Computer Organization

“Evolution History of the Computer”

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Drops from Cahit Karakuş

- *I want to be a lone wolf or a horsefly.*
- *I am not a very talented person, but I focus on my work and work with discipline.*
- *Once I walk through the door, I start a change.*
- *This world is a school of consciousness for the journey to another universe.*
- *Humankind has discovered immortality by becoming conscious.*
- *Even though it seems like I am educating you, this is not true; I am trying to educate your grandchildren in your mind map.*
- *If you want to be respected, your priority should be to act respectfully.*
- *I don't plant love in the mind map of someone who holds a grudge.*
- *If hundreds of jackals do not attack me, I cannot be called as a wolf.*
- *When the fish realizes the stretching force of the water between the waves, it knows very well that it will definitely jump much higher and further in one of its attempts.*
- *In war, retreat does not always mean defeat, and on rare occasions, it is the moment when great victories are won.*
- *Don't say "welcome", say "you come me on good".*

Industrial Revolution

- The change that started the industrial revolution was the studies on increasing the performance and efficiency of wheel-turning systems using steam power. The person who started this was James Watt. Then, if we list the other inventions:
- discovery of electricity
- message transmission over conductors, electrical signal transmission as analog signal
- Subatomic particles, we call them quantum.
- The discovery of the transistor, the circuit element that controls the flow of electrons from subatomic particles, served as both the basic element of the computer and allowed the rapid spread of information technologies.
- Transistors are used as the basic electronic circuit element in all microprocessors and memories.
- Today, there are very rapid developments in artificial intelligence, quantum computing and quantum computers.

“Computer”

Computer Science

- Computer Science is the study of how computers work and how to make them do useful things.
- It combines mathematics, logic, and engineering to understand and design systems that process information.
- What computer science involves: It’s the science of computation. Understanding how to represent, process, and store information using computers.
- Computer Science focuses on both theoretical foundations (like algorithms and data structures) and practical applications (like software design and artificial intelligence).

Main Areas of Computer Science

- Algorithms and Data Structures: How to solve problems efficiently and organize data for fast access.
- Programming Languages: How to express instructions to a computer in different languages (Python, Java script, C++, C-Sharp, ...).
- Software Engineering: How to design, develop, and maintain large, reliable software systems.
- Machine Learning (Artificial Intelligence): How to make computers “learn” from data set and make decisions.
- Computer Architecture: How hardware components like CPUs, memory, and networks work together.
- Networks and the Internet: How computers communicate with each other securely and efficiently.
- Cybersecurity: How to protect data and systems from unauthorized access or attacks.
- Data Science and Databases: How to store, manage, and analyze large amounts of information. Information obtains from data.
- Human-Computer Interaction (HCI): How people interact with computers and how to make systems user-friendly.
- Theory of Computation: What problems can (and cannot) be solved by computers, and how efficiently. Goal of Computer Science is to understand computation itself
  - how problems can be described and solved by machines.
  - To build systems that improve human life
  - from mobile apps to AI assistants and self-driving cars.

The Concept of “Computer”

- The word "computer" has been used in English since 1646.
- In dictionaries prior to 1940, "computer" was the professional designation given to someone who performed calculations.
- Calculator: A machine that performs calculations.
- The modern definition and use of the term "computer" emerged with the development of the first electronic computing devices.
- Almost all devices used today contain computers.

What is a “Computer”?

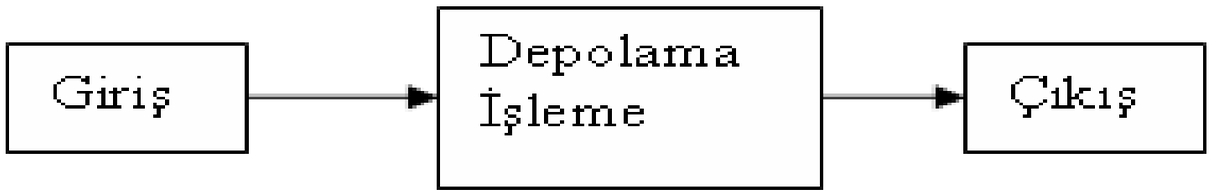
- Computer is a electronic device that receives any data as input (voice, text, image, video, sensing signal, analog signal, …), all datas convert to to digital signal (bit:0/1 as electrical signal), stores them, processes them, and produces them as output. It is electronic and consists of transistors. Computer performs its calculations based on the processing and transmission of electrical signals.
- A computer is an electronic circuit that processes a set of instructions stored in program memory that tell it what to do.
  - It is fast: It processes faster than the human brain.
  - It is stupid: It has no emotion or intuition of its own. It does what its pre-given commands tell it to do and nothing else.
  - It is compliant: It does what it is told to do.

Basic Components of the Computer

- Microprocessor
- Memories (Cache, Ram / Rom)
- I/O
- Timing and Clock
- Communication Buses, System Bus: Address, Data and Control
  - On address bus lines, only one way. CPU select memory and memory cell or I/O units.
  - On data bus lines, two directional. CPU writes or read tha data to memor cell or I/O units
  - On control bus, CPU synchronize the all process.

Basic Operations on a Computer

- Data Input: A computer receives data from external sources for internal processing.
- Data Storage: Data to be processed within a computer is stored in memory.
- Memory types: Registers: Special-Purpose Temporary Registers, Cache: Precautionary Memory, RAM: Volatile Memory, ROM: Permanent Memory, etc.
- Data Processing: ***The computer processes data in registers within the microprocessor according to the instructions***, reading or writing **data from RAM**. It performs its operations according to ***the codes in ROM memory***.
- Operation in computer: Arithmetic, Logic, Comparison, Transferring data between registers or memory,
- Data Output: The computer produces the processed data for external use.



Computer Types-Supercomputer

- It can perform trillions of calculations per second.
- It has large processing and storage capabilities.
- Midrange computers are also known as workstations.
- Microcomputers are the least powerful but fastest-developing type. PCs used today are in this class.
- Laptop
- Pocket-sized computers (Smartphones, Personal Digital Assistants (PDAs)

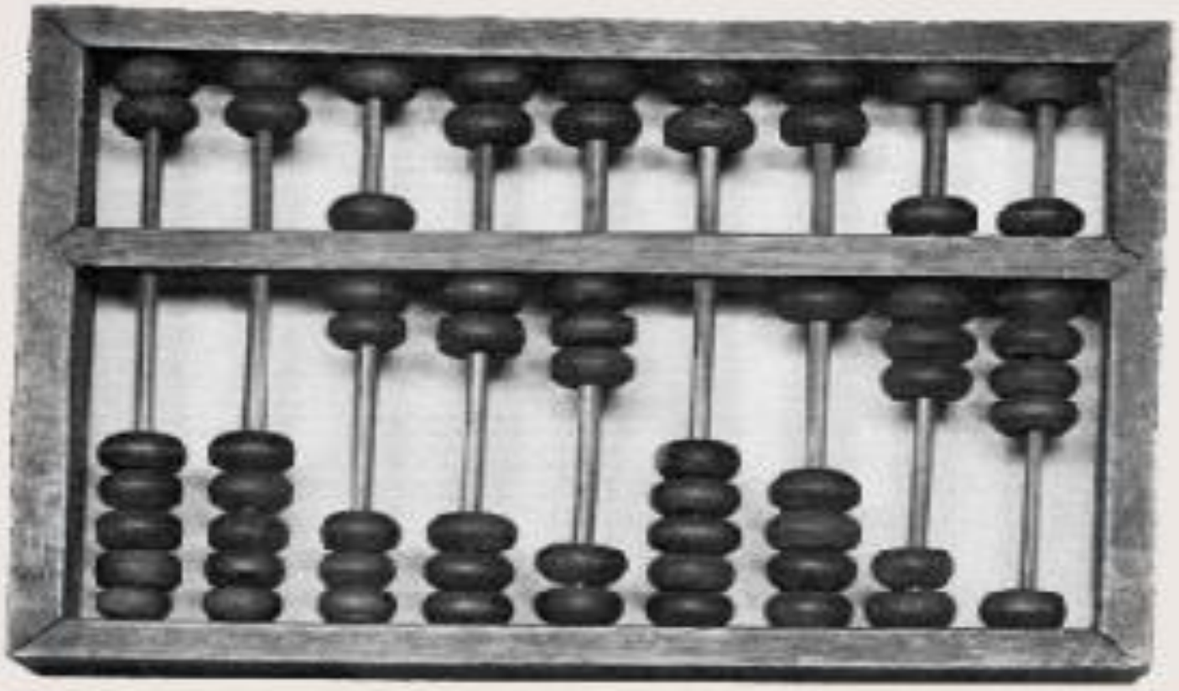
Data Collection, Storage and Preparation

- Data Analytics: Data collection, classification, analysis, visualization (two or three-dimensional graphical drawing)
- Data preparation: debugging, normalization, missing data, manipulated data
- Data Mining: It is the storage of large amounts of information designed for query and analysis and the process of transforming data into information.
- Data Lake: It is a data pool that can store large amounts of structured, semi-structured and unstructured data.
- Data Lake uses the ELT (Extract Load Transform) process, while Data Warehouse uses the ETL (Extract Transform Load) process.
- Data structuring: Classification, clustering, regression
- Database
- Common programming languages: Python, C++, Java Script, Matlab
- Artificial intelligence is the development of behaviors that are independent of humans, which we call autonomous. It is about determining the coefficients in mathematical expressions from the data set. Especially in machine learning and deep learning algorithms, algorithms are developed by making intelligent decisions through the classification, clustering and regression of the data set.

“Computer History”

Abacus 3000 BC

The Abacus, a simple counting aid, was most likely invented in Babylonia.



El-Harezmi

- A scientist who worked in mathematics, astronomy, geography, and algorithms. Al-Khwarizmi was born in 780 in Khiva, Khwarezm, Uzbekistan. He died in Baghdad in 850. He was fluent in both Indian and Greek.
- Latin translations of his works on Indian numerals introduced the decimal number system to the Western world in the 12th century.
- Al-Khwarizmi's Concise Book of Calculation by Completion and Balancing provided the first systematic solution of linear and quadratic equations.
- Al-Khwarizmi is considered the father or founder of algebra because he was the first to teach algebra as an independent discipline and to introduce the methods of "reduction" and "balancing" (simplifying similar terms on different sides of an equation by bringing them to the same side).
- He is credited with discovering the number zero. After researching Indian arithmetic, he created the decimal number system, known as Arabic numerals.
- His works on algebra were used as basic mathematics textbooks in European universities until the 16th century. The term "algorithm" is derived from the technique of performing arithmetic with Hindu-Arabic numerals developed by al-Khwārizmī. Both "algorithm" and "algorism" are derived from the Latin forms of al-Khwārizmī's name, "Algoritmi" and "Algorismi," respectivel

Automatic Machines of Ebu-ul-Iz El Cezeri

- Abu'l-iz Al-Jazari, who invented numerous technical and mechanical inventions such as water clocks, water robots, and automatic thermoses, was born in Cizre in 1136.
- Abu'l-Iz Al-Jazari (1136-1206), who worked on today's cybernetics and robotics technologies in the history of world science, presented these works in his work Kitab-ül Jami Beyn'el İlmi ve el Ameli'en Nafi fi Sinaati'l Hiyel (Book Containing the Utilization of Mechanical Movements in Engineering), which he wrote for the Sultan of the Artuqids.
- Although the original of Al-Jazari's book has not survived, ten copies are preserved in various European museums, and five copies are in the Topkapı Palace and Süleymaniye libraries. The work, known as Kitab-ül Hiyel, consists of six chapters.
- It is no coincidence that many scholars, especially Abu'l-Iz, were educated in Cizre during that period.
- Cizre at that time: It is a city that hosts different cultures and where scientific research is carried out along with religious sciences.

the slide rule 1622

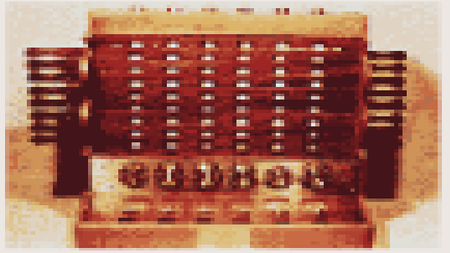
- The **slide rule** is a mechanical precursor of the pocket calculator. It was invented in England by William Oughtred and was very commonly used until the 1970s when it was made obsolete for most purposes by electronic calculators.

The First Mechanical Calculators

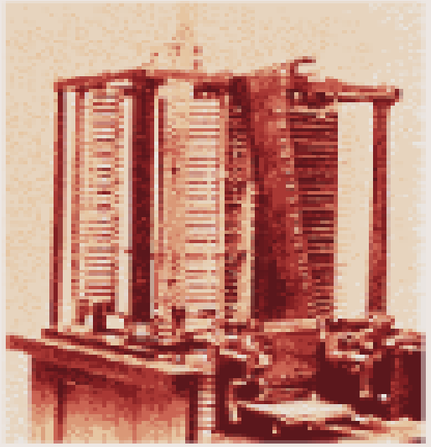
- The first mechanical calculator emerged in 1623 when Wilhelm Schickard developed a device consisting of interconnected gears.

1623 - 1833

•1623: **Wilhelm Schickard**, a professor at the University of Tubingen, Germany, builds the first mechanical calculator. It can work with six digits, and carries digits across columns



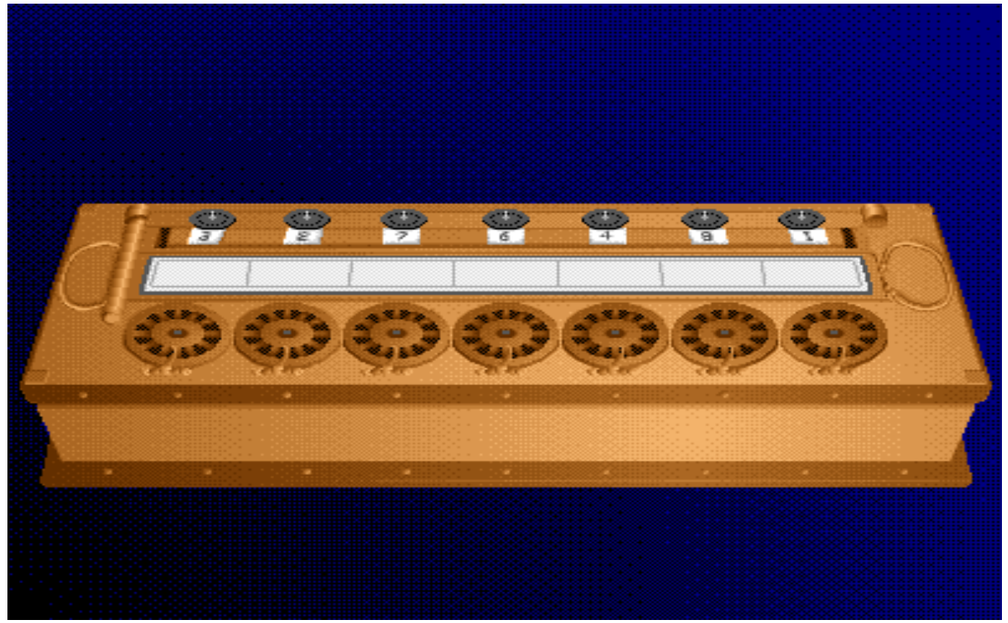
- 1640: **Blaise Pascal** invents the first commercial calculator, a hand powered adding machine
- 1673: **Gottfried Leibniz** builds a mechanical calculating machine that multiplies, divides, adds and subtracts
- 1780: American **Benjamin Franklin** discovers electricity
- 1801: a Frenchman, **Joseph-Marie Jacquard** builds a loom that weaves by reading punched holes stored on small sheets of hardwood.



