TECHNO INDIA UNIVERSITY
WESTBENGAL

Data Structures & Algorithms
(PCC-CS 301)

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Topics Covered

1. Introduction to Data Structures
2. Introduction to Algorithms
3. Overview of the Course
4. Books to be followed

Introduction to Data Structures

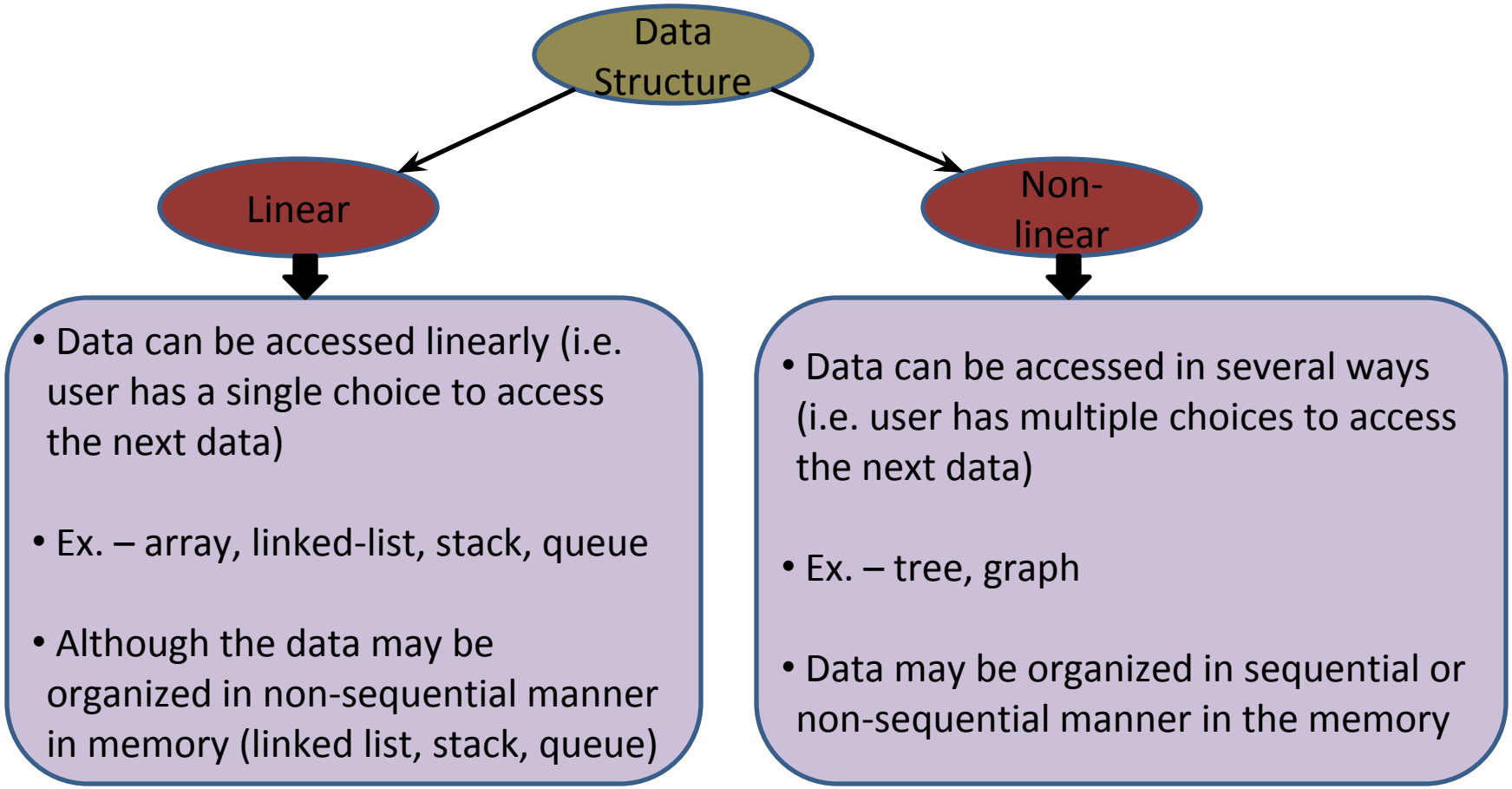
- Data Structure:

  - Definition
    - Data structure is a way of **storing data** in such an **organized manner** so that it can be **accessed efficiently**

  - Need
    - To store a single data in computer memory, it is sufficient to use a variable of primitive type (int, float, char etc.)
    - To store a large number of related data (similar/dissimilar type), we need to use a data structure

Introduction to Data Structures

- Data Structure: classification



Introduction to Data Structures

- Abstract Data Type (ADT):

  - Motivation
    - To solve any problem, we need to use certain data structures and a set of operations that to be performed on those data structures
    - To simplify the process of solving the problems, the data structures are sometimes combined with their operations which is called **abstract data type**
  - Example:
    - Linked-list, stack, queue, priority queue, binary tree, dictionary, disjoint set, hash table, graph etc.

