

COM 510 Lecture Schedule 1

Concepts of Computers – Brief History of Computers – Generations and its Evolution, Characteristics of Computers

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Introduction to Computers:

In the beginning of civilization, people used fingers and pebbles for computing purposes. The word digits in Latin actually means finger and calculus means pebble. The need for a mechanism to perform lengthy calculations led to the invention of, first, calculator and then computers. Since the computer covers a huge area of application this era is called as information age.

What is a computer?

- An electronic device for processing and storing information.
- A computer is a programmable machine.
- The two principal characteristics of a computer are: it responds to a specific set of instructions in a well-defined manner and it can execute a prerecorded list of instructions (a program).
- Does not create information. Cannot think (unlike brain).

The main characteristics of computers are:

a) Speed :

Computers process data at an extremely fast rate, at millions or billions of instructions per second. The speed of a computer is calculated in MHz i.e. 1 million instructions per second. At present the powerful computer can perform billions of operations in just one second.

b) Accuracy:

The computers are very accurate. Since the computer is capable of doing only what it is instructed to do, faulty instructions for data processing may lead to faulty results. This is known as Garbage In Garbage Out(GIGO).

c): Diligence:

Computer, being a machine, does not suffer from human traits of tiredness and lack of concentration. If four million calculations have to be performed then the computer perform the last four million calculations with the same accuracy and speed as the first calculation.

d) Reliability:

Reliability is the measurement of the performance of a computer, which is measured against some predetermined standard for operation without failure. At hardware level, computer does not require any human intervention between its processing operations. Computers have built in diagnostic capabilities which help in the continuous monitoring of the system.

e) Storage:

Computers can store large amounts of data and can recalled the record information almost instantaneously. The main memory of the computer is relatively small and can hold only a certain amount of data and temporary also. So the data are stored in large amounts on secondary storage devices such as magnetic tape or disks permanently.

f) Versatility:

Computers are versatile in nature. It can perform multiple tasks simultaneously with equal ease. For example, at one moment it can be used to draft a letter, another moment it can be used to play music and in between one can print a document as well.

g) Resource sharing:

Today computers have the capability to connect with each other. This has made the sharing of costly resources like printers possible. Apart from device sharing, data and information can also be shared among groups of computers, thus creating a large information and knowledge base.

Limitations of computer:

A computer can only perform what it is programmed to do. The computer needs well defined instructions to perform any operations. Hence Computers are unable to give any conclusion without going through intermediate steps. A computer's use is limited in areas where qualitative considerations are important. For instance, It can make plans based on situations and information, but it cannot foresee whether they will succeed.

Evolution of Computers:

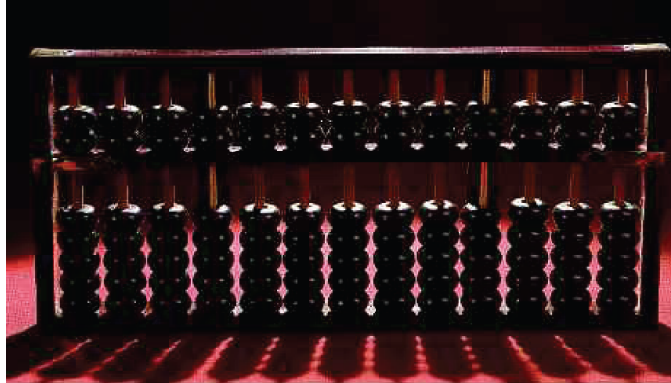
The need for devices to do calculations along with the growth in commerce and other human activities explains the evolution of computers. Having the right tool to perform these tasks has always been important for human beings. In their quest to develop efficient computing devices, humankind developed many apparatuses. However many centuries elapsed before technology was adequately advanced to develop computers.

Calculate with pebbles

- The early man was in need of counting the cattle before and after grazing.
- He made use of the pebbles to count the cattle. That is the genesis of calculation.

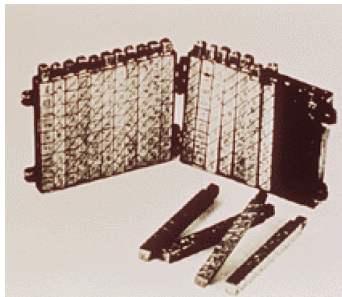
Abacus

- In the beginning people used either their fingers or pebbles along lines in the sand to count or add. For the sake of convenience people in Asia Minor built a counting device called abacus through which calculations were performed using a system of sliding beads arranged on a rack.



