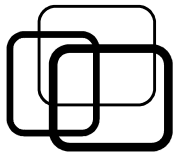
Programming Overview

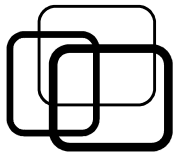
Inst. Nguyễn Minh Huy

Contents



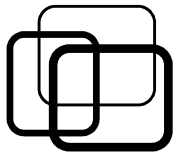
- Computer programming.
- Computer algorithm.

Contents



- **Computer programming.**
- Computer algorithm.

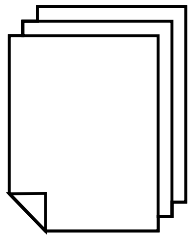
Computer programming



- Programming concepts:
  - Problem:
    - Teach a kid to find sum of max and min among 7, 1, 9.
    - Rules:
      - The kid knows addition and comparison between two numbers.
      - Write solution in step-by-step.
  - Programming ~ teaching:
    - From what computer knows.
    - Step-by-step.

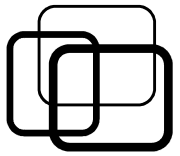
Computer

Programming



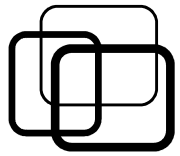
Program

Computer programming



- Programming concepts:
  - Computer has a set of hard-wired instructions.
  - Programming: write instructions for computer.
  - Computer program:
    - Written organized instructions.
    - Follow step-by-step.
    - To solve problem.

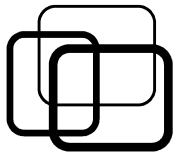
Computer programming



- Programmer:
  - Person who writes the program.
  - Programmer, coder, developer.
  - To become a good programmer:
    - Logical thinking.
    - Analytical and careful.
    - Hands-on and explore.
  - The first programmer?

Ada Lovelace

Computer programming

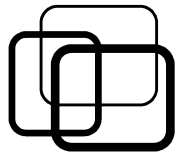


- Instruction code:
  - Machine code:
    - Binary sequence of ‘0’ and ‘1’.
    - Computer can execute directly.
  - Pseudo-code:
    - Natural language.
    - Human can understand.
  - Source code:
    - Intermediate language.
    - Easy to read, not too vague.
    - Can be translated to machine code.
      - Compiler vs. Interpreter.
      - Who wrote the first compiler?

Step 1: add a, b.
Step 2: compare a, c.
Step 3: output a.
…

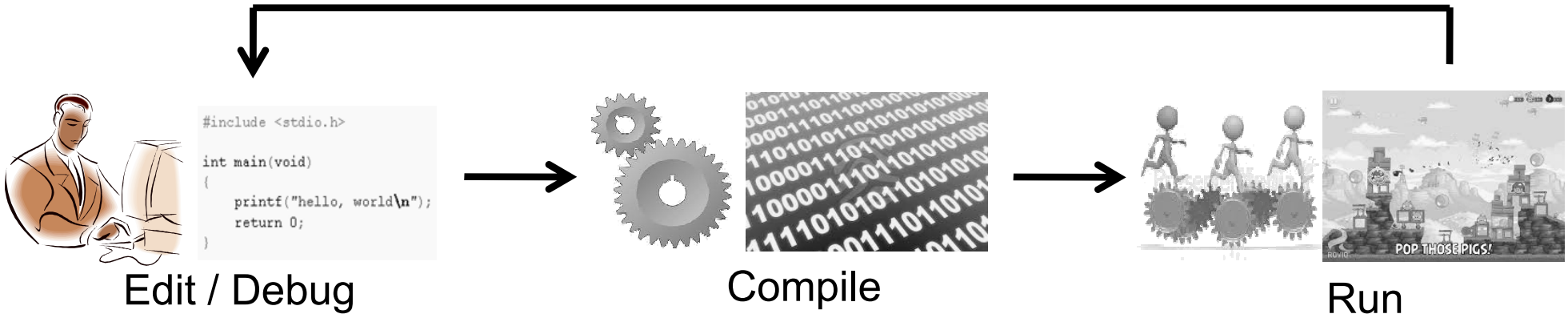
```c
#include <stdio.h>

int main(void)
{
    printf("hello, world\n");
    return 0;
}
```

Computer programming

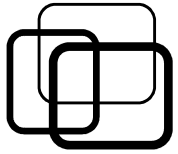


- Programming cycle:
  - Edit: write source code.
  - Compile: source code → machine code.
  - Run: execute machine code to perform tasks.
  - Debug: review source code to fix errors.

