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Computers' Evolution

Prof. Daniele Gorla

Mechanical Computers

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From the Abacus (3000 B.C.) to Charles Babbage (1812)

Abacus (China, 3000 BC) then Ancient Greece and Rome

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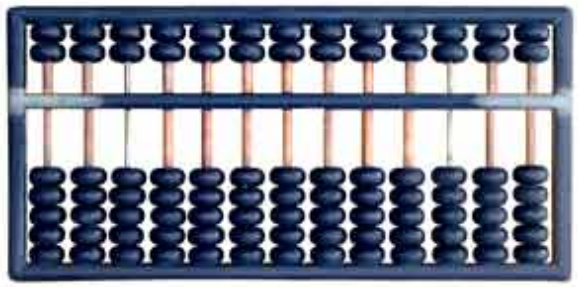

Napier (1617) (multiplications, divisions, roots)

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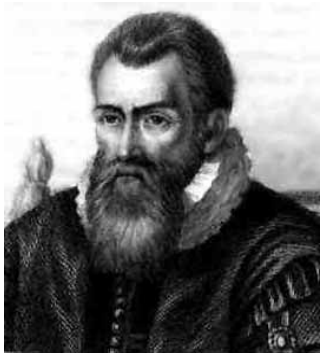

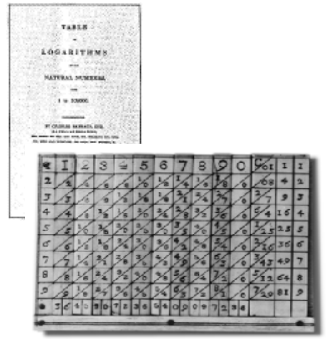

Picture courtesy IBM

Calculating machines by Oughtred (1621) and Schickard (1623)

Nepier's system through rolling mechanisms

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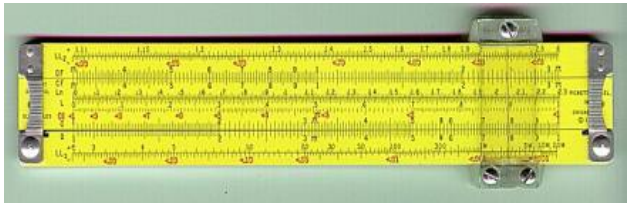

The "Pascaline" by Blaise Pascal (1645)

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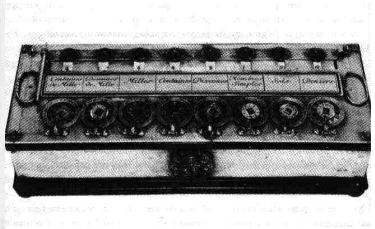
Sums and subtractions through dials rotations



Leibnitz (1674): First complete calculatrix

→ actually realized only 120 years after its proj ct

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Joseph-Marie Jacquard and looms controlled by punched cards (1804)

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Computers' Father: Charles Babbage (1791-1871)

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Inventor:

- Locomotive's pilot
- dynamometer
- Uniform postal rates
- Occulting lights in lighthouses
- Codes decrypting
- …

The Differential Machine (1823) for solving polynomials, never realized

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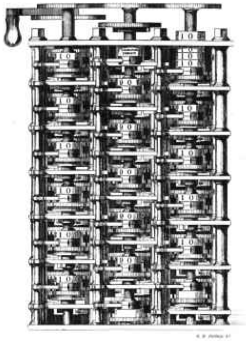

The analytical machine (1842)

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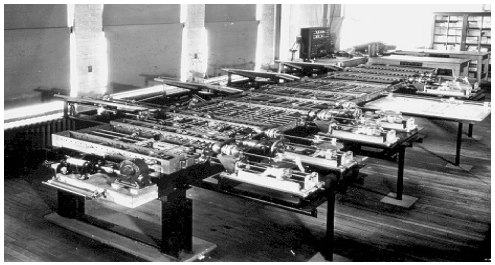
→ cal solve every calculation → programmable machine (!!!)
→ input from punched cards
→ arithmetical and control units