Introduction to Data Structures

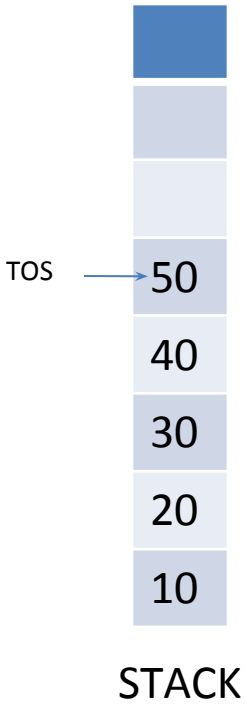
- Abstract Data Type (ADT):

  - Components
    - Declaration of data structure
    - Declaration of operations

  - Properties
    - Implementation of an ADT remains hidden (or abstract), user can implement it by their own way
    - Only the operations and associated constraints on the data structures are defined

Introduction to Data Structures

- Abstract Data Type (ADT): example
  - Stack
    - Associated operations
      - PUSH (inserting an element into stack)
      - POP (deleting the top most element of the stack)
      - DISPLAY (showing the elements from top of the stack)
    - Constraints
      - It follows Last In First Out (LIFO), an element inserted last will be deleted first
      - Only the Top most element can be accessible through a pointer called top of the stack (TOS)
      - Stack should be of fixed size

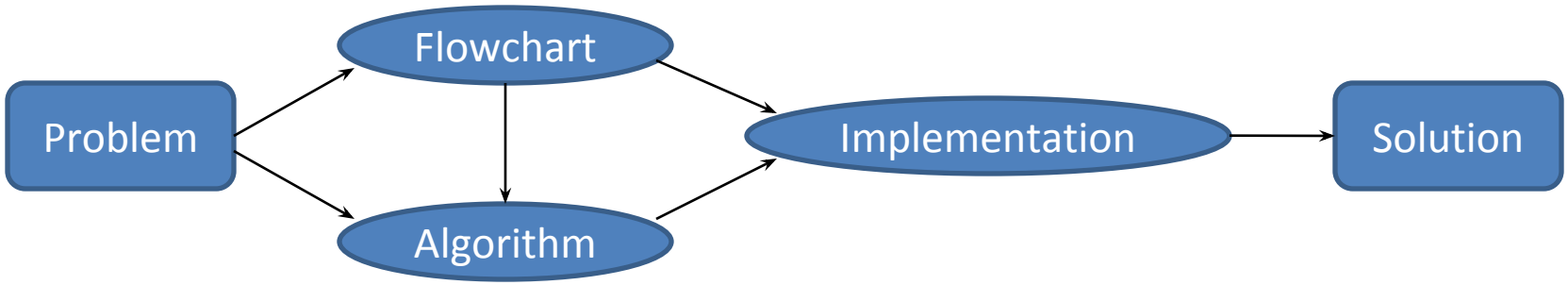


Introduction to Algorithms

- Algorithm

  - Definition
    - An algorithm is a well defined set of instructions to solve a given problem

