Computer peripherals and interfacing

What is computer?

Computer is a device for processing, storing, and displaying information. *Computer* once meant a person who did computations, but now the term almost universally refers to automated electronic machinery.

Basic terminology:

hardware – the physical components of the computer.

e.g., processor (Pentium 4, Celeron, Athlon, PowerPC, Alpha).
memory (RAM, cache, hard drive, floppy drive, flash stick).
input/output devices (keyboard, mouse, monitor, speaker).

software – programs that run on the hardware.

e.g., operating system (Windows XP, Mac OS X, Linux).
applications (Word, Excel, Powerpoint, RealPlayer, IE, Mozilla).
development tools (JDK, BlueJ, .NET, CodeWarrior).

"The easiest way to tell the difference between hardware and software is to kick it. If it hurts your toe, it's hardware" -Carl Farrell

Computer peripheral:

A computer peripheral is a device that is connected to a computer but is not part of the core computer architecture. A peripheral device connects to a computer system to add functionality. Examples are a mouse, keyboard, monitor, printer and scanner.

There are three different types of peripherals:

1. *input devices*: which interact with or send data from the user to the computer (mice, keyboards, etc.)
2. *output devices:* which provide output to the user from the computer (monitors, printers, etc.)
3. *input/output devices*: that perform both functions touch screen, modem.

Interface:

The interface is the combination of hardware and software needed to link the CPU to the peripherals and to enable them to communicate with the CPU despite all their differing characteristics.

- The hardware is the bit you connect the cable into e.g. USB.
- The software is the driver disk that you usually need to install when you get the device, e.g. printer driver.

Computer peripherals all have different characteristics. For example, they may:

1. Have different data transfer rates.
2. Transmit data in serial or in parallel form.
3. Even work at higher voltages than the CPU.
4. All operate at much slower speeds than the CPU etc.

The main functions of an interface that you need to know about are:

1. Buffering.
2. Converting data to and from serial and parallel forms.
3. Converting data to and from analogue and digital forms.
4. Voltage conversion etc.

The four basic types of computers are as under:

- Supercomputer.
- Mainframe Computer.
- Minicomputer.
- Microcomputer.

Super computers:

- Most powerful computers characterized as fastest, very high processing speed and of large data storage.
- Specifically used for complex applications by big organization.
- Good example is NASA and ISRO uses supercomputers to track and control space discovery, other examples include weather forecasting, scientific simulations, nuclear energy research.

Mainframe computers:

- Capable of performing high processing speed and data storage but not powerful as super computers.
- Wired in air-conditioned rooms.
- Example: ISP providers use mainframe computers to process information about millions of internet users.
- Other examples include: banks educational institutions & insurance companies use mainframe computers to store data about their customers, students & insurance policy holders.

Mini computers:

- Less processing speed than mainframe computers.
- Departments of large company's uses this type of computers.
- They can handle large database and accounting efficiently.
- Example: Department of computer monitoring the network traffic of whole company.

Micro computers:

- Least powerful type of computers but are the most widely used and growing in the fastest rate.
- Hardware peripherals can be attached easily.
- Includes Desktop computers, Laptops, tablet pc's, Personal Digital Assistants (PDA) etc.

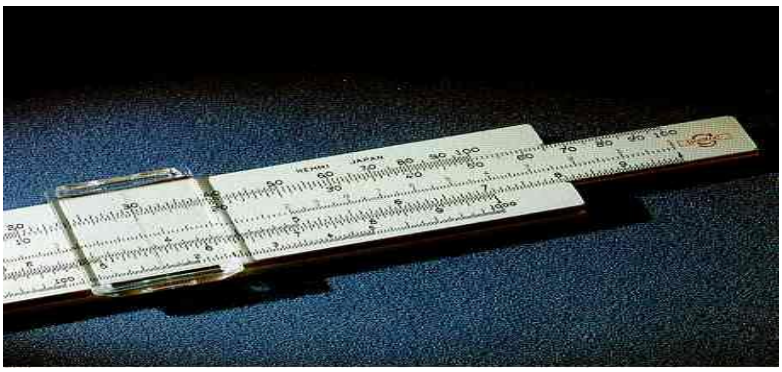
Early counting devices:

The Abacus:

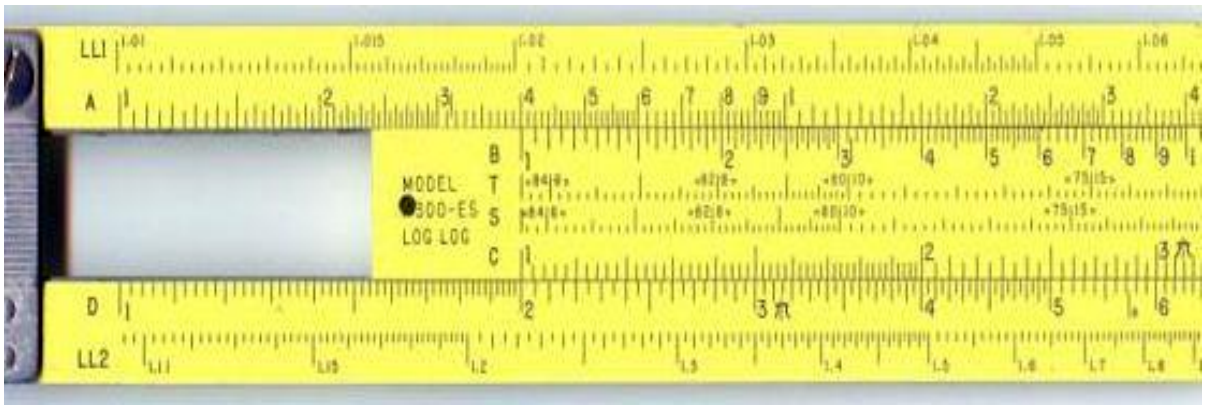
The abacus (*plural* abaci or abacuses), also called a counting frame, is a calculating tool that was in use in Europe, China and Russia, centuries before the adoption of the written Hindu–Arabic numeral system and is still used by merchants, traders and clerks in some parts of Eastern Europe, Russia, China and Africa.

Online abacus: https://www.educalc.net/1003489.page

The Slide Rule (invented early 1600s):



In its most basic form, the slide rule uses two logarithmic scales to allow rapid multiplication and division of numbers. These common operations can be time-consuming and error-prone when done on paper. More elaborate slide rules allow other calculations, such as square roots, exponentials, logarithms, and trigonometric functions.



This slide rule is positioned to yield several values: From C scale to D scale (multiply by 2), from D scale to C scale (divide by 2), A and B scales (multiply and divide by 4), A and D scales (squares and square roots).

More info: *https://en.wikipedia.org/wiki/Slide_rule*

History of computers:

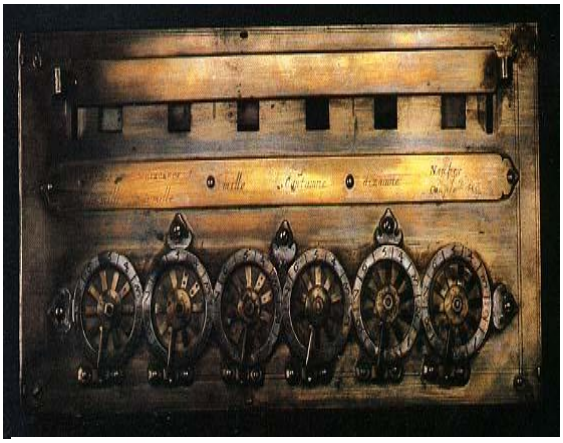
the history of computers can be divided into generations, with each generation defined by a technological breakthrough

1. gears and relays
2. vacuum tubes
3. transistors
4. integrated circuits
5. very large scale integration
6. parallel processing & networking

Generation 0: Mechanical Computers (1642-1945):

1642 – **Pascal built mechanical calculating machine**

- Pascal's calculator is a mechanical calculator invented by Blaise Pascal in the early 17th century. It was called the arithmetic machine and later became known as the Pascaline.
- The machine could add, subtract, multiply, and divide. Multiplication and division were somewhat difficult to do, by performing multiplication and division by repeated addition and subtraction.
- Pascal's calculator was especially successful in the design of its carry mechanism, which adds 1 to 9 on one dial, and when it changes from 9 to 0, carries 1 to the next dial.
- It used mechanical gears, hand-crank, dials and knobs.
- Other similar machines followed it.

