

PROG0101
FUNDAMENTALS OF PROGRAMMING

Chapter 3
Algorithms

Introduction to Algorithms

- A sequence of instructions.
- A procedure or formula for solving a problem.
- It was created mathematician, Mohammed ibn-Musa al-Khwarizmi.
- Often used for calculation, data processing and programming.
- Algorithms can be expressed in any language.

Topics

- Algorithms
- Pseudocode
- Flowcharts

Introduction to Algorithms

- Algorithms for making things will often be divided into sections;
 - the parts/components/ingredients (**inputs**) required to accomplish the task
 - actions/steps/methods (**processing**) to produce the required outcome (**output**).
- For example to build a model car, the parts (**inputs**) are needed plus instructions on how to assemble the car (**processing**) and the result is the car (**output**).

Introduction to Algorithms

- Two forms of Algorithm:
 - Pseudocode
 - Flow chart

Pseudocode

- Pseudocode (which means fake code, because its not really programming code) specifies the steps required to accomplish the task.
- Pseudocode is a type of structured English that is used to specify an algorithm.
- Pseudocode cannot be compiled nor executed, and there are no real formatting or syntax rules.

Pseudocode

Example of Pseudocode:

```
Ready and open subscriber file
Get a record
Do while more records
    If current subscriber subscription count is > 3 then
Output the record
    Get another record
end
```

Advantages of Pseudocode

- Reduced complexity.
- Increased flexibility.
- Ease of understanding.

Why is Pseudocode Necessary?

- The programming process is a complicated one.
- You must first understand the program specifications.
- Then you need to organize your thoughts and create the program.
- You must break the main tasks that must be accomplished into smaller ones in order to be able to eventually write fully developed code.
- Writing Pseudocode will save you time later during the construction & testing phase of a program's development.

How to Write Pseudocode Statements?

There are six basic computer operations

1. A computer can receive information
 - Read (information from a file)
 - Get (information from the keyboard)
2. A computer can put out information
 - Write (information to a file)
 - Display (information to the screen)

How to Write Pseudocode Statements?

There are six basic computer operations

3. A computer can perform arithmetic

Use actual mathematical symbols or the words for the symbols

Example:

Add number to total

Total = total + number

+, -, *, /

Calculate, Compute also used

How to Write Pseudocode Statements?

There are six basic computer operations

4. A computer can assign a value to a piece of data

3 cases

i. to give data an initial value

Initialize, Set

How to Write Pseudocode Statements?

There are six basic computer operations

4. A computer can assign a value to a piece of data

3 cases

ii. to assign a value as a result of some processing

'='

* $x=5+y$

How to Write Pseudocode Statements?

There are six basic computer operations

4. A computer can assign a value to a piece of data

3 cases

iii. to keep a piece of information for later use

Save, Store

How to Write Pseudocode Statements?

There are six basic computer operations

5. A computer can compare two piece of information and select one of two alternative actions

IF condition THEN

 some action

ELSE

 alternative action

ENDIF

How to Write Pseudocode Statements?

There are six basic computer operations

6. A computer can repeat a group of actions

WHILE condition (is true)

some action

ENDWHILE

FOR a number of times

some action

ENDFOR

Data Dictionaries

- The pseudo code by itself doesn't provide enough information to be able to write program code.
- Data Dictionaries are used to describe the data used in the Pseudo Code.
- The standard data types used in Pseudo Code are Integer, Double, String, Char and Boolean.

Data Dictionaries

Name	Data Type	Description
number1	Integer	The first number to be added
number2	Integer	The second number to be added
total	Integer	The total of number1 and number2 added together

Example 1:

Program Specification:

Write a program that obtains two integer numbers from the user. It will print out the sum of those numbers.

Pseudocode:

Prompt the user to enter the first integer

Prompt the user to enter a second integer

Compute the sum of the two user inputs

Display an output prompt that explains the answer as the sum

Display the result

Example 2:

Finding average of any three numbers.

