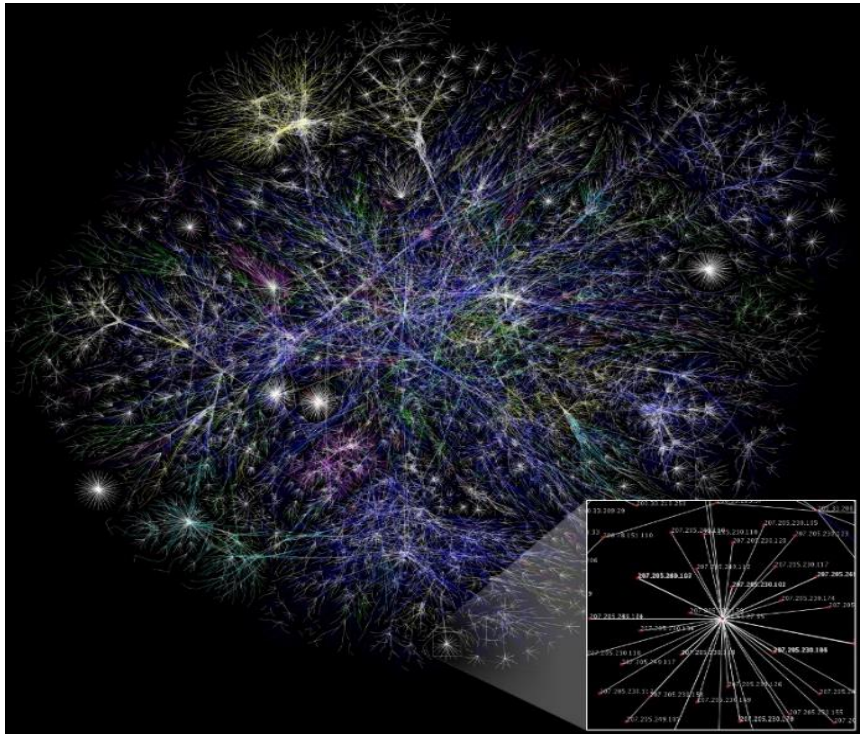
IBM Personal Computer

Background and historical perspectives

Fifth generation (1981 - 1995)

The Internet is an intricate, decentralized assemblage of interconnected networks employing the TCP/IP family of protocols. This architecture ensures that the diverse physical networks comprising the Internet coalesce into a unified, globally-reaching logical network.

- Massive increase in Client/Server type applications.
- Widespread dissemination of applications and services following the advent of the initial web pages.
- Novel service categories rooted in distributed:
  - e-commerce
  - Email
  - Multimedia
  - Medical applications
  - Supercomputing on the Internet



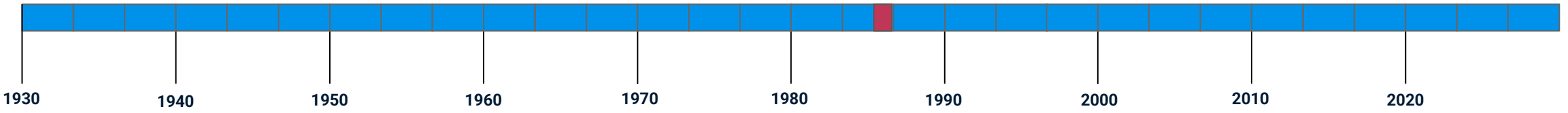
Background and historical perspectives

Fifth generation (1981 - 1995)

The backpropagation, or backward propagation of errors, algorithm was designed by Rumelhart, Hinton y Williams (1986) becoming in the standard training algorithm for ANN.

Algorithm 1 Backpropagation Algorithm

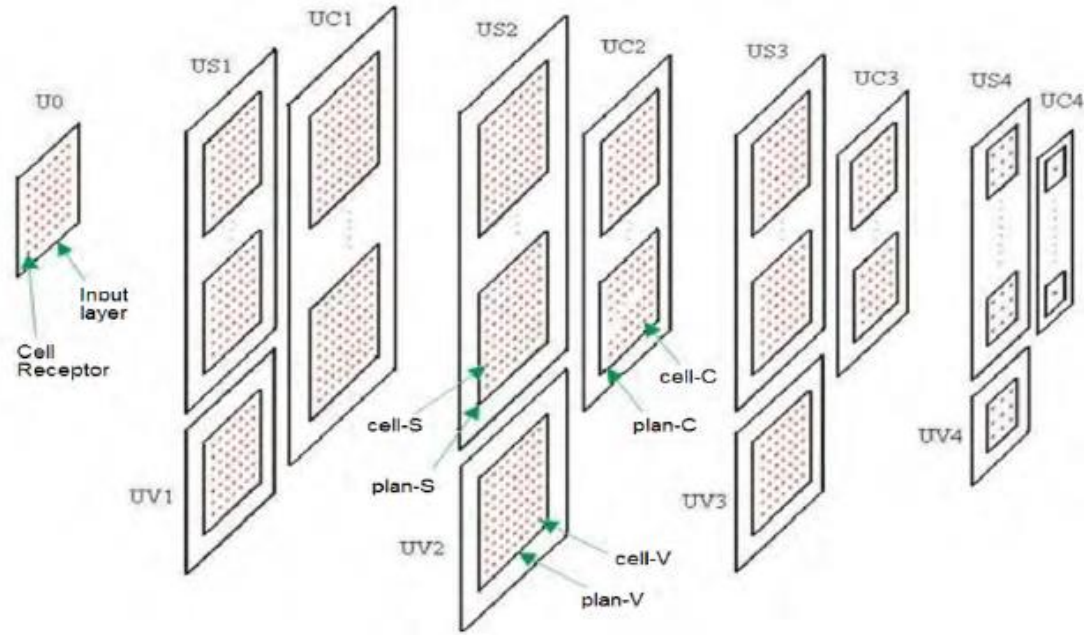
procedure TRAIN
  $X \leftarrow$ Training Data Set of size mxn
  $y \leftarrow$ Labels for records in X
  $w \leftarrow$ The weights for respective layers
  $l \leftarrow$ The number of layers in the neural network, 1...L
  $D_{ij}^{(l)} \leftarrow$ The error for all l,i,j
  $t_{ij}^{(l)} \leftarrow 0$. For all l,i,j
  For $i = 1$ to m
    $a^l \leftarrow feedforward(x^{(i)}, w)$
    $d^l \leftarrow a(L) - y(i)$
    $t_{ij}^{(l)} \leftarrow t_{ij}^{(l)} + a_j^{(l)} \cdot t_i^{l+1}$
  if $j \neq 0$ **then**
    $D_{ij}^{(l)} \leftarrow \frac{1}{m} t_{ij}^{(l)} + \lambda w_{ij}^{(l)}$
  else
    $D_{ij}^{(l)} \leftarrow \frac{1}{m} t_{ij}^{(l)}$
    where $\frac{\partial}{\partial w_{ij}^{(l)}} J(w) = D_{ij}^{(l)}$