Lady Augusta Ada, Countess of Lovelace

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- Babbage's biographer
- programmer for its machine

Electro-mechanical Computers

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From Herman Hollerith (1890) to Howard Aiken (1944)

Herman Hollerith and the census count machine (1884)

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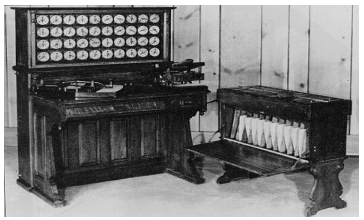
Characteristics:
→ punched cards for data collection
→ a sorting machine (right)
→ an elaborating machine (left)
→ cards were read through a matrix of electrical wires
(passing through a whole of the card,they activated an electrical connection)
→ count took3 months
instead of 7 years!!

Evolution:
→ Computer Tabulating Recording Company (1913)
→ 1918: the new leader becomes Thomas J. Watson
→ 1924: International Business Machines



Harvard Mark I (1944)
a.k.a. IBM Automatic Sequence Controlled Calculator (ASCC)

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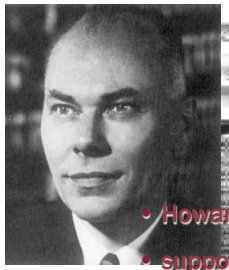
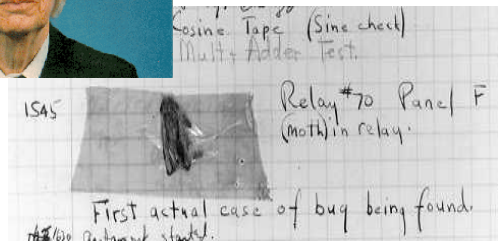


- Howard Aiken (physics from Harvard)
- supported from IBM
- mechanical relays
- 35 tons with 500 miles of wires (!!)

The first computer bug ☺

Rear Admiral Dr. Grace Murray Hopper (COBOL)



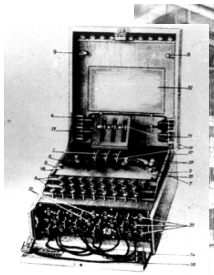
Electronical and Digital Computers

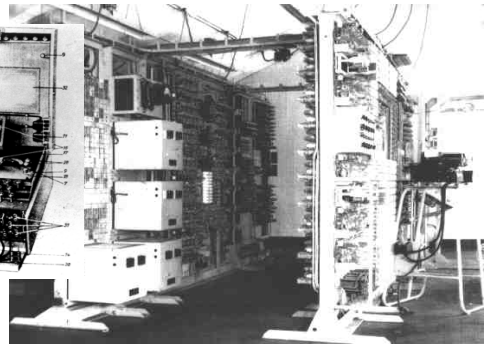
From John Vincent Atanasoff (1939) and Atanasoff-Berry Computer (ABC) to nowadays

Alan Turing
(1912 – 1954)

Turing Machine
That is
The Universal Machine
(1936)
→ works in binary
→ can solve every "solvable" problem
→ Mathematical model

Bletchley Park's Colossus (1943)





Enigma
(german)

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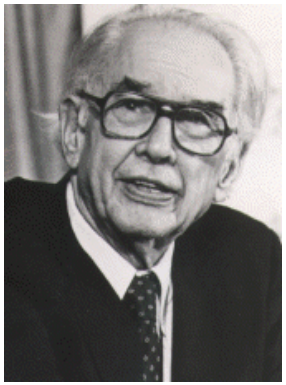

John Vincent Atanasoff (1903 – 1995)

Physics of the Iowa State University

1937: idea for the first modern computer

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Clifford Berry (1918 – 1963)

Atanasoff's PhD student

1939: a paper describing ABC

The Atanasoff-Berry Computer (ABC)

