

# **Fundamentals of Computer Engineering**

## **Module I - Unit 1 Background and historical perspectives.**

**Teachers: Moisés Martínez (1ºA English)**

**Year: 2022 - 2023**



Background and historical perspectives.

**Do you know any  
programming language?**

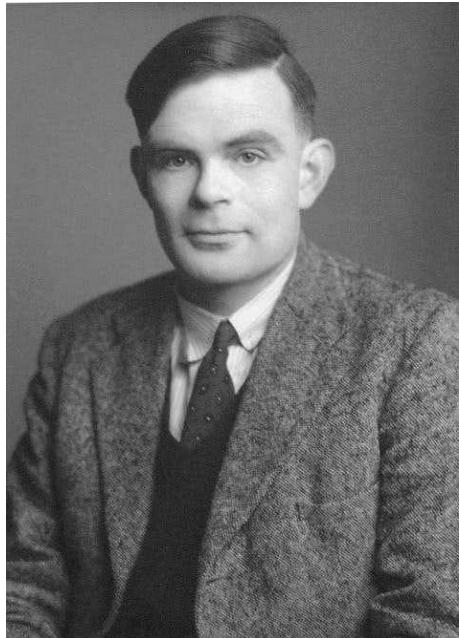
Background and historical perspectives.

# **What is Computer Engineering?**

# The evolution of the Computer Science

# Background and historical perspectives.

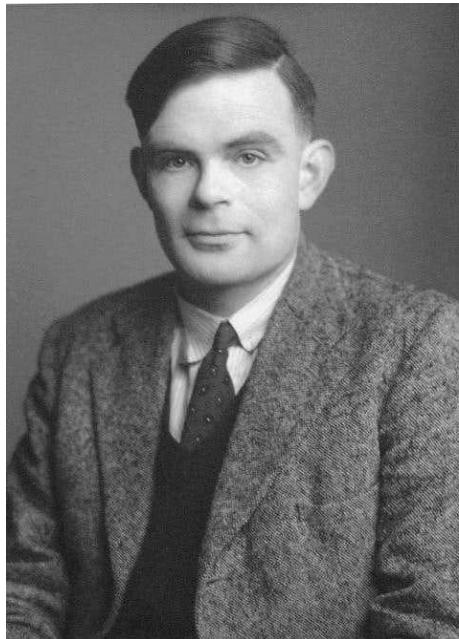
## The Beginning of Everything (Before 1940)



**Who is this guy?**

# Background and historical perspectives.

## The Beginning of Everything (Before 1940)



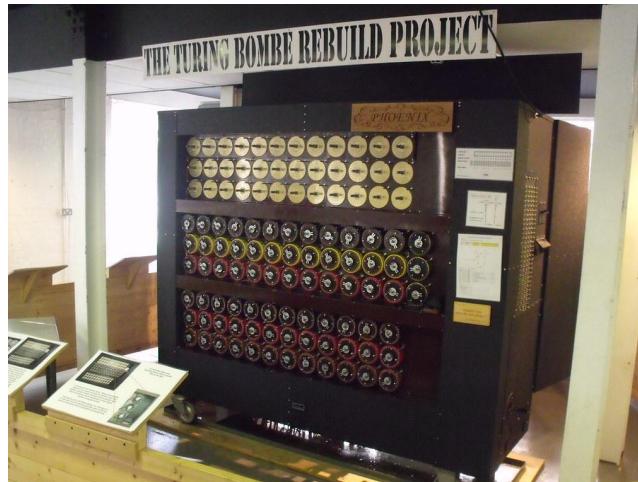
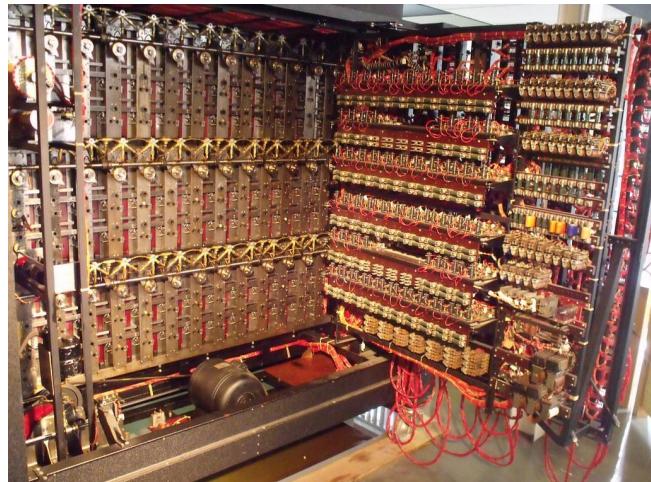
Alan Turing (1912-1954) was a British mathematician who is considered one of the fathers of modern computing and Artificial Intelligence.

- He created the bomb, known as the phoenix (Phoenix) that allowed to decipher the codes of the enigma machine.
- He defined the Turing Test (1950), which is a test or test that allows evaluating the level of intelligence of a machine based on its answers, checking if these are indistinguishable from those of a human being.
- He defined the concept of Turing Machine, which is an automaton that can recognize any formal language.

# Background and historical perspectives.

## The Beginning of Everything (Before 1940)

The Bomba (1940), known as the Phoenix, was a special-purpose mechanical computer that looked up the configuration of the enigma machine's rotors, implementing a chain of logical deductions for each possible combination.



Reproduction of the bomb in Bletchley Park (England).

Enigma Machine

# First generation

## Programing using punched cards

# Background and historical perspectives.

## First generation (1940 - 1958)

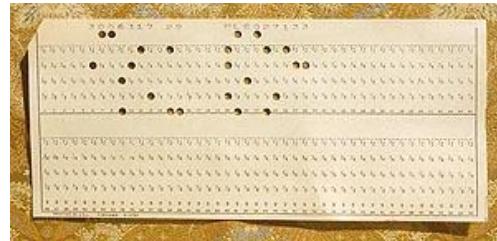
The thermionic valve, vacuum valve, vacuum tube or bulb, is an electronic component used to amplify, switch, or modify an electrical signal by controlling the movement of electrons in an empty space at very low pressure, or in the presence of certain gases.



vacuum valve



Mercury tube



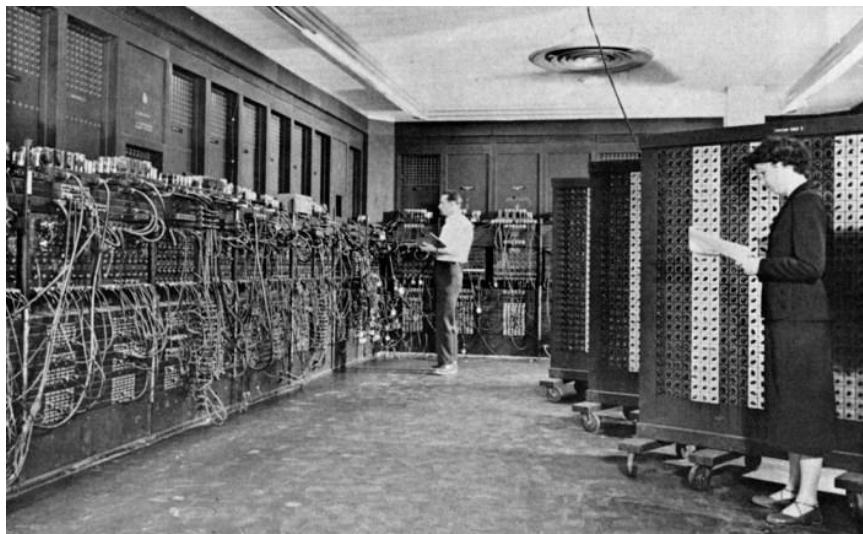
Punched Card

- Memory was built using liquid mercury tubes and magnetic drums.
- The internal storage was made up of a rapidly rotating drum, on which a read/write device placed magnetic marks.
- Programs were loaded via punch cards

# Background and historical perspectives.

## First generation (1940 - 1958)

ENIAC (Electronic Numerical Integrator And Computer) is considered one of the first general-purpose electromechanical computers, that is, depending on the programming applied to it, it could perform one task or another.



It was built to calculate the artillery firing tables of the United States Army and occupied 167 square meters and weighed about 27 tons.

- 5.000 adds.
  - 300 multiplications.
- } Per second

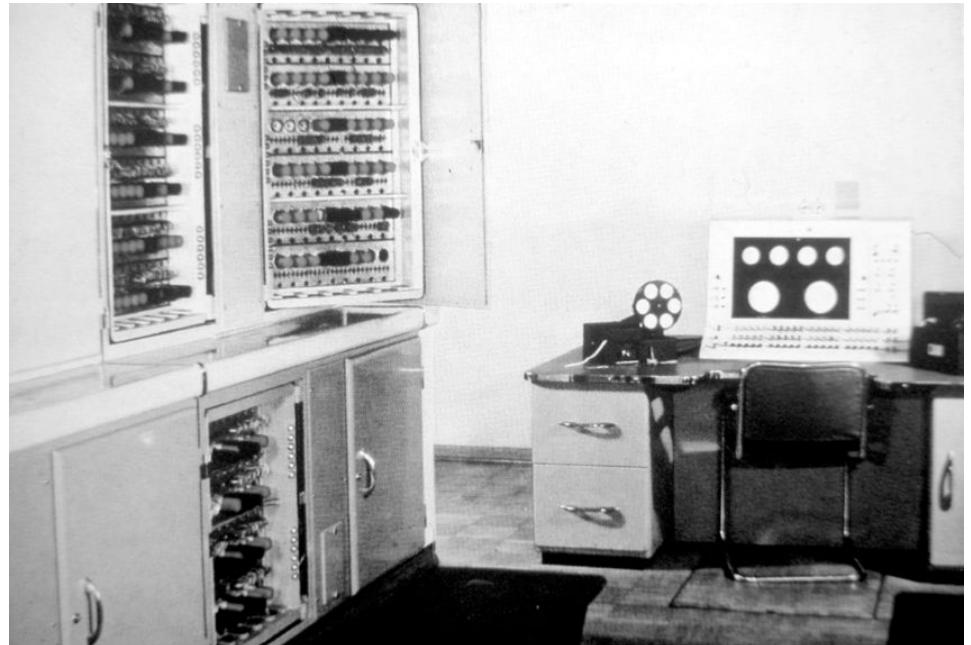
Programs were programmed through the use of punched cards.

