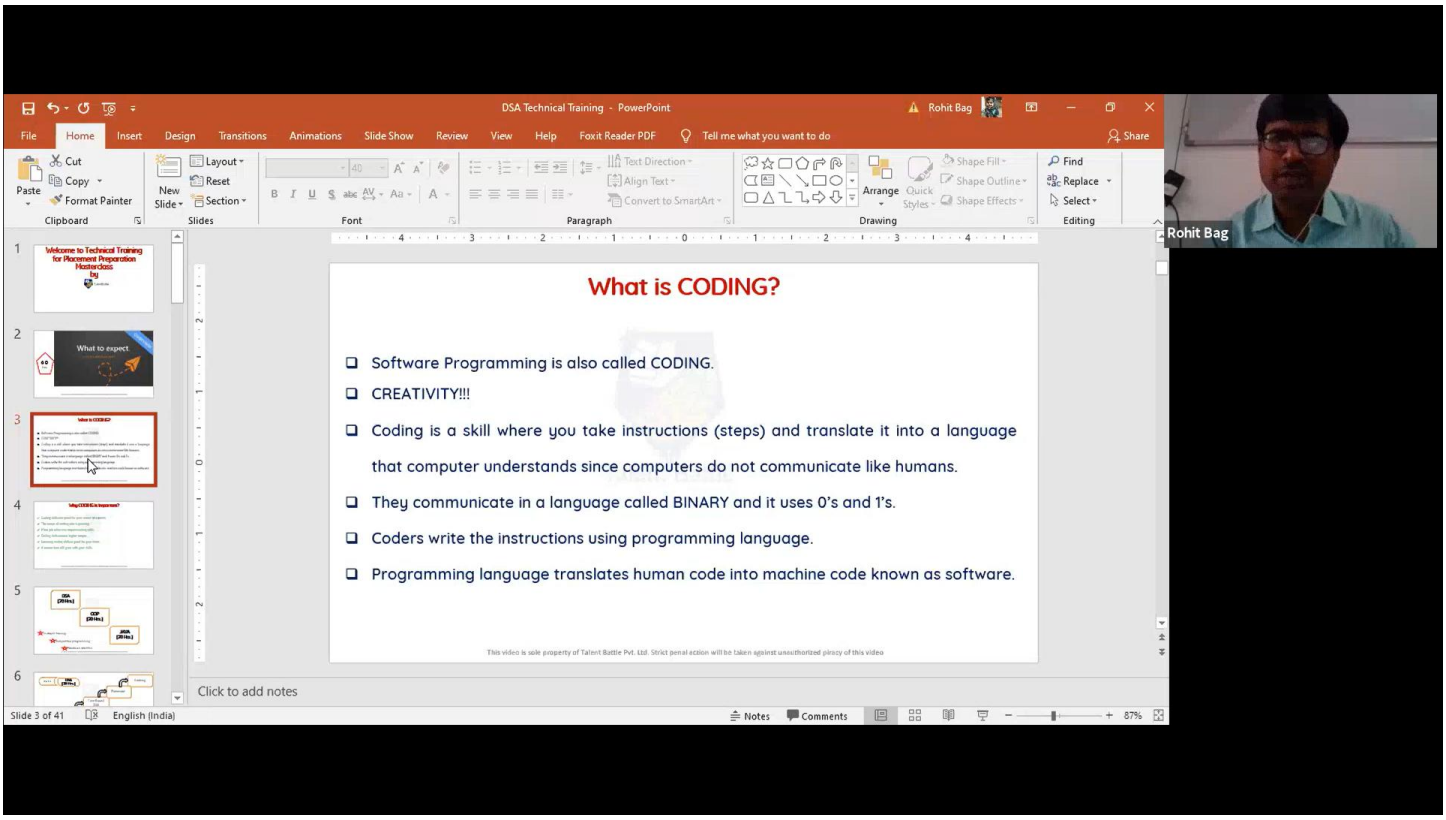
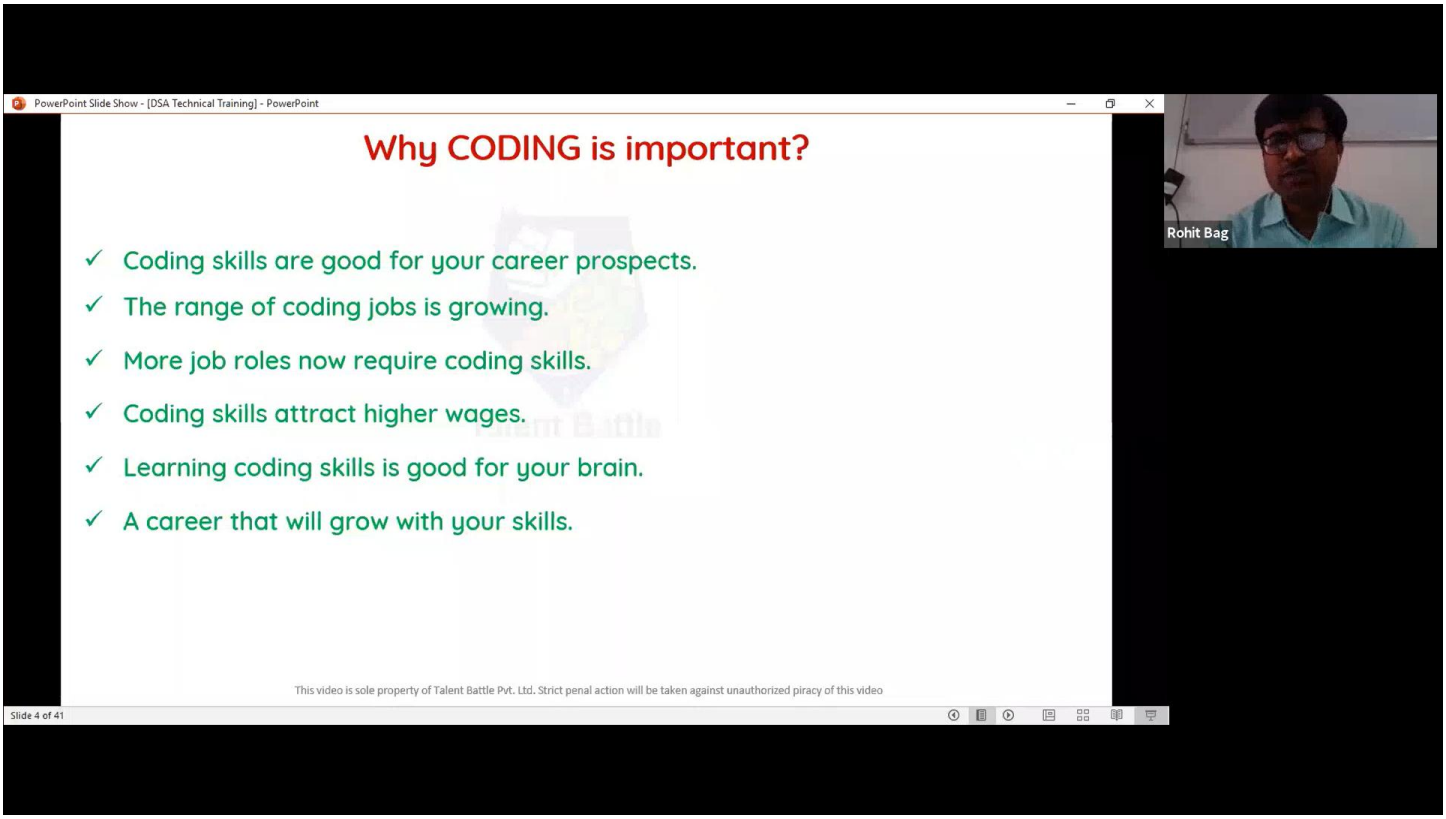
