Fundamentals of Computers

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Syllabus

- Basics
  - Principals of computers
  - Binary computation
  - History of programming
- Basics of **Python** programming
  - Data types & variables
  - Strings & lists
  - Control structures
  - Functions
  - Files
- Problem solving
  - Searching & sorting
  - Recursive programming

Grading & Resources

- Final 40%
- HW 30%
- Project 30%

1. Understanding Computers: Today and Tomorrow, 16th edition, Deborah Morley, Charles S. Parker
2. Python Crash Course, A Hands-On, Project-Based Introduction to Programming, 2nd Edition, Eric Matthes
3. Think Python, How to think like a computer scientist, Allen B. Downey

Why learning to program?

- Improve your logical thinking skills
- Coding and programming careers have great earning potential
  - Attractive salaries
  - Get to Work From Home
  - Many job offers
  - Valuable skills on your resume
- You Can Create Anything You Want

Computers in Your Life

- Before 1980
  - Computers were large, expensive
  - Very few people had access to them
  - Computers were mostly used for high-volume processing tasks
- Microcomputers in the early 80s
  - Inexpensive personal computers
  - Computer use increased dramatically
- Today
  - More than 60% of US households include a computer, and most use computers at work
  - basic computer literacy— knowing about and understanding computers and their uses—is an essential skill today for everyone.

Computers on the Go

- Computers are encountered in nearly every aspect of daily life
  - Portable PCs and handheld computers
  - ATM machines and retail stores
  - Self-checkout systems and consumer kiosks
  - GPS systems

What Is a Computer and What Does It Do?

- Computer: A programmable, electronic device that accepts data, performs operations on that data, and stores the data or results as needed
  - Computers follow instructions, called programs, which determine the tasks the computer will perform
- Basic operations
  - Input: Entering data into the computer
  - Processing: Performing operations on the data
  - Output: Presenting the results
  - Storage: Saving data, programs, or output for future use
  - Communications: Sending or receiving data

What Is a Computer and What Does It Do?

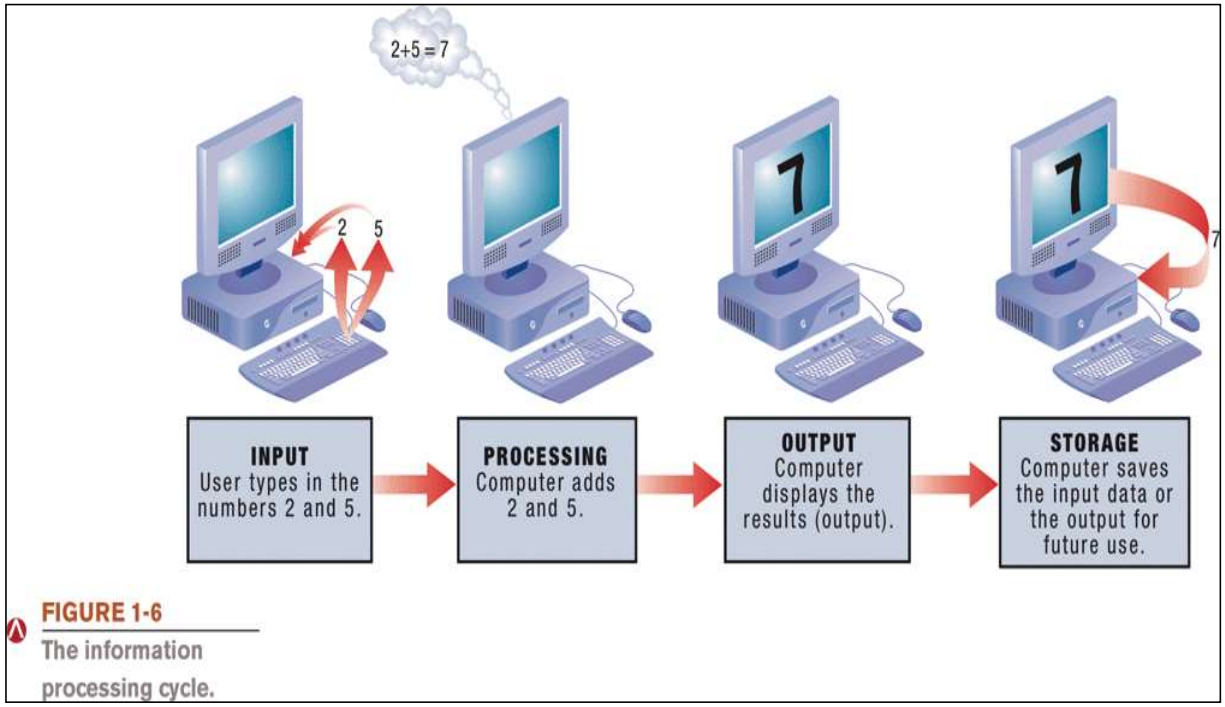

FIGURE 1-6
The information processing cycle.