  → Debug takes the most time!

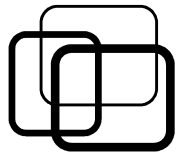


Computer programming



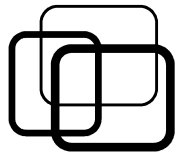
- Programming language:
  - Intermediate language between human and computer.
  - Concise and precise.
  - There are thousands of programming languages!
  - Learning programming thinking is more important than learning programming language.

Computer programming



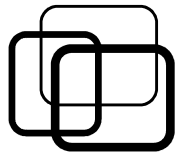
- Programming language:
  - Low-level language:
    - 1st generation: machine code.
    - 2nd generation: assembly language.
  - High-level language:
    - Procedural: Fortran, Pascal, C.
    - Functional: Lisp, Haskell, F#.
    - Object oriented: C++, Java, C#.
  - Trends:
    - Scripting languages: JavaScript, Python.
    - AI prompts: ask AI to generate source code.

Computer programming



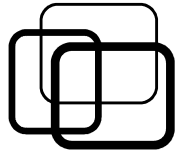
- Programming environment:
  - A platform of tools supporting programming tasks.
  - Source code editor:
    - Edit text, syntax highlight, code completion.
  - Compiler:
    - Translate source code to machine code.
  - Terminal:
    - Command-line tool to run program and shell commands.
  - Debugger:
    - Run program step-by-step.
    - Monitor computer memory.

Computer programming



- Programming environment:
  - IDE – Integrated Development Environment:
    - A single application combining programming tools all-in-one.
    - User friendly, configuration-free, add-in features.
    - Cons:
      - Heavy memory and storage usage.
      - Limit configuration skill.
      - Require license.
      - Track user data.

Computer programming



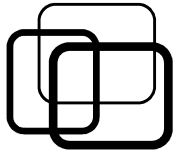
- C/C++ programming environment:

Tools	Windows	MacOS	Linux
Editor	Notepad++ VS Code (*) Sublime Text (*)	TextMate VS Code (*) Sublime Text (*)	Vim, Emacs VS Code (*) Sublime Text (*)
Compiler	MSVC (*) GCC (+) Clang (+)	Clang GCC	GCC Clang
Debugger	MSVC (*) GDB	LLDB GDB	GDB LLDB
IDE	Visual Studio (*) Code::Blocks CodeLite	Xcode (*) Code::Blocks CodeLite	Code::Blocks CodeLite

(*): Proprietary software and track user data.

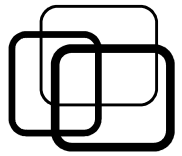
(+): Run on Linux simulated environment like MinGW64, WSL.

Computer programming



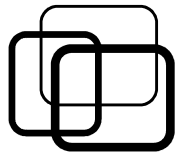
- C/C++ programming environment:
  - Set up loosely-coupled environment:
    - Windows: MinGW64, GCC, GDB.
      - Project WinLibs: light-weight, not extensible, https://winlibs.com
      - Project MSYS2: get MSYS2 and toolchain, https://www.msys2.org
    - Linux (Ubuntu/Debian): GCC, GDB.
      - Install package **build-essential**.
    - MacOS: Clang, LLDB.
      - Terminal command: **xcode-select --install**.
  - Set up IDE:
    - Visual Studio (Windows): https://visualstudio.microsoft.com
    - Xcode (MacOS): xcode-select --install, then Get Xcode.
    - Code::Blocks: https://www.codeblocks.org
    - CodeLite: https://codelite.org

