

# Analysis and Design of Algorithms

## Introduction to Algorithms

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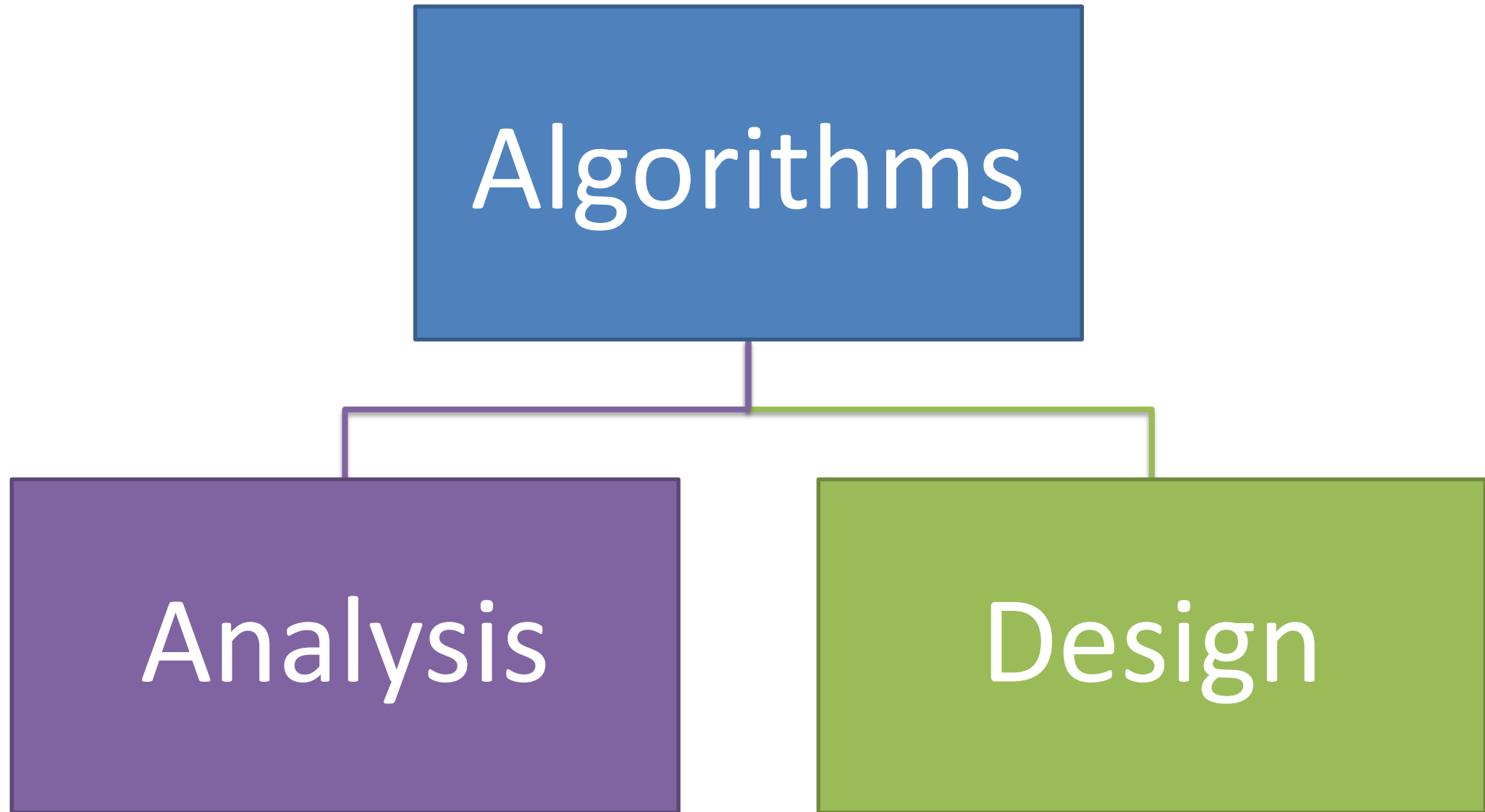
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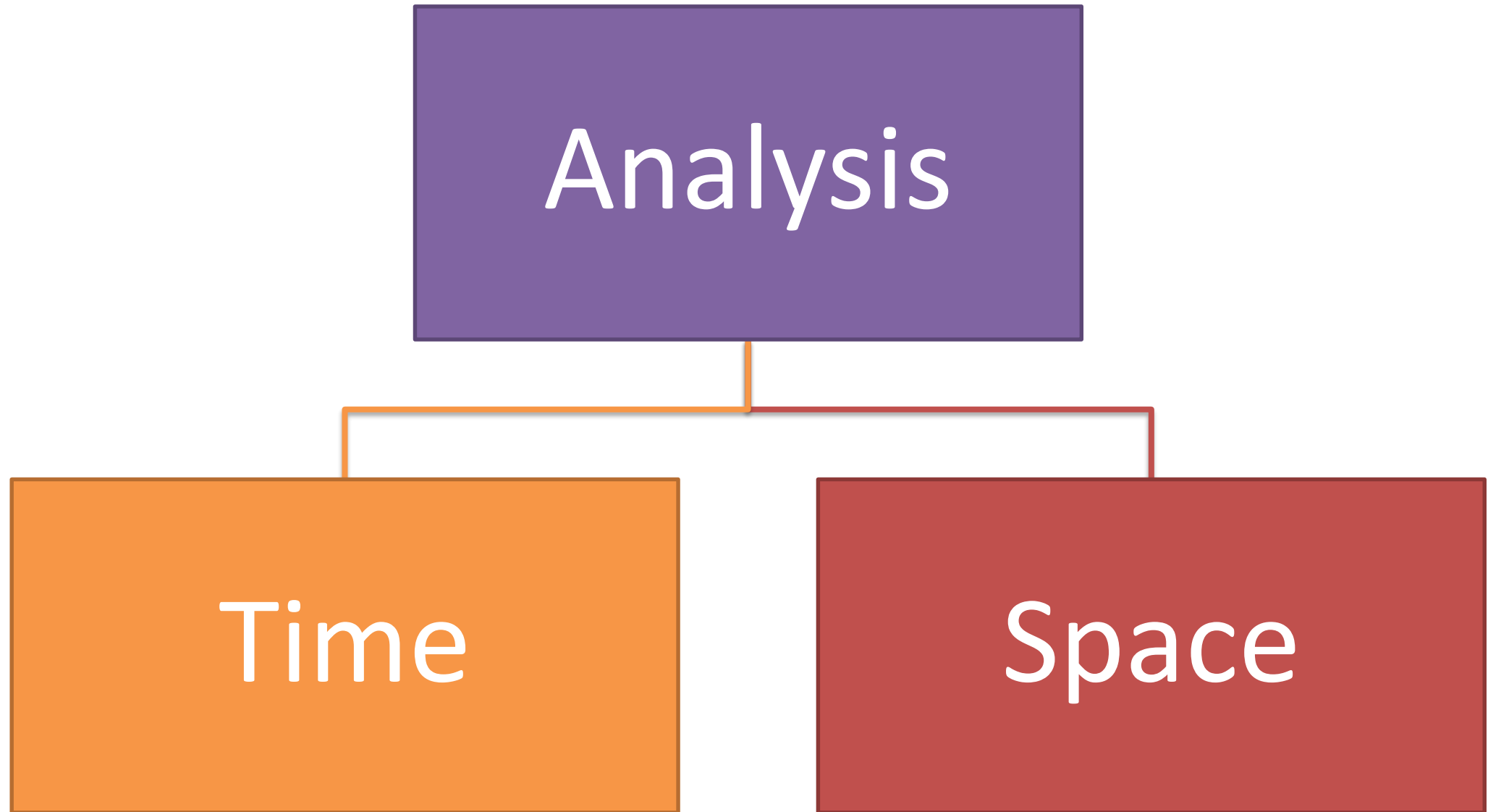
# Algorithms

- ❑ An algorithm is a set of steps of operations to solve a problem performing calculation, data processing, and automated reasoning tasks.
- ❑ An algorithm is the best way to represent the solution of a particular problem in a very simple and efficient way.



# Algorithms

- Analysis: predict the cost of an algorithm in terms of resources and performance
- Design: creating an efficient algorithm to solve a problem in an efficient way using minimum time and space.



# Time Complexity & Space Complexity

- ❑ Time Complexity is a function describing the amount of time required to run an algorithm in terms of the size of the input.
- ❑ Space Complexity is a function describing the amount of memory an algorithm takes in terms of the size of input to the algorithm.

# Time Complexity & Space Complexity

## □ Time Complexity

What make algorithm “fast”?

## □ Space Complexity

How much **memory** is used?

# Algorithms

- ❑ Input: sequence  $\langle a_1, a_2, \dots, a_n \rangle$  of numbers.
- ❑ Output: permutation  $\langle a'_1, a'_2, \dots, a'_n \rangle$  such that
$$a'_1 \leq a'_2 \leq \dots \leq a'_n .$$

**Example:**

<b>Input</b>	<b>8</b>	<b>12</b>	<b>5</b>	<b>9</b>	<b>2</b>
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<b>Output</b>	<b>2</b>	<b>5</b>	<b>8</b>	<b>9</b>	<b>12</b>
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# Algorithm vs Pseudocode

- ❑ An algorithm is a formal definition with some specific characteristics that describes a process. Generally, the word "algorithm" can be used to describe any high level task in computer science.
- ❑ Pseudocode is an informal and human readable description of an algorithm leaving many details of it. Writing a pseudocode has no restriction of styles and its only objective is to describe the high level steps of algorithm.

# Algorithm vs Pseudocode

## □ Algorithm: Selection Sort

**Input:** A list  $L$  of integers of length  $n$

**Output:** A sorted list  $L_1$  containing those integers present in  $L$

**Step 1:** Find the minimum value in the list  $L$

**Step 2:** Swap it with the value in the current position

**Step 3:** Repeat this process for all the elements until the entire list is sorted

**Step 4:** Return the sorted list  $L_1$

**Step 5:** Stop

# Algorithm vs Pseudocode

## □ Pseudocode : Selection Sort

for  $j \leftarrow 1$  to  $n-1$

    smallest  $\leftarrow j$

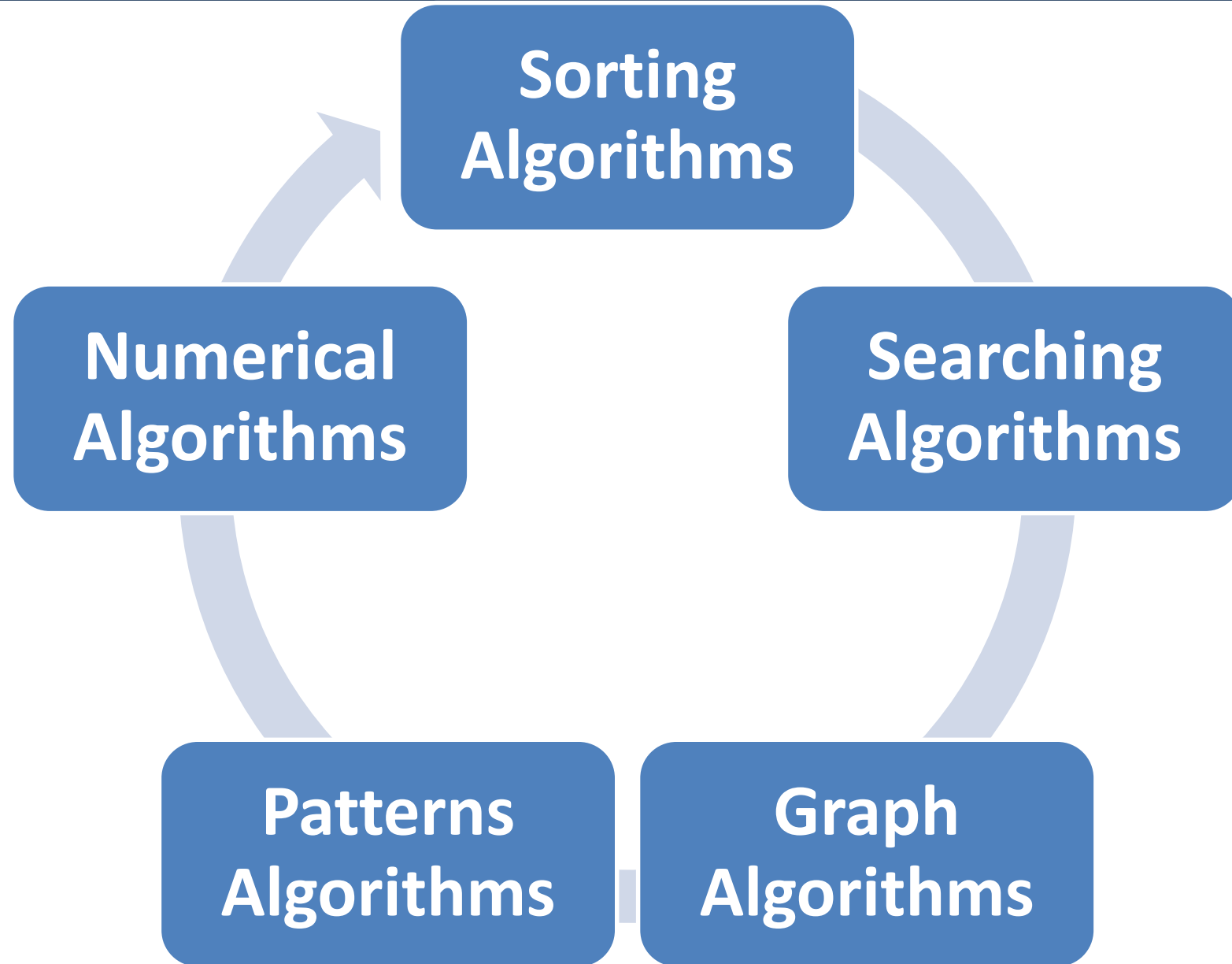
        for  $i \leftarrow j + 1$  to  $n$

            if  $A[i] < A[\text{smallest}]$

                smallest  $\leftarrow i$

        Exchange  $A[j] \leftrightarrow A[\text{smallest}]$

# Some Algorithm Types



# Some Algorithm Types

- ❑ **Sorting Algorithms** are to rearrange the items of a given list in non decreasing order.
- ❑ **Searching Algorithms** deal with finding a given value, called a search key, in a given set.

# Some Algorithm Types

- ❑ **Pattern (String) Algorithms** deal with string which comprise letters, numbers, and special characters; bit strings, which comprise zeros and ones; and gene sequences
  
- ❑ **Numerical Algorithms** deal with mathematical problems that solving equations and systems of equations, computing definite integrals ,evaluating functions, and so on.

# Some Algorithm Types

- **Graph Algorithms** deal with graphs. Graph can be thought of as a collection of points called vertices, some of which are connected by line segments called edges. Graphs can be used for modeling a wide variety of applications, including transportation, communication, social and economic networks, project scheduling, and games.