  - Problem Solving Steps



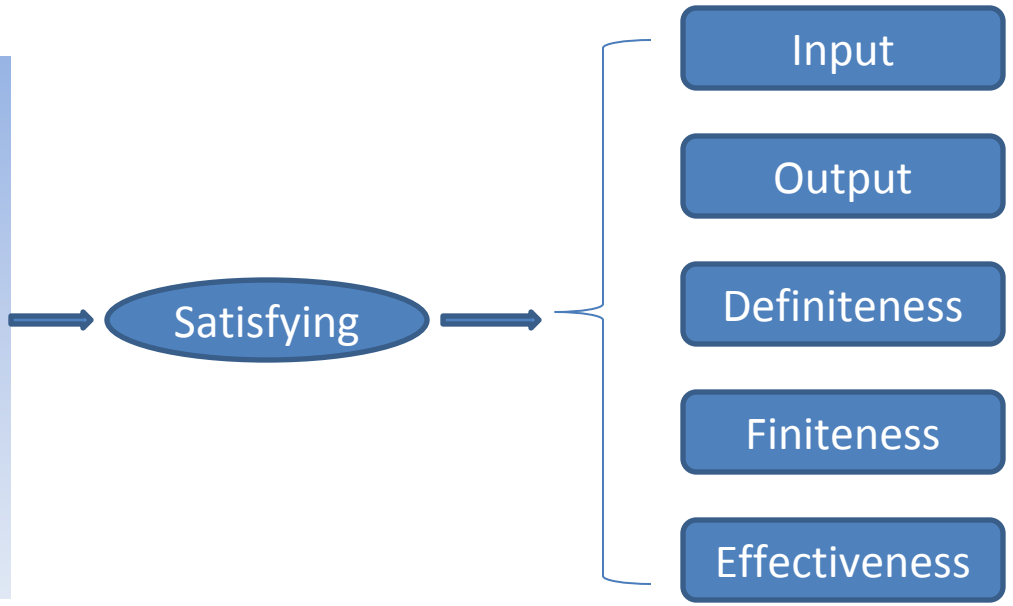
Introduction to Algorithms

- Algorithm: properties
  - Input
    - There should be zero or more inputs into an algorithm
  - Output
    - It should produce at least one output
  - Definiteness
    - Each instructions must be clear and unambiguous
  - Finiteness
    - For every input it should be stopped after a finite amount of time
  - Effectiveness
    - All the instructions should be feasible (implementable)

Introduction to Algorithms

- Can you write an algorithm for any problem
  - A given number is odd or even?

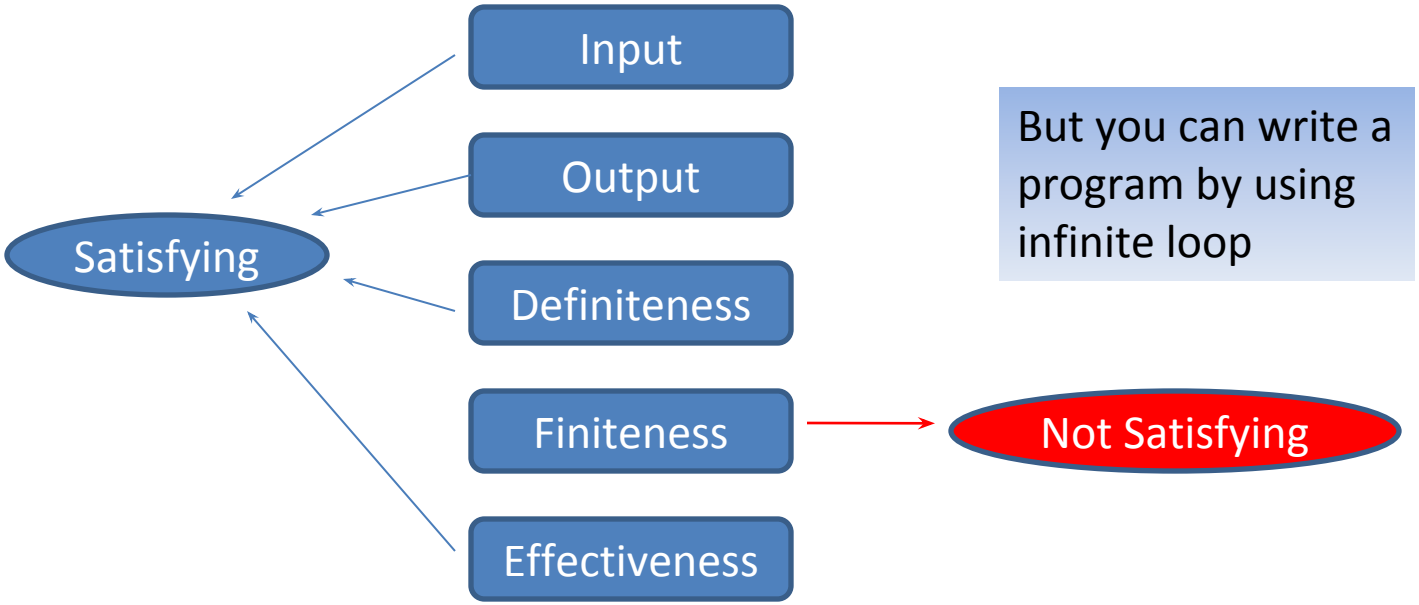
```
Odd_even_test ( n )
{
  m := n (mod) 2
  If m := 0
     Print n as EVEN
  Else
     Print n as ODD
  return
}
```



Algorithm is possible as all the criteria fulfil

Introduction to Algorithms

- Can you write an algorithm for any problem
  - Find and print all prime numbers.



