
ST. JOSEPH'S
COLLEGE OF ENGINEERING
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# DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

ALGORITHMIC THINKING WITH PYTHON

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# Module 2

# Module 2

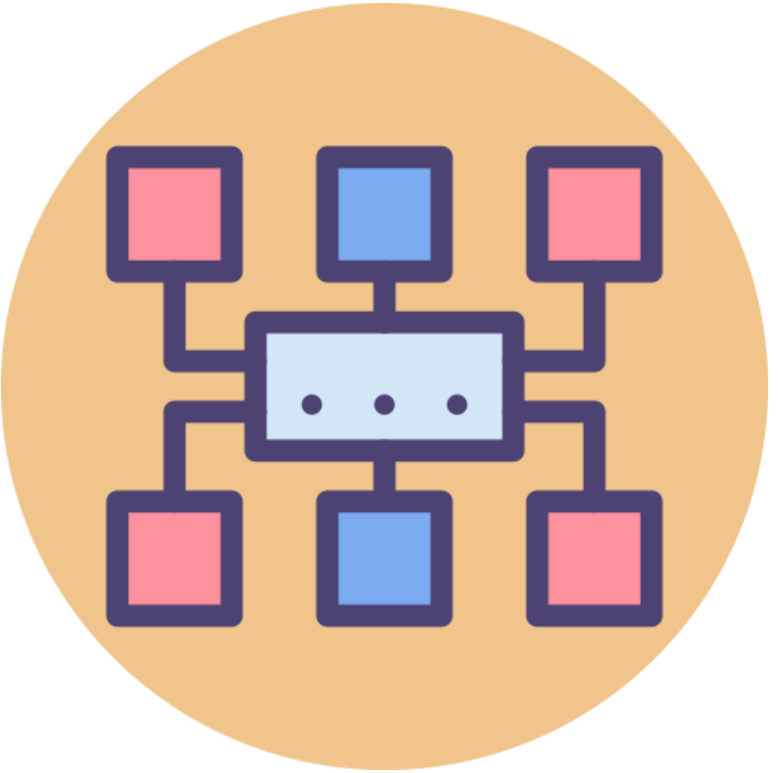
- ALGORITHM AND PSEUDOCODE REPRESENTATION:- Meaning and Definition of Pseudocode, Reasons for using pseudocode, The main constructs of pseudocode - Sequencing, selection (if-else structure, case structure) and repetition (for, while, repeat-until loops), Sample problems

- FLOWCHARTS :- Symbols used in creating a Flowchart - start and end, arithmetic calculations, input/output operation, decision (selection), module name (call), for loop (Hexagon), flow-lines, on-page connector, off-page connector.

# Algorithms and pseudocodes

# Algorithms and pseudocodes

- **Algorithm**
  - A step-by-step procedure for solving a problem.
  - Uses pure English phrases or sentences.
- **Pseudocode**
  - A high-level representation of an algorithm.
  - Uses a mix of natural language and programming-like syntax.
  - More structured than algorithms.



# Pseudocodes

- Confused between algorithms and pseudocodes? Let us take an example. We will now write an algorithm and a pseudocode to evaluate an expression, say d = a + b ∗ c.

EVALUATE-ALGO

1 Start
2 Read the values of $a, b$ and $c$.
3 Find the product of $b$ and $c$.
4 Store the product in a temporary variable $temp$.
5 Find the sum of $a$ and $temp$.
6 Store the sum in $d$.
7 Print the value of $d$.
8 Stop.

**Algorithm**

EVALUATE-PSEUDO

1 Start
2 READ$(a, b, c)$
3 $d = a + b * c$
4 PRINT$(d)$
5 Stop

**Pseudocode**

# Why pseudocodes?

Wondering why pseudocodes are important? Here are a few motivating reasons:

- **Ease of understanding**: Since the pseudocode is programming language independent, novice developers can also understand it very easily.
- **Focus on logic**: A pseudocode allows you to focus on the algorithm's logic without bothering about the syntax of a specific programming language.
- **More legible**: Combining programming constructs with English phrases makes pseudocode more legible and conveys the logic precisely.
- **Consistent**: As the constructs used in pseudocode are standardized, it is useful in sharing ideas among developers from various domains.
- **Easy translation to a program**: Using programming constructs makes mapping the pseudocode to a program straightforward.
- **Identification of flaws**: A pseudocode helps identify flaws in the solution logic before implementation.

