INTRODUCTION TO DATA STRUCTURES

Lesson 1 – Data Structures and Algorithm

MR. ROWELL L. MARQUINA

IT Instructor, PUP Biñan

WHAT IS A DATA STRUCTURE?

What is Data?

Data is a set of discrete or continuous values that convey information by representing quantity, quality, fact, statistics, or other basic units of meaning, or simply sequences of symbols that can be formally understood.

It is commonly arranged into tables to provide more context and definition to it.

IMAGE SOURCE: https://businessfig.com/wp-content/uploads/2023/02/how-to-learn-big-data-7-places-to-start-in-2022.jpg

What is Data?

The term "data" was first used to refer to "transmissible and storable computer information" in 1946.

Examples of Data:

- name
- height
- address
- temperature
- salary
- device model number

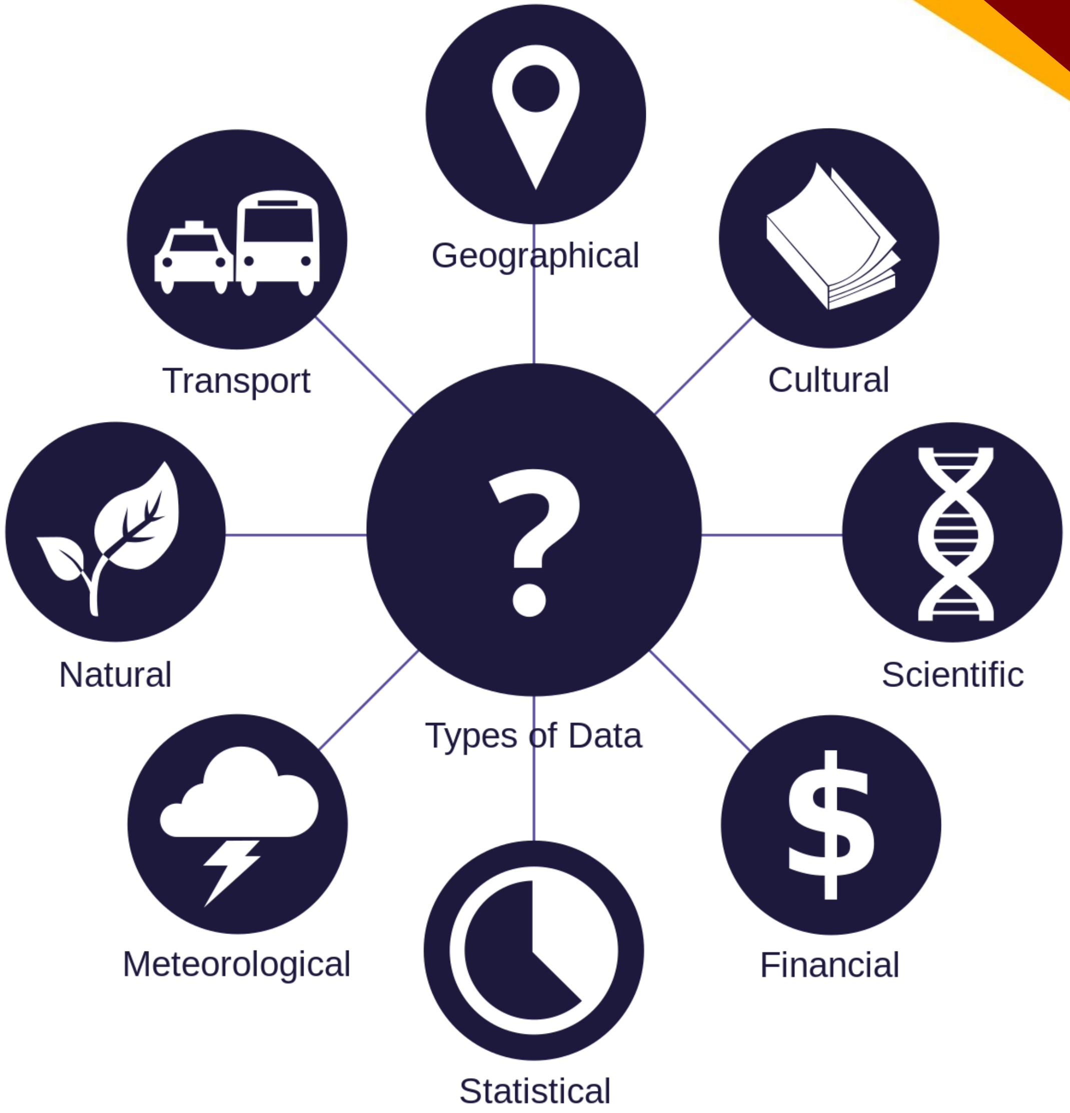


IMAGE SOURCE: https://upload.wikimedia.org/wikipedia/commons/thumb/6/6d/Data_types_-_en.svg/1200px-Data_types_-_en.svg.png

What is Data Structure?

Data Structure is a branch of computer Science that deals with how data can be stored, organized, and retrieved in the most efficient way possible.

