Introduction to Scientific and Engineering Computation
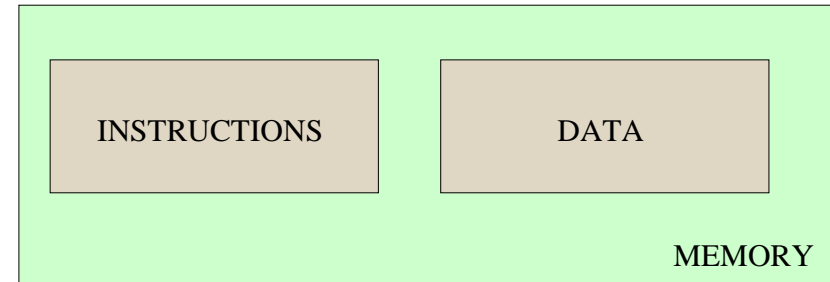## (BIL 102E)

LECTURE 2

Computer

A machine that can **store** data and do **arithmetic and logic operations** on this data by **following** a predetermined set of **instructions**.

INSTRUCTIONS	DATA

MEMORY

Brief History

Abacus and adding machines can be considered as first computers.

- 2000BC – Abacus is known to be used since

- 1642 – Blaise Pascal is first to create a mechanical adding machine (for tax computations) (was not reliable)

- 1670 – Gottfried and Leibniz create a reliable adding machine capable of adding, subtracting, multiplying, dividing and finding square roots.

1842 – Charles Babbage designs an analytical engine to perform general calculations automatically. Ada Byron, daughter of the poet Lord Byron, assists him in programming.

National Museum of Science and Technology (London)

•1890 – Herman Hollerith designs the first punch card reader. (Programs are written in punched cards.) Hollerith starts a company that will eventually become IBM.

•1939 – John Atasanof (University of Iowa) builds the first digital computer.

• 1946 – J Presper Eckert and John Mauchly (University of Pennsylvania) build the Electronic Numerical Integrator and Calculator (ENIAC). (18000 vacuum tubes – costs $500,000) (Room size: 20m x 50m)

The ENIAC Computer (1946)

•1951 – Eckert and Mauchly build the first general-purpose commercial computer called Universal Automatic Computer (UNIVAC)

•1957 – FORTRAN is developed as the first high level language

•1958 – Transistors are used as switching devices in a computer (IBM 7090)

•1964 – The first computer using integrated circuits is announced (IBM 360)

•1975 – The first microcomputer is introduced (the Altair)

•1975 – The first supercomputer is announced (Cray-1)

•1977 – Production of first Apple Computers

•1981 – The first IBM personal computer

•1982 – Sun Microsystems introduce their first workstation (Sun 100)

•1984 – Apple introduces Macintosh, the first widely available computer with a "graphical user interface", using icons, windows and a mouse device

•1992 – Personal computers that can handle more than 10 million instructions per second are sold in wide quantities.

•1994 – Internet (1970) and world wide web experiences explosive growth and popularity.

•2000 – Personal computers with microprocessors capable of handling more than 1 billion instructions are available.

Comparison

If Automobiles had developed as fast as computers since 1960, today's automobile would have an engine that is less than 0.1 inch in length, would get 120,000 miles per gallon, have a top speed of 500,000 kilometers per hour and would cost $4.00.

Main Components of a Computer

All computers consist of *hardware*, the physical equipment, and *software*, the programs loaded into the hardware to perform computational tasks.

Most computers have the following hardware components:

• The Central Processing Unit (CPU)

• Main memory

• Secondary memory (hard disk, floppy disk, CD-ROM)

• Input devices (keyboard, mouse, scanner, microphone)

•Output devices (monitor, printer, speakers)
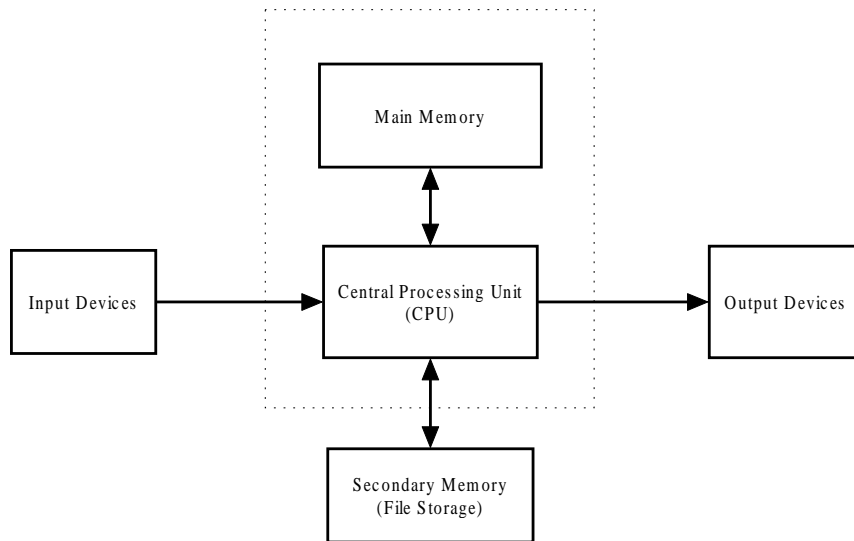
A conceptual structure of computer hardware

