Introduction to Computer Science

BSc in Computer Science
University of New York, Tirana

Assoc. Prof. Dr. Marenglen Biba

General info

- **Course : Intro to CS (3 credit hours)**
- **Instructor : Assoc. Prof. Dr. Marenglen Biba**
- **Office : Faculty building 2nd floor**
- **Office Hours : Thursday 15-17 or by appointment**
- **Phone : 42273056 / ext. 112**
- **E-mail : marenglenbiba@unyt.edu.al**
- **Course page : http://www.marenglenbiba.net/introcs/**
- **Course Location and Time**
- Laboratory Room 4B, Wed. 14-17.

Course description

- This module covers essential concepts of computer science at an introductory level.
- Students are introduced to the history and evolution of computing and to the impact of information technology on the society.

Course Outcomes

- At the end of the course students will be able to:

- Understand and distinguish the main **historical milestones** in the evolution of computer science
- Understand the **impact of computer science** in society in the past and in the future
- Understand and describe how computers perform **basic operations**
- Understand and describe simple **problem-solving strategies** and how these can be implemented through computers
- Understand general principles of **networking**, Internet and World Wide Web

Required Readings

- Glen Brookshear. Computer Science: an overview. 11th Edition. Addison Wesley, 2012.

Content of the Course

- History of computing systems
- History of modern computers
- Introduction to modern computer systems
- Introduction to how computers work: basics of computer architecture
- Introduction to operating systems
- Introduction to problem solving, algorithms and programming
- Introduction to networks, Internet and World Wide Web
- Social aspects of computers and information technology

Assumptions for this Class

- ESL III

Grading Policy

Assignments	30%
Midterm	30%
Final	40%

What happens if I don't participate in the classes and exercises?

- Reasons of failure
  - Lack of concentration?
  - Lack of continuity?
  - Lack of determination?
  - Lack of target?
  - Lack of fortune?
  - Lack of work?
  - …
  - …
- Response
  - Hard work will help!!!

Recommendations

- Start studying now
- Do not be shy! Ask any questions that you might have. Every questions makes you a good candidate.
- The professor is a container of knowledge and the goal is to get most of him, thus come and talk.
- Respect the deadlines
- Respect the appointments
- Try to study from more than one source, Internet is great!
- If you have any problems come and talk with me in advance so that we can find an appropriate solution

GOOD LUCK!

Outline of Lesson 1

- What is Computer Science?
- Evolution of Computing Machines

PART I – What is Computer Science?

- The Role of Algorithms
- The Origins of Computing Machines
- The Science of Algorithms
- An Outline of Our Study
- Social Repercussions

What is Computer Science

- Computer science is the discipline that seeks to build a scientific foundation for such topics as:
  - computer design
  - computer programming
  - information processing
  - algorithmic solutions of problems
  - algorithmic process itself.
- Draws from other subjects, including
  - Mathematics
  - Engineering
  - Psychology
  - Physics
  - Social science

- The science of **algorithms**

What is CS?

- *Computer Science is the study of algorithms, including*
  - *Their formal and mathematical properties*
  - *Their hardware realizations*
  - *Their linguistic realizations*
  - *Their application*

Big ideas about CS

- “Computing is no more about the study of computers than astronomy is about telescopes” [Edsger Dijkstra]
- “Computer Science is not equal to programming” [Andre deHon]

Terminology

- **Algorithm:** A set of steps that defines how a task is performed
- **Program:** A representation of an algorithm
- **Programming:** The process of developing a program
- **Software:** Programs and algorithms
- **Hardware:** Equipment

History of Algorithms

- The study of algorithms was originally a subject in mathematics.
- Early examples of algorithms
  - Euclidean Algorithm
    - Compute the greatest common divisor of two values.
- **Gödel's Incompleteness Theorem**: Some problems cannot be solved by algorithms.☺

Figure 0.2 **The Euclidean algorithm**

Description: This algorithm assumes that its input consists of two positive integers and proceeds to compute the greatest common divisor of these two values.

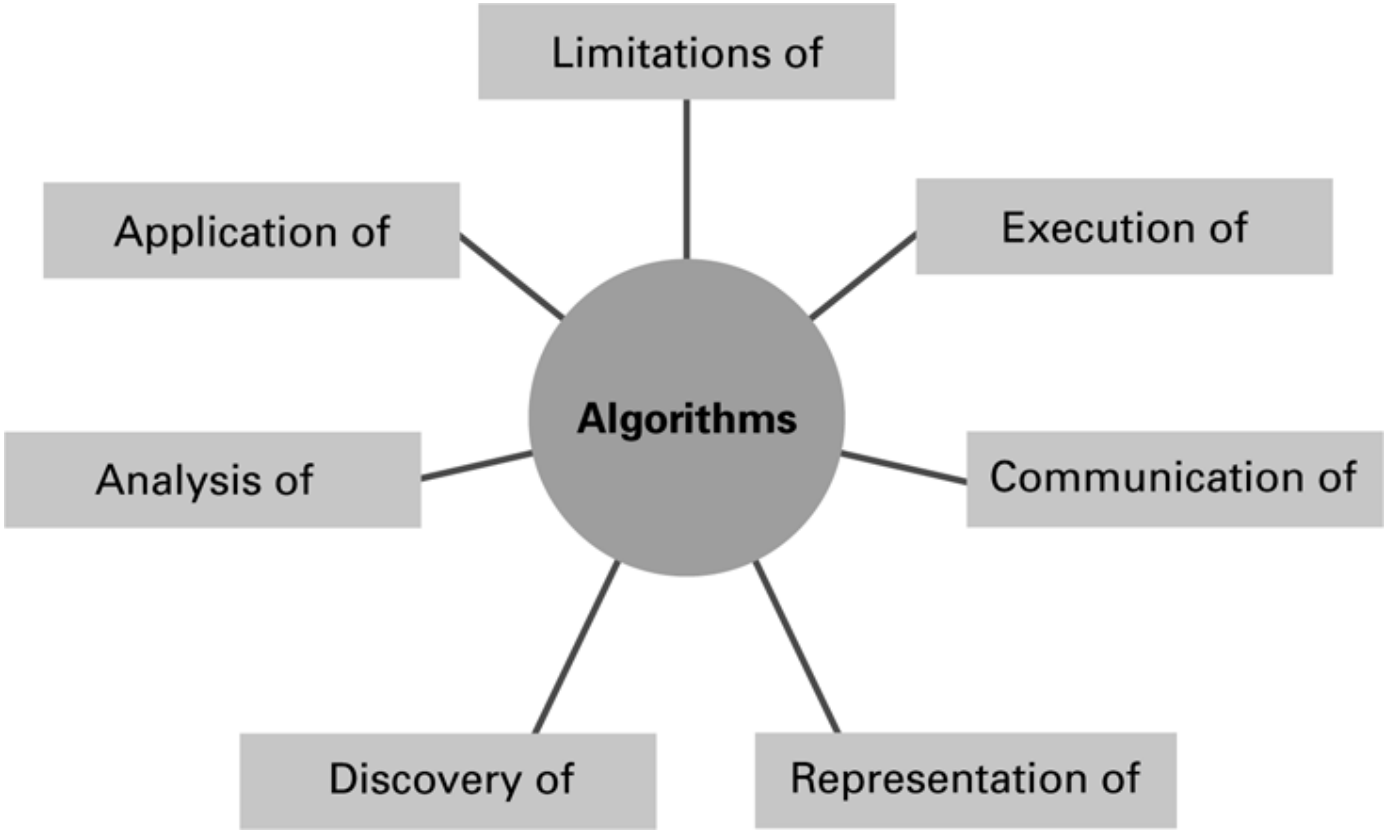
Procedure:

Step 1. Assign M and N the value of the larger and smaller of the two input values, respectively.

Step 2. Divide M by N, and call the remainder R.

Step 3. If R is not 0, then assign M the value of N, assign N the value of R, and return to step 2; otherwise, the greatest common divisor is the value currently assigned to N.

Figure 0.5 The central role of algorithms in computer science



Algorithms and programming

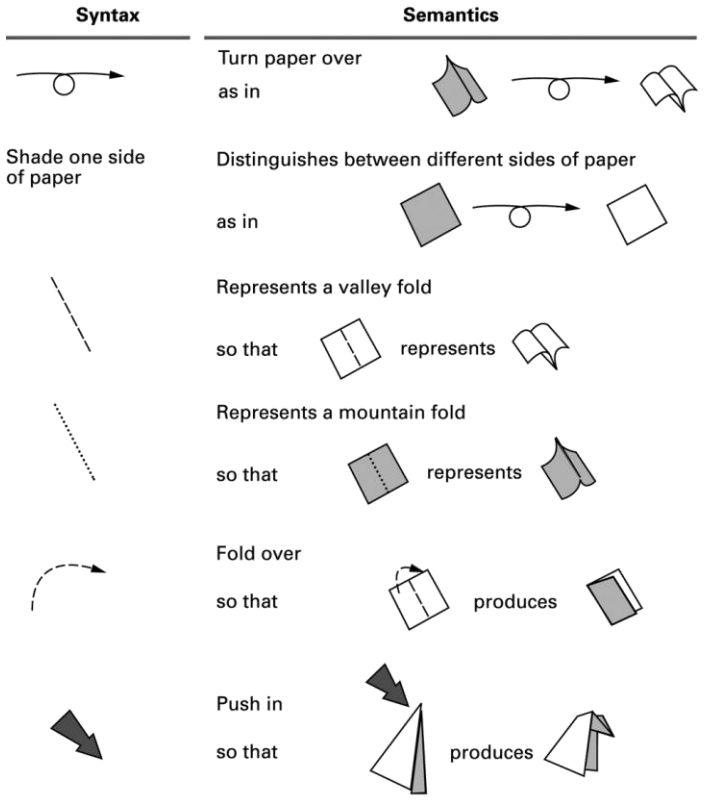
- Some algorithms:
  - for cooking (called recipes),
  - for finding your way through a strange city (more commonly called directions),
  - for operating washing machines
  - for playing music (expressed in the form of sheet music), and
  - for performing magic tricks.
- Before a machine such as a computer can perform a task, an algorithm for performing that task must be **discovered and represented in a form that is compatible with the machine**.

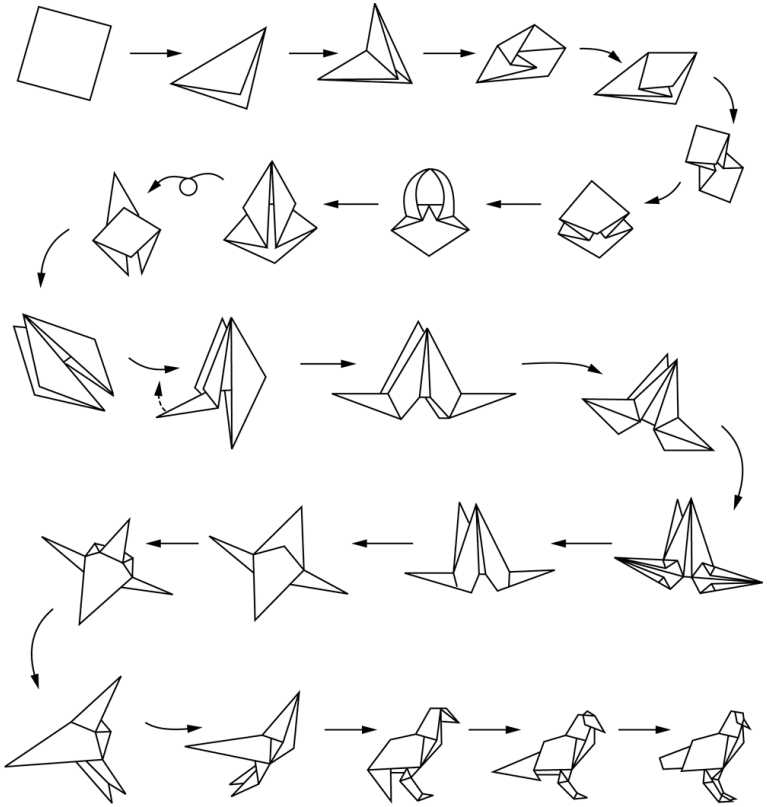
Algorithms and programming

- A representation of an algorithm is called a **program**.
  - For the convenience of humans, computer programs are usually **printed** on paper or **displayed** on computer screens.
  - For the convenience of machines, programs are **encoded** in a manner compatible with the technology of the machine.
- The process of developing a program, encoding it in machine-compatible form, and inserting it into a machine is called **programming**.
- Programs, and the algorithms they represent, are collectively referred to as **software**, in contrast to the machinery itself, which is known as **hardware**.

Algorithms: Recipes on computers ☺

- The recipe to do everything on computers



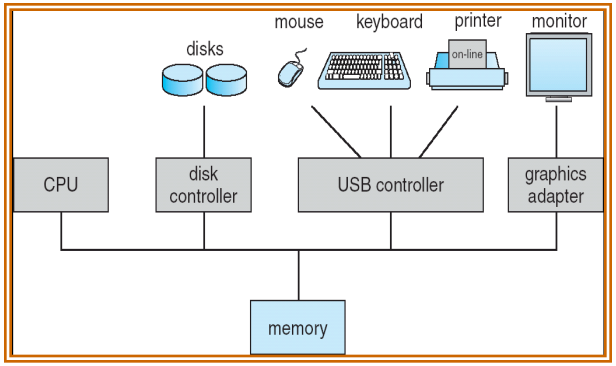


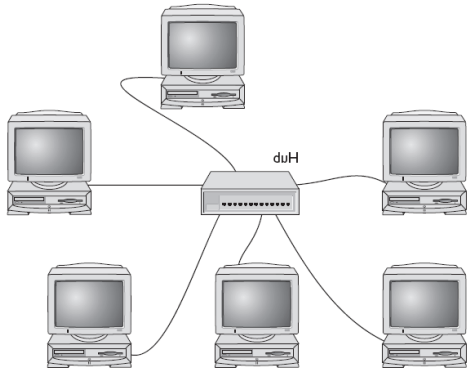
The science of algorithms

- Algorithms
  - Algorithms - what is an algorithm? Find largest GCD, Selection Sort, Binary Search
  - Compound Interest - Credit card
  - Sorting - Selection Sort, Heap sort
  - Compression - Run encoding, Huffman, LZW
- Languages
  - HTML
  - Excel formulas
  - SQL
  - Formal Logic (Circuit Minimization)
- Applications
  - Write letter home in first week - must include photos, table, fonts, formats
  - Excel
  - Database
  - Have them explain Heap sort in PowerPoint
  - Website for circuit diagrams
- Complexity
  - Linear and quadratic time problems. Halting problem, NP Completeness

What are you going to learn in the CS degree?