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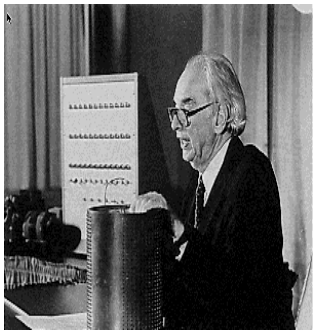

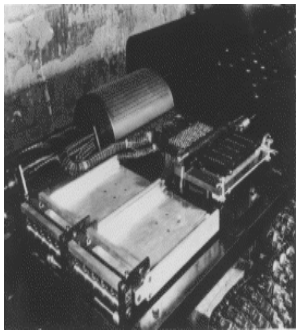

The first example of an electronic and digital computer realized

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1946
ENIAC

John Presper Eckert (1919-1995)
John Mauchly (1907-1980)

University of Pennsylvania Moore School of Engineering

ENIAC
Electronic Numerical Integrator and Computer

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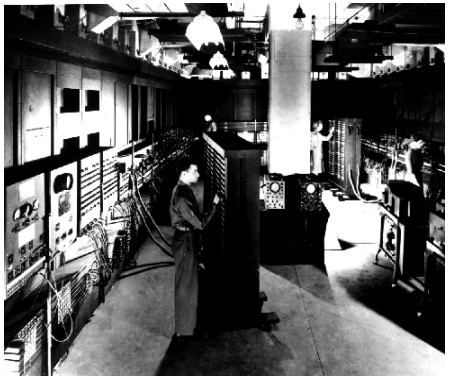

- 30 tons
- 18000 tubes
- performances of a current PC

Programming ENIAC

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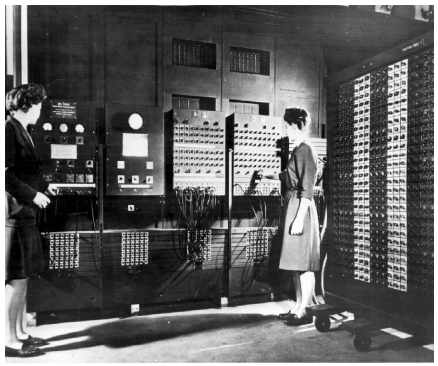

programming
=
Manually changing electonic connections

Von Neumann's Machine

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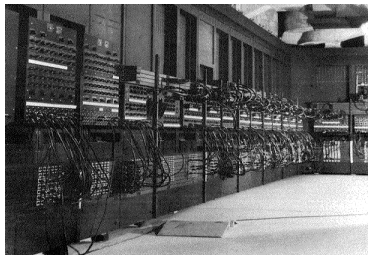

Using part of the computer internal memory to "store" the program.

The computer then retrieves the instructions from its memory and runs them.

Von Neumann's Architecture

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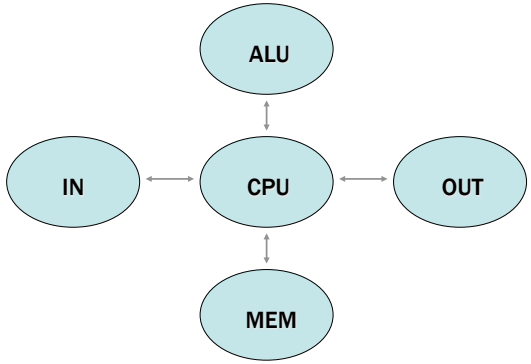

Costs (1968)

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Model	Description	Purchase Price	Installation Fee
3011-95	1108 CPU	$566,460	$2,200
7005-72	131 K word Core Memory	$823,500	$2,250
5009-00	FASTRAND^{tm} Controller	$41,680	$600
6010-00	FASTRAND II Storage Unit	$134,400	$1,080
5012-00	FH-432/FH-1782 Drum Controller	$67,360	$600
6016-00	FH-432 Drum (capacity 262,144 words)	$34,640	$480
6015-00	FH-1782 Drum (capacity 2,097,152 words)	$95,680	$540
4009-99	Console (TTY-35)	$29,365	$200