# Background and historical perspectives.

## First generation (1940 - 1958)



UNIVAC (UNIVersal Automatic Computer)

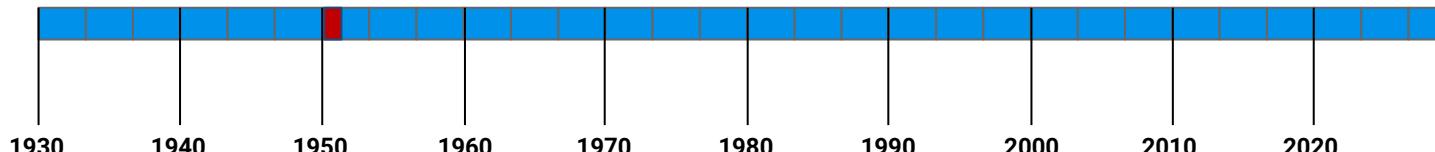
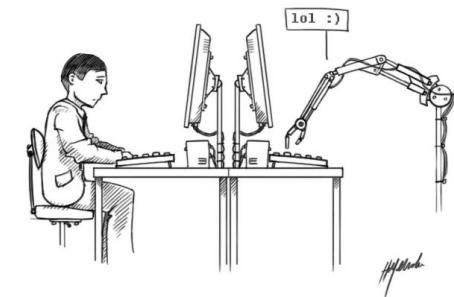


Ferranti Mark I

# Background and historical perspectives.

## First generation (1940 - 1958)

Alan Turing published the book "Computing Machinery and Intelligence" (1950). This book describes the famous Turing Test.

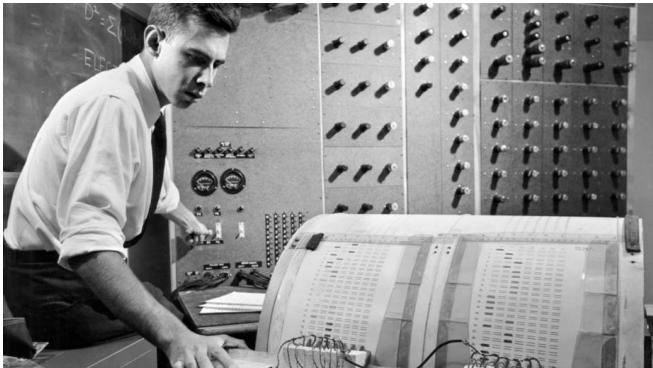




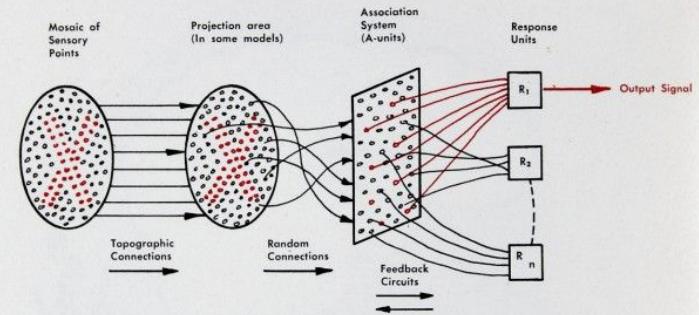
# Background and historical perspectives.

## First generation (1940 - 1958)

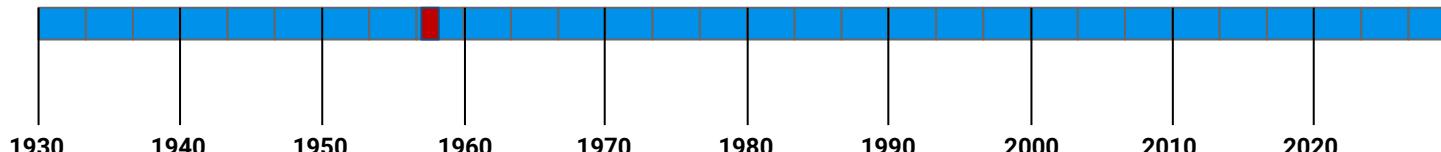
1957 - Frank Rosenblatt develops the perceptron which is considered to be the first network of artificial neurons.



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



**FIG. 2 — Organization of a perceptron.**



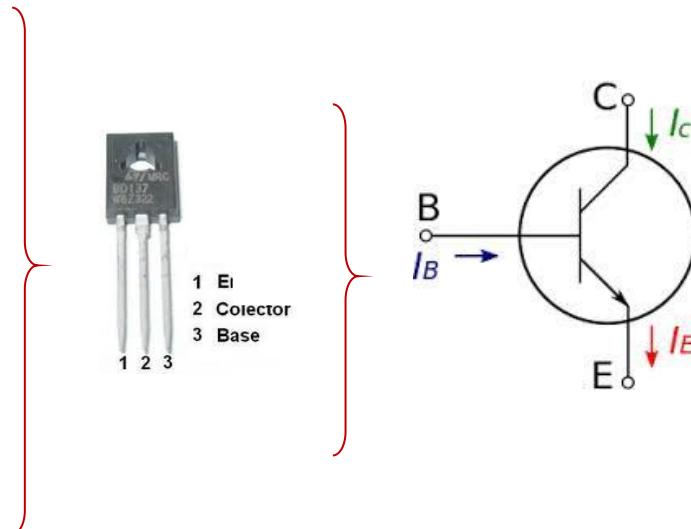
# Second generation

The arrival of transistors.

# Background and historical perspectives.

## Second generation (1959 - 1964)

Transistor is a semiconductor electronic device used to produce an output signal in response to an input signal which can be amplified, oscillated, switched or rectified.

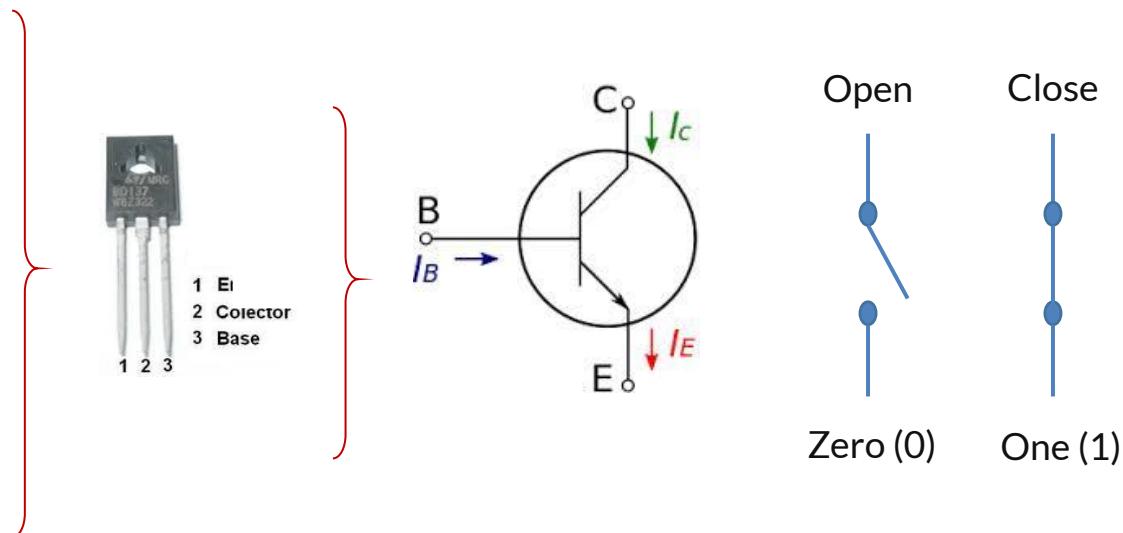


Replica first transistor

# Background and historical perspectives.

## Second generation (1959 - 1964)

Transistor is a semiconductor electronic device used to produce an output signal in response to an input signal which can be amplified, oscillated, switched or rectified.



Replica first transistor

It can function as a switch (Digital Electronics) since it allows the passage of current between the collector and the emitter to be activated or deactivated by using a low-intensity current through the base ( $I_B$ ) that activates the flow of current between the collector ( $I_C$ ) and emitter ( $I_E$ ).