# Difference between Algorithm and Pseudocode

| Criteria | Algorithm | Pseudocode |
|---|---|---|
| **Level of Detail** | More abstract and language-agnostic. | More structured and resembles a programming language. |
| **Readability** | Often less readable due to abstraction. | More readable as it mimics coding structures. |
| **Execution** | Can be directly implemented in a programming language. | Not directly executable. It requires multiple transitions to be used in the programming language. |
| **Purpose** | Defines the logic and steps of a solution. | An intermediary step for planning before coding. |

# Constructs of a pseudocode

# Constructs of a pseudocode

- A good pseudocode should follow the structured programming approach.
- Structured coding aims to improve the readability of pseudocode by ensuring that the execution sequence follows the order in which the code is written.
- The main constructs are
  - Sequencing
  - Selection
  - Repetition (loop)

# Constructs of a pseudocode - Sequence

- This is the most elementary construct where the instructions of the algorithm are executed in the order listed.
- It is the logical equivalent of a straight line.
- Consider the code below.

```
S1
S2
S3
.
.
Sn
```

- The statement S1 is executed first, which is then followed by statement S2, so on and so forth, Sn until all the instructions are executed.
- No instruction is skipped and every instruction is executed only once.

# Constructs of a pseudocode - Sequence

- Example: Write a pseudocode to find the area of a square

```
1. Start
2. Read the side length of the square
3. area: area = side_length * side_length
4. Print the area
5. End
```

- All the statements in the given pseudocode will execute in sequential order, without skipping any line.

# Constructs of a pseudocode - Decision or Selection

- A selection structure consists of a test condition together with one or more blocks of statements.
- The result of the test determines which of these blocks is executed.
- There are mainly two types of selection structures
- `if` structure
  - Simple **`if`** structure
  - **`If…else`** structure
  - **`if ..else if.. else`** structure
- Case Structure

# Constructs of a pseudocode - Decision or Selection

- Simple If
- The general form of this structure is

```
if (condition)
    TRUE_INSTRUCTIONS
endif
```

```
CHECKPOSITIVE(x)
1  if (x > 0)
2      PRINT(x," is positive")
3  endif
```

The pseudocode CheckPositive(*x*) checks if an input value *x* is positive.

# Constructs of a pseudocode - Decision or Selection

- if .. else structure
- The general form of this structure is

```
if (condition)
        TRUE_INSTRUCTIONS
else
        FALSE_INSTRUCTIONS
endif
```

- This structure contains two blocks of statements.
- If the test condition is met, the first block (denoted by true_instructions) is executed and the algorithm skips over the second block (denoted by false_instructions).
- If the test condition is not met, the first block is skipped and only the second block is executed.

```
PERSONTYPE(age)
1  if (age >= 18)
2        PRINT("You are a major")
3  else
4        PRINT("You are a minor")
5  endif
```

The pseudocode PersonType(age) checks if a person is a major or not.

# Constructs of a pseudocode - Decision or Selection

- `if ..else if .. else` structure
- When a selection is to be made out of a set of more than two possibilities, you need to use the if else if else structure, whose general form is given below:

```
if (condition1)
    TRUE_INSTRUCTIONS1
else if (condition2)
    TRUE_INSTRUCTIONS2
else
    FALSE_INSTRUCTIONS
endif
```

  - Here, if `condition1` is met, `TRUE_INSTRUCTIONS1` will be executed.
  - Else `condition2` is checked. If it evaluates to True, `TRUE_INSTRUCTIONS2` will be selected.
  - There is no limit to the number of **`else if`** statements, but in the end, there has to be an **`else`** statement.
  - The conditions are tested one by one starting from the top, proceeding downwards.
  - Once a condition is evaluated to be True, the corresponding block is executed, and the rest of the structure is skipped.
  - **If none of the conditions are met, the final else part is executed**.