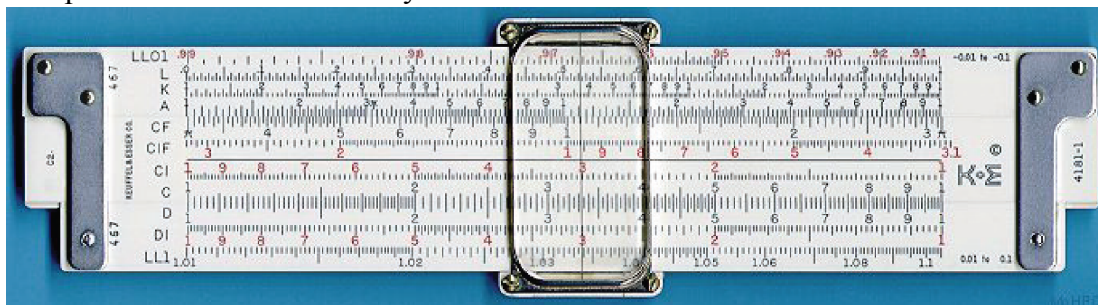
Napier's Bones

In 1617 an eccentric Scotsman named John Napier invented logarithms, that allows multiplication to be performed via addition.



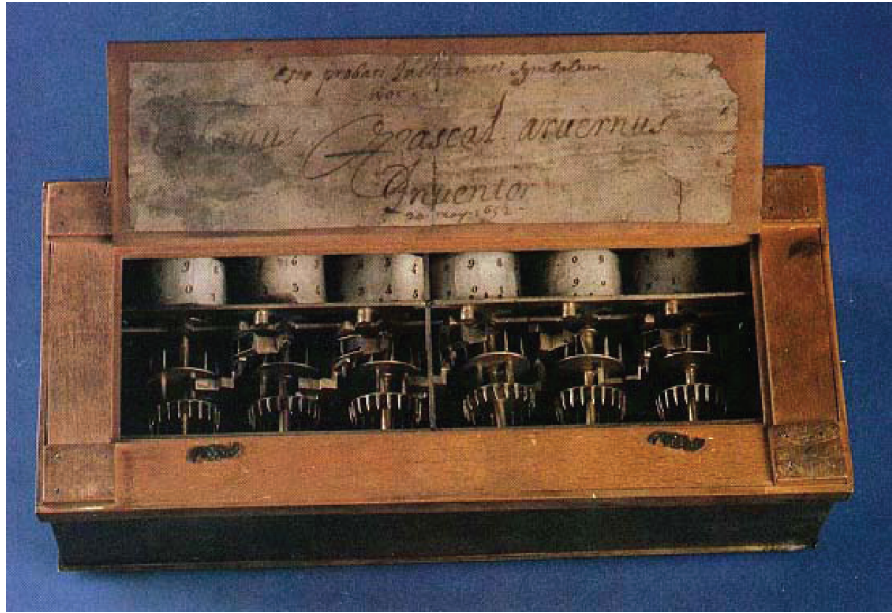
Slide Rule

Napier's invention led directly to the slide rule.



Pascaline

In 1642, a French mathematician, Blaise Pascal invented the first functional automatic calculator. This brass rectangular box is also called as Pascaline, used eight movable dials to add numbers up to eight figures long.



Leibniz Machine

In 1674, a German mathematician, Gottfried Wilhelm von Leibniz made a machine that could perform multiplication, division and square root. This machine is known as the Stepped Reckoner. It was the first mass producing calculating device which was designed to perform multiplication by repeated additions. It worked by a system of gears and tiles. But it lacked mechanical precision in its construction and was not reliable.

Charles Babbage - 1792-1871

In 1822, Charles Babbage (Father of Computer) proposed a machine to perform differential equations called the Difference Engine which is powered by steam. The machine would have a stored program and could perform calculations and print the results automatically. But it was not completed.

Analytical Engine 1833

In 1833, Charles Babbage developed an analytical engine with input devices in the form of perforated cards containing operating instructions and a "store" for the memory of thousand numbers of upto fifty decimal digits long. Babbage borrowed the idea of punch cards to encode the machine instruction from Joseph Marie Jacquard's loom although the analytical engine never constructed the outline basic elements of a modern computer.