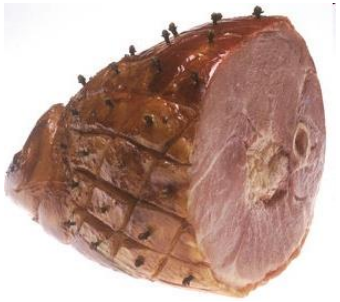
- How computers work.
  - Data representation
  - Data manipulation
  - Operating system
  - Computer network



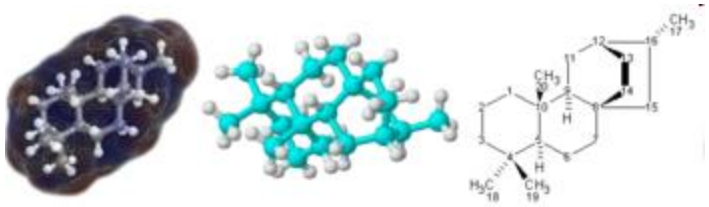


Data representation

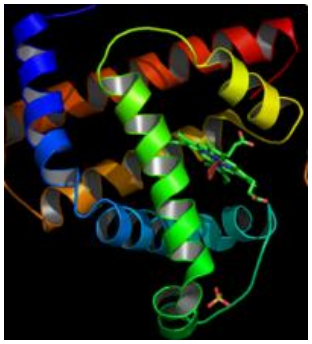
- Ingredients



Ham



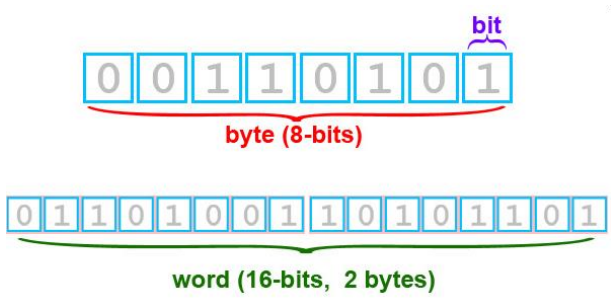
Molecules and atoms



Proteins

Data

Files



Bits and bytes

Data manipulation

- The tools





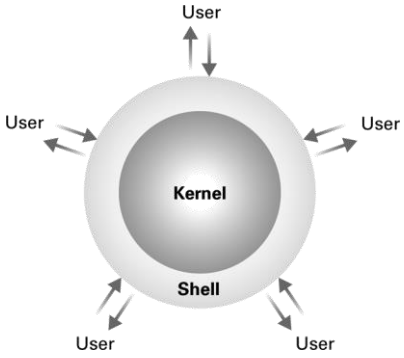


Operating system

- The manager of the house

File System

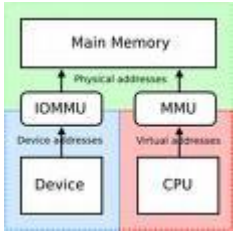
Process Management



User interaction

Booting

Security

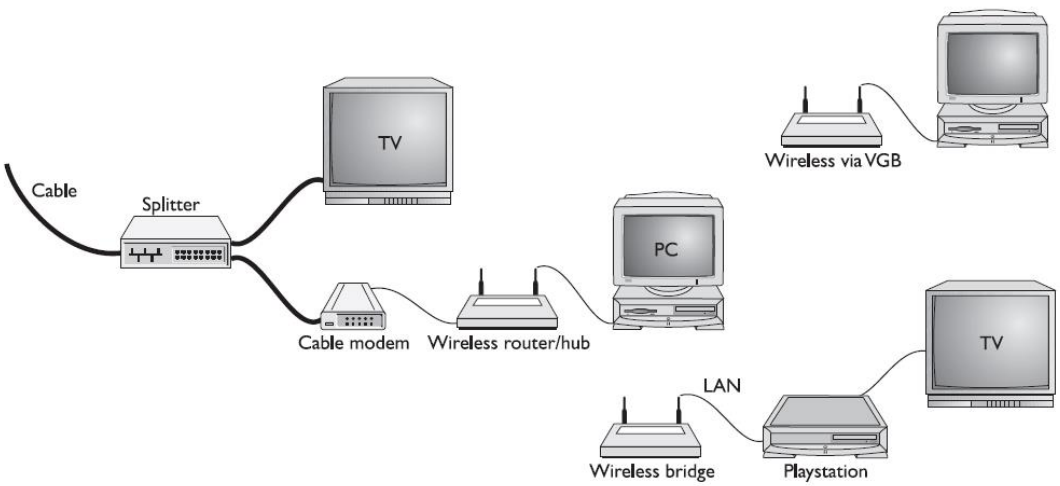


Memory management

Hardware Management

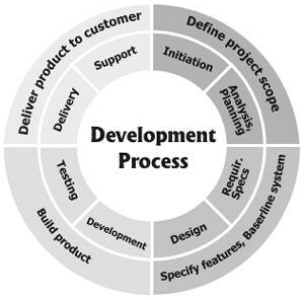
Computer network

- The system that links computers and lets them communicate



What else?

- How to make computers work.
  - Algorithm
  - Data structures
  - Programming languages
  - System development and software engineering



Algorithms

- The recipe for computers

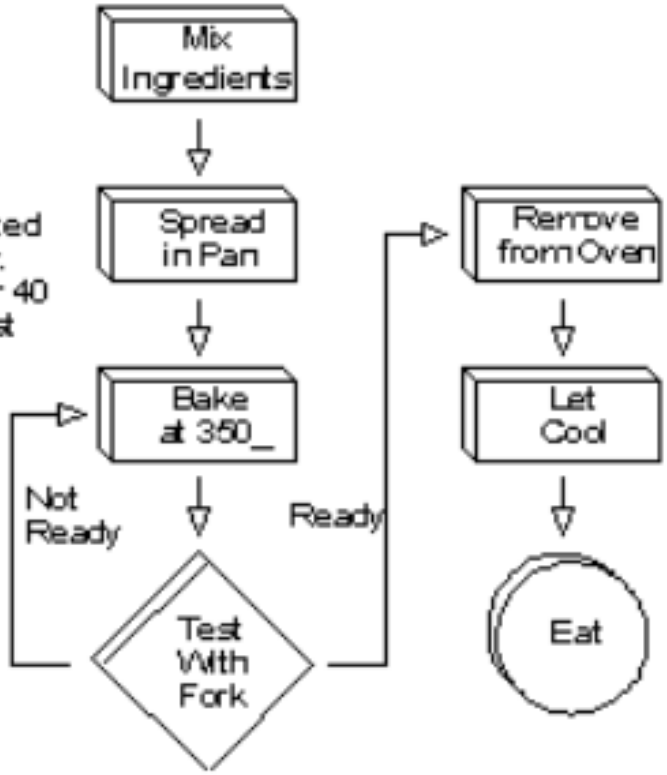
Recipe
CHOCOLATE CAKE

4 oz. chocolate	3 eggs
1 cup butter	1 tsp. vanilla
2 cups sugar	1 cup flour

Melt chocolate and butter. Stir sugar into melted chocolate. Stir in eggs and vanilla. Mix in flour. Spread mix in greased pan. Bake at 350_ for 40 minutes or until inserted fork comes out almost clean. Cool in pan before eating.

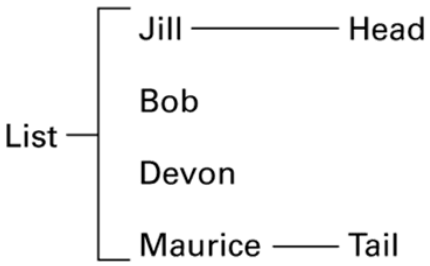
Program Code

```
Declare variables:
    chocolate   eggs        mix
    butter      vanilla
    sugar       flour
mix = melted ((4*chocolate) + butter)
mix = stir (mix + (2*sugar))
mix = stir (mix + (3*eggs) + vanilla)
mix = mix + flour
spread (mix)
While not clean (fork)
bake (mix, 350)
```

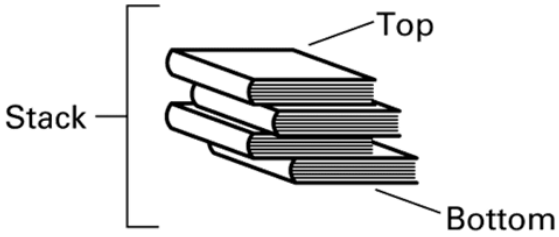


Data structures

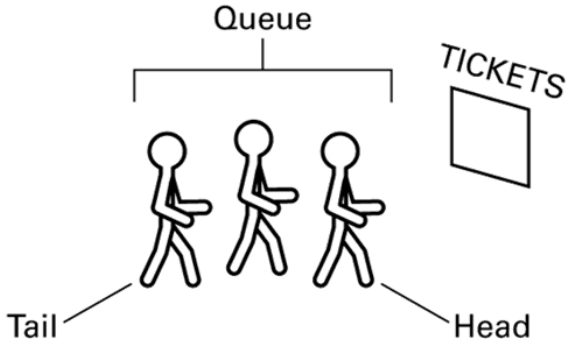
- The data arrangement that makes algorithms and programs efficient



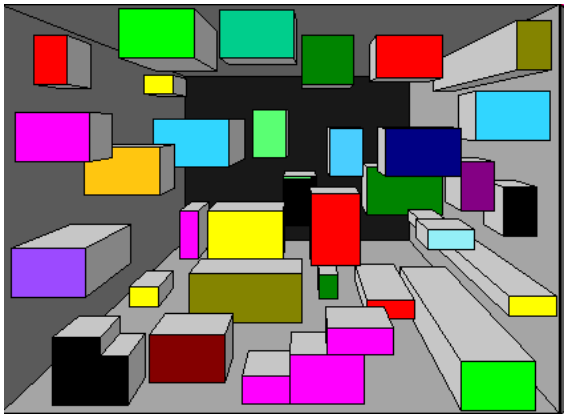
a. A list of names



b. A stack of books

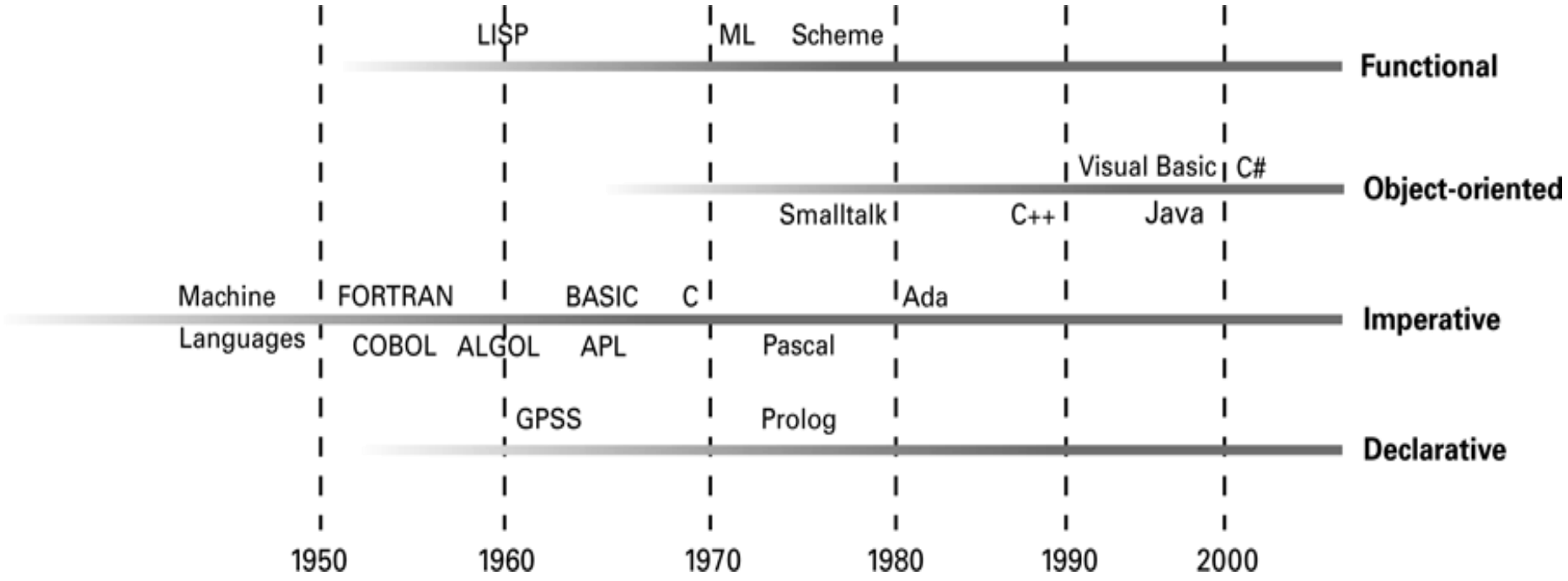


c. A queue of people



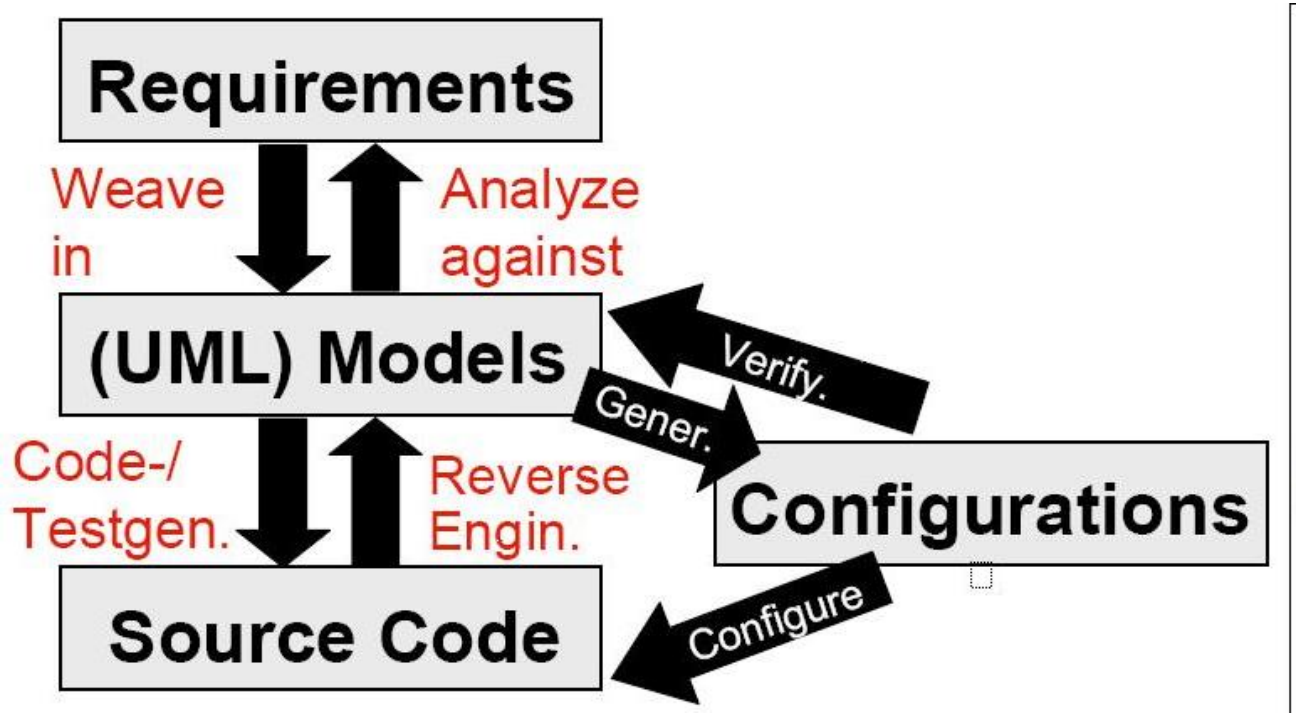
Programming languages

- The spells to command computers



Software engineering

- The principles of software development.



