ELE 108 Overview of Computers & Programming

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Mehmet Demirer

- **Text Book**:
- J.R.Hanly and E.B.Koffman, *Problem Solving and Program Design in C*, Addison Wesley, Fifth Edition, 2006 (older editions can also be used).
- You will have irregular lab hours within the semester at the Computer Lab. in the department (see below).
- **Instructors**:
- Dr. Ali Ziya Alkar (section 21) Dr. Mehmet Demirer (section 22)
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- **Course's Homework**

  Softcopy:
- **Check the web page for the latest homework through the web page below. Submit your homework through internet.**
- http://www.ee.hacettepe.edu.tr/~alkar/ELE108/labs
- **Hardcopy:**
- **---**
  Topics: Introduction. Constants, variables, expressions, statements. Selective structures. Repetitive structures and arrays. Functions. Pointers. Multi-dimensional arrays.

- **<u>Grading</u>**: Midterm %40, Final %40, Homeworks/Attendance/In Class Participation %5, Lab %15
- **<u>Attendance</u>** is required in all course hours and labs.

- **Course Outline**
- 1. Overview of Computers and Programming
  1.1 Computer Architecture
  1.2 Program Development

  2. Overview of C (1.*, 2.1-2.6, 3.2, 7.1-7.2)
  2.1 C Language Elements
  2.2 Variable Declarations and Data Types
  2.3 Executable Statements
  2.4 General Form of a C Program
  2.5 Arithmetic Expressions
  2.6 Formatting Numbers in Program Output
  2.7 Library Functions
  2.8 Representation and Conversion of Numeric Types
  2.9 Representation and Conversion of Type char

  3. Selection Structures: IF and SWITCH Statements (4.*)
  3.1 Relational and Logical Operators
  3.2 if Statement
  3.3 Compound Statements
  3.4 Nested if Statements
  3.5 switch Statement

4. Repetition and Loop Statements (5.*)
4.1 while Statements
4.2 for Statements
4.3 do-while Statements
4.4 Nested Loops

5. Modular Programming (3.4-3.5, 6.*)
5.1 Functions without Arguments
5.2 Functions with Input Arguments
5.3 Functions with Simple Output Parameters
5.4 Scope of Names
5.5 Formal Output Parameters as Actual Arguments

6. Arrays (8.*)
6.1 Declaring and Referencing Arrays
6.2 Array Subscripts
6.3 Using for Loops for Sequential Access
6.4 Using Array Elements as Function Arguments
6.5 Arrays Arguments
6.6 Multidimensional Arrays

7. Strings (9.1-9.4)
7.1 String Basics and strcpy, strcat, strcmp, strchr, strstr
7.2 String Comparison

Collaboration Policy

- exams: no access to any material nor discussion with anyone (except the instructor) is allowed.
- assignments: solutions should be developed independently. Giving or receiving any code drawings, diagrams, text, or designs from another person is not allowed. Having access to another student's work electronically or giving access is not allowed.
- max penalty for academic dishonesty: **F** in the course; reported to the university.

Outline

- A little History and intro
- Overview of Computers
  - Hardware
  - Memory
  - Software
- Computer Languages
- Software Development Method
- Pseudo Code and Flowcharts

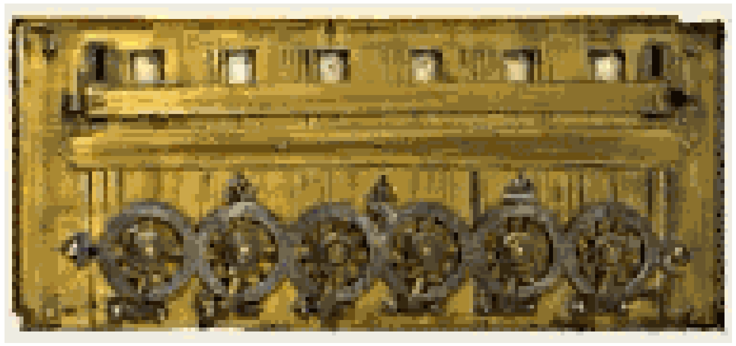
Computer History

- 3000BC-500BC

  Abacus

  - 1642

    Blaise Pascal, a French religious philosopher and mathematician, builds the first practical mechanical calculating machine.

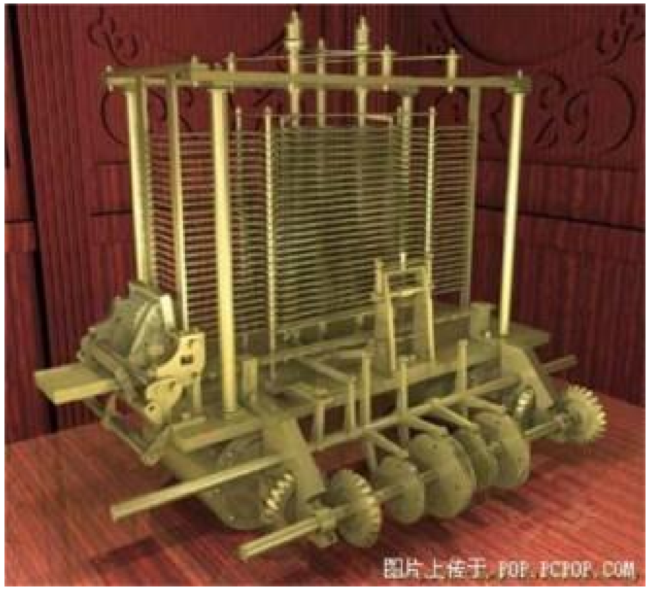


Computer History (Cont.)

- 1673

  Leibnitz invented Multiplication Machine
- 1830

  The "Analytical Engine" is designed by Charles Babbage



Computer History (Cont.)

- 1890

    The U.S. Census Bureau adopts the Hollerith Punch Card, Tabulating Machine and Sorter to compile results of the 1890 census, reducing an almost 10-year process to 2 ½ years, saving the government a whopping $5 million. Inventor Herman Hollerith, a Census Bureau statistician, forms the Tabulating Machine Company in 1896. The TMC eventually evolved into IBM.

Computer History (Cont.)

- **1939**

  The first semi-electronic digital computing device is constructed by John Atanassoff.
- **1941**

  German inventor Konrad Zuse produces the Z3 for use in aircraft and missile design but the German government misses the boat and does not support him.
- **1943**

  English mathematician Alan Turing begins operation of his secret computer for the British military. It was used by cryptographers to break secret German military codes. It was the first vacuum tube computer but its existence was not made public until decades later.
- **Thomas Harold Flowers built the first digital and programmable computer called the Colossus**

Computer History (Cont.)

- First generation electronic computers
  - 1946
    - ENIAC (Electronic Numerical Integrator And Calculator)
    - 30 tons, 8 ft high, 30 ft long
    - Used thousands tubes & valves
  - 1951

    Univac I (Universal Automatic Computer), using a Teletype keyboard and printer for user interaction, and became the first commercially available computer. It could handle both numerical and alphabetic data.