Contents

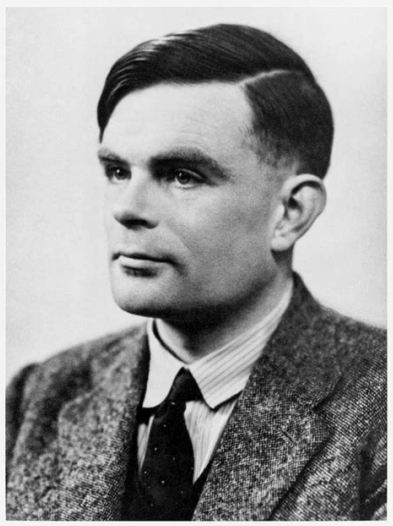


- Computer programming.
- **Computer algorithm.**

Computer algorithm

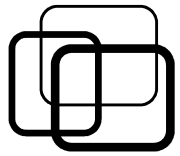


- Algorithm concepts:
  - Different machines have different instruction code.
  - Turing machine: abstract machine and instructions.
  - Algorithm ~ program on Turing machine:
    - Finite steps to solve problem on Turing machine.
    - Does not depend on specific machine.
    - Is more abstract than program.

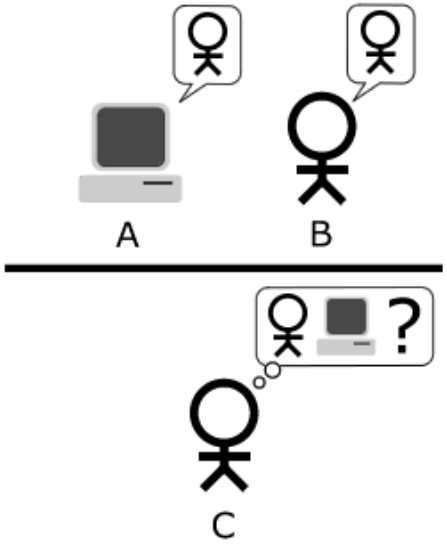


Alan Turing

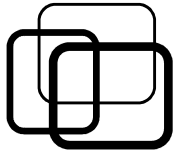
Computer algorithm



- Algorithm basic instructions:
  - Read input, write output.
  - Arithmetic operations: +, -, *, /, =.
  - Comparisons: >, <, >=, <=, ==, !=.
  - Condition: if-else.
  - Loop: while.
- Can machines think?
  - The Imitation game - Turing test.



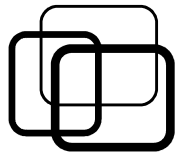
Computer algorithm



- Algorithm representations:
  - Pseudo-code:
    - Use natural language.
    - Notations:

Instructions	Notations	Example
Read input Write output	Input Output	-Step 1: **Input** a, b, c. -Step 2: **Output** a + b + c.
Arithmetic operations	+, -, *, /, %, =	-Step 1: a = 5. -Step 2: b = (a + 5) / (a – 3).
Condition	If <condition> … Else …	-Step 1: **Input** a. -Step 2: **If** a < 0 **Output** “Negative” **Else Output** “Positive”.
Loop	While <condition> ...	-Step 1: a = 0. -Step 2: **While** a < 10 **Output** a. a = a + 1.

Computer algorithm



- Algorithm representations:
  - Pseudo-code:

* Find max among 3 numbers:

-Step 1: **Input** a, b, c.

-Step 2: max = a.

-Step 3: **If** b > max
max = b.

-Step 4: **If** c > max
max = c.

-Step 5: **Output** max.

* Compute factorial of N:

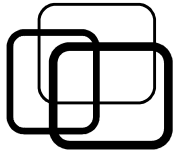
-Step 1: **Input** N.

-Step 2: S = 1.

