Data Structures and their utilization in Real-Time Applications

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ABSTRACT

A data structure is a special format for organizing, processing, retrieving, and storing data. There are several basic and extended types of data structures, each designed to organize data according to a specific purpose. Data structures allow users to easily access the data they need and work with them in the right way. Most importantly, data structures shape information organizations that can be better understood by machines and humans. This article focuses on the types of data structures, their importance in the real world, and how they are used in real-time applications. The purpose of this paper is to provide a high-level overview of the use of data structures in emerging technologies and how data structures play an important role in future technologies.

1. Introduction

Data Structures are a special way to organize your data, so that you can use it effectively. Data structures play an important role in all branches of computer science today. As technology advances day by day, software requirements also improve, and wherever these concepts of data structures are used, their implementation can reduce complexity and must be robust. The concepts of data structures are widely using in many recent technologies and devices and we will discuss how the concepts like arrays, linked lists, stacks, queues, trees, heaps, hash tables and graphs are being used in real-time applications with examples.

2. Concept of Data Structures

A data structure is a special format for organizing, processing, retrieving, and storing data. There are several basic and extended types of data structures, each designed to organize data according to a specific purpose. Data structures allow users to easily access the data they need and work with them in the right way. Most importantly, data structures shape information organizations that can be better understood by machines and humans.

A data structure is a combination of data objects that allows a computer to collect, process, and use data. Data Structures are used appreciably in almost each element of Computer Science for easy in addition to complicated calculations. They are practiced in all such regions which include AI, Graphics, Operating System, etc.

Data structures are an integral part of some computer algorithms that allow programmers to manage their data efficiently. By choosing your data structure wisely, you can improve the performance of your computer program or algorithm in a more convenient way.

It increases the complexity of computer algorithms and increases data usage. This affects the execution of your application and can lead to significant issues such as processing speed, data retrieval, and multiple requests. Data structures are used to counter this.

Systematic use of memory usage of data structures can be optimized. For example, you can use a linked list instead of an array when you don't care about the size of the data. When memory is no longer used, it can be cleared.

Executing certain data structures allows them to be reused in separate locations. Implementations of data structures can be compiled into libraries that can be used by various clients.

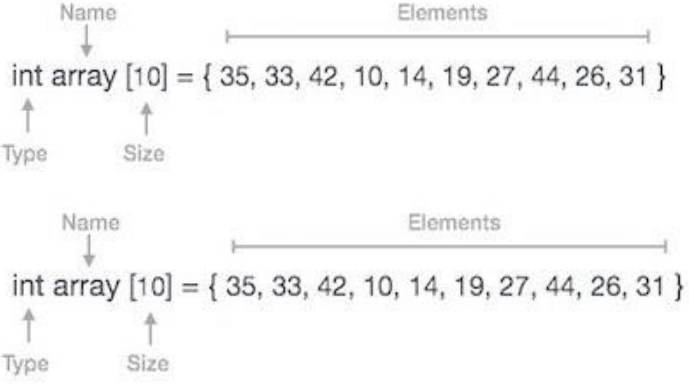
Data structures are the integral constituent of any programming language or complex computations. Mostly, structured data structures are crucial to designing efficient algorithms.

2.1 Types of Data Structures

There are many different types of data structures, but here are eight key data structures that will be used primarily in new technologies and will be widely used in the future.

I. Arrays

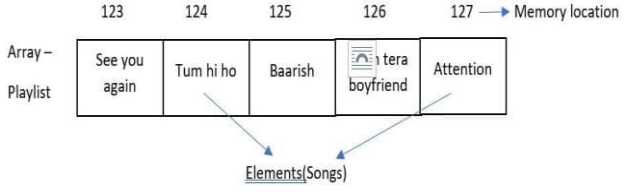
An array is a collection of elements stored in contiguous locations. The idea is to store multiple items of the same type together. This makes it easy to calculate the position of each element by simply adding an offset to the base value. NS. Space for the first element of the array. They can be represented as.



