# 1. Introduction to Computers

[ECE10002] C Programming

# Announcement

- Lab on next class.
  - Bring your lap-top computer with fully charged battery
    - Install Code::Blocks before the class
    - Download link: https://www.fosshub.com/Code-Blocks.html/codeblocks-16.01mingw-setup.exe

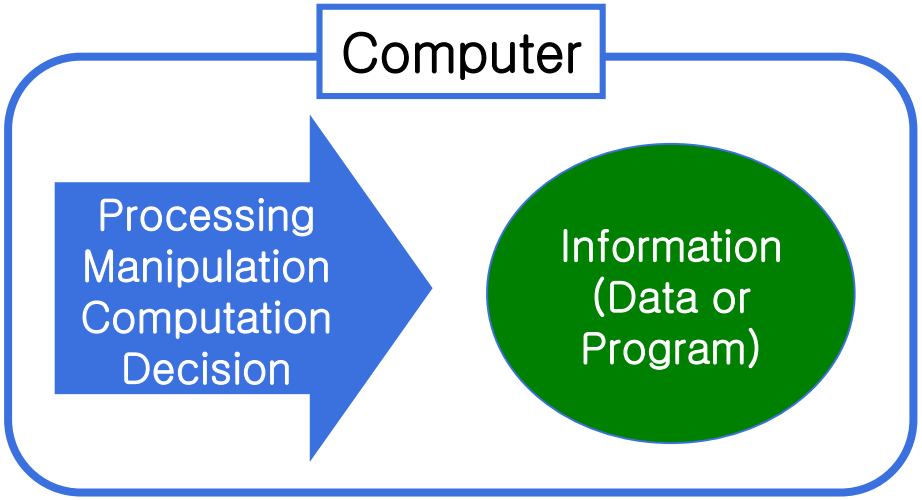
# Agenda

- Computer Systems
- (Stored Program Architecture)
- Programming Languages
- Creating and Running Programs
- Algorithm

# What is a Computer?

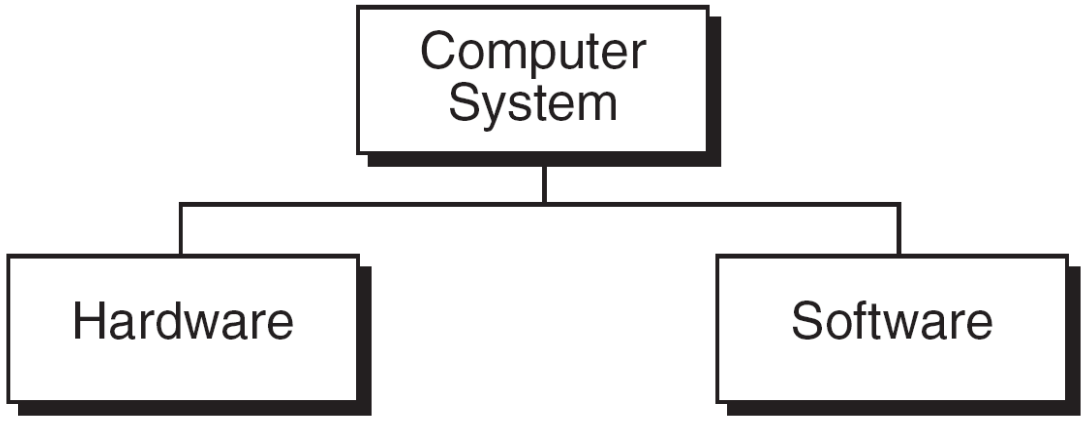
- A computers is a machine for manipulating data according to a list of instructions known as a program
  - Computations
  - Making logical decisions

