CSE123 - Introduction to Computing

Lecture 1: Introduction to Computers – History, Parts and Operation

Assist. Prof. Barış Yılmaz
Syllabus

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Lecture notes & Assignments :
  mimoza.marmara.edu.tr/~byilmaz/Courses/ES117
Office hours: Thursday 10:00 – 12:00

Text Books
• Other resources: A number of MATLAB resources (primers, tutorials, guides) are available on the web. http://www.mathworks.com/
What is a computer?

“AN ELECTRONIC MACHINE THAT CAN STORE, RETRIEVE AND PROCESS DATA ACCORDING TO A SET OF INSTRUCTIONS”
What is a computer?

- can do a huge number of primitive operations very fast

- Flexible: can handle a wide range of tasks
  - Word processing, calculations, games

- Hardware and software
  - Hardware: physical parts of the computer
  - Software: programs and data
    - Program: series of instructions
(a) Notebook Computer
(HP Pavilion dv5©, Courtesy of Hewlett-Packard).

(b) Palmtop Computer
(iPhone 3G©, Courtesy of Apple, Inc.)

(c) Desktop Computer
(iMac©, Courtesy of Apple, Inc.)
Basic components of a computer

- **Input**: data from the user to the computer
  - Keyboard, mouse, scanner, camera, microphone

- **Storage**
  - Primary storage – RAM (temporary storage)
  - Secondary storage – HDD, CD-ROM etc. (permanent storage)

- **Processing**
  - CPU - Supervises and coordinates the other sections of the computer
  - ALU - Performs arithmetic calculations and logic decisions

- **Output**: data from the computer to the user
  - Monitor, printer, speakers
Basic components of a computer

- Input Devices
- Memory (RAM)
- Central Processing Unit (CPU)
- Output Devices
- Storage Devices
Components of a Computer

Secondary storage

Input devices

Main memory

Central processing unit

Output devices
CPU: Central Processing Unit

Brain of the computer:
- executes program instructions
- processes data

Components:
- Arithmetic and Logic Unit (ALU): a digital circuit that performs arithmetic and logical operations
- Control Unit: Controls the flow of information - extracts instructions from memory, decodes and executes them
- Registers: Small storage areas
A microprocessor incorporates most or all of the functions of a CPU on a single integrated circuit (microchip) → personal computers
Primary storage/Memory
Directly accessible by the CPU, stores data that is in active use.

RAM (Random Access Memory): read-write memory. Volatile → data are erased when the computer power is off.

ROM (Read Only Memory): contains certain programs that must always be present. Non volatile → can not be modified.
Storage

Secondary storage

- Not directly accessible by the CPU
- Data not in active use
- Non volatile
- Floppy disk, hard drive, CD/DVD, flash drive, memory cards
Motherboard

- holds many of the crucial components of the system
  - CPU
  - Storage
  - Bus: a set of electrical lines that connect the CPU, RAM, slots and other connectors
  - Card slots and other connectors
Data representation

Computers represent data using the binary system: two digits $\rightarrow$ 0 and 1

**Binary digit $\rightarrow$ Bit**

- Electrical signals can be in one of 2 discreet states: $1 = \text{ON}; \ 0 = \text{OFF}$
- Not sufficient for information processing, numerical and alphabetical characters are needed.
  - Byte: Bits combined into groups to represent letters, numbers and special characters
  - 8 bits = 1 byte
Bits and bytes

- Speed of a modem in kilobit/s (kbps) or kilobyte/s (KBps)
- File size in Megabytes (MB)
- Hard disk size in Gigabytes (GB)

<table>
<thead>
<tr>
<th>Prefixes for bit and byte multiples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Decimal</strong></td>
</tr>
<tr>
<td>Value</td>
</tr>
<tr>
<td>1000</td>
</tr>
<tr>
<td>1000²</td>
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<tr>
<td>1000³</td>
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<td>1000⁷</td>
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<td>1000⁸</td>
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</table>

producers of computer storage  
software and computer industries
Decimal system

- 10 digits → 0, 1, 2,..., 9
- Base 10 → each digit is multiplied by 10 raised to a power corresponding to that digit’s position

<table>
<thead>
<tr>
<th>1000s $10^3$</th>
<th>100s $10^2$</th>
<th>10s $10^1$</th>
<th>1s $10^0$</th>
<th>Decimal number</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1</td>
<td></td>
<td></td>
<td>$81 = (8 \times 10^1) + (1 \times 10^0)$</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td>$123 = (1 \times 10^2) + (2 \times 10^1) + (3 \times 10^0)$</td>
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<tr>
<td>4</td>
<td>7</td>
<td>5</td>
<td>8</td>
<td>$4758 = (4 \times 10^3) + (7 \times 10^2) + (5 \times 10^1) + (8 \times 10^0)$</td>
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</table>
Binary system

- 2 digits $\rightarrow$ 0, 1
- Base 2 $\rightarrow$ each digit is multiplied by 2 raised to a power corresponding to that digit’s position