Software lifecycle

Databases

- The system appearing everywhere in our daily life.

Archives

Cashier systems

ATM

Parking bills

Bills

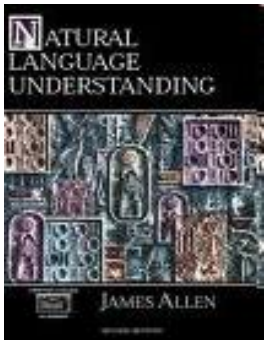
Stock Exchange

Library

Artificial intelligence

- The study and design of intelligent agents

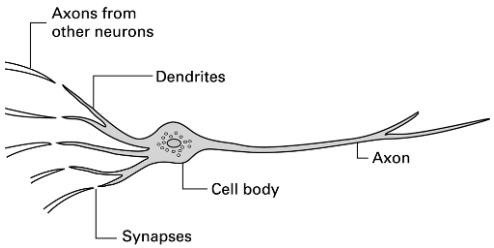
Computer Vision



Natural Language

Games

Robots



Neural network

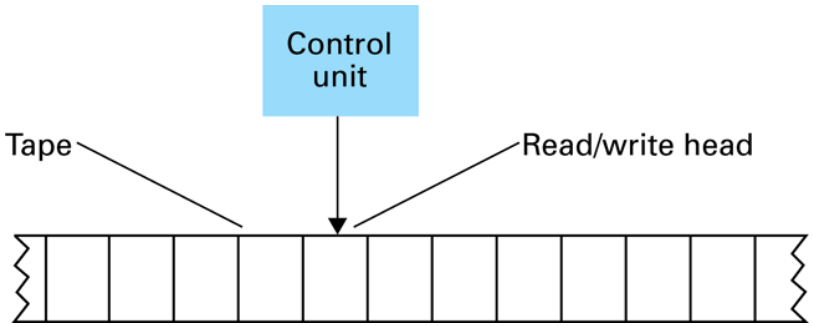
Perception

Data mining

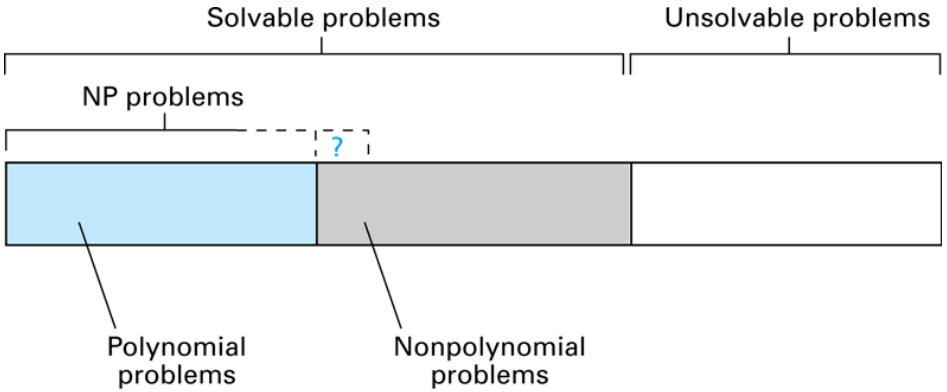
Software agent

Theory of computation

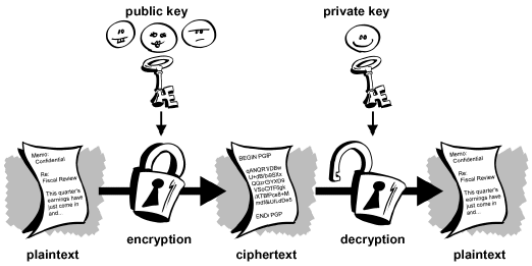
- Knowing the limitations of computers.



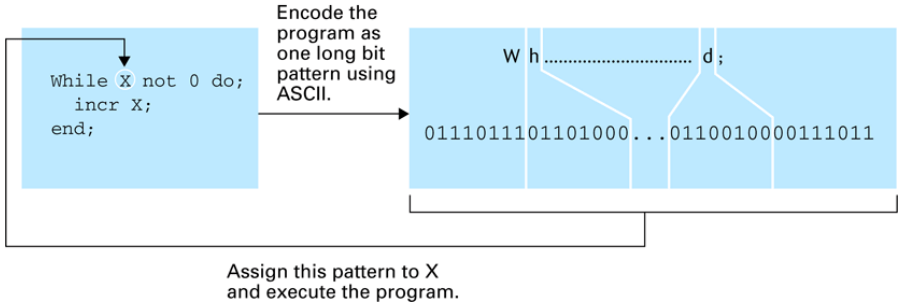
Turing machine



Problem classification



Problem of unknown difficulty



The unsolvable: the halting problem

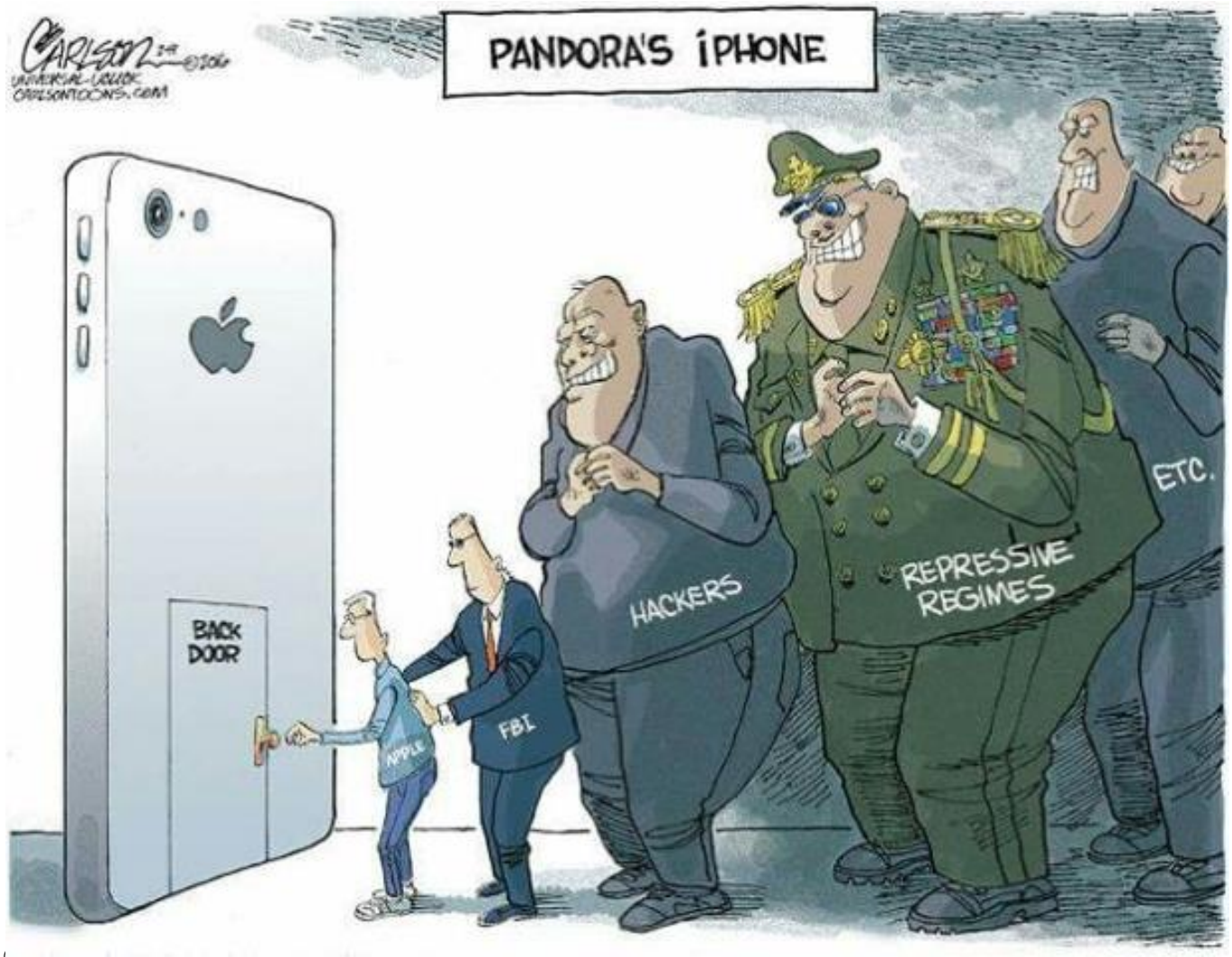
Outline of our study in this course

- History of computing
- Intro to Data Storage
- Intro to Data Manipulation
- Intro to Operating Systems
- Intro to Networks and the Internet
- Intro to Algorithms
- Intro to Programming Languages
- Intro to social and ethical issues

Social Repercussions

- Advances in computer science raise new questions.
  - In law: Questions of rights and liabilities
  - In government: Questions of regulation
  - In the work place: Questions of professionalism
  - In society: Questions of social behavior

Apple's case in 2016



Ethical Theories

- Consequence based:

  What leads to the greatest benefit?
- Duty based:

  What are my intrinsic obligations?
- Contract based:

  What contracts must I honor?
- Character based:

  Who do I want to be?

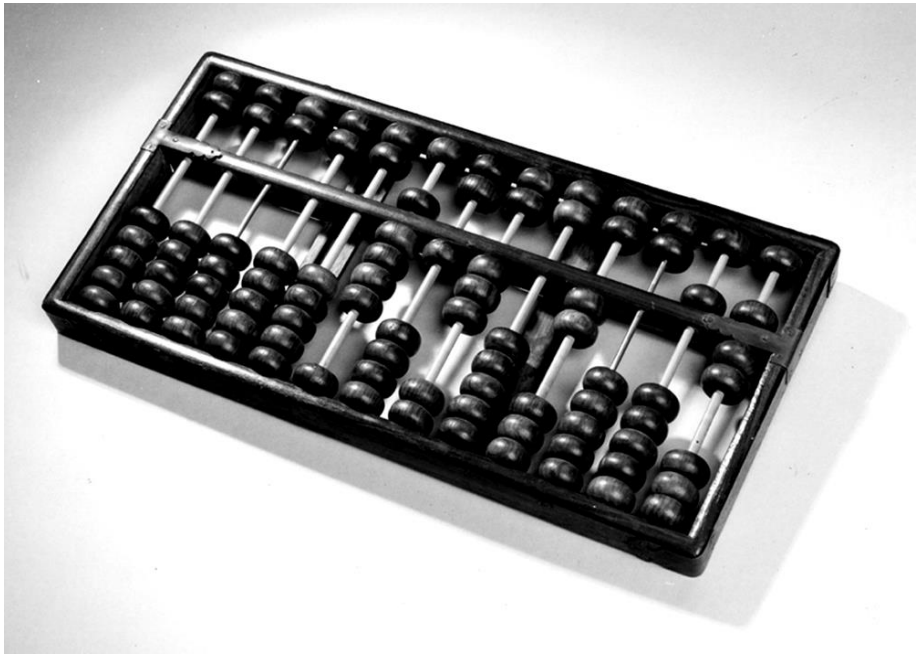
PART II – Evolution of Computing machines

Origins of Computing Machines

- Early computing devices
  - Abacus: positions of beads represent numbers
  - Gear-based machines (1600s-1800s)
    - Positions of gears represent numbers
    - Blaise Pascal, Wilhelm Leibniz, Charles Babbage

An Abacus (also called a counting frame)

- It is in the positions of the beads that this "computer" represents and stores data.
- For control of an algorithm's execution, the machine relies on the human operator.
- Thus the abacus alone is merely a **data storage system**;
- It must be **combined with a human** to create a complete computational machine.