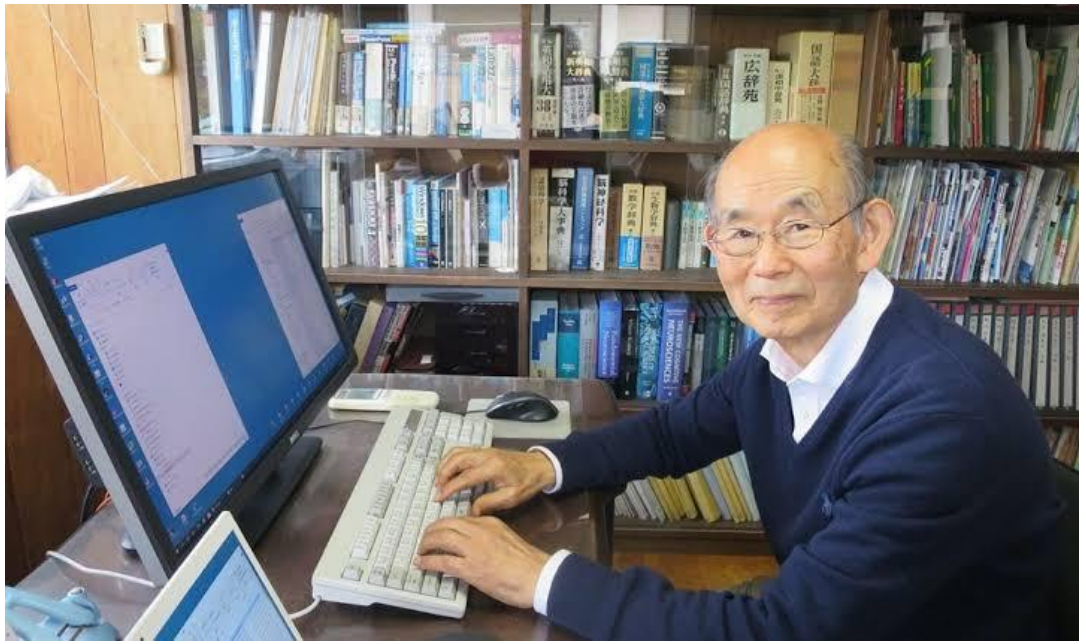


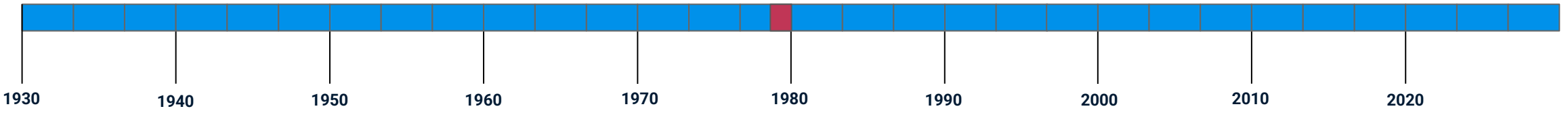
Background and historical perspectives

Fifth generation (1981 - 1995)

First artificial Neural Network, called the neocognitron, for image recognition was proposed by Kunihiko Fukushima in 1979.



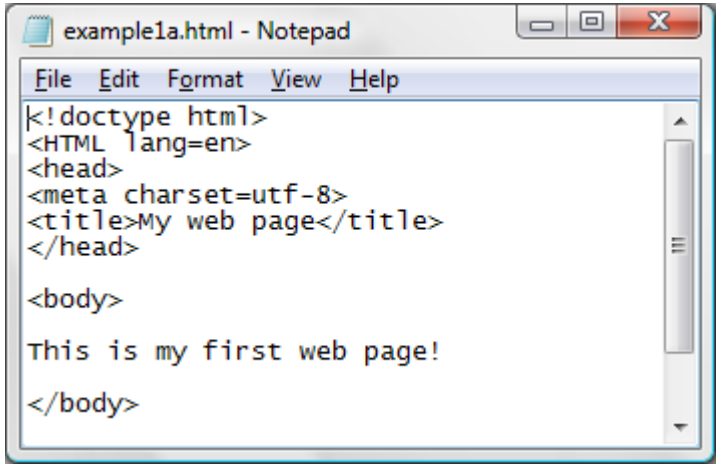


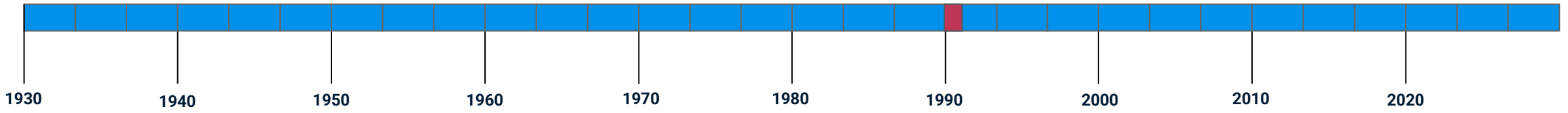


Background and historical perspectives

Fifth generation (1981 - 1995)

HTML (HyperText Markup Language, 1991) is a comprehensive markup language employed for delineating the structural framework of web pages by means of tags (e.g., <head>) that specify the nature of the content they encapsulate. Presently, HTML stands as the prevailing standard language for constructing web applications.