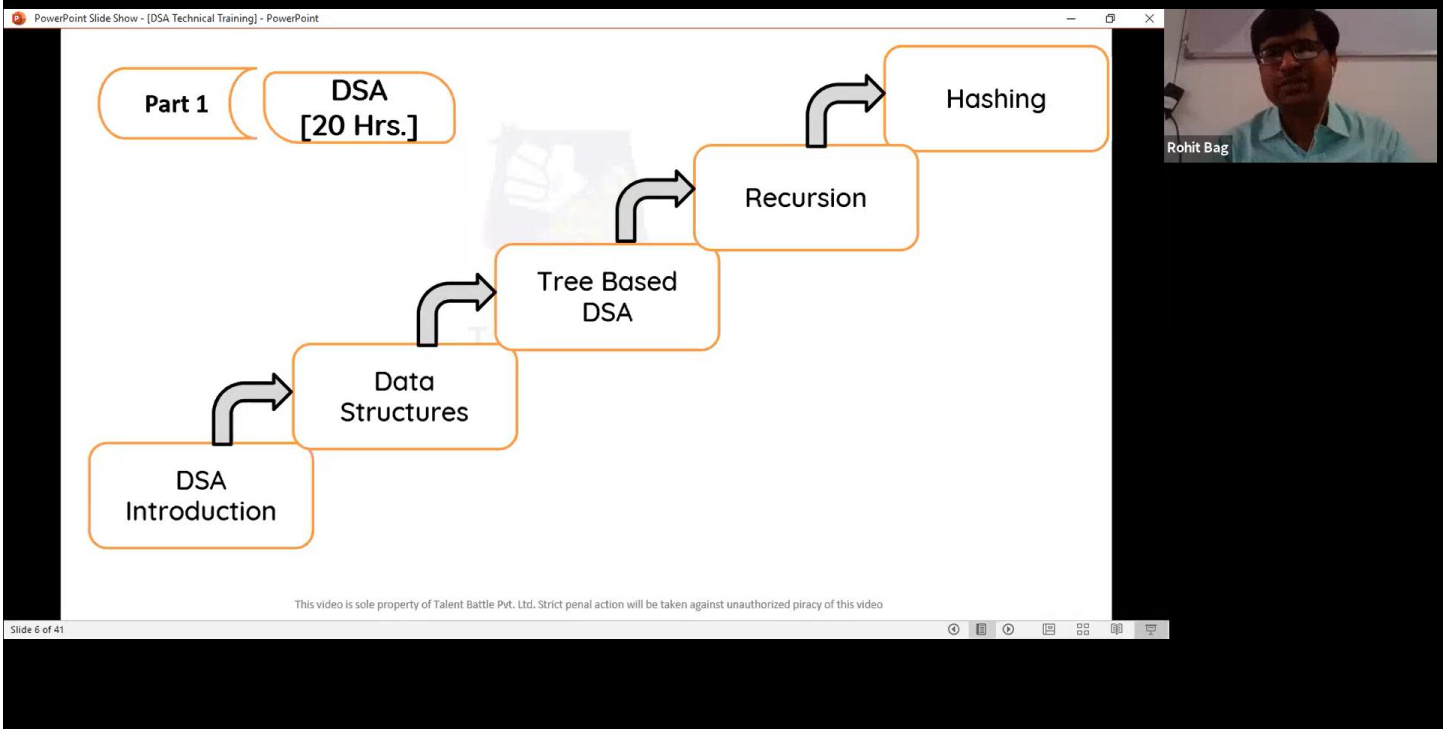
Day 1
Data Structures & Algorithms (using C++)
DSA Introduction Part 1

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Part 1
DSA
[20 Hrs.]
DSA Introduction
Data Structures
Tree Based DSA
Recursion
Hashing
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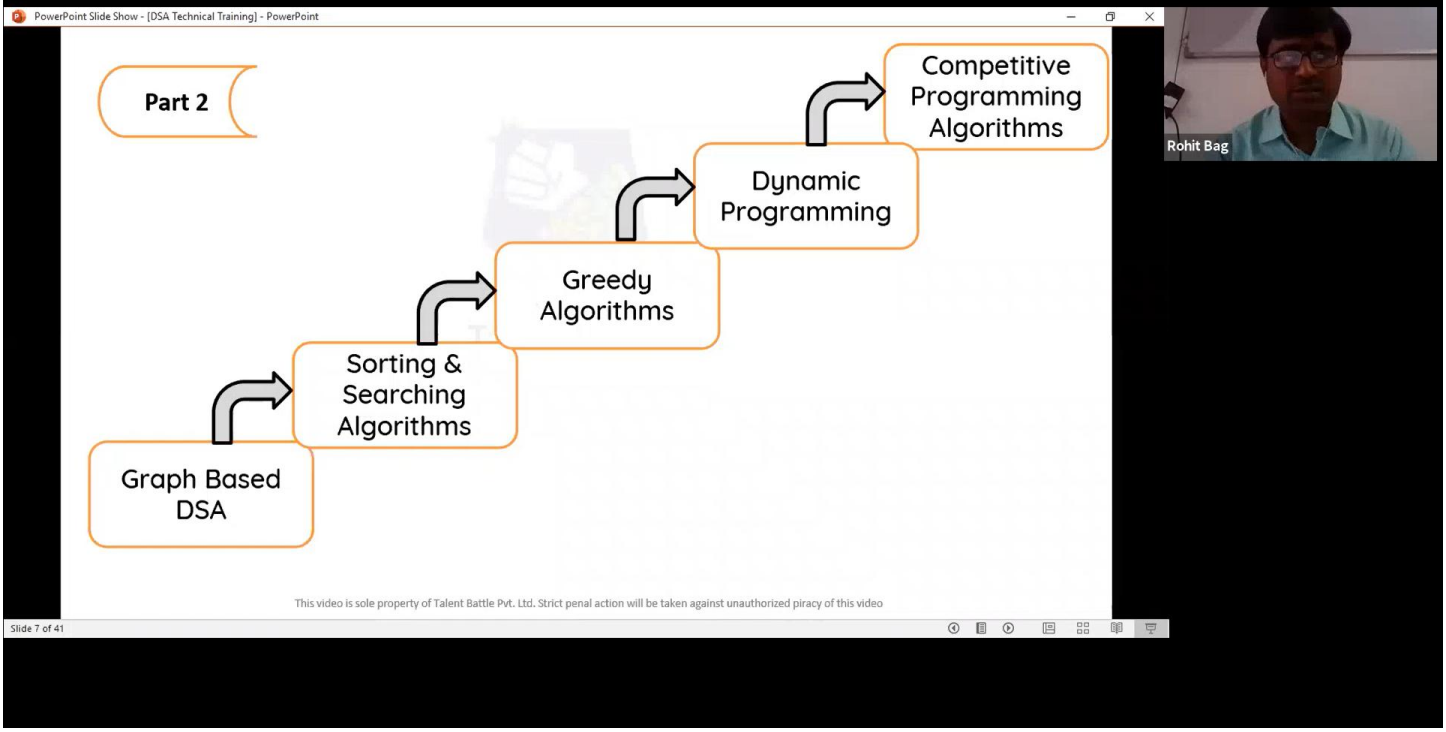
Slide 6 of 41
Rohit Bag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Part 2
Graph Based DSA
Sorting & Searching Algorithms
Greedy Algorithms
Dynamic Programming
Competitive Programming Algorithms
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## Introduction

- A computer program is a collection of instructions to perform a specific task. For this, a computer program may need to store data, retrieve data, and perform computations on the data.
- A data structure is a named location that can be used to store and organize data.






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## Good Computer Program

- Run efficiently and correctly.
- User friendly interface.
- Easy to read and understand.
- Easy to debug.
- Easy to modify.
- Easy to maintain.





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## Good Computer Program

Program consists of 2 things:

a) Algorithms

b) Data Structures

*Good program is combination of both.



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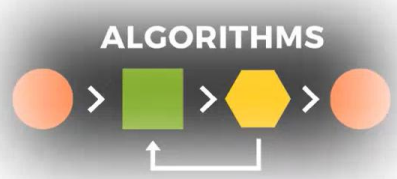
## Algorithm??

- An **algorithm** is a precise procedure for solving a problem in finite number of steps.
- An **algorithm** states the actions to be executed and the order in which these actions are to be executed.



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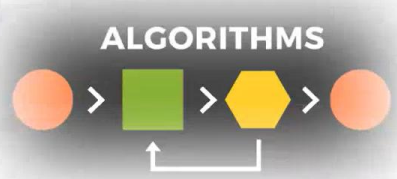
## Algorithmic Properties

- It must be correct.
- Composed of series of concrete steps.
- No ambiguity.
- Composed of finite number of steps.
- Must terminate.
- It takes zero or more inputs.
- It should use less memory space as much as possible.
- It results in one or more outputs.



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## How to develop algorithm?

- Defining the algorithm.
- Validating the algorithm.
- Expressing the algorithm.




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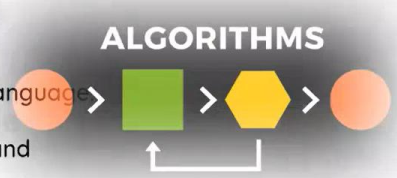
## Efficiency of an algorithm.

- Algorithms are programs in general form.
- It is an idea upon which program is designed.
- It should be independent of the programming language.
- Every programmer having enough knowledge and experience should understand it.
- It should be applicable to inputs of all sizes.



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## Efficiency of an algorithm.

- Efficiency of an algorithm denotes the rate at which an algorithm solves a problem of size n.
- Time and Space
- Time = no. of steps algorithm executes.
- Space = no. of unit memory storage it requires.
- Algorithm complexity calculation: Time taken & Space required.




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## Characteristics of an algorithm.

- ❑ Unambiguous
- ❑ Input
- ❑ Output
- ❑ Finiteness
- ❑ Feasibility
- ❑ Independent







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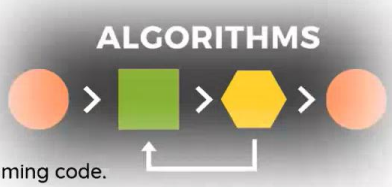
## How to write an Algorithm?




- ❑ It is problem and resource dependent.
- ❑ Algorithm are never written to support a particular programming code.
- ❑ Problem domain should be well defined.
- ❑ Example: Design an algorithm to add 2 numbers and display the result.

**Step 1** – START
**Step 2** – declare three integers **a**, **b** & **c**
**Step 3** – define values of **a** & **b**
**Step 4** – add values of **a** & **b**
**Step 5** – store output of step 4 to **c**
**Step 6** – print **c**
**Step 7** – STOP



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## Time Complexity of an algorithm.

- The time taken for an algorithm is comprised of:

  Compilation Time

  Run Time

- Compile time is the time taken to compile an algorithm.

  It checks syntax and semantic errors.

- Run time is the time to execute the compiled program.

Is runtime calculated only for executable statements or declaration statements?







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## Time Complexity of an algorithm.

- Time complexity of an algorithm is generally classified as three types:

  Worst Case

  Average Case

  Best Case







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## Time Complexity of an algorithm.

- **Worst Case**: Longest time that an algorithm will use to produce desired results.
- **Average Case** : Average time that the algorithm will use. It depends upon probability distribution.
- **Best Case**: Shortest time that the algorithm will use to produce desired results.







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## Space Complexity of an algorithm.

- Space complexity of the program is the amount of memory consumed.
- Fixed amount of memory.
- Variable amount of memory.
- Memory taken by instruction not in control of programmer.
- Memory taken by variable is in control of programmer.

  Datatype Array[size];







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## Space Complexity of an algorithm.

- There are 3 different spaces considered for determining the amount of memory used by the algo.

1. **Instruction Space**: occupied by compile version of program.
2. **Data Space**: used to hold variables, data structures, data elements.
3. **Environment Space**: used for run time stack on function call.




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## Problem Solving??

- A Programmer should identify all the requirements to solve the problem:

✓ Type of programming language
✓ Narration of the program describing tasks to be performed
✓ Frequency of processing
✓ Input & Output of the program
✓ Limitations & restrictions for the program
✓ Detailed specifications




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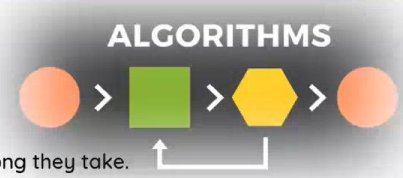
## Algorithm Analysis





- **Method 1**: Code each algorithm and run them to see how long they take.
  - **Problem**: How will you know there is better program?
- **Method 2**: Develop a model of the way computers work and compare how the algorithm behaves in the model.
- Able to distinguish between good and bad algorithms.



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## How to measure algorithm performance?


- Length of the program (LOC)
- Ease of programming (bugs, maintenance)
- Memory required
- Running time




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## Importance of studying Algorithm?

- Interview Preparations : provides competitive advantage during job search process.
- Keeping your programming skills sharp.

"Practice makes Perfect"


- Long term career goals.

**"Practicing algorithms will increase your skill and your visibility at work".**



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## Summary

- Introduction
- Good Computer Program
- DSA Introduction
- Algorithm
- Algo. Properties
- How to develop algo.
- Efficiency of algo.
- Characteristics of algo.
- How to write an algo.
- Time complexity
- Space complexity
- Problem solving
- Algorithm Analysis
- How to measure algo. Performance
- Importance of studying algorithm




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