# Constructs of a pseudocode - Decision or Selection

- `if ..else if .. else` structure
- Example

```
CompareVars(x, y)
1  if (x > y)
2        Print(x,"is greater than",y)
3  else if (x < y)
4        Print(y,"is greater than",x)
5  else
6        Print("The two values are equal")
7  endif
```

The pseudocode `CompareVars(x, y)` compares two variables `x` and `y` and prints the relation between them.

# Constructs of a pseudocode - Case Structure

- The case structure is a refined alternative to if else if else structure.
- The pseudocode representation of the case structure is given below.

**caseof** $(expression)$
**case** 1 $value_1$:
    $\text{BLOCK}_1$
**case** 2 $value_2$:
    $\text{BLOCK}_2$
    :
**default** :
    DEFAULT_BLOCK
**endcase**

- First, the value of an expression (which could also be a single variable) is compared to a predefined value1.
- If a match is found, the first block of code, referred to as block1, is executed.
- Typically, each block ends with a break statement, which exits the case structure.

# Constructs of a pseudocode - Case Structure

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**caseof** $(expression)$
**case** 1 $value_1$:
    $\text{BLOCK}_1$
**case** 2 $value_2$:
    $\text{BLOCK}_2$
    :
**default** :
    DEFAULT_BLOCK
**endcase**

- If there is no match with value1, the expression or variable is then compared with value2.
- If this comparison results in a match, block2 is executed, and the case structure is exited with the corresponding break statement.

# Constructs of a pseudocode - Case Structure

- The case structure is a refined alternative to if else if else structure.
- The pseudocode representation of the case structure is given below.

**caseof** $(expression)$
**case** 1 $value_1$:
    $\text{BLOCK}_1$
**case** 2 $value_2$:
    $\text{BLOCK}_2$
    :
**default** :
    DEFAULT_BLOCK
**endcase**

- This comparison process continues for each case until either a match is found, or all cases are exhausted.
- If no matches are found for any of the cases, the default_block will be executed.
- This block handles cases where the expression doesn't match any predefined values.

# Constructs of a pseudocode - Case Structure

- The case structure is a refined alternative to if else if else structure.
- The pseudocode representation of the case structure is given below.

**caseof** $(expression)$
**case** 1 $value_1$:
    $\text{BLOCK}_1$
**case** 2 $value_2$:
    $\text{BLOCK}_2$
    ⋮
**default** :
    DEFAULT_BLOCK
**endcase**

- If a break statement is omitted from a block, the program will continue executing the subsequent blocks, regardless of whether the subsequent cases match, until a break is encountered or the end of the case structure is reached.

# Constructs of a pseudocode - Case Structure

- Example

```
PRINTDIRECTION(dir)
 1  caseof (dir)
 2        case 'N':
 3              PRINT("North")
 4              break
 5        case 'S':
 6              PRINT("South")
 7              break
 8        case 'E':
 9              PRINT("East")
10              break
11        case 'W':
12              PRINT("West")
13              break
14        default :
15              PRINT("Invalid direction code")
16  endcase
```

The pseudocode `PRINTDIRECTION(dir)` prints the direction name based on the value of a character called dir.

# Constructs of a pseudocode - Repetition or loop

- When a certain block of instructions is to be repeatedly executed, we use the repetition or loop construct.
- Each execution of the block is called an **iteration** or a **pass**.
- **Definite iteration**: If the number of iterations (how many times the block is to be executed) is known in advance.
- **Indefinite or conditional iteration**: If the number of iterations is not known in advance
- The block that is repeatedly executed is called the **loop body**.