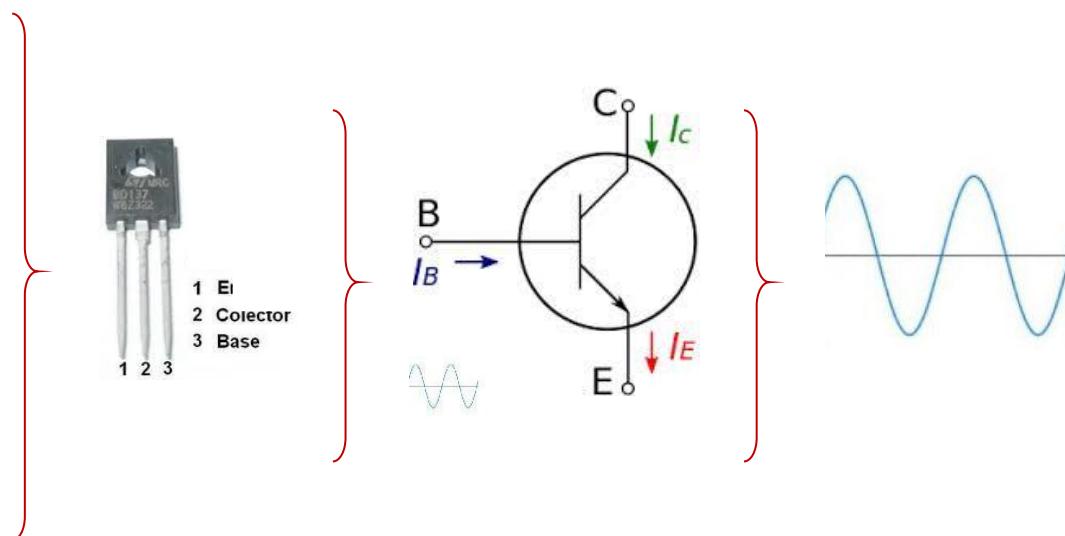
# Background and historical perspectives.

## Second generation (1959 - 1964)

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Replica first transistor



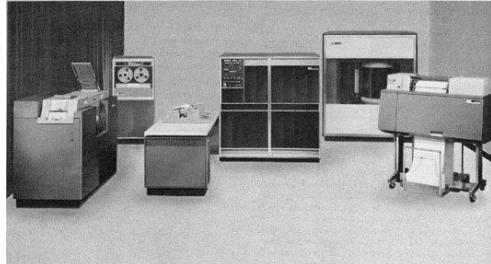
It can function as a switch (Digital Electronics) since it allows the passage of current between the collector and the emitter to be activated or deactivated by using a low-intensity current through the base ( $I_B$ ) that activates the flow of current between the collector ( $I_C$ ) and emitter ( $I_E$ ).

# Background and historical perspectives.

## Second generation (1959 - 1964)



PDP 1



IBM 1401



IBM 1621



IBM 360

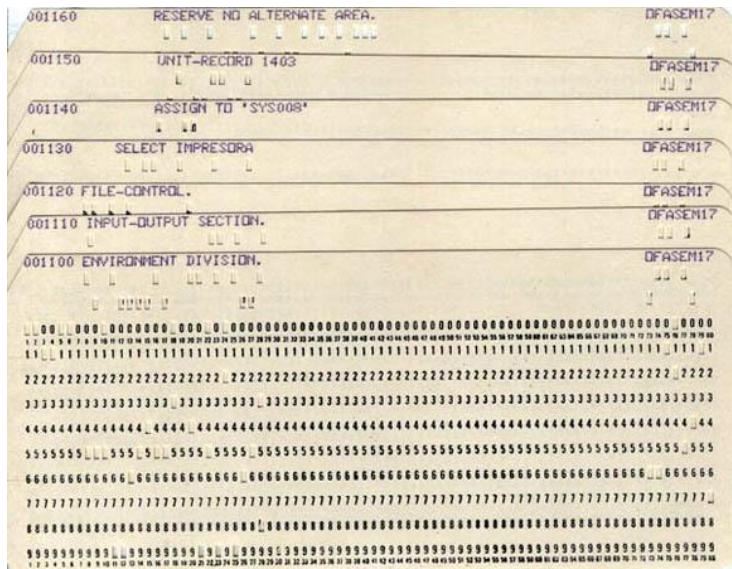
Central computers (Mainframe or iron) are centralized electronic devices used by large organizations for critical applications such as "Big Data" processing, enterprise resource planning and "large-scale" transactions.

- Time-sharing systems through centralized resources.
- Simple terminals for user access.
- Unfriendly user interfaces.
- They could be programmed using high-level programming languages independently of the hardware.

# Background and historical perspectives.

## Second generation (1959 - 1964)

COBOL (COmmon business-Oriented Language, 1959) is considered the first universal general-purpose high-level programming language of imperative type, since it was created to be executed on any computer by using a compiler.



COMMAND → SCROLL → CSR

```
000974 PROC-REG-ENTRADA.
000975 MOVE CLI-TIPCTA-ENT TO CLI-TIPCTA-SAL.
000976 MOVE NUMCIA-ENT IO NUMCIA-SAL.
000977 MOVE NOMREP-ENT IO NOMREP-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-MOUS-ENT GREATER SALDOMAX-ENT
000985 MOVE B TO IND-VALOR-1
000986 ELSE
000987 COMPUTE IND-VALOR-1 ROUNDED = 1 -
<NUM-MOUS-ENT / SALDOMAX-ENT>.
000988 *
000989 MOVE FEC-VALOR-ENT TO FEC-VALOR-SAL.
000990 MOVE FEC-OPER-ENT TO FEC-OPER-SAL.
000991 IF FEC-OPER-ENT =
000992 MOVE ZERO TO NUM-DIAS-DIF
000993 ELSE
000994 CALL 'DIFERDIA' USING FEC-VALOR-ENT.
000995
```



The mathematician Grace Hopper was one of the biggest promoters of COBOL in the private and military sectors in the US.



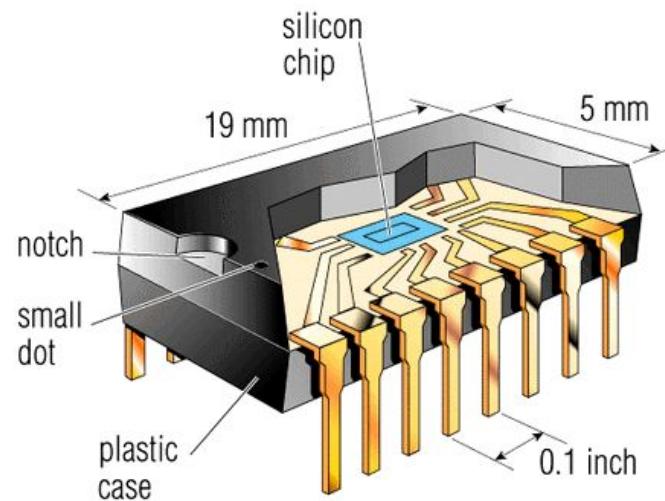
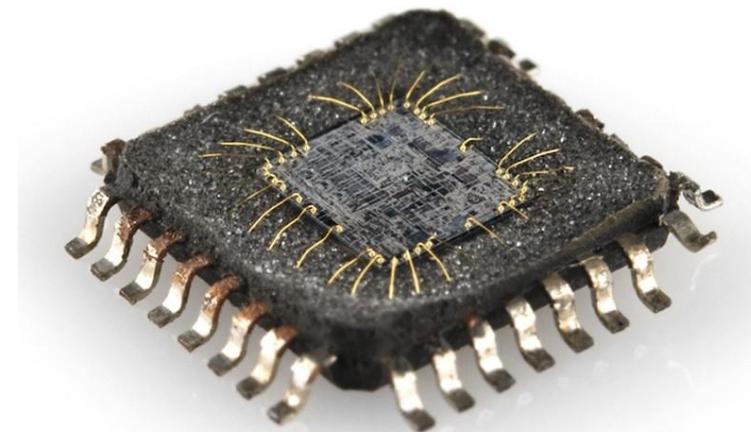
# Third generation

Combining transistors  
to create integrated circuits

# Background and historical perspectives.

## Third generation (1964 - 1971)

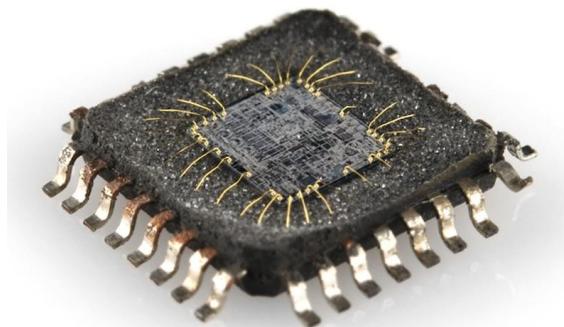
Integrated Circuit (1959) is an electronic device, commonly called a chip or microchip, used to perform a specific function, such as amplifying a signal. Integrated circuits are built using semiconductor materials such as Silicon, which have shown properties similar to those observed in vacuum tubes.



# Background and historical perspectives.

## Third generation (1964 - 1971)

Integrated Circuit (1959) is an electronic device, commonly called a chip or microchip, used to perform a specific function, such as amplifying a signal. Integrated circuits are built using semiconductor materials such as Silicon, which have shown properties similar to those observed in vacuum tubes.



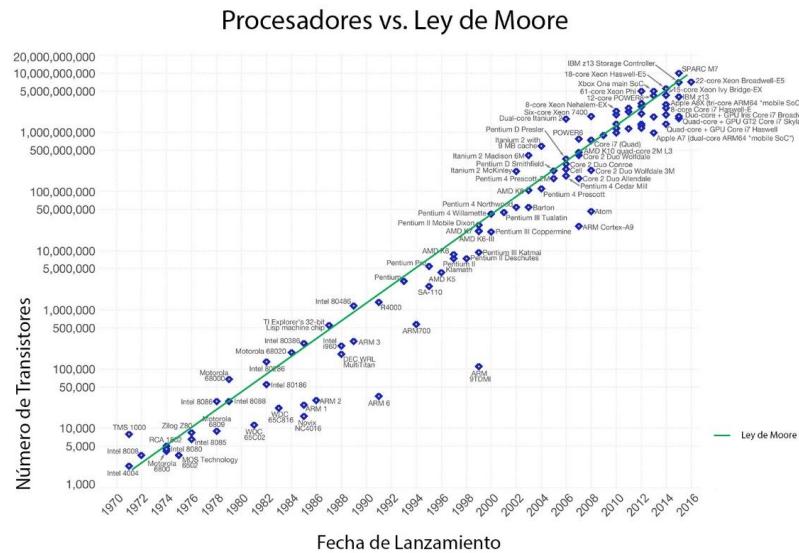
Analog integrated circuits: They are built by means of transistors encapsulated together that function as amplifiers or oscillators of the signal.

Digital integrated circuits: They are built by transistors encapsulated together that work as basic logic gates (And, Not, Or, Xor) to work with binary values.

# Background and historical perspectives.

## Third generation (1964 - 1971)

Moore's Law (1971) is an empirical law that indicates that approximately every two years the number of transistors on a chip will double. Initially, this law was enunciated establishing that the duplication would take place annually.



# Background and historical perspectives.

## Third generation (1964 - 1971)

Emergence of imperative-type teaching-oriented languages such as BASIC (Beginner's All-purpose Symbolic Instruction Code, 1964) and Pascal (1971), which were created as training-type languages to teach future programmers.

The screenshot shows a BASIC editor interface. The code is as follows:

```
Text following the apostrophe sign ('') represents a comment and is not compiled into an executable code.

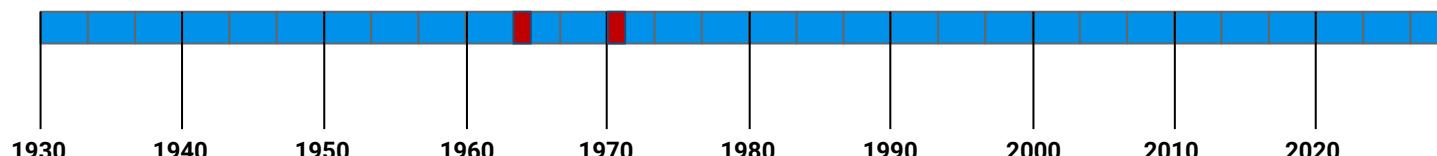
Header
Symbol outputs
Symbol outputs
Symbol outputs
Constant TURNOFF = const TURNOFF as byte =>00
const TURNON as byte =>FF
Variable k = dim k as byte
Statement
TURNOFF=00
k=0
Label Main
Main:
    for k=1 to 10
        output TURNOFF
        delay_ms(1000)
        output=TURNON
        delay_ms(1000)
    next k
    goto Main
Subroutine
Blink:
    output=TURNON
    delay_ms(1000)
    output=00
    delay_ms(1000)
    output=TURNOFF
    delay_ms(1000)
    output=00
    delay_ms(1000)
    return
end.
Comments
```

Source code example in BASIC

The screenshot shows a Pascal editor interface. The code is as follows:

```
File Edit Run Compile Options Debug Break/watch
Line 15 Col 39 Insert Indent Unindent * D:NONAME.PAS
program KenLovestenTurboPascal;
uses
  crt;
var
  age: Integer;
  name: String;
  message: String;
begin
  ClrScr;
  name := 'Ken Egozi';
  age := 30;
  if age < 10 then
    message := ' loves Turbo Pascal'
  else
    message := ' loved Turbo Pascal';
  write (name);
  writeln (message);
end.
```

Source code example in Pascal



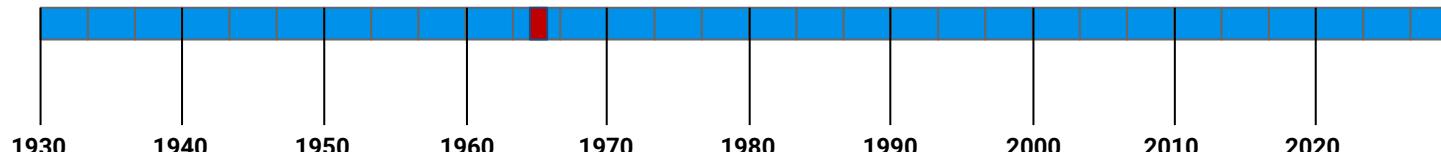
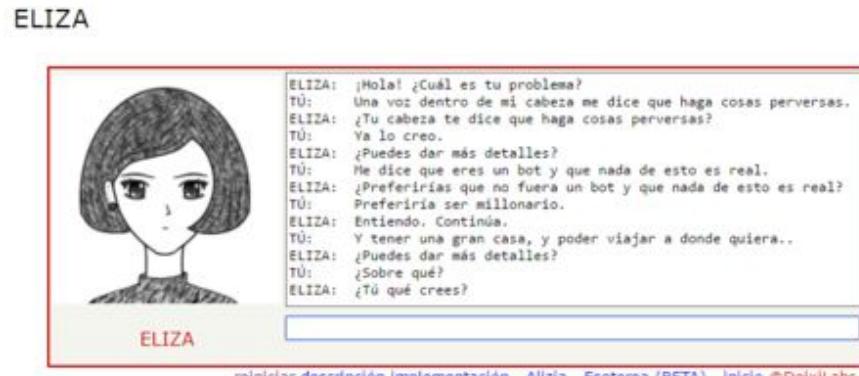
# Background and historical perspectives.

## Third generation (1964 - 1971)

Creation of ELIZA (1965) which is considered the first conversational bot. ELIZA worked by looking for keywords in the input phrase and responded with a model phrase registered in its database.

```
=====
EEEEEEEEE L IIIIIIII ZZZZZZZZ AAA
E L I Z A A A
E L I Z A A A
EEEEEEEEE L IIIIIIII ZZZZZZZZ AAA
E L I Z A A A
EEEEEEEEE LLLL LLLL IIIIIIII ZZZZZZZZ AAA
=====

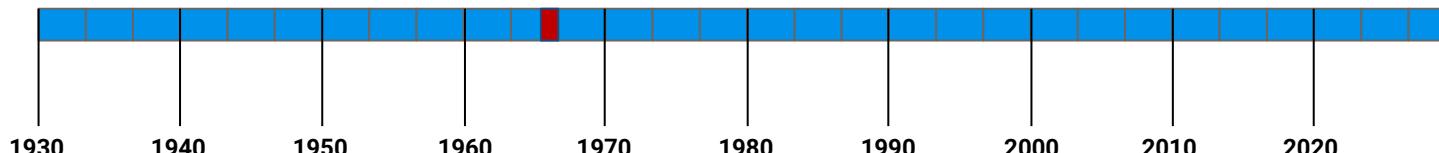
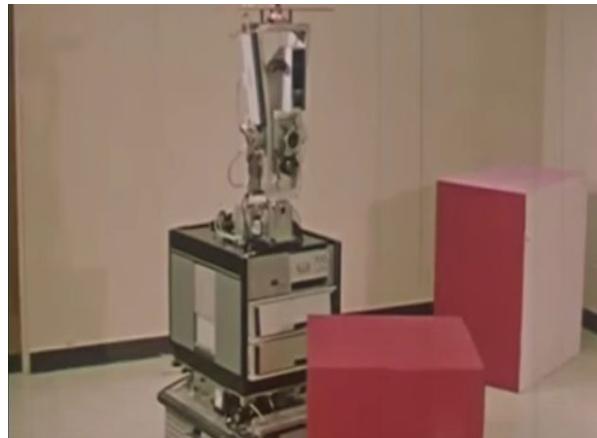
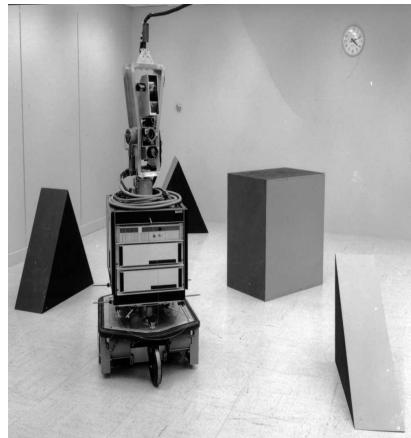
ELIZA > (PLEASE TYPE IN ALL CAPS) WHAT'S YOUR NAME DEAR ?
AMIT
ELIZA > HI, I'M ELIZA. WHAT DO YOU WANT TO TALK ABOUT ?
AMIT
ELIZA > CAN I TALK ABOUT MY PROBLEM ?
ELIZA > SURE... !
AMIT > DUE TO ON GOING EXAMS IN COLLEGE, I HAVE A LOT OF STRESS.
ELIZA > PLEASE RELAX A LITTLE. SLEEP WELL.
AMIT > THANKS FOR YOUR ADVICE.
ELIZA > NO MENTION.
AMIT > BYE
ELIZA > BYE AND KEEP IN TOUCH...
=====
```



# Background and historical perspectives.

## Third generation (1964 - 1971)

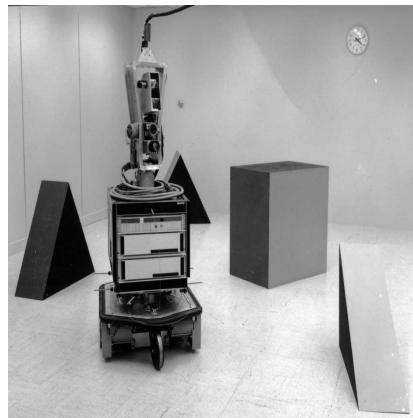
Shakey (1966) is created, the first robot capable of reasoning about its actions using the GPS system (General Problem Solver) through the use of Automatic Planning.