•1833: **Charles Babbage** designs the Analytical Machine that follows instructions from punched-cards. It is the first general purpose computer

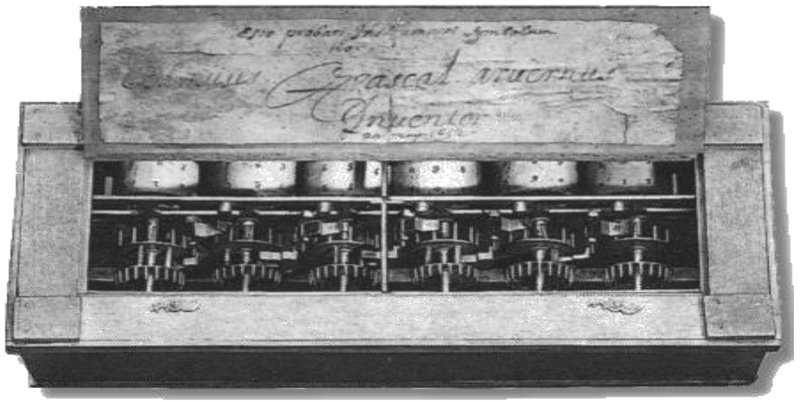
Blaise Pascal (approx. 1650)

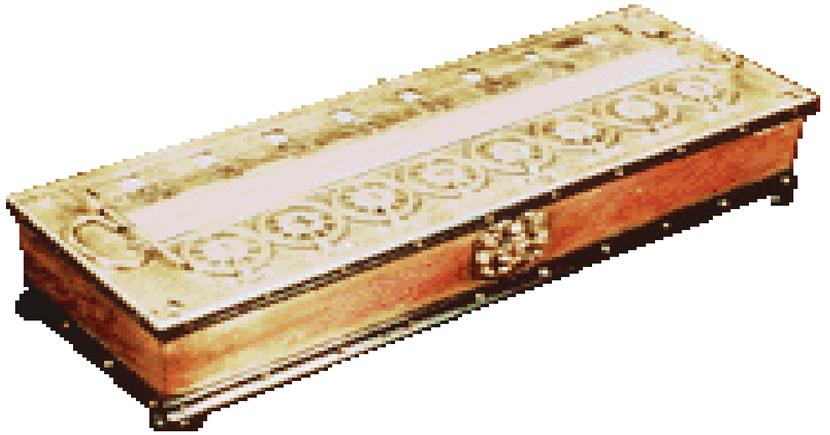
- French Mathematician, theologian and scientist
- Built a machine with 8 gears called the Pascaline to assist French government in compiling tax reports



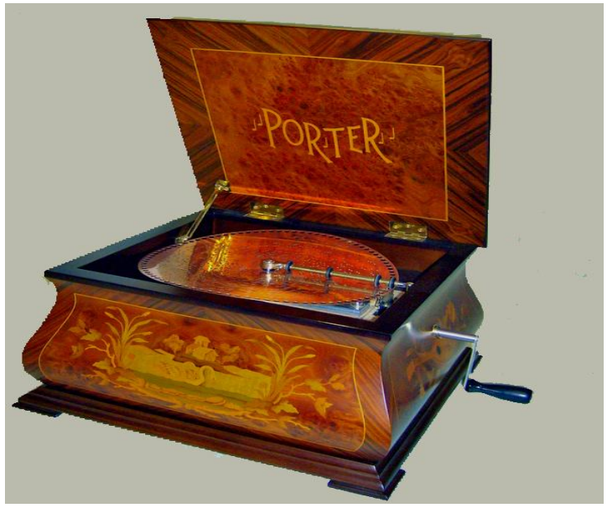
Pascaline

- The device called "Pascaline", developed by Blaise Pascal in 1642, could perform mechanical addition, subtraction, multiplication and division operations.



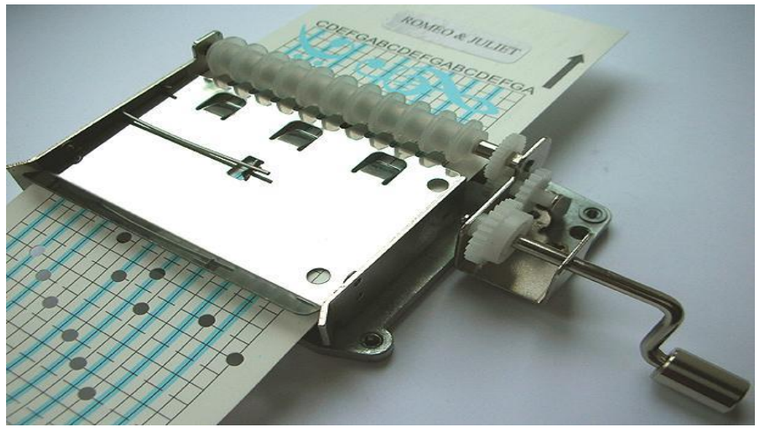


Programmable Machines



1883 Music Box

The ipods of their day?

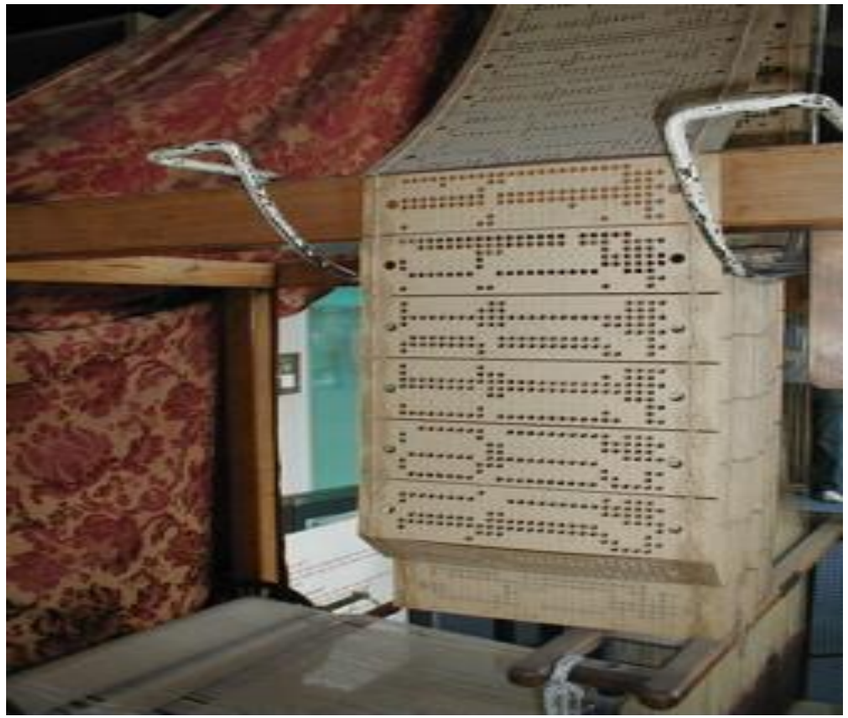


Leibniz Calculator

- In 1673, another mechanical calculator, called the "Leibniz Calculator," was produced by a German Baron, Gottfried Wilhelm von Leibniz.

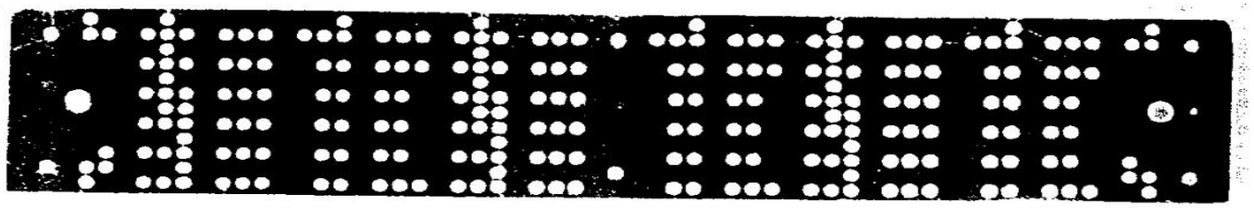
First Computer: Joseph Marie Jacquard (1752 – 1834)

- In the 18th century, the world's finest silk weaving industry in Lyon had become a powerhouse. Thousands of looms were operating.
- Silk weaving, which included ornamentation and relief, was a laborious process and incredibly slow.
- In 1804, Joseph Marie Jacquard designed a device with a highly complex mechanism, a miracle of creativity, that created patterns and symbols in silk weaving.
- Images, reliefs, and symbols were converted into information on punched cards. These looms were miracles of creativity. These punched cards determined which of the numerous threads would be used in each pattern, when, and for how long.
- Spoken language could be symbolized through binary language (bit:0/1). This was a profound and forward-thinking idea. Information could be converted into abstract symbols (1/0), stored, and manipulated. Thus, the power of information was unleashed.
- Information was transferred onto punched cards. The symbols and patterns were converted into 0s and 1s, and patterned fabrics were woven very quickly. These machines were the first computer-controlled machines to process initial instructions. There's no electricity...
- The software codes for the patterns and symbols have been generated and loaded into memory...



J.M. Jacquard (early 1800’s)

- developed loom that used punched cards stored programs)



Jacquard’s Loom

Punched cards:

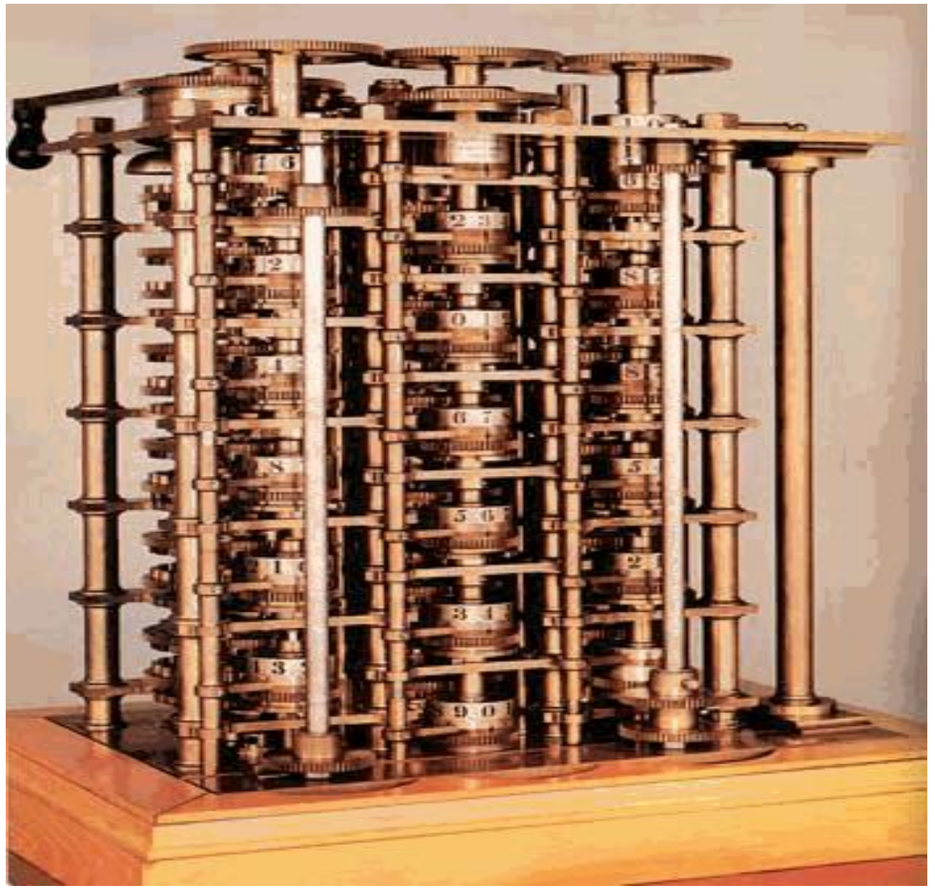
- information coded on cards (forerunner of modern storage devices)
- cards could be linked in a series (forerunner of programs)
- Such programs can automate human tasks

Countess
Ada Augusta Lovelace

- Lord Byron’s daughter
- Mathematician
- Devised way to use punched cards to give instructions to Babbage’s machines
- The ‘first computer programmer’

Charles Babbage

- British scientist and inventor, 1860’s
- known as ‘the Father of the Computer’
- Difference Engine could compute and print tables, but never got out of the 'working prototype' stage because of technological limits
- Babbage’s dream machine: The Analytical Engine
- steam powered calculating machine using programs on punched cards.
- The analytical engine was never completed in his lifetime.



Mechanics

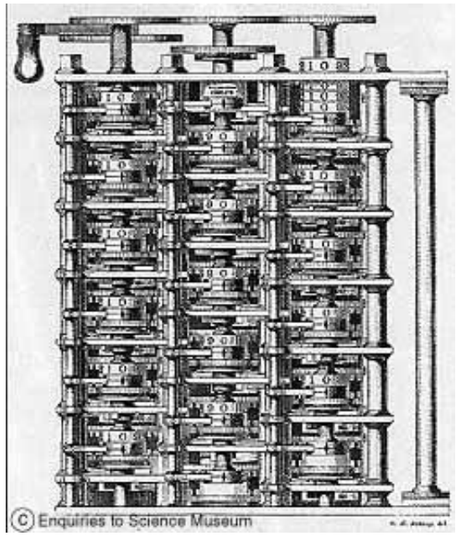
Ada Byron,
Lady Lovelace
1815-1852

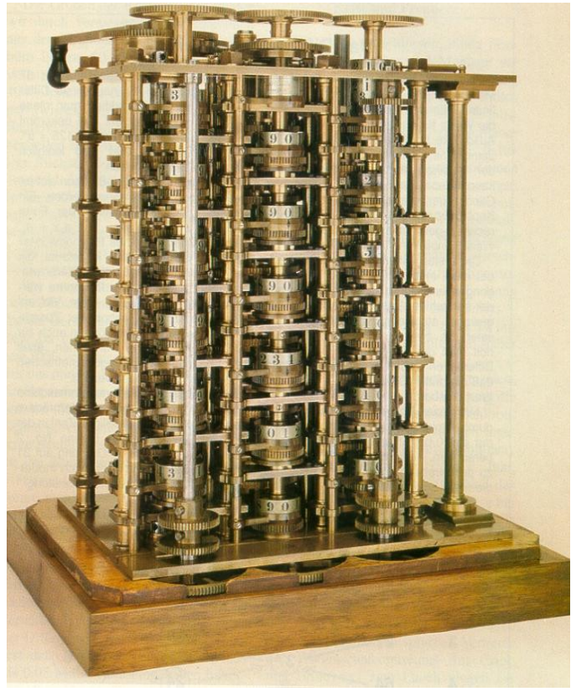
First `Programmer'
and

Inventor of the
Difference Engine
1834

The `full' version of this machine was built in1991 by the Science Museum,London

Charles Babbage
1791-1871





Enigma,
cracked by
Alan Turing
with help of
COLOSSUS

Herman Hollerith
(1890 census)

- Invented a tabulating machine using punched cards (same size as ours today). There was electrical signal and relay.

- Founded forerunner of IBM

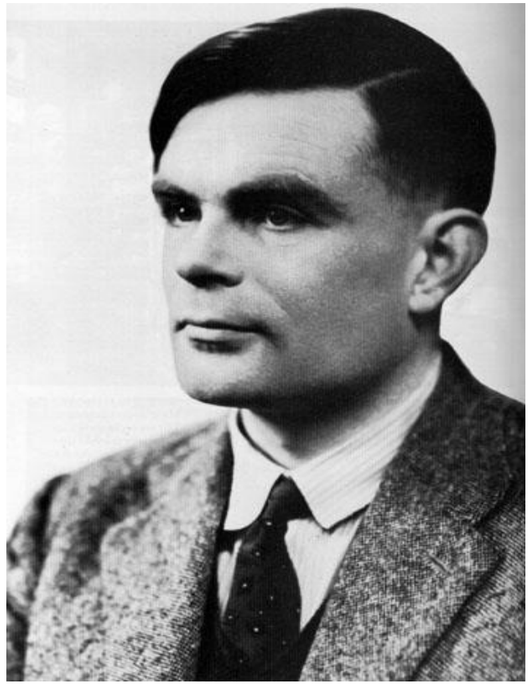
Thomas Watson, Sr.
(head of IBM in 1924)

- Made his fortune in punched card tabulating equipment and office equipment
- Never convinced that computing machines were worth the risk.
- Turned over the company to his son in mid 1950’s

Who invented computers?

- Computer science has its roots in two areas:
  - Mathematics
    - Alan Turing and the Turing machine (1930s)
    - Theories developed with pencil and paper on how to perform calculations by hand
  - Engineering
    - John von Neumann and the von Neumann machine (1940s)
    - Showed how to build physical computers from electronic circuits.

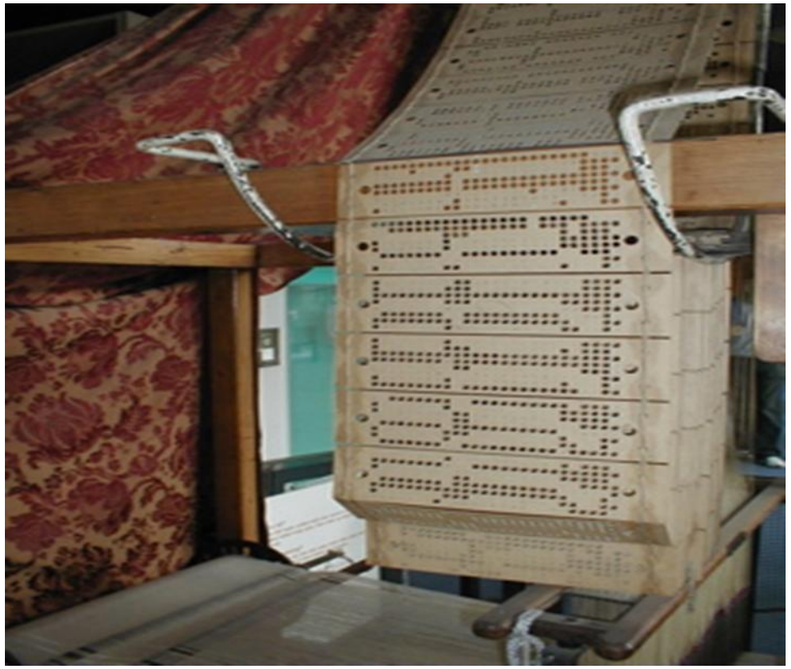
Computer Science History



- Alan Turing solved the German encryption system Enigma.
  - WW II
  - Enigma
  - “Computers and AI”
- John von Neumann invented the stored program concept (data and instructions stored in memory in binary form).
  - Programs as data
- ENIAC

Mathematical Roots of the Computer

- Harazmi: Algorithm, Logical Thinking
- Leibniz's Dream (1600s)
  - Can we find a universal language for mathematical algorithms that would allow us to describe and solve any problem?
    - Reduce all reasoning to a fixed set of fundamental rules
    - Determine the truth or falsity of sentences using fixed rules for manipulating sentences
- George Boole (1800s)
  - Introduces binary notation of calculation
  - Computers use binary systems for logic and arithmetic
- Joseph Marie Jacquard (1752–1834) The Weaving Machine. Joseph Marie Jacquard (1752–1834) was a French inventor best known for creating the Jacquard weaving loom, a revolutionary machine that greatly influenced both the textile industry and the development of computing.