FIRE

Computer History (Cont.)

- 2nd Generation Computers (1954-59)
  - Transistor invented by William Shockley at Bell Labs
  - National Bureau of Standards (NBS) introduced its Standards Eastern Automatic Computer (SEAC)
  - The first magnetic disk drive designed by Jacob Rabinow
  - IBM introduced the 702 business computer in 1955
  - Bendix G-15A small business computer sold for only $45,000, designed by Harry Huskey of NBS in 1956

Computer History (Cont.)

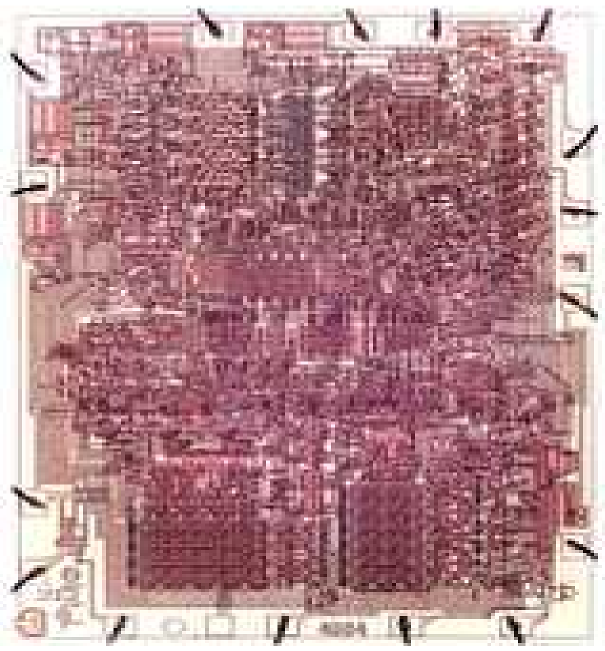
- 3rd Generation Computers (1959-71)
  - Jack Kilby of Texas Instruments patented the first integrated circuit (IC) in Feb. 1959
  - IBM announced the System/360 all-purpose computer, using 8-bit character word length (a "byte") in 1964
  - DEC introduced the first "mini-computer", the PDP-8, in 1968
  - Development began on ARPAnet, funded by the DOD in 1969

Computer History (Cont.)

- 4th Generation Computers (1971--?)
  - Large Scale Integration (LSI) and VLSI
  - Intel inc introduced the 4-bit 4004, a VLSI of 2300 components in 1971
  - IBM developed the first true sealed hard disk drive, called the "Winchester" in 1973

Computer History (Cont.)

- 4th Generation Computers (1971--?)
  - In 1980, IBM signed a contract with the Microsoft Co. of Bill Gates and Paul Allen and Steve Ballmer to supply an operating system for IBM's new PC model. Microsoft paid $25,000 to Seattle Computer for the rights to QDOS that became Microsoft DOS, and Microsoft began its climb to become the dominant computer company in the world.
  - Apple Computer introduced the Macintosh personal computer 1984



Computer History (Cont.)

- Fifth Generation Computer (?)

  bio-computer?

Category

- Personal computer
  - Used by a single person at a time.
- Mainframes
  - Large real-time transaction processing systems
- Supercomputer
  - Largest capacity and fastest mainframes

Computer Components

- Hardware

  equipment to perform computations
- Software

  programs used to executed on a computer by providing the instructions.

Computer Hardware

- Main Memory

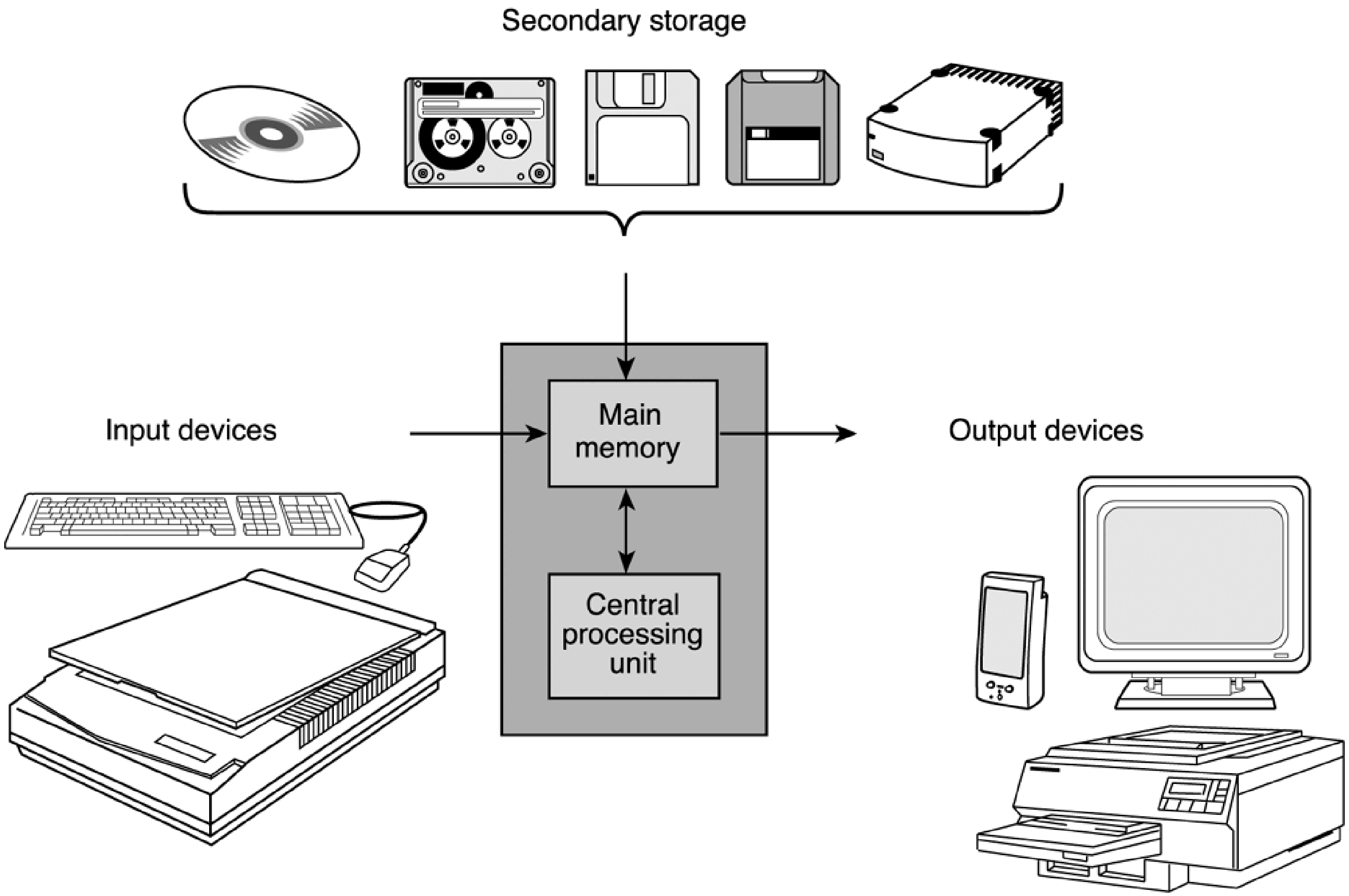
  ROM, RAM, etc.
- Secondary Memory

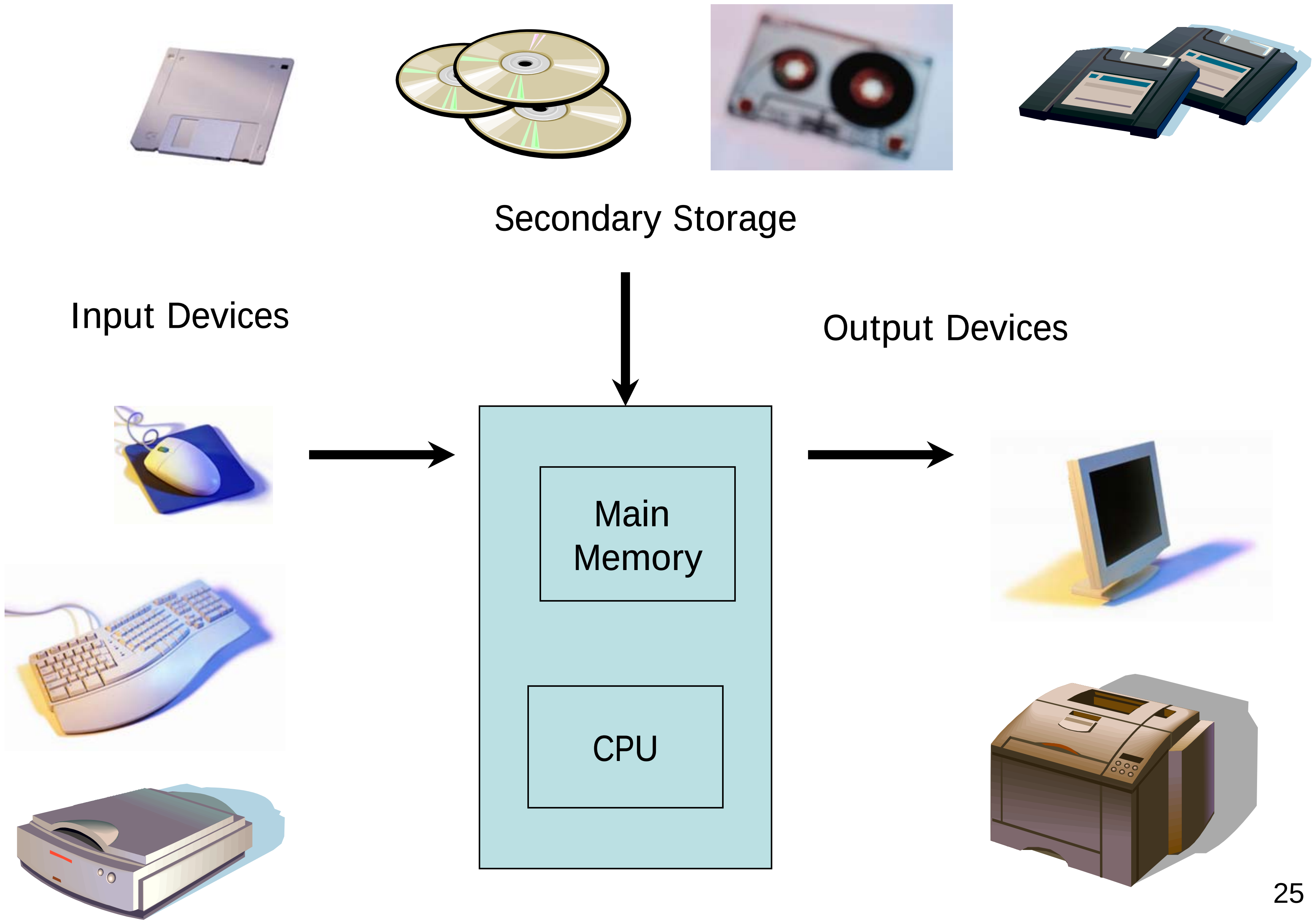
  Hard disk, floppy disk, CD, DVD, zip etc.
- Central Processing Unit (CPU)
- Input devices

  keyboard, mouse, scanners etc.
- Output Devices

  monitors, printers etc.

Components of a Computer




Secondary Storage
Input Devices
Output Devices
Main Memory
CPU

Main Memory

- Memory cell
- Address
- Bytes and bits
- Store and retrieve

Address	Content
0	-27.2
1	354
2	0.005
3	-26
4	H
⋮	⋮
998	X
999	75.62

Hardware & Software

- Hardware is the equipment used to perform the necessary computations.
  - i.e. CPU, monitor, keyboard, mouse, printer, speakers etc.
- Software consists of the programs that enable us to solve problems with a computer by providing it with a list of instructions to follow
  - i.e. Word, Internet Explorer, Linux, Windows etc.

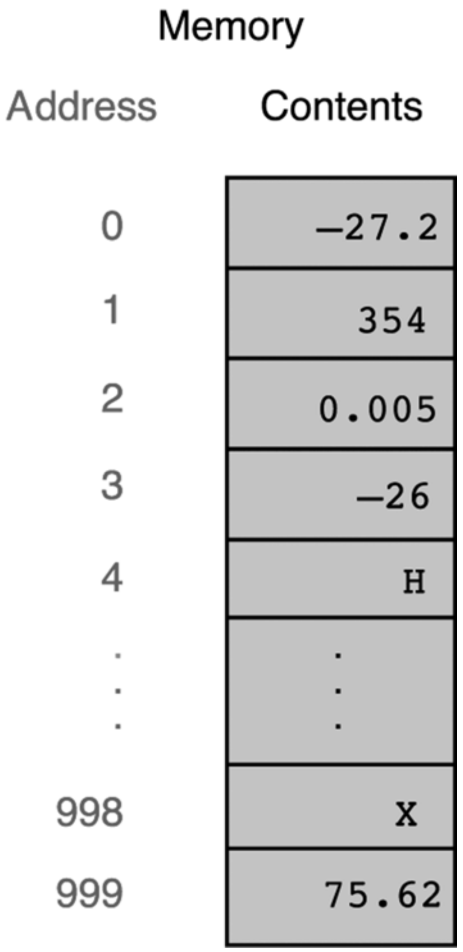
Computer Hardware

- Main Memory
  - RAM - Random Access Memory - Memory that can be accessed in any order (as opposed to sequential access memory), volatile.
  - ROM - Read Only Memory - Memory that cannot be written to, no-volatile.
- Secondary Memory - Hard disks, floppy disks, zip disks, CDs and DVDs.
- Central Processing Unit - Coordinates all computer operations and perform arithmetic and logical operations on data.
- Input/Output Devices - Monitor, printer, keyboard, & mouse.
- Computer Networks – Computers that are linked together can communicate with each other. WAN, LAN, MAN, Wireless-LAN.

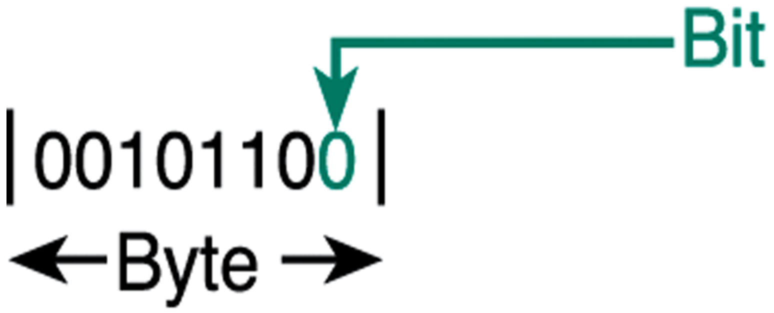
Memory

- Memory Cell (MC) – An individual storage location in memory.
- Address of a MC- the relative position of a memory cell in the main memory.
- Content of a MC – Information stored in the memory cell. e.g Program instructions or data.
    - Every memory cell has content, whether we know it or not.
- Bit – The names comes from binary digit. It is either a 0 or 1.
- Byte - A memory cell is actually a grouping of smaller units called bytes. A byte is made up of 8 bits.
    - This is about the amount of storage required to store a single character, such as the letter H.

1000 memory cells in Main memory



Relationship Between a Byte and a Bit



Main Memory (Cont.)

- Random access memory (RAM)

  temporary storage of programs and data, the contents will be eliminated when the computer is off

- Read-only memory (ROM)

  store program or data permanently, used to store startup and critical instructions.

Secondary Storage

- Main memory is small and expensive
- Secondary memory: large and inexpensive

floppy disks

tapes

hard disks

CDs

DVDs

zip

jump drive

CPU

- Coordinating all computer operations and performing arithmetic and logical operations on data
- Fetch instructions and perform the actual manipulation
- Modern CPU is housed in a single integrated chip. (it also hosts registers, caches, etc.)

Computer Network

- Local Area Network (LAN)
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN)

Internet access methods:

Dial up, DSL, Cable Modem and network cable

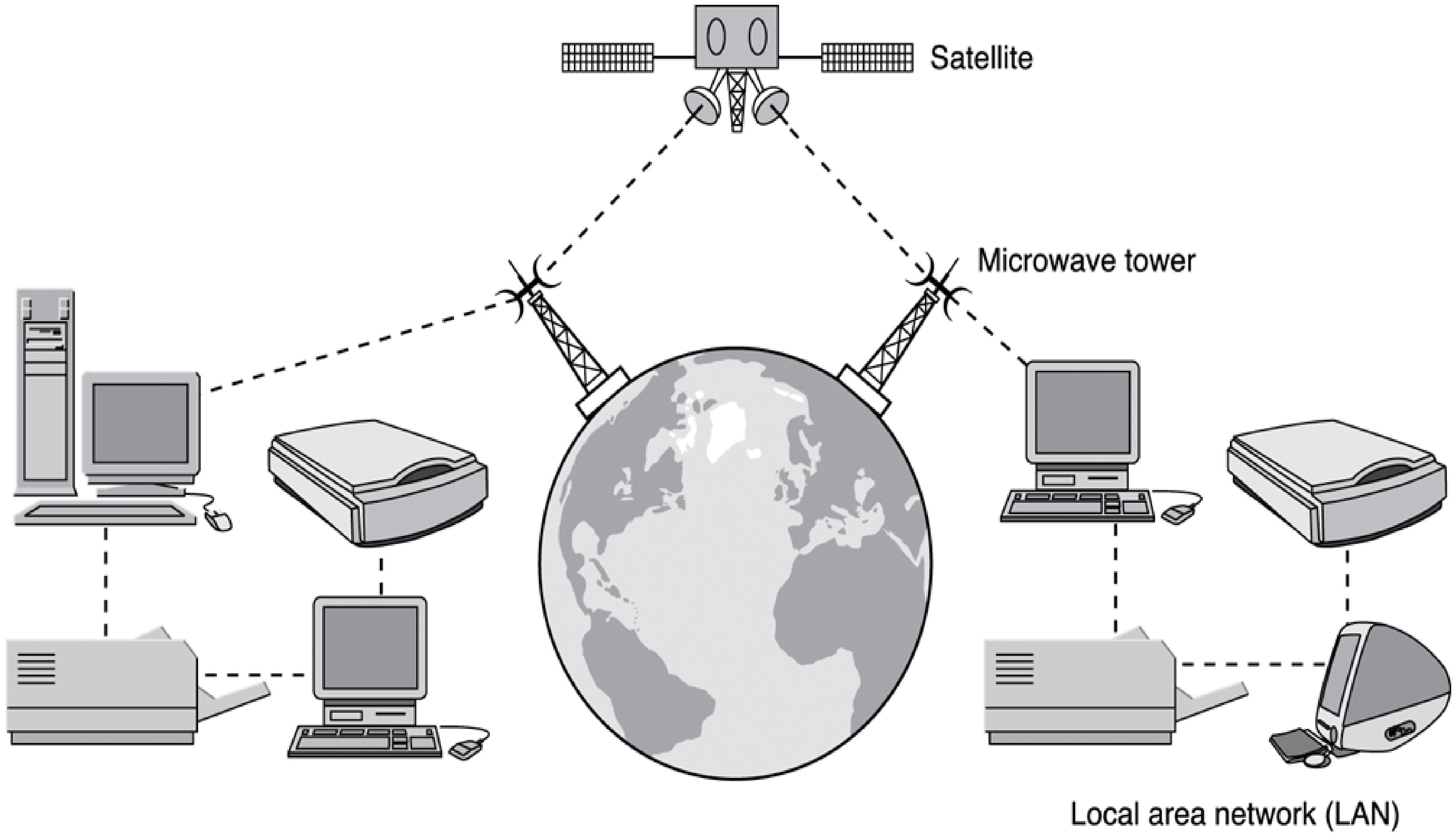
Internet Evolution

- 1962: the idea of distributed, packet-switching networks.
- ARPANET goes online in 1969.
- Bob Kahn and Vint Cerf develop the basic ideas of the Internet in 1973.
- In 1974 BBN opens the first public packet-switched network - Telenet.
- A UUCP link between the University of North Carolina at Chapel Hill and Duke University establishes USENET in 1979.
- TCP/IP (Transmission Control Protocol and Internet Protocol) is established as the standard for ARPANET in 1982.