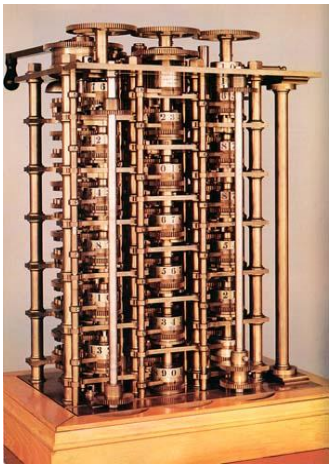


Jacquard loom:

- 1805 – first programmable device
- wove tapestries with elaborate, programmable patterns
- pattern represented by metal punch-cards, fed into loom
- could mass-produce tapestries, reprogram with new cards

More information: http://www.luigi-bevilacqua.com/en/what-is-a-jacquard-loom/

The Difference Engine (by Charles Babbage, 1822):



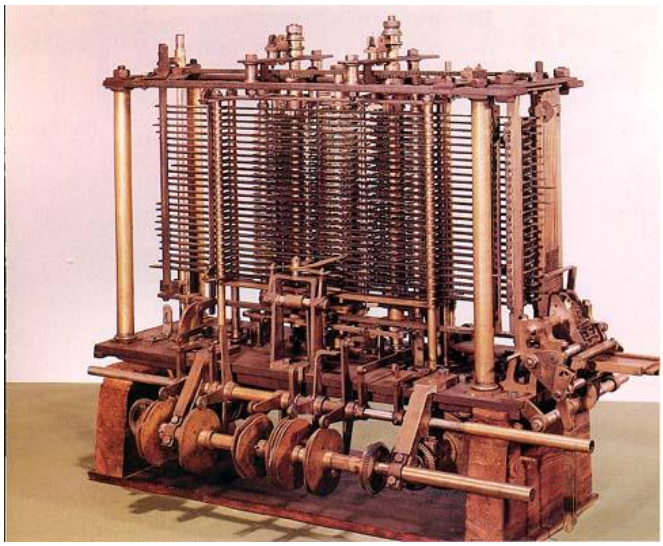
- A difference engine is an automatic mechanical calculator designed to tabulate polynomial functions.
- The name derives from the method of divided differences, a way to interpolate or tabulate functions by using a small set of polynomial coefficients.
- Most mathematical functions commonly used by engineers, scientists and navigators, including logarithmic and trigonometric functions, can be approximated by polynomials, so a difference engine can compute many useful tables of numbers.
- Due to a lack of funding, he was never able to complete a full-scale functional version of this machine. However, in June of 1991 the London Science Museum completed the Difference Engine No 2 and later completed the printing mechanism in 2000.

Further info and Method of differences: *https://en.wikipedia.org/wiki/Difference_engine*

Analytical Engine:

- mid 1800's – Babbage designed "analytical engine"
- You can think of the Analytical Engine basically as a regular computer, which would have a program coded in punched cards, which were attached to each other forming a chain.
- The machine also had a control unit whose job was to decode the instructions of this program and perform them on the data that was stored in a memory capable of holding a thousand numbers.
- It described general layout of modern computers.
- Features included a store and mill, analogous to today's memory and processor.
- It was never functional, beyond technology of the day.

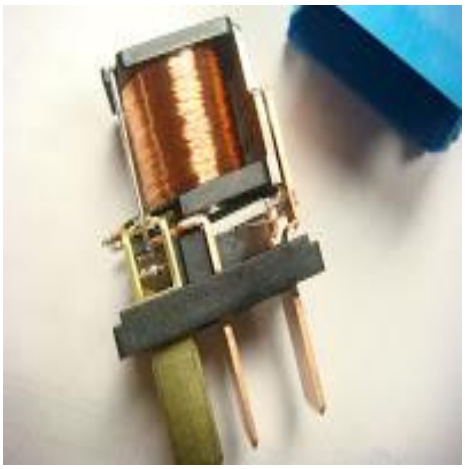
Details on punched cards: *http://www.fourmilab.ch/babbage/cards.html*



Generation 1: Vacuum Tubes (1945-1954)

- mid 1940's – vacuum tubes replaced relays
- glass tube w/ partial vacuum to speed electron flow
- faster than relays
- invented by de Forest in 1906
- 1940's – hybrid computers using vacuum tubes and relays were built

Vaccume tube

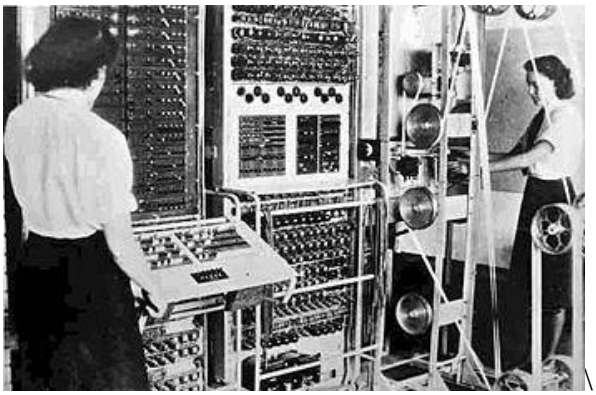


Relay

COLOSSUS (1943)

