

UNIT II ALGORITHMIC PROBLEM SOLVING

CHAPTER 6

SPECIFICATION AND ABSTRACTION

PART I Choose the Best Answer

- Which of the following activities is algorithmic in nature?
 - Assemble a bicycle.**
 - Describe a bicycle.
 - Label the parts of a bicycle.
 - Explain how a bicycle works.
- Which of the following activities is not algorithmic in nature?
 - Multiply two numbers.
 - Draw a kolam.
 - Walk in the park.
 - Braid the hair.**
- Omitting details inessential to the task and representing only the essential features of the task is known as
 - specification
 - abstraction**
 - composition
 - decomposition
- Stating the input property and the as :-output relation a problem is known
 - specification**
 - statement
 - algorithm
 - definition
- Ensuring the input-output relation is
 - the responsibility of the algorithm and the right of the user.
 - the responsibility of the user and the right of the algorithm.
 - the responsibility of the algorithm but not the right of the user.
 - the responsibility of both the user and the algorithm.**
- If $i = 5$ before the assignment $i := i - 1$ after the assignment, the value of i is
 - 5
 - 4**
 - 3
 - 2
- If $0 < i$ before the assignment $i := i - 1$ after the assignment, we can conclude that
 - $0 < i$
 - $0 \leq i$**
 - $i = 0$
 - $0 \geq i$

PART II Very Short Answers

1. Define an algorithm.

- An algorithm is a step-by-step sequence of statements to solve a problem.
- As an algorithm is executed, a process evolves which solves the problem.

2. Distinguish between an algorithm and a process.

ALGORITHM	PROCESS
An algorithm is a step-by-step sequence of statements to solve a problem	An instruction describes an action
As an algorithm is executed, a process evolves which solves the problem.	When the instructions are executed, a process evolves, which accomplishes the intended task or solves the given problem

3. Initially,

farmer, goat, grass, wolf = L, L, L, L

and the farmer crosses the river with goat. Model the action with an assignment statement.

- the goat cannot be left alone with the grass:
if goat = grass then farmer = goat
- the goat cannot be left alone with the wolf:
if goat = wolf then farmer = goat

4. Specify a function to find the minimum of two numbers.

Minimum(A,B)

--inputs: A and B are integers (or) Real numbers**--Outputs:** A is minimum ($A < B$) (or) B is minimum ($B < A$)**5. If $\sqrt{2} = 1.414$, and the square_root() function returns -1.414, does it violate the following specification?***-- square_root (x)**-- inputs: x is a real number , $x \geq 0$* *-- outputs: y is a real number such that $y^2 = x$*

Yes, it violate the specification.

Ex: $x=9, y=?$

Square(x)

Square(9)= 3×3 Square(9)= 3^2 $3^2=9 \Rightarrow Y^2=X$ **PART III Short Answers****1. When do you say that a problem is algorithmic in nature?**

We usually say that a problem is algorithmic in nature when its solution involves the construction of an algorithm. Some types of problems can be immediately recognized as algorithmic.

2. What is the format of the specification of an algorithm?

Let **P** be the required property of the inputs and **Q** the property of the desired outputs. Then the algorithm **S** is specified as

1. **algorithm_name (inputs)**2. **--inputs : P**3. **--outputs: Q****3. What is abstraction?**

A problem can involve a lot of details. Several of these details are unnecessary for solving the problem. Only a few details are essential.

Abstraction is the process of **hiding or ignoring** the details irrelevant to the task so as to model a problem only by its essential features.

4. How is state represented in algorithms?

- State is a basic and important abstraction.
- Computational processes have state. A computational process starts with an initial state. As actions are performed, its state changes. It ends with a final state.
- State of a process is abstracted by a set of variables in the algorithm. The state at any point of execution is simply the values of the variables at that point.

5. What is the form and meaning of assignment statement?**Assignment statement**

- Variables are named boxes to store values. Assignment statement is used to store a value in a variable.
- It is written with the variable on the left side of the assignment operator and a value on the right side.

Format / Form:

variable := value

Example:

m := 2

6. What is the difference between assignment operator and equality operator?

ASSIGNMENT OPERATOR	EQUALITY OPERATOR
Assignment operator is used to assign the right hand side value into left hand side variable.	Equality operator is used to the values of both right hand side variable and left hand side variable and results in either true or false.
Example: A=5 B=10	Example: A==B (a=5, b=5) True A≠B (a=5, b=10) True

PART IV Explain

- Write the specification of an algorithm hypotenuse whose inputs are the lengths of the two shorter sides of a right angled triangle, and the output is the length of the third side.

Answer:

Hypotenuse (S₁, S₂)

--Inputs: S₁ and S₂ are Real numbers or Integers.

--Outputs: L is a Real number such that $L^2 = S_1^2 + S_2^2$

Explanation:

S₁, S₂ - Input Length of the Real number variables

L - Length of the Third side.

- Suppose you want to solve the quadratic equation $ax^2 + bx + c = 0$ by an algorithm.

quadratic_solve (a, b, c)

-- inputs : ?