Internet Evolution (Cont.)

- 1987: the number of network hosts breaks 10,000.
- 1989: the number of hosts breaks 100,000.
- Tim Berners-Lee develops the World Wide Web. CERN releases the first Web server in 1991.
- 1992: the number of hosts breaks 1,000,000.
- The World Wide Web sports a growth rate of 341,634% in service traffic in its third year, 1993.
- The number of hosts today are nearly 275,000,000.

A Wide Area Network with Satellite Relays of Microwave Signals



Computers

- Computers receive, store, process, and output information.
- Computer can deal with numbers, text, images, graphics, and sound.
- Computers are worthless without programming.
- Programming Languages allow us to write programs that tells the computer what to do and thus provides a way to communicate with computers.
- Programs are then converted to machine language (0 and 1) so the computer can understand it.

Computer Software

- Operating System - controls the interaction between machine and user. Example: Windows, Unix, Dos etc.
    - Communicate with computer user.
    - Manage memory.
    - Collect input/Display output.
    - Read/Write data.
- Application Software - developed to assist a computer use in accomplishing specific tasks. Example: Word, Excel, Internet Explorer.

Computer Languages

- Machine Language – A collection of binary numbers
  - Not standardized. There is a different machine language for every processor family.
- Assembly Language - mnemonic codes that corresponds to machine language instructions.
  - Low level: Very close to the actual machine language.
- High-level Languages - Combine algebraic expressions and symbols from English
  - High Level **:** Very far away from the actual machine language
  - For example: Fortran, Cobol, C, Prolog, Pascal, C#, Perl, Java.

Example

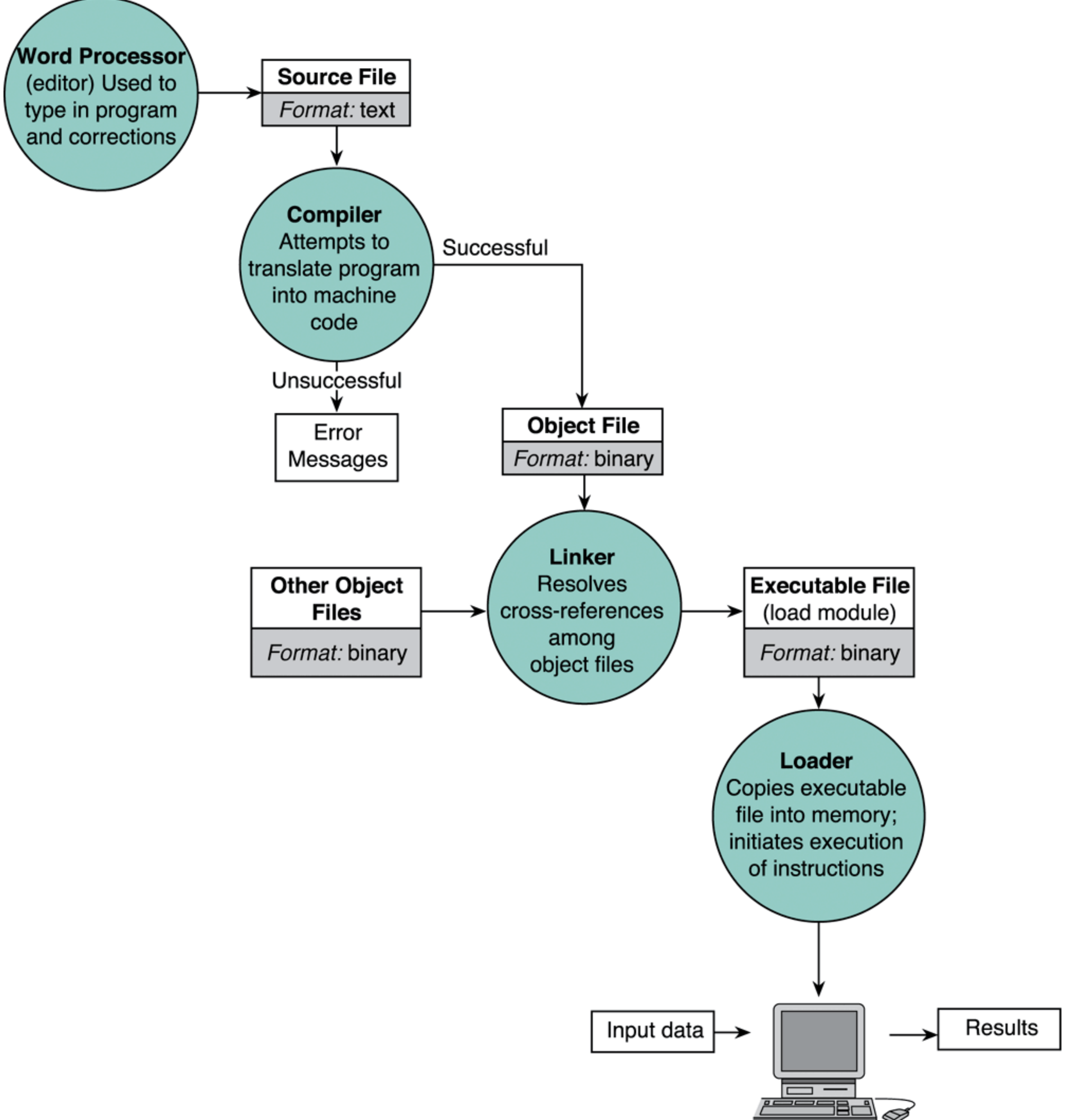
Memory addresses	Machine Language Instructions	Assembly Language Instructions
00000000	00000000	CLA
00000001	00010101	ADD A
00000010	00010110	ADD B
00000011	00110101	STA A
00000100	01110111	HLT
00000101	?	A ?
00000110	?	B ?

High-level language

- Easy to write, easy to understand
- Can not be executed directly
- Complier is used to convert high-level language into the target computer’s machine language
- Linker is used to generate the executable program

Some concepts

- compiler
- Source file
- Syntax
- Object file
- Linker
- Integrated development environment (IDE)
- Input data
- Program output


Word Processor (editor) Used to type in program and corrections
Source File
Format: text
Compiler Attempts to translate program into machine code
Successful
Unsuccessful
Error Messages
Object File
Format: binary
Other Object Files
Format: binary
Linker Resolves cross-references among object files
Executable File (load module)
Format: binary
Loader Copies executable file into memory; initiates execution of instructions
Input data
Results

Example of Computer Languages

C Source Code:

```
char name[40];
printf("Please enter your name\n");
scanf("%s", name);
printf("Hello %s", name);
```

Assembly Code:

```
push       offset string "Please enter your name\n"
(41364Ch)
call      dword ptr [__imp__printf (415194h)]
add        esp,4
lea        eax,[name]
push       eax
push       offset string "%s" (413648h)
call      dword ptr [__imp__scanf (41519Ch)]
add        esp,8
lea        eax,[name]
push       eax
push       offset string "Hello %s" (41363Ch)
call      dword ptr [__imp__printf (415194h)]
add        esp,8
```