Central Processing Unit

The CPU is the brain of the computer. It coordinates all computer operations (controller unit), and performs arithmetic and logical operations (arithmetic-logic unit – ALU) .

The CPU follows instructions contained in a program which has been loaded into memory.

These instructions specify which operations should be carried out and **in what order**.

The CPU does the following in an infinite loop

1. Retrieve the instruction (**fetch** the instruction),

2. Interpret (**decode**) the instruction to determine what to do

3. Retrieve any data necessary to carry out the instruction,

4. Perform (**execute** the instruction) the actual manipulation of the data.

5. If necessary store the results back in memory.

6. Move to the next instruction

The CPU can perform basic arithmetic and logic operations on data. Based on simple comparisons it can also make simple decisions about which instruction to execute next.

Main Memory

Main memory is used for storing information and programs. All types of information such as numbers, character strings, lists, and even pictures can be stored in main memory (all as combinations of two digits 1 and 0).

The simplest memory unit that can hold the binary information 1 or 0 is called a **bit**.
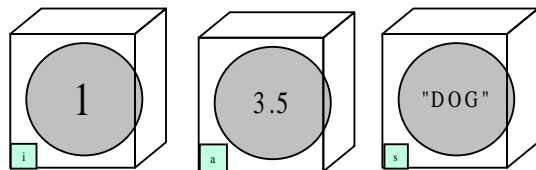
8 bits form a **byte**.

2^{10} = 1024 bytes is a **kilobyte** (KB)

1024 kilobytes is a **megabyte** (MB)

You can imagine the memory as a set of storage locations like glass boxes.

Each storage location has a label (address) attached and carries something all the time .

These labels are often called **variables** in programming terminology to underline the fact that the values shown by these names can be changed. There are also **constants**, where changing the value is not allowed.

Secondary Memory (File Storage)

- Hard drives, floppies, zips, CD-ROMs, VCDs

- Optical or magnetic data

- Peripheral devices provide long-term storage

- Access times thousands of times slower than accessing main memory

- All data from secondary storage have to be brought to main memory to be used

Input/Output (I/O) Devices

These devices are used to communicate with the computer. The mostly used ones are the keyboard, mouse (as input devices), monitor and printer (as output devices).

For example when you press a key on your keyboard a binary coded version of that character is sent to the CPU which puts this information in main memory.

Software Components

This includes

1. BIOS (Basic Input Output System)

2. OS (Operating System) such as Unix, DOS, Windows

3. Windowing System such as X-Windows, MS Windows

4. Applications such as games, word processors, mathematical programs

Our aim is to develop applications using a high level language called C.

History of C

First programs are written in the machine language, the only language that a computer understands. All the other languages have to be translated to the machine language.

Each machine language instruction is a binary sequence (string of 0s and 1s) that specifies an operation and the memory cells involved in the operation.

For example three instructions in a machine language might be:

Instruction	Data Address
0010 0000	0000 0100
0100 0010	0000 0101
0011 0110	0000 0110

Later, *mnemonics* for instructions and *labels* for data addresses are used in order to increase the readability of programs. Hence, **Assembly language** was born. In Assembly language the same three instructions we have seen before, for example, could be represented as:

Mnemonic	Label
LOAD	Cost
ADD	Profit
STORE	Price

•In 1953, John Backus (IBM) started a new research group to develop a more efficient way of programming.

•In 1970, the language B was developed by Ken Thompson.

•The C language was first developed in 1972 by Dennis Ritcie at AT&T Bell Labs. (The language is called C because there was a language called B).

• In 1983, American National Standards Institute (ANSI) established a committee to provide a standard for C. The result was ANSI C (1989).

• Today there are many C compilers all with their extra support for the language. However, all of these compilers support ANSI C, the language we shall cover in this course.