Computers Then and Now

- The computer as we know it is a fairly recent invention
- The history of computers is often referred to in terms of generations
- Each new generation is characterized by a major technological development

- Precomputers and early computers (before 1945)
  - Abacus, slide rule, mechanical calculator
  - Punch Card Tabulating Machine and Sorter

Computers Then and Now

- First-generation computers (1946-1957)
  - Enormous and powered by vacuum tubes
  - Used a great deal of electricity, and generated a lot of heat
  - ENIAC and UNIVAC

- Second-generation computers (1958-1963)
  - Used **transistors**
  - Computers were smaller, more powerful, cheaper, more efficient, and more reliable
  - Punch cards and magnetic tape were used to input and store data

Computers Then and Now

- Third-generation computers (1964-1970)
  - Used integrated circuits (ICs)
  - Keyboards and monitors introduced
- Fourth-generation computers (1971-present)
  - Use microprocessors
  - IBM PC, Apple Macintosh
  - Use keyboards, mice, monitors, and printers
  - Use magnetic disks, flash memory, and optical disks for storage
  - Computer networks, wireless technologies, Internet introduced

Computers Then and Now

- Fifth-generation (now and the future)
  - Infancy stage
  - Based on artificial intelligence (AI)
  - Likely use voice input
  - May be based on optical computers and utilize nanotechnology

Computers Then and Now

PRECOMPUTERS AND EARLY COMPUTERS
Dr. Herman Hollerith's Punch Card Tabulating Machine and Sorter is an example of an early computing device. It was used to process the 1890 U.S. Census in about one-quarter of the time usually required to tally the results by hand.

FIRST-GENERATION COMPUTERS
First-generation computers, such as ENIAC shown here, were large and bulky, used vacuum tubes, and had to be physically wired and reset to run programs.

SECOND-GENERATION COMPUTERS
Second-generation computers, such as the IBM 1401 mainframe shown here, used transistors instead of vacuum tubes so they were physically smaller, faster, and more reliable than earlier first-generation computers.

THIRD-GENERATION COMPUTERS
The integrated circuit marked the beginning of the third generation of computers. These chips allowed the introduction of smaller computers, such as the DEC PDP-8 shown here, which was the first commercially successful minicomputer.

FOURTH-GENERATION COMPUTERS
Fourth-generation computers, such as the original IBM PC shown here, are based on microprocessors. Most of today's computers fall into this category.

FIGURE 1-7
A brief look at computer generations.