Roots of computer engineering

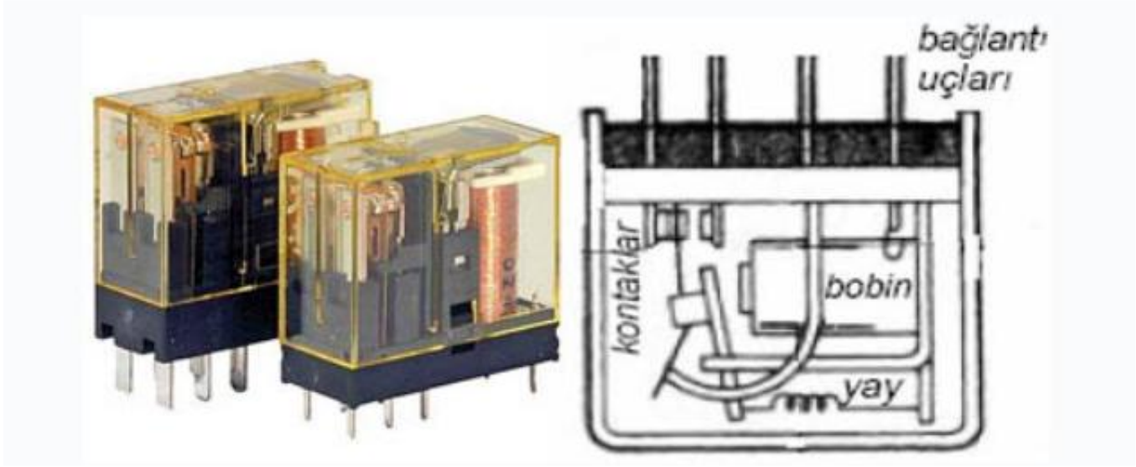
- Early development of calculators
  - Abacus - Developed 5,000 years ago in the Middle East
  - Pascaline - The first mechanical calculator that used gears for calculation (1642)
  - Charles Babbage's Difference Engine - Conceptual design that used hundreds of gears to calculate mathematical functions (1820s)

Electronic circuits

- Telegraph – uses electrical signals to transmit messages and information quickly (1844). Messages were transmitted using electrical signals on conducting wires or electromagnetic waves through the air (dit or dot). Relay and contact systems were used.
- Hollerith Tabulating Machine – uses electricity and punched cards to calculate the US census (1890).
- Z2 – circuit used to calculate arithmetic operations (1930s)
- Transistor, 1947

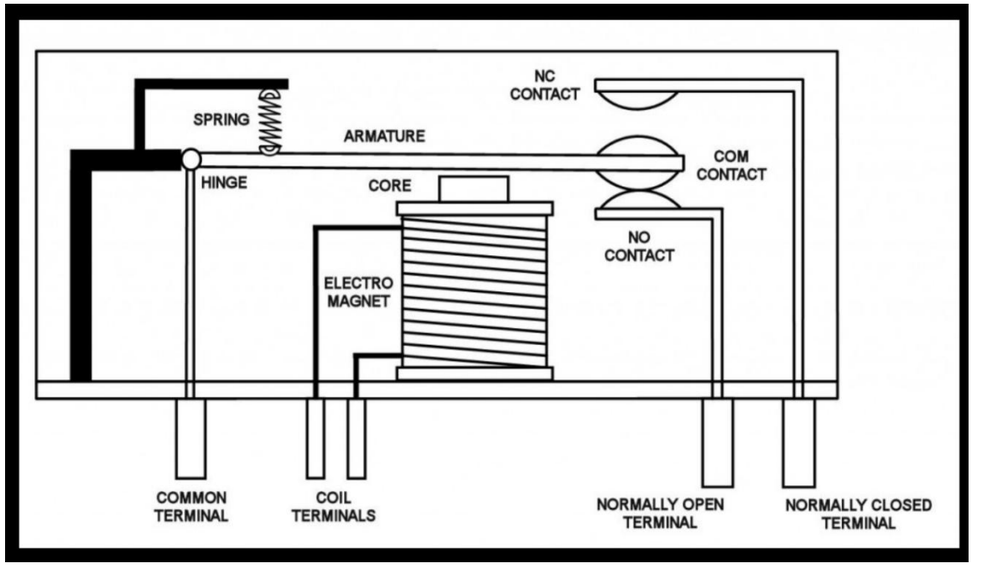
Relay

- Relays are used where it is necessary to control a circuit with an independent low-power signal, or where several circuits must be controlled by a single signal.
- Relays were first used as signal repeaters in long-distance telegraph circuits: they repeat a signal from one circuit by transmitting it through another.
- Relays were widely used to perform logical operations in telephone exchanges and early computers.



Relay

- A relay is an electrically operated switch — it uses a small electrical signal to control a much larger one.
- Basic Parts
  - Electromagnet (coil): A wire wrapped around an iron core that creates a magnetic field when current flows through it.
  - Armature: A small movable metal lever that is attracted by the electromagnet.
  - Spring: Returns the armature to its original position when the current stops.
  - Contacts: Metal switches that open or close the controlled circuit.



Transistor

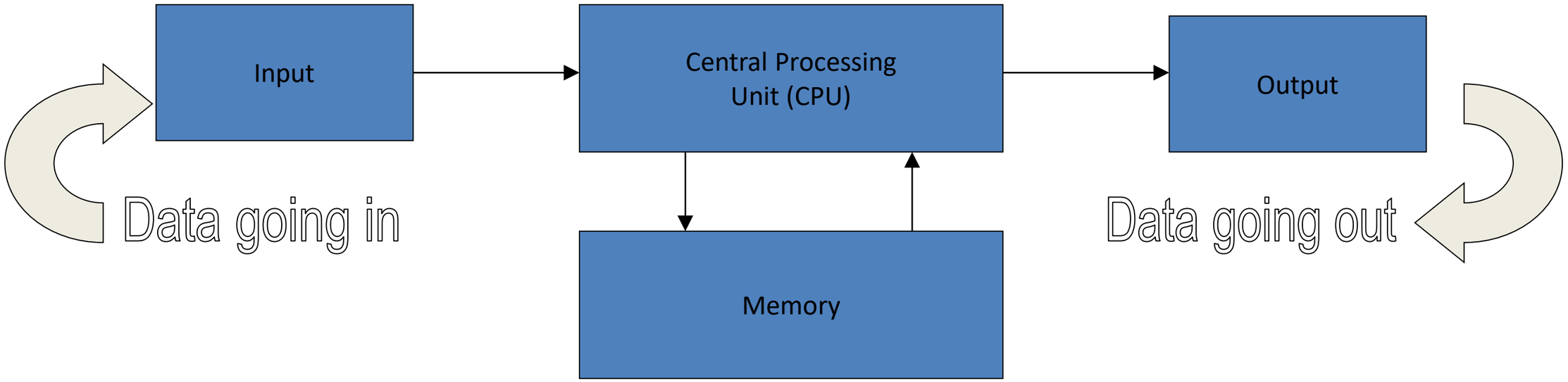
- The transistor was discovered in 1947.
- A semiconductor circuit element that controls the flow of electrons (electric current).
- Subatomic particles (Quantum Mechanics): Proton, Neutron, Electron, Photon
- Current is generated by the flow of electrons.
- A transistor is a memory element that stores bit (0/1) states. It performs switching operations. Or it amplifies the signal.
- The transistor is the most widely used electronic circuit element in the world. Today, they are manufactured in atomic form.
- The transistor is the smallest basic electronic circuit element in a microprocessor.
- Because transistors turn on and off millions, even billions, of times per second, the basic function cycles of a CPU occur at a dizzying speed.

Programmed Devices

- Joseph Marie Jacquard's Loom - weaves fabric using a pattern specified using punched cards (1804)
- Analytical Engine - Conceptual design for a machine consisting of a mill, store, printer, and reader. He led Ada Lovelace to define programming concepts such as subroutines.
- ENIAC - one of the first programmable electronic computers (1945). Programmed with routing wires and rotary switches

von Neumann Machine

- Store programs in electronic memory along side the data (1943)
  - Move and manipulate a program like data
  - Enabled high-level programming languages

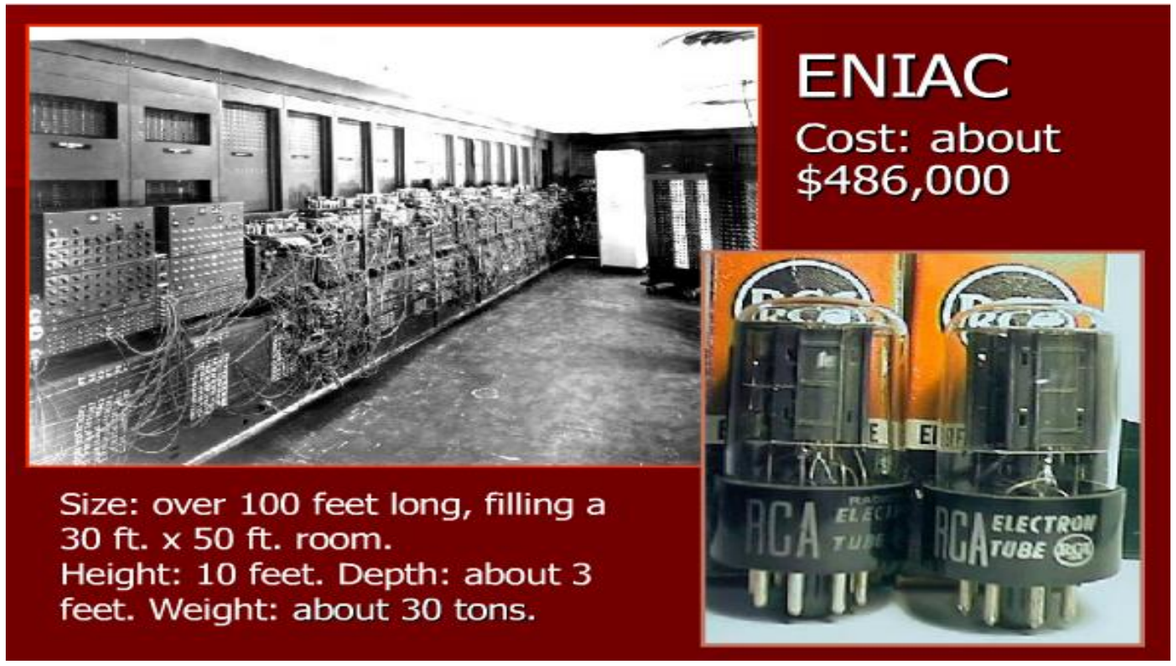


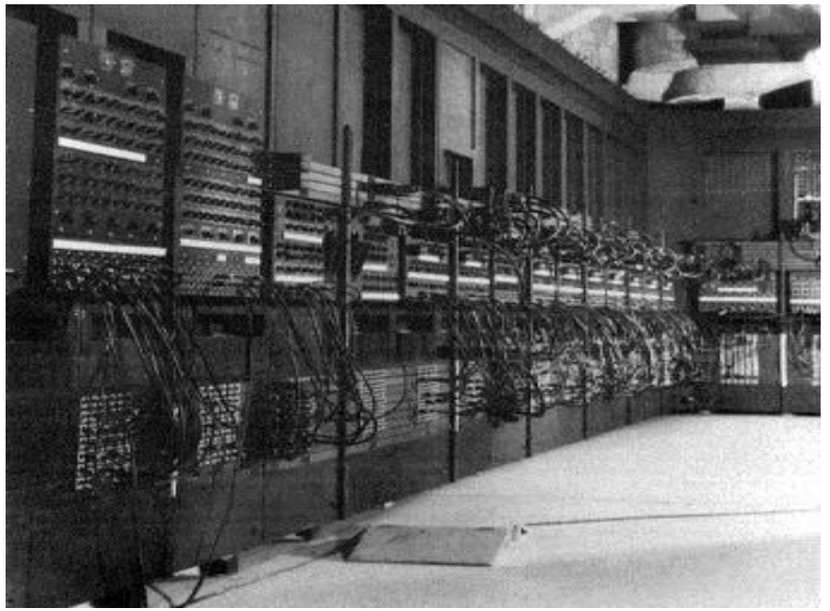
Electronic Computers

- Iowa State University professors John V. Atanasoff and Clifford E. Berry developed the Atanasoff-Berry Computer (ABC) between 1937 and 1942.
- The ABC was the first computer to use vacuum tubes instead of electro - mechanical switches (relay). It was the first digital computer. Its calculations were based on the binary number system.
- While Atanasoff was working on ABC, German engineer Konrad Zuse also developed a computer called the Z3. Due to the Nazi regime in Germany and the subsequent outbreak of World War II, the design of this computer was kept secret. Information about this design emerged after the war.
- In the 1930s, IBM was working on a variety of computer architectures. In 1939, IBM supported a project by engineer Howard Aiken. 75 IBM Automatic Calculating Machines were combined into one unit.
- In 1943, a group led by John W. Mauchly and J. Presper Eckert began work on the ENIAC (Electronic Numerical Integrator and Calculator). ENIAC was intended for wartime operations by the United States military. It was completed in November 1945, three months after the war ended.

The Size of ENIAC

- ENIAC was 100 feet (30 m) long, 10 feet (3 m) high, and weighed 30 tons.
- It consisted of 18,000 vacuum tubes and required 174,000 W of power to operate.
- ENIAC could perform 5,000 additions in one second.
- Because of the need to set and wire 6,000 switches, it could be programmed in approximately two days.



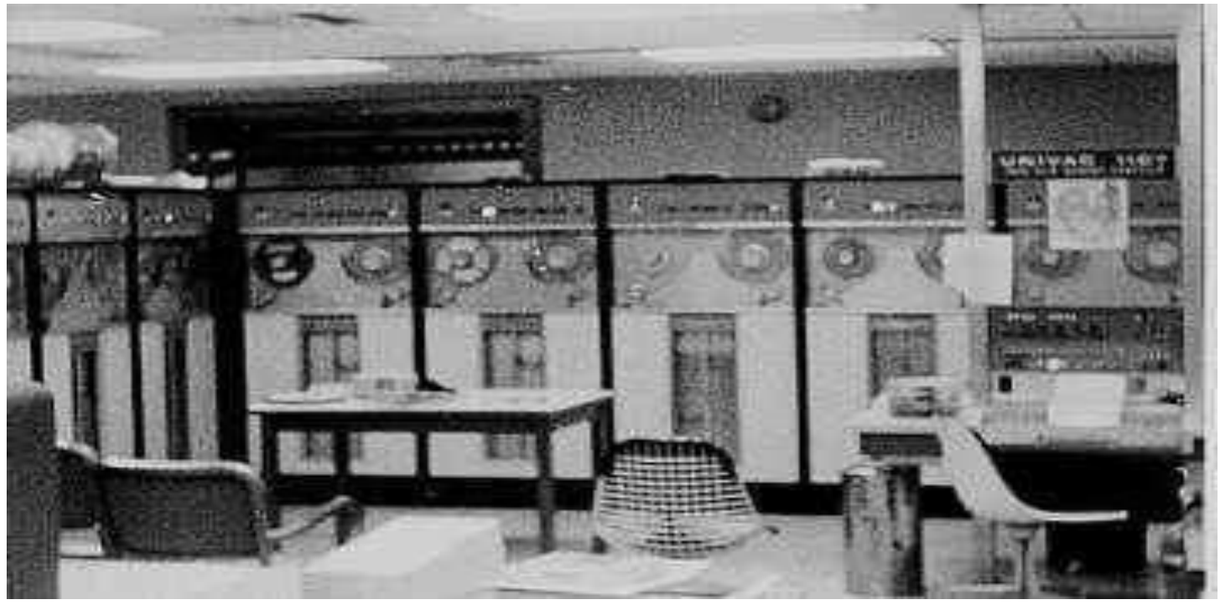


ENIAC

- The first computer was ordered secretly by the military in 1941, following the US entry into World War II, for the Moore School of Electrical Engineering at the University of Pennsylvania. The goal was to use it in calculations for long-range artillery and missiles with fewer hits and errors.
- It was manufactured by scientists John Mauchly and Presper Eckert in approximately four years. Its cost was approximately $500,000. ENIAC began its first test run in 1945. However, with the surrender of Japan on September 2, 1945, the war ended, eliminating the need for such a machine. It was not until 1947 that it became fully operational.
- The ENIAC was unveiled to the press in 1947. Following the war, ENIAC was primarily used in weather forecasting, atomic energy calculations, cosmic ray studies, thermal triggering, random number generation, wind tunnel design, and other scientific research. By 1951, it was being used for industrial purposes.
- The ENIAC's components are currently on display at the National Museum of Fine Arts in Washington, D.C.
- The ENIAC could separate the image of a number, compare equations, multiply, divide, add, subtract, and calculate square roots. The ENIAC's accumulators (preregister regions) served both as accumulators and as memory.
- Data was fed into the ENIAC via an IBM card reader. Processed data was received via an IBM punched card machine, which was then decoded by a punched card reader also produced by IBM (a similar example would be the IBM 405).

UNIVAC

- The first commercially available digital computer was the UNIVAC (Universal Automatic Computer). Designed by Eckert-Mauchly Computer, it was purchased by Remington Rand.
- It was used to predict American presidential elections.
- Between 1951 and 1958, 48 UNIVAC computers were delivered to Remington-Rand customers.



