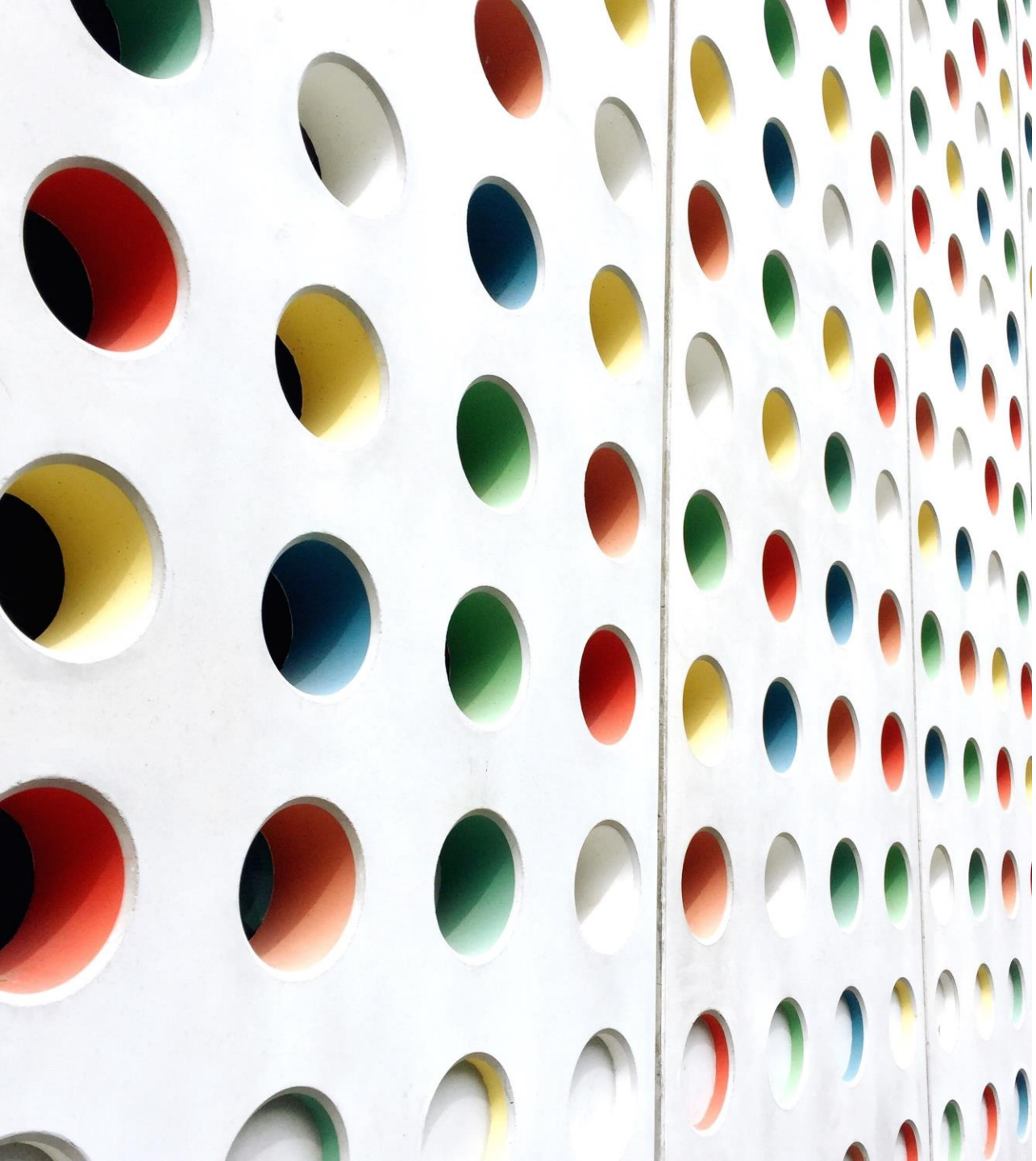


2006

MAPÚA
MALAYAN COLLEGES
LAGUNA

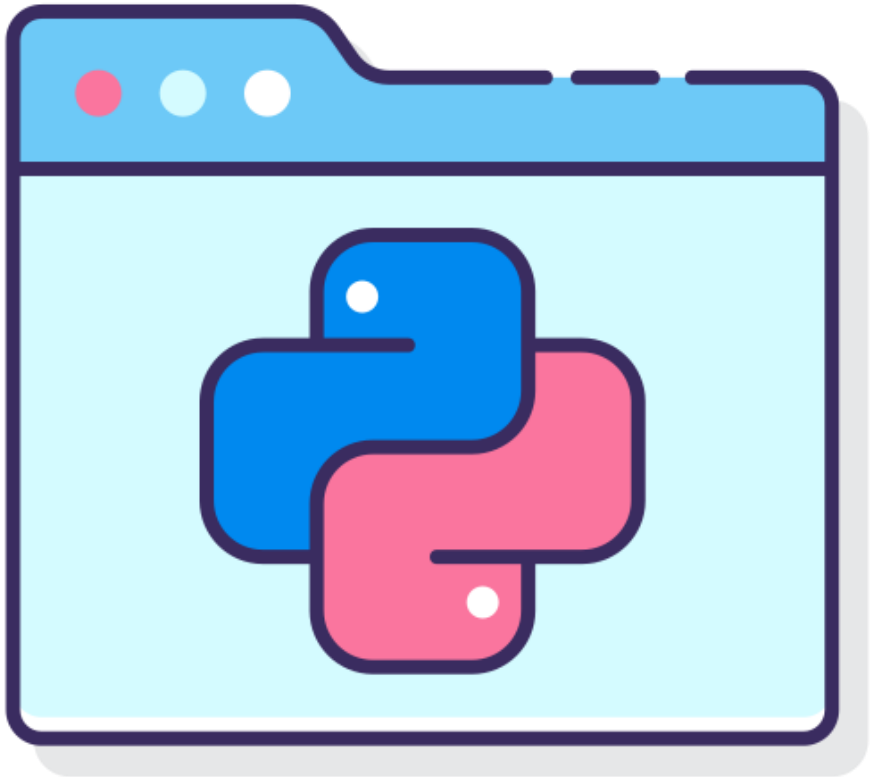
EXCELLENCE AND VIRTUE

3rd Term 2023-2024

CCIS

COLLEGE OF COMPUTER
AND INFORMATION SCIENCE
MAPÚA MALAYAN COLLEGES LAGUNA

CS121- MODULE 1.0
Topic 1.1 Role of Algorithms



Learning Outcome :

CO1. Classify different characteristics and behaviors of fundamental algorithm techniques.

Topic Content

OVERVIEW OF DESIGN AND ANALYSIS OF ALGORITHMS

NEEDS OF ALGORITHM ANALYSIS AND THE DIFFERENT TYPES

APPLICATIONS AND COMPLEXITY OF ALGORITHMS

Overview – Design and Analysis of Algorithms

- Design and analysis of algorithms is a essential course of computer science technology that deals with developing and studying efficient algorithms for fixing computational issues.
- It prerequisites several steps, which includes problem formulation, algorithm layout, algorithm analysis, and algorithm optimization.
- **Problem formulation process** identifies the computational problem to be solved as well as specifying the input and output criteria.
- **Algorithm design process** creates a set of instructions that a computer can use to solve the problem.
- **Algorithm analysis process** determines the method's efficiency in terms of time and space complexity.
- **Algorithm optimization process** involves enhancing the method's efficiency by making changes to the design or implementation.

Overview - Design and Analysis of Algorithms

- Several strategies for any algorithm's design and evaluation, including *brute force algorithms, divide and conquer algorithms, dynamic programming, and greedy algorithms.*
- Each method has its very own strengths and weaknesses, and the choice of approach depends on the nature of the problem being solved.