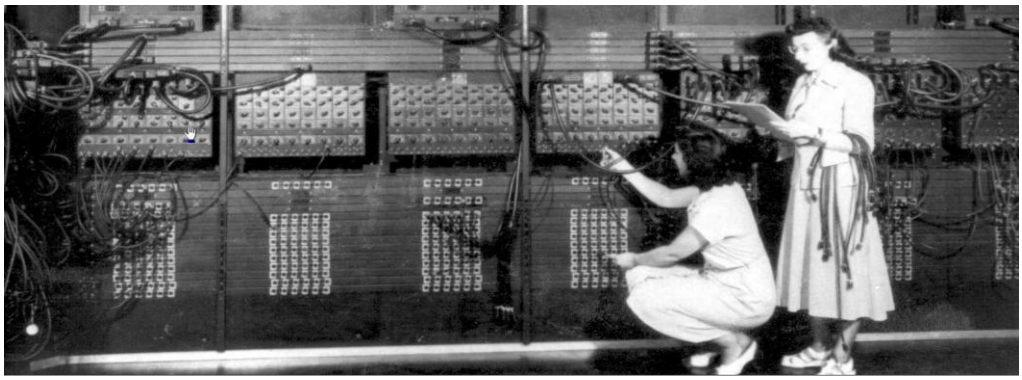
1. Colossus was the world's first programmable electronic digital computer. British codebreakers used Colossus to help to read German coded radio messages during World War II.
2. These messages were sent between the German High Command, and Adolf Hitler's top army commanders. Reading these messages helped the Allies to win the war.
3. Codebreaker Max Newman worked at the Government Code and Cypher School (GC&CS) at Bletchley Park.
4. His problem was how to get a machine that would help turn German coded radio teleprinter messages into ordinary language.

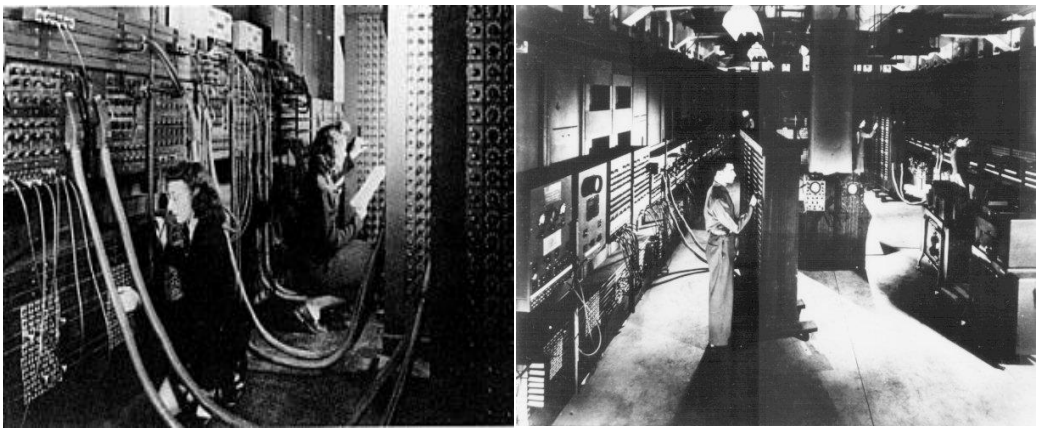
5. A group of Post Office engineers led by Tommy Flowers worked out how to do this.
6. Their design, which was called "Colossus" used many vacuum tubes (valves).



ENIAC:

- ENIAC stands for Electronic Numerical Integrator and Computer.
- It was a secret World War II military project carried out by John Mauchly, a 32-year-old professor in an effort to calculate artillery firing tables for the United States Army's Ballistic Research Laboratory.
- It was designed to give table giving data needed for firing an artillery accurately on a target under standard conditions, and also the corrections that must be made for special conditions such as winds or variations of temperature.
- Its construction began in 1943 and was not completed until 1946. The ENIAC occupied about 1,800 square feet, used 17,468 vacuum tubes, 15,000 relays, used a teletype, weighed almost 50 tons, uses 200 kilowatts of electricity, and cost about $500,000. Although it was not completed until the end of the World War II, the ENIAC was created to help with the war effort against German forces.