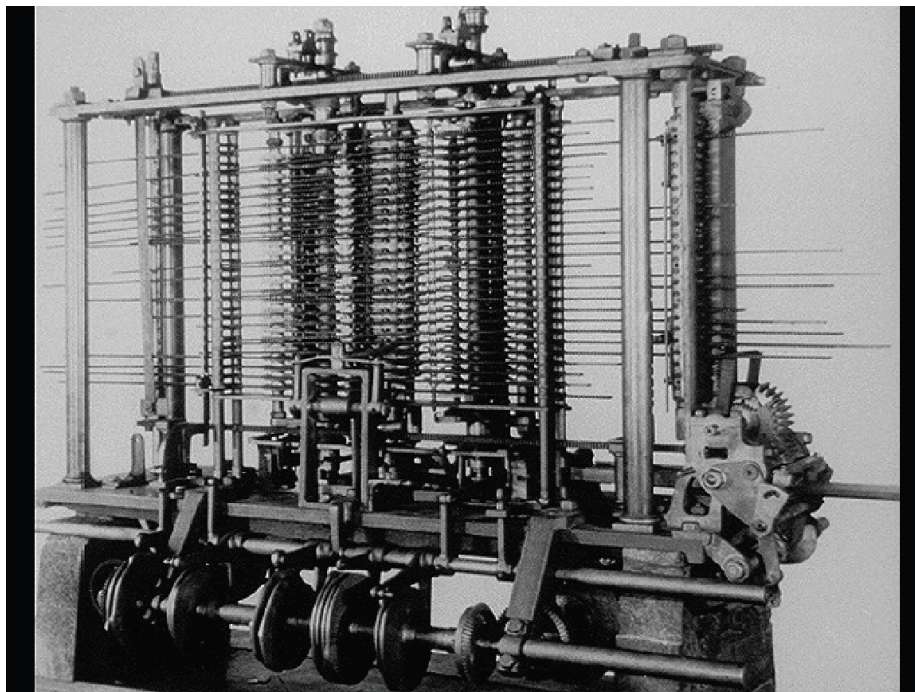
In 1889, Herman Hollerith worked for the U.S census bureau applied Jacquard's loom concept to computing. Hollerith's method used cards to store data which fed into a machine that compiled the results mechanically. The start of World War 2 produced a substantial need for a computer capacity, especially for military purposes.

Harvard Aiken and IBM in 1944 built mark 1 using relays and electro magnetic components to replace mechanical components. In 1946, John Eckert and John Mauchly of the Moore School of Engineering at the University of Pennsylvania developed the Electronic Numerical Integrator and Calculator (ENIAC).

The computer used electronic vacuum tubes John Eckert and John Mauchly also proposed the development of Electronic Discrete Variable Automatic Computer(EDVAC) which was the first electronic to use the stored program concept introduced by John van Neumann. This computer could stop any time and then resume operations.

In 1949, at Cambridge University, a team headed by Maurice Wilkes developed the Electronic Delay Storage Automatic Calculator (EDSAC) based on John van Neumann stored program. The machine used mercury delay lines for memory and vacuum tubes for logic. The Eckert – Mauchly Corporation manufactured the universal automatic computer (UNIVAC) in 1959.

In 1960's efforts to design and develop the fastest possible computer with greatest capacity reached a turning point with the Livermore Advanced Research Computer (LARC) add access time of less than $1\mu s$ and the total capacity 100,000,000.



Generations of Computers:

In computer terminology, the word generation is described as a stage of technology development or innovation. Changing the way the computer operate, resulting in increasingly smaller, cheaper, more powerful, and more efficient and reliable devices are the characters of various generations of computers. According to the type of processor installed in a machine there are five generations of computers.

First Generation 1940 – 1956

First-generation computers used vacuum tubes, relied on binary-coded language or machine language, punched cards and paper tape for input and printouts for output. These

Computers used vacuum tubes for circuitry and magnetic drums for memory. In first generation computers each machine fed with different binary codes and hence difficult to program. This resulted in lack of versatility and speed. Examples: ENIAC, EDVAC and UNIVAC.