Machine Code:

```
68 4C 36 41 00 FF 15 94 51 41 00 83 C4 04 8D 45 D8
50 68 48 36 41 00 FF 15 9C 51 41 00 83 C4 08 8D 45
D8 50 68 3C 36 41 00 FF 15 94 51 41 00 83 C4 08
```

C & Java: Source to execution

- For C, the generation and execution appear as in the following diagram

  C source code → compiler (program) → object code →linking and loading (program) → Executable

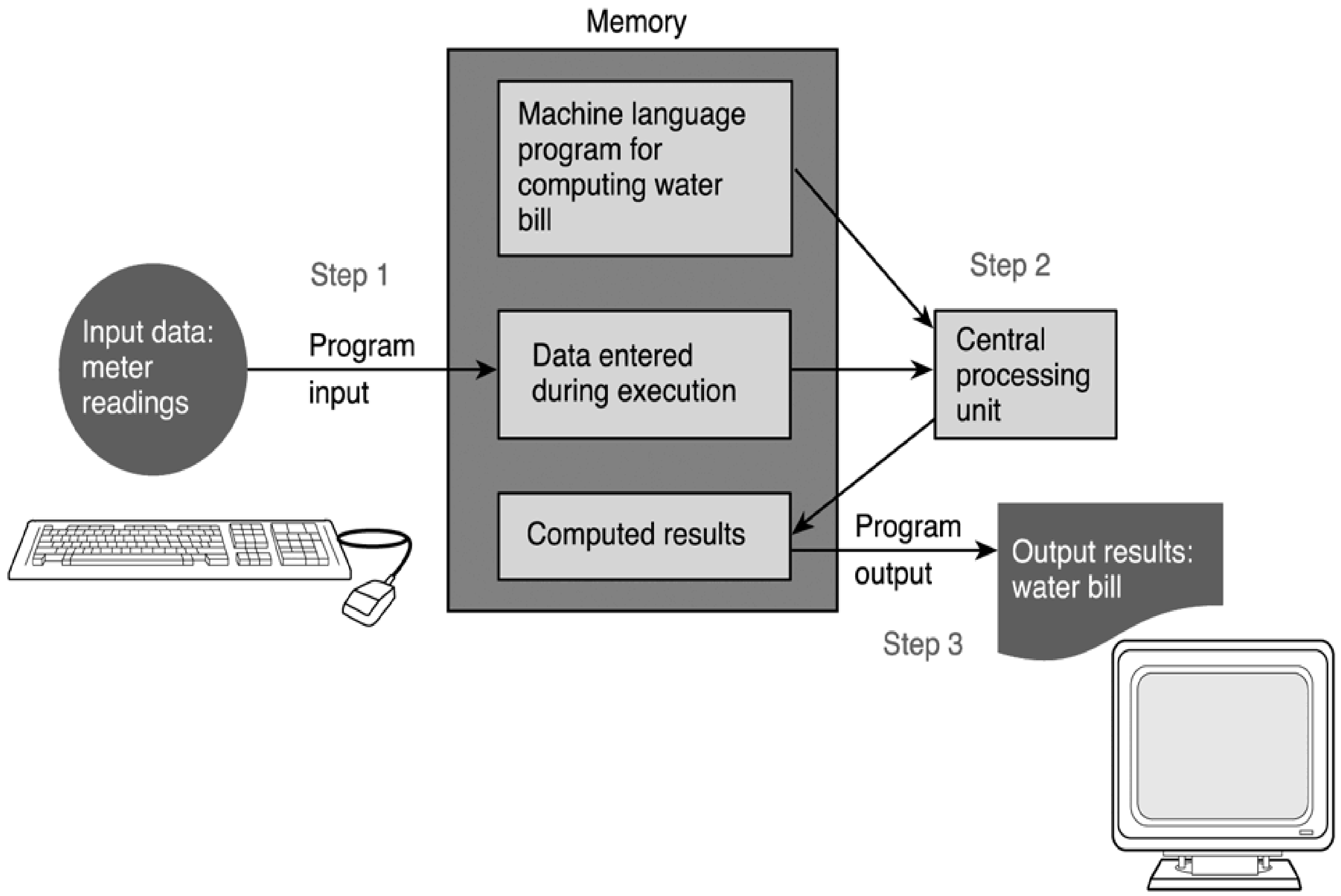
- Java programs do not ordinarily go through this set of steps. Java programs are "executed" by an interpreter; in a diagram it appears as

  Java source code → compiler (program) → Java byte codes → interpreter (program)

- More specifically, the compilation of C programs appears in diagram as

  C source code → preprocessor (program) → compiler (program) → lining and loading (program) → program execution

Flow of Information During Program Execution


Memory
Machine language program for computing water bill
Step 1
Input data: meter readings
Program input
Data entered during execution
Step 2
Central processing unit
Computed results
Program output
Output results: water bill
Step 3

Software Development Method

1. Specify **problem** requirements
2. **Analyze** the problem
3. **Design** the algorithm to solve the problem
4. **Implement** the algorithm
5. **Test** and verify the completed program
6. **Maintain** and update the program

Steps Defined

1. **Problem** - Specifying the problem requirements forces you to understand the problem more clearly.
2. **Analysis** - Analyzing the problem involves identifying the problem's inputs, outputs, and additional requirements.
3. **Design** - Designing the algorithm to solve the problem requires you to develop a list of steps called an **algorithm** that solves the problem and then to verify the steps.
4. **Implementation** - Implementing is writing the algorithm as a program.
5. **Testing** - Testing requires verifying that the program actually works as desired.
6. **Maintenance** - Maintaining involves finding previously undetected errors and keep it up-to-date.

Converting Miles to Kilometers

1. **Problem**: Your summer job wants you to convert a list of miles to kilometers. You're too lazy to do this by hand, so you decide to write a program.
2. **Analysis**
   - We need to get miles as input
   - We need to output kilometers
   - We know 1 mile = 1.609 kilometers
3. **Design**
   1. Get distance in miles
   2. Convert to kilometers
   3. Display kilometers

4. Implementation

```c
/*
 * Converts distance in miles to kilometers.
 */
#include <stdio.h>              /* printf, scanf definitions */
#define KMS_PER_MILE 1.609      /* conversion constant       */

int
main(void)
{
      double miles,  /* input - distance in miles.       */
             kms;    /* output - distance in kilometers  */

      /* Get the distance in miles. */
      printf("Enter the distance in miles> ");
      scanf("%lf", &miles);

      /* Convert the distance to kilometers. */
      kms = KMS_PER_MILE * miles;

      /* Display the distance in kilometers. */
      printf("That equals %f kilometers.\n", kms);

      return (0);
}
```

Sample Run

```
Enter the distance in miles> 10.00
That equals 16.090000 kilometers.
```

Miles to Kilometers cont’d

5. Test

- We need to test the previous program to make sure it works. To test we run our program and enter different values and make sure the output is correct.