UNIVAC'ın Özellikleri

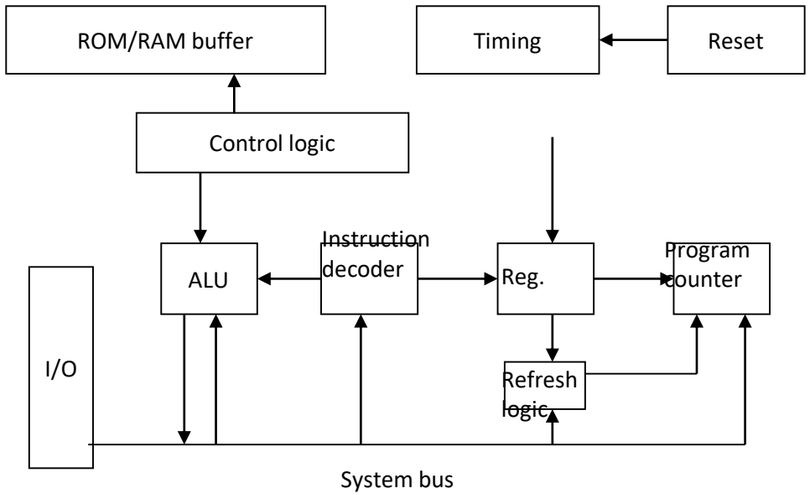
- The UNIVAC was 14.5 feet (4.5 m) long, 7.5 feet (2.3 m) high, and 9 feet (2.7 m) wide.
- It was smaller than the ENIAC but more powerful.
- It could read 7,200 characters per second and process 2.25 million statements.
- It had 12,000 characters (12kJ) of memory (RAM).
- It used magnetic tapes to store and retrieve data.
- Its lowest official retail price was approximately $930,000.

Evolution of Computers

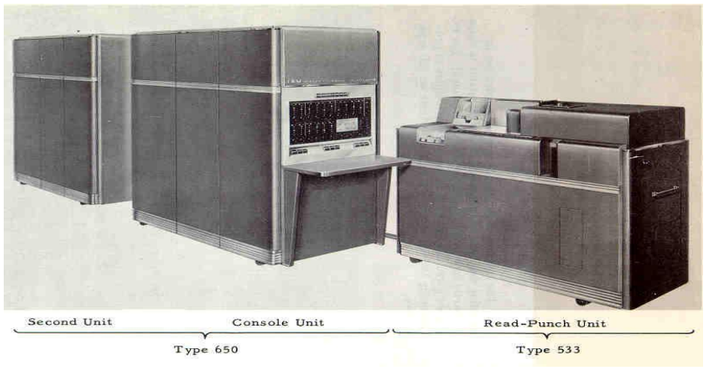
- First generation (1939-1954) - vacuum tube
- Second generation (1954-1959) - transistor
- Third generation (1959-1971) - IC
- Fourth generation (1971-present) - microprocessor

In 1971, Intel developed 4-bit 4004 chip for calculator applications.

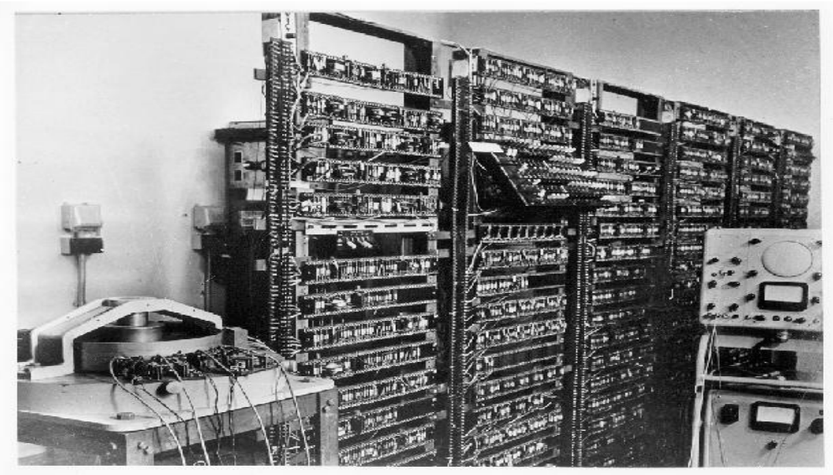
- Fifth generation (1995-future) – Quantum Computer



Block diagram of Intel 4004



IBM 650, 1954



Manchester University Experimental Transistor Computer

Microprocessor

Fifth Generation **Pentium**

Fourth Generation
During 1980s
Low power version of HMOS technology (HCMOS)
32 bit processors
Physical memory space 2^{24} bytes = 16 Mb
Virtual memory space 2^{40} bytes = 1 Tb
Floating point hardware
Supports increased number of addressing modes
Intel 80386

Third Generation
During 1978
HMOS technology ⇒ Faster speed, Higher packing density
16 bit processors ⇒ 40/ 48/ 64 pins
Easier to program
Dynamically relatable programs
Processor has multiply/ divide arithmetic hardware
More powerful interrupt handling capabilities
Flexible I/O port addressing

Intel 8086 (16 bit processor)

Second Generation
During 1973
NMOS technology ⇒ Faster speed, Higher density, Compatible with TTL
4 / 8/ 16 bit processors ⇒ 40 pins
Ability to address large memory spaces and I/O ports
Greater number of levels of subroutine nesting
Better interrupt handling capabilities

Intel 8085 (8 bit processor)

(4004) First Generation
Between 1971 – 1973
PMOS technology, non compatible with TTL
4 bit processors ⇒ 16 pins
8 and 16 bit processors ⇒ 40 pins
Due to limitations of pins, signals are multiplexed

“Computer Systems”

Binary Numbering System

- Bit: 0/1
- Arithmetic: 0/1
- Comparison: 0/1
- Logic: 0/1
- Data Transfer: 0/1

Computer System

- The most fundamental electronic circuit element of a computer is the transistor. Transistor is manufactured at the atomic scale. It operates using electrical signals. It has reached its limit. Quantum computers operate using quanta of electrons.
- CPU (Microprocessor)
- Memory: RAM, ROM, CMOS, Cache, SSD, Register
  - RAM: R/W, Volatile
  - ROM: R, Non-volatile
  - CMOS: W/R, Electrical power (Battery), non-volatile
- I/O
- System Bus

RAM (Random Access Memory)

- RAM (Random Access Memory) is a type of computer memory that stores data and instructions temporarily while your computer is running.
- RAM acts like your computer's short-term memory. It keeps the data your CPU (Central Processing Unit) needs right now — such as open programs, active files, and system processes. When you turn off your computer, everything stored in RAM is lost (it's volatile memory).
- When you open a program (like a web browser or a game), it is loaded from your hard drive (long-term storage) into RAM. The CPU reads data from RAM much faster than from a hard drive or SSD. This speed allows for quick access and smooth performance while multitasking.

ROM (Read-Only Memory)

- ROM (Read-Only Memory) is a type of non-volatile memory that permanently stores data and instructions your computer needs to start and operate properly.
- ROM contains essential programs that run automatically when you turn on your computer — for example, the BIOS or UEFI firmware, which starts the hardware and loads the operating system. Unlike RAM, data in ROM does not disappear when the power is turned off. It's usually written once (by the manufacturer) and cannot be easily modified.
- When you power on the computer, the CPU looks into the ROM to find startup instructions. These instructions tell the computer how to:
  - Test the hardware (keyboard, memory, etc.).
  - Find and load the operating system from the hard drive or SSD.
  - Because the data is permanent, the system can always boot — even if the hard drive is empty.

CMOS Memory

- CMOS memory is a small, special type of memory chip on a computer's motherboard that stores system configuration settings — things like the date, time, and hardware settings (e.g., boot order, CPU settings, memory information).
- CMOS = Complementary Metal-Oxide Semiconductor. It's actually the technology used to build the chip, not the data itself. This chip is used because it consumes very little power, making it ideal for holding settings even when your computer is turned off.
- CMOS stores settings that the BIOS/UEFI firmware uses when starting up the computer. For example, it keeps:
  - System date and time
  - Boot sequence (which drive to start first)CPU and memory configuration
  - Hardware passwords
  - Fan and voltage settings,
- CMOS memory is volatile, which means it loses data when power is off. To prevent this, it's powered by a small coin-cell battery (usually a CR2032) on the motherboard. If this battery dies: The system clock resets. BIOS settings return to defaults. You may see an error like:"CMOS Checksum Error" or "Date and Time Not Set"

Cache memory

- Cache memory is a very fast type of memory that stores frequently used data and instructions close to the CPU, so the processor can access them much faster than if it had to get them from RAM.
- Cache acts as the CPU's high-speed assistant. When the CPU needs data, it first checks the cache. If the data is there (a cache hit), it's retrieved instantly. If not (a cache miss), the CPU must fetch it from RAM, which is slower. This process greatly improves system speed and efficiency.
- You open a program or run a task. The CPU starts using certain data repeatedly (like instructions in a loop).That data gets copied into the cache, because it's likely to be used again soon. The next time the CPU needs it, it's already waiting there — no delay.

Cache memory

Modern processors have multiple levels of cache memory:

Level	Location	Size	Speed	Description
L1 Cache	Inside CPU core	Very small (32–256 KB)	Very fast	Stores the most frequently used instructions and data
L2 Cache	On CPU chip (shared or per core)	Medium (256 KB–8 MB)	Fast	Holds data not found in L1
L3 Cache	Shared across all cores	Large (4–64 MB)	Slower than L1/L2	Coordinates data between cores

SSD (Solid State Drive) memory

- SSD (Solid State Drive) memory is a type of storage device used in computers to store data permanently, like your operating system, programs, and files — but it’s much faster than traditional hard drives (HDDs).
- SSD = Solid State Drive“Solid state” means no moving parts — unlike older hard drives that use spinning magnetic disks.SSDs store data using flash memory chips (like those in USB drives or smartphones).
- Data is stored in memory cells made of NAND flash chips.Each cell holds electrical charges that represent bits (0s and 1s).The controller inside the SSD manages where and how the data is stored, read, and erased.Because it’s all electronic (no spinning parts), data can be accessed almost instantly.
- Much faster than HDDs — boots Windows in seconds
- No moving parts, so more resistant to drops or shocks
- Uses less power, good for laptops. Compact and lightweight. Completely silent.
- More expensive per GB than HDDs
- SSD memory = fast, durable, silent storage that permanently holds your data.It makes computers boot faster, load programs instantly, and run more smoothly overall.

Registers inside CPU

- Registers are the fastest and smallest type of memory inside the CPU (Central Processing Unit).
- They are used to store data, instructions, and addresses that the CPU is currently working on — in other words, they are the CPU's working desk. Let's explain it clearly.
- Registers hold tiny pieces of data that the CPU needs immediately — like numbers to add, memory addresses to fetch, or results to store. They are built directly into the processor chip, so accessing them is much faster than accessing cache or RAM. The CPU uses them for arithmetic, logic, control, and data storage operations.
- When you run a program:
  - The CPU fetches an instruction from memory (RAM).
  - That instruction and its data are loaded into registers.
  - The ALU (Arithmetic Logic Unit) performs operations using the data in those registers.
  - The result may be stored back into another register, cache, or main memory.
  - Every CPU instruction works directly with registers — they are the "hands" of the processor.

System Bus

- All buses originate from the CPU. Each bus is a single line. Each line has a 0 or 1 state (bit).
- **Address Bus:** Originates from the CPU and goes to the memory and I/O units. It selects the memory and memory cell. It is unidirectional and is represented by a 2^n byte value. In here, n is number of the address bus. It defines the memory capacity.
- Data Bus: Sends or reads data to the memory and registers in the I/O unit. It is bidirectional and is represented by a 10^m bit/s value.
- Control Bus: Groups originate from the CPU and are unidirectional. Each line operates independently. Some lines originate from the CPU, while others enter the CPU. They perform functions such as synchronous, w/r, reset, halt, and interrupt.

Internal architecture of the CPU

- Registers
- ALU – Arithmetic Logic Unit
- Control Unit
- Flags
- Clock & Timing
- System Bus: Address, Data, and Control
- Cash Memory
- Pipeline: Processing different commands simultaneously in different units within the CPU. (Read/Write, ALU, Transfer, ...)

- Production: Intel / Motorola

“Evolution of Computers”

Hardware “Generations”

- Hardware
  - vacuum tubes
  - transistors
  - printed circuits
  - integrated circuits
- Moore’s law
  - Circuit capacity doubles every 18 months
  - True from 1972 to the present day

Evolution of Computers

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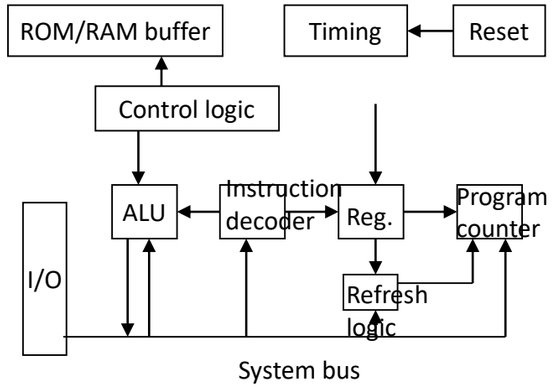
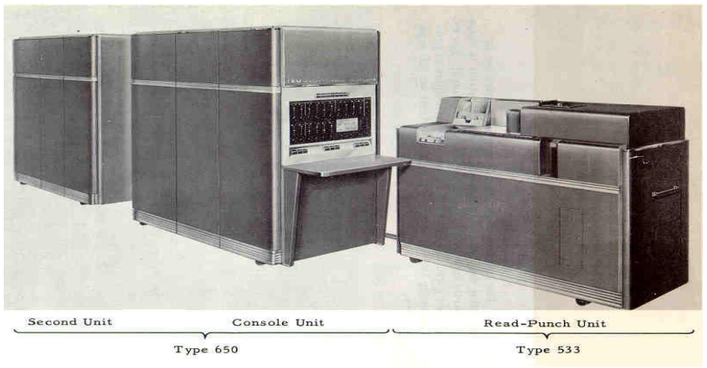
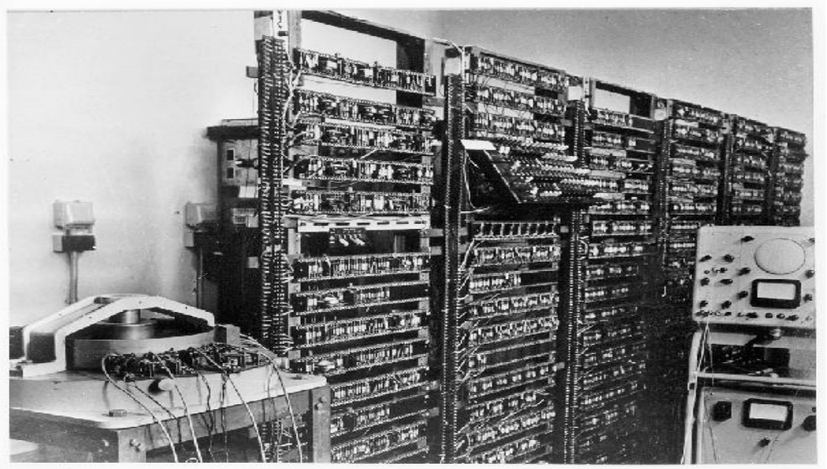


Block diagram of Intel 4004



IBM 650, 1954



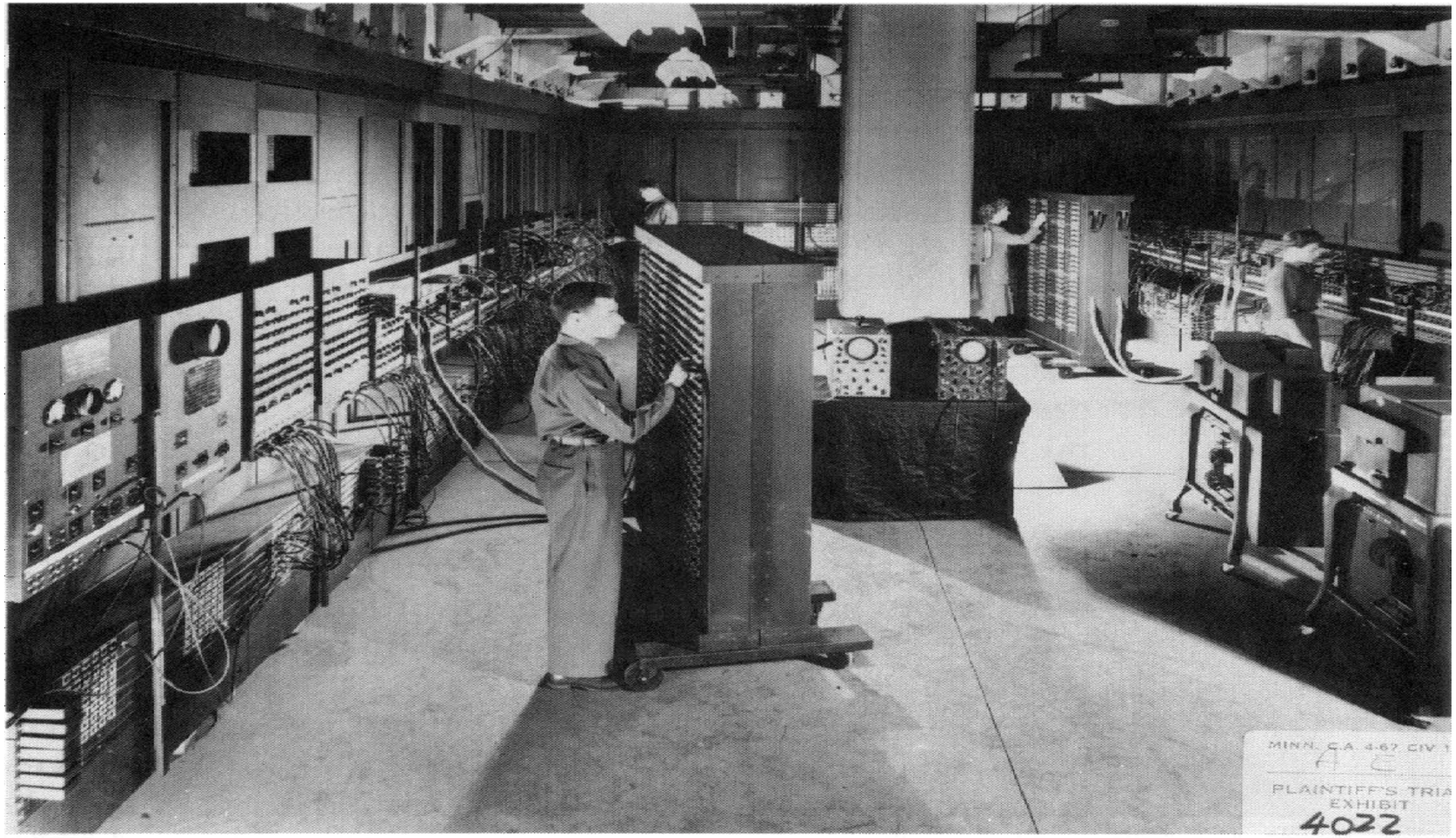
Manchester University Experimental Transistor Computer