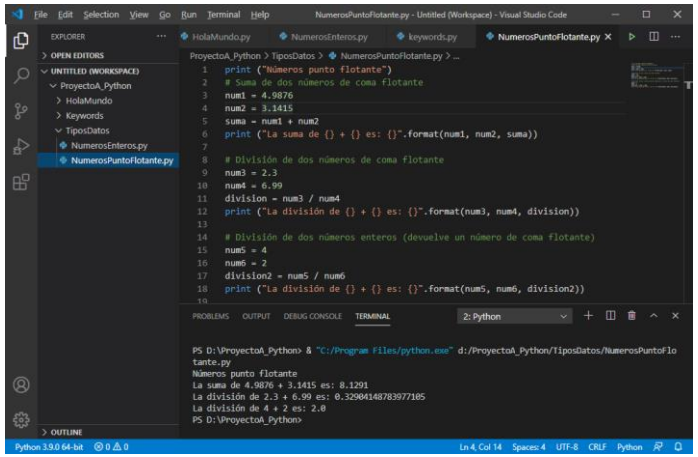




Background and historical perspectives

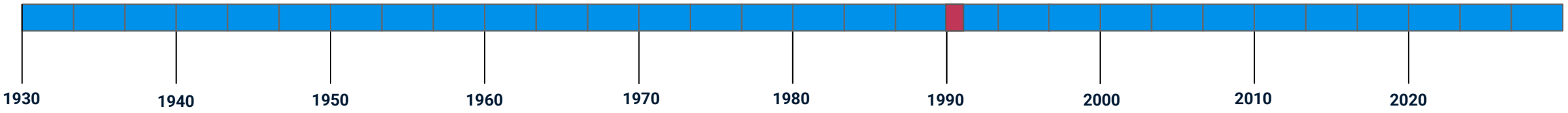
Fifth generation (1981 - 1995)

The Python language, introduced in 1991, represents a versatile general-purpose programming language that amalgamates elements of functional, object-oriented, and imperative paradigms. It was conceived with the primary objective of enhancing code readability, thereby facilitating its utilization by programmers.



- Multi-paradigm: Object-oriented, imperative and functional.
- It operates as an interpreted language.
- Dynamic typing.
- Cross-platform compatibility.

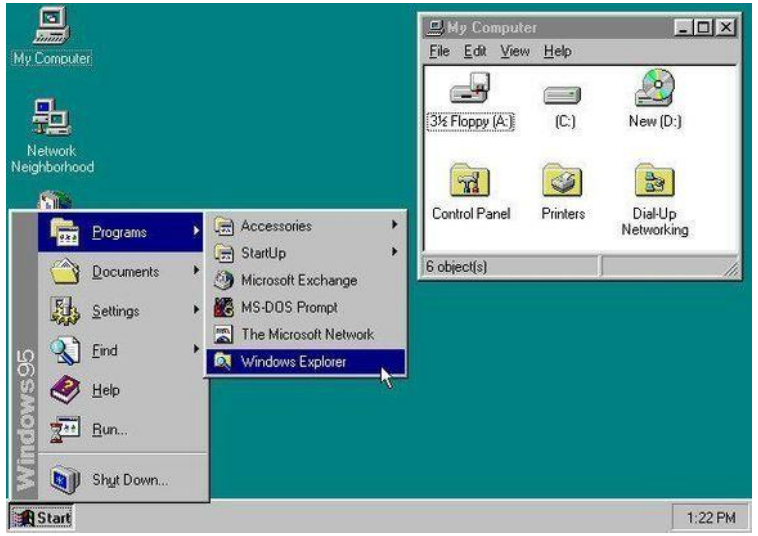
It is the most used language for building applications related to Big Data and Artificial Intelligence.

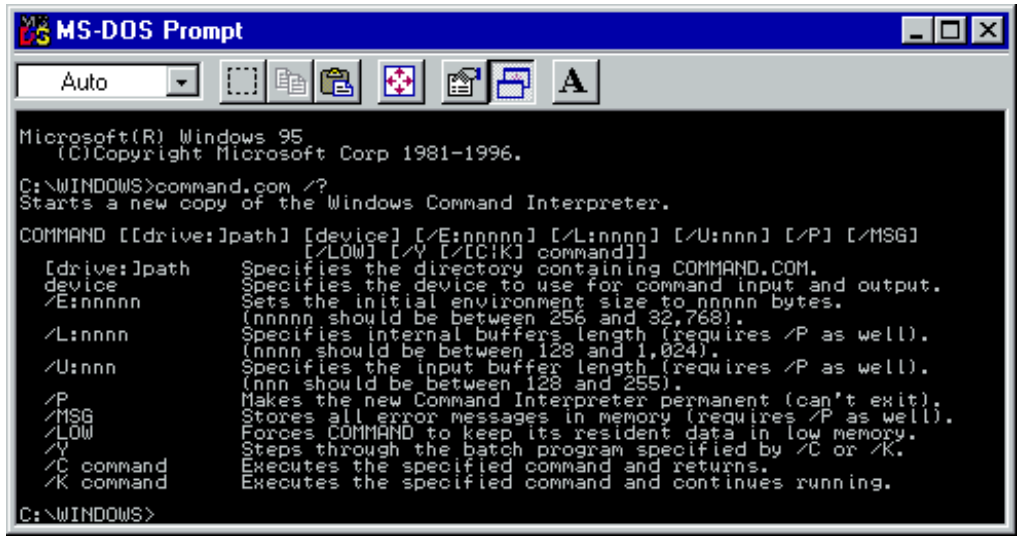


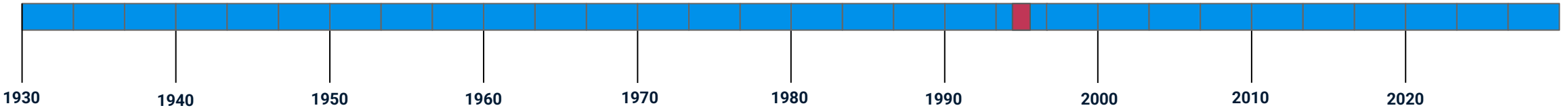
Background and historical perspectives

Fifth generation (1981 - 1995)

The Windows 95 operative system, launched in 1995, revolutionized personal computing with its user-friendly start menu and taskbar. Besides it introduced two important features: (1) plug-and-play hardware integration and (2) widespread Internet access; setting the standard for modern desktop operating systems.