We might usually specify the procedure of solving this problem as “add the three numbers and divide by three”. Here, Read (or Ask) and Write (or Say) are implied. However in an algorithm, these steps have to be made explicit. Thus a possible algorithm is:

Example 2:

- | | |
|--------|------------------------|
| Step 1 | Start |
| Step 2 | Read values of X, Y, Z |
| Step 3 | $S = X + Y + Z$ |
| Step 4 | $A = S / 3$ |
| Step 5 | Write value of A |
| Step 6 | Stop |

Example 2:

Or you can write like this:

Step 1	Start
Step 2	Read values of X, Y, Z
Step 3	$S = X + Y + Z$
Step 4	$A = S / 3$
Step 5	Write value of A
Step 6	Stop

Example 3:

Finding square and cube.

- | | |
|--------|----------------------|
| Step 1 | Start |
| Step 2 | Read value of N |
| Step 3 | $S = N * N$ |
| Step 4 | $C = S * N$ |
| Step 5 | Write values of S, C |
| Step 6 | Stop |

Example 4:

Finding biggest of two numbers.

- | | |
|--------|---|
| Step 1 | Start |
| Step 2 | Read A, B |
| Step 3 | If $A > B$, then $BIG = A$, otherwise $BIG = B$ |
| Step 4 | Write BIG |
| Step 5 | Stop |

Example 5:

Calculate pay.

Step 1	Start
Step 2	Input hours
Step 3	Input rate
Step 4	$\text{pay} = \text{hours} * \text{rate}$
Step 5	Print pay
Step 6	End

Exercise:

Write a Pseudocode for these problems.

1. $S = (A + B + C) / Y$
2. Convert from Celsius to Fahrenheit.
(Multiply by 9, then divide by 5, then add 32)
3. Area of Circle (πr^2)
4. Volume of Sphere ($\frac{4}{3} \pi r^3$)
5. Average speed = $\frac{\text{Distance traveled}}{\text{Time taken}}$