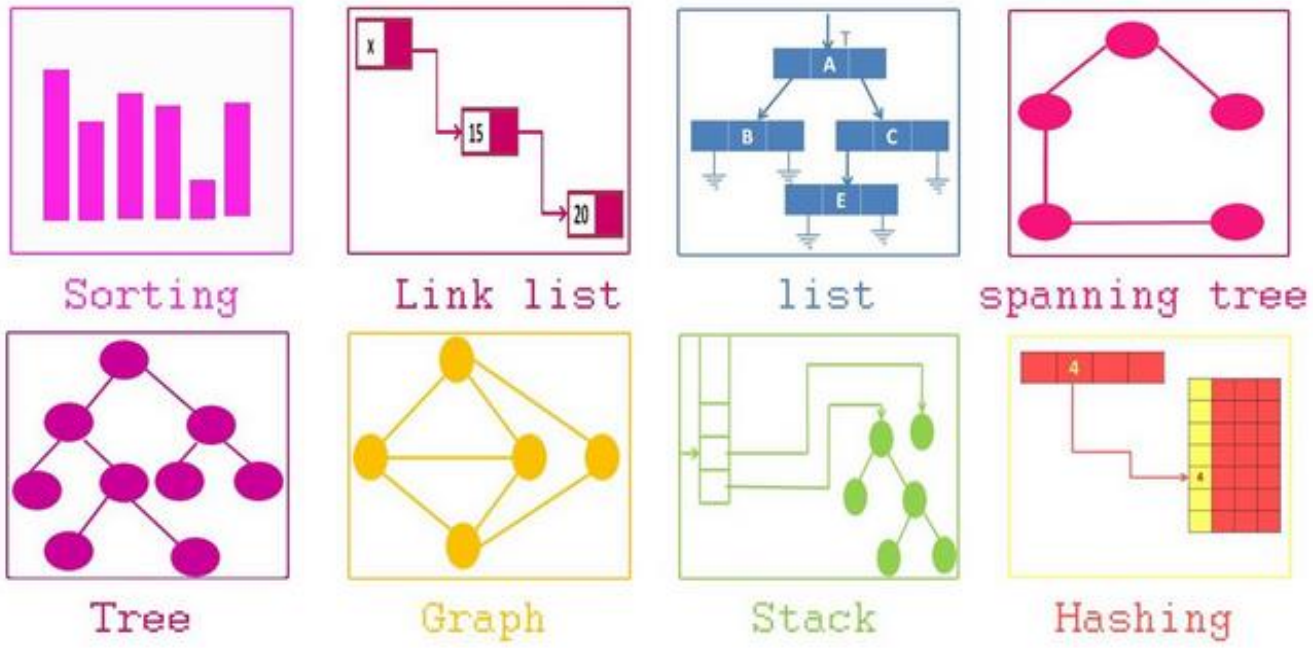


IMAGE SOURCE: https://miro.medium.com/v2/resize:fit:753/1*3hSAy-MRkYgKIp6ybUdjjw.png

WHY LEARN DATA STRUCTURE AND ALGORITHM?

Why Learn Data Structure?

Two of the most significant areas of computer science are data structure and algorithms.

- Proficiency in data structures enable us to organize and store data in the most efficient way possible.
- Proficiency in algorithms enable us to process that data more meaningfully.

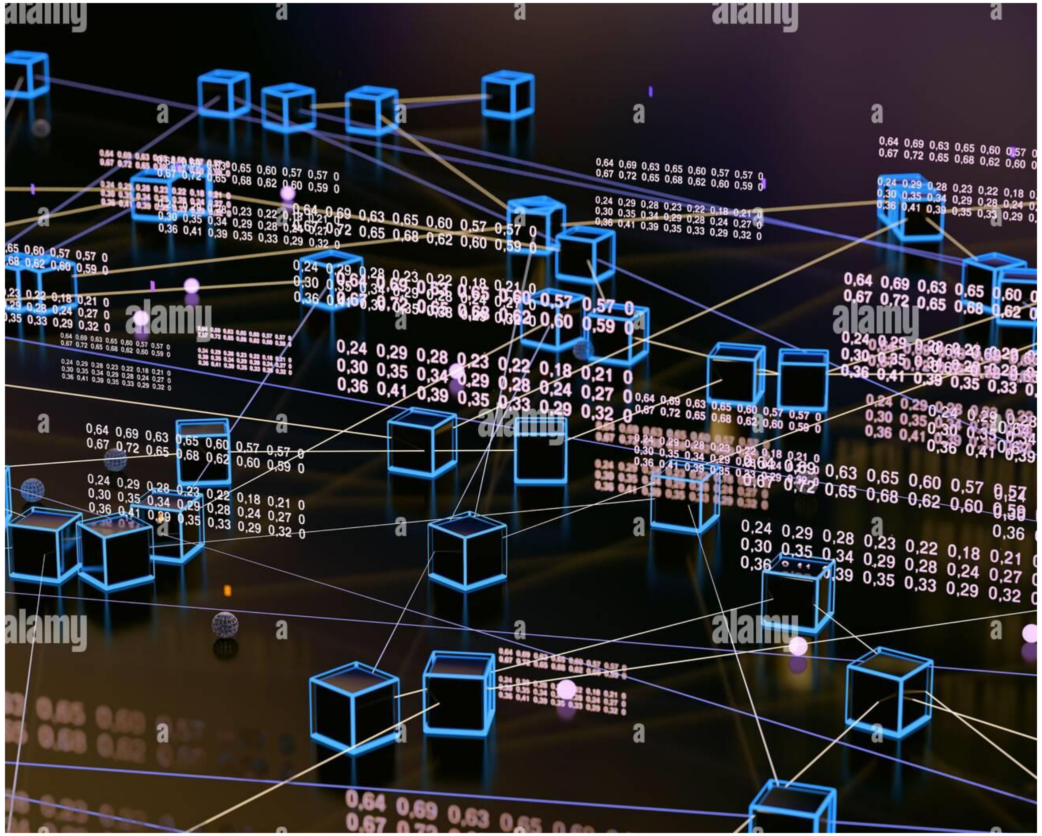


IMAGE SOURCE: https://c8.alamy.com/comp/2DAKBX0/data-volume-analysis-and-computer-science-industry3d-illustrationdata-structure-and-information-tools-for-networking-business-2DAKBX0.jpg

OBJECTIVES OF DATA STRUCTURE

CORRECTNESS

It entails that the data structure implementation should always adhere to the set specifications and the outputs is grounded in the expectations set for the program.

EFFICIENCY

Data structures must also be efficient. It should process data fast without consuming a lot of computer resources, such as memory space.

FEATURES OF DATA STRUCTURE:

ROBUSTNESS

All computer program must yield accurate responses for every possible input by the user. Programs should be able to respond accurately with valid and invalid inputs.

ADAPTABILITY

Computer programs are expected to be able to adjust to evolving technologies and industry conventions.

REUSABILITY

Computer programs must be able to reuse the resources they use to help future applications.

OPERATIONS ON DATA STRUCTURES

OPERATIONS ON DATA STRUCTURE

There are six operations involving Data Structures:

- Searching
- Insertion
- Deletion
- Sorting
- Merging
- Updating

OPERATIONS ON DATA STRUCTURE

SEARCHING

Searching is the process of locating a certain data within a given data structure.

INSERTION

Insertion refers to the method of adding a new element to a data structure.

DELETION

Deletion is a method use to remove data from a data structures.

SORTING

Sorting is the action of organizing the data elements in a data structure in a predetermined order (ascending or descending).

OPEARTIONS ON DATA STRUCTURES

MERGING

Merging can be considered simply appending a group of elements from one data structure after elements from another data structure with the same element structure.

UPDATING

Updating is a method where a data structure is revisited for performing specific changes.

CLASSIFICATION OF DATA STRUCTURES

CLASSIFICATION OF DATA STRUCTURES

Data Structures can be classified into two categories:

- **Primitive Data Structure**
- **Non-Primitive Data Structure**

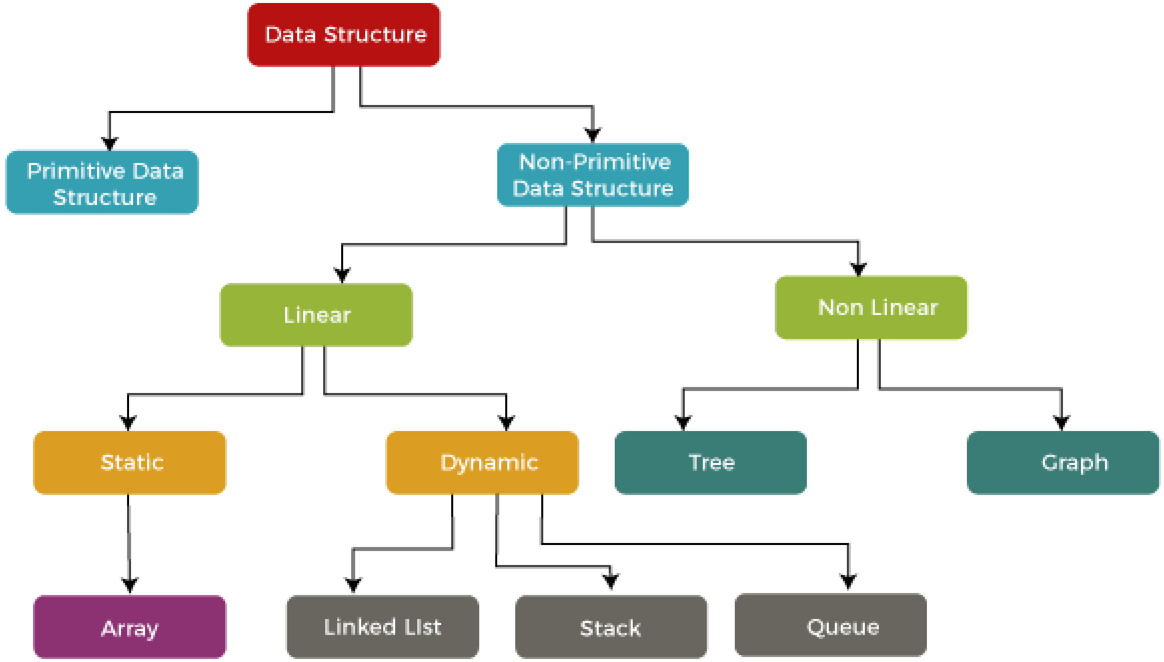


IMAGE SOURCE: https://static.javatpoint.com/ds/images/primitive-vs-non-primitive-data-structure.png

PRIMITIVE DATA STRUCTURES

PRIMITIVE DATA STRUCTURES

Primitive Data Structures is the most elementary kind of data used in programming language composed of character, number, and Boolean.

These data types are also known as **simple Data Types** since they include characters that cannot be further subdivided.

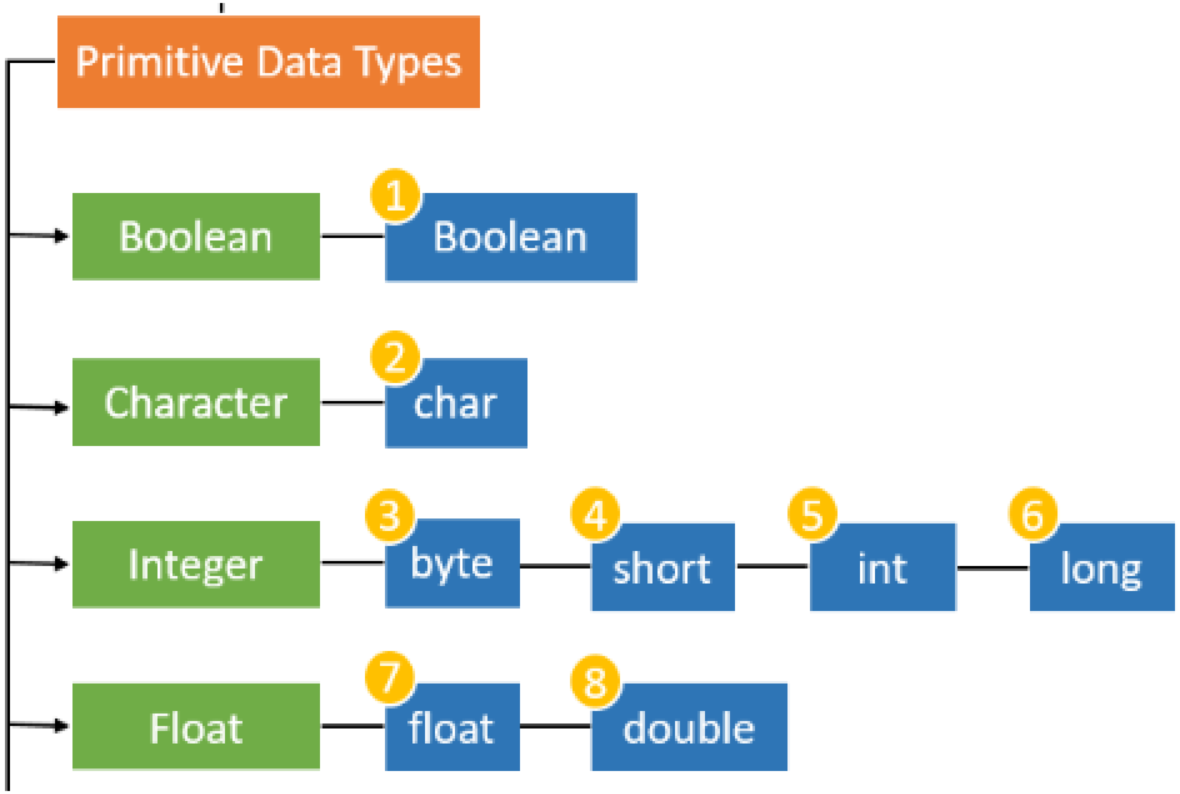


IMAGE SOURCE: https://www.shiksha.com/online-courses/articles/wp-content/uploads/sites/11/2022/05/image-162.png

PRIMITIVE DATA STRUCTURES

byte	refers to 8-bit signed two's complement integers that ranges from **-128** to **127**
short	refers to 16-bit signed two's complement integer that ranges from **-32,768** to **32,767**
int	refers to 32-bit signed two's complement integer that ranges from **-2,147,483,648** to **2,147,483,647**
long	refers to 64-bit two's complement integer that ranges from **-9,223,372,036,854,775,808** to **9,223,372,036,854,775,807**
float	refers to single-precision 32-bit IEEE 754 floating point numbers that has a precision of up to **7-digits** after the decimal point.
double	refers to single-precision 64-bit IEEE 754 floating point numbers that has a precision of up to **15-digits** after the decimal point.
char	refers to a single 16-bit Unicode character that is used to store a **single character**. It can be a single letter, number, or symbol.
Boolean	refers to the data type that can only store any of the two reserved values of **either true or false**.

NON-PRIMITIVE DATA STRUCTURES

NON-PRIMITIVE DATA STRUCTURES

Non-Primitive Data Structures are objects or instances constructed by the programmer rather than defined by the programming language.

They are also known as "**reference variables**" or "**object references**" since they refer to a memory region where the data is stored.

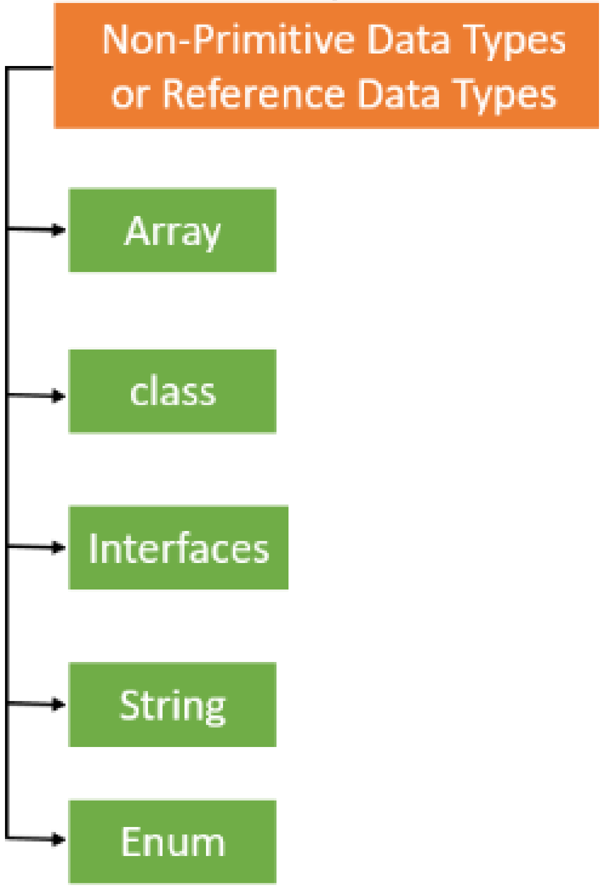
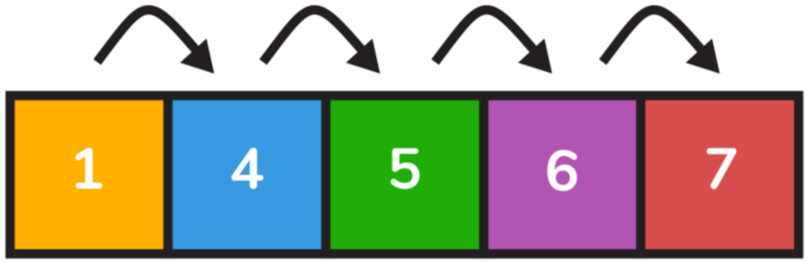


IMAGE SOURCE: https://www.shiksha.com/online-courses/articles/wp-content/uploads/sites/11/2022/05/image-166.png

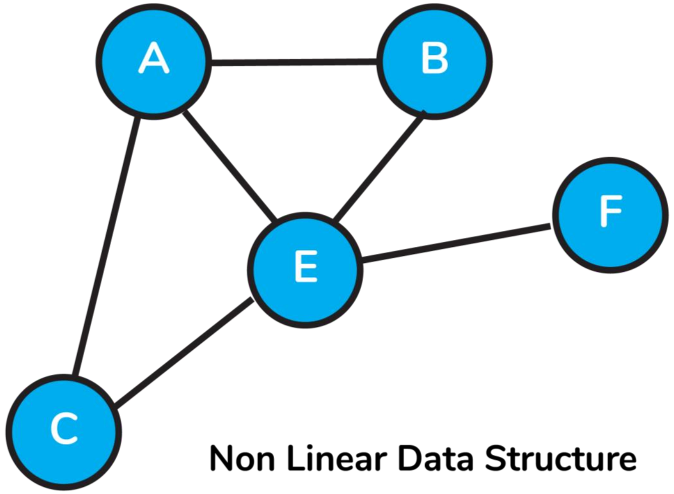
NON-PRIMITIVE DATA STRUCTURES

We can divide these data structures into two sub-categories based on the structure and placement of the data:

- **Linear Data Structures**
- **Non-Linear Data Structures**



Linear Data Structure



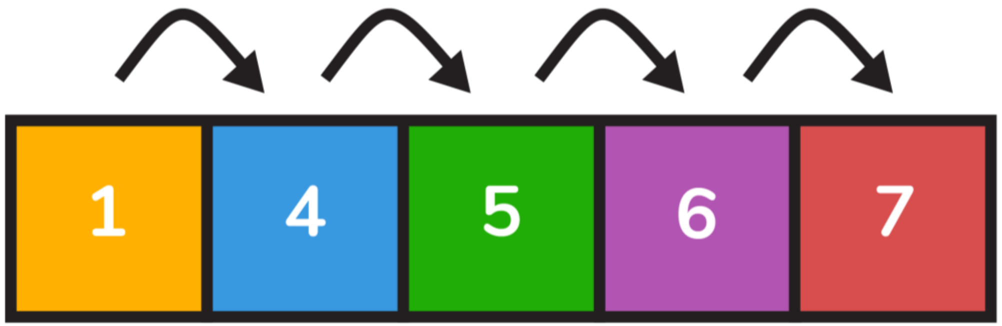
Non Linear Data Structure

IMAGE SOURCE: https://cdn.discuss.boardinfinity.com/original/2X/2/21a0512ec5a8a8c9175277c007f783a01b2c08e2.png

LINEAR DATA STRUCTURES

LINEAR DATA STRUCTURES

The **Linear Data Structure** is the data structure where data elements are constructed sequentially or follow a linear trend. The elements are adjacently attached and in a specified order.



Linear Data Structure

IMAGE SOURCE: https://cdn.discuss.boardinfinity.com/original/2X/2/21a0512ec5a8a8c9175277c007f783a01b2c08e2.png

LINEAR DATA STRUCTURES

There are five types of Linear Data Structures:

- Array
- Stack
- Queue
- Linked List
- Hash Tables

LINEAR DATA STRUCTURES

ARRAY

Is a type of linear data structure that stores elements of the same data type in memory locations that are adjacent to each other. Each element in an array is given an index number for easier identification.