ENIAC –
The first electronic computer (1946)

18,000 tubes

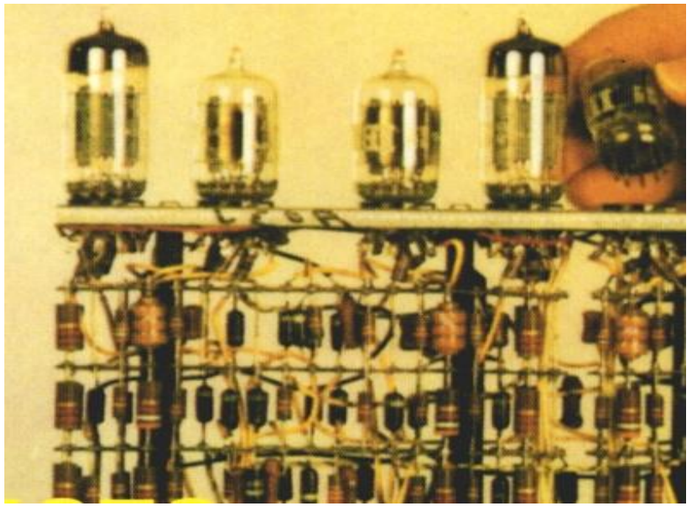
300 Tn

170 KWatt



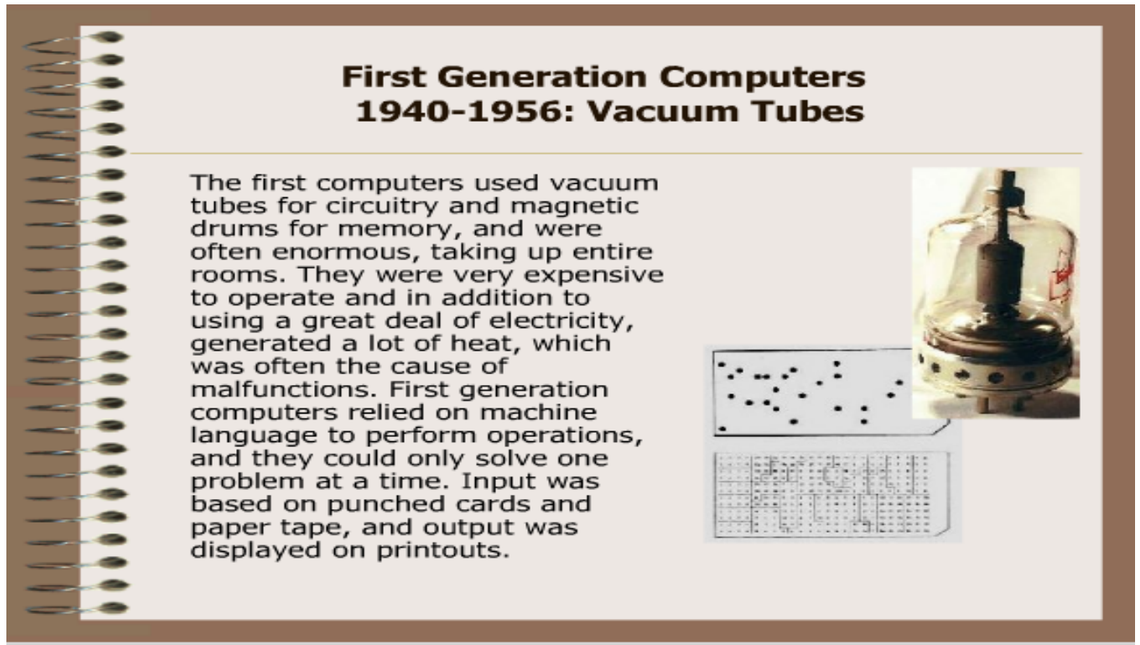
The First Generation of Computers

- 1951-1958
- Vacuum tubes for internal operations
- Magnetic drums for memory
- Limited memory
- Heat and maintenance problems
- Punched cards for input and output
- Slow input, processing and output
- Low-level symbolic languages for programming



Birinci Nesil Bilgisayarlar: Vakum Tüpleri

- Birinci kuşak bilgisayarların ortak özellikleri vakum tüpleri kullanmaları idi.
- En büyük dezavantajları, çoğu ısıya dönüşen, çok büyük miktarda güç harcamaları ve çok çabuk yanma özellikleri idi.
- İlk kuşak bilgisayarların her biri yalnızca belirli işlemleri yapmak üzere programlanabilirlerdi.
- Programların değiştirilmesi, uzun süren kablo ve anahtar bağlantıları yapılarak mümkün olabilirdi.
- Birinci kuşak bilgisayarların döneminin sonlarına doğru Assembly adı verilen bir programlama dili geliştirildi.
- Programcılar bu dilde programlarını daha kolay, ancak yalnızca o bilgisayarda kullanabilmek üzere yazabilme imkanına kavuştular.

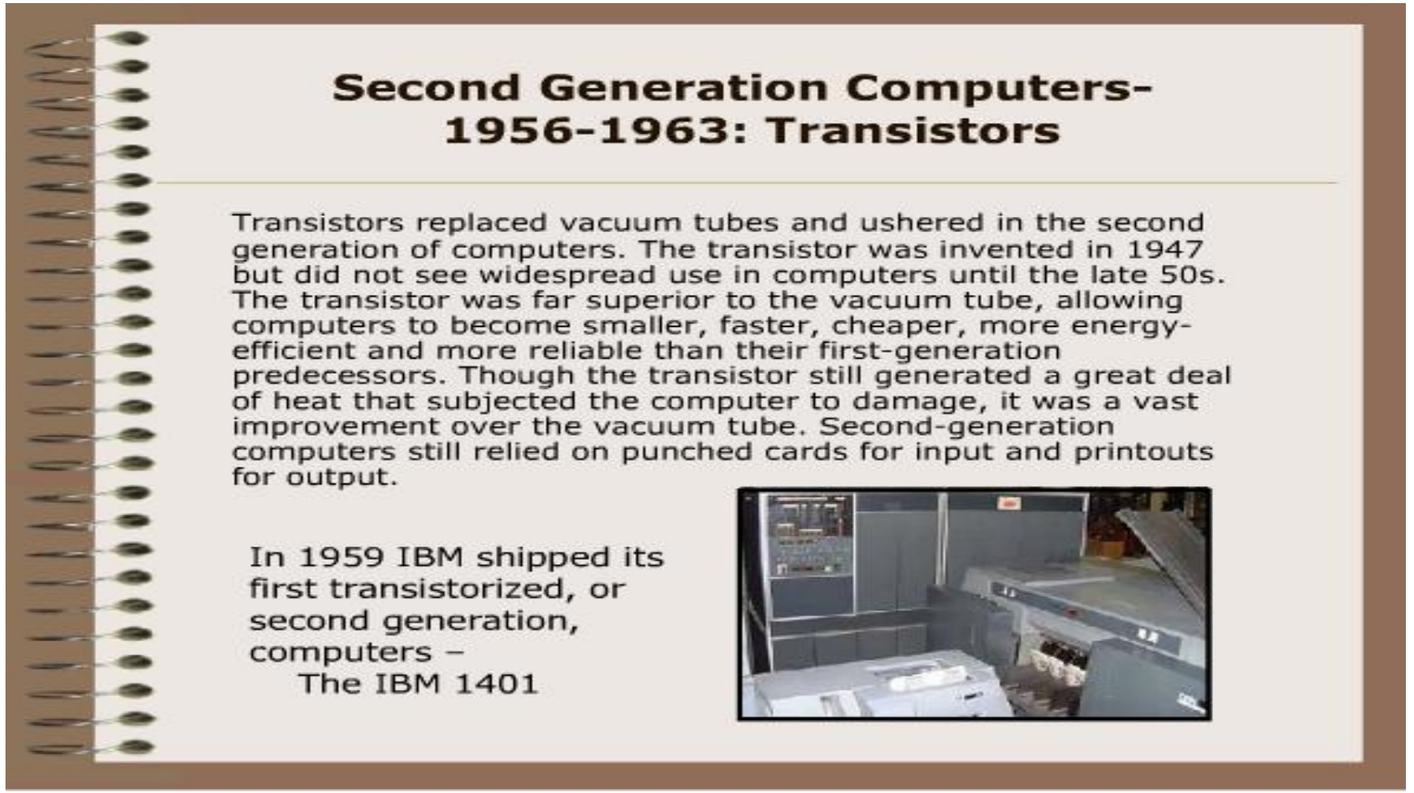


Assembly language

- Made programming easier.
- Uses abbreviations instead of binary code. ie. LD for load.
- Machine-dependent (not portable)

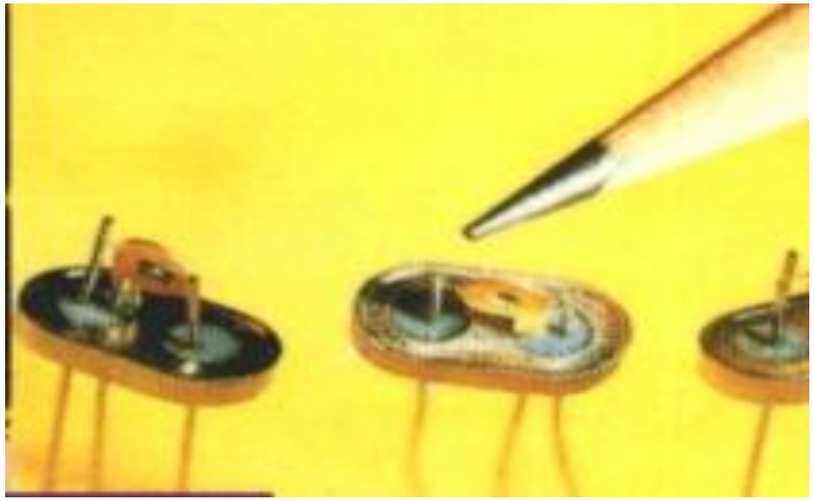
2. kuşak bilgisayarların çağı: Transistör

- İlk olarak 1947 yılında AT&T'nin Bell laboratuarlarında geliştirildi.
- Vakum tüplerinin işlevini gerçekleştirmekteydi.
- Daha küçük, daha ucuz ve daha güvenilirdi.
- Daha az enerji harcamakta idi



The Second Generation of Computers

- 1959-1964
- Transistors for internal operations
- Magnetic cores for memory
- Increased memory capacity
- Magnetic tapes and disks for storage
- Reductions in size and heat generation
- Increase in processing speed and reliability
- Increased use of high-level languages



High-level languages

- The first high-level programming languages were
  - FORTRAN (1954)
  - COBOL (1956)
  - LISP (1961)
  - BASIC (1964)

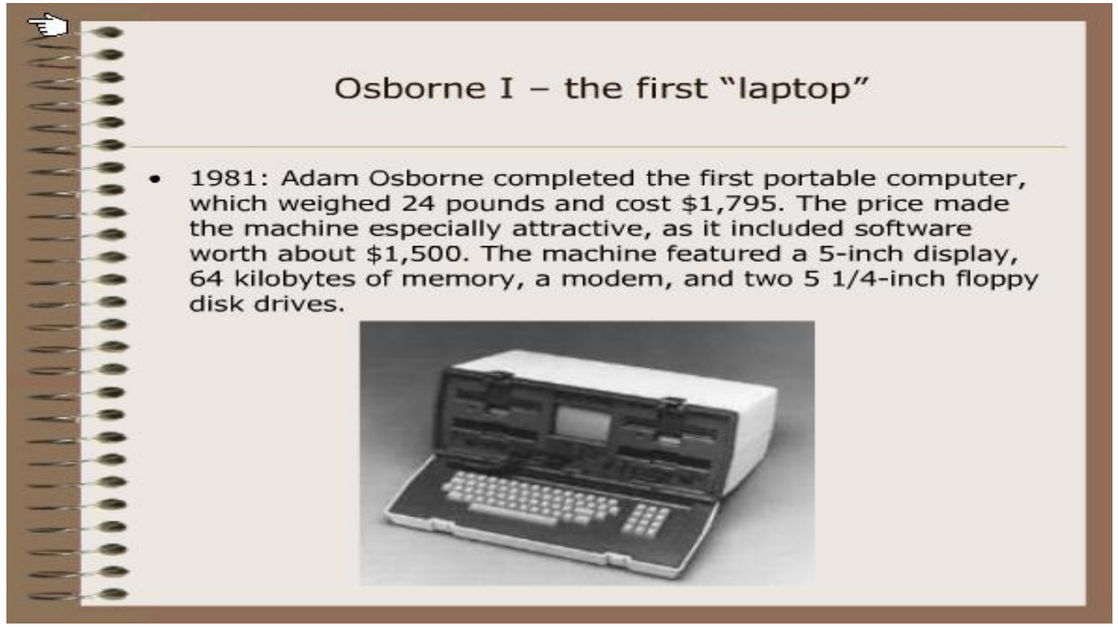
Grace Hopper

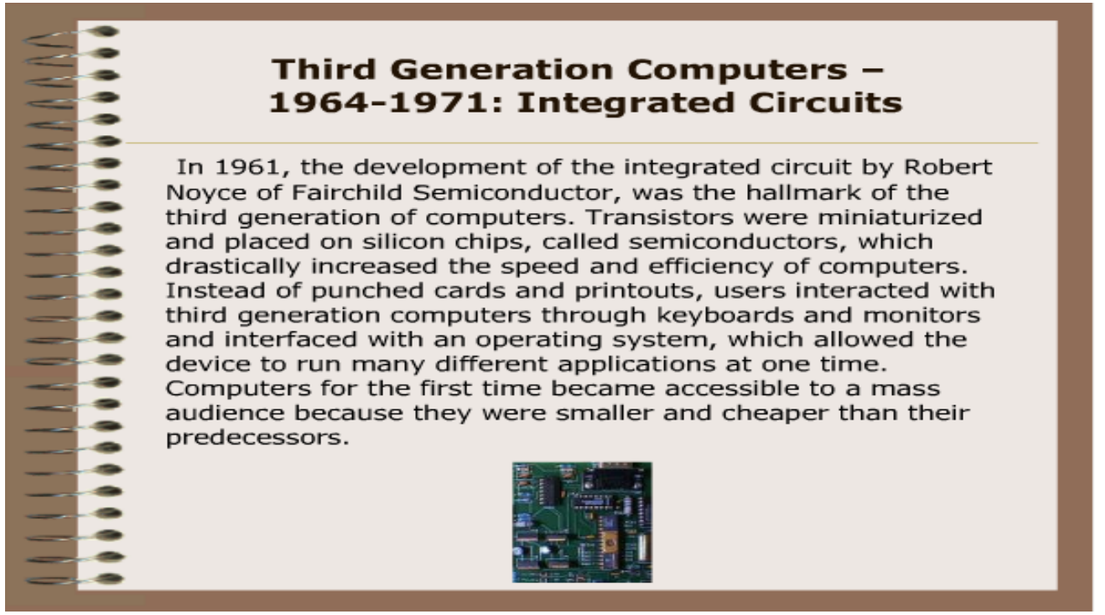
1952
She introduces the new concept that computers could be programmed using symbols on paper (languages).

Later writes the COBOL language.

Üçüncü Nesil Bilgisayarlar: Entegre Devre Çağı

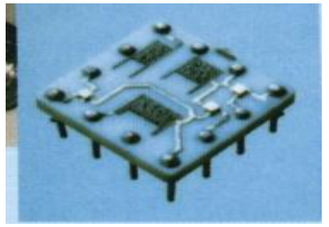
- Texas Instruments'da çalışan Jack Kilby ve Fairchild Semiconductor'da çalışan Robert Noyce'un birbirlerinden bağımsız olarak çalışmaları sonucunda "entegre devre" (Integrated Circuits-IC) ortaya çıktı.
- Entegre devre teknolojisi, binlerce vakum tüpü veya transistörü tek bir minyatür yonga (chip) üzerinde birleştirmeye imkan vermiş, böylece bilgisayar gibi cihazların fiziksel boyut, ağırlık ve güç ihtiyaçlarını büyük ölçüde azaltmıştır.
- "Entegre Devreler" üçüncü kuşak bilgisayarların gerçekleştirilmelerini sağlamıştır.