- The picture is a public-domain U.S. Army Photo of the ENIAC. All of the wires, switches and components are part of the ENIAC with two of the team of operators helping run the machine.

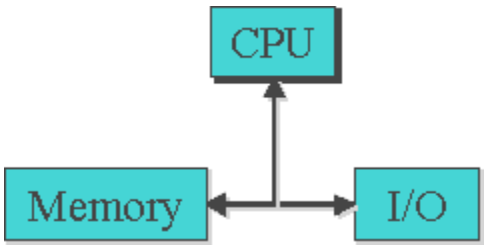
COLOSSUS and ENIAC were not general purpose computers

- could enter input using dials & knobs, paper tape
- but to perform a different computation, needed to reconfigure

von Neumann popularized the idea of a "stored program" computer

- store both data and programs in Memory
- Central Processing Unit (CPU) executes by loading program instructions from memory and executing them in sequence
- interact with the user via Input/Output devices

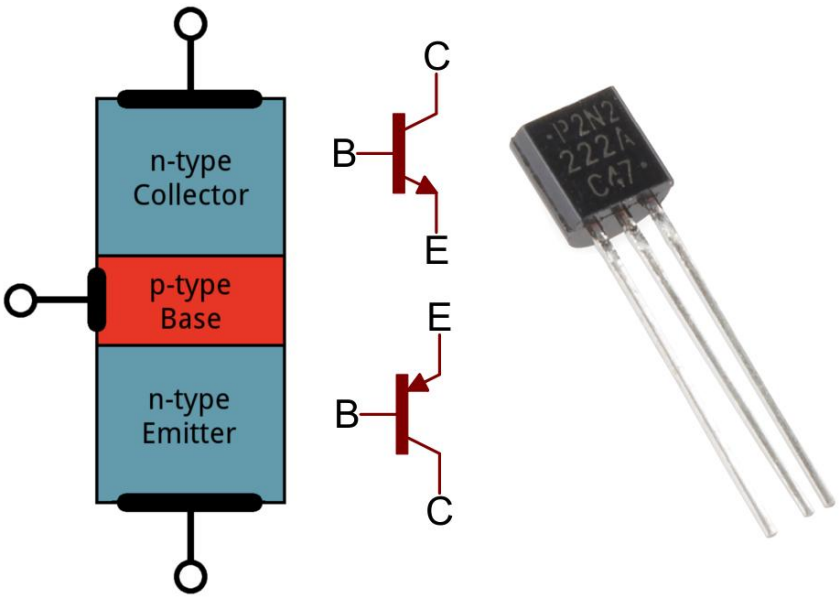
virtually all modern machines follow this *von Neumann Architecture*



Programming was still difficult and tedious as machine language was used. Later assembly language replaced machine language.

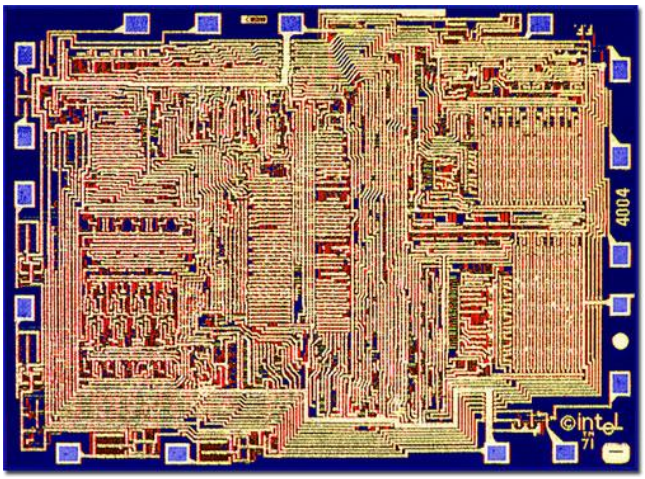
Generation 2: Transistors (1954-1963)

- mid 1950's – transistors began to replace tubes
- piece of silicon whose conductivity can be turned on and off using an electric current
- smaller, faster, more reliable, cheaper to mass produce
- invented by Bardeen, Brattain, & Shockley in 1948 (won 1956 Nobel Prize in physics)
- computers became commercial as cost dropped



Generation 3: Integrated Circuits (1963-1973)

- As transistor size decreased, could package many transistors with circuitry on silicon chip.
- Mass production further reduced prices.
- 1971 – Intel marketed first *microprocessor,* the 4004, a chip with all the circuitry for a calculator.