➔ Universal information-processing machines

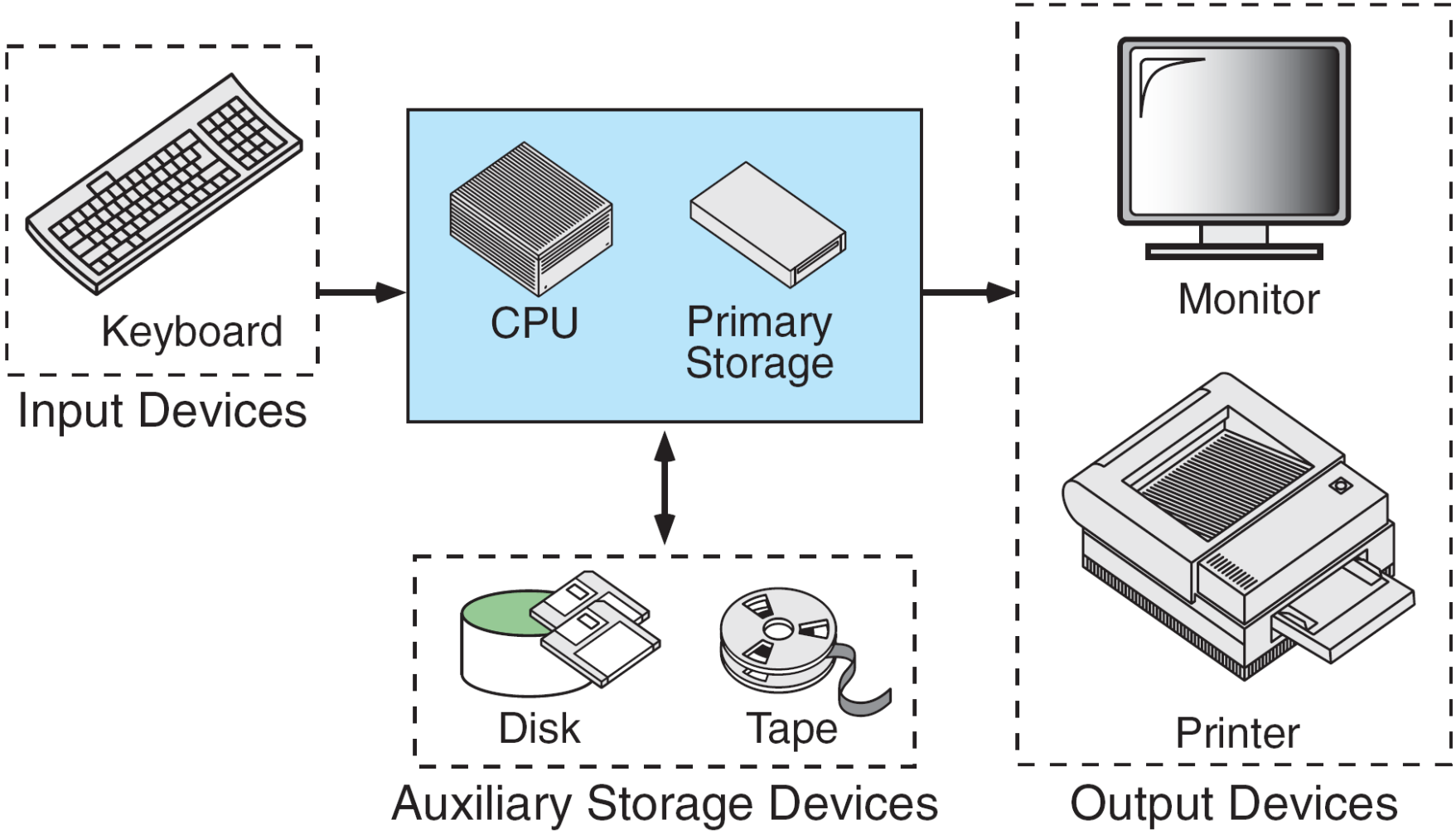


# Computer System

- Computer system = hardware + software
  - Hardware: physical components of computer (machine)
  - Software: programs (+ $\alpha$) that enable a computer to perform a specific task