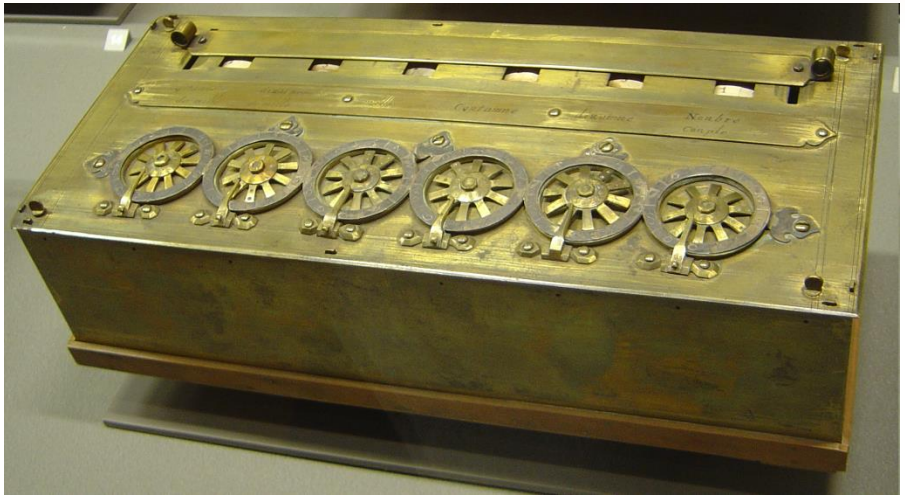
- **Mesopotamian abacus**
- The period 2700–2300 BC saw the first appearance of the Sumerian abacus, a table of successive columns which delimited the successive orders of magnitude of their number system.

Origin of algorithms

- Abū Abdallāh Muḥammad ibn Mūsā **al-Khwārizmī** (c. 780 – c. 850) was a Persian mathematician, astronomer and geographer, a scholar in the House of Wisdom in Baghdad.
- *His book "**The Compendious Book on Calculation by Completion and Balancing**"* presented the first systematic solution of linear and quadratic equations.
- He is considered the founder of **algebra**. "Algebra" is derived from ***al-jabr***, one of the two operations he used to solve quadratic equations.
- *Algorism* and *algorithm* stem from **Algoritmi**, the Latin form of his name.
- His name is the origin of (Spanish) *guarismo* and of (Portuguese) *algarismo*, both meaning digit.

Pascal

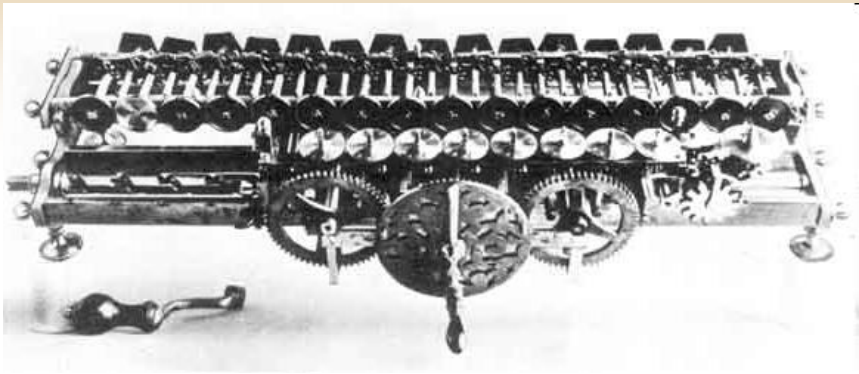
- **Blaise Pascal** (1623 - 1662) was a French mathematician, physicist, and religious philosopher.

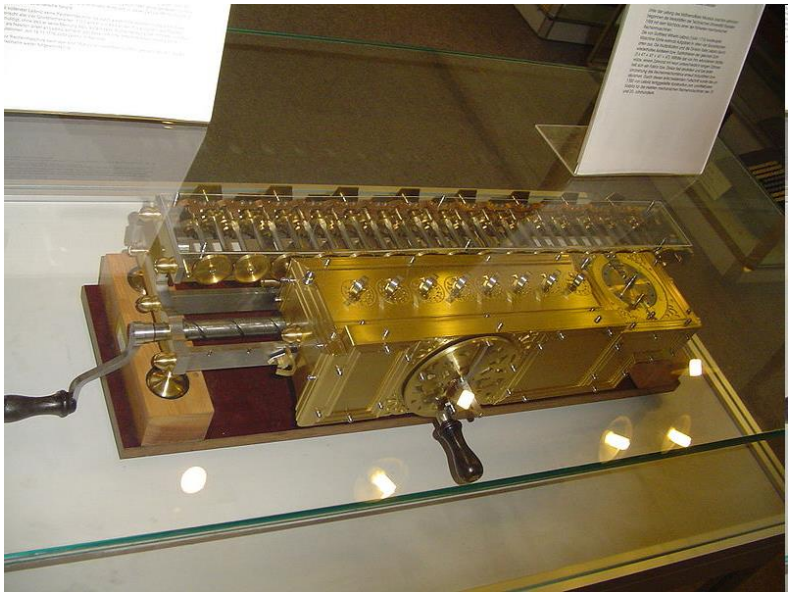


- In 1642, in an effort to ease his father's endless, exhausting calculations, and recalculations, of taxes owed and paid, Pascal, **not yet nineteen**, constructed a mechanical calculator **capable of addition and subtraction**, called Pascal's calculator or the **Pascaline**.
- The Musée des Arts et Métiers in Paris and the Zwinger museum in Dresden, Germany, exhibit two of his original mechanical calculators.
- Though these machines are early forerunners to computer engineering, the calculator failed to be a great commercial success. Because it was extraordinarily expensive the **Pascaline** became little more than a toy, and status symbol, for the very rich both in France and throughout Europe. However, Pascal continued to make improvements to his design through the next decade and built fifty machines in total.

Leibniz

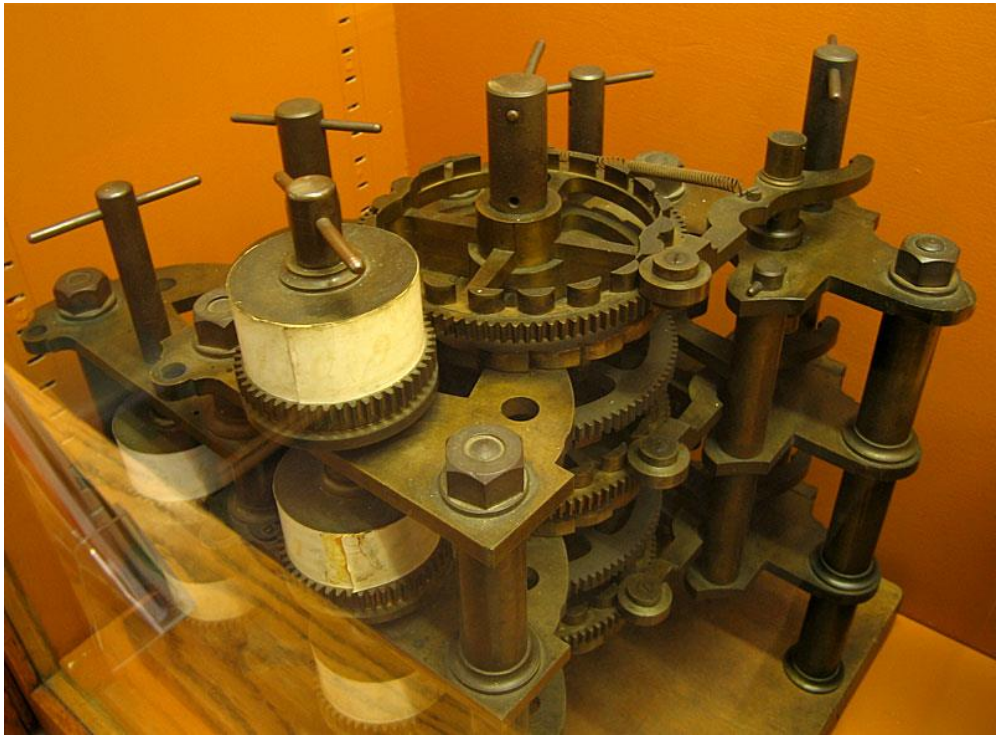
- Gottfried Wilhelm Leibniz (1646-1716) was a German philosopher, polymath and mathematician
- He occupies a grand place in both the history of philosophy and the history of mathematics.
- He invented infinitesimal calculus independently of Newton, and his notation has been in general use since then.
- **He also invented the binary system, foundation of virtually all modern computer architectures**.





- The **Calculus Ratiocinator** is a theoretical universal logical calculation framework, a concept described in the writings of Gottfried Leibniz, usually paired with his more frequently mentioned *characteristica universalis*, a universal conceptual language.
- There are two contrasting points of view on what Leibniz meant by *calculus ratiocinator*. The first is associated with **computer software**, the second is associated with **computer hardware**.

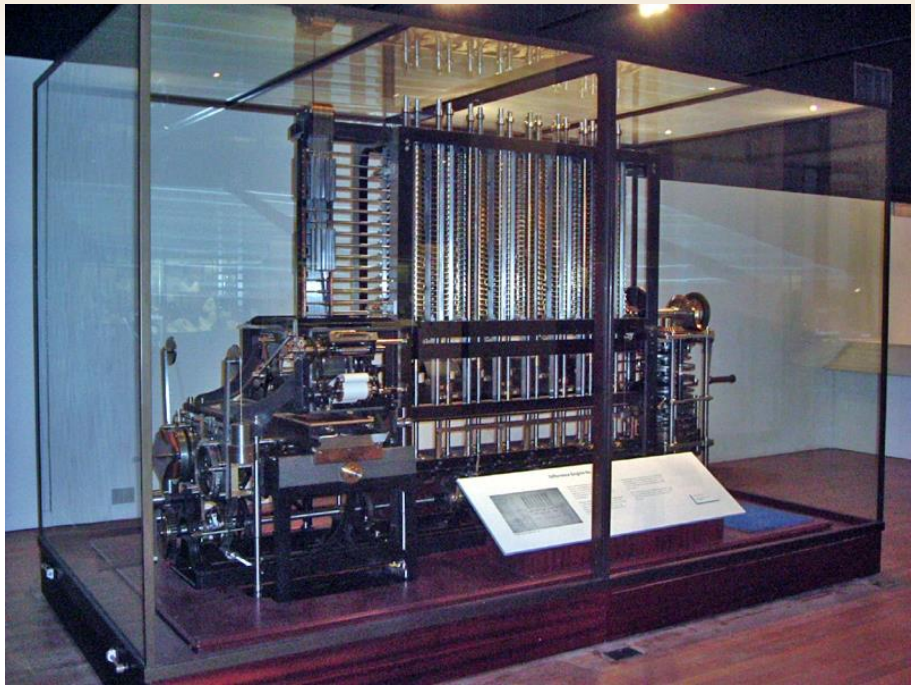
History of Computers: Difference Machine 1822



The **Difference Engine** was an automatic, mechanical calculator designed to **tabulate polynomial functions**. Both logarithmic and trigonometric functions can be approximated by polynomials, so a difference engine can compute many useful sets of numbers.

In 1822, Charles Babbage proposed the use of such a machine in a paper to the Royal Astronomical Society on 14 June entitled "Note on the application of machinery to the computation of astronomical and mathematical tables".

Analytical machine



Science Museum London, 1992.
Analytical machine re-built.

The **analytical engine**, an important step in the history of computers, was the **design of a mechanical general-purpose computer** by the British mathematician Charles Babbage. It was first described in 1837, but Babbage continued to work on the design until his death in 1871. Because of financial, political, and legal issues, the engine was never built. In its logical design the machine was essentially modern, anticipating the first completed general-purpose computers by about 100 years.

The Babbage Engine built

- Video at:
  - http://www.computerhistory.org/babbage/

Ada Lovelace (1815-1852) (the first programmer ever)

Lord Byron’s daughter

- She is mainly known for having written a description of Charles Babbage's early mechanical general-purpose computer, the **analytical engine**.
- She is today appreciated as the "**first programmer**" since she was writing programs, that is, encoding an algorithm in a form to be processed by a machine, for a machine that Babbage had not yet built.
- She also foresaw the capability of computers to go beyond mere calculating or number-crunching while others, including Babbage himself, focused only on these capabilities.

Evolution of computing machines

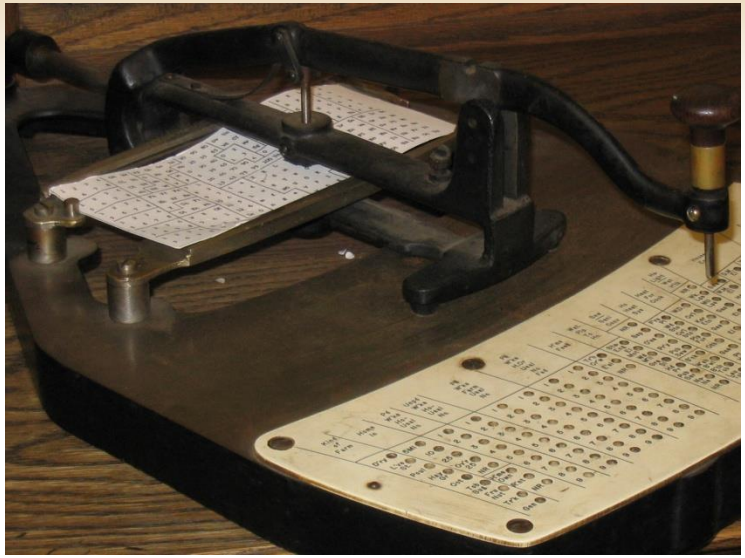
- As for the ability to follow an algorithm, we can see a progression of flexibility in these machines.
  - Pascal's machine was built to perform **only addition**.
  - Consequently, the appropriate sequence of steps was **embedded into the structure** of the machine itself.
  - In a similar manner, Leibniz/s machine had its algorithms firmly **embedded in its architecture**, although it offered a variety of arithmetic operations from which the operator could select.
  - Babbage's Difference Engine (of which only a demonstration model was constructed) could be **modified to perform a variety of calculations**, but his Analytical Engine (the construction for which he never received funding) **was designed to read instructions in the form of holes in paper cards**.
  - Thus Babbage's Analytical Engine was **programmable.**

Punch cards

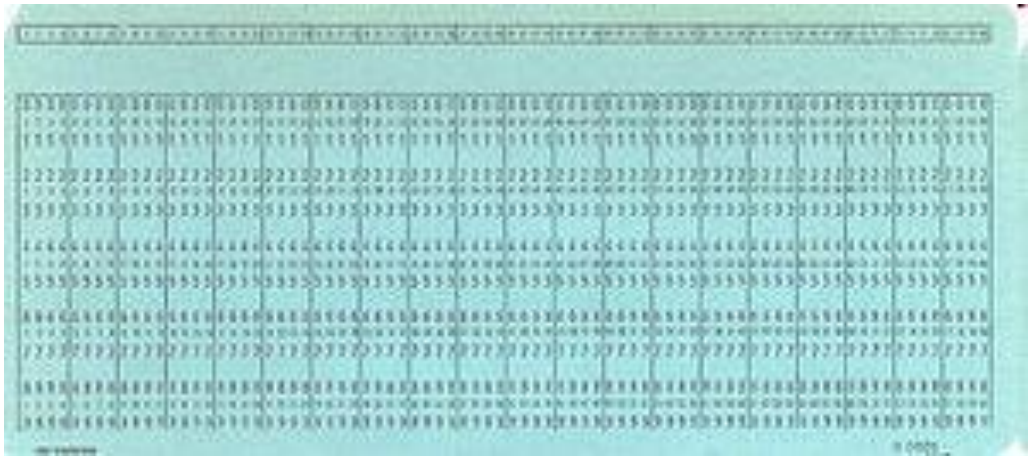
- The idea of communicating an algorithm via holes in paper was not originated by Babbage.
- He got the idea from **Joseph Jacquard** (1752-1834), who, in 1801, had developed a weaving loom in which the steps to be performed during the weaving process were determined by patterns of holes in paper cards.
- In this manner, the algorithm followed by the loom could be changed easily to produce different woven designs.