- The **time complexity** of an algorithm refers to the amount of time it takes to clear up a problem as a characteristic of the input size.
- The **space complexity** of an algorithm refers to the quantity of memory required to solve a problem as a function of the enter length.

First of Bit of History – Design and Analysis of Algorithms

- The word algorithm has been derived from the Persian author's name, **Abu Ja 'far Mohammed ibn Musa al Khowarizmi (c. 825 A.D.),** who has written a textbook on Mathematics.
- The word is taken based on providing a special significance in computer science.
- The algorithm is understood as a method that can be utilized by the computer as when required to provide solutions to a particular problem.

Advantages - Design and Analysis of Algorithms

- **Improved efficiency**: A properly designed algorithm can notably improve the performance of a program, leading to quicker execution instances and reduced resource utilization.
- **Better scalability**: As the size of the input information will increase, poorly designed algorithms can quickly turn out to be unmanageable, leading to slow execution times and crashes.
- **Improved code exceptional:** A nicely designed algorithm can result in better code first-rate standard, because it encourages developers to think seriously about their application's shape and organization
- **Increased innovation:** By knowing how algorithms work and how they can be optimized, developers can create new and progressive solutions to complex problems.
- **Competitive benefit:** In industries where pace and performance are vital, having properly designed algorithms can provide an extensive competitive advantage.