But you can write a program by using infinite loop

Algorithm is not possible as all the criteria are not satisfying

Introduction to Algorithms

- Algorithm: performance analysis

  - Motivation
    - To solve a problem there may have several algorithms
    - Most efficient and suitable algorithm will be in demand
    - Thus the performance analysis is necessary

  - Comparison measure
    - Time complexity
    - Space complexity

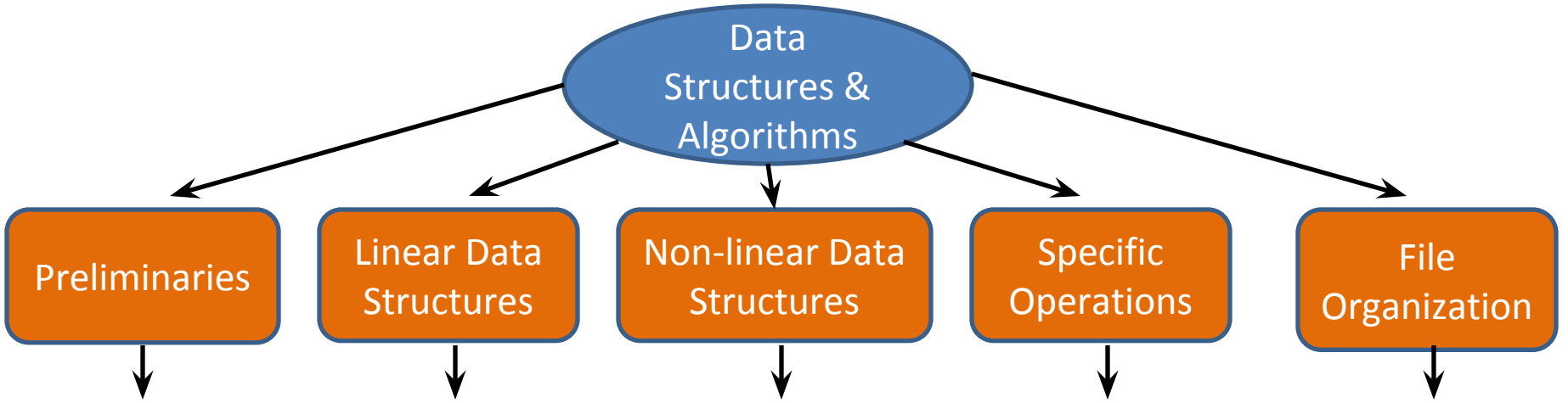
Introduction to Algorithms

- Algorithm: performance analysis

  - Time complexity
    - It is measured as the running time of an algorithm as a function of the input size
    - The rate at which the running time increases with the input size (called as rate of growth)
    - It is **not measured** by the time taken in minute/sec/millisecond because an instruction execution time is purely architecture dependent

  - Space complexity
    - It is measured through the amount of primary memory consumes by the algorithm during implementation

Overview of the Course



Introduction to data structures & algorithms, performance analysis, ADT, recursion, asymptotic notation, time-space trade-off

Array, Linked list, Stack, Queue and it's variants, it's different representations, associated operations, applications

Tree and it's variants, Graph and it's variants, memory representations, applications

Searching: linear & binary search, DFS, BFS, hashing
Sorting: Comparison based sorting, divide-conquer based sorting

Organization, different types of accessing schemes

Books and References

- Text Book:
  - ✔ *Fundamentals of Data Structures, E. Horowitz and S. Sahni*
  - ✔ *Data Structures and Algorithms, Alfred V. Aho, John E. Hoppcroft, Jeffrey D. Ullman*

- Reference Book:
  - ✔ *The Art of Computer programming: Volume I: Fundamental Algorithms, Donald E. Knuth*
  - ✔ *Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein*
  - ✔ *Open Data Structures: An Introduction (Open paths to Enriched Learning), 31st Edition, Pat Morin*
  - ✔ *Data Structures and Algorithms Made Easy, N. Karumanchi*

Queries?