Characteristic of First Generation Computers:

- Used vacuum tubes
- Large in size and non-portable
- Required much air conditioning
- Relatively slow
- Lacked in versatility and speed
- Unreliable and prone to frequent hardware failure
- Expensive to operate and used large amount of electricity
- Used magnetic drum as storage media
- Used binary-coded language or machine language (language of 0s and 1s)
- Speeds in thousands of a second
- Average storage capacity - 4000 bytes or 4K (K stands for thousands)

Second Generation of Computers (1956 to 1963)

Second generation of computers used transistors which are made up of semiconductor material like germanium and silicon. Second generation of computers relied on assembly language, punched cards for input and printouts for output. Since the transistor is a small device, the physical sizes of computers were greatly reduced. Computers became smaller, faster, cheaper, energy efficient and more reliable than their predecessors. In the Second generation of computers, magnetic cores were used as the primary memory and magnetic disks as the secondary storage devices. Early high level programming languages such as COBOL and FORTRAN also came into existence in this period. Examples: PDP-8, IBM 1401 and IBM 7090.

Characteristic of Second Generation Computers:

- Used transistors
- Smaller and portable
- Required air conditioning
- Less expensive
- Generated less heat
- More reliable and less prone to hardware failure
- Magnetic core replaced magnetic drum
- Supported auxiliary or secondary storage devices
- Used assembly language (mnemonics or abbreviations for instructions such as ADD for addition and MULT for multiplication rather than 0s and 1s)
- Speeds in millions of a second
- Average storage capacity 32000 or 32K

Third Generation of Computers (1964 to Early 1970s)

Integrated circuits also called ICs consist of a single chip with many electronic components such as transistors and resistors fabricated on it. Third generation of computers used integrated circuits, interfaced with the operating system through keyboards and monitors, and used high level programming languages. This allowed this device to run many different

applications simultaneously with a central program that monitored the memory. Examples: NCR 395 and B6500.

Characteristics of Third Generation of Computers:

- Used integrated circuits
- Smaller, cheaper, easily portable and more reliable
- Generated less heat and consuming less power
- Used operating System and high level programming languages
- Hardware rarely failed, the maintenance cost was quite low
- Speeds in billions and trillions of a second
- Average storage capacity 128000 or 128K
- Commercial production becomes easier and cheaper.

Fourth Generation of Computers (Early 1970s to Till Date)

Fourth Generation of Computers is an extension of third Generation technology. This generation of computers used the microprocessor (circuits containing millions of transistors). Fourth Generation of Computers led to an era of Large Scale Integration (LSI) and VLSI (Very Large Scale Integration) technology. Large Scale Integration increased the number of electronic components that can be fabricated onto a single chip. VLSI (Very Large Scale Integration) and ULSI (Ultra Large Scale Integration) technologies still increased the number of components into millions of components that can be fabricated onto a single chip. Fourth generation of computers used these technologies to develop personal computers. This generation of computers could be linked to form computer networks that led to the development of the internet. Graphical User Interface (GUI) operating systems are developed. Examples: Apple II, Altair 8800 and CRAY-1.

Characteristics of Fourth Generation of Computers:

- Used microprocessors
- Very small, cheap, portable and quite reliable
- Generate negligible amount of heat
- Very low production cost
- Used GUI operating systems and pointing devices (mouse)
- Interconnection of computers led to better communication and resource sharing

Fifth Generation of Computers (Present and Beyond)

The process of developing Fifth Generation of Computers is still in the development stage. Fifth Generation of Computers uses expert system concepts. The expert system is defined as a computer system that attempts to mimic the thought process and reasoning of experts in specific areas.