<table>
<thead>
<tr>
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<th>64s $2^6$</th>
<th>32s $2^5$</th>
<th>16s $2^4$</th>
<th>8s $2^3$</th>
<th>4s $2^2$</th>
<th>2s $2^1$</th>
<th>1s $2^0$</th>
<th>Binary number</th>
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<tr>
<td>0</td>
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<td>0</td>
<td>1</td>
<td>0</td>
<td>2=(1×2)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3=(1×2)+(1×2)</td>
</tr>
<tr>
<td>0</td>
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<td>0</td>
<td>1</td>
<td>0</td>
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<td>0</td>
<td>4=(1×2)</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20=(1×2)+(1×2)</td>
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<tr>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>123</td>
</tr>
</tbody>
</table>
**American Standard Code for Information Interchange (ASCII)**

A character-encoding scheme representing text in computers.

Developed from telegraphic codes

<table>
<thead>
<tr>
<th>Binary</th>
<th>Oct</th>
<th>Dec</th>
<th>Hex</th>
<th>Glyph</th>
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<tr>
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<td>100</td>
<td>64</td>
<td>40</td>
<td>@</td>
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</tr>
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<td>102</td>
<td>66</td>
<td>42</td>
<td>B</td>
</tr>
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<td>103</td>
<td>67</td>
<td>43</td>
<td>C</td>
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<td>68</td>
<td>44</td>
<td>D</td>
</tr>
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<td>G</td>
</tr>
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<td>100 1000</td>
<td>110</td>
<td>72</td>
<td>48</td>
<td>H</td>
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<td>111</td>
<td>73</td>
<td>49</td>
<td>I</td>
</tr>
<tr>
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<td>112</td>
<td>74</td>
<td>4A</td>
<td>J</td>
</tr>
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<td>113</td>
<td>75</td>
<td>4B</td>
<td>K</td>
</tr>
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<td>100 1100</td>
<td>114</td>
<td>76</td>
<td>4C</td>
<td>L</td>
</tr>
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<td>100 1101</td>
<td>115</td>
<td>77</td>
<td>4D</td>
<td>M</td>
</tr>
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<td>100 1110</td>
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<td>78</td>
<td>4E</td>
<td>N</td>
</tr>
<tr>
<td>100 1111</td>
<td>117</td>
<td>79</td>
<td>4F</td>
<td>O</td>
</tr>
<tr>
<td>101 0000</td>
<td>120</td>
<td>80</td>
<td>50</td>
<td>P</td>
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<td>101 0110</td>
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<td>101 1001</td>
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<td>Y</td>
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<tr>
<td>101 1010</td>
<td>132</td>
<td>90</td>
<td>5A</td>
<td>Z</td>
</tr>
</tbody>
</table>

Oct: Base 8  
Dec: Base 10  
Hex: Base 16
Software

- A set of programs, procedures, algorithms and its documentation concerned with the operation of a data processing system
- Provides the instructions for telling a computer what to do and how to do it
System software

A set of programs containing instructions that coordinate all the activities among computer hardware

Functions

- Booting
  - a process that begins when a user turns on a computer system and prepares the computer to perform its normal operations
- Housekeeping
- User interface
- Managing computer resources
- Managing data and tasks
Operating Systems

- DOS
- Microsoft Windows
- Mac OS
  - easy to use interface
- UNIX
- LINUX
  - open source
Application software

- **Productivity/Business**
  - Word processing, spreadsheet, database, presentation graphics, document management (pdf)

- **Graphics and Multimedia**
  - Image, video, audio editing, web page authoring, Computer-Aided Design (CAD)

- **Home/Personal/Educational**

- **Communication**
  - E-mail, chatroom, instant messaging, ftp, blogging, web browser, video conferencing, phone calls
History of Computers
History of Computers

Computer: a person who makes calculations

Human computers: inaccurate and tedious work

Human computers in the NACA High Speed Flight Station "Computer Room", Dryden Flight Research Center Facilities, USA, 1949
A COMPUTER WANTED.

WASHINGTON, May 1.—A civil service examination will be held May 18 in Washington, and, if necessary, in other cities, to secure eligibles for the position of computer in the Nautical Almanac Office, where two vacancies exist—one at $1,000, the other at $1,400.

The examination will include the subjects of algebra, geometry, trigonometry, and astronomy. Application blanks may be obtained of the United States Civil Service Commission.
Charles Babbage (1791-1871)

British mathematician, engineer, inventor

Idea to “calculate with steam”

- The difference engine
- The analytical engine
The difference engine

- First automatic calculating machine designed to calculate and tabulate polynomial functions by the method of finite differences
- A calculating section and a printer
- Funded by British government
- Not completed
- Can only do one thing: calculate using the method of differences
- A better idea: A machine with many different uses
The difference engine

- Based on original designs from 1847-1849
- 8000 parts, 7 feet high, 11 feet long, 18 inches deep
- On public display at the Science Museum in London
- IT WORKS!
The analytical engine

First mechanical general-purpose computer

- A machine with many different uses: up to the user to decide
- The fundamental concept of the modern computer: Separation of the “mill” (CPU) and the “store” (memory)
- Programmable using punch cards
Ada Lovelace (1815-1852)

“The first computer programmer”

- An impressive mathematician and one of the few people who fully understood Babbage's ideas
- 1843: Published her notes on the analytical engine including translation of Babbage’s work
- First published description of a stepwise sequence of operations for calculating Bernoulli numbers
Konrad Zuse (1910-1995)

“The inventor of the modern computer”

- A German civil engineer and computer pioneer
- He realized that an automatic-calculator device would require three basic elements:
  - a control,
  - a memory, and
  - a calculator for the arithmetic.