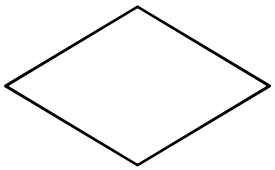
-Step 3: **While** N > 1
S = S * N.
N = N – 1.

-Step 4: **Output** S.

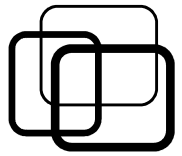
Computer algorithm



- Algorithm representations:
  - Flowchart:
    - Use diagram.
    - Visualize flow of process.
    - Notations:

Intrustions	Notations	Example
Read input Write output		a, b, c x, y
Arithmetic operations		a = a + b
Condition		a < 0
Transition		

Computer algorithm



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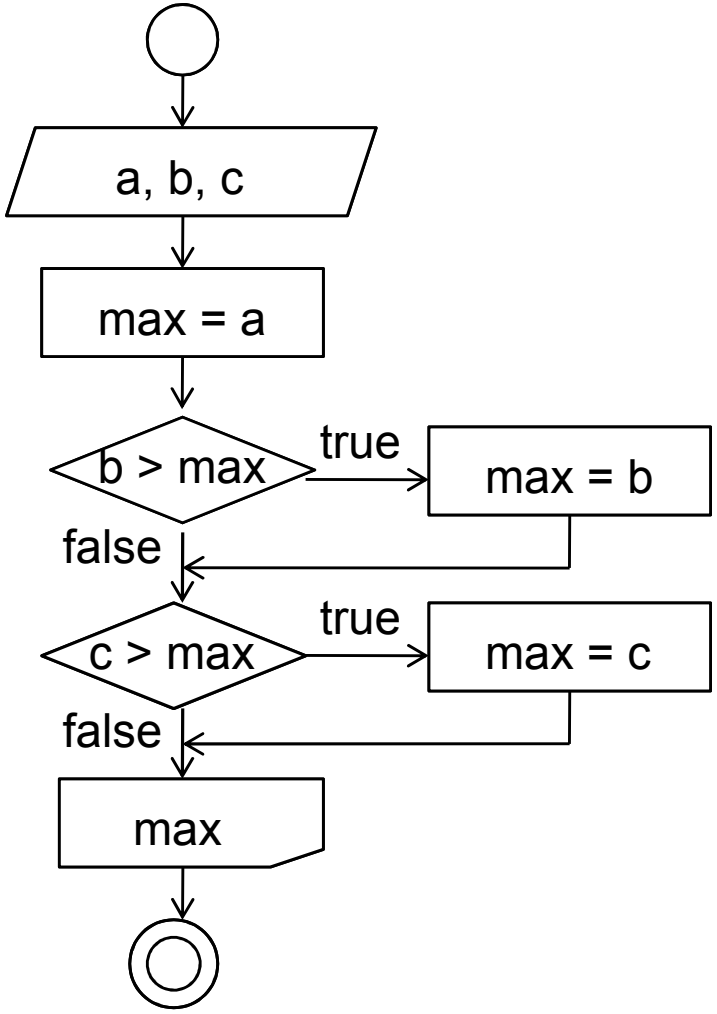
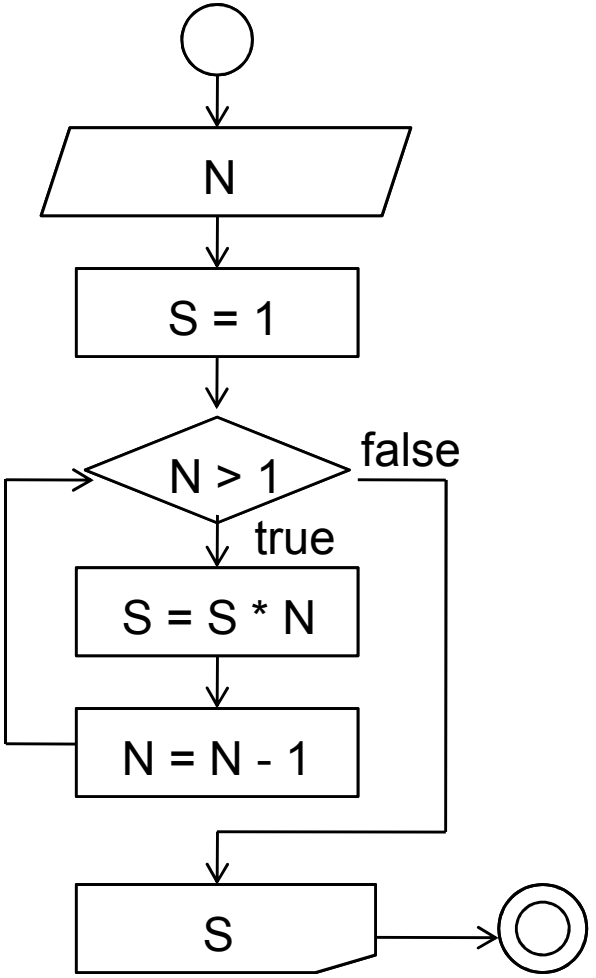
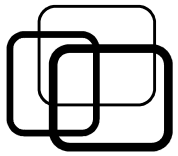
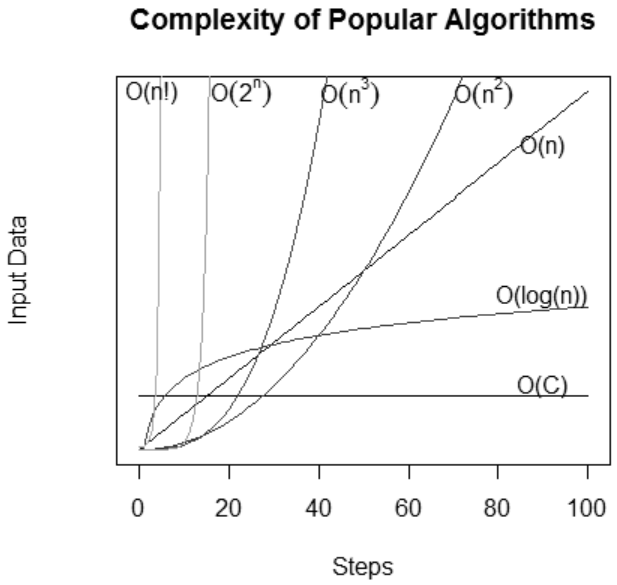