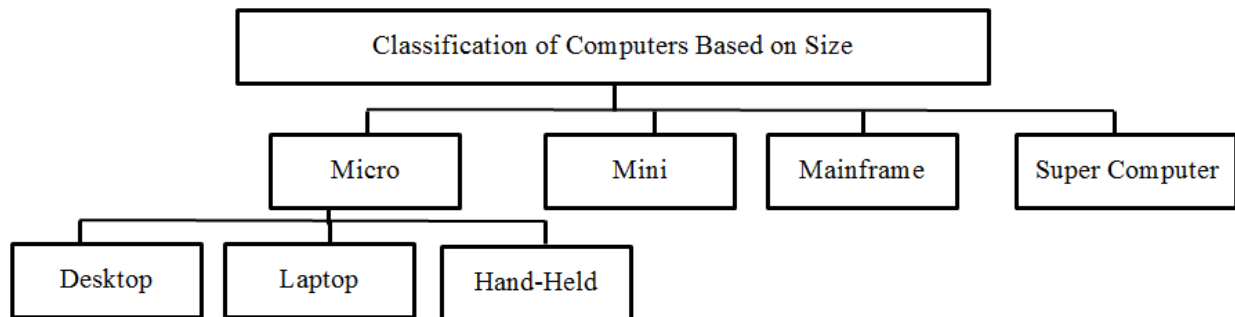
Three characteristics can be identified with the fifth generation computers are:

- Use Super Large Scale Integration (SLSI) or mega chips.

- Parallel processing computers (previous generations are uniprocessing computers that use only one processor for processing only one instruction at a given time) which use more than one processor or multiple processors to process more than one instruction at a time.
- Based on artificial intelligence which is a series of related technologies that try to simulate and reproduce human behavior including thinking, speaking and reasoning. AI comprises a group of related technologies: expert system (ES is defined as a computer system that attempts to mimic the thought process and reasoning of expert in specific area), natural language processing (NLP), speech recognition, vision recognition and robotics.

Classification of Computers:

Computers are classified based on physical size, performance, data-processing ability and application areas. Generally computers can be classified into four major categories such as micro, mini, mainframe and supercomputers.



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Microcomputers:

A microcomputer is a small, low-cost digital computer which consists of a microprocessor, storage unit, input channel, output channel. The micro computers are generally smallest of the computer family and designed for individual users only. Microcomputers include desktop, laptop and hand-held devices such as Personal Digital Assistants (PDAs).

Desktop Computer:

Desktop computers also known as Personal Computers (PC) are intended for stand-alone use by an individual. Some of the major PC manufacturers are APPLE, IBM, DELL and Hewlett-Packard.

Laptop:

A laptop known as a notebook computer is a portable computer. Laptops are powered by rechargeable batteries. However, they are expensive as compared to desktop computers.

Difference between Desktop and Laptop:

Desktop	Laptop
Also called as personal computer	Also called as notebook
Large in size	Smaller when compared to desktop
Non-portable	Portable

Powered by direct electrical line	Powered by rechargeable batteries
Components are not integrated as a single unit	All parts are integrated as a single unit
Individuals RAM units are used by processor and VDU	RAM is being shared among VDU and processor

Hand-held Computers:

A hand-held computer also called a palmtop computer such as Portable Digital Assistance (PDA) is a portable computer that can conveniently be stored in a pocket and used while the user is holding it. PDA uses a pen or electronic stylus instead of keyboard for input, small cards to store programs and data instead of disk drive and can be connected to a printer or disk drive to generate output and store data.

Examples: Apple Newton, Casio Cassiopeia and Franklin eBookMan.

Minicomputers:

A minicomputer called a mid-range computer is designed to meet the computing needs of several people simultaneously in a small to medium sized business environment. It is about the size of a two-drawer filing cabinet. It is capable of supporting from four to two hundred simultaneous users. Minicomputers are usually multi-user systems. They are also used for real-time controls and engineering design work. Example: PDP 11, IBM(8000 series) and VAX 7500.

Mainframes:

Mainframe is an ultra-high performance computer made for high-volume, processor-intensive computing. Mainframes are powerful computers used mainly by large organizations for critical applications, typically bulk data processing such as census, industry and consumer statistics, enterprise resource planning, and financial transaction processing and having extensive data storage. Mainframes are the second largest (in compatibility and size) of the computer family, the largest being the supercomputers.

Example: IBM's ES000, VAX 8000 and CDC 6600.

Supercomputers:

Supercomputers are special purpose machines with highest processing power at a given time for solving scientific and engineering problems. Supercomputers are especially designed to maximize the number of floating point operations per second(FLOPS).Supercomputer contains number of CPUs that operate in parallel to process millions of Floating Point Operations per Second (FLOPS).

Example: CRAY-3, Cyber 205 and PARAM

In 2003, India's Center for Development of Advanced Computing (C-DAC) developed a supercomputer namely PARAM Padma with processing speed up to 1 Teraflop per second.