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Array in phone.

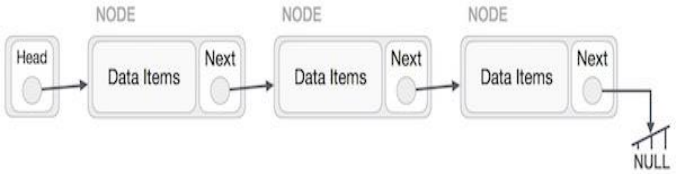
Our Phone Contacts app contains a lot of contacts. They are stored in the form of an array. Adding or removing contacts over the phone is similar to adding or removing items in an array. Some uses for phone-based arrays are music playlists we create. Here, playlists are arrays and songs are elements. Imagine what it would look like. The following figure is just a recognition, not an accurate one.



II. Linked Lists

A linked list is a set of data structures that are linked together by links. A linked list is a set of links that contain items. Each link contains a link to another link. Linked lists are the second most frequently used data structure after arrays. Following are the important terms to understand the concept of Linked List.

Representation of linked list.



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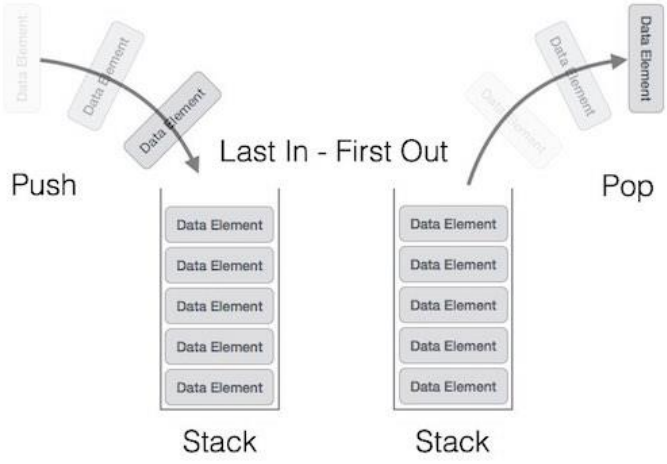
In phone
The images are linked to each other. Therefore, the image viewer software uses a linked list to display the previous and next images with the Previous and Next buttons.

In Websites
You can access the web page using the URL links before and after the link from the linked list.

In Music Players
Music players use the same technique to switch music. Circular linked lists are used to track rounds in multiplayer games.

III. Stacks

The stack is a linear data structure that follows the LIFO principle (LastInFirstOut). The stack has one end and the queue has two ends (front and back). Pointer pointing to the top element of the stack Contains only one top pointer. Whenever an item is added to the stack, it is added to the top of the stack and the item can only be removed from the stack. That is, a stack can be defined as a container that can be inserted and removed from one end of the top of the stack.
Representation of stack.



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In Websites
Forward – backward browsing in browser
History of visited websites.

In Phone
The message log and received messages are put on the stack Call logs, emails, Google Photos gallery, YouTube downloads, notifications (latest comes first).

Others
It is used by many virtual machines such as the JVM. Scratch cards earned after Google Pay transactions

IV. Queues

Queues are an abstract data structure that resembles a stack. In contrast to the stack, the queue is open at both ends. One end is always used to insert data (enqueue) and the other end is used to delete data (dequeue). The queue follows the FirstInFirstOut methodology. NS. The first stored data element is accessed first.

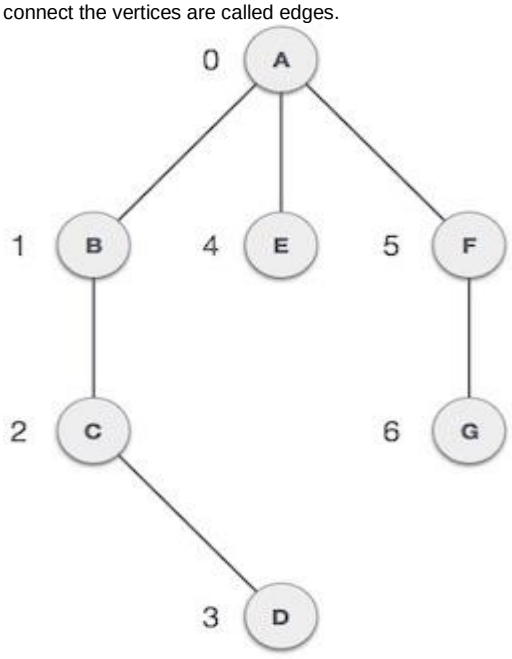


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The uploading and downloading of the photos that are initially retained for upload / download is completed first (not threaded). Most internet requests and processes use queues. When switching between multiple applications, Windows uses circular queues.

The operating system uses queues to schedule jobs. Queues can be used to handle network congestion. Data packets in communication are placed in a queue format. Send an email and it will be queued Server when responding to requests

V. Graphs

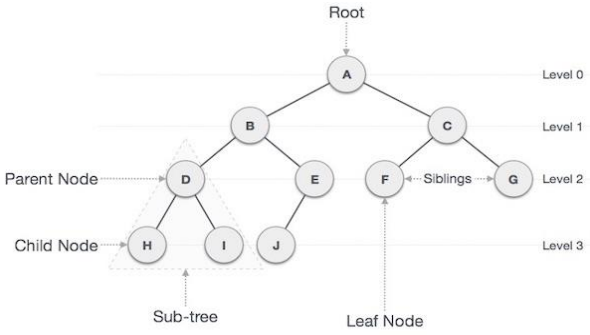
A graph is a pictorial representation of a set of objects where some pairs of objects are connected by links. The interconnected objects are represented by points termed as vertices, and the links that connect the vertices are called edges.



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Facebook's Graph API uses a graph structure. Google's Knowledge Graph is also related to the graph. The Dijkstra algorithm or the Shortest Path First algorithm also use the graph structure to find the minimum path between the nodes of the graph. The GPS navigator also uses the Shortest Path API. Network components have a wide range of uses for graphs Facebook, Instagram, and all social media networking sites are all user nodes Data organization.

VI. Trees

The tree represents the nodes connected by the edges. Specifically, we will discuss binary trees or binary search trees. Binary trees are special data structures used for data storage purposes. Binary trees have the special condition that each node can have up to two children. Binary trees have the advantage of both ordered and linked lists in that searches are as fast as sorted arrays and inserts or deletes are as fast as linked lists.



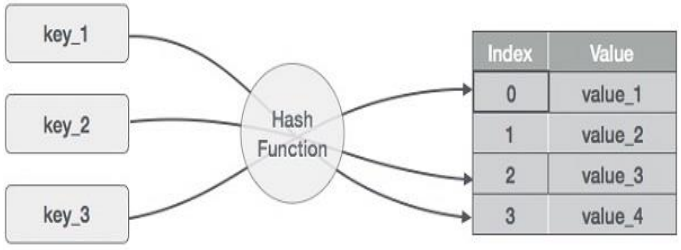
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The XML parser uses a tree algorithm. Decision-based algorithms are used in machine learning that works with tree algorithms. The database also uses a tree data structure for indexing. Domain Name Server (DNS) also uses a tree structure. File Explorer / My Computer on Phone / Any Computer BST used in computer graphics When you post a question to a site like Quora, the comment becomes a child of the question

VII. Hash Tables

A hash table is a data structure that associates and stores data. Hash tables store data in an array format, and each data value has its own index value. If you know the index of the data you need, accessing the data will be very fast.

Therefore, insert and search operations are very fast data structures, regardless of the size of the data. Hash tables use arrays as storage media and use hashing techniques to index where to insert elements or where they can be found.