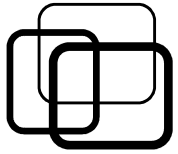
Computer algorithm



- Algorithm efficiency:
  - Complexity:
    - Algorithm performance varies with different inputs.
    - Big-O notation: O(), growth rate.
    - Time complexity: input ~ instructions.
    - Space complexity: input ~ memory.
    - Classes of complexity:
      - Constant: O(1).
      - Logarithmic: O(log(n)).
      - Linear: O(n).
      - Polynomial: O(n^2), O(n^3), …
      - Exponential: O(2^n).
      - Factorial: O(n!).



Computer algorithm

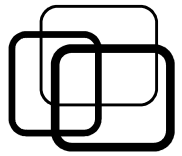


- Algorithm efficiency:
  - Popular algorithm complexities:

Algorithm	Complexity	Form
Finding max (3 numbers)	O(1)	Constant
Binary Search(N elements)	O(log(n))	Logarithmic
Factorial N!	O(n)	Linear
Sorting (N elements)	Bubblesort: O(n^2) Quicksort: O(n*log(n))	Polynomial
Traveling Salesman (N city)	O (K^n) O(n!)	Exponential Factorial

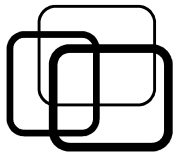
  - Simplicity:
    - Easier to understand and implement.
    - Reduce cost in debugging and maintenance.