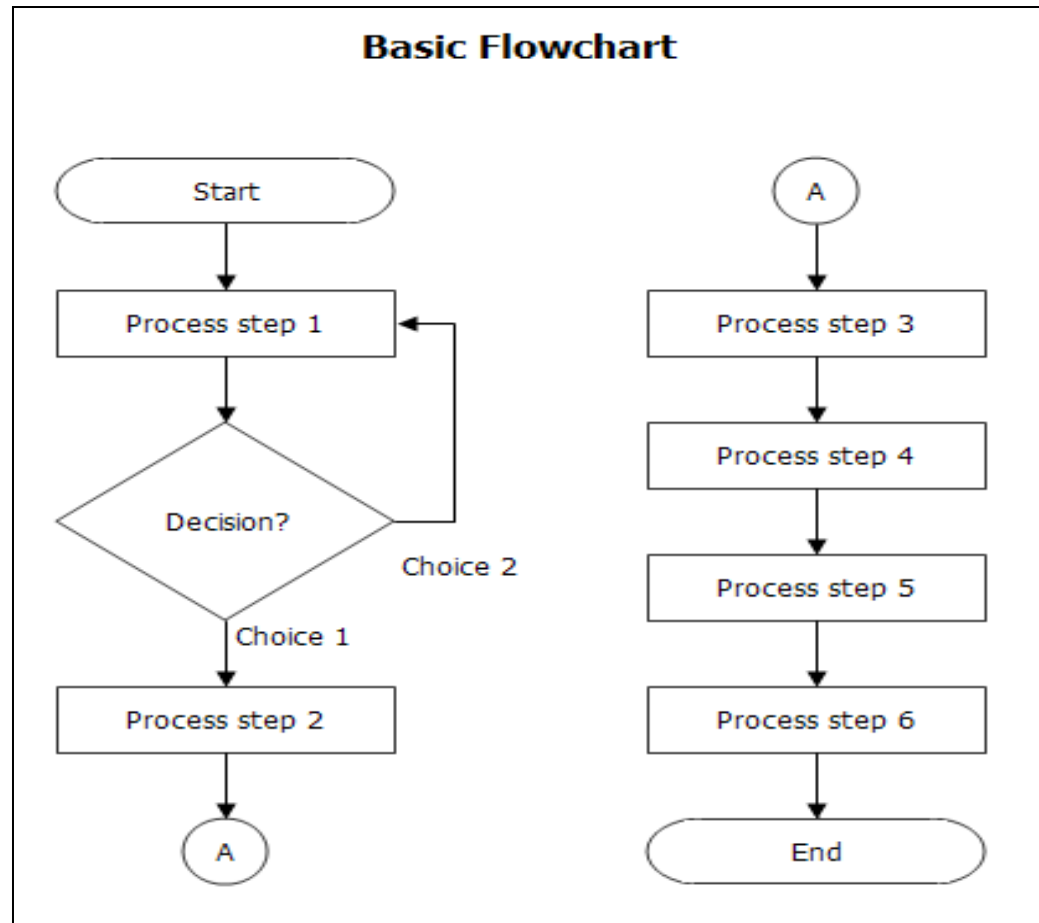
Flowchart

- A **flowchart** is a graphical representation of an algorithm.
- These flowcharts play a vital role in the programming of a problem and are quite helpful in understanding the logic of complicated and lengthy problems.
- Once the **flowchart** is drawn, it becomes easy to write the program in any high level language.

Flowchart

- A flowchart can therefore be used to:
 - Define and analyze processes
 - Build a step-by-step picture of the process for analysis, discussion, or communication
 - Define, standardize or find areas for improvement in a process

Flowchart



Flowchart Symbols

Start and end symbols



- Represented as lozenges, ovals or rounded rectangles
- Usually containing the word "Start" or "End", or another phrase signalling the start or end of a process, such as "submit enquiry" or "receive product".

Flowchart Symbols

Arrows



- Showing what's called "flow of control" in computer science.
- An arrow coming from one symbol and ending at another symbol.
- Represents that control passes to the symbol the arrow points to.

Flowchart Symbols

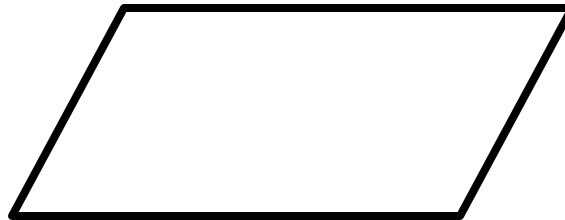
Processing steps



- Represented as rectangles.
- Examples: "Add 1 to X"; "replace identified part"; "save changes" or similar.

Flowchart Symbols

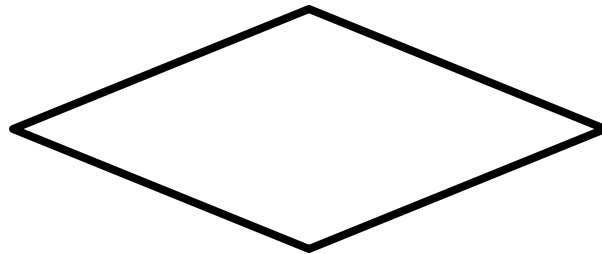
Input/Output



- Represented as a parallelogram.
- Examples: Get X from the user; display X.

Flowchart Symbols

Conditional or decision



- Represented as a diamond (rhombus).
- These typically contain a Yes/No question or True/False test.

Flowchart Symbols

Display



- Indicates a process flow step where information is displayed to a person (e.g., PC user, machine operator).