# Constructs of a pseudocode - Repetition or loop

- There are three types of loop constructs as discussed below
  - while loop
  - repeat-until loop
  - for loop

# Constructs of a pseudocode – while loop

- A while loop is generally used to implement indefinite iteration. The general form of the while loop is as follows:

```
while (condition)
        TRUE_INSTRUCTIONS
endwhile
```

- Here, the loop body (`TRUE_INSTRUCTIONS`) is executed repeatedly as long as condition evaluates to True.
- When the condition is evaluated as False, the loop body is bypassed

# Constructs of a pseudocode – repeat-until loop

- The second type of loop structure is the **repeat-until** structure.
- This type of loop is also used for **indefinite iteration**.
- Here the set of instructions constituting the loop body is **repeated** as long as **condition evaluates to False**.
- When the condition evaluates to **True**, the **loop is exited**

```
repeat
        FALSE_INSTRUCTIONS
until (condition)
```

# Constructs of a pseudocode – repeat-until loop

- There are two major differences between while and repeat-until loop constructs:
  - In the **while loop**, the pseudocode **continues** to execute as long as the resultant of the condition is **True**; in the **repeat-until** loop, the looping process **stops** when the resultant of the condition becomes **True**.
  - In the **while** loop, the condition is **tested at the beginning**; in the **repeat until** loop, the condition is **tested at the end**.
- For this reason, the **while** loop is known as an **entry controlled** loop and the **repeat-until** loop is known as an **exit controlled** loop.

# Constructs of a pseudocode – for loop

- The for loop implements **definite iteration**.
- for loop constructs use a variable (call it the *loop variable*) as a counter that starts counting from a specific value called *begin* and updates the loop variable after each iteration.
- The loop body repeats execution until the loop variable value reaches *end*.

```
for var = begin to end
    LOOP_INSTRUCTIONS
endfor
```

- The condition var <= end is tested first.
- If the condition is True, the loop body is executed.
- After the first iteration, the loop variable is incremented (increased by 1).
- The condition var <= end is tested again with the updated value of var.
- If the condition remains True, the loop body is executed again.The loop continues: updating the loop variable after each iteration and testing the condition.When the loop variable becomes greater than end, the condition evaluates to False.At this point, the loop execution stops.

# Constructs of a pseudocode – for loop

```
for var = begin downto end
      LOOP_INSTRUCTIONS
endfor
```

- In the second for loop variant, whose pseudocode syntax is given
- The loop variable is decremented (decreased by 1) after every iteration
- The condition being tested is var >= end.
- Here, *begin* should be greater than or equal to *end*, and the loop exits when this condition is violated.

# Constructs of a pseudocode – for loop

```
for var = begin to end by step
    LOOP_INSTRUCTIONS
endfor
```

- It is also possible to update the loop variable by an amount other than 1 after every iteration.
- The value by which the loop variable is increased or decreased is known as step.
- In the pseudocode shown below, the step value is specified using the keyword **by** .

# Constructs of a pseudocode – for loop

| Loop construct | Description | Values taken by *var* |
|---|---|---|
| **for** *var* = 1 **to** 10 | *var* gets incremented by 1 till it reaches 10 | $1, 2, \cdots 9, 10$ |
| **for** *var* = 10 **downto** 1 | *var* gets decremented by 1 till it reaches 1 | $10, 9, \cdots 2, 1$ |
| **for** *var* = 2 **to** 20 **by** 2 | *var* gets increased by 2 till it reaches 20 | $2, 4, \cdots 18, 20$ |
| **for** *var* = 20 **downto** 2 **by** 2 | *var* gets decreased by 2 till it reaches 2 | $20, 18, \cdots 4, 2$ |

lists some examples of **for** loops. In these examples, *var* is the loop variable.