Punch cards

- Another beneficiary of Jacquard's idea was **Herman Hollerith** (1860-1929), who applied the concept of representing information as holes in paper cards to speed up the tabulation process in the 1890 U.S. census. (It was this work by Hollerith that led to the creation of **IBM**.)
- Such cards ultimately came to be known as **punched cards** and survived as a popular means of communicating with computers well into the 1970s. Indeed, the technique lives on today, as witnessed by the voting issues raised in the 2000 U.S. presidential election.

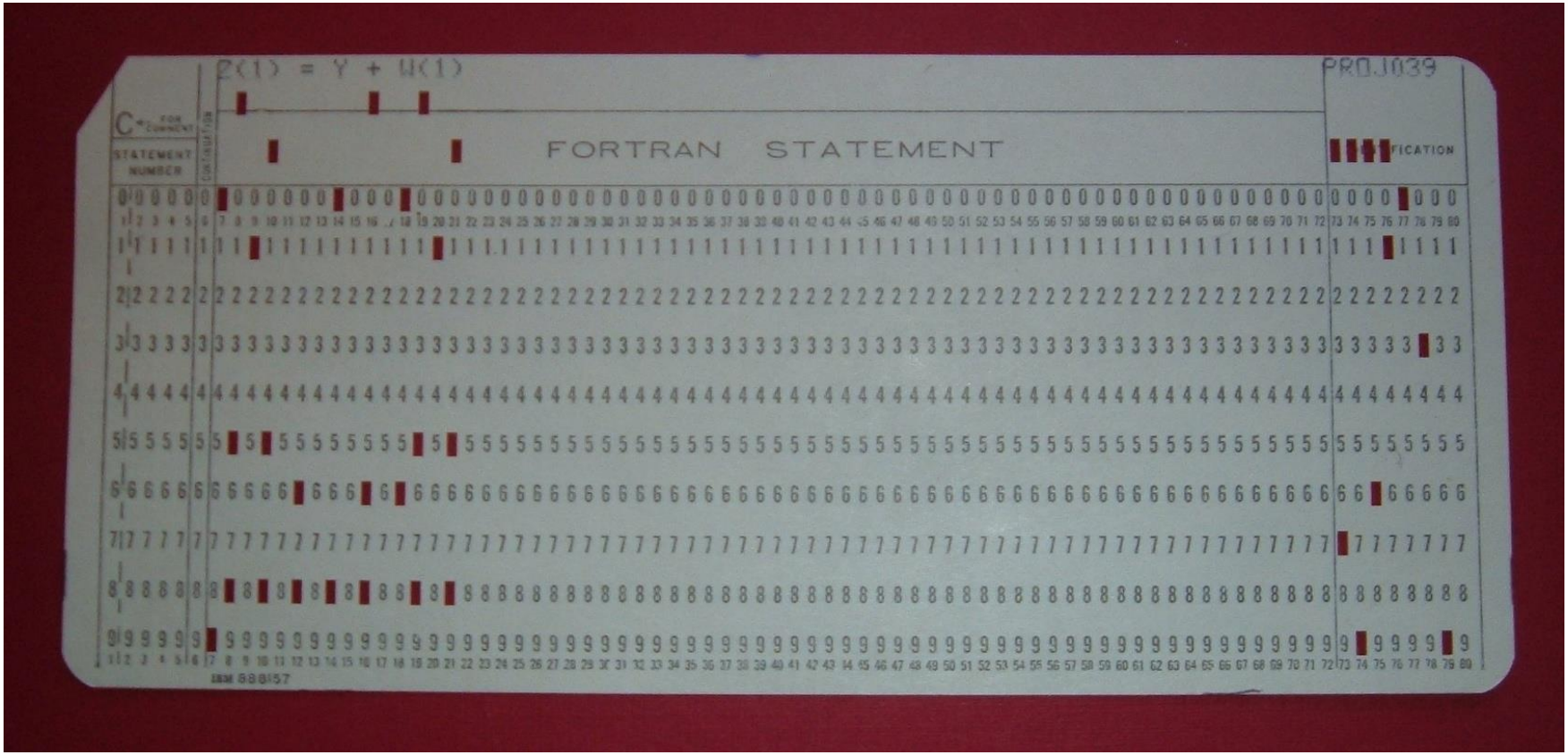


Hollerith's Keyboard (pantograph) Punch, used for the 1890 census.



A standard blank IBM punched card of the type used to store data.

Card from a Fortran program: Z(1) = Y + W(1)

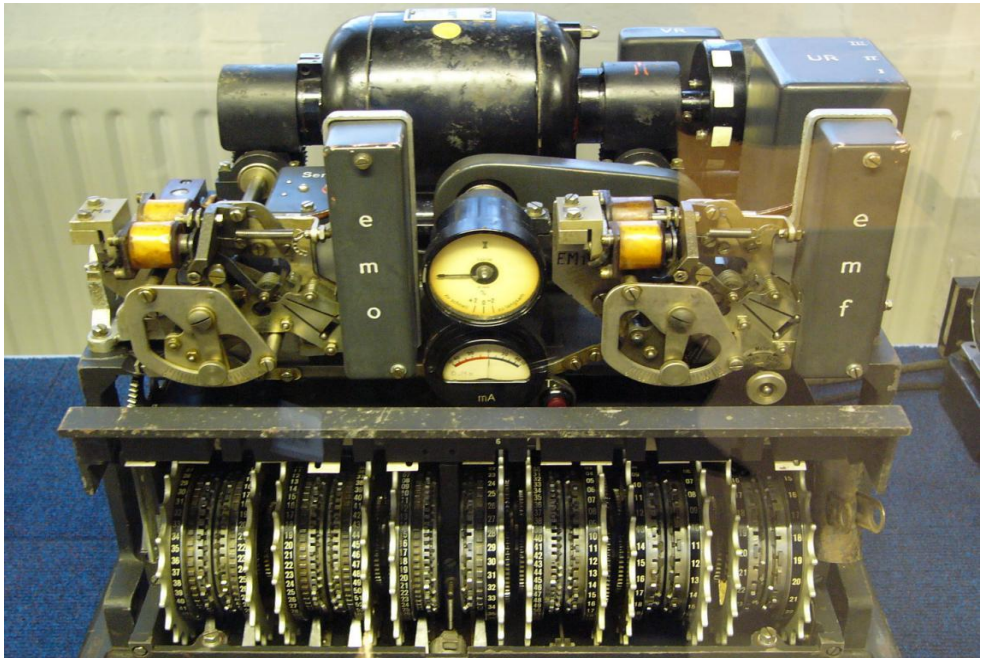


Generation of computers

- First generation 1940 - 1955
  - vacuum tubes, plug boards
- Second generation 1955 - 1965
  - transistors, batch systems
- Third generation 1965 – 1980
  - ICs and multiprogramming
- Fourth generation 1980 – present
  - personal computers

Lorenz cipher

- The Lorenz SZ 40 and SZ 42 (Schlüsselzusatz, meaning "cipher attachment") were German cipher machines used during World War II for teleprinter circuits.
- British codebreakers, who referred to encrypted German teleprinter traffic as "Fish", termed the machine and its traffic "Tunny".
- While the well-known Enigma machine was generally used by field units, the Lorenz machine was used for high-level communications which could support the heavy machine, teletypewriter and attendant fixed circuits.



Enigma

An **Enigma machine** is any of a family of related electro-mechanical rotor machines used for the encryption and decryption of secret messages. The first Enigma was invented by German engineer Arthur Scherbius at the end of World War I.

The Enigma rotor assembly. In the Wehrmacht Enigma variant, the three installed movable rotors are sandwiched between two fixed wheels: the entry wheel on the right and the reflector (here marked "B") on the left.

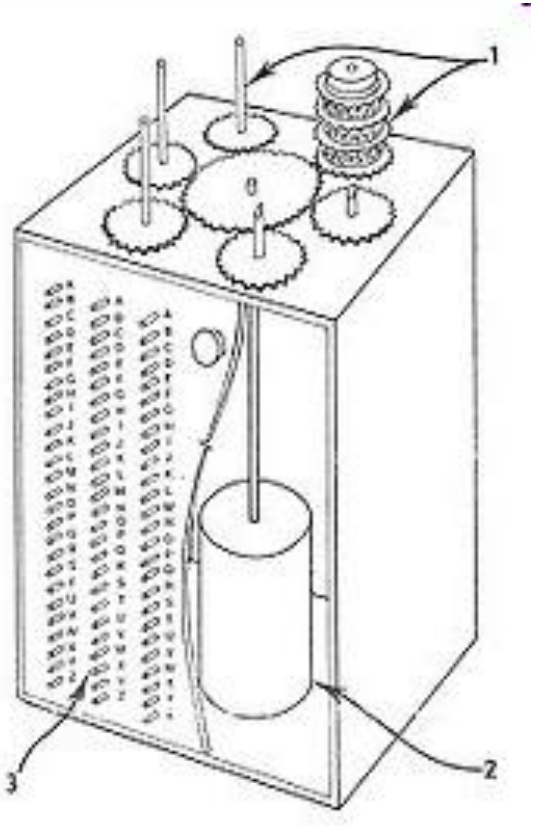
Enigma

The plugboard, keyboard, lamps, and finger-wheels of the rotors emerging from the inner lid of a three-rotor German military Enigma machine

Enigma in use, 1943

Bomba

- The bomba, or bomba kryptologiczna (Polish for "bomb" or "cryptologic bomb") was a special-purpose machine designed about October 1938 by Polish Cipher Bureau cryptologist Marian Rejewski to **break German Enigma-machine ciphers.**



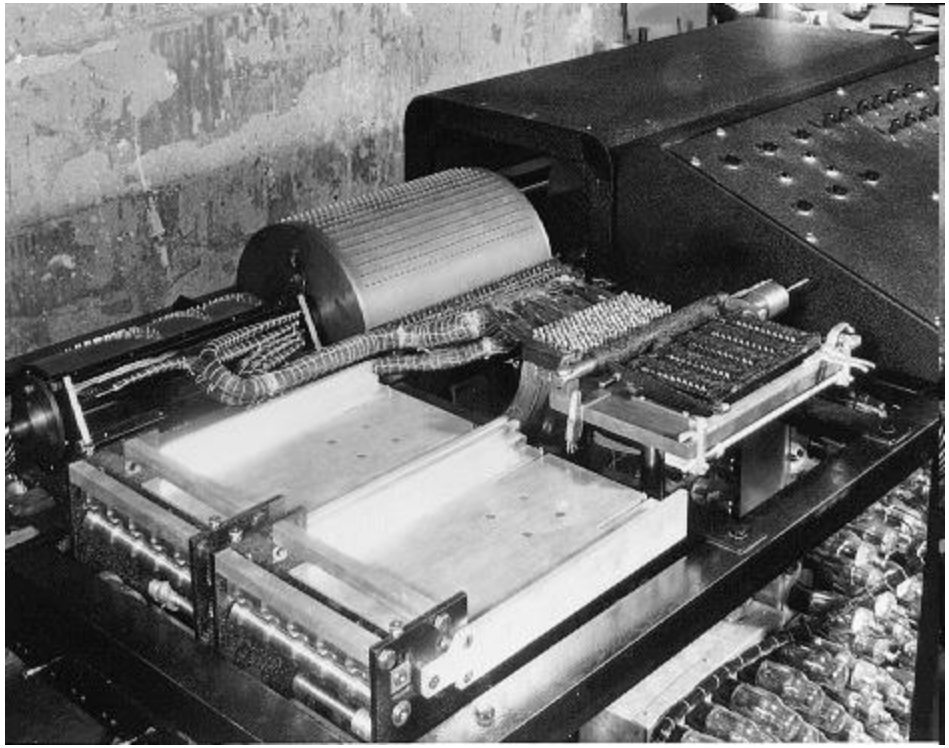
Zuse Z3

- Konrad Zuse's Z3 was the **world's first working programmable, fully automatic computing machine**; whose attributes, with the addition of conditional branching, have often been the ones used as criteria in defining a computer.
- The Z3 was built with 2,000 relays. A request for funding for an electronic successor was denied as "strategically unimportant". It had a clock frequency of ~5–10 Hz, and a word length of 22 bits.
- Calculations on the computer were performed in **full binary floating point arithmetic.**
- Z3 read programs off a **punched film**.
- The machine was completed in 1941. On 12 May 1941, it was successfully presented to an audience of scientists (e.g. Prof. Alfred Teichmann, Prof. C. Schmieden) of the Deutsche Versuchsanstalt für Luftfahrt ("German Laboratory for Aviation"), in Berlin. The original Z3 was destroyed in 1943 during an Allied bombardment of Berlin.