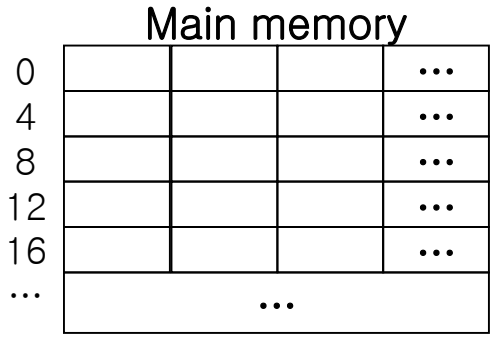


# Computer Hardware



# Computer Hardware

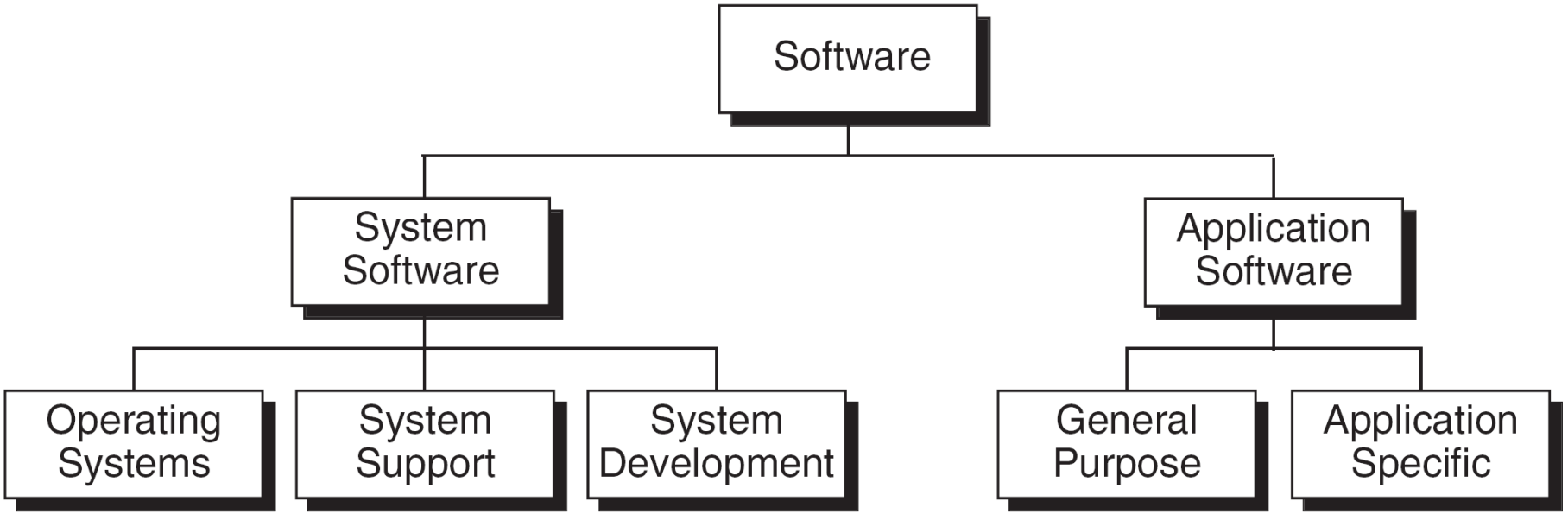
- CPU
  - Arithmetic operations, logical operations
  - Control
- Memory
  - Main memory
    - List of cells to store data or instruction
    - Each cell is identified by its address.
    - Fast, volatile
  - Auxiliary memory
    - SSD, HDD, optical disks (CD,DVD), magnetic tapes, …
    - Large capacity, non-volatile, slow, cheap




- I/O devices: the means by which the computer communicates with the outside world
  - Input devices: keyboard, mouse, scanner, camera, microphone, …
  - Output device; monitor, printer, speaker, …

# Computer Software

- Categories of software
  - Application software: software to do valuable tasks
    - Business software, educational software, medical software, databases, computer games, …
  - System software: software that provides environment to develop or execute software