Overall: $1.801.035, i.e. around 10 MILIONS DOLLARS today

Valves (1941 – 1956)

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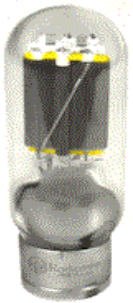
First Generation Electronic Computers

Designed by Lee de Forrest in 1907

used in ABC and ENIAC

Glass tubes that contain circuits with the vacuum inside, to protect the Electronic components



Transistors (1956-1963)

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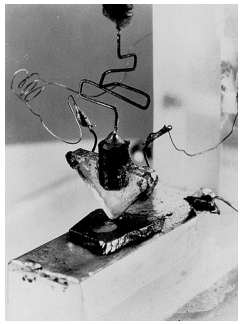
Second Generation Computers

silicon

1948: William Shockley and his group at the Bell Labs (Nobel)

on-off swtiches

Higher speed because of the smaller dimensions w.r.t. valves



Integrated circuits (1963-1971)

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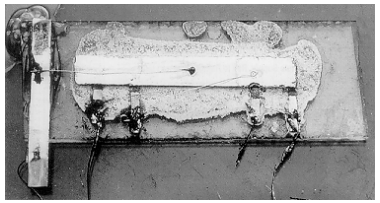
Third Generation Computers

Integrated Circuits (chips) are transistors, resistors and capacitors integrated together



Very Large Scale Integrated Circuit (VLSI), 1971 - today

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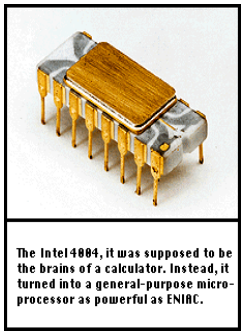
Kilby and Noyce (founders of Intel)

INTEL 4004 Microprocessor (designed by Hoff)

- 2,250 transistors
- 4 bits words (1 or 0)
- 108 Khz
- called “Microchip”



The Intel 4004, it was supposed to be the brains of a calculator. Instead, it turned into a general-purpose micro-processor as powerful as ENIAC.

Personal Computer (1)

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MITS Altair - 1975

- 256 bytes memory
- chip Intel 8080 2 MHz
- A box with lights
- Cost: $395 kit, $495 assembled

PC (2)

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IBM PC – 1981

- joint venture IBM-Intel Microsoft
- First commercial PC
- 8088 Microchip - 29,000 transistors
- 4.77 Mhz Processor
- 256 K RAM standard
- 1 or 2 floppy disk drives

PC (3)

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Apple II (1977)

- Spread in schools

Macintosh (left - 1984)

- Microchip processor Motorola 68000
- First commercial compuetr with graphical user interface (GUI) and mouse

Summing up: Evolution of modern computers

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	UNIVAC (1951-1970) (1968 vers.)	Mits Altair (1975)	IBM PC (1981)	Macintosh (1984)	Pentium IV
Circuits	Integrated Circuits	2 Intel 8080 Microchip	Intel 8088 Microchip - 29,000 Transistors	Motorola 68000	Intel P-IV Microchip - 7.5 million transistors
RAM Memory	512 K	265 Bytes	256 KB		256 MB
Speed	1.3 MHz	2 KHz	4.77 MHz		3200 MHz = 3.2 GHz
Storage	100 MB Hard Drive	8” Floppy Drive	Floppy Drive	Floppy Drives	Hard Drive, Floppy, CD-Rom
Size	Whole Room	Briefcase (no monitor)	Briefcase + Monitor	Two shoeboxes (integrated monitor)	Small Tower
Cost	$1.6 million	$750	$1595	~$4000	$1000 - $2000