Summary



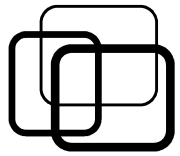
- Computer programming:
  - Write instructions for computer to solve problem.
  - Programming cycle: edit, compile, run, debug.
  - Programming language:
    - Intermediate language to communicate with computer.
    - Low-level vs high-level.
    - Trends: scripting languages, AI prompts.
  - Programming environment:
    - Platform of tools supporting programming tasks.
    - Editor, compiler, terminal, debugger.
    - IDE: Integrated Development Environment.

Summary



- Computer algorithm:
  - Finite steps to solve a problem on Turing machine.
  - Turing machine: abstract machine and instructions.
  - Basic instructions:
    - Input, output.
    - Arithmetic operations, comparisons.
    - Condition, loop.
  - Representations: pseudo-code, flowchart.
  - Efficiency:
    - Complexity: Big-O notation, growth rate.
    - Simplicity: easy to understand or implement.

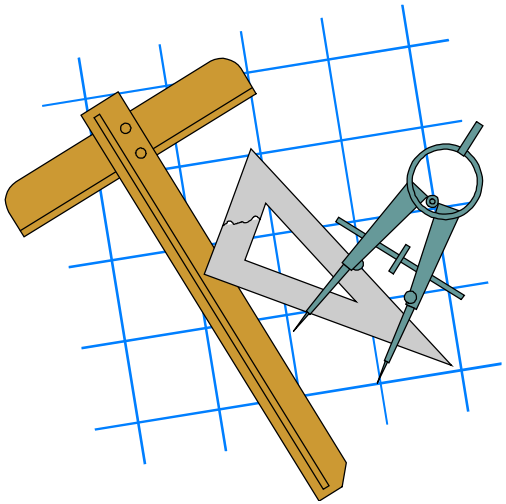
Practice



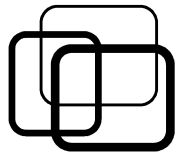
- ## Practice 1.1:

  Write algorithm to compute person age as follow:

  - Input person birth-year.
  - Compute and output person age.



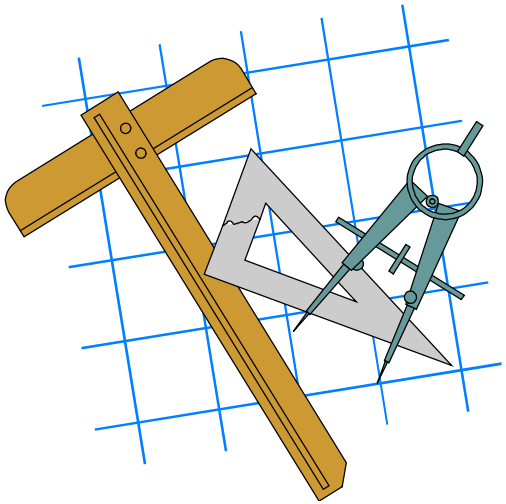
Practice



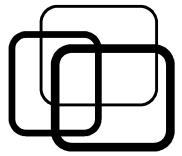
- Practice 1.2:

  Write algorithm to compute lucky number of a car as follow:

  - Input car registration number (a 5-digit number).
  - Compute and output the lucky number.



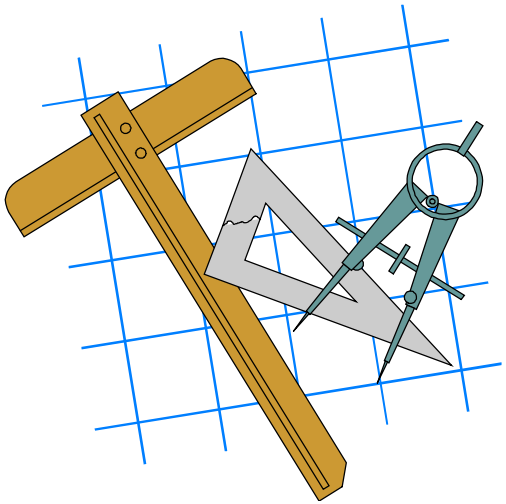
Practice



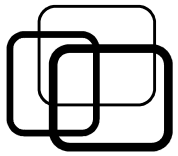
- Practice 1.3:

  Write algorithm to simulate a calculator as follow:

  - Input two integers.
  - Input an operation (+, -, *, /).
  - Perform the operation on two integers and output result.