Need of Algorithms - Design and Analysis of Algorithms

1. To understand the basic idea of the problem.

2. To find an approach to solve the problem.

3. To improve the efficiency of existing techniques.

4. To understand the basic principles of designing the algorithms.

5. To compare the performance of the algorithm with respect to other techniques.

6. It is the best method of description without describing the implementation detail.

7. The Algorithm gives a clear description of requirements and goal of the problem to the designer.

Need of Algorithms - Design and Analysis of Algorithms

8. A good design can produce a good solution.

9. To understand the flow of the problem.

10. To measure the behavior (or performance) of the methods in all cases (best cases, worst cases, average cases)

11. Identify the resources (memory, input-output) cycles required by the algorithm.

12. With the help of algorithm, we convert art into a science.

13. To understand the principle of designing.

14. It measures and analyze the complexity (time and space) of the problems concerning input size without implementing and running it; it will reduce the cost of design.

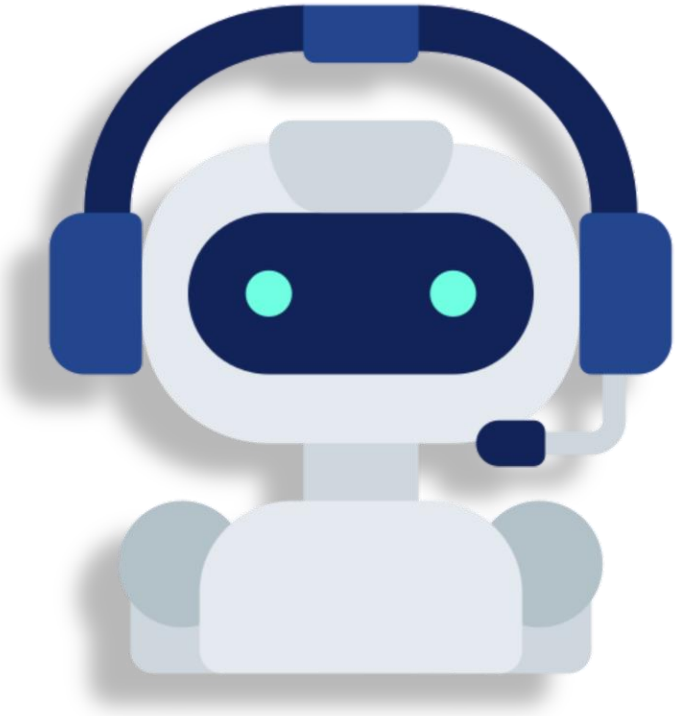
Algorithm Analysis - Design and Analysis of Algorithms

- Algorithm analysis refers to how to investigate the effectiveness of the algorithm in terms of time and space complexity.
- The fundamental purpose of algorithm evaluation is to decide how much time and space an algorithm needs to solve the problem as a feature of the scale of the input.
- The time complexity of an algorithm is typically measured in phrases of the wide variety of simple operations (which includes comparisons, assignments, and mathematics operations) that the algorithm plays at the enter records.
- The spatial complexity of an algorithm refers to the quantity of reminiscence the algorithm needs to solve the problem as a function of the size of the input.

Essentials of Algorithm Analysis - Design and Analysis of Algorithms

- To forecast the behavior of an algorithm without putting it into action on a specific computer.
- It is far more convenient to have basic metrics for an algorithm's efficiency than to develop the algorithm and access its efficiency each time a specific parameter in the underlying computer system changes.
- It is hard to predict an algorithm's exact behavior. There are far too many variables to consider.
- As a result, the analysis is simply an approximation; it is not perfect.
- More significantly, by comparing several algorithms, we can identify which one is ideal for our needs.

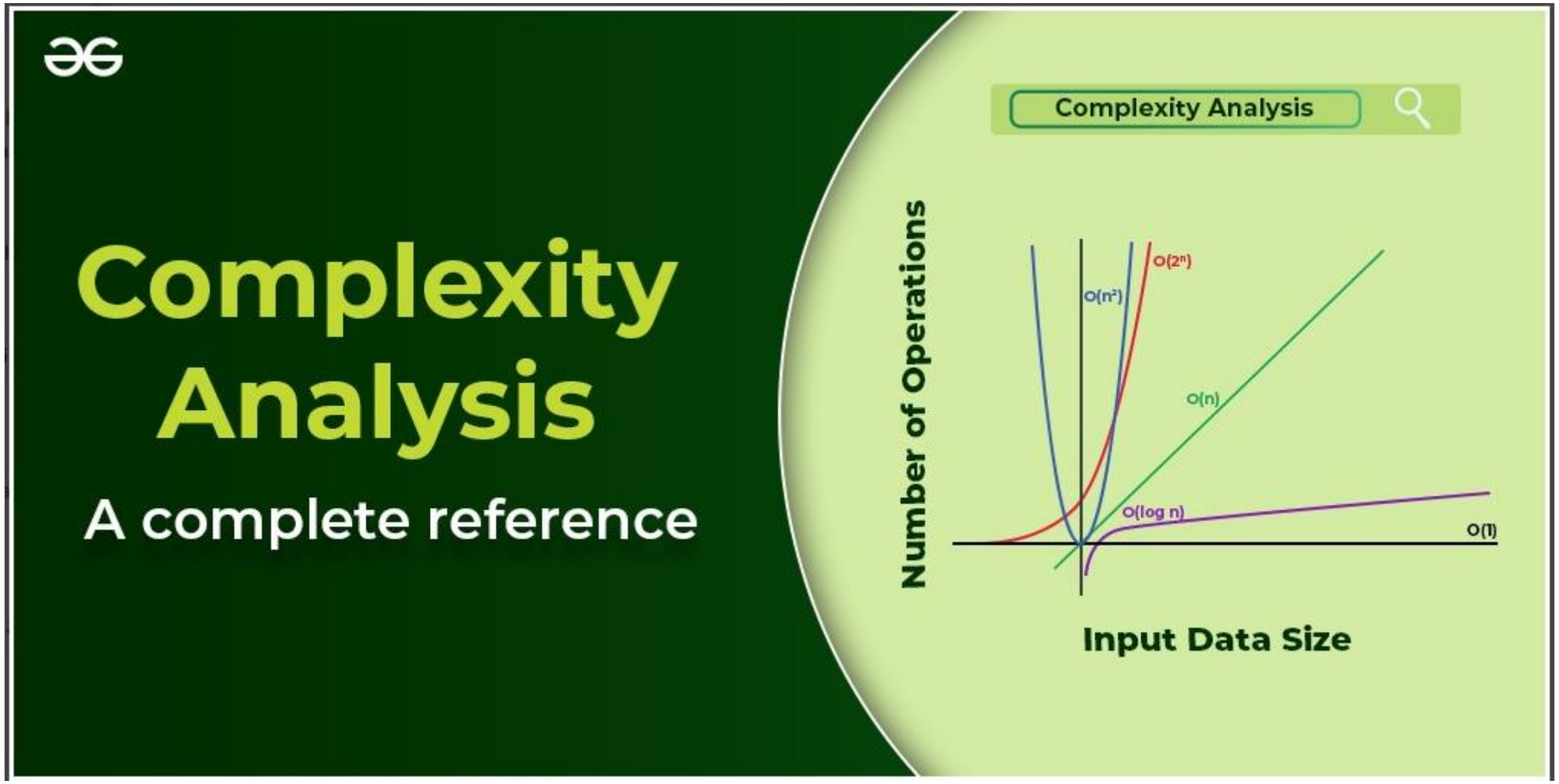
Do you have any questions?



Types of Algorithm Analysis - Design and Analysis of Algorithms

- **Time complexity evaluation**: measures the running time of an algorithm as a characteristic of the input length.
- **Space complexity evaluation**: measures the amount of memory required via an algorithm as a characteristic of the enter size
- **Worst-case evaluation**: measures the worst-case running time or space utilization of an algorithm.
- **Average-case analysis**: measures the predicted walking time or area usage of an algorithm, assuming a probabilistic distribution of inputs.
- **Best-case evaluation**: measures the nice case running time or area utilization of an algorithm, assuming the input is the easiest possible for the algorithm to address.
- **Asymptotic analysis**: measures the overall performance of an algorithm as the enter size methods infinity.

Complexity of Algorithms - Design and Analysis of Algorithms



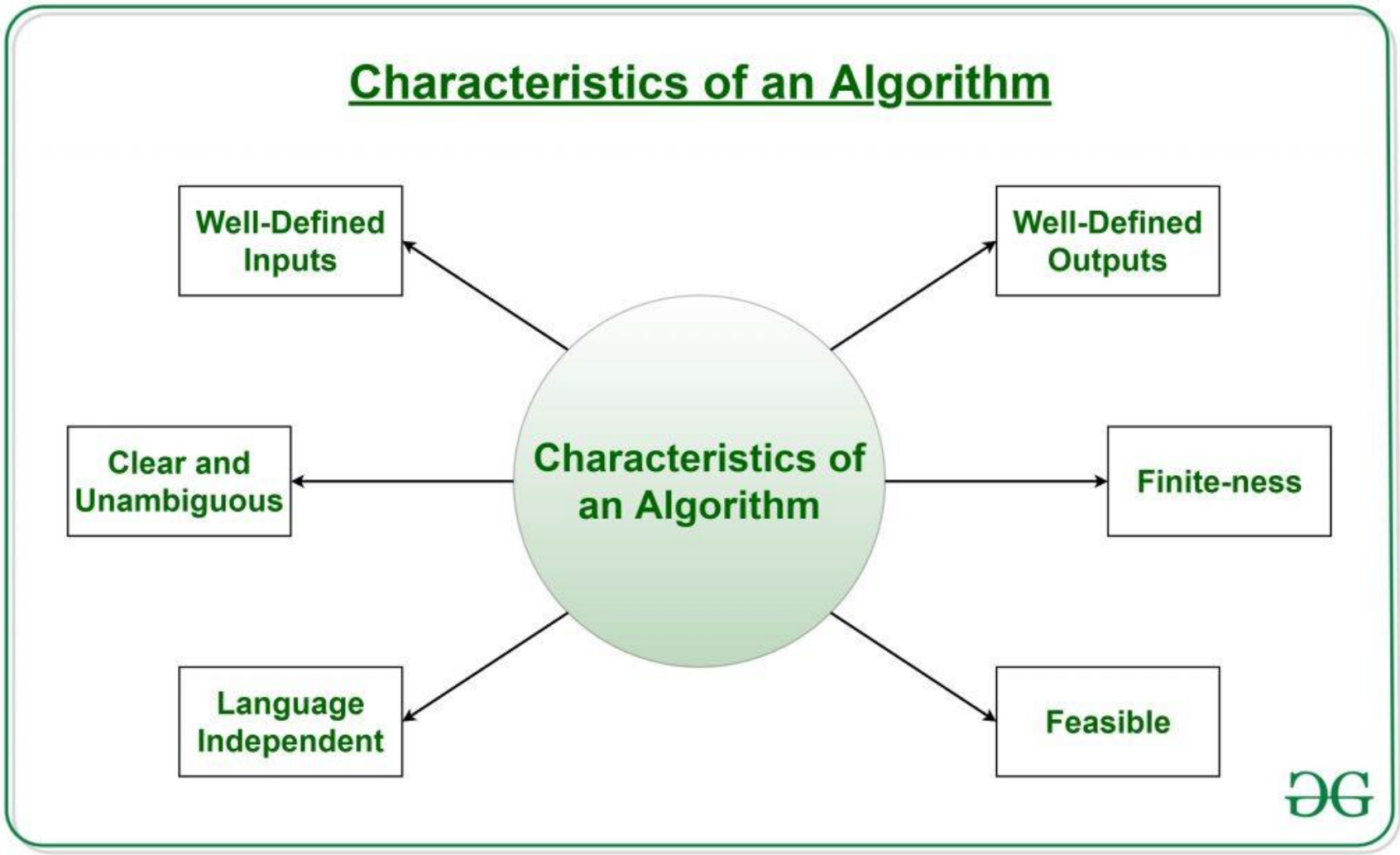
Complexity of Algorithms - Design and Analysis of Algorithms

- Complexity analysis is defined as a technique to characterize the time taken by an algorithm with respect to input size (independent from the machine, language and compiler).
- It is used for evaluating the variations of execution time on different algorithms.
- Complexity Analysis determines the amount of time and space resources required to execute it.
- It is used for comparing different algorithms on different input sizes.
- Complexity helps to determine the difficulty of a problem.
- Often measured by how much time and space (memory) it takes to solve a particular problem.

Complexity of Algorithms - Design and Analysis of Algorithms

- The term algorithm complexity measures how many steps are required by the algorithm to solve the given problem.
- It evaluates the order of count of operations executed by an algorithm as a **function of input data size.**
- To assess the complexity, the order (approximation) of the count of operation is always considered instead of counting the exact steps.
- O(f) notation represents the complexity of an algorithm, which is also termed as an **Asymptotic notation** or **"Big O" notation.**
- The complexity of the asymptotic computation O(f) determines in which order the resources such as CPU time, memory, are consumed by the algorithm that is articulated as a function of the size of the input data.
- The complexity can be found in any form such as **constant, logarithmic, linear, n*log(n), quadratic, cubic, exponential**, and make it even more precise, the complexity of an algorithm as **"running time".**

Complexity of Algorithms - Design and Analysis of Algorithms



Applications - Design and Analysis of Algorithms

Algorithms are central to computer science and are used in many different fields.

- **Search engines**: Google and other search engines use complex algorithms to index and rank websites, ensuring that users get the most relevant search results.
- **Machine Learning:** Machine learning algorithms are used to train computer programs to learn from data and make predictions in applications such as image recognition, speech recognition, and natural language processing.
- **Cryptography:** Cryptographic algorithms are used to secure data transmission and protect sensitive information such as credit card numbers and passwords.
- **Optimization:** Optimization algorithms are used to find the optimal solution to a problem, such as the shortest path between two points or the most efficient resource allocation path.

Applications - Design and Analysis of Algorithms

- **Finance:** Algorithms are used in finance for applications such as risk assessment, fraud detection, and frequent trading.
- **Games:** Game developers use artificial intelligence and algorithms to navigate, allowing game characters to make intelligent decisions and navigate game environments more efficiently
- **Data Analytics**: Data analytics applications use algorithms to process large amounts of data and extract meaningful insights, such as trends and patterns.
- **Robotics:** Robotics algorithms are used to control robots and enable them to perform complex tasks such as recognizing and manipulating objects.

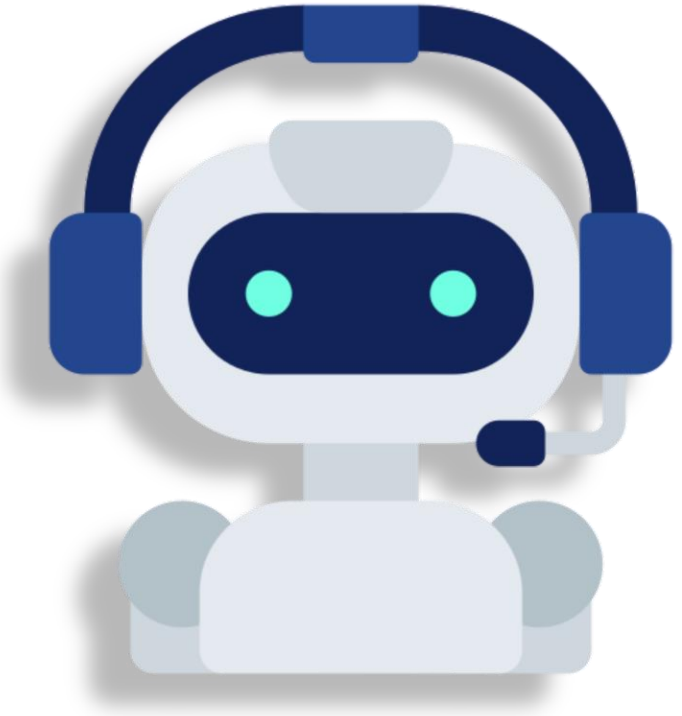
Summary - Design and Analysis of Algorithms

- An algorithm can be defined as a finite set of steps, which has to be followed while carrying out a particular problem. It is nothing but a process of executing actions step by step.
- An algorithm is a distinct computational procedure that takes input as a set of values and results in the output as a set of values by solving the problem.
- An algorithm can be described by incorporating a natural language such as English, Computer language, or a hardware language.

Summary - Design and Analysis of Algorithms

- The speed of processor increases, performance is frequently said to be less central than other software quality characteristics (e.g. security, extensibility, reusability etc.).
- Large problem sizes are commonplace in the area of computational science, which makes performance a very important factor.
- Longer computation time, to name a few mean slower results, less through research and higher cost of computation.
- *The study of Algorithm, therefore, gives us a language to express performance as a function of problem size.*

Do you have any questions?

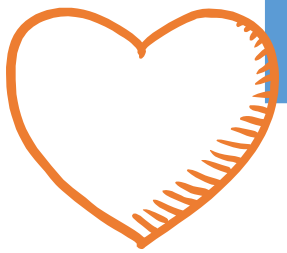


Student Assessment Task

- Pro Active !
- Check BBL all the time
- Always read the Announcement

References

- JAVATPoint
- GeeksforGeeks
- TutorialPoint



Merci!

Any questions?

You may send your question in MS Teams Account

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