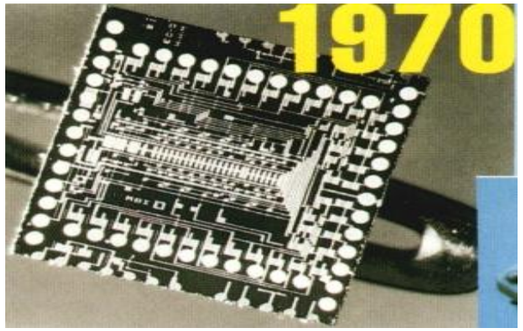




The Third Generation of Computers

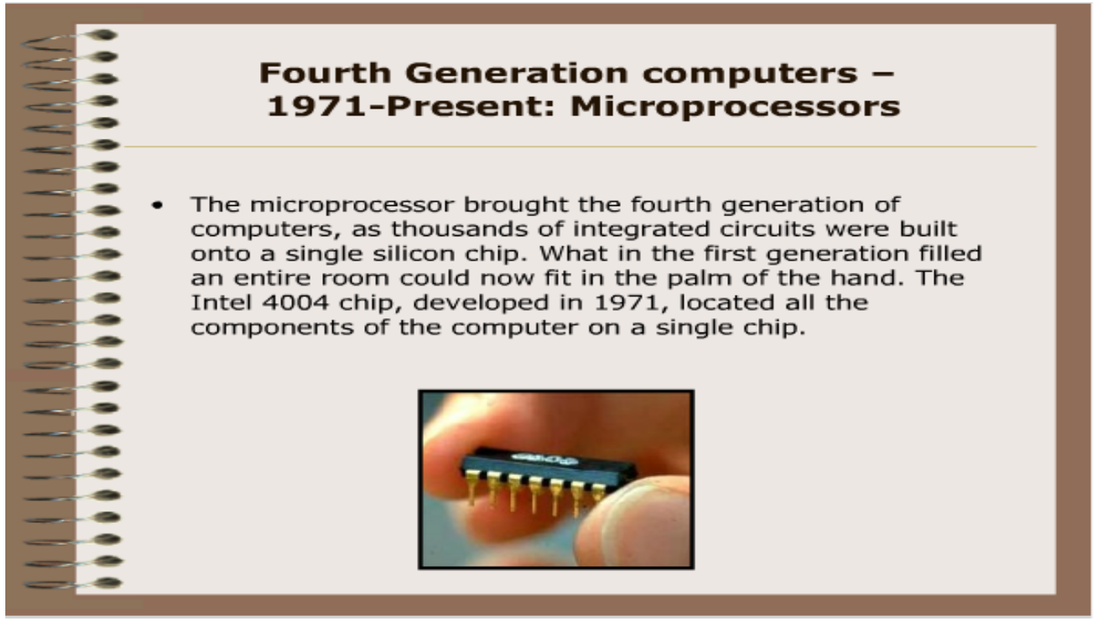
- 1965-1970
- Integrated circuits on silicon chips for internal operations (IC's)
- Increased memory capacity
- Common use of minicomputers
- Emergence of the software industry
- Reduction in size and cost
- Increase in speed and reliability
- Introduction of families of computers
- LSI (Large Scale Integration) - method by which circuits containing thousands of components are packed on a single chip
- Compatibility problems (languages, I/O devices, etc. were informally standardized)
- Minicomputers popular in offices.





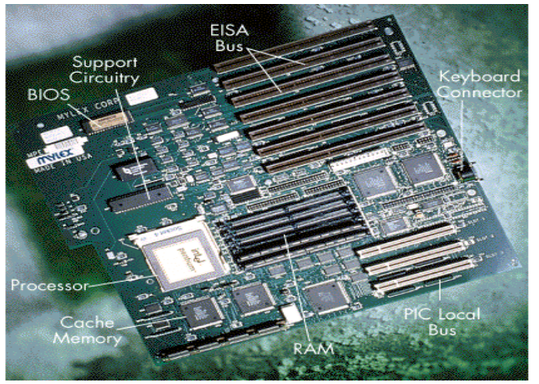
Dördüncü Nesil Bilgisayarlar: Mikroişlemci Çağı

- Ted Hoff'un 1971 yılında ilk genel amaçlı mikroişlemciyi üretmesi ile dördüncü kuşak bilgisayarlar ortaya çıkmaya başlamıştır.
- İlerleyen yıllarda, mikroişlemci üreticilerinin sayısı artmıştır.
- Intel, Texas, Zilog ve Motorola önde gelen mikroişlemci üreticileridir.
- İlk mikroişlemci olan Intel 4004, üçüncü kuşak bilgisayarlardan daha hızlı, daha küçük ve daha ucuz bilgisayarların yapımını sağlamıştır .
- Intel 4004 işlemcisi, bir mısır gevreği kadar küçük olmasına rağmen, ENIAC'ın işlem kapasitesi ve gücüne sahip olarak piyasada kullanılmıştır.
- Intel 4004'ün içinde, tek bir yonga üzerinde 2,800 transistör bulunmakta, saniyede 60,000 komutu işleyebilmekteydi.
- Intel, 4004 modelinden sonra ilk 8-bit mikroişlemci olan 8008 modelini piyasaya sürmüştür.



The Fourth Generation of Computers

- 1971-today
- VLSI (100,000's of components/chip)
- Development of the microprocessor
- Microcomputers and supercomputers
- VLSI (each wafer has 100-400 IC’s with millions of transistors on each one)
- Greater software versatility
- Increase in speed, power and storage capacity
- Parallel processing
- Artificial intelligence and expert systems
- Robotics
- Graphic User Interfaces (GUI)
- Microprocessor: programmable unit on a single silicon chip, containing all essential CPU components (ALU, controller)
- Microcomputer: small, low-priced, personal computer.
- Supercomputer: perform millions of operations per second and process enormous amounts of data. Costs in tens of millions of dollars.

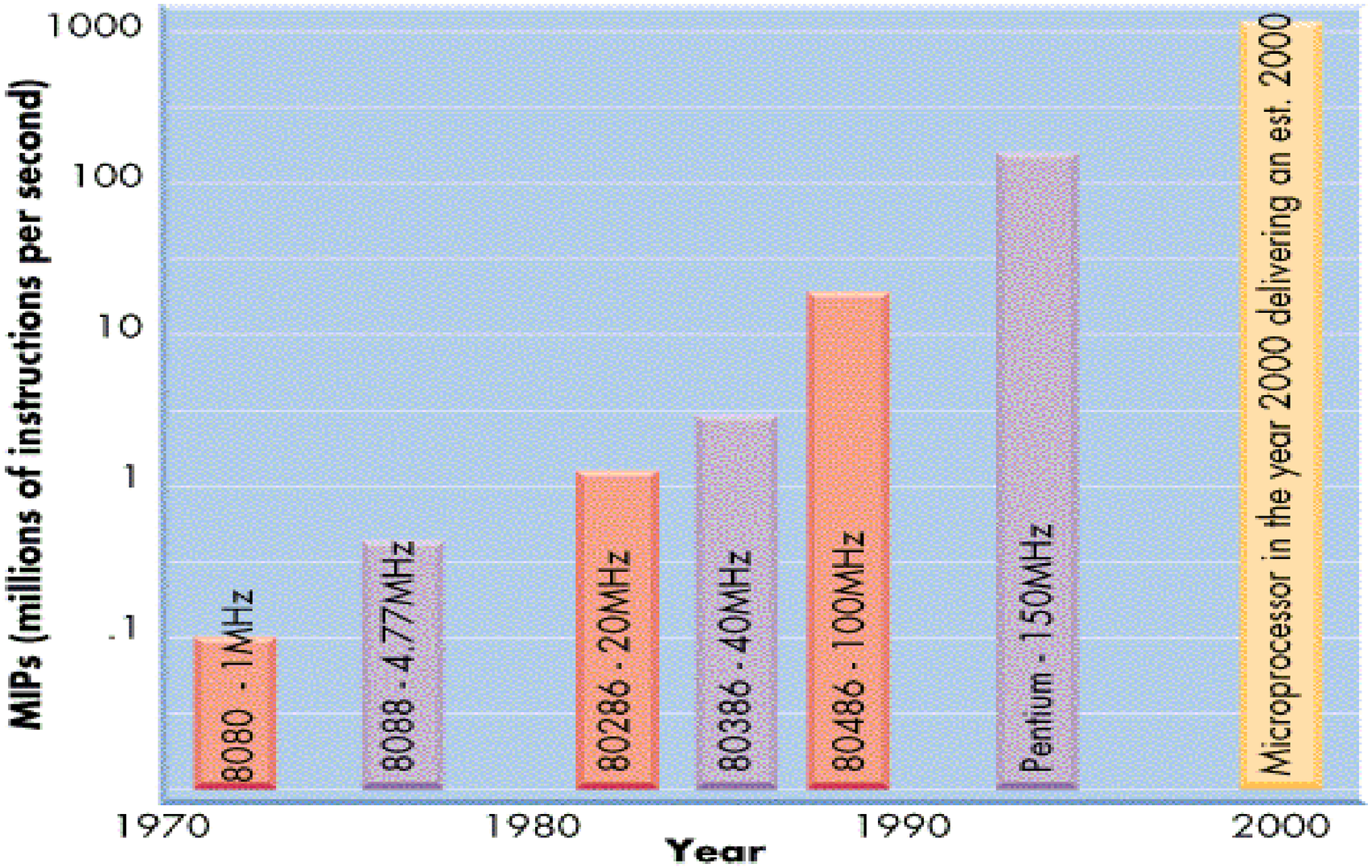


Environment “Generations”

- Environments
  - single process
  - batch process
  - time-shared
    - one powerful computer serving multiple users
  - personal computer
    - multiple individual computers
  - client/server
    - individual computers (clients) interacting with powerful computer providing services to multiple users (server)

“Mikroişlemcilerin Gelişim Süreci”

Processor speed growth



Microprocessor

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4 bit processors ⇒ 16 pins
8 and 16 bit processors ⇒ 40 pins
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Ability to address large memory spaces and I/O ports
Greater number of levels of subroutine nesting
Better interrupt handling capabilities

Intel 8085 (8 bit processor)

Third Generation
During 1978
HMOS technology ⇒ Faster speed, Higher packing density
16 bit processors ⇒ 40/ 48/ 64 pins
Easier to program
Dynamically relatable programs
Processor has multiply/ divide arithmetic hardware
More powerful interrupt handling capabilities
Flexible I/O port addressing

Intel 8086 (16 bit processor)

Fourth Generation
During 1980s
Low power version of HMOS technology (HCMOS)
32 bit processors
Physical memory space 2^{24} bytes = 16 Mb
Virtual memory space 2^{40} bytes = 1 Tb
Floating point hardware
Supports increased number of addressing modes
Intel 80386

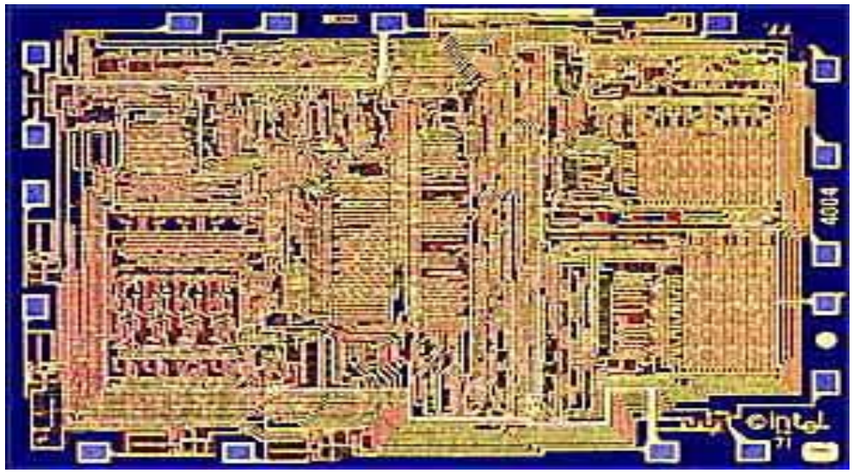
Fifth Generation Pentium

Microcomputer Processors

- Intel
  - Leading manufacturer of processors
  - Intel 4004 was worlds first microprocessor
  - IBM PC powered by Intel 8086
  - Current processors
    - Centrino
    - Itanium
    - Pentium
    - Core i7, Core i9
    - Xeon

In the beginning (8-bit) Intel 4004

- First general-purpose, single-chip microprocessor
- Shipped in 1971
- 8-bit architecture, 4-bit implementation
- 2,300 transistors
- Performance < 0.1 MIPS
  (Million Instructions Per Sec)
- 8008: 8-bit implementation in 1972
  - 3,500 transistors
  - First microprocessor-based computer (Micral)
    - Targeted at laboratory instrumentation
    - Mostly sold in Europe



Motorola, MOS, Zilog ve Intel Rekabeti

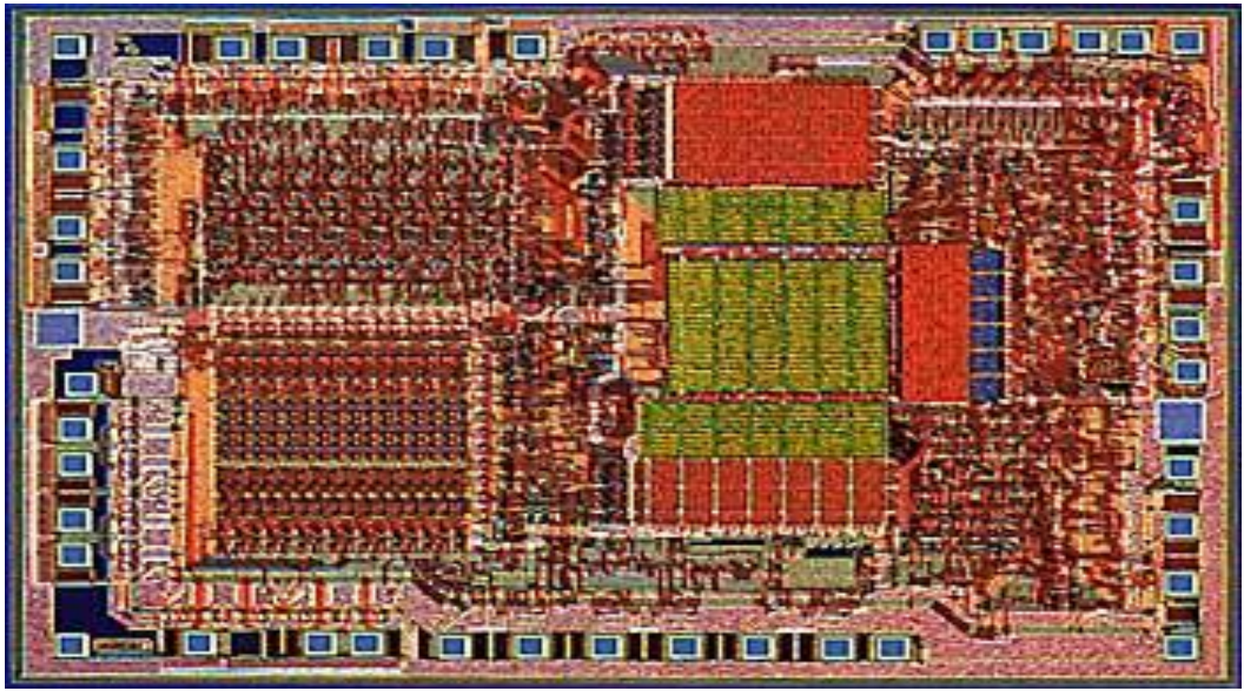
- 1974 yılında Motorola 8-bit'lik 6800 mikroişlemcisini piyasaya sürmüştür.
- MOS Technologies Apple-II ve Commodore kişisel bilgisayar sistemlerinde kullanılan 6502 işlemciyi üretmişlerdir.
- 1976 yılında Zilog, ilk bilgisayar sistemlerinde kullanılan ve 8080 mikroişlemcinin daha geliştirilmiş bir modeli olan Z80 işlemcisini üretmiştir.
- Aynı yıl, Intel, 8080 işlemcisinin daha gelişmiş bir modeli olan 8085 modelini üretmiştir.
- Intel mikroişlemcileri genellikle Windows işletim sistemi kullanan bilgisayarlarda, 8086, 8088, 80286, 80386, 80486, Pentium ve Itanium şeklinde adlandırılarak kullanılmışlardır.
- Motorola mikroişlemcileri ise Apple MacIntosh bilgisayarlarda kullanılan 68000 serisi ile 1990ların başında görülen PowerPC mikroişlemcileri şeklinde kullanılmışlardır.