Sixth generation
The modern world

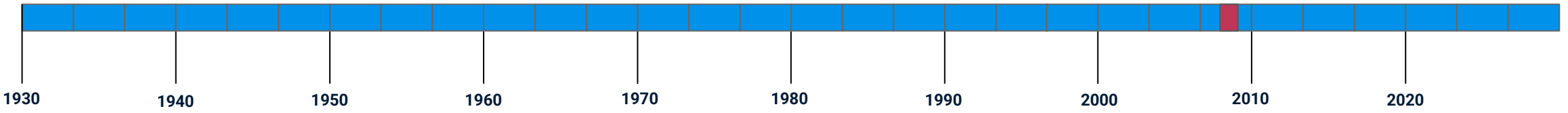
06

Background and historical perspectives

Sixth generation (1995 - Now)

The first smartphone, introduced in 2009, marked the commencement of commercial availability, integrating the capabilities of both a mobile phone and a computer.

IPhone 3

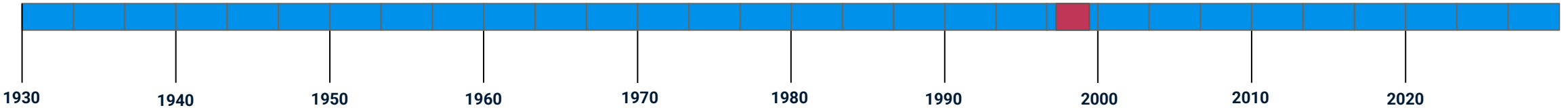


Background and historical perspectives

Sixth generation (1995 - Now)

IBM unveiled Deep Blue in 1997, a supercomputer renowned for its parallel computing process. It engaged in two highly publicized chess matches against the reigning chess champion, Garry Kasparov.

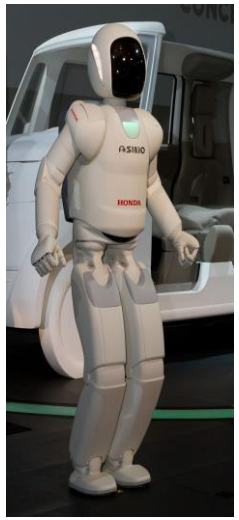
Deepblue vs Kasparov en 1997: 4-2
Deepblue vs Kasparov en 1998: 6-0



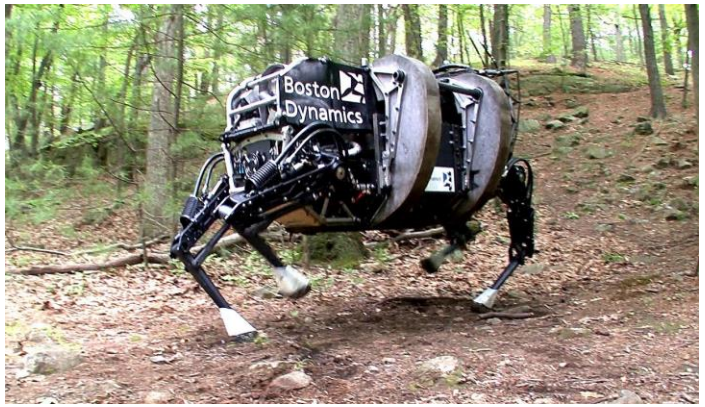
Background and historical perspectives

Sixth generation (1995 - Now)

The era of assistant robots began with the introduction of AIBO, Roomba, and ASIMO, marking a significant milestone in the development of consumer and service robotics.



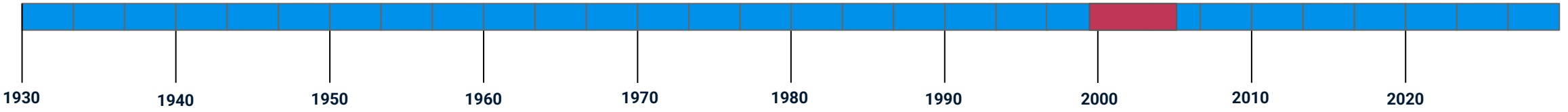
ASIMO - 2000



BigDog - 2005

First roomba 2002

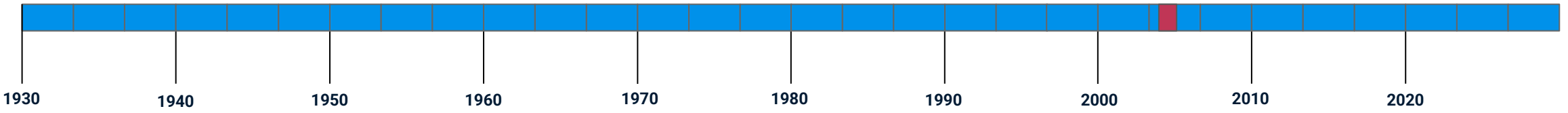
AIBO 1999



Background and historical perspectives

Sixth generation (1995 - Now)

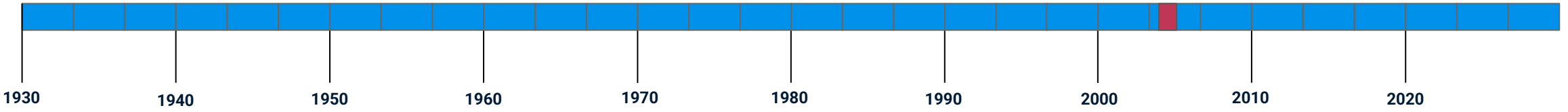
Facebook, founded in 2004, was the collaborative effort of Mark Zuckerberg, Eduardo Saverin, Andrew McCollum, Dustin Moskovitz, and Chris Hughes. The nomenclature of the platform was inspired by the 'face book' directories traditionally distributed among American university students.