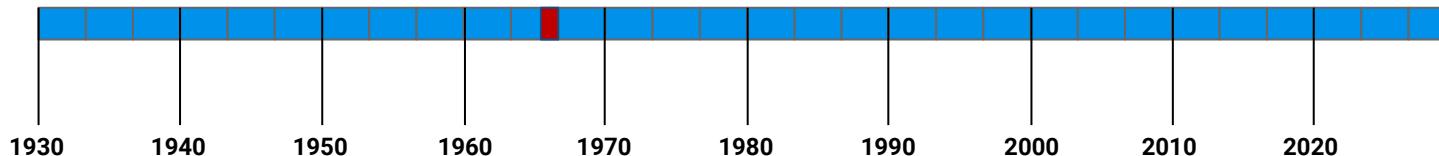
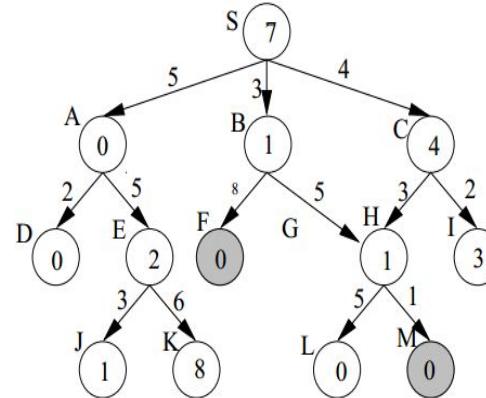
# Background and historical perspectives.

## Third generation (1964 - 1971)

The A\* algorithm (1968) is created, which gives rise to the informed heuristic search for the resolution of search, optimization and reasoning problems.



7	6	5	6	7	8	9	10	11		19	20	21	22
6	5	4	5	6	7	8	9	10		18	19	20	21
5	4	3	4	5	6	7	8	9		17	18		20
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
5	4	3	4	5	6	7	8	9	10	11	12	13	14
6	5	4	5	6	7	8	9	10	11	12	13	14	15



# Four generation

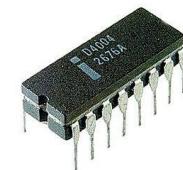
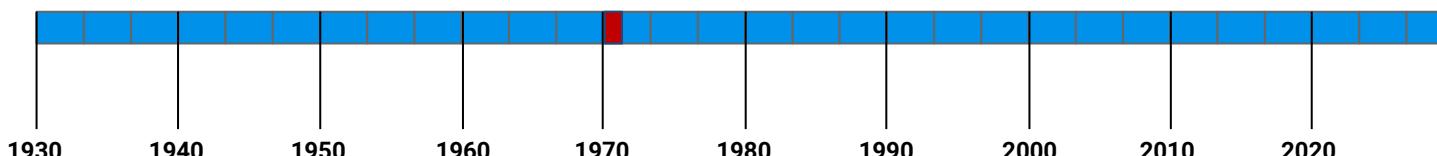
## Microprocessors and computer networks

# Background and historical perspectives.

## Four generation (1971 - 1981)

Microprocessor (1971), is an integrated circuit capable of executing instructions in binary language, performing simple arithmetic and logical operations, such as adding, subtracting, multiplying, dividing, binary logic (and, or, etc) and memory accesses. It is made up of at least two basic elements:

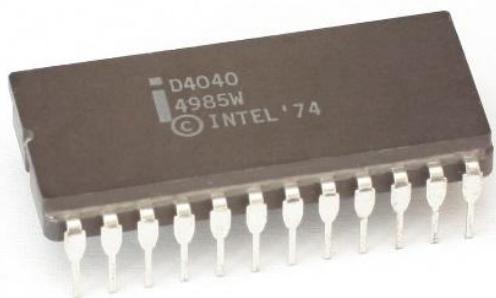
- Arithmetic Logic Uni (ALU): Digital circuit that allows executing arithmetic operations and logical operations between values stored in the registers of the register band.
- Register Bank: is a set of high-speed, small-capacity memory registers for storage of operands and results.



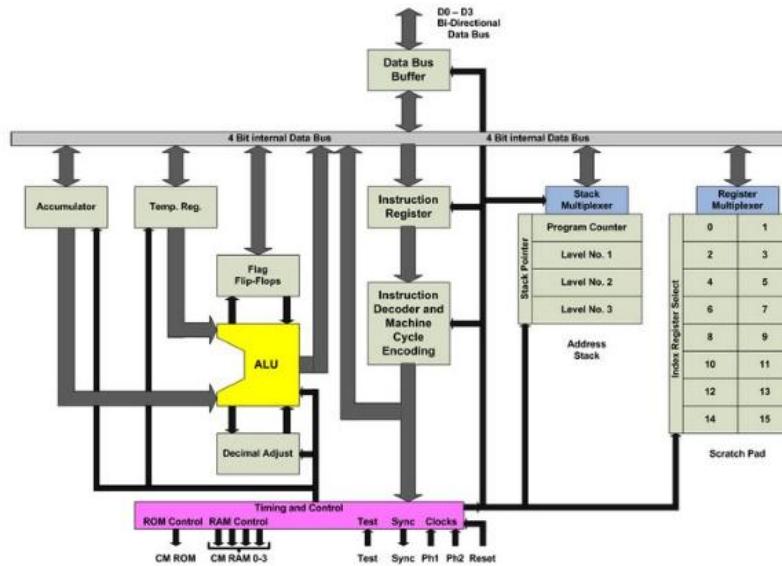
# Background and historical perspectives.

## Four generation (1971 - 1981)

The first microprocessor, the Intel 4040, was created in 1971 by Intel for a calculator with a 4-bit CPU (Central Process Unit) that had an ALU, a register bank and a 4-bit Bus on the same chip.



Intel 4040

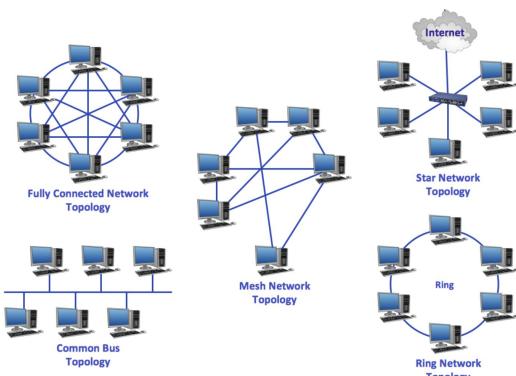


# Background and historical perspectives.

## Four generation (1971 - 1981)



High-speed computer networks: A high-speed network can be defined as a platform for data exchange and resource sharing between different systems. These allow thousands of machines within a building or campus or city to be connected in such a way that small amounts of information can be transferred between them in a few microseconds.



- LAN (Local Area Network): It is a wired local area network for a small set of systems.
- MAN (Metropolitan Area Network): It is a “metropolitan” type network that allows LAN or WLAN type networks to connect to each other at high speed. It is usually deployed to connect areas of the same city or small cities.
- WAN (Wide Area Network): It is a wide area network that connects LAN, WLAN and MAN networks to each other. These types of networks are normally deployed by Internet providers (ISP, Internet Service Provider).
- WLAN (Wireless Local Area Network): It is a wireless local area network for a small set of systems to access through a wireless access point.

# Background and historical perspectives.

## Four generation (1971 - 1981)

UNIX (1971) is a family of multitasking, multiuser computer operating systems. Unix systems are characterized by a modular design that is sometimes called the "Unix philosophy":

- A unified and inode-based filesystem (the Unix filesystem)
- An inter-process communication mechanism known as "pipes" serve as the main means of communication.
- shell scripting and command language (the Unix shell) is used to combine the tools to perform complex workflows.

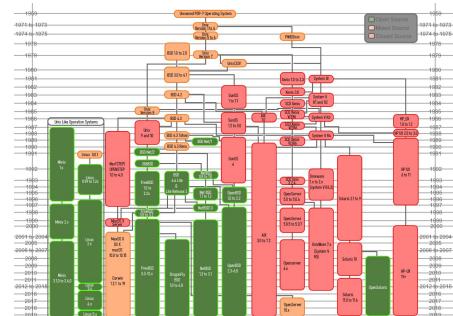
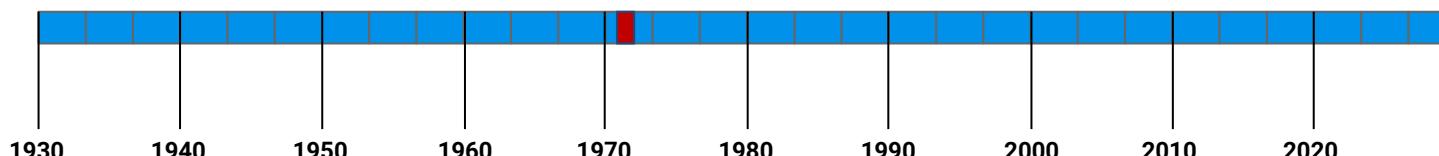


Dennis Ritchie (C) and Ken Thompson (UNIX).

```
$ simh-pdp11 boot.ini
PDP-11 simulator V3.10-0
Disabling XQ
#0 unix

UNIX/3.0.1: unixhptm
real mem = 262144 bytes
avail mem = 195776 bytes
unix
single-user
# init 2
# process accounting started
errdemom started
cron started
multi-user
type ctrl-d

Login: root
UNIX Release 3.0
# uname -a
unix unix 3.0.1 hptm
#
```



# Background and historical perspectives.

## Four generation (1971 - 1981)

C (1972) is a structured, imperative-type general-purpose language based on the B and BCPL programming languages. It is considered a low-level language since it does not implement memory management since it can be combined with assembly code in order to optimize access to memory and other devices, although it allows the use of elements and data structures of high-level languages. level.

```
#include <stdio.h>

/* print Fahrenheit-Celsius table
   for fahr = 0, 20, ..., 300; floating-point version */
main()
{
    float fahr, celsius;
    int lower, upper, step;

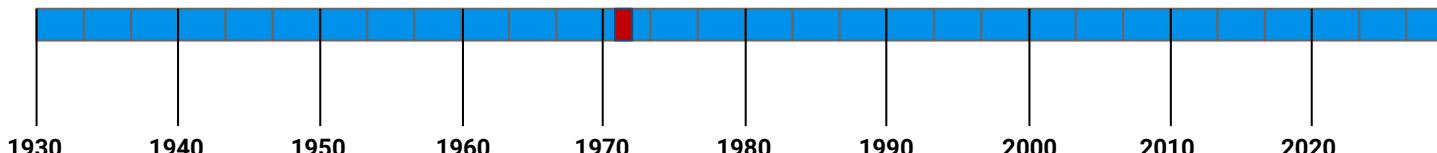
    lower = 0;      /* lower limit of temperature table */
    upper = 300;    /* upper limit */
    step = 20;      /* step size */

    fahr = lower;
    while (fahr <= upper) {
        celsius = (5.0/9.0) * (fahr-32.0);
        printf("%3.0f %6.1f\n", fahr, celsius);
        fahr = fahr + step;
    }
}
```

It is one of the most used programming languages for the construction of Operating Systems, drivers, compilers, etc.