6. Maintenance

- Next summer, your boss gets a contract with NASA, so he wants you to add support for converting to AU’s

Pseudo code & Flowchart

- **Pseudo code -** A combination of English phrases and language constructs to describe algorithm steps
- **Flowchart -** A diagram that shows the step-by-step execution of a program.
- **Algorithm -** A list of steps for solving a problem.

Why use pseudo code?

- Pseudo code cannot be compiled nor executed, and there are no real formatting or syntax rules.
- It is simply one step - an important one - in producing the final code.
- The benefit of pseudo code is that it enables the programmer to concentrate on the algorithms without worrying about all the syntactic details of a particular programming language.
- In fact, you can write pseudo code without even knowing what programming language you will use for the final implementation.
- Example:

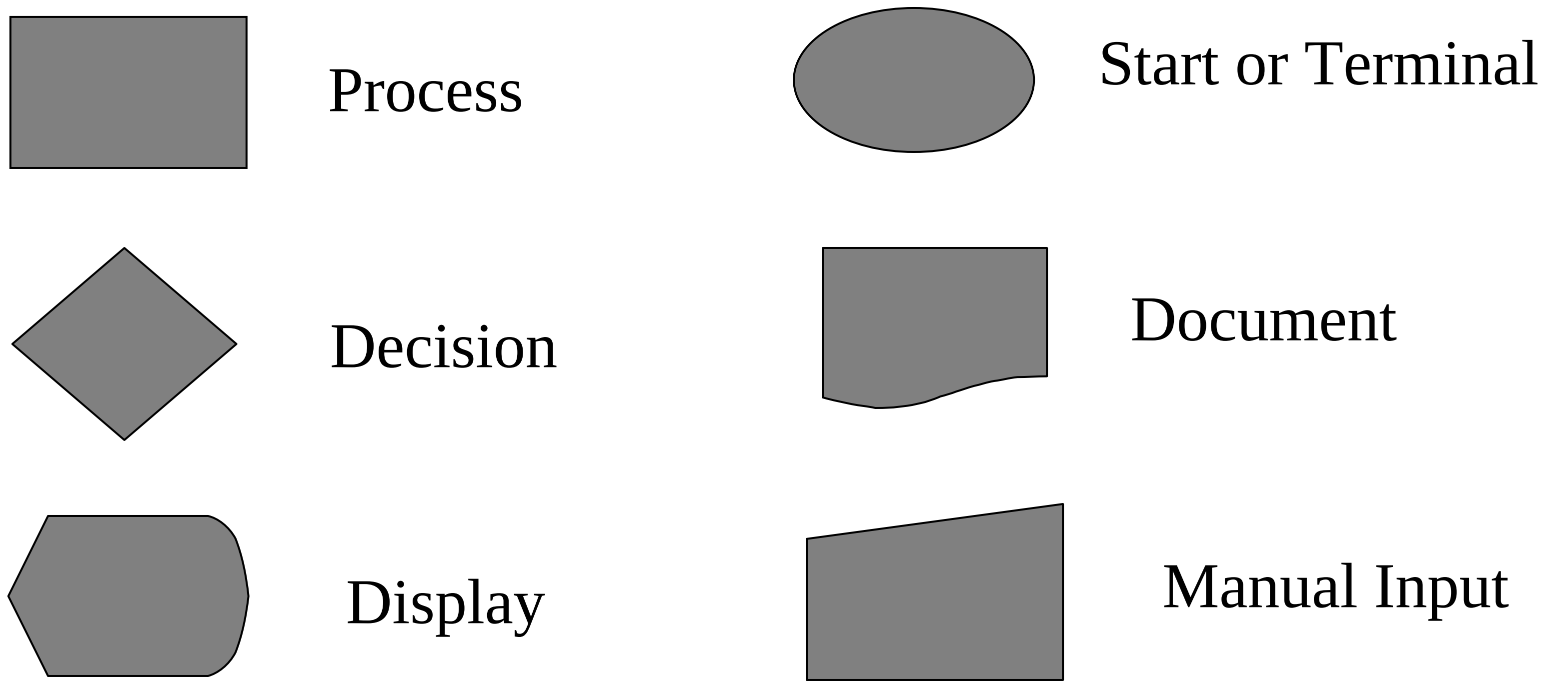
```
Input Miles
Kilometers = Miles * 1.609
Output Kilometers
```

Another Example of Pseudo code

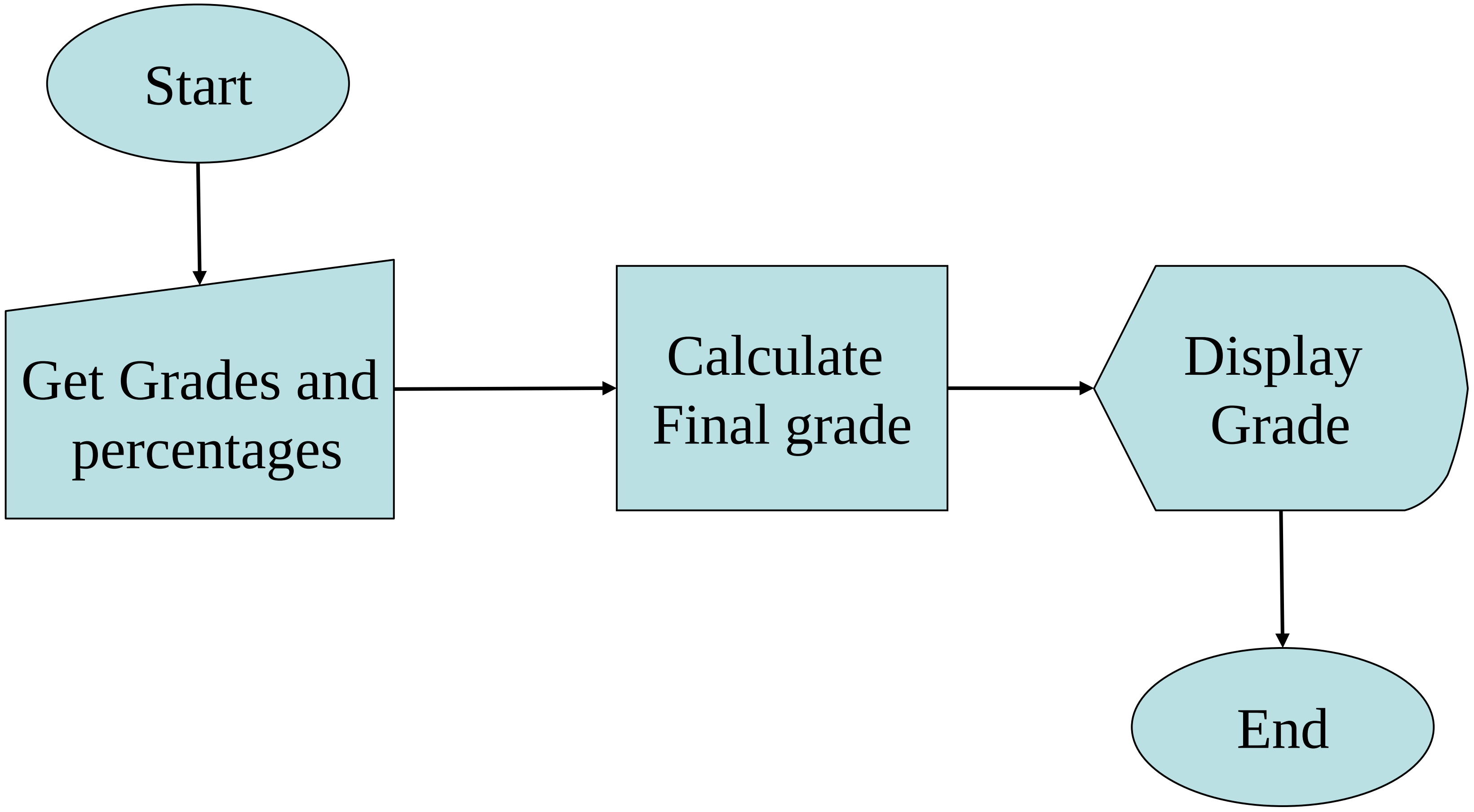
- **Problem**: Calculate your final grade for CS 201
- **Specify the problem -** Get different grades and then compute the final grade.
- **Analyze the problem -** We need to input grades for exams, labs, quizzes and the percentage each part counts for. Then we need to output the final grade.
- **Design**
  1. Get the grades: quizzes, exams, and labs.
  2. Grade = .30 * 2 regular exams & quizzes + .20 * Final exam + .50 * labs
  3. Output the Grade
- **Implement –** Try to put some imaginary number and calculate the final grade after you learn how to program.

Flowcharts

Flowchart uses boxes and arrows to show step by step execution of a program.

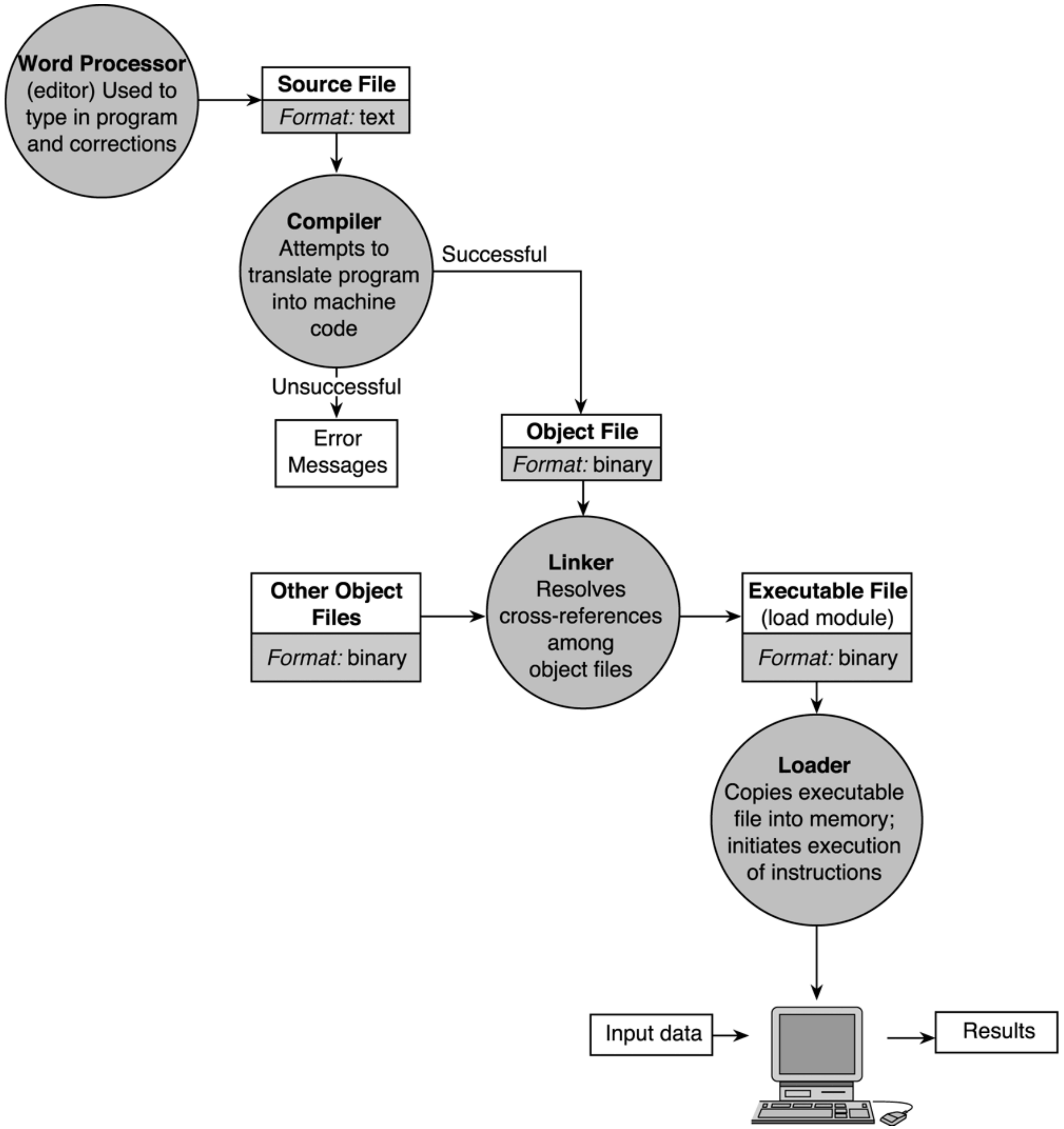


Example of a Flowchart



Compiler

- Compilation is the process of translating the source code (high-level) into executable code (machine level).
- Source file - A file containing the program code
  - A Compiler turns the Source File into an Object File
- Object file - a file containing machine language instructions
  - A Linker turns the Object File into an Executable
- Integrated Development Environment (IDE) - a program that combines simple word processing with a compiler, linker, loader, and often other development tools
  - For example, Eclipse or Visual Studio



Word Processor (editor) Used to type in program and corrections
Source File
Format: text
Compiler Attempts to translate program into machine code
Successful
Unsuccessful
Error Messages
Object File
Format: binary
Other Object Files
Format: binary
Linker Resolves cross-references among object files
Executable File (load module)
Format: binary
Loader Copies executable file into memory; initiates execution of instructions
Input data
Results

Fig 1.12 Entering, Translating, and Running a High-Level Language Program