Hardware

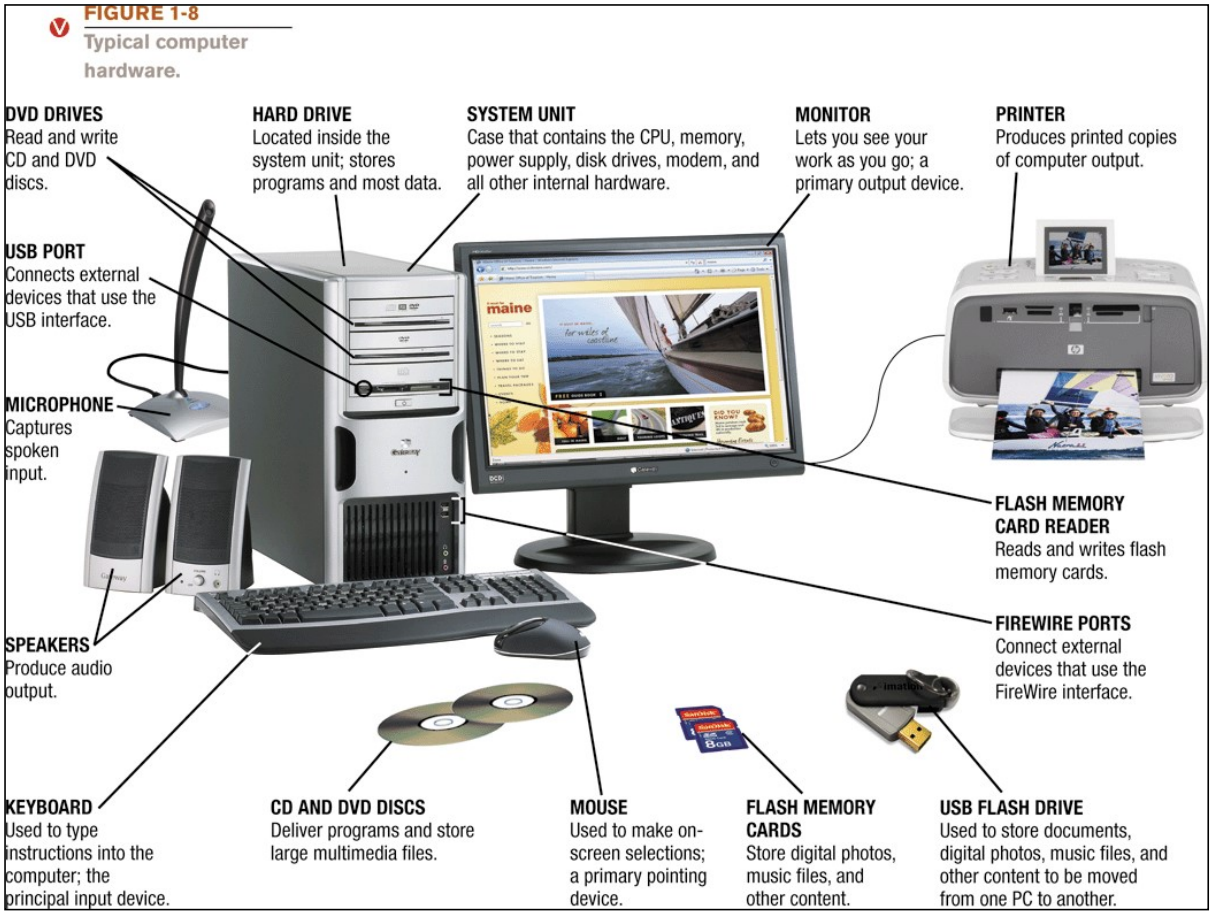
FIGURE 1-8
Typical computer hardware.
DVD DRIVES
Read and write CD and DVD discs.
HARD DRIVE
Located inside the system unit; stores programs and most data.
SYSTEM UNIT
Case that contains the CPU, memory, power supply, disk drives, modem, and all other internal hardware.
MONITOR
Lets you see your work as you go; a primary output device.
PRINTER
Produces printed copies of computer output.
USB PORT
Connects external devices that use the USB interface.
MICROPHONE
Captures spoken input.
FLASH MEMORY CARD READER
Reads and writes flash memory cards.
FIREWIRE PORTS
Connect external devices that use the FireWire interface.
SPEAKERS
Produce audio output.
KEYBOARD
Used to type instructions into the computer; the principal input device.
CD AND DVD DISCS
Deliver programs and store large multimedia files.
MOUSE
Used to make on-screen selections; a primary pointing device.
FLASH MEMORY CARDS
Store digital photos, music files, and other content.
USB FLASH DRIVE
Used to store documents, digital photos, music files, and other content to be moved from one PC to another.

Hardware

- Input devices
  - Used to input data into the computer
  - Keyboards, mice, scanners, cameras, microphones, joysticks, etc.
- Processing devices
  - Perform calculations and control computer's operation
  - Central processing unit (CPU) and memory
- Output devices
  - Present results to the user
  - Monitors, printers, speakers, projectors, etc.

Hardware

- Storage devices
  - Used to store data on or access data from storage media
  - Hard drives, DVD disks and drives, USB flash drives, etc.
- Communications devices
  - Allow users to communicate with others and to electronically access information
  - Modems, network adapters, etc.