- Z3 in 1941:
  - The first functional general-purpose computer
ENIAC: Electronic Numerical Integrator and Computer (1946)

- Shortage of human computers to calculate weapon trajectories (30-40 hours/trajectory, 4 years for a firing table)
- Built at the University of Pennsylvania by John Mauchly and J. Presper Eckert to aid military calculations
- The first general-purpose electronic computer
- Used vacuum tubes as switches (1000-2000 times faster than relays)
ENIAC

- 18000 vacuum tubes
- 50 feet by 30 feet room
- 5000 additions per second
- Programmed by rewiring using wiring diagrams: 6000 switches, hundreds of cables
Many early computers were not reprogrammable. They executed a single hardwired program. Other computers, though programmable, stored their programs on punched tape which was physically fed into the machine as needed.

- First electronic stored-programme computer in 1948: Manchester Baby, University of Manchester
- The first practical computer with stored programs: Maurice Wilkes at Cambridge in 1949
Alan Turing (1912-1954)

- A British mathematician, logician, cryptanalyst, and computer scientist
- Recognized the limitless potential of computers
  “A universal machine, it can carry out any task that can be described in symbols”
- Inspired the inventors of Colossus: the world's first electronic, digital, programmable computer, 1943
- Artificial Intelligence
The Five Generations of Computers

- The history of computer development is often referred to in reference to the different generations of computing devices.
- Characterized by a major technological development that fundamentally changed the way computers operate
  → resulting in increasingly smaller, cheaper, more powerful and more efficient and reliable devices.
First Generation, 1940-1956:
Vacuum tubes

- Used vacuum tubes for circuitry and magnetic drums for memory
- Often enormous, taking up entire rooms
- Very expensive to operate. In addition to using a great deal of electricity, generated a lot of heat
- Could only solve one problem at a time
- ENIAC, Manchester Baby
Second Generation, 1956-1963: Transistors

- Transistor was far superior to the vacuum tube, allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable.
- Still generated a great deal of heat
- Second-generation computers still relied on punched cards for input and printouts for output.

- Two separate inventors, unaware of each other's activities, invented almost identical integrated circuits or ICs at nearly the same time.
  - Jack Kilby at Texas Instruments (The Nobel Prize in Physics 2000) and Robert Noyce at Fairchild Camera: 1958-1959
- Huge number of transistors packed on a single wafer of silicon (chip), which drastically increased the speed and efficiency of computers
- Instead of punched cards and printouts, users interacted with these computers through keyboards and monitors and interfaced with an operating system
  - allowed the device to run many different applications at one time with a central program that monitored the memory.
Fourth Generation, 1971-today: Microprocessors

- Thousands of integrated circuits were built onto a single silicon chip. What in the first generation filled an entire room could now fit in the palm of the hand.
- The Intel 4004 chip, developed in 1971, located all the components of the computer, from the central processing unit and memory to input/output controls, on a single chip.
- 1981: IBM introduced its first computer for the home user.
- 1984: Apple introduced the Macintosh.
- Development of graphical user interfaces (GUIs), the mouse and handheld devices.
"the science and engineering of making intelligent machines"

- Robotics
- Neural networks
- Natural language
- Game playing
- Long term goal → general intelligence
Three types of programming languages

1. **Machine languages**
   - Strings of numbers giving machine specific instructions
   - Example:
     
     +1300042774  
     +1400593419  
     +1200274027

2. **Assembly languages**
   - English-like abbreviations representing elementary computer operations (translated via assemblers)
   - Example:
     
     LOAD BASEPAY  
     ADD OVERPAY  
     STORE GROSSPAY
Three types of programming languages (continued)

3. **High-level languages**
   - Codes similar to everyday English
   - Use mathematical notations (translated via compilers)
   - Example:
     \[
     \text{grossPay} = \text{basePay} + \text{overTimePay}
     \]
High-level Languages

- **Other high-level languages**
  - C, FORTRAN
    - Used for scientific and engineering applications
  - COBOL
    - Used to manipulate large amounts of data
  - Pascal
    - Intended for academic use
Entering, Translating, and Running a High-Level Language Program
Flow of Information During Program Execution

- **Input data:** meter readings
- **Program input:**
  - Machine language program for computing water bill
  - Data entered during execution
  - Computed results
- **Central processing unit**
- **Output results:** water bill