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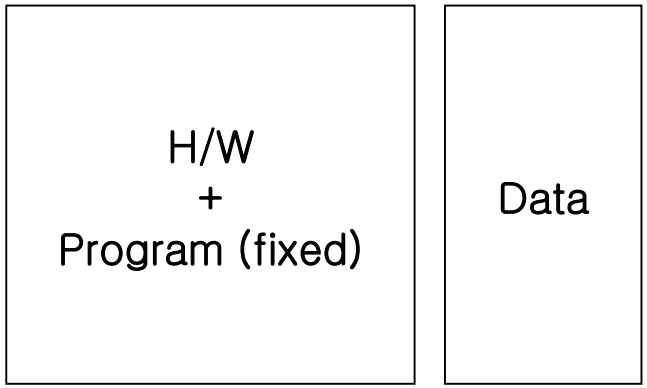
# Stored Program Architecture

- Program: a set (or sequence) of instructions for computer to execute
  - Background: stored-program architecture

- Early computing machines could perform only some fixed operations

  Ex) calculators



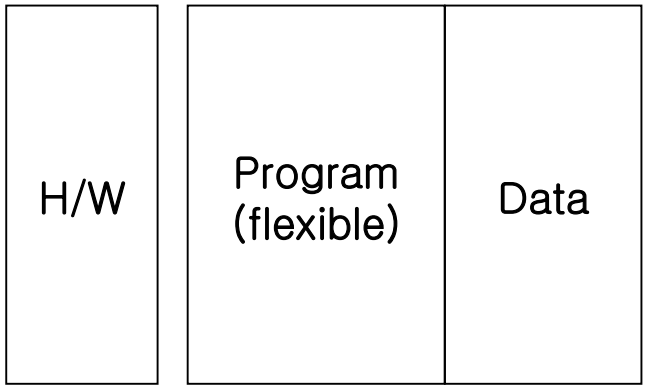

# Stored Program Architecture

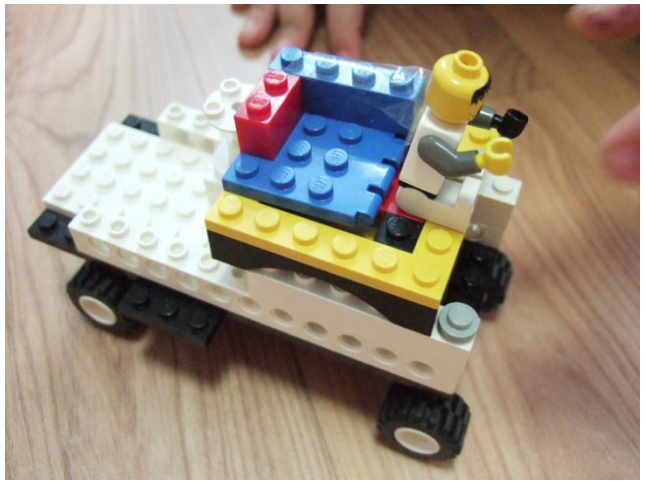
- Stored program architecture [Eckert]
  - Machine can execute a limited set of primitive instructions
  - Function of computer can be specified by a series of the primitive instructions