# Solved problems - Algorithms

- Problem: To find simple interest

SIMPLEINTEREST

1 Start
2 READ($principal, rate, years$)
3 $SI = (principal * rate * years)/100$
4 PRINT($SI$)
5 Stop.

# Solved problems - Algorithms

- Problem: To determine the larger of two numbers

```
LargerTwo
1 Start
2 Read(number1, number2)
3 if (number1 > number2)
4 large = number1
5 else
6 large = number2
7 endif
8 Print(large)
9 Stop.
```

# Solved problems - Algorithms

- Problem: To determine the smallest of three numbers.

```
SmallestThree
1 Start
2 Read(number1, number2, number3)
3 if (number1 < number2)
4 small = number1
5 else
6 small = number2
7 endif
8 if (number3 < small )
9 small = number3
10 endif
11 Print(small )
12 Stop.
```

# Solved problems - Algorithms

- Problem: To determine the entry-ticket fare in a zoo based on age.

| Age | Fare |
|---|---|
| $< 10$ | 7 |
| $>= 10$ and $< 60$ | 10 |
| $>= 60$ | 5 |

```
TicketFare
1 Start
2 Read(age)
3 if (age < 10)
4 fare = 7
5 else if (age < 60)
6 fare = 10
7 else
8 fare = 5
9 endif
10 Print(fare)
11 Stop
```

# Solved problems - Algorithms

- Problem: To print the colour based on a code value as follows:.

| Grade | Message |
|---|---|
| *R* | Red |
| *G* | Green |
| *B* | Blue |
| Any other value | Wrong code |

```
PrintColour
1 Start
2 Read(code)
3 caseof (code)
4 case ‘R’:
5 Print(“Red”)
6 break
7 case ‘G’:
8 Print(“Green”)
9 break
10 case ‘B’:
11 Print(“Blue”)
12 break
13 default :
14 Print(“Wrong code”)
15 endcase
16 Stop
```

# Solved problems - Algorithms

- Problem: To print the numbers from 1 to 50 in descending order.

```
PrintDown
1 Start
2 for count = 50 downto 1
3 Print(count)
4 endfor
5 Stop
```

# Solved problems - Algorithms

- Problem: To find the factorial of a number.

```
Factorial
1 Start
2 Read(number)
3 fact = 1
4 for var = number downto 1
5 fact = fact * var
6 endfor
7 Print(fact)
8 Stop
```

# Solved problems - Algorithms

- Problem: To determine the largest of n numbers.

```
LARGEN
1   Start
2   READ(n, num)
3   large = num
4   for count = 1 to n − 1
5       READ(num)
6       if (num > large)
7           large = num
8       endif
9   endfor
10  PRINT(large)
11  Stop
```

# Solved problems - Algorithms

- Problem: To determine the average age of students in a class. The user will stop giving the input by giving the age as 0.

AVERAGEAGEV1

```
1   Start
2   sum = 0
3   count = 0
4   READ(age)
5   while (age!=0)
6         sum = sum + age
7         count = count + 1
8         READ(age)
9   endwhile
10  average = sum/count
11  PRINT(average)
12  Stop
```

# Solved problems - Algorithms

- Problem: To determine the average age of students in a class. The user will stop giving the input by giving the age as 0. use repeat-until loop

```
AVERAGEAGEV2
1   Start
2   sum = 0
3   count = 0
4   READ(age)
5   repeat
6       sum = sum + age
7       count = count + 1
8       READ(age)
9   until (age == 0)
10  average = sum/count
11  PRINT(average)
12  Stop
```

# Solved problems - Algorithms

- Problem: To find the average height of boys and average height of girls in a class of n students

```
AVERAGEHEIGHT
1   Start
2   READ(n)
3   btotal = 0
4   bcount = 0
5   gtotal = 0
6   gcount = 0
7   for var = 1 to n
8         READ(gender, height)
9         if (gender == 'M')
10              btotal = btotal + height
11              bcount = bcount + 1
12        else
13              gtotal = gtotal + height
14              gcount = gcount + 1
15        endif
16  endfor
17  bavg = btotal/bcount
18  gavg = gtotal/gcount
19  PRINT(bavg, gavg)
20  Stop
```

# References


- https://www.scaler.com/topics/how-to-write-pseudo-code/
- Algorithmic Thinking with Python – Ajeesh Ramanujan, Narasimhan T

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# Thank You

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