Rules for Flowchart

1. Every flow chart has a START symbol and a STOP symbol.
2. The flow of sequence is generally from the top of the page to the bottom of the page. This can vary with loops which need to flow back to an entry point.
3. Use arrow-heads on connectors where flow direction may not be obvious.
4. There is only one flow chart per page.

Rules for Flowchart

5. A page should have a page number and a title.
6. A flow chart on one page should not break and jump to another page
7. A flow chart should have no more than around 15 symbols (not including START and STOP).

Advantages of Using Flowcharts

- **Communication:** Flowcharts are a better way of communicating the logic of a system to all concerned.
- **Effective analysis:** With the help of flowchart, a problem can be analysed in a more effective way.
- **Proper documentation:** Program flowcharts serve as a good program documentation, which is needed for various purposes.
- **Efficient Coding:** The flowcharts act as a guide or blueprint during the systems analysis and program development phase.

Advantages of Using Flowcharts

- **Proper Debugging:** The flowchart helps in debugging process.
- **Efficient Program Maintenance:** The maintenance of operating program becomes easy with the help of flowchart. It helps the programmer to put efforts more efficiently on that part.

Basic Control Structures

- Sequence
- Selection
- Loop

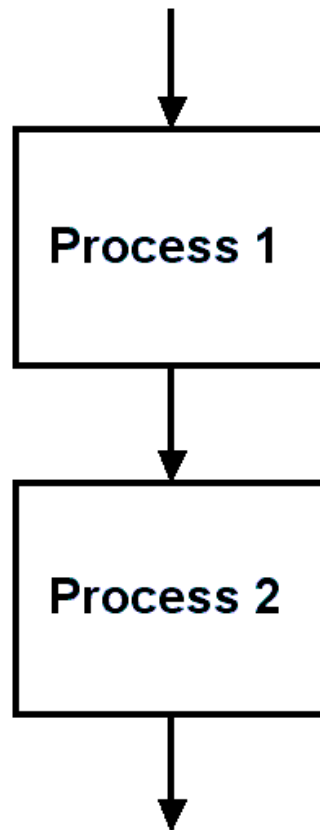
Basic Control Structures

Sequence

- Steps that execute in sequence are represented by symbols that follow each other top to bottom or left to right.
- Top to bottom is the standard.

Basic Control Structures

Sequence



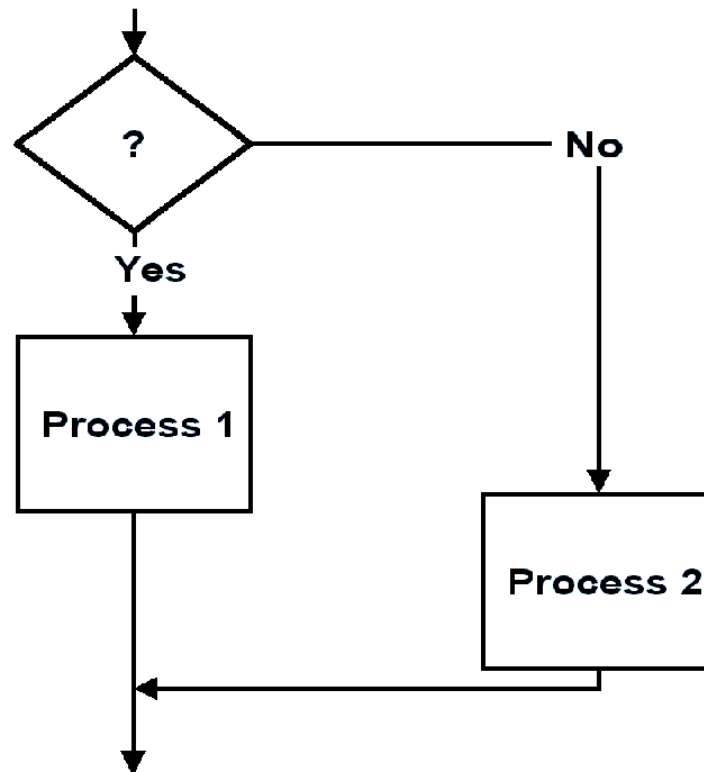
Basic Control Structures

Selection

- Once the condition is evaluated, the control flows into one of two paths.
- Once the conditional execution is finished, the flows rejoin before leaving the structure.