Dennis Ritchie (C)  
Ken Thompson (UNIX).



# Background and historical perspectives.

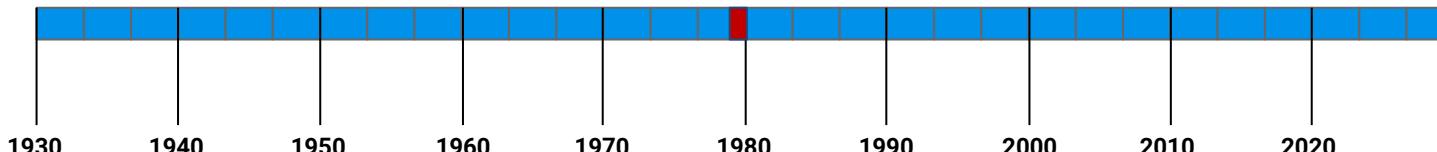
## Four generation (1971 - 1981)

C++ (1979) is an object-oriented, imperative-type general-purpose language based on C. This language was created to extend the C programming language by allowing it to be goal-oriented, making 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;
                }
            }
        };
    }
```

Its name derives from its own syntax, since C++ means increment of C, indicating that C++ is an extension of C.



# Fifth generation

## The rise of Internet

# Background and historical perspectives.

## Fifth generation (1981 - 1995)

A personal computer (Personal Computer, PC) is a programmable digital machine that executes a series of commands to process input data, generating information that is later sent to output units.

- The use of individual workstations (PCs) is becoming popular.
- More complex and friendly local execution applications appear at the personal and business level.
- Local Area Networks (LANs)



Apple II

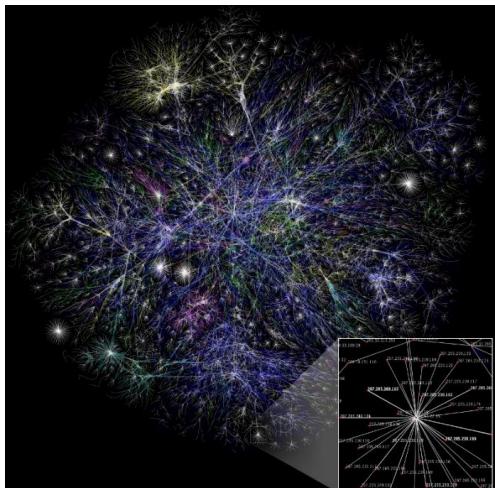


IBM Personal  
Computer

# Background and historical perspectives.

## Fifth generation (1981 - 1995)

The Internet is a decentralized set of interconnected networks that use the TCP/IP family of protocols, which guarantees that the heterogeneous physical networks that comprise it constitute a single logical network with a global reach. Its origin was marked in 1969, when the first connection of computers from different locations, known as ARPANET, was established between three universities in California.

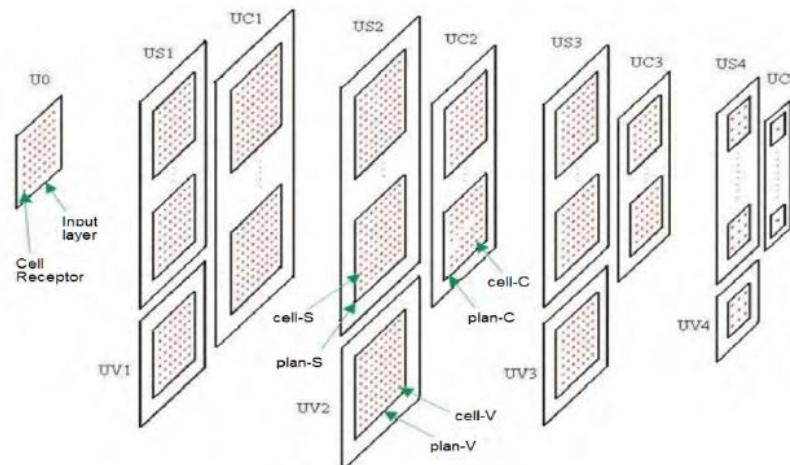


- Massive increase in Client/Server type applications.
- Wide spread of applications and services due to the appearance of the first web pages.
- New types of services based on distributed programming appear:
  - e-commerce
  - Email
  - Multimedia
  - Medical applications
  - Supercomputing on the Internet

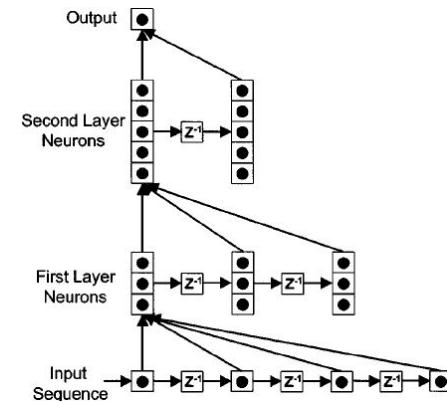
# Background and historical perspectives.

## Fifth generation (1981 - 1995)

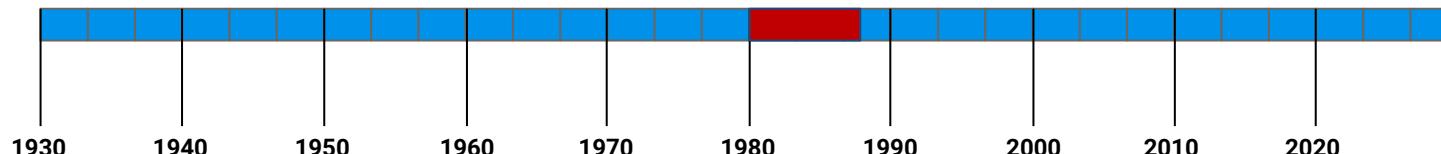
First Neural Network for Image Classification.



Neocognitron



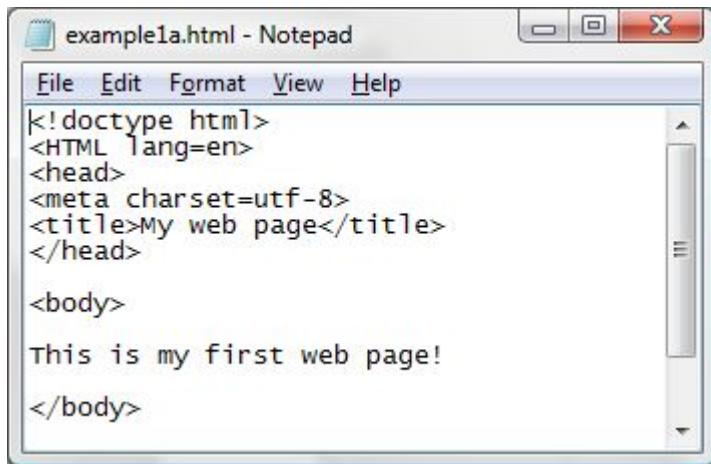
Time delay neural network



# Background and historical perspectives.

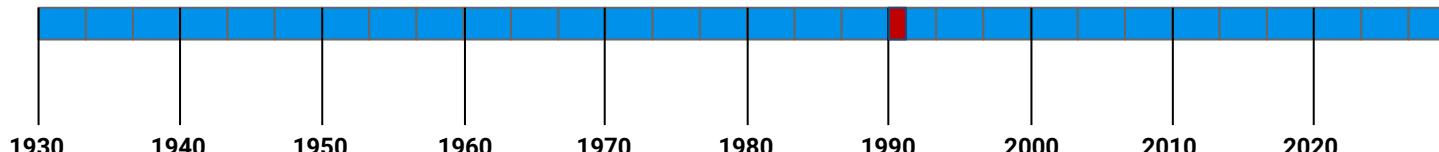
## Fifth generation (1981 - 1995)

HTML (HyperText Markup Language, 1991) is a general markup language for defining the structure of web pages through the use of tags (<head>) that define the type of content. It is currently the standard language for building web applications.



```
example1a.html - Notepad
File Edit Format View Help
<!doctype html>
<HTML lang=en>
<head>
<meta charset=utf-8>
<title>My web page</title>
</head>

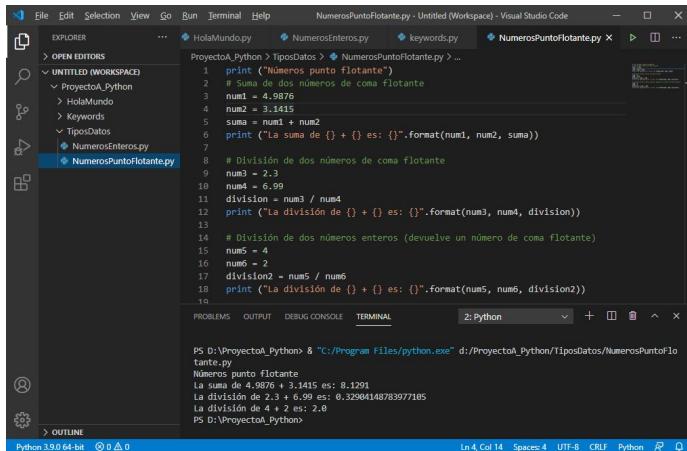
<body>
This is my first web page!
</body>
```



# Background and historical perspectives.

## Fifth generation (1981 - 1995)

Python (1991) is a partially functional, object-oriented, imperative-type hybrid general-purpose programming language developed to make code easier for programmers to read, thus simplifying its use.



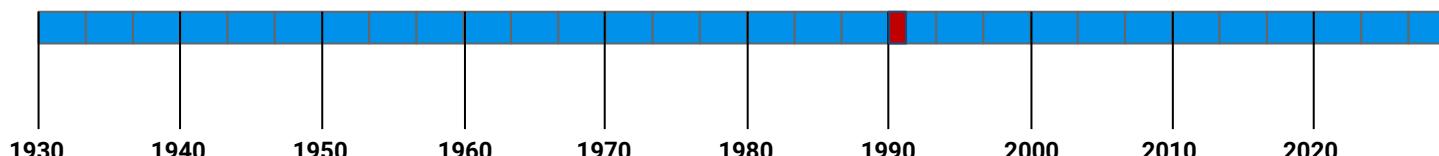
A screenshot of the Visual Studio Code interface. The left sidebar shows a file tree with 'ProyectoA\_Python' containing 'HolaMundo.py', 'NumerosEnteros.py', 'TiposDatos.py', and 'NumerosPuntoFlotante.py'. The main editor area displays Python code for performing arithmetic operations on floating-point numbers. The bottom terminal window shows the output of running the script, displaying results like 4.9876, 3.1415, and 8.32984148783977165. The status bar at the bottom indicates the code is run in Python 3.9.0 64-bit.

```
1 print ("Números punto flotante")
2 # Suma de dos números de coma flotante
3 num1 = 4.9876
4 num2 = 3.1415
5 suma = num1 + num2
6 print ("La suma de {} + {} es: {}".format(num1, num2, suma))
7
8 # División de dos números de coma flotante
9 num3 = 2.3
10 num4 = 6.99
11 division = num3 / num4
12 print ("La división de {} + {} es: {}".format(num3, num4, division))
13
14 # División de dos números enteros (devuelve un número de coma flotante)
15 num5 = 4
16 num6 = 2
17 division2 = num5 / num6
18 print ("La división de {} + {} es: {}".format(num5, num6, division2))
19
```

```
PS D:\ProyectoA_Python & "C:/Program Files/python.exe" d:/ProyectoA_Python/TiposDatos/NumerosPuntoFlotante.py
Números punto flotante
La suma de 4.9876 + 3.1415 es: 8.1291
La división de 2.3 + 6.99 es: 0.32984148783977165
La división de 4 + 2 es: 2.0
PS D:\ProyectoA_Python>
```

- Multi-paradigm: Object-oriented, imperative and functional.
- interpreted language.
- dynamic typing.
- Multi platform.

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



# Sixth generation

## Mobile phones, robots and AI.

# Background and historical perspectives.

## Sixth generation (1995 - Now)

The first "Smartphones" (2009) that combine the functions of a cell phone and a computer begin to be sold.

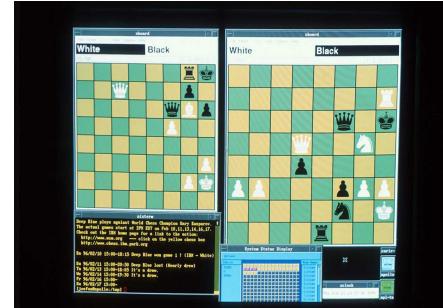


Iphone 3

# Background and historical perspectives.

## Sixth generation (1995 - Now)

IBM introduces Deep Blue (1997), a supercomputer capable of parallel computation, and faces the chess champion (Kasparov) twice.



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



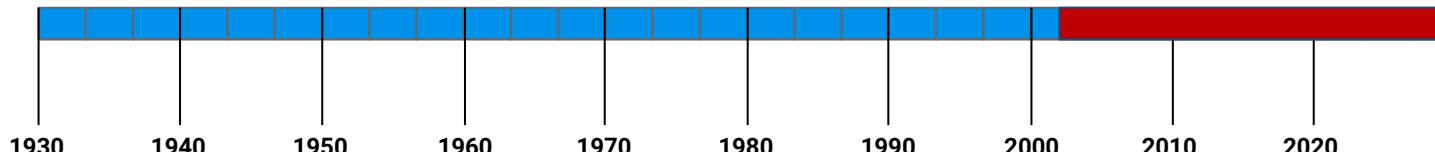
# Background and historical perspectives.

## Sixth generation (1995 - Now)

Facebook was created (2004) by Mark Zuckerberg, Eduardo Saverin, Andrew McCollum, Dustin Moskovitz, and Chris Hughes, its name comes from the face book directories often given to American university students.



A screenshot of Scott Pearson's profile on thefacebook.com. The profile page has a blue header with '[ thefacebook ]'. The top navigation bar includes 'home', 'search', 'global', 'social net', 'invite', 'faq', and 'logout'. The profile picture shows two men. The left sidebar contains links for 'My Profile [edit]', 'My Groups', 'My Friends', 'My Messages', 'My Away Message', 'My Mobile Info', 'My Account', and 'My Privacy'. The right sidebar shows 'Account Info' with details like Name: Scott Pearson, BS, Member Since: January 12, 2005, Last Update: February 3, 2005, and Email: pearsons2@scranton.edu. It also shows 'Basic Info' with details like Status: Alumnus/Alumna, Sex: Male, Year: 2004, Concentrations: Computing Sciences, Mathematics, Phone: 570-492-4018, High School: Dunmore HS '00, and Extended Info' with details like Screenname: ScottPearP7, Looking For: Friendship, Dating, A Relationship, Random play, Whatever I can get, Interested In: Women, Relationship Status: Single, Political Views: Liberal, and Interests: Drinking, Football, Basketball, Tennis, saying you'll have that. The main content area shows 'Information' with a photo of two men and links for 'Picture [edit]', 'Information [edit]', 'Visualize My Friends', 'Edit My Profile', 'My Account Preferences', and 'My Privacy Preferences'. It also shows 'Connection' with 'This is you.' and 'Access' with the note 'Scott is currently logged in from a non-residential location.'



# Background and historical perspectives.

## Sixth generation (1995 - Now)

The era of assistant robots begins with the creation of AIBO, Roomba and ASIMO.



ASIMO - 2000



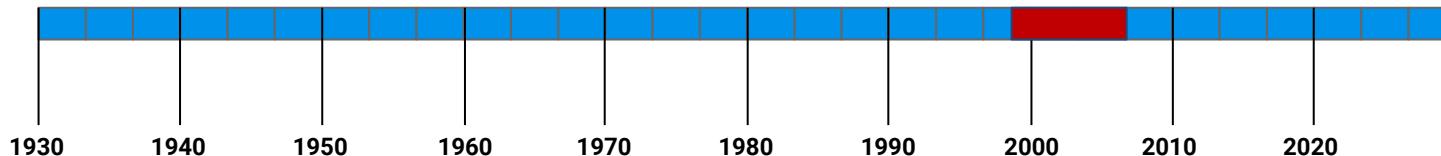
BigDog -2005



Primera roomba  
2002



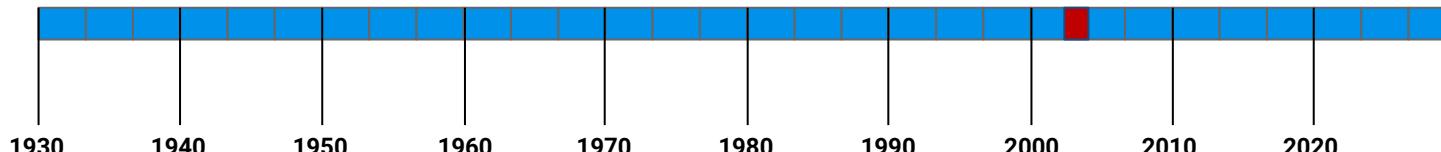
AIBO 1999



# Background and historical perspectives.

## Sixth generation (1995 - Now)

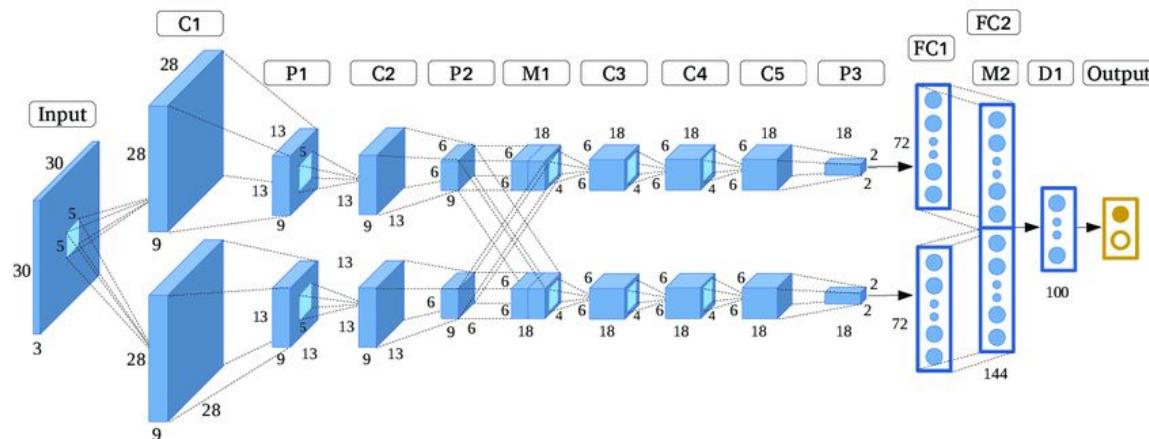
Creation of the DARPA Challenge (2004). Competition for autonomous vehicles organized by DARPA (Defense Advanced Research Projects Agency).



# Background and historical perspectives.

## Sixth generation (1995 - Now)

Creation of the first efficient deep neural networks for the identification of objects by means of Artificial Vision. AlexNet (2012).



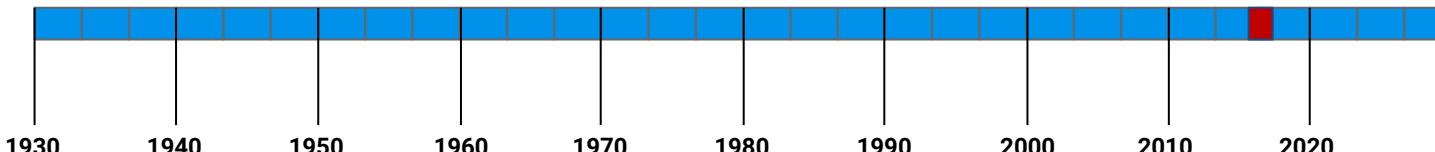
# Background and historical perspectives.

## Sixth generation (1995 - Now)

AlphaGo (2016) a Go player built using Machine Learning who was able to defeat the best Go player in the world.



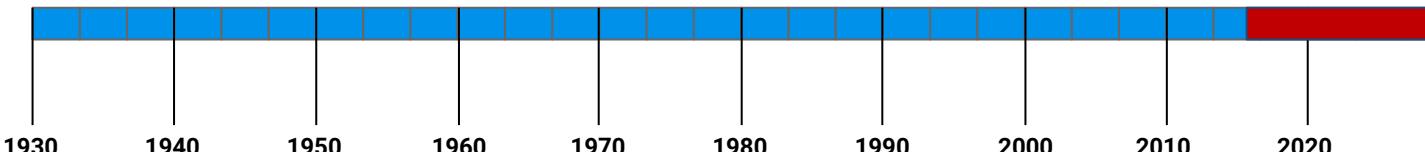
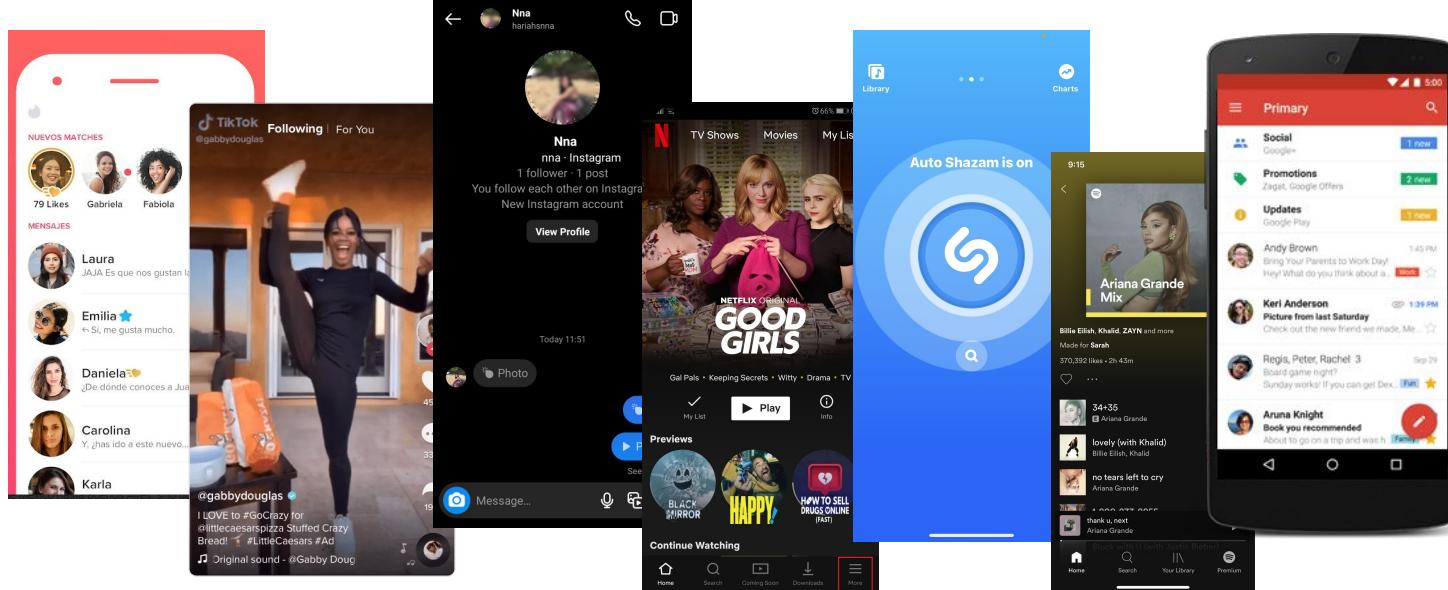
<https://www.youtube.com/watch?v=WXuK6gekU1Y>



# Background and historical perspectives.

## Sixth generation (1995 - Now)

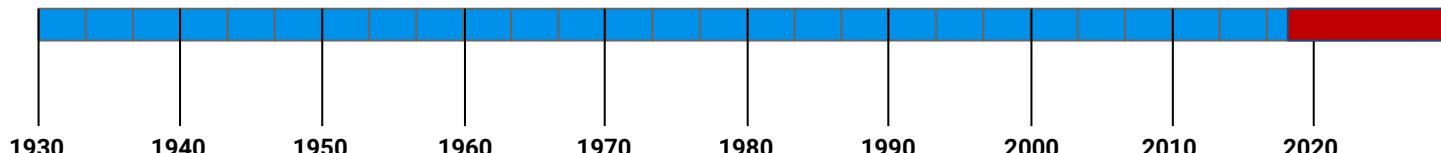
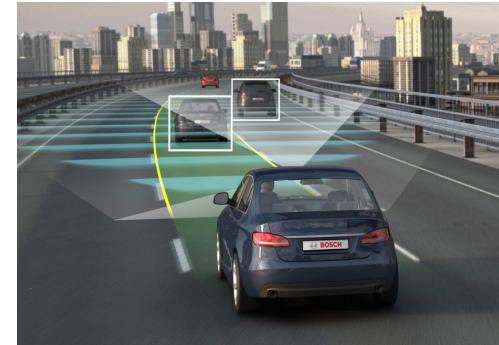
The apps' development becomes one of the most important industries in computer engineering.



# Background and historical perspectives.

## Sixth generation (1995 - Now)

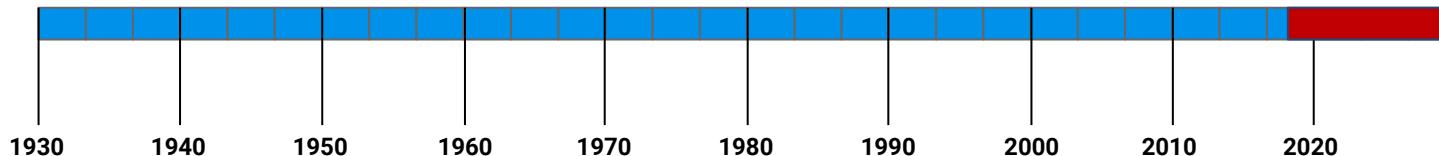
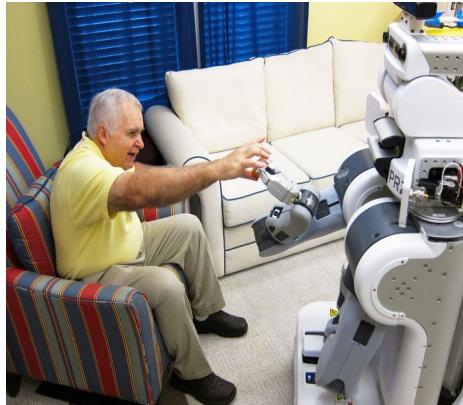
Development of different autonomous vehicles.



# Background and historical perspectives.

## Sixth generation (1995 - Now)

Design of the first robots that use advanced Artificial Intelligence techniques to be able to interact and reason with the environment.



# Background and historical perspectives.

## Sixth generation (1995 - Now)

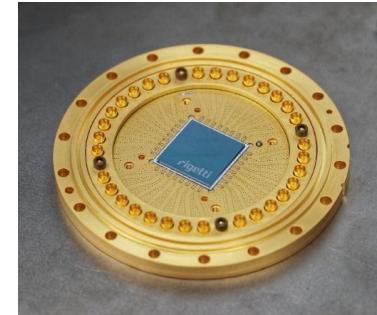
Construction of the first quantum computers that use Qubits instead of traditional bits.



IBM – 50 Qubits



Google – 72 Qubits



Rigetti – 20 Qubits