Atanasoff–Berry Computer

- John Vincent Atanasoff's and Clifford Berry's Computer (ABC) was the **first electronic digital computing device**. Conceived in 1937, the machine was **not programmable**, being designed only to solve systems of linear equations.
- It was successfully tested in 1942. However, its **intermediate result storage** mechanism, a paper card writer/reader, was unreliable, and when Atanasoff left Iowa State University for World War II assignments, work on the machine was discontinued.
- The ABC pioneered important elements of modern computing, including **binary arithmetic and electronic switching elements**, but its special-purpose nature and **lack of a changeable, stored program** distinguish it from modern computers.
- The Atanasoff–Berry computer work was not widely known until it was rediscovered in the 1960s, amidst conflicting claims about the first instance of an electronic computer.
- At that time, the ENIAC was considered to be the first computer in the modern sense, but in 1973 a U.S. District Court invalidated the ENIAC patent and concluded that the **ABC was the first "computer“.**

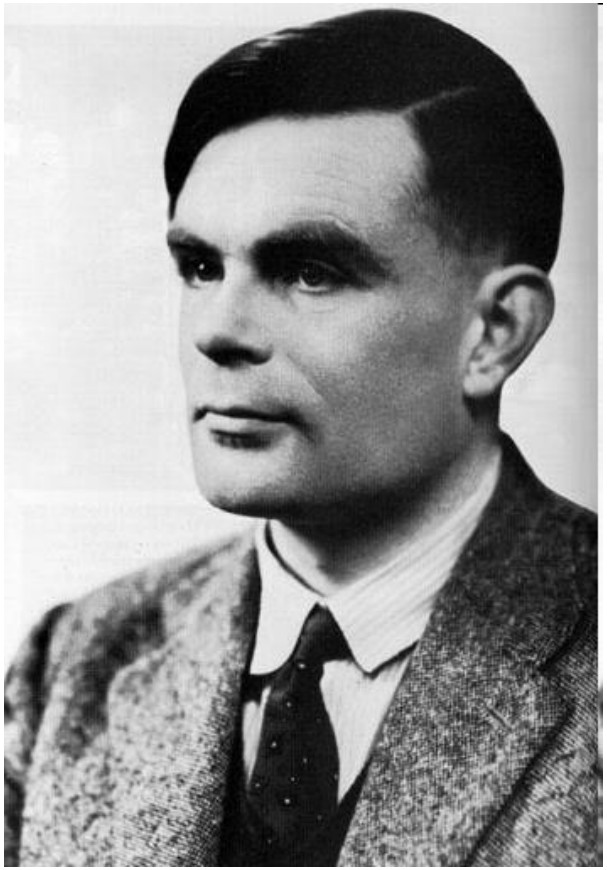
Atanasoff–Berry Computer



The Atanasoff-Berry Computer [photo © 2002 IEEE]

Alan Turing (father of Computer Science)

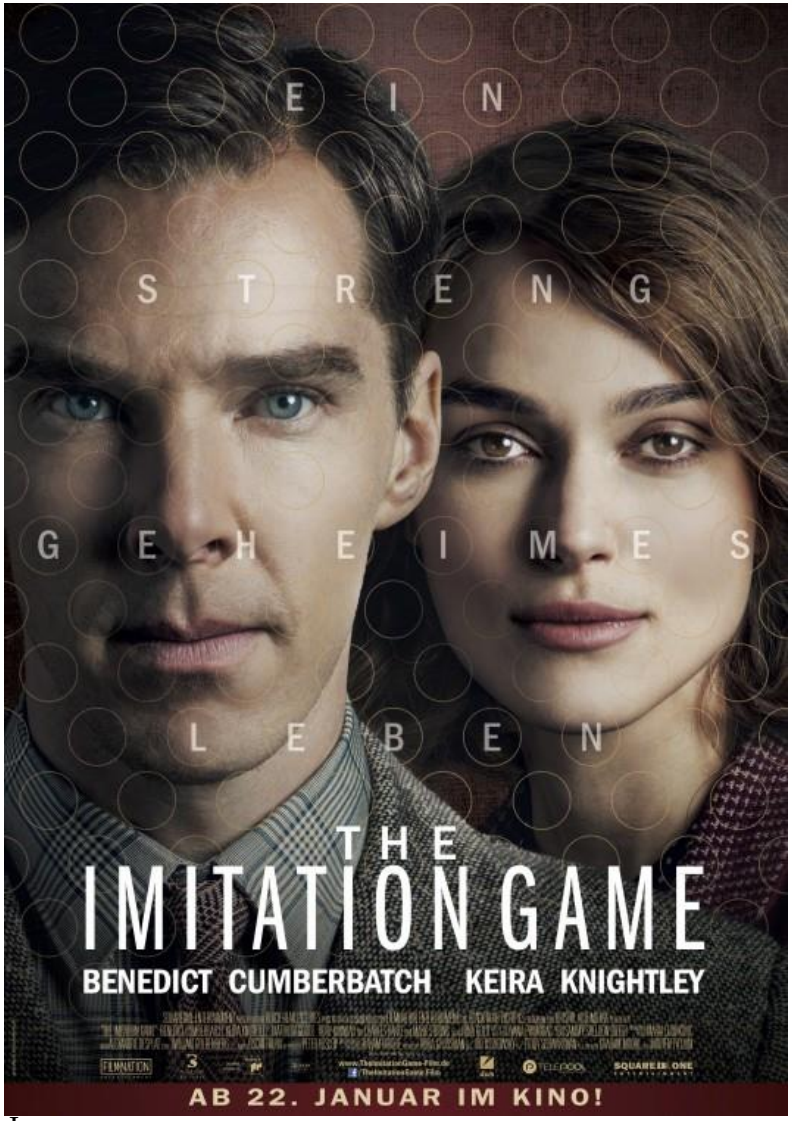
- Alan Mathison Turing, (23 June 1912 – 7 June 1954), was an English mathematician, logician, cryptanalyst, and computer scientist.
- He was influential in the development of computer science and provided an influential **formalisation of the concept of the algorithm and computation with the Turing machine.**
- **In 1999 Time Magazine named Turing as one of the 100 Most Important People of the 20th Century for his role in the creation of the modern computer.**
- His Turing test was a significant and characteristically provocative contribution to the debate regarding artificial intelligence.



Turing: the first codebreaking machines

- During the Second World War, Turing worked for the Government Code and Cypher School at Bletchley Park, Britain's codebreaking centre.
- For a time he was head of **Hut 8**, the section responsible for German naval cryptanalysis.
- He devised a number of techniques for **breaking German ciphers**, including the method of **the bombe, an electromechanical machine** that could find settings for the Enigma machine.
- After the war he worked at the National Physical Laboratory, where he created one of the first designs for a stored-program computer, the ACE.

What you should do in your free time?



Turing–Welchman bombe

- Within weeks of arriving at Bletchley Park Turing had designed an electromechanical machine which could help **break Enigma faster** than bomba from 1932, the bombe, named after and building upon the original Polish-designed bomba.

- The bombe, with an enhancement suggested by mathematician Gordon Welchman, became one of the primary tools, and the major automated one, used to attack

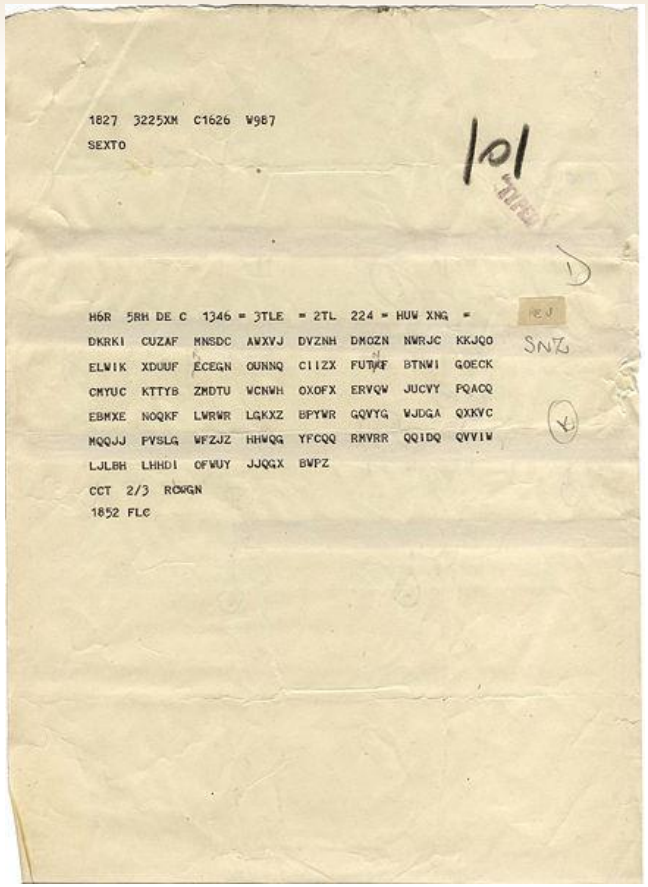
  Enigma-protected message traffic.

Replica of a bombe machine

ULTRA

- Ultra (sometimes capitalised ULTRA) was the name used by the British for intelligence resulting from decryption of encrypted German radio communications in World War II.
- The term eventually became the standard designation in both Britain and the United States for all intelligence from high-level cryptanalytic sources.
- The name arose because the **code-breaking success** was considered more important than the highest security classification available at the time (Most Secret) and so was regarded as being Ultra secret.
- Much of the German cipher traffic was encrypted on the Enigma machine, hence the term "Ultra" has often been used almost synonymously with "Enigma decrypts".
- However, in terms of the intelligence value, Lorenz SZ 40/42 decrypts were more important.

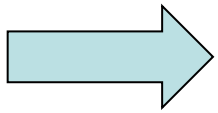
Deciphering documents with ULTRA: WWII

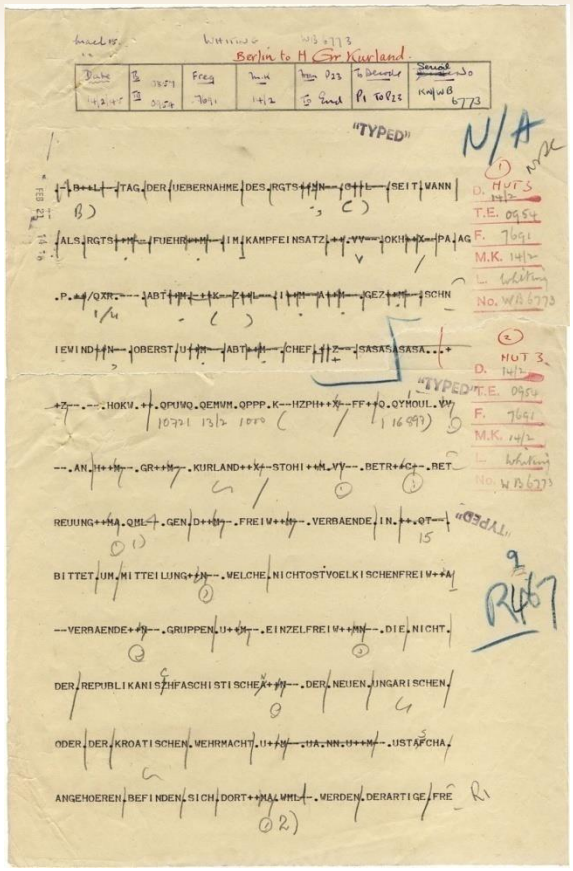


1827 3225XM C1626 W987
SEXTO

101

H6R 5RH DE C 1346 = 3TLE = 2TL 224 = HUW XNG =
DKRKI CUZAF MNSDC AWXVJ DVZNH DMOZN NWRJC KKJQO
ELWIK XDUUF ECEGN OUNNQ CIIZX FUTWF BTNWI GOECK
CMYUC KTTYB ZMDTU WCNWH OXOFX ERVQW JUCVY PQACQ
EBMXE NOQKF LWRWR LGKXZ BPYWR GQVYG WJDGA QXKVC
MQQJJ PVSLG WFZJZ HHWQG YFCQQ RMVRR QQIDQ QVVIW
LJLBH LHHDI OFWUY JJQGX BWPZ
CCT 2/3 ROMGN
1852 FLC





Berlin to H Gr Kurland

"TYPED"

N/A

Coded document

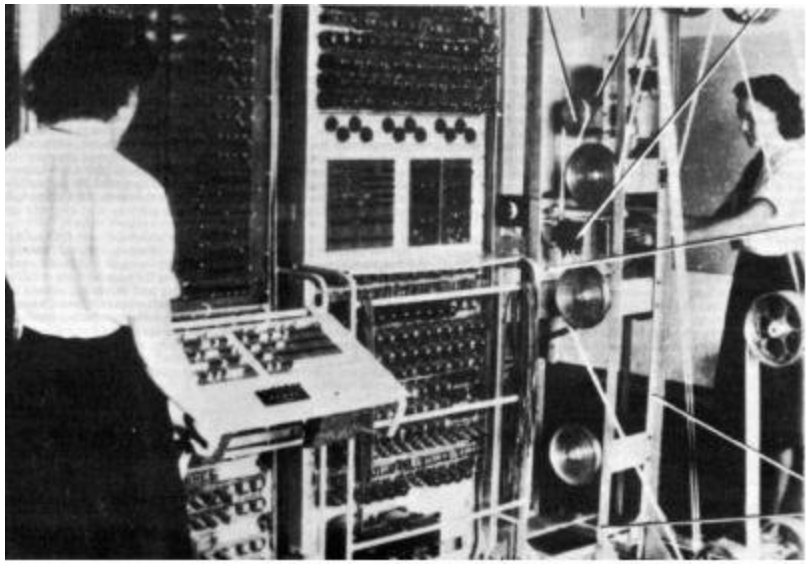
Deciphered document

F.W. Winterbotham, in *The Ultra Secret* (1974), quotes the western Supreme Allied Commander, Dwight D. Eisenhower, as at war's end describing Ultra as having been "decisive" to Allied victory in World War II.