Operating Systems:

- 1960's saw the rise of Operating Systems.
- An *operating system* is a collection of programs that manage peripheral devices and other resources.
- Allowed for *time-sharing*, where users share a computer by swapping jobs in and out.
- As computers became affordable to small businesses, specialized programming languages were developed : Pascal (1971, Wirth), C (1972, Ritche).

Generation 4: VLSI (1973-1985)

Very Large Scale Integration (VLSI)

- By mid 1970's, could fit hundreds of thousands of transistors w/ circuitry on a chip.
- Could mass produce powerful microprocessors and other useful ic's.
- Computers finally affordable to individuals.

Personal Computing:

- late 1970's saw rise of personal computing.
- Gates & Allen founded Microsoft in 1975.
- Gates wrote BASIC compiler for personal computer would grow into software giant.

- Wozniak and Jobs founded Apple in 1977 went from garage to $120 million in sales by 1980
- IBM introduced PC in 1980.

IBM PC:

- The first IBM PC, formally known as the IBM Model 5150, was based on a 4.77 MHz Intel 8088 microprocessor and used Microsoft´s MS-DOS operating system. The very first PC's had only 16 KB RAM and was expandable to 256KB.
- Apple countered IBM with Macintosh in 1984.

Generation 5: Parallelism & Networking (1985-????)

High-end machines (e.g. servers) can have multiple CPU's.

- in 1997, highly parallel Deep Blue beat Kasparov in speed chess match.

Most computers today are networked.

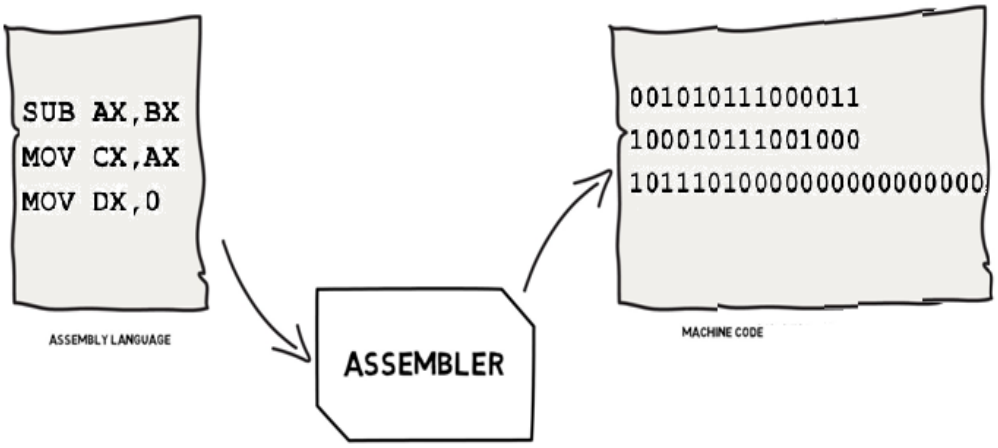
- Internet born in 1969, connected 4 computers (UCLA, UCSB, SRI, & Utah).
- mainly used by govt. & universities until late 80's/early 90's.
- Web invented by Berners-Lee at CERN in 1989 ,designed to allow physics researchers to share data and documents, not popular until 1993 when Andreessen developed graphical browser (Mosaic).
- Andreessen would go on to found Netscape, and Internet Explorer soon followed.

Evolution of programming: machine language

- late 40's / early 50's: programmers coded directly in machine language.
- each machine had its own set of instructions (sequences of 0's & 1's) corresponding to its underlying hardware .
- extremely tedious, error-prone.

Evolution of programming: assembly language

- Mid 1950's: assembly languages replaced numeric codes with mnemonic names
- An assembler is a program that translates assembly code into machine code
- Input: assembly language program output: machine language program
- Still low-level & machine-specific, but easier to program



Evolution of programming: high-level language

- late 1950's – present: high-level languages allow the programmer to think at a higher-level of abstraction
- a compiler is a program that translates high-level code into machine code
- Input: C++ language program output: machine language program
- It is similar to assembler, but more complex
- An interpreter is a program that reads and executes each language statement in sequence.
- Java programs are first compiled into a virtual machine language (Java byte code) then the byte code is executed by an interpreter (Java Virtual Machine)