Basic Control Structures

Selection



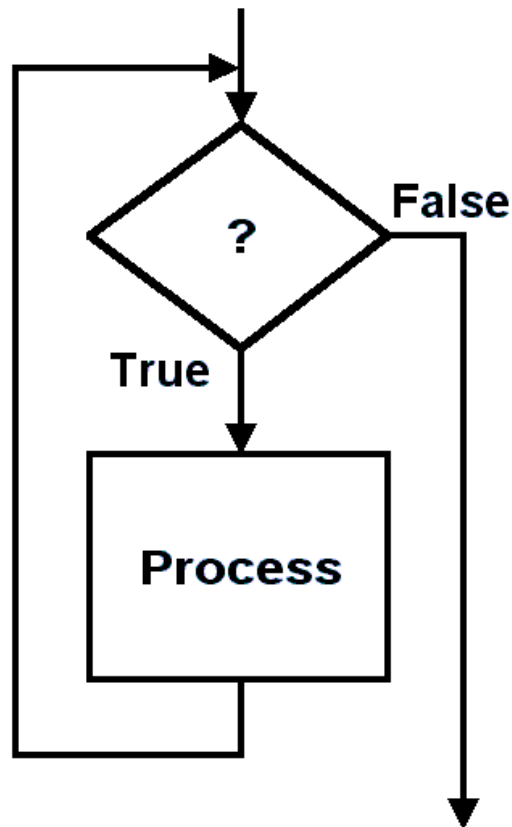
Basic Control Structures

Loop

- Either the processing repeats or the control leaves the structure.
- Notice that the return line joins the entry line before the question.

Basic Control Structures

Loop



Example 1:

Algorithm:

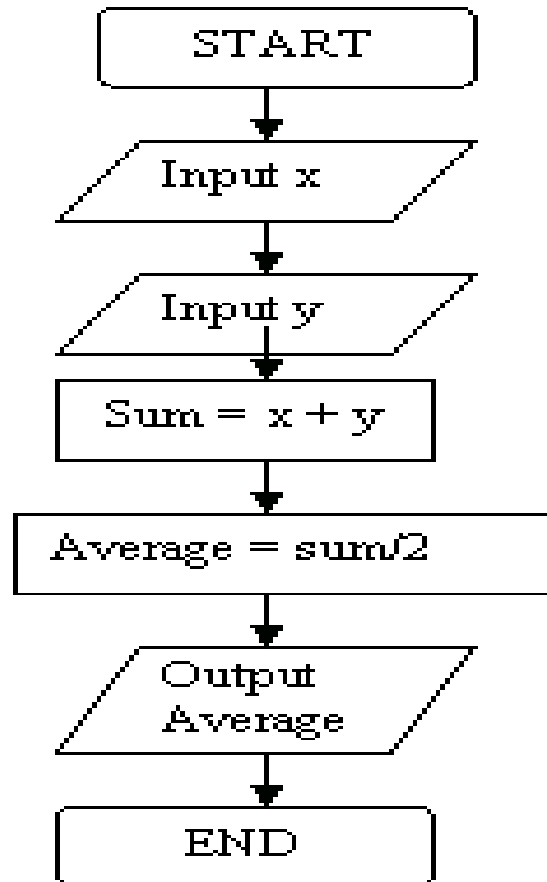
Input: two numbers x and y

Output: the average of x and y

Steps:

1. input x
2. input y
3. $sum = x + y$
4. $average = sum / 2$
5. output average

Example 1:



Example 2:

Draw a flowchart to find the largest of three numbers A, B, and C.

Example 2:

