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Linear vs Non-Linear data structure

What is Data structure?

A data structure is a technique of storing and organizing the data in such a way that the data can be utilized in an efficient manner. In computer science, a data structure is designed in such a way that it can work with various algorithms. A data structure is classified into two categories:

- Linear data structure
- Non-linear data structure

Now let's have a brief look at both these data structures.

What is the Linear data structure?

A linear data structure is a structure in which the elements are stored sequentially, and the elements are connected to the previous and the next element. As the elements are stored sequentially, so they can be traversed or accessed in a single run. The implementation of linear data structures is easier as the elements are sequentially organized in memory. The data elements in an array are traversed one after another and can access only one element at a time.

The types of linear data structures are Array, Queue, Stack, Linked List.

Let's discuss each linear data structure in detail.

- **Array:** An array consists of data elements of a same data type. For example, if we want to store the roll numbers of 10 students, so instead of creating 10 integer type variables, we will create an array having size 10. Therefore, we can say that an array saves a lot of memory and reduces the length of the code.

- **Stack:** It is linear data structure that uses the LIFO (Last In-First Out) rule in which the data added last will be removed first. The addition of data element in a stack is known as a push operation, and the deletion of data element form the list is known as pop operation.

- **Queue:** It is a data structure that uses the FIFO rule (First In-First Out). In this rule, the element which is added first will be removed first. There are two terms used in the queue **front** end and **rear** The insertion operation performed at the back end is known ad enqueue, and the deletion operation performed at the front end is known as

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○ **Linked list:** It is a collection of nodes that are made up of two parts, i.e., data element and reference to the next node in the sequence.

## What is a Non-linear data structure?

A non-linear data structure is also another type of data structure in which the data elements are not arranged in a contiguous manner. As the arrangement is nonsequential, so the data elements cannot be traversed or accessed in a single run. In the case of linear data structure, element is connected to two elements (previous and the next element), whereas, in the non-linear data structure, an element can be connected to more than two elements.

Trees and **Graphs** are the types of non-linear data structure.

Let's discuss both the data structures in detail.

○ **Tree**

It is a non-linear data structure that consists of various linked nodes. It has a hierarchical tree structure that forms a parent-child relationship. The diagrammatic representation of a **tree** data structure is shown below:
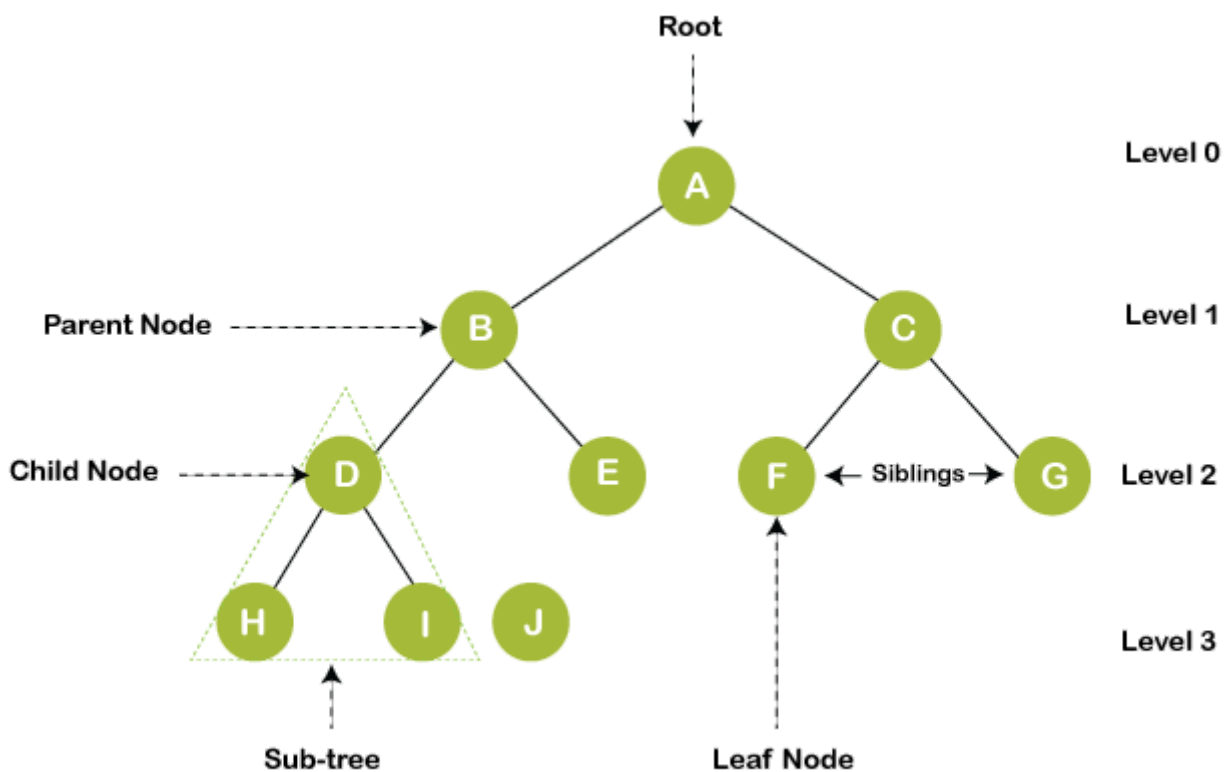
For example, the posts of employees are arranged in a tree data structure like managers, officers, clerk. In the above figure, **A** represents a manager, **B** and **C** represent the officers, and t the clerks.

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- **Graph**

A graph is a non-linear data structure that has a finite number of vertices and edges, and these edges are used to connect the vertices. The vertices are used to store the data elements, while the edges represent the relationship between the vertices. A graph is used in various real-world problems like telephone networks, circuit networks, social networks like LinkedIn, Facebook. In the case of facebook, a single user can be considered as a node, and the connection of a user with others is known as edges.
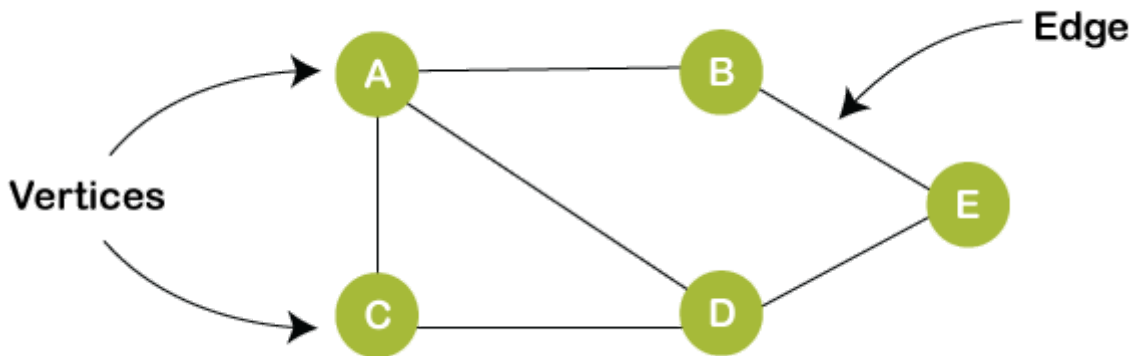
Differences between the Linear data structure and non-linear data structure.
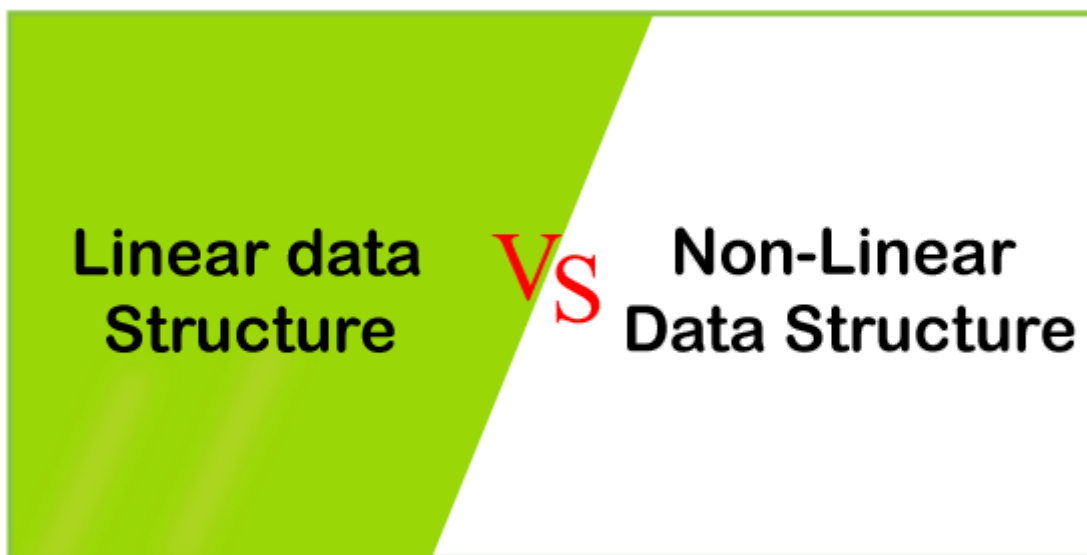
	Linear Data structure	Non-Linear Data structure
Basic	In this structure, the elements are arranged sequentially or linearly and attached to one another.	In this structure, the elements are arranged hierarchically or non-linear manner.

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Types	Arrays, linked list, stack, queue are the types of a linear data structure.	Trees and graphs are the types of a non-linear data structure.
implementation	Due to the linear organization, they are easy to implement.	Due to the non-linear organization, they are difficult to implement.
Traversal	As linear data structure is a single level, so it requires a single run to traverse each data item.	The data items in a non-linear data structure cannot be accessed in a single run. It requires multiple runs to be traversed.
Arrangement	Each data item is attached to the previous and next items.	Each item is attached to many other items.
Levels	This data structure does not contain any hierarchy, and all the data elements are organized in a single level.	In this, the data elements are arranged in multiple levels.
Memory utilization	In this, the memory utilization is not efficient.	In this, memory is utilized in a very efficient manner.
Time complexity	The time complexity of linear data structure increases with the increase in the input size.	The time complexity of non-linear data structure often remains same with the increase in the input size.
Applications	Linear data structures are mainly used for developing the software.	Non-linear data structures are used in **image processing** and **Artificial Intelligence**.

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