Background and historical perspectives

Sixth generation (1995 - Now)

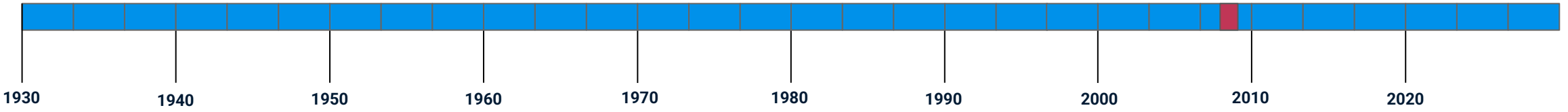
The establishment of the DARPA Challenge in 2004 marked the inception of a competition for autonomous vehicles, meticulously organized by the Defense Advanced Research Projects Agency (DARPA).

Background and historical perspectives

Sixth generation (1995 - Now)

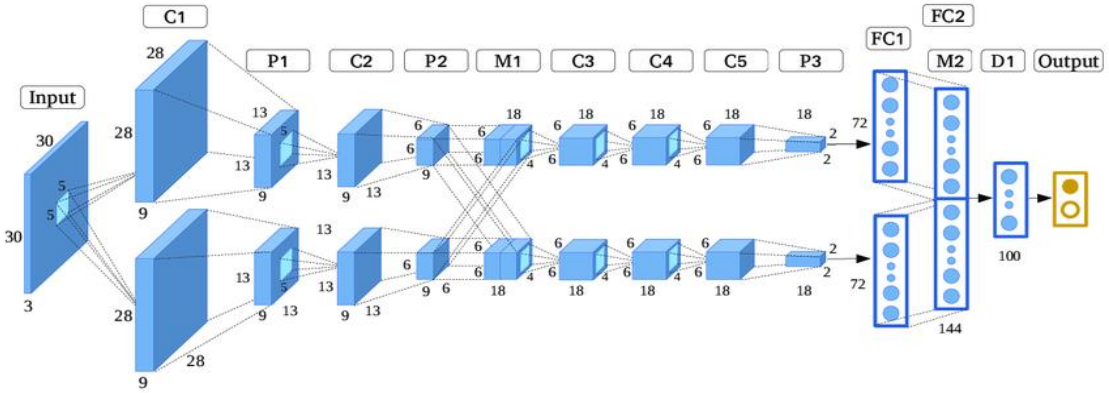
The first smartphone, introduced in 2008, marked the commencement of commercial availability, integrating the capabilities of both a mobile phone and a computer.

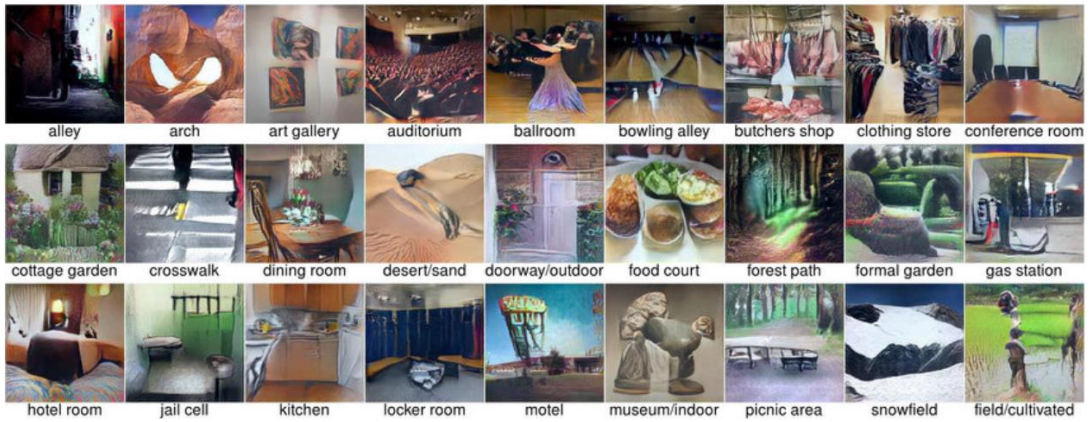


Background and historical perspectives

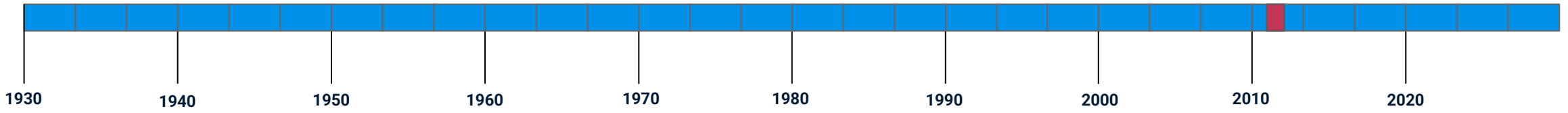
Sixth generation (1995 - Now)

The AlexNet Neural Network created by Alex Krizhevsky in collaboration with Ilya Sutskever and Geoffrey Hinton won the ImageNet Large Scale Visual Recognition Challenge in 2012 showing the powerful of Deep CNN.





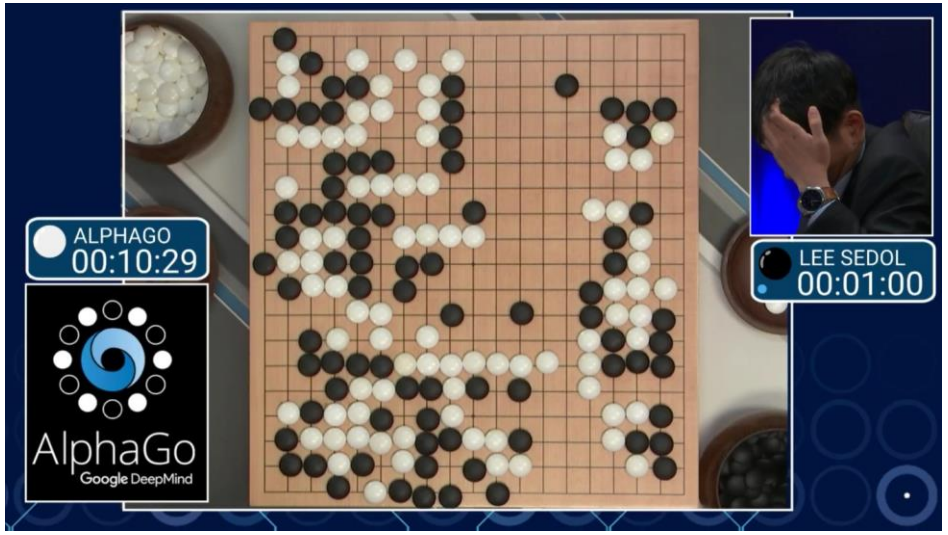
https://proceedings.neurips.cc/paper_files/paper/2012/file/c399862d3b9d6b76c8436e924a68c45b-Paper.pdf