The birth of Colossus

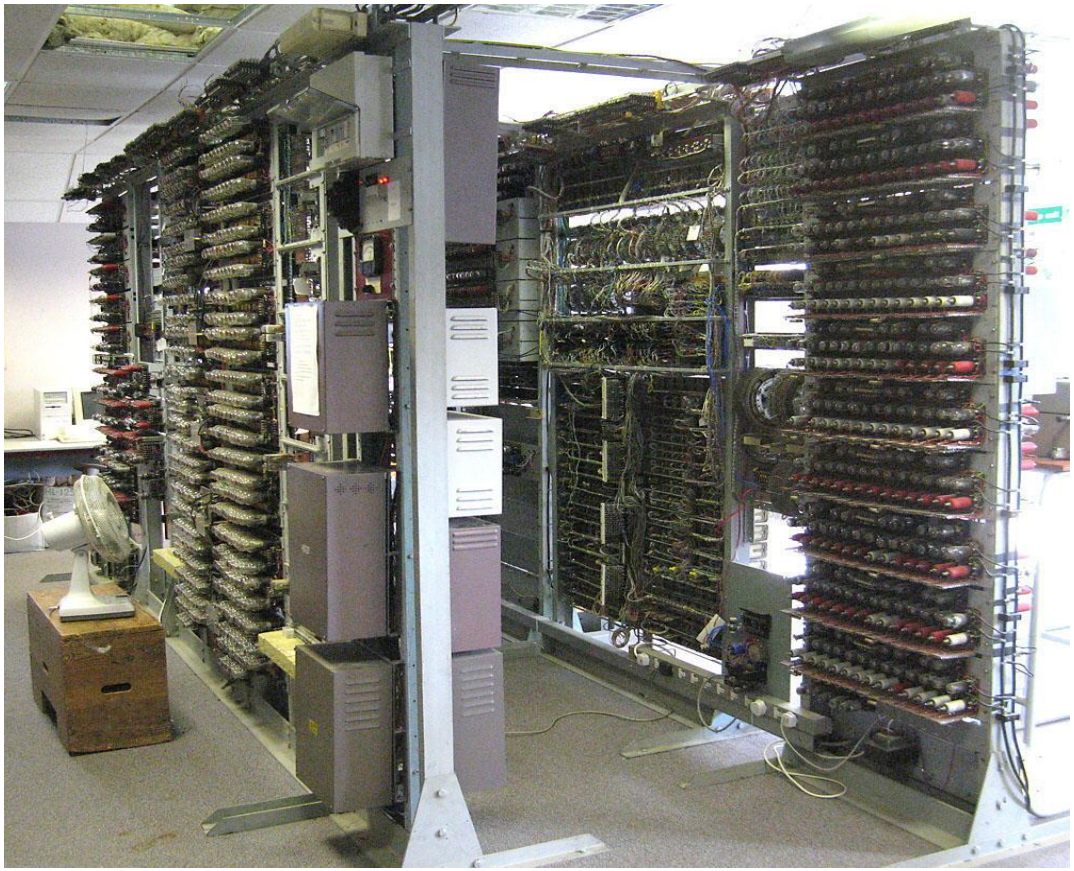
- In July 1942, Turing devised a technique termed ***Turingismus*** or ***Turingery*** for use against the Lorenz cipher used in the Germans' new Geheimschreiber machine ("secret writer") which was one of those codenamed "Fish".
- He also introduced the Fish team to Tommy Flowers who, under the guidance of Max Newman, went on to build the Colossus computer, the **world's first programmable digital electronic computer**, which replaced simpler prior machines and whose superior speed allowed the **brute-force decryption techniques** to be applied usefully to the daily-changing cyphers.
- A frequent misconception is that Turing was a key figure in the design of Colossus; this was not the case.
- While working at Bletchley, Turing, a talented long-distance runner, occasionally ran the 40 miles to London when he was needed for high-level meetings

Colossus – Mark I



COLOSSUS - Top-secret vacuum tube computer designed to break the Lorenz SZ40 (a relative of the Enigma) intercepted cyphers. This was a single purpose computer programmed cables and plugboards. Bletchley Park, Britain (1943)

Colossus rebuilt

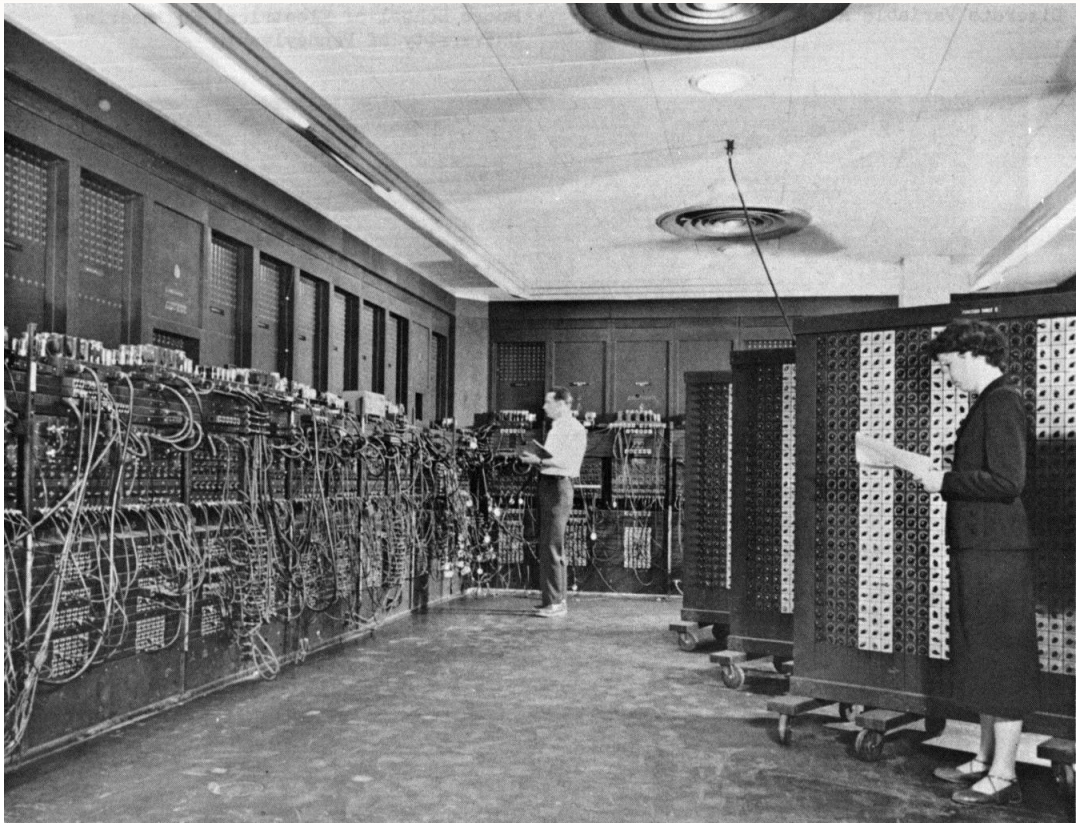


Harvard Mark I

- The IBM Automatic Sequence Controlled Calculator (ASCC), called the Mark I by Harvard University, was the **first large-scale automatic digital computer in the USA**. It is considered by some to be the **first universal calculator.**
- The electromechanical ASCC was devised by Howard H. Aiken, built at IBM and shipped to Harvard in February 1944.
- It began computations for the U.S. Navy Bureau of Ships in May and was officially presented to the university on August 7, 1944.
- The main advantage of the Mark I was that it was fully automatic—it didn't need any human intervention once it started.
- It was the first fully automatic computer to be completed. It was also very reliable, much more so than early electronic computers. It is considered to be "**the beginning of the era of the modern computer**" and "the real dawn of the computer age".

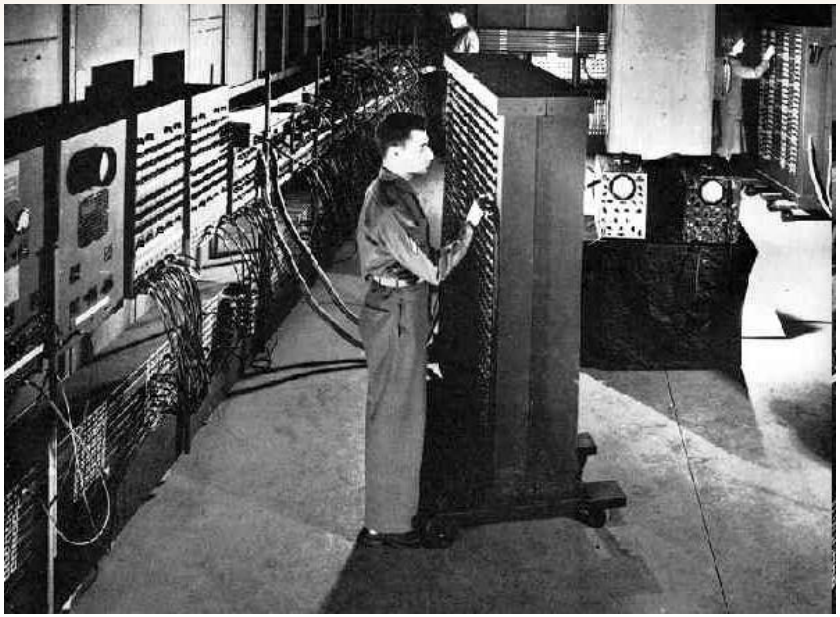
The Mark I computer

ENIAC



ENIAC - Electronic Numerical Integrator and Calculator –
John Mauchley and J Presper Eckert - Programmed
via switches and jumper cables and utilized 20 10-digit decimal registers –
University of Pennsylvania (1946)

ENIAC

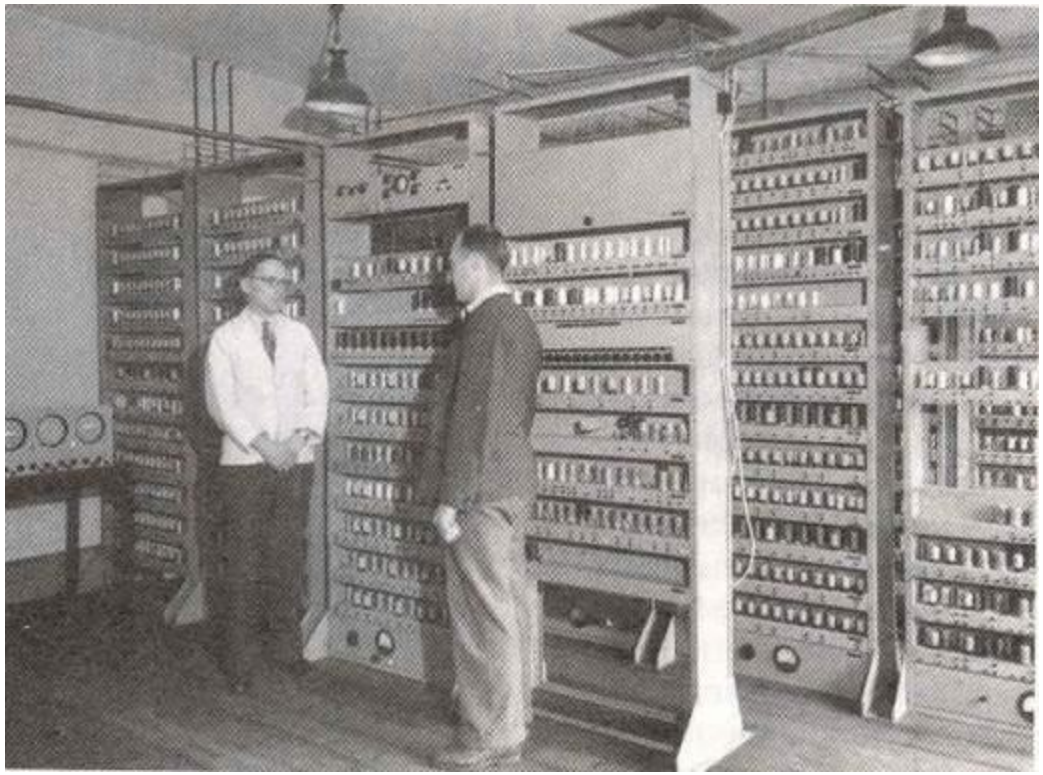


- Two views of ENIAC: the "Electronic Numerical Integrator and Calculator" (note that it wasn't even given the name of computer since "computers" were people) [U.S. Army photo]

Manchester Small-Scale Experimental Machine

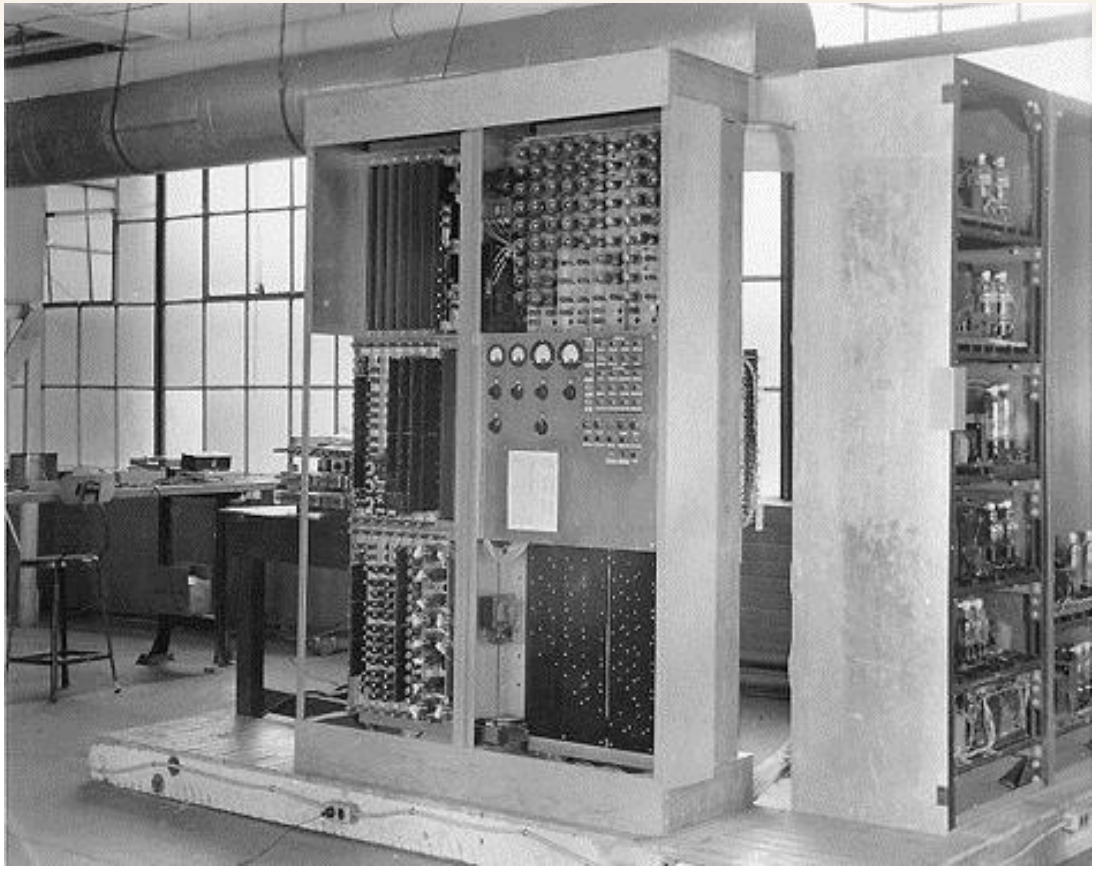
- The Manchester Small-Scale Experimental Machine (SSEM), nicknamed Baby, was the **world's first stored-program computer.**
- It was built at the Victoria University of Manchester by Frederic C. Williams, Tom Kilburn and Geoff Tootill, and ran its first program on 21 June 1948
- The SSEM had a 32-bit word length and a memory of 32 words.
- As it was **designed to be the simplest possible stored-program computer, the only arithmetic operations implemented in hardware were subtraction and negation**; other arithmetic operations were implemented in software.
- The first of three programs written for the machine found the **highest proper divisor of 2^{18}** (262,144), a calculation it was known would take a long time to run — and so prove the computer's reliability — by testing every integer from $2^{18} - 1$ downwards, as divisions had to be implemented by repeated subtractions of the divisor. The program consisted of 17 instructions and ran for 52 minutes before reaching the correct answer of 131,072, after the SSEM had performed 3.5 million operations (for an effective CPU speed of 1.1 kIPS).