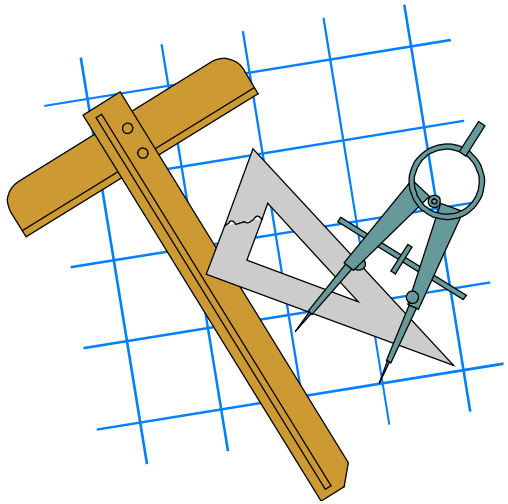
Practice



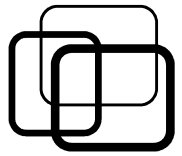
- Practice 1.4:

  Write algorithm to rank a student as follow:

  - Input literature, math, physics points.
  - Calculate student GPA.
  - Rank student based on GPA:
    + Excellent: GPA >= 8.5.
    + Good: GPA >= 7.0.
    + Fair: GPA >= 5.0.
    + Failed: GPA < 5.0.
  - Output GPA and rank.



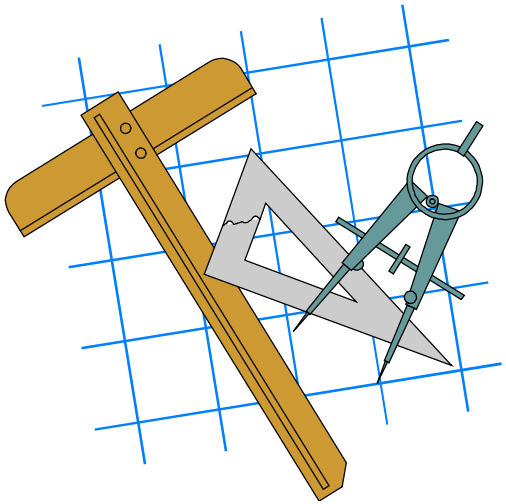
Practice



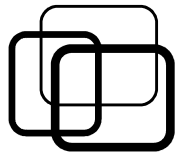
- ## Practice 1.5:

  Write algorithm to count number of days in a month as follow:

  - Input a month and a year.
  - Count number of days in that month and output result.



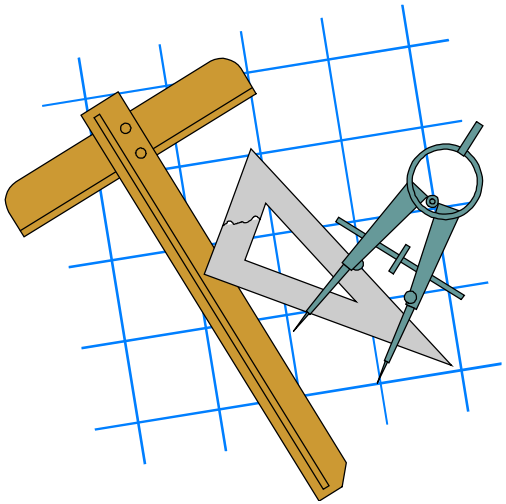
Practice



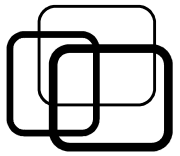
- **Practice 1.6:**

  Write algorithm to compute exponentiation of an integer as follow:

  - Input x and n.
  - Compute x^n and output result.