➔ Various function can be implemented by combining primitive instructions

  - Both instructions and data are stored in a single memory structure

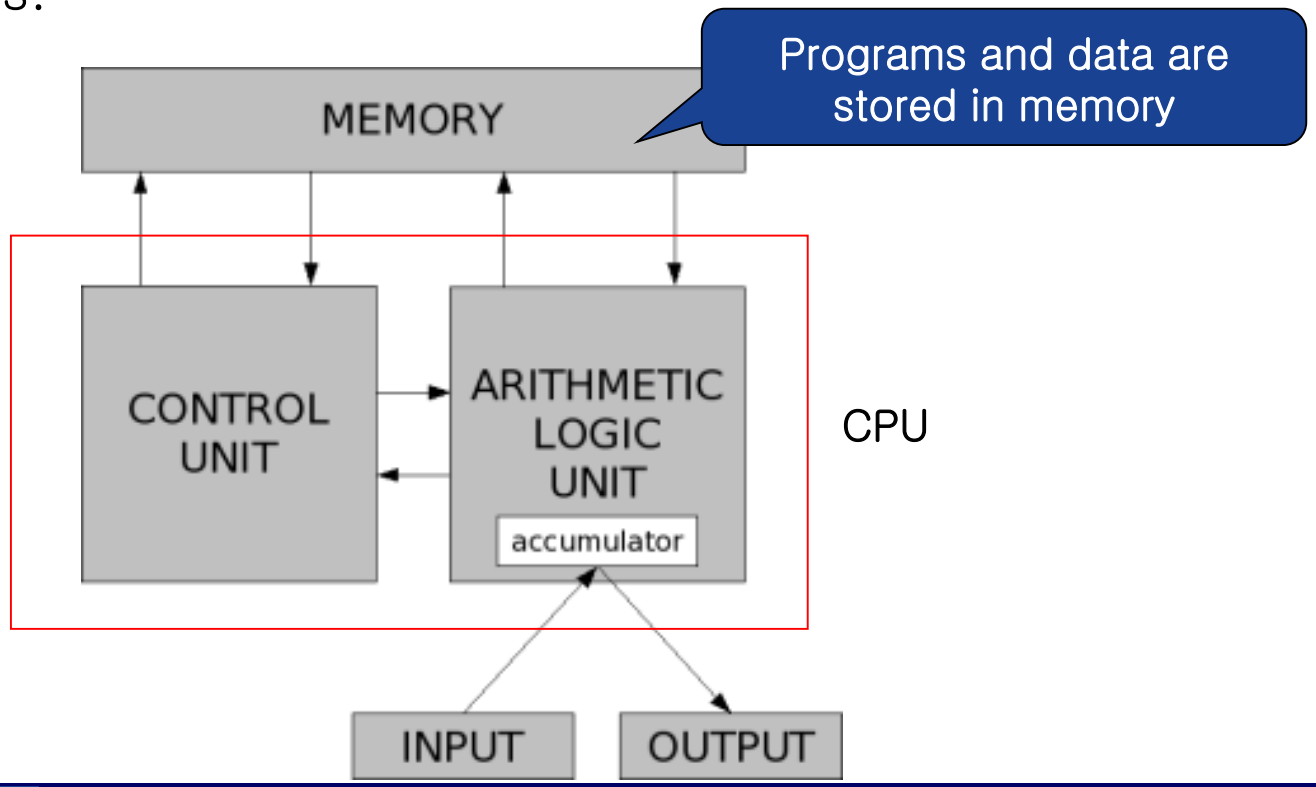
➔ Programs are separated from processing unit and as the result, editable.



# Stored Program Architecture

- Stored program architecture provides great flexibility of works that can be done by computers
  - We can specify function of a computer by writing proper programs.



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# Programming Language

- Programming language: artificial language to write computer programs
  - A method to specify the works a computer should do.

- Types of programming languages
  - Machine languages
  - Assembly languages
  - High-level languages
    - C, C++, Java, C#, …
    - Basic, Pascal, Fortran, Cobol, …

# Machine Language

- Machine languages
  - Consist of streams of 0's and 1's (machine instructions)
  - The only languages understood by computer hardware

→ Too difficult to write or understand

```
          00000000 00000100 0000000000000000
01011110 00001100 11000010 0000000000000010
          11101111 00010110 0000000000000101
          11101111 10011110 0000000000001011
11111000 10101101 11011111 0000000000010010
          01100010 11011111 0000000000010101
11101111 00000010 11111011 0000000000010111
11110100 10101101 11011111 0000000000011110
00000011 10100010 11011111 0000000000100001
11101111 00000010 11111011 0000000000100100
01111110 11110100 10101101
11111000 10101110 11000101 0000000000101011
00000110 10100010 11111011 0000000000110001
11101111 00000010 11111011 0000000000110100
          01010000 11010100 0000000000111011
                   00000100 0000000000111101
```

# Assembly Language

- Assembly languages
  - Consists of mnemonics, each of which is directly mapped to a machine instruction
  - To be executed, mnemonics should be transformed to machine instructions by assembler