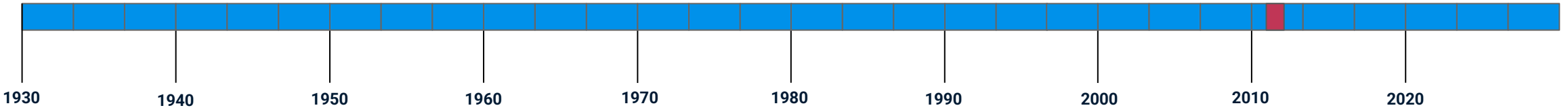
Background and historical perspectives

Sixth generation (1995 - Now)

AlphaGo, introduced in 2016, represents a Go-playing system constructed using Deep Learning techniques. It achieved the remarkable feat of defeating the world's foremost Go player.



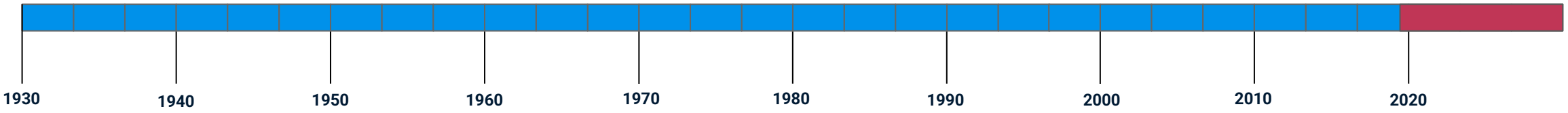
https://www.youtube.com/watch?v=WXuK6gekU1Y



Background and historical perspectives

Sixth generation (1995 - Now)

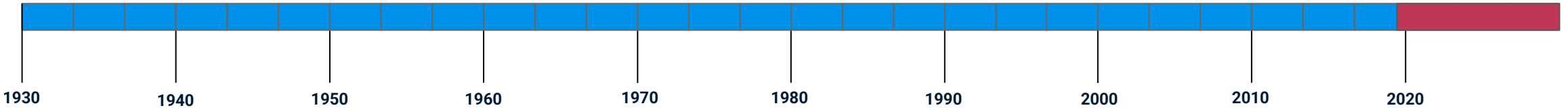
The development of applications has emerged as one of the pivotal sectors within the field of computer engineering.



Background and historical perspectives

Sixth generation (1995 - Now)

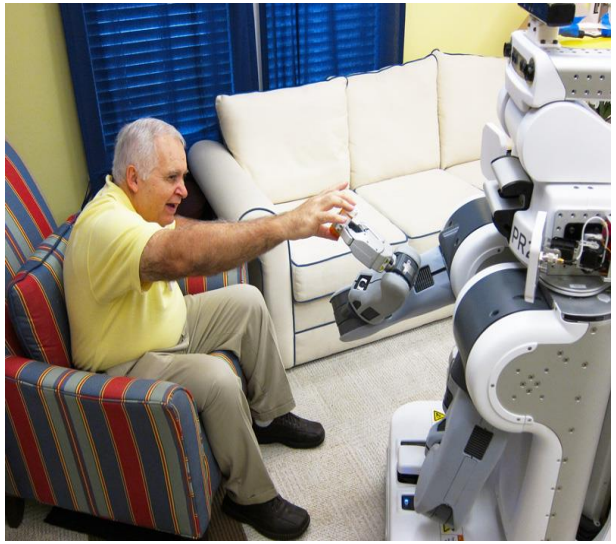
The first self-driving cars begin to make their appearance on our roadways.

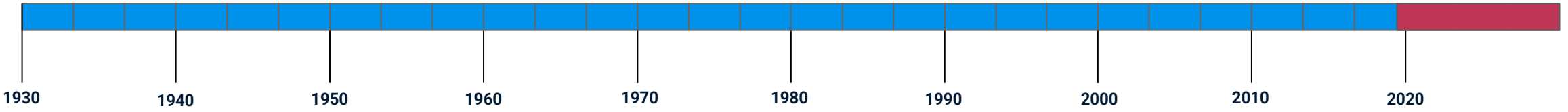


Background and historical perspectives

Sixth generation (1995 - Now)

The conceptualization and development of the inaugural robots equipped with advanced Artificial Intelligence methodologies, enabling them to interact with and engage in cognitive reasoning within their environment.