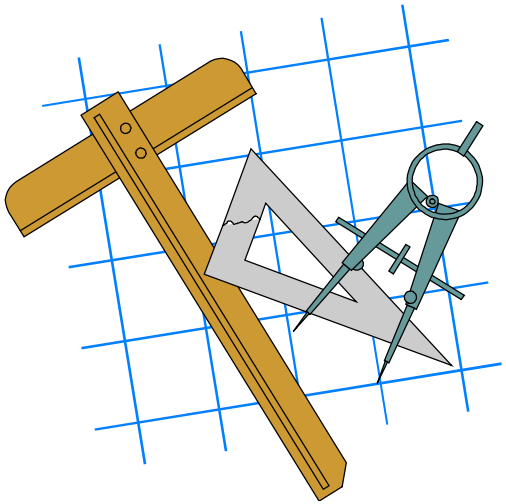
Practice



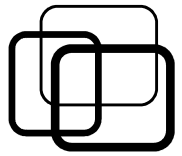
- ## Practice 1.7:

  Write algorithm to do the following:

  - Input 2 integers x, n (n > 0).
  - Calculate and output $S = x + x^2 + \ldots + x^n$.

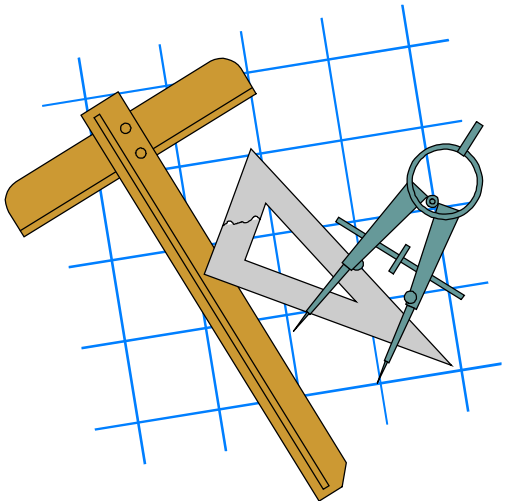


Practice

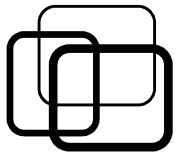


- Practice 1.8:

  Set up a C/C++ programming environment on your computer.



Practice



- **Practice 1.9:**

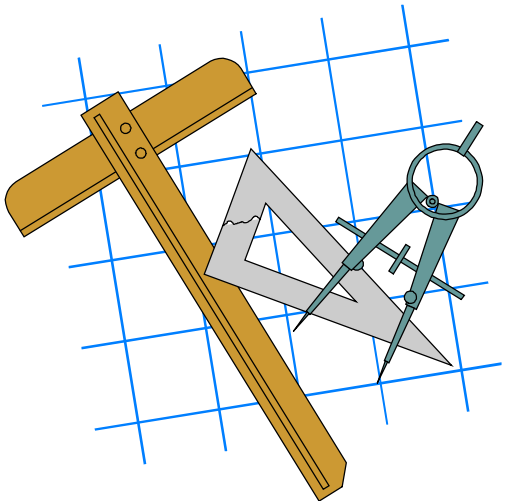
  Edit, compile and run the following C/C++ program.

  What does the program ask for?

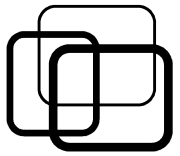
  What does the program print to screen?

```
#include <stdio.h>

int main()
{
        int   a, b, c, max;
        printf("Enter 3 integers = ");
        scanf("%d %d %d", &a, &b, &c);
        max = a;
        if (b > max) max = b;
        if (c > max) max = c;
        printf("max = %d", max);
}
```



Practice



- **Practice 1.10:**

  Edit, compile, run and debug the following C/C++ program.

  a) What does the program ask for and print to screen?

  b) When enter n = 10, list the values of s when n = 3.

```
#include <stdio.h>

int main()
{
        int             n;
        long long  s;
        printf("Enter an integer = ");
        scanf("%d", &n);
        for (s = 1; n > 0; n--)
            s = s * n;
        printf("Factorial = %lld ", s);
}
```