→ Better than machine language, but still too primitive

```
1        entry   main,^m<r2>
2        subl2   #12,sp
3        jsb     C$MAIN_ARGS
4        movab   $CHAR_STRING_CON
5
6        pushal  -8(fp)
7        pushal  (r2)
8        calls   #2,SCANF
9        pushal  -12(fp)
10       pushal  3(r2)
11       calls   #2,SCANF
12       mull3   -8(fp),-12(fp),-
13       pusha   6(r2)
14       calls   #2,PRINTF
15       clrl    r0
16       ret
```

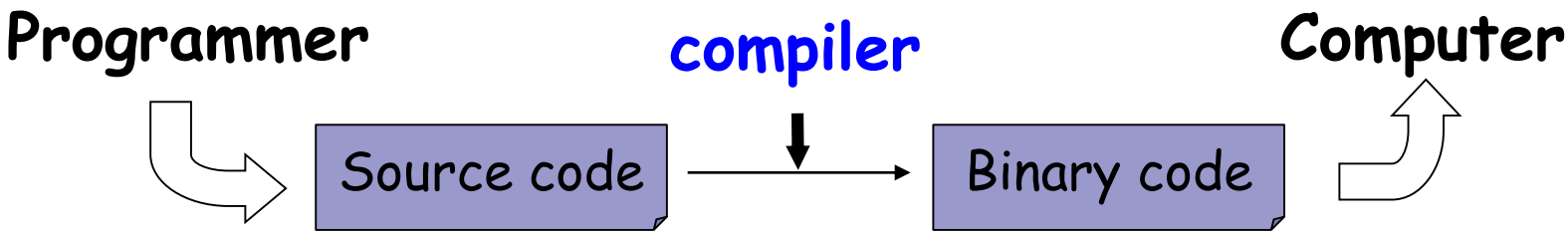
Assembler

```
1            00000000 00000100 0000000000000000
2   01011110 00001100 11000010 0000000000000010
3            11101111 00010110 0000000000000101
4            11101111 10011110 0000000000001011
5   11111000 10101101 11011111 0000000000010010
6            01100010 11011111 0000000000010101
7   11101111 00000010 11111011 0000000000010111
8   11110100 10101101 11011111 0000000000011110
9   00000011 10100010 11011111 0000000000100001
10  11101111 00000010 11111011 0000000000100100
11  01111110 11110100 10101101
12  11111000 10101110 11000101 0000000000101011
13  00000110 10100010 11111011 0000000000110001
14  11101111 00000010 11111011 0000000000110100
15           01010000 11010100 0000000000111011
16                    00000100 0000000000111101
```

# High-Level Languages

- More human-friendly programming language
  Ex) C/C++, Java, C#, Pascal, Basic, Python, ...
  - Easy to write and read program

- To be executed, programs in high-level language (source code) should be translated into machine language (binary code) by compiler.



# High-Level Languages

```
1  /* This program reads two integers from the keyboard
2     and prints their product.
3        Written by:
4        Date:
5  */
6  #include <stdio.h>
7
8  int main (void)
9  {
10 // Local Definitions
11    int number1;
12    int number2;
13    int result;
14
15 // Statements
16    scanf  ("%d", &number1);
17    scanf  ("%d", &number2);
18    result = number1 * number2;
19    printf ("%d", result);
20    return 0;
21 }  // main
```