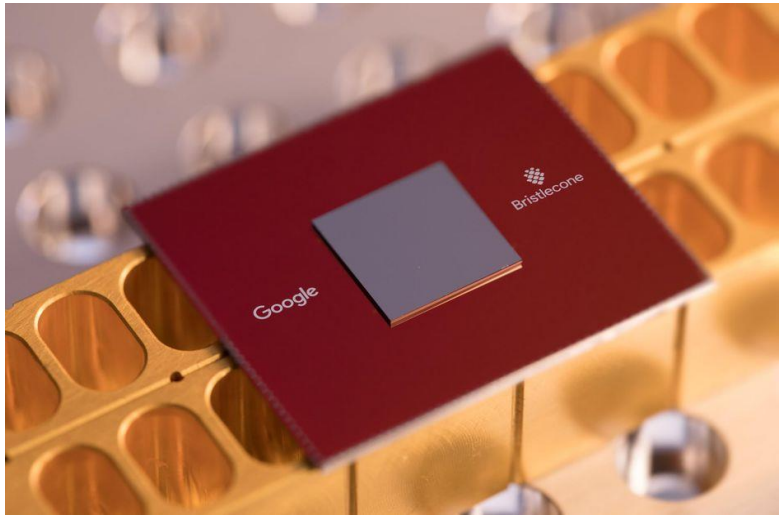


Background and historical perspectives

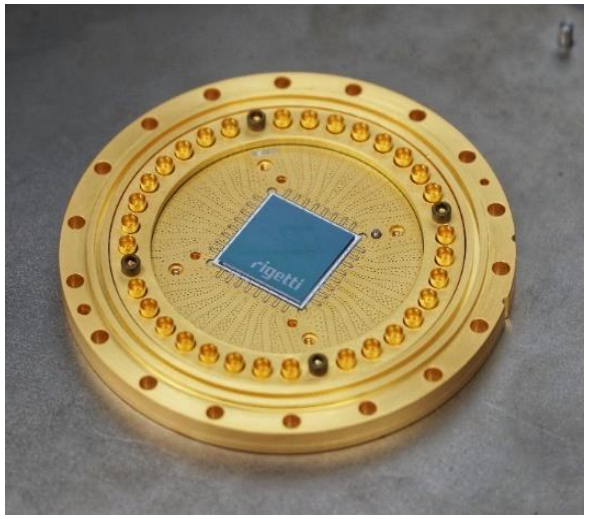
Sixth generation (1995 - Now)

The initial quantum computers, which utilize Qubits instead of conventional bits, are constructed