-- outputs: ?

You intend to use the formula and you are prepared to handle only real number roots. Write a suitable specification.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Answer:

quadratic_solve (a, b, c)

-- inputs : a, b are integers, $a \neq 0$

-- outputs: X is a real number, the quadrature equation $ax^2 + bx + c = 0$ is satisfied by exactly two values fx, namely

$$X_1 = \frac{-b + \sqrt{b^2 - 4ac}}{2a}$$

and

$$X_2 = \frac{-b - \sqrt{b^2 - 4ac}}{2a}$$

3. Exchange the contents: Given two glasses marked A and B. Glass A is full of apple drink and glass B is full of grape drink. For exchanging the contents of glasses A and B, represent the state by suitable variables, and write the specification of the algorithm.

Answer:

Exchange (a, b)

--Inputs: a, b are integers, $a \neq 0$, $b \neq 0$

--Outputs: a, b are Integers,

t:=a

a:=b

b:=t

EXTRA QUESTIONS:

2 Marks:

1. Write the basic building blocks of construct algorithm?

We construct algorithms using basic building blocks such as,

- Data
- Variables
- Control flow
- Functions

2. What is Variable?

- Variables are named boxes for storing data. When we do operations on data, we need to store the results in variables.
- The data stored in a variable is also known as the value of the variable.

3. What are the three important control flow statements to alter the control flow depending on the state.

- sequential control flow
- alternative control flow
- iterative control flow

4. Define: State

State is a basic and important abstraction. Computational processes have state. A computational process starts with an initial state.

5. Specification abstracts:

Specification abstracts a problem by the essential variables of the problem.

6. What is state of the process?

The values of the variables in an algorithm define the state of the process. Assignment statement changes the values of variables, and hence the state.

3 Marks:**1. What is Control flow? Explain.**

- An algorithm is a sequence of statements. However, after executing a statement, the next statement executed need not be the next statement in the algorithm. The statement to be executed next may depend on the state of the process.
- Thus, the order in which the statements are executed may differ from the order in which they are written in the algorithm. This order of execution of statements is known as the control flow.

2. Define: Function.

- The parts of an algorithm are known as functions.
- A function is like a sub algorithm. It takes an input, and produces an output, satisfying a desired input output relation.

3. What are the Algorithm Design Techniques?

- Specification
- Abstraction
- Composition
- Decomposition

4. Explain: Composition

- An algorithm is composed of assignment and control flow statements.
- A control flow statement tests a condition of the state and, depending on the value of the condition, decides the next statement to be executed.

5. What is Decomposition?

- We divide the main algorithm into functions.
- We construct each function independently of the main algorithm and other functions.
- Finally, we construct the main algorithm using the functions. When we use the functions, it is enough to know the specification of the function.

5 Marks:**1. Explain the types of control flow statements.**

There are three important control flow statements to alter the control flow depending on the state.

- In sequential control flow, a sequence of statements are executed one after another in the same order as they are written.
- In alternative control flow, a condition of the state is tested, and if the condition is true, one statement is executed; if the condition is false, an alternative statement is executed.
- In iterative control flow, a condition of the state is tested, and if the condition is true, a statement is executed. The two steps of testing the condition and executing the statement are repeated until the condition becomes false.

2. Explain in detail how you will construct an algorithm.

We construct algorithms using basic building blocks such as

- Data
- Variables
- Control flow
- Functions

1. Data

Algorithms take input data, process the data, and produce output data. Computers provide instructions to perform operations on data.

For example, there are instructions for doing arithmetic operations on numbers, such as add, subtract, multiply and divide. There are different kinds of data such as numbers and text.

2. Variables

Variables are named boxes for storing data. When we do operations on data, we need to store the results in variables. The data stored in a variable is also known as the value of the variable. We can store a value in a variable or change the value of variable, using an assignment statement.

3. Control flow

An algorithm is a sequence of statements. However, after executing a statement, the next statement executed need not be the next statement in the algorithm. The statement to be executed next may depend on the state of the process.

4. Functions

The parts of an algorithm are known as functions. A function is like a sub algorithm. It takes an input, and produces an output, satisfying a desired input output relation.

3. Explain how you will design algorithms.

There are a few basic principles and techniques for designing algorithms.

1. Specification:

The first step in problem solving is to state the problem precisely. A problem is specified in terms of the input given and the output desired. The specification must also state the properties of the given input, and the relation between the input and the output.

2. Abstraction:

A problem can involve a lot of details. Several of these details are unnecessary for solving the problem. Only a few details are essential. Ignoring or hiding unnecessary details and modeling an entity only by its essential properties is known as abstraction.

3. Composition:

An algorithm is composed of assignment and control flow statements. A control flow statement tests a condition of the state and, depending on the value of the condition, decides the next statement to be executed.

4. Decomposition:

We divide the main algorithm into functions. We construct each function independently of the main algorithm and other functions.

Finally, we construct the main algorithm using the functions. When we use the functions, it is enough to know the specification of the function. It is not necessary to know how the function is implemented.

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*****ALL THE BEST*****