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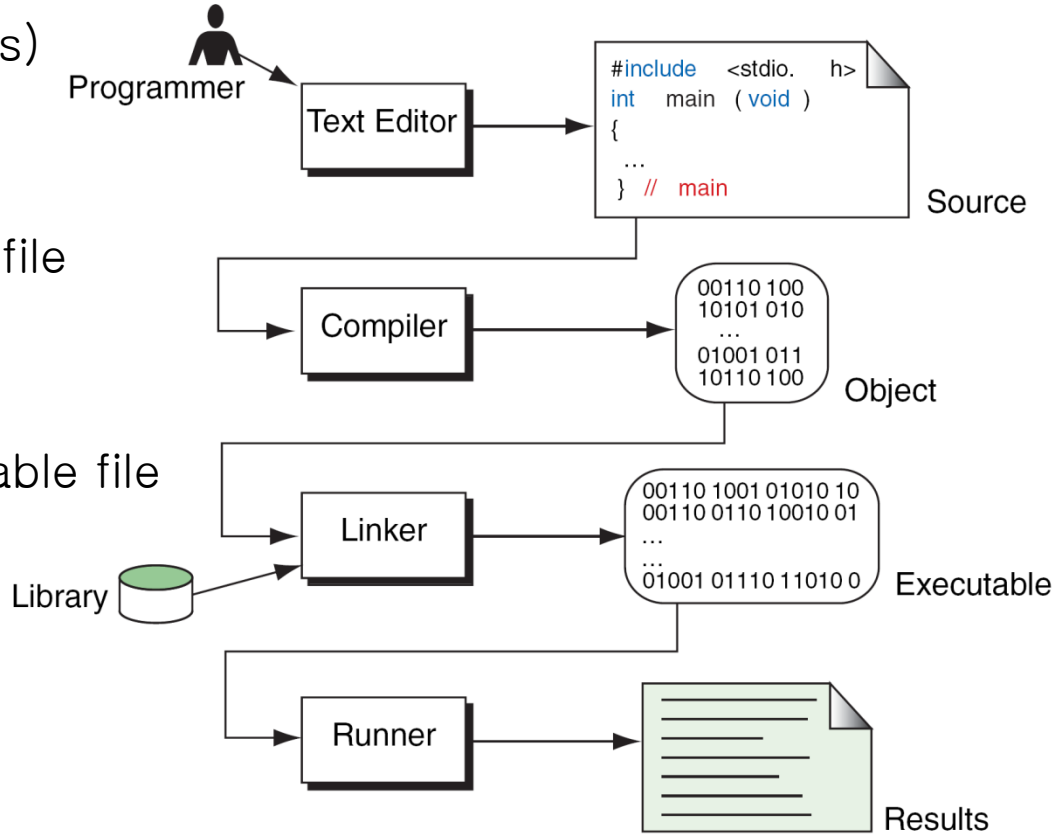
# Creating and Running Programs

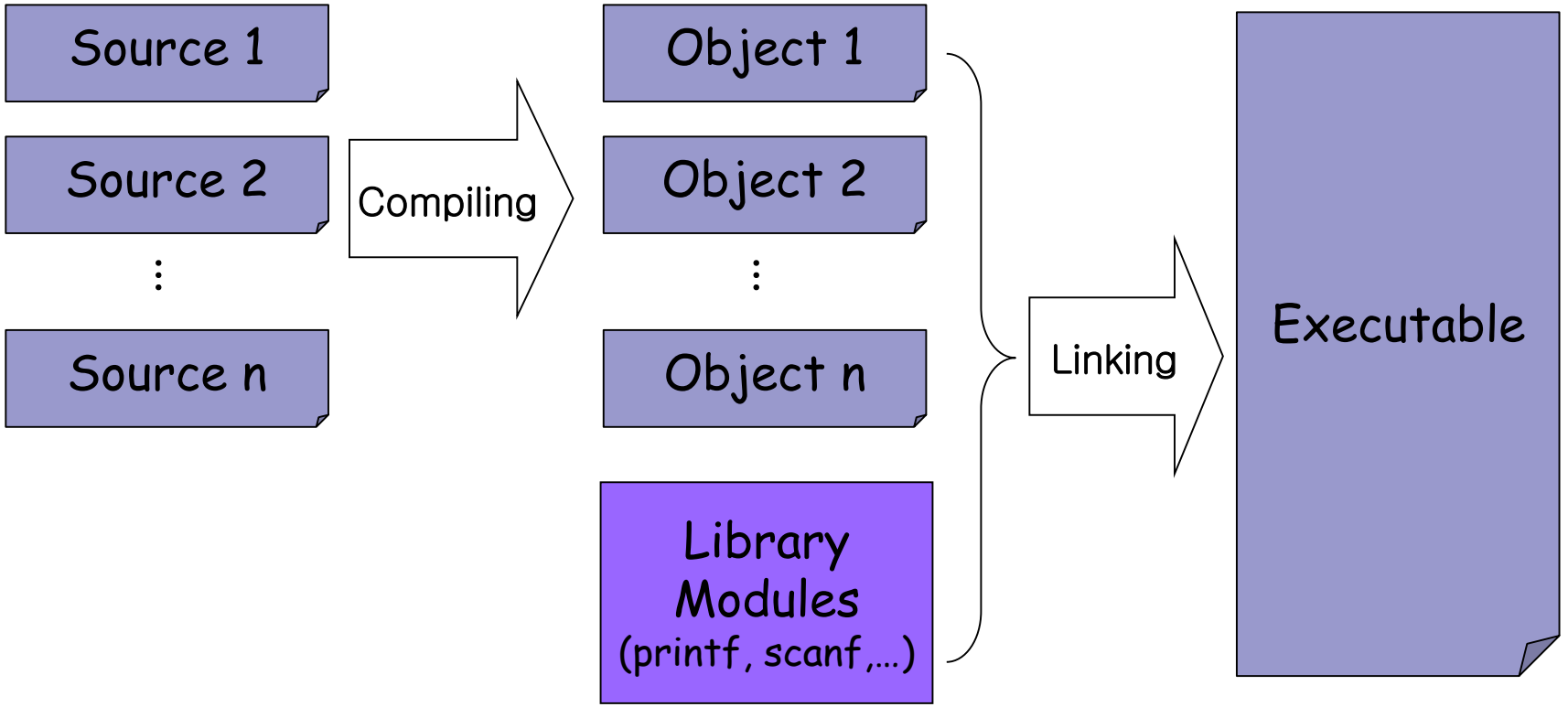
- Process to write and execute a program
  1. Write program
     - Stored in source file(s)
  2. Compile
     - Source file → object file
  3. Link
     - Object file → executable file
  4. Execute



# Creating and Running Programs

- Link
  - Integrating objects and library modules required to execute

Note! a program can be distributed in multiple source files.



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# General Steps of Program Development

1. Understand the problem
   - Clarify exact purpose and goal

2. Develop the solution
   - Design and describe solution in a way which is easy to write and understand

   ***"Resist the temptation to code"***

3. Write the solution in programming language
   - Implement the solution in programming language

4. Test the program

# An Example

- A program is a sequence of instructions each of which specifies an action.

  Ex) Putting an elephant into a refrigerator?

# Algorithm

- Computing problems can be solved by executing a series of actions in a specific order

- Algorithm: procedure in terms of
  - Actions to be executed
  - The order in which these actions are to be executed

  Ex) *Rise-and-shine* algorithm

  *Get out of bed*
  *Take off pajamas*
  *Take a shower*
  *Get dressed*
  *Eat breakfast*
  *Carpool to work*

➔ A program can be regarded as an algorithm written in a programming language.

# Description of Algorithm

- Programming language
  - Representation including implementation details
- Alternative representation
  - Pseudo code
    - Text-based representation
  - Flow chart
    - Graphical representation

# Description of Algorithm

- Pseudo code
  - Artificial and informal language that helps programmers develop algorithms
  - Similar to natural language
  - Not actually executed on computers but helps us “think out” a program before writing it
    - Easy to convert into a program
    - Consists only of executable statements

```
Algorithm Calculate BathRooms
 1  prompt user and read linoleum price
 2  prompt user and read number of bathrooms
 3  set total bath area and baths processed to zero
 4  while ( baths processed < number of bathrooms )
    1   prompt user and read bath length and width
    2   total bath area =
    3           total bath area + bath length * bath width
    4   add 1 to baths processed
 5  bath cost = total bath area * linoleum price
 6  return bath cost
end Algorithm Calculate BathRooms
```

# Description of Algorithm

- Flow chart
  - Graphical representation of algorithm
  - Drawn using special purpose symbols
    - Parallelogram, rectangles, diamonds, ovals, circles, …