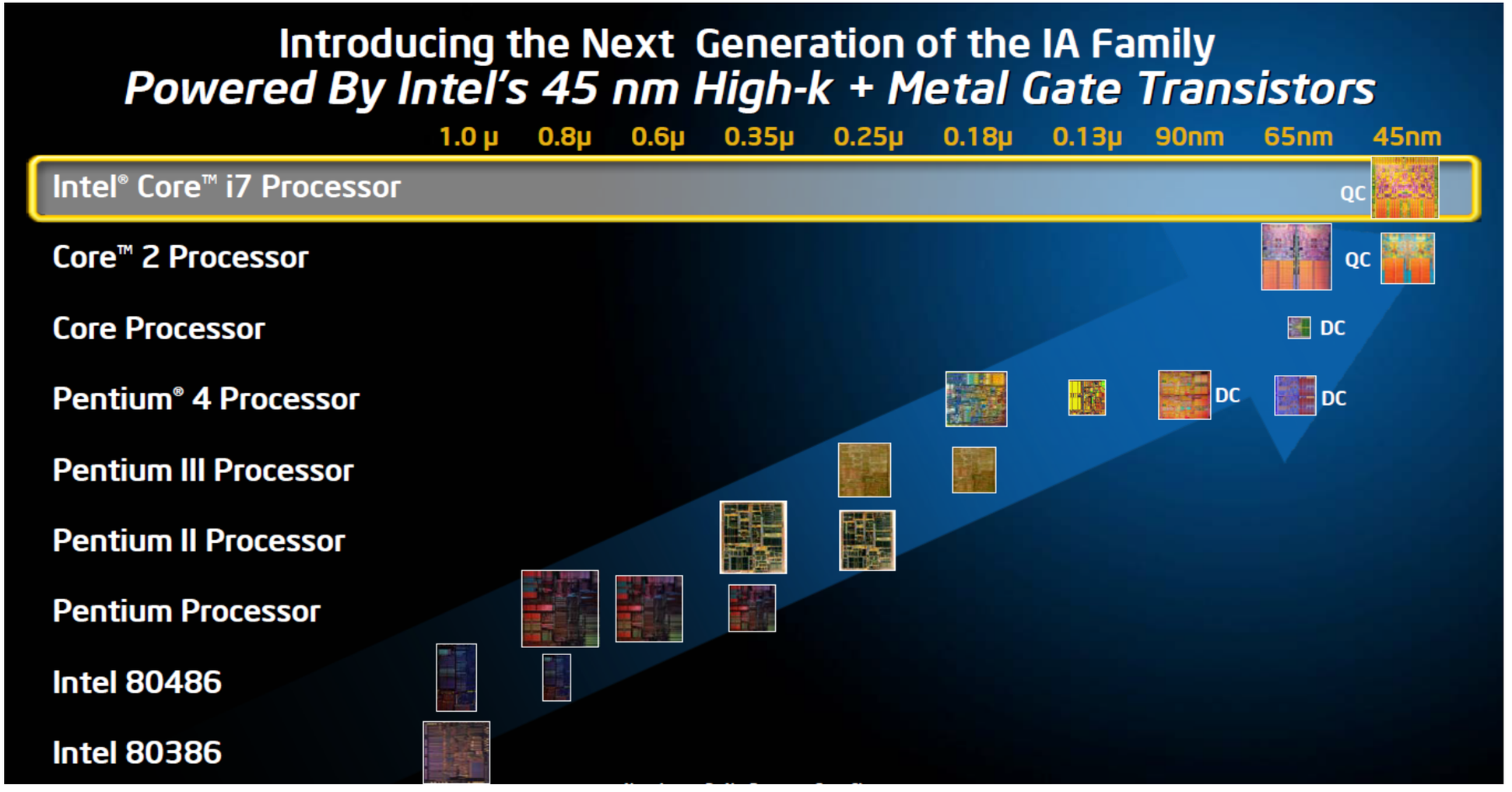
Typical microprocessors

- Most commonly used
  - 68K - Motorola
  - X86 - Intel
  - IA-64 - Intel
  - MIPS - Microprocessor without interlocked pipeline stages
  - ARM - Advanced RISC Machine
  - PowerPC - Apple-IBM-Motorola alliance
  - Atmel AVR

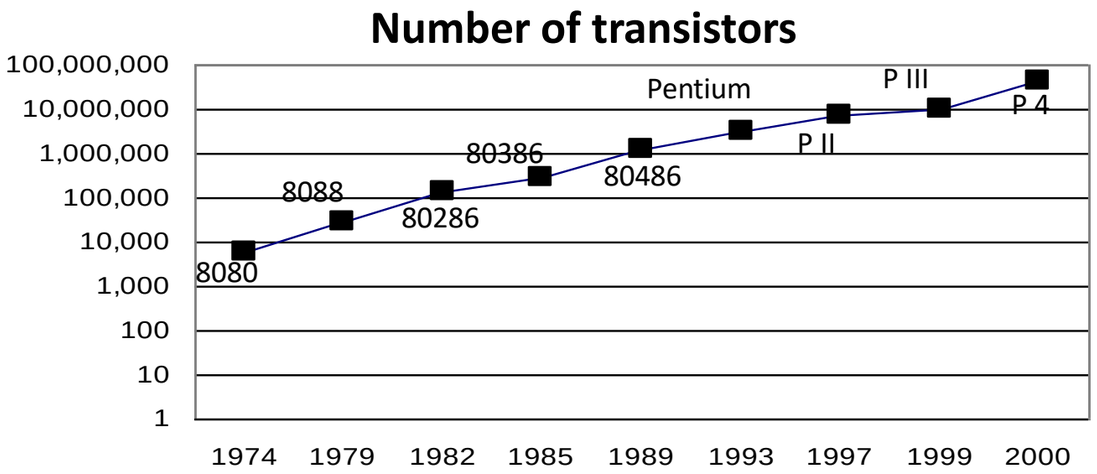
1st Generation (16-bit) Intel 8086

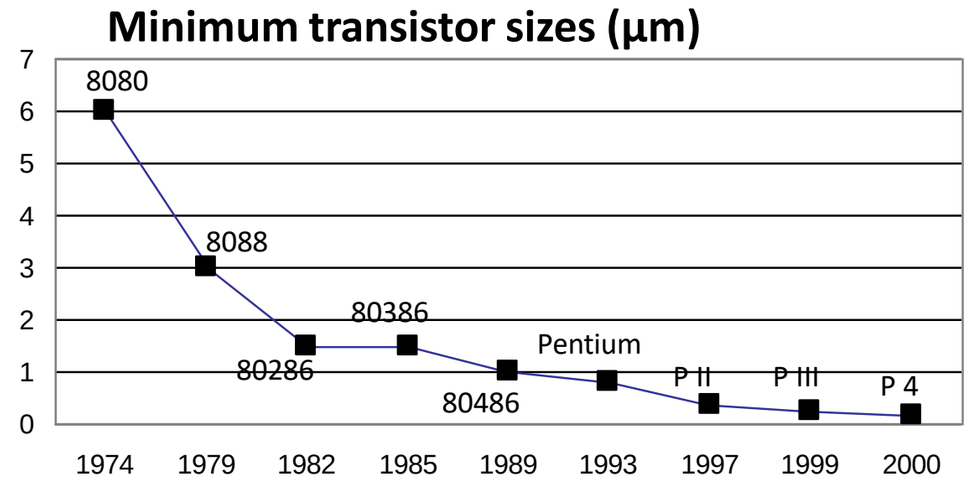
- Introduced in 1978
  - Performance < 0.5 MIPS
- New 16-bit architecture
  - “Assembly language” compatible with 8080
  - 29,000 transistors
  - Includes memory protection, support for Floating Point coprocessor
- In 1981, IBM introduces PC
  - Based on 8088--8-bit bus version of 8086

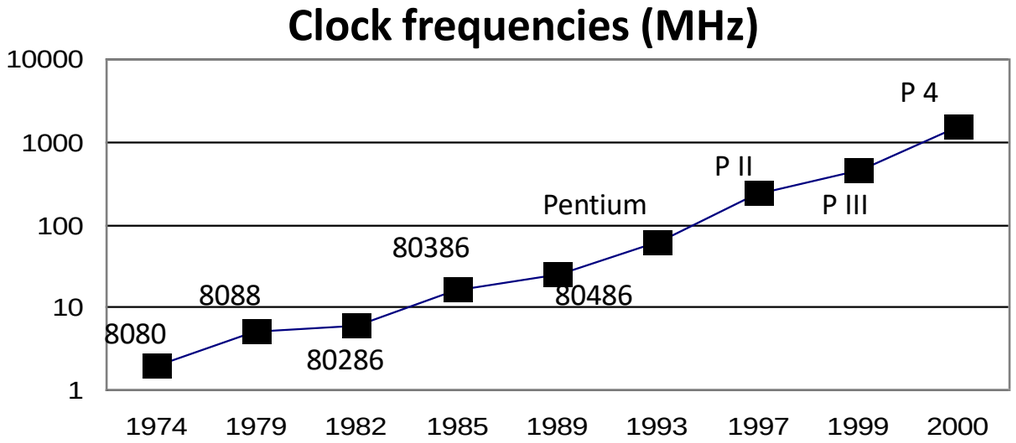


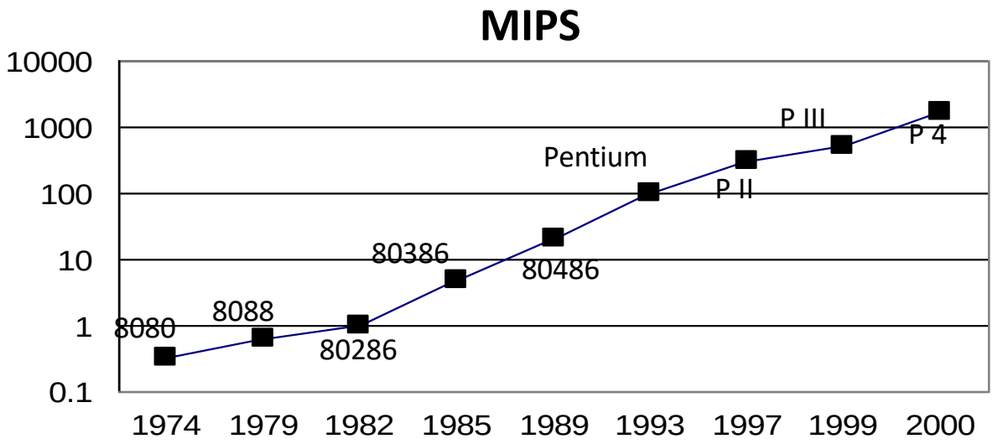

Introducing the Next Generation of the IA Family
Powered By Intel's 45 nm High-k + Metal Gate Transistors
1.0 µ
0.8µ
0.6µ
0.35µ
0.25µ
0.18µ
0.13µ
90nm
65nm
45nm
Intel® Core™ i7 Processor
QC
Core™ 2 Processor
QC
Core Processor
DC
Pentium® 4 Processor
DC
DC
Pentium III Processor
Pentium II Processor
Pentium Processor
Intel 80486
Intel 80386

Evolution of Intel Microprocessors



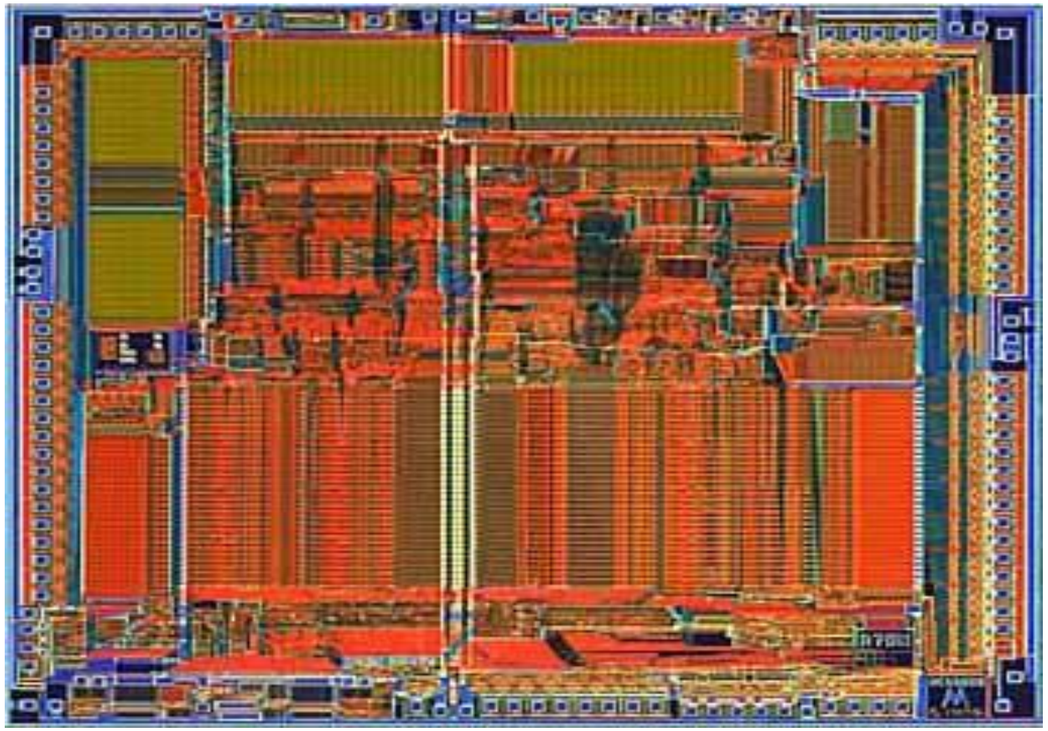






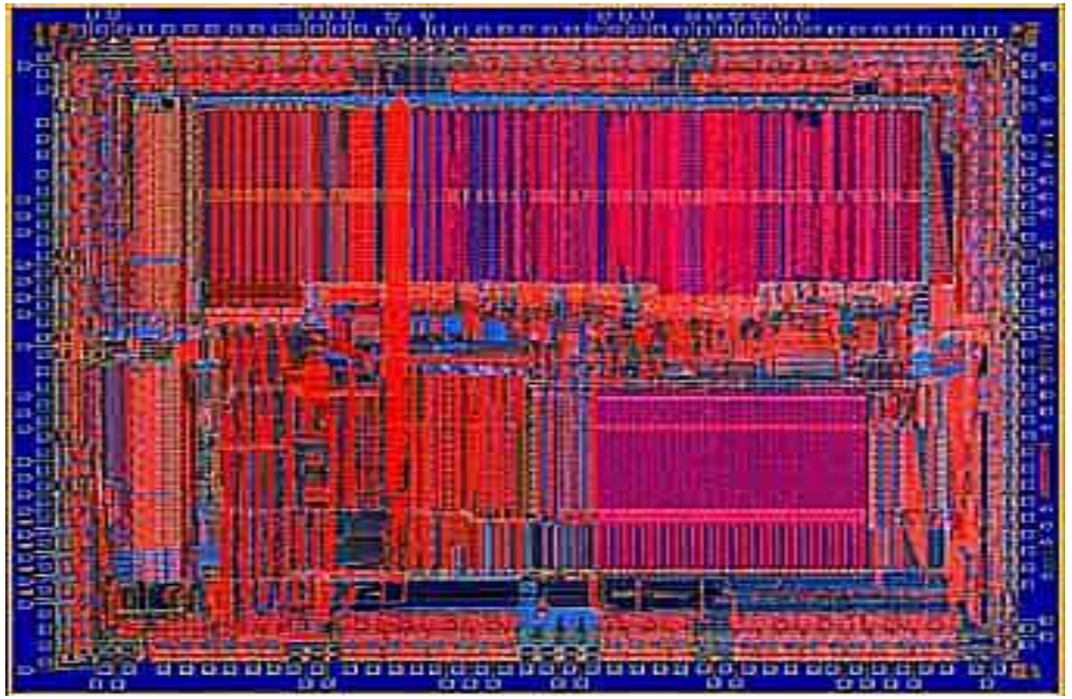
2nd Generation (32-bit) Motorola 68000

- Major architectural step in microprocessors:
  - First 32-bit architecture
    - initial 16-bit implementation
  - First flat 32-bit address
    - Support for paging
  - General-purpose register architecture
    - Loosely based on PDP-11 minicomputer
- First implementation in 1979
  - 68,000 transistors
  - < 1 MIPS (Million Instructions Per Second)
- Used in
  - Apple Mac
  - Sun , Silicon Graphics, & Apollo workstations



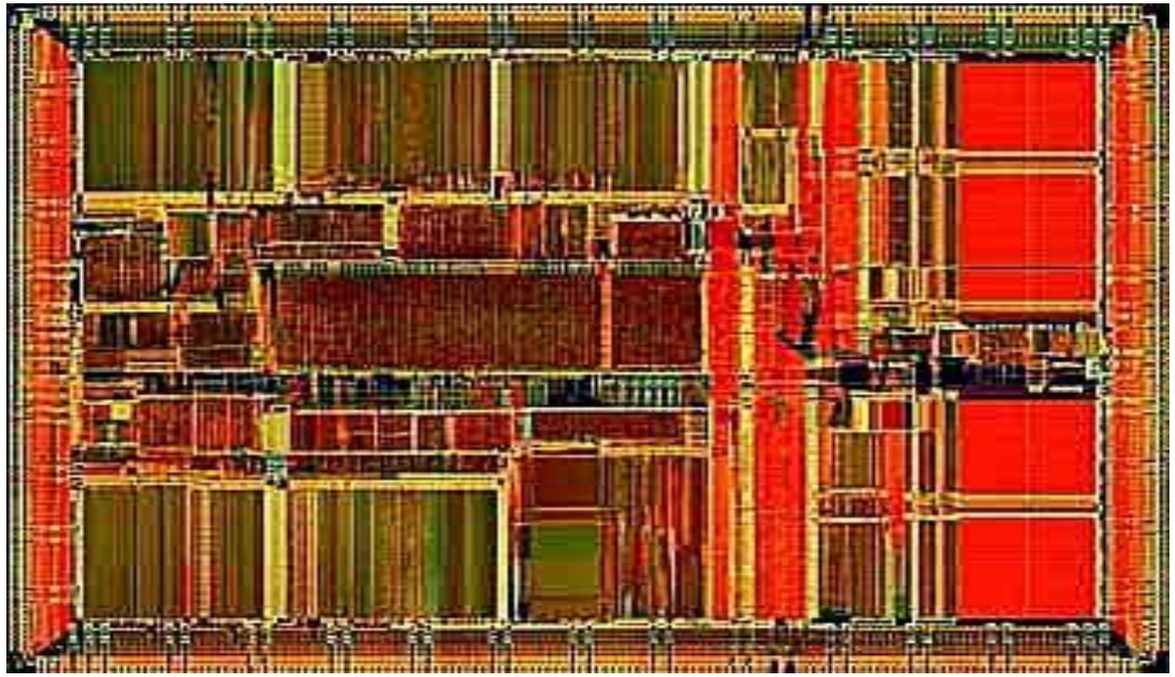
3rd Generation: MIPS R2000

- Several firsts:
  - First (commercial) RISC microprocessor
  - First microprocessor to provide integrated support for instruction & data cache
  - First pipelined microprocessor (sustains 1 instruction/clock)
- Implemented in 1985
  - 125,000 transistors
  - 5-8 MIPS (Million Instructions per Second)