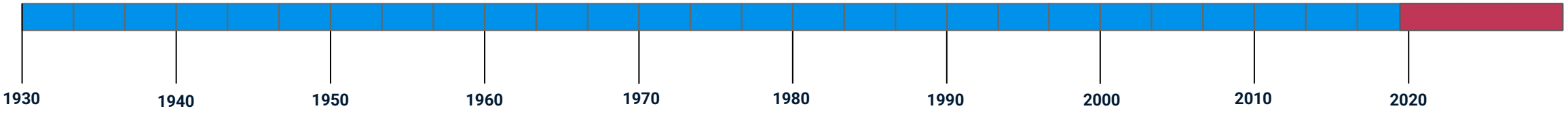
IBM – 127 Qubits



Google – 72 Qubits



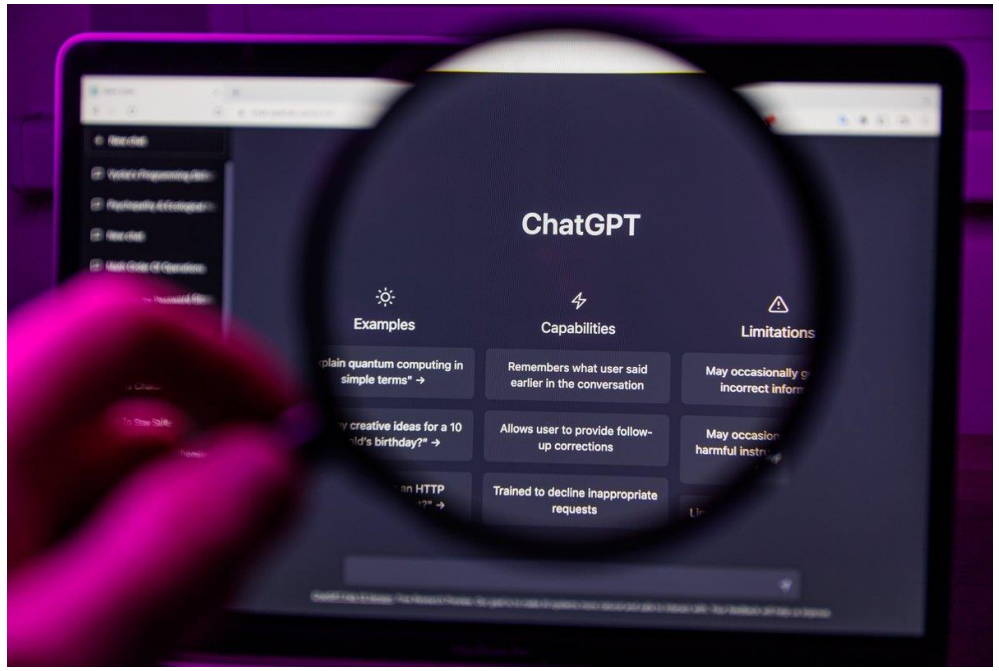
Rigetti – 20 Qubits

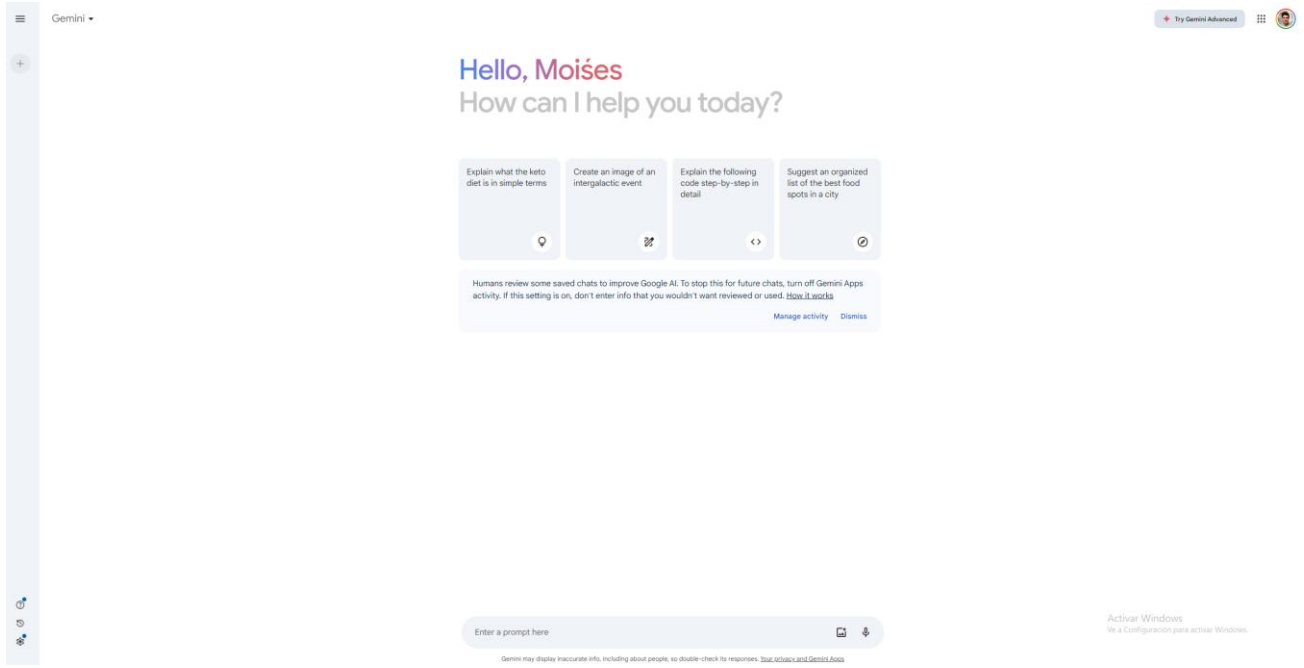


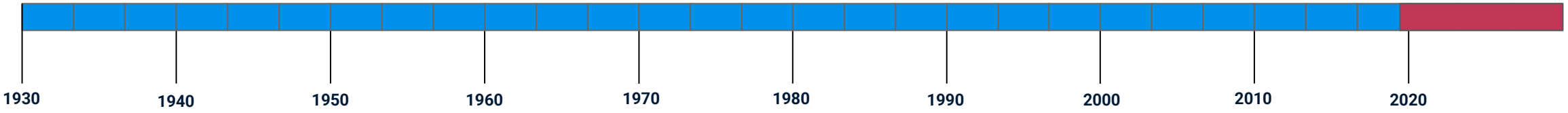
Background and historical perspectives

Sixth generation (1995 - Now)

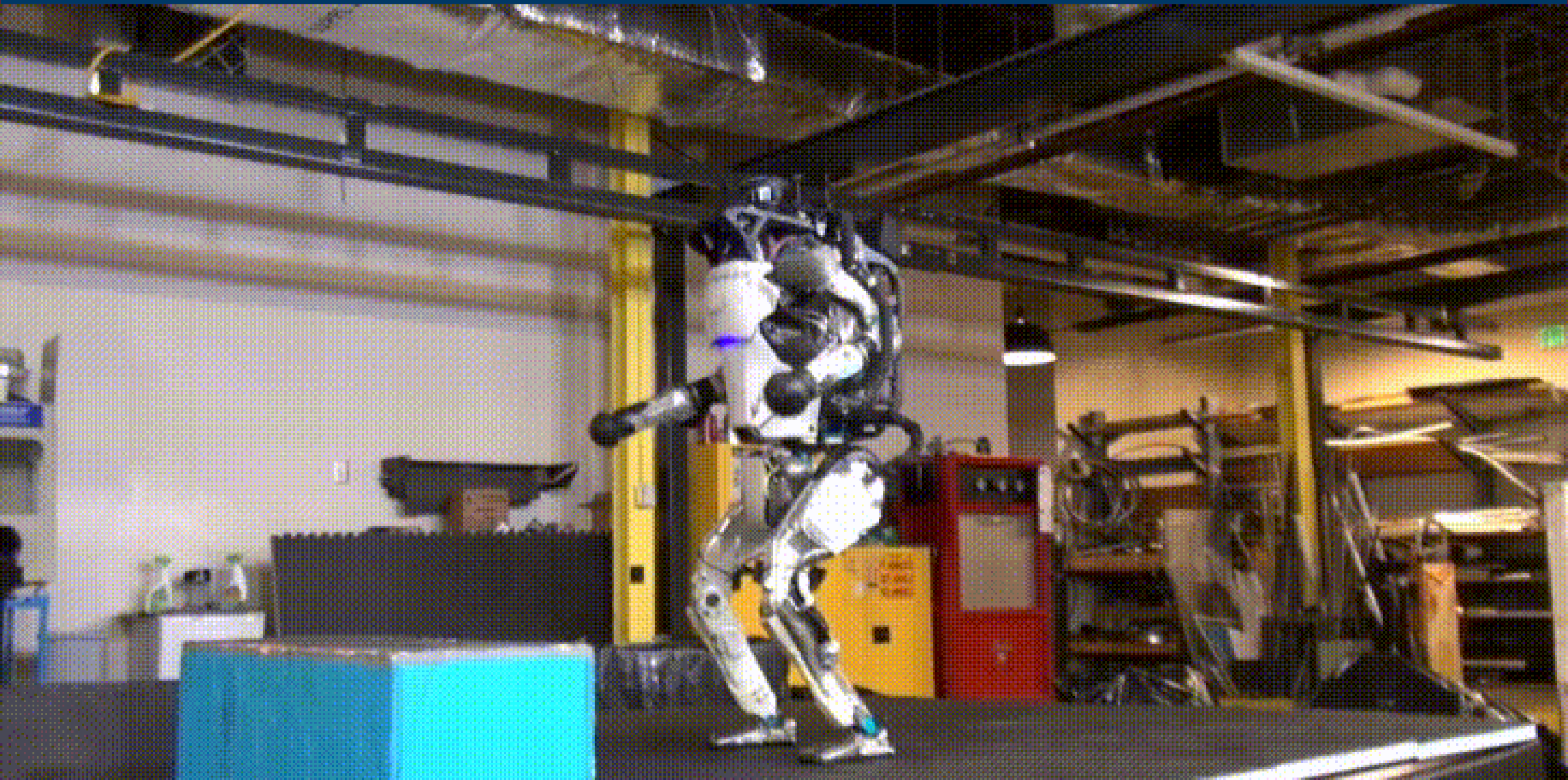
If want to know more ask to Gemini and/or ChatGpt ……







Background and historical perspectives

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