Hardware

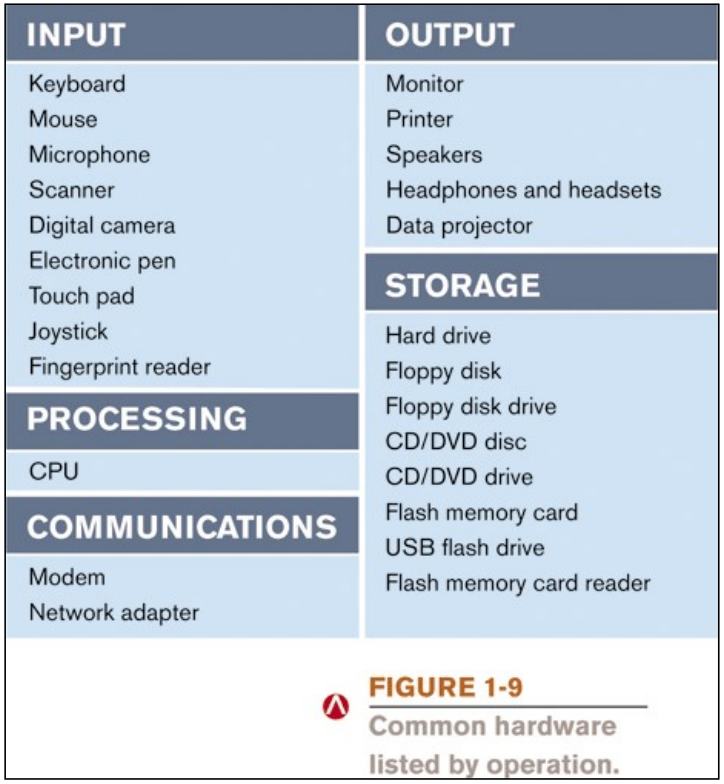

FIGURE 1-9
Common hardware listed by operation.

Software

- Software: The programs or instructions used to tell the computer hardware what to do
  - System software: Operating system allows a computer to operate
    - Boots the computer and launches programs at the user's direction
    - Most use a GUI to interact with the user via windows, icons, menus, buttons, etc.
    - Windows, Mac OS, Linux, etc.

Application Software

- Application software: Performs specific tasks or applications
  - Creating letters, budgets, etc.
  - Managing inventory and customer databases
  - Editing photographs
  - Scheduling appointments
  - Viewing Web pages
  - Sending and receiving e-mail
  - Recording / playing CDs
  - Designing homes
  - Playing games

Computers to Fit Every Need

- Six basic categories of computers
  - Embedded computers
  - Mobile devices
  - Personal computers
  - Midrange servers
  - Mainframe computers
  - Supercomputers

Embedded Computers

- Embedded computer: Embedded into a product and designed to perform *specific tasks* or *functions* for that product
- Cannot be used as general-purpose computers
- Often embedded into:
  - Household appliances
  - Thermostats
  - Sewing machines
  - Cars

Mobile Devices

- Mobile device: A very small device with some type of built-in computing or Internet capability
- Typically based on cellular phones
- Examples:
  - Smart phones
  - Smart watches
  - Handheld gaming devices
  - Portable digital media players

Personal Computers/Desktop PCs

- Personal computer: a computer system designed to be used by one person at a time
  - Also called a microcomputer
  - Can be desktop or portable computers

- Desktop PCs: fit on or next to a desk
  - Can use tower case, desktop case, or all-in-one
  - Can be PC-compatible or Macintosh
  - Not designed to be portable

Portable PCs

FIGURE 1-16
Notebook and tablet PCs.

- Notebook (laptop) computers
  - Typically use clamshell design
- Tablet PCs
  - Can be slate tablets or convertible

Thin Clients and Internet Appliances

- Thin client or network computer (NC): PC designed to access a network for processing and data storage
  - Lower cost and easier maintenance
  - Limited or no local storage
  - Not able to function as a computer if network is down
- Internet appliance: Specialized network computer designed for Internet access and/or e-mail exchange
  - Often set-top boxes
  - Can include Internet-enabled gaming consoles

Thin Clients and Internet Appliances

FIGURE 1-19
Thin clients and Internet appliances.

Midrange Servers

- Midrange server: A medium-sized computer used to host programs and data for a small network
  - Users connect via a network with a computer, thin client, or dumb terminal

FIGURE 1-20
Midrange servers.

Mainframe Computers

- Mainframe computer: Powerful computer used by several large organizations to manage large amounts of centralized data
  - Standard choice for large organizations, hospitals, universities, large businesses, banks, government offices
  - Located in climate-controlled data centers and connected to the rest of the company computers via a network
  - Larger, more expensive, and more powerful than midrange servers
  - Usually operate 24 hours a day
  - Also called high-end servers or enterprise-class servers

Mainframe Computers

FIGURE 1-21
Mainframe computers.

Supercomputers

- Supercomputer: Fastest, most expensive, most powerful type of computer
  - Generally run one program at a time, as fast as possible
  - Commonly built by connecting hundreds of smaller computers, supercomputing cluster
  - Used for space exploration, missile guidance, satellites, weather forecast, oil exploration, scientific research, complex Web sites, decision support systems, 3D applications, etc.

Supercomputers

FIGURE 1-22
The Blue Gene/L supercomputer.
Supercomputers are used for specialized situations in which immense processing speed is required.

BLUE GENE/L SUPERCOMPUTER
This supercomputer is installed at Lawrence Livermore National Laboratory.

BLUE GENE/L CIRCUIT BOARDS
Each rack holds several circuit boards; each circuit board contains four processors.