4th Generation (64 bit) MIPS R4000

- First 64-bit architecture
- Integrated caches
  - On-chip
  - Support for off-chip, secondary cache
- Integrated floating point
- Implemented in 1991:
  - Deep pipeline
  - 1.4M transistors
  - Initially 100MHz
  - > 50 MIPS
- Intel translates 80x86/ Pentium X instructions into RISC internally



İlk Üçüncü Kuşak Programlama Dilleri

- Programcıların istedikleri işlemleri kolay yapabilmelerine imkan sağlayacak programlama dil arayışları da sürmekte idi.
- İlk olarak FORTRAN (Formula Translator) programlama dili mühendislik hesapları için ortaya çıktı
- Ticari uygulamalarda kullanılmak üzere COBOL (Common Business Oriented Language) programlama dili ortaya çıktı.
- Diğer programlama dilleri bu dilleri takip etti. Pascal, C, C++, Python, Assemble, Matlab

Öğrenerek Karar Veren Gezgin Otonom Makineler

Ölçerseniz Yönetirsiniz

- Mesafe ölçümleri günlük hayatta alışık olduğumuz boyutlarda kolaydır; bir masanın uzunluğunu basit bir cetvel kullanarak rahatlıkla ölçebiliriz. Ancak mesafeler küçüldükçe veya büyüdükçe, elimizdeki cetvellerin hassasiyeti yetersiz olmaya başlar.
- Güneş'in Dünya'ya olan uzaklığını hiçbir cetvelle ölçemeyiz. Yapılması gereken, fizik yasalarını kullanarak elde edilmiş yeni bir astronomik cetvel icat etmektir.
- Yıldızlar, hidrostatik dengedeki dev plazma toplarıdır. Kütleçekimi içeriye doğru basınç uygulayıp yıldızı çökertmeye çalışırken, yıldız içerisindeki nükleer reaksiyonlar neticesinde oluşan ışınım basıncı da buna karşı koyar. Bir yıldız ömrünün büyük kısmında hidrojeni helyuma dönüştürerek ışınım basıncı elde eder. Helyuma dönüştürecek hidrojen kalmadığında ise yakıt olarak helyum kullanılır ve helyumdan karbon füzyonu elde edilir.

Nanobilgisayar

- Bilim adamları nanoteknolojiyi çok küçük yongalar ve mantık kapıları yapmak için kullanmaya çalışıyorlar.
- Nanoteknoloji kullanılarak geliştirilecek yongalar daha küçük cihazların yapılmasını sağlayacaktır.
- Sadece birkaç atomdan oluşacak ve nanoteller olarak adlandırılan elektrik iletkenleri sadece bir atom kalınlığında olacak ve bir veri biti bir elektronun superpozisyonu ve dolanıklığı ile temsil edilecektir.
- Uçan, Yüzen, yürüyen bütünleşik nanorobotların insan tıbbının geleceğinin bir parçası olacağı tahmin edilmektedir.

MIT Biomechatronics - Hugh Herr

- 17 yaşında Amerika’nın en iyi dağcıları arasına giriyor. Ne var ki bir dağ tırmanışında, fırtınaya yakalanıp donduğu için bacakları kesiliyor. Şu anda ölümsüz bacakların sahibi! "Önemli olan yeteneklerdir, yetersizlikler değil", Andrew Carnegie .
- Hugh Herr, doğal uzuvların işlevini taklit eden biyonik uzuvlar geliştiriyor.
- Herr, fiziksel engelli kişilere daha fazla hareketlilik ve yeni bir umut sağlayan biyonik uzuvlarda çığır açan ilerlemelerden sorumludur.
- Herr'in ekibi, insan yürüyüşünün metabolik maliyetini düşürmek için ilk otonom dış iskeleti geliştirdi.Herr's Biomechatronics grubu, düşük ayak, felç, serebral palsi ve multipl sklerozun neden olduğu bir yürüyüş patolojisi olan hastalar için, transfemoral amputeler için yürüyüşe uyumlu diz protezleri ve değişken empedans ayak bileği-ayak ortezleri geliştirdi.
- Ayrıca BiOM Ayak Bileği Sistemi adı verilen dünyanın ilk biyonik alt bacağı olan kendi biyonik uzuvlarını da tasarladı. Royal Society'nin 2012 Tutanaklarında yayımlandığı gibi, BiOM Ayak Bileği Sisteminin biyomekanik ve fizyolojik normalizasyon sağlayan ilk bacak protezi olduğu ve bacak amputasyonu olan kişilerin bacakları gibi normal hız ve metabolizma seviyelerinde yürümelerine izin veren klinik olarak gösterilmiştir.
- Biyomekanikler, sıradan protezlerden farklıdır. Teknolojik sentetik deriler ana gövdeye bağlanarak ne yapılmak istenildiğini anlıyor ve ona göre hareket ediyorlar. Hatta, o kadar iyi hareket ediyorlar ki, engeli olmayan insanlarla yapılan denemelerde, destek ünitelerinin, biyolojik uzuvlarınızdan daha iyi çalışıyor oldukları ortaya çıkıyor. Düşünebiliyor musunuz, yapılan çalışmalarla, bir dansçıyı tekrar dans ettirecek kadar hassas biyomekanik uzuvlar yaratılabiliniyor.

IoT- Nesnelerin İnterneti

- IoT (Internet of Things) , nesnelerin interneti, farklı protokolleri kullanarak birbirleri ile akıllı ağ yapısında haberleşen ve algılayıcılardan toplanan verilerden bilgi üreten akıllı nesnelerdir. Gezgin (mobil) ağlar ve internetin gelişimiyle birlikte akıllı nesnelerin kişiler ile iletişim kurmaları kolaylaştı ve insanlar da onları her yerden, her zaman gözlemleme ve kontrol etme şansına sahip oldu.
- Yakın gelecekte akıllı nesneler sayesinde ortaya çıkacak veri miktarı inanılmaz derecede arttacak ve bu büyük verilerin çözümlenerek işlenmesi zor ve karmaşık hale gelecektir. Otonom yazılımlar stratejik rol oynayacaktır.
- Verilerin gizliliği ve güvenliği de önemli bir konu olarak karşımıza çıkmaktadır.
- Karşılıklı etkileşimin her nesnenin içine gireceği ve farklı nesnelerin ortak amaçlar için gezgin hareket edeceği bir döneme gireceğiz.
- Bu arada insanların fizyolojik ve psikolojik olarak bu değişime nasıl karşılık vereceği de önemli soru olarak kendini göstermektedir.
- Sürücüsüz araçlarda, insanlar can güvenliklerini nesneler teslim etmişlerdir.

Yapay Zeka

- “Yapay Zeka” terimi 1956 yılında Massachusetts Teknoloji Enstitüsü'nden John McCarthy tarafından oluşturuldu. Bilgisayarların insan gibi davranmasını amaçlayan bilgisayar biliminin bir dalıdır.
- Yapay Zeka, gerçek yaşam durumlarında karar veren makineler geliştirmek için, insan dillerini anlamak, etkileşimli oyunlar oynamak için bilgisayarların programlanmasıdır.
- Bilgisayarları duyusal uyaranları duymak, görmek ve bunlara tepki vermek üzere programlamak ve insan beynindeki nöronlar (sinir ağları) arasındaki fiziksel bağlantı türlerini yeniden üretmeye çalışarak insan zekasını taklit eden sistemler tasarlamak.
- Bilgisayar kontrollü robotik organlar geliştirmek.

Yapay Zeka

- İnsanlarda öğrenme süreci, beyindeki biyolojik nöron ağlarının birbirleri arasında kurduğu sınırsız bağlantılar aracılığıyla oluşur. Beyne gelen her yeni uyarı, sinir ağları arasında yeni bağlantılar oluşturarak, nöronlar arasındaki ilişkilerin yeniden düzenlenmesine yol açar. Neticede belli bir görevin sürekli tekrarlanması, bu göreve dair nörolojik bağlantıların güçlenmesini beraberinde getirir ve öğrenme gerçekleşir. Öğrenme bir kez gerçekleştikten sonra, beyin yeni uyarılara karşı vereceği tepkileri değerlendirirken daha önce oluşan bu bağlantıları da dikkate alır.

- Yapay zekânın temelini oluşturan yapay sinir ağları, beynin biyolojik işleyiş biçiminin dar bir kapsamda, çok daha basit olarak taklit edilmesini temel alıyor. Öğrenmeye programlanmış yazılımlar istatistiksel veri analizi kullanarak tahminler yürütmeye çalışır.

Öğrenerek Karar Veren Makineler

- Bilgisayar kontrolündeki bir sistemin ya da cihazın faaliyetlerini insan zekasına benzer şekilde yerine getirme yeteneği kazandırılması için veri yığınından öğrenen zekanın geliştirilmesi makine öğrenmesi ile mümkün olabilir.
- Kendi kendine öğrenen matematiksel modeller ve algoritmalar ile veri yığınında insandan bağımsız otonom davranış geliştirilmesidir.
- Verilere dayalı tahminler ve otonom davranış desenleri (paternleri) geliştiren matematiksel modeller ve algoritmalar, makine öğrenmesinde bilgisayar sistemlerinin temel yazılımlarıdır.

Soruyorum:

- Karar veren, bir insanın zihninde neler olur?
- Karar veren kişi için hayati öneme sahip olan şey nedir?
- Karar verme işleminde insan beyninde anahtar işlev nedir?

Öğrenerek Karar Veren Makineler

- Yapay zekâ, ister makine öğrenmesi kullansın ister kullanmasın herhangi bir tahmin veya karar işlemini gerçekleştiren teknolojilerin genel adıdır. Genel kanaatin aksine yapay zekâ makine öğrenmesi veya derin öğrenme algoritmaları olmaksızın da çalışan bir algoritma olabilir. Makine öğrenmesi algoritmaları ortaya çıkana kadar yapay zekâ çalışmaları “hard-coded” olarak nitelendirilen yani tüm mantıksal ve matematiksel işlemlerin yazılımcı tarafından bizzat kodlandığı bir yapıya dayanmaktaydı. Örneğin ilk satranç oyuncusu yapay zekâ algoritmaları tamamen böyleydi. Yapay zekânın bu türü sembolik yapay zekâ olarak adlandırılmaktadır.
- Yapay zekanın en aktif olarak kullanıldığı alan kuşkusuz robot teknolojileridir. Yapay zekanın gelişmesi robot teknolojilerinin gelişimini de doğrudan etkiledi. Robotlarda gerçekleşen performans problemlerini kolay bir şekilde algılayabilen yapay zeka, ihtiyaç halinde sorunları giderebiliyor. Böylece robotlar kendini yenileyebiliyor.
- Makine öğrenmesini hard-coded olarak kodlanmış sembolik yapay zekâ algoritmalarından ayıran özellik algoritmanın tamamen veriden öğrenmesidir.
- Derin öğrenme modeli, verinin yapısına göre hangi parametrelere ne ağırlık verileceğini kendisi keşfetmektedir.

Öğrenerek Karar Veren Makineler

Öğrenerek karar veren makineler birer sistemdir ve sinyalleri işlerler, çıktı olarak da sinyal üretirler.

- İstatiksel veri analizi
- Olasılık
- Sinyaller ve Sistemler
- Algılayıcılar, ölçerler, transducer (güç çevirici, enerji aktarıcı)
- Uygulamalı matematik: Yörünge, Sapma, Kritik noktalar, kaotik davranış (Faz düzlemde diff. Denklemler)
- Filtre, Örnekleme, Analog – Sayısal dönüştürücüler
- Dönüştürücüler: Fourier, Laplace, Z
- Computer Organization (Mimari, Bellek, Bellek haritalama)
- Programlama: Matlab, C++, Python, Assemble
- Matematiksel modelleme, Algoritmalar, Kod üretme

Quantum Computer

Kuantum Hesaplama

- Makinenin makine (M2M – Mechine to Machine) ile iletişimi
- Nesnelerin interneti (IoT: Internet of Things)
- Kuantum Hesaplama (QC - Quantum Computing)
- Makine Öğrenmesi (ML – Machine Learning)
- QC destekli ML ve Quantum ML (QML)
- Gezgin Akıllı Makineler
- 5G / 6G

What is a Quantum Computer?

- Quantum Computer
  - Quantum süperpozisyon ve dolanma gibi cihazlar aracılığıyla veriler üzerinde işlemler gerçekleştirmek için kuantum mekaniği fenomeni kullanan bir bilgisayar.

- Classical Computer (Binary)
  - Tamamen klasik mekanik ile hesaplanabilen, devrelerden ve kapılardan geçen voltajı kullanan bir bilgisayar.

Quantum Computing

- Klasik bilgisayarlarda silikon tabanlı çipler kullanılırken, bilgiler elektriksel sinyaller ile taşınmakta, saklanmakta ve işlenmektedir.
- Kuantum bilgisayarlarda ise atom altı parçacıklar, foton veya elektron gibi kuantum sistemleri kullanılır. İşlemci, verileri çok hızlı işleyebilmesi için kuantalama hesaplama yaparken bitler elektronlar ya da fotonlar ile temsil edilmektedir.
- Elektronlar iletkenlerdeki bir atomdan diğerine akan elektrik akımını oluşur. 1 amperlik akımın oluşabilmesi için iletkenin herhangi bir noktasından 1 saniyede $6{,}25 \times 10^{18}$ elektron akması gerekir.
- Transistör elektron akışını kontrol eden, yarı iletken teknolojisinde üretilen bir devre elemanıdır. Mikrodalga tüpleri elektron akışını hızlandırıp yavaşlatır.
- Quantum bilgisayarlarda nanoteller olarak adlandırılan elektrik iletkenleri sadece bir atom kalınlığındadır ve bir veri biti bir elektronun superpozisyonu ve dolanıklığı ile temsil edilmektedir.
- Kuantum bilgi işlem, kuantum mekaniği kanunlarına göre davranır ve olasılık hesaplama, süper konum ve dolanıklık gibi kavramlardan yararlanır. Bu kavramlar, karmaşık sorunları çözmek için kuantum bilişiminin gücünden yararlanan kuantum algoritmalarının temelini oluşturur. Olasılık, tahmin ederek karar vermeye dönüştüğünden performansı artıracak yetenekler ve deneyimler kazandıran algoritmalara ihtiyaç duyulmaktadır.

Kuantum Makine Öğrenmesi

- Son yıllarda veri analizi uygulamaları ve akıllı makineler ilgili araştırmalar güçlü bir şekilde yeniden ortaya çıkmıştır.
- Bu güçlenen ilgi kısmen klasik hesaplama yöntemlerindeki gelişmeler ve kısmen de Kuantum Hesaplama (QC - Quantum Computing) ve ilgili kuantum teknolojileri tarafından sunulan muazzam paralellik potansiyelinden kaynaklanmaktadır.
- Hesaplama yöntemlerindeki bu gelişmeler, Makine Öğrenmenin (ML – Machine Learning), veri güdümlü öğrenme ve kuantum destekli hesaplama yöntemleri, hizmet odaklı tamamen akıllı bir iletişim ağının isteklerini gerçekleştirmede güçlü bir potansiyele sahiptir.
- Ortaya çıkan insan ve makine arası bağlantıyı artırma paradigmasında, ağ düğümü sayısı ve veri trafiğinde önemli bir artış beklenmektedir.
- Makine Öğrenmesi (ML) ve Quantum Hesaplama (QC) yöntemleri hacimli verilerin verimli bir şekilde işlenmesine yönelik olarak, Quantum ML (QML) teknolojilerini sağlayan yeni bir çerçeve sunacaktır.
- IOT
- 5G ve 6G

Kaynaklar

While preparing this document has been based on the document on the following web page;

- ‘’Architecture 8086 Microprocessor’’, http://www.pcpolytechnic.com/computer/ppt/micro/Chap%203_1.pptx
- *http://history.acusd.edu/gen/recording/computer1.html*
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- *http://www.computer50.org/kgill/transistor/trans.html*
- *The History of The Microprocessor, Bell Labs Technical Journal, Autumn, 1997*
- *http://www.intel.com*
- *www.cs.sjsu.edu/faculty/lee/chapter3_presentation2.ppt*
- *https://profs.basu.ac.ir/.../722.1869.file_ref.1998.2468.ppt*
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- *https://users.cs.jmu.edu/.../IntelProcessors4004ToPentiumPr...*
- *Microprocessor, Atul P. Godse, Deepali A. Gode, Technical publications, Chap 11*

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Sincerely,

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