EDSAC



EDSAC - Electronic Delay Storage Automatic Calculator – Maurice Wilkes – **The first general purpose stored program computer** – An example of the **von Neuman Architecture** in which data and instructions share a common data path. - University of Cambridge (1949)

EDVAC



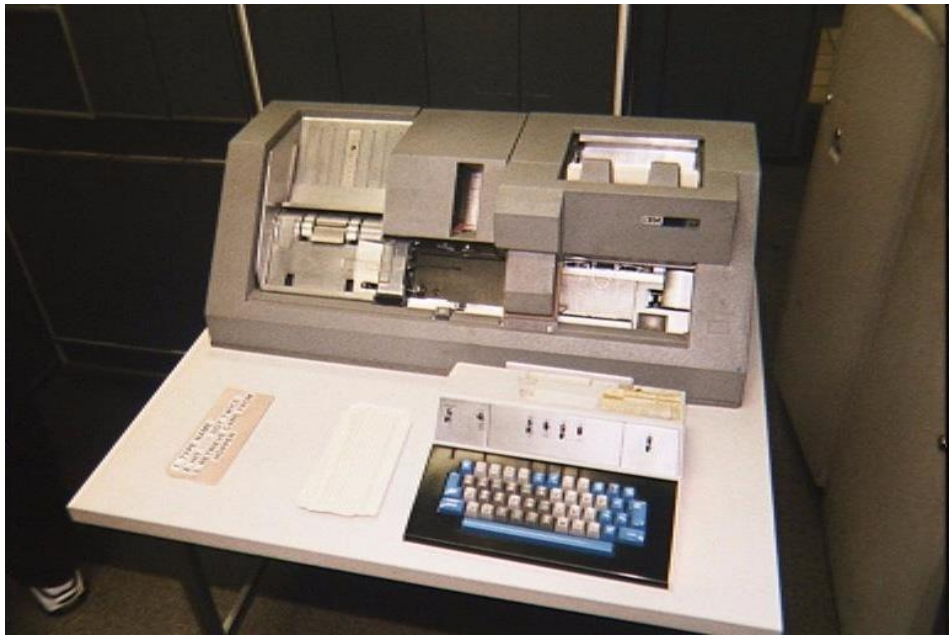
EDVAC - Electronic Discrete Variable Automatic Computer - Eckert/Mauchley – similar in capability and intent to the EDSAC - University of Pennsylvania (1951)

UNIVAC

- In the 1950's, UNIVAC (a contraction of "Universal Automatic Computer") was the household word for "computer“.
- The first UNIVAC was sold, appropriately enough, to the Census bureau.
- UNIVAC was also **the first computer to employ magnetic tape**. Many people still confuse a picture of a reel-to-reel tape recorder with a picture of a mainframe computer.

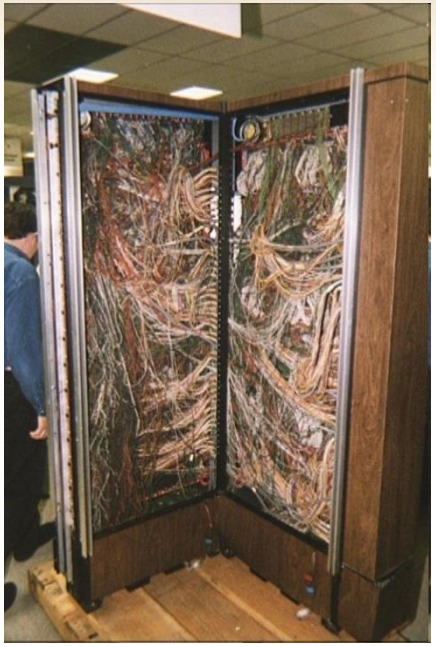
Punch cards 1970

- University students in the 1970's bought blank cards from the university bookstore.
- Each card **could hold only 1 program statement**. To submit your program to the mainframe, you placed your stack of cards in the hopper of a card reader.
- Your program would be run whenever the computer made it that far.
- You often submitted your deck and then went to dinner or to bed and came back later hoping to see a successful printout showing your results.
- Obviously, a program run in batch mode could not be interactive.

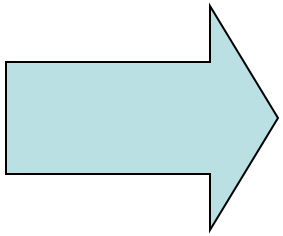


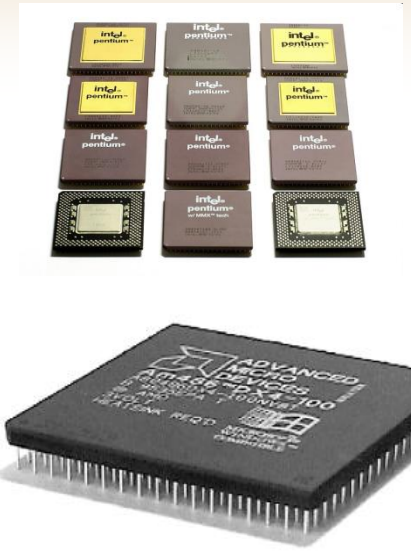
An IBM Key Punch machine which operates like a typewriter except it produces punched cards rather than a printed sheet of paper

Revolution: from wires to integrated circuits



Typical wiring in an early mainframe computer [photo courtesy The Computer Museum]





This transformation was a result of the invention of the ***microprocessor***. A microprocessor (uP) is a computer that is fabricated on an integrated circuit (IC). Computers had been around for 20 years before the first microprocessor was developed at ***Intel*** in 1971. The micro in the name microprocessor refers to the physical size. Intel didn't invent the electronic computer. But they were the first to succeed in cramming an entire computer on a single ***chip*** (IC). Intel was started in 1968 and initially produced only semiconductor memory (Intel invented both the DRAM and the EPROM, two memory technologies that are still going strong today).

Desktop computers

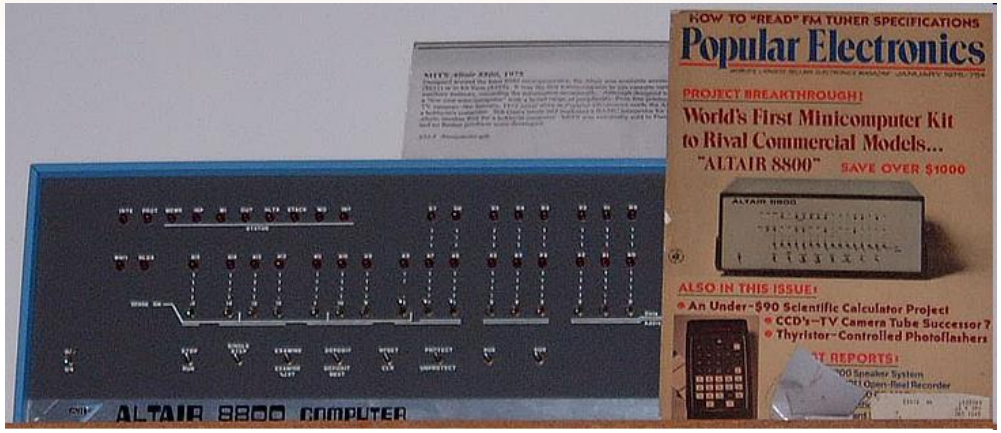
- A major step toward popularizing computing was the development of **desktop computers**.
- The origins of these machines can be traced to the computer hobbyists who began to experiment with homemade computers shortly after the development of the large research machines of the 1940s.
- It was within this "underground" of hobby activity that **Steve Jobs and Stephen Wozniak** built a commercially viable home computer and, in 1976, established Apple Computer, Inc., to manufacture and market their products. Other companies that marketed similar products were Commodore, Heathkit, and Radio Shack.
- Although these products were popular among computer hobbyists, they were not widely accepted by the business community, which continued to look to the well-established IBM for the majority of its computing needs.

A home computer of 1976 such as this *Apple I* which was sold for only $600

DEC-PDP 12

- Digital Equipment Corporation PDP-12
- The PDP-12 was a 12 bit machine introduced in 1969. It sold for $27,900.
- Applications included applied psychology, chemistry, patient monitoring, and industrial testing.

The first personal computer



The Altair 8800, the first PC

- Intel 4004, **the first microprocessor** (uP). The 4004 consisted of 2300 transistors and was clocked at 108 kHz (i.e., 108,000 times per second).
- Compare this to the **42 million transistors** and the 2 GHz clock rate (i.e., 2,000,000,000 times per second) used in a Pentium 4. One of Intel's 4004 chips still functions aboard the Pioneer 10 spacecraft, which is now the man-made object farthest from the earth.
- Intel followed the 4004 with the 8008 and 8080. Intel priced the 8080 microprocessor at $360 dollars as an insult to IBM's famous 360 mainframe which cost millions of dollars.
- The 8080 was employed in the ***MITS Altair*** computer, which was the world's first ***personal computer*** (PC)

IBM Personal Computer

IBM introduced the PC in 1981.

- Accepted by business
- Became the standard hardware design for most desktop computers
- Most PCs use software from Microsoft

The original IBM Personal Computer (PC)

Microsoft and PCs

- A Harvard freshman by the name of ***Bill Gates*** decided to drop out of college so he could concentrate all his time writing programs for this computer.
- This early experienced put Bill Gates in the right place at the right time once **IBM decided to standardize** on the Intel microprocessors for their line of PCs in 1981.
- The Intel Pentium 4 used in today's PCs is still compatible with the **Intel 8088** used in IBM's first PC.
- 1980s
  - IBM released IBM Personal Computer
  - DOS: Disk Operating System
    - Bill Gates bought it from Seattle Computer Products ($50.000)
    - Package DOS/Basic was offered by Gates to IBM
    - IBM wanted some modifications on the system
    - Microsoft’s hired programmer Tim Paterson who wrote DOS
    - MS-DOS

Timeline of computer history

Computer History Year/Enter	Computer History Inventors/Inventions	Computer History Description of Event
1936	Konrad Zuse - **Z1 Computer**	First freely programmable computer.
1942	John Atanasoff & Clifford Berry **ABC Computer**	Who was first in the computing biz is not always as easy as ABC.
1944	Howard Aiken & Grace Hopper **Harvard Mark I Computer**	The Harvard Mark 1 computer.
1946	John Presper Eckert & John W. Mauchly **ENIAC 1 Computer**	20,000 vacuum tubes later...
1948	Frederic Williams & Tom Kilburn **Manchester Baby Computer & The Williams Tube**	Baby and the Williams Tube turn on the memories.
1947/48	John Bardeen, Walter Brattain & Wiliam Shockley **The Transistor**	No, a transistor is not a computer, but this invention greatly affected the history of computers.
1951	John Presper Eckert & John W. Mauchly **UNIVAC Computer**	First commercial computer & able to pick presidential winners.
1953	International Business Machines **IBM 701 EDPM Computer**	IBM enters into 'The History of Computers'.
1954	John Backus & IBM **FORTRAN Computer Programming Language**	The first successful high level programming language.
1955 (In Use 1959)	Stanford Research Institute, Bank of America, and General Electric **ERMA and MICR**	The first bank industry computer - also MICR (magnetic ink character recognition) for reading checks.
1958	Jack Kilby & Robert Noyce **The Integrated Circuit**	Otherwise known as 'The Chip'
1962	Steve Russell & MIT **Spacewar Computer Game**	The first computer game invented.
1964	Douglas Engelbart **Computer Mouse & Windows**	Nicknamed the mouse because the tail came out the end.
1969	**ARPAnet**	The original Internet.
1970	**Intel 1103 Computer Memory**	The world's first available dynamic RAM chip.

Timeline of computer history

1971	Faggin, Hoff & Mazor **Intel 4004 Computer Microprocessor**	The first microprocessor.
1971	Alan Shugart &IBM **The "Floppy" Disk**	Nicknamed the "Floppy" for its flexibility.
1973	Robert Metcalfe & Xerox **The Ethernet Computer Networking**	Networking.
1974/75	**Scelbi & Mark-8 Altair & IBM 5100 Computers**	The first consumer computers.
1976/77	**Apple I, II & TRS-80 & Commodore Pet Computers**	More first consumer computers.
1978	Dan Bricklin & Bob Frankston **VisiCalc Spreadsheet Software**	Any product that pays for itself in two weeks is a surefire winner.
1979	Seymour Rubenstein & Rob Barnaby **WordStar Software**	Word Processors.
1981	IBM **The IBM PC - Home Computer**	From an "Acorn" grows a personal computer revolution
1981	Microsoft **MS-DOS Computer Operating System**	From "Quick And Dirty" comes the operating system of the century.
1983	**Apple Lisa Computer**	The first home computer with a GUI, graphical user interface.
1984	**Apple Macintosh Computer**	The more affordable home computer with a GUI.
1985	**Microsoft Windows**	Microsoft begins the friendly war with Apple.

Into the Millennia

- Internet revolutionized communications
  - World Wide Web
  - Search Engines (Google, Yahoo, and Microsoft)
- Miniaturization of computing machines
  - Embedded (GPS, in automobile engines)
  - Smartphone

Readings

- These slides
- Book
  - Chapter 0