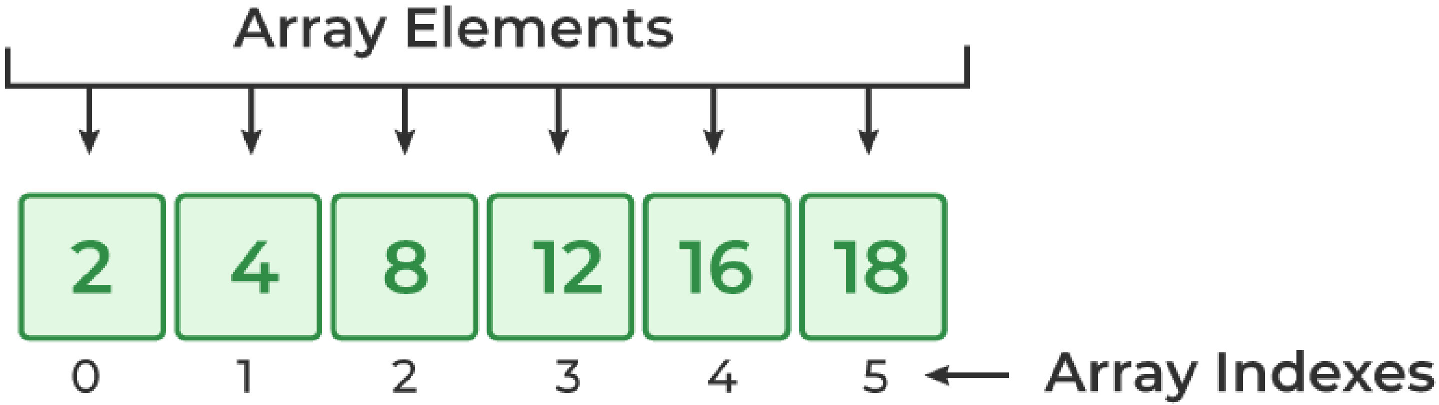


IMAGE SOURCE: https://www.geeksforgeeks.org/c-arrays/

LINEAR DATA STRUCTURES

STACK

A stack is a linear data structure characterized by the **LIFO (Last-In-First-Out)** approach, whereby items are added and removed like a pile, with new elements placed on top of existing ones.

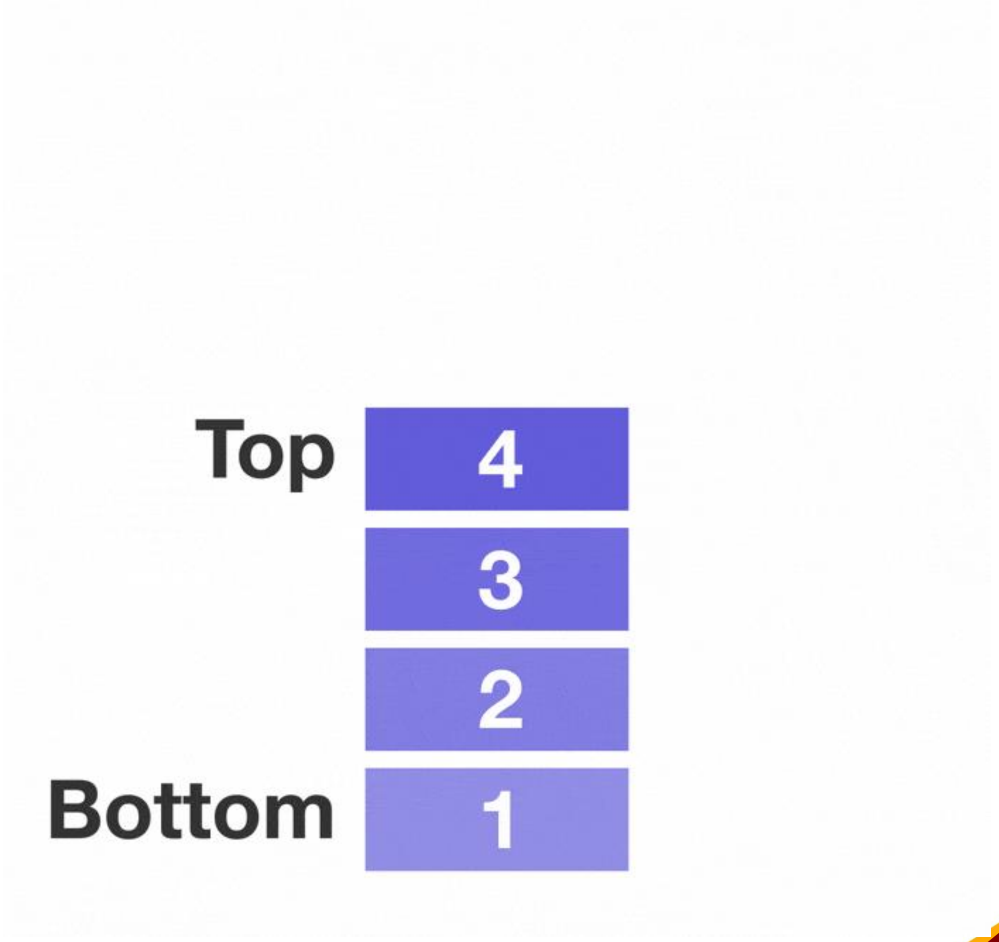


IMAGE SOURCE: https://miro.medium.com/v2/resize:fit:1400/1*tQ9Y11OdaMnhXwbfCF-edA.gif

LINEAR DATA STRUCTURES

Push method is used to enter an element to the pile.

Pop method is used to remove an element from the file.

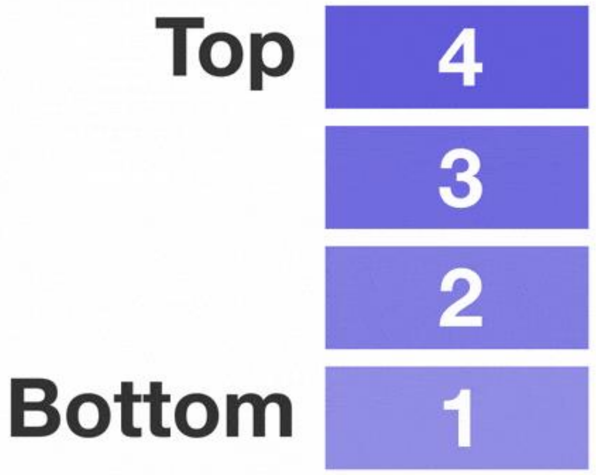


IMAGE SOURCE: https://miro.medium.com/v2/resize:fit:1400/1*tQ9Y11OdaMnhXwbfCF-edA.gif

LINEAR DATA STRUCTURES

QUEUE

A queue is a linear data structure that employs the **First In, First Out (FIFO)** approach for accessing its elements. Within the queue, adding items to the list occurs exclusively at one end, whereas removing items from the list occurs solely at the opposite end.

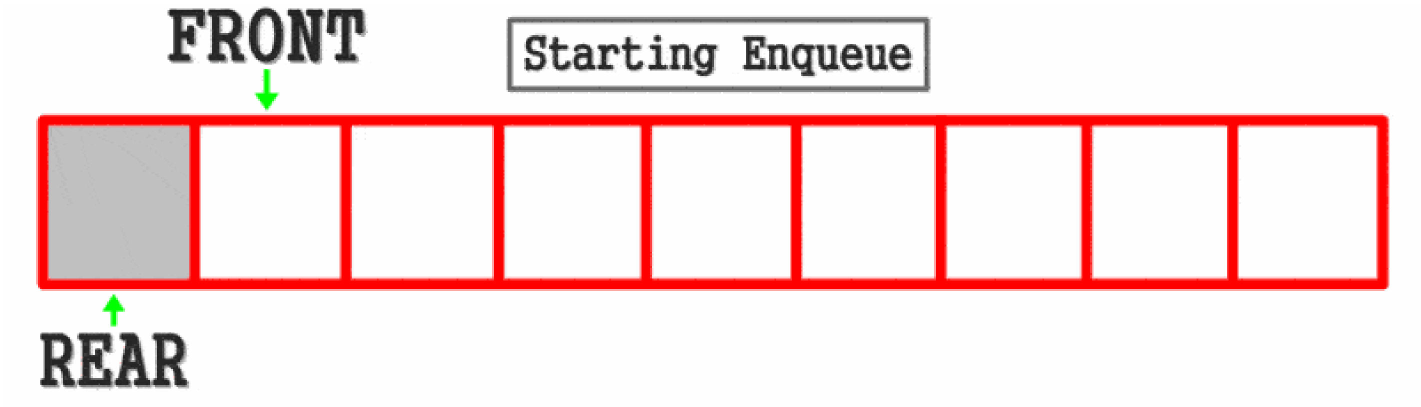


IMAGE SOURCE: https://ds1-iiith.vlabs.ac.in/exp/breadth-first-search/images/circular%20queue.gif

LINEAR DATA STRUCTURES

LINKED LIST

The linked list is the type of linear data structure that stores data elements through interconnected nodes, with each node containing the data and the address to the next node in the sequence.

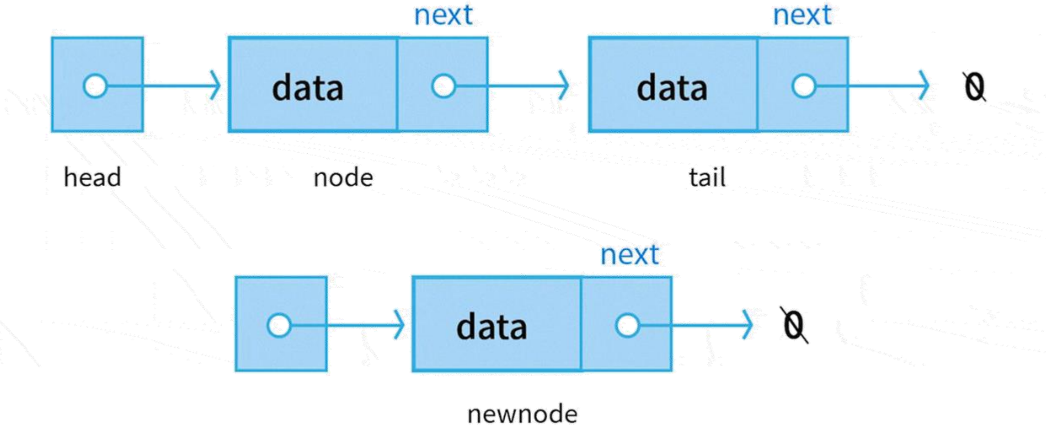


IMAGE SOURCE: https://scaler-topics-articles-md.s3.us-west-2.amazonaws.com/insertion-operation-of-linked-list.gif

LINEAR DATA STRUCTURES

HASH TABLES

Hash tables are a type of linear data structure that uses a hash function to generate a key that points to the address and value of each element.

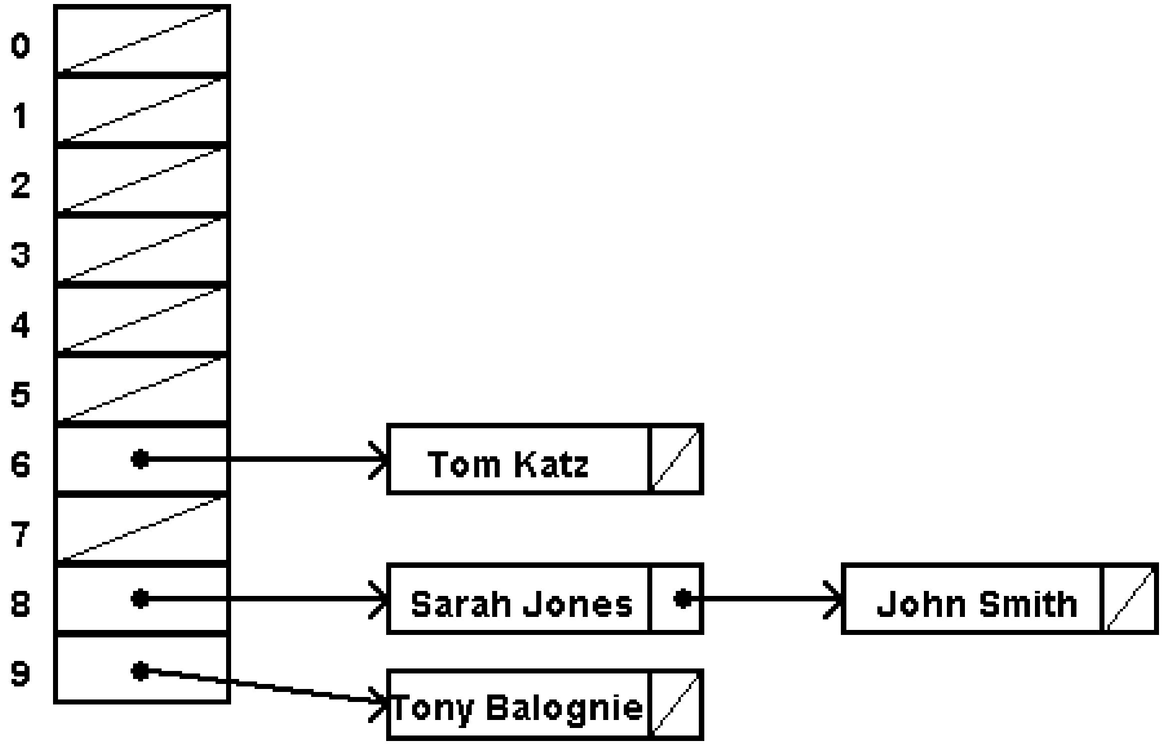


IMAGE SOURCE: https://scaler-topics-articles-md.s3.us-west-2.amazonaws.com/insertion-operation-of-linked-list.gif

NON-LINEAR DATA STRUCTURES

NON-LINEAR DATA STRUCTURES

A **Non-Linear Data Structure** is a type of data structure in which the arrangement of data elements does not follow a sequential or linear trend. In these type of data structure, the data elements are stored in **hierarchical or a network-based structure.**

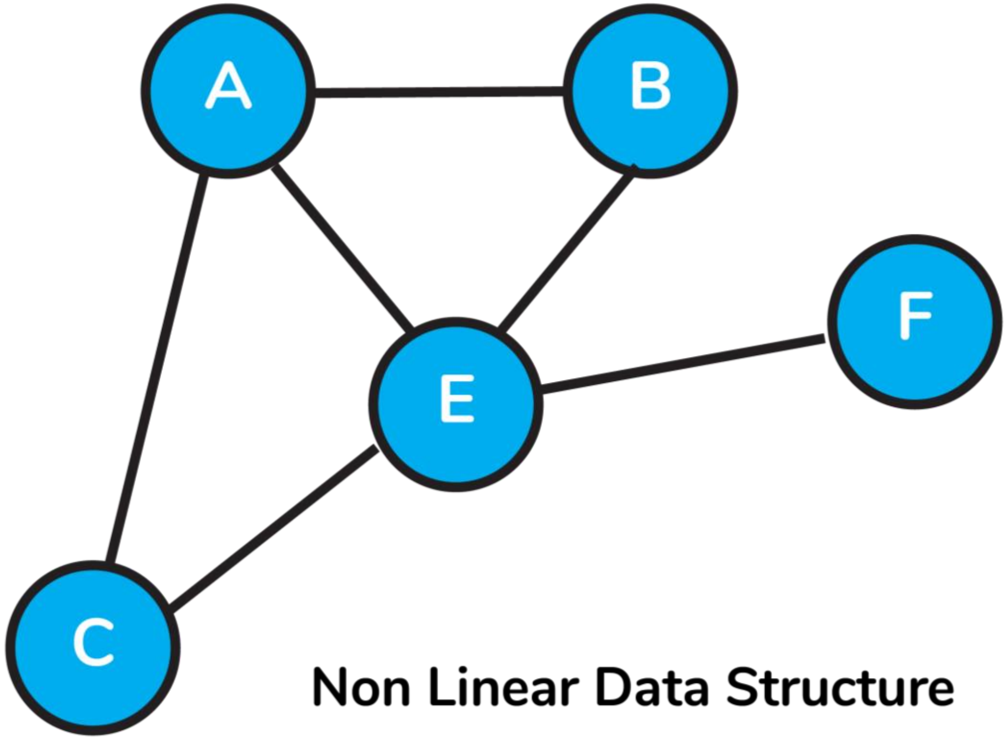
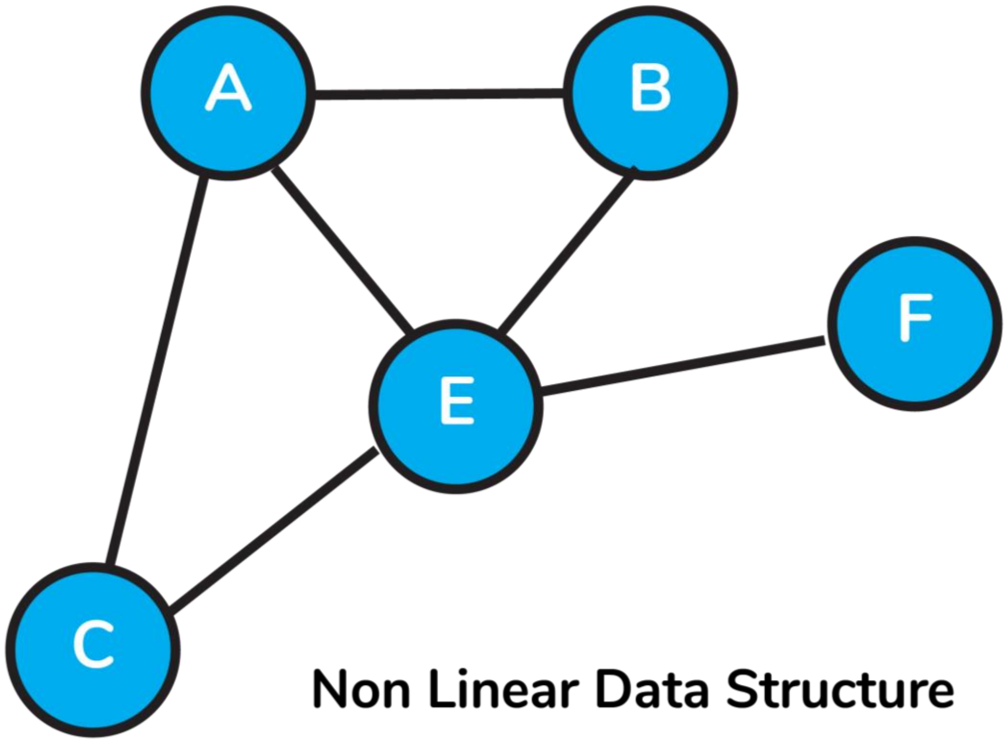


IMAGE SOURCE: https://cdn.discuss.boardinfinity.com/original/2X/2/21a0512ec5a8a8c9175277c007f783a01b2c08e2.png

NON-LINEAR DATA STRUCTURES

There are Two Types of Non-Linear Data Structures:

- Tree Data Structure
- Graph Data Structure



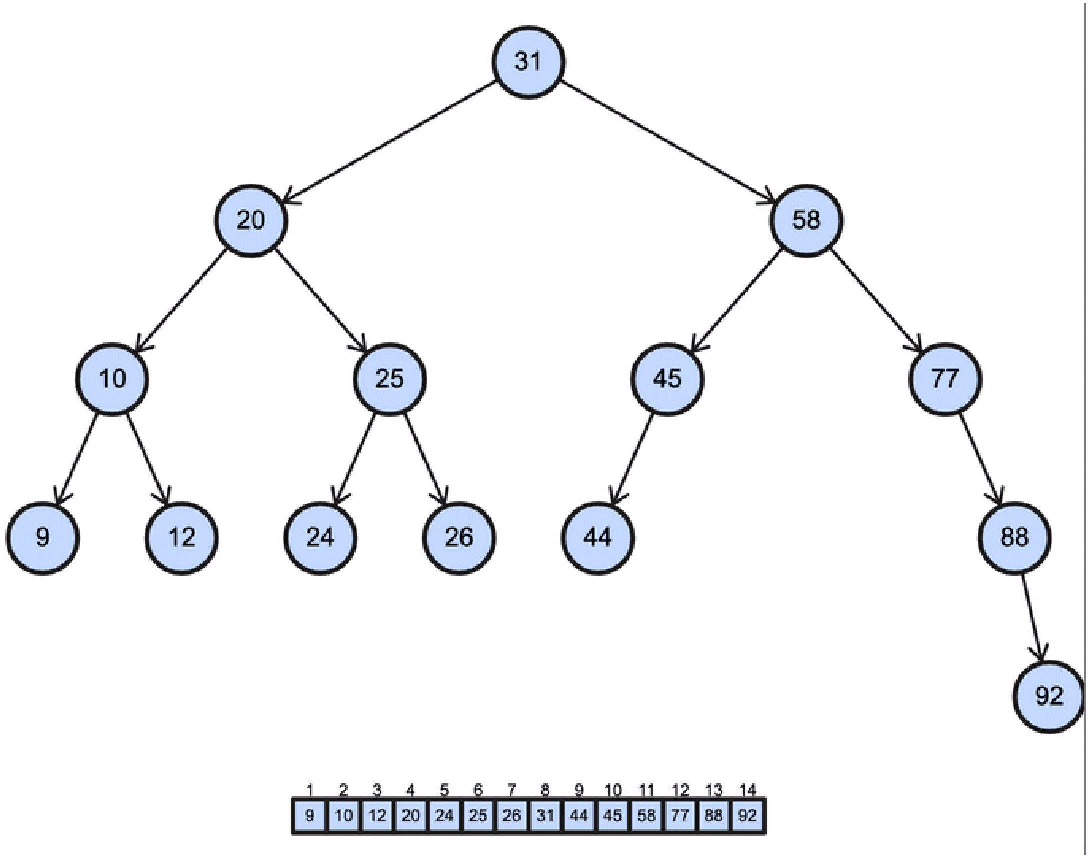
Non Linear Data Structure

IMAGE SOURCE: https://cdn.discuss.boardinfinity.com/original/2X/2/21a0512ec5a8a8c9175277c007f783a01b2c08e2.png

NON-LINEAR DATA STRUCTURES

TREE DATA STRUCTURE

A tree is a type of data structure that hierarchically organizes data. It is a compilation of interconnected nodes linked together via edges. In each structure, every node possesses a parent node and may have an arbitrary number of child nodes.



1	2	3	4	5	6	7	8	9	10	11	12	13	14
9	10	12	20	24	25	26	31	44	45	58	77	88	92

IMAGE SOURCE: https://res.cloudinary.com/practicaldev/image/fetch/s--zaYuwulZ--/c_limit%2Cf_auto%2Cfl_progressive%2Cq_66%2Cw_880/https://dev-to-uploads.s3.amazonaws.com/i/w0z2pz1f7th1k0ut8rbr.gif

NON-LINEAR DATA STRUCTURES

GRAPH DATA STRUCTURE

Graphs Data Structures are non-linear data structures composed of a finite number of interconnected vertices and edges.

The **vertices (nodes)** are responsible for storing the data elements, while the **edges** conveys the relationships between the vertices.

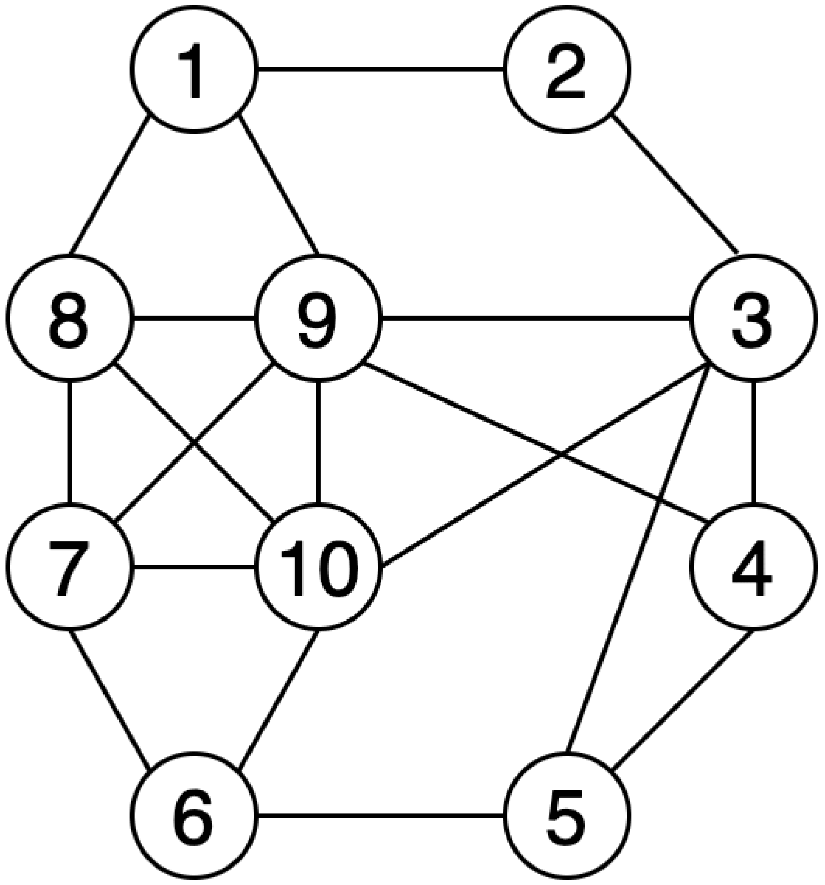


IMAGE SOURCE: https://miro.medium.com/v2/resize:fit:1208/1*SSSa5VrhhjNrXDdWTBGXlA.gif

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MR. ROWELL L. MARQUINA
Professional Lecturer,
Polytechnic University of the Philippines

Email Address:
rowell.marquina001@deped.gov.ph
sirrowellmarquina@gmail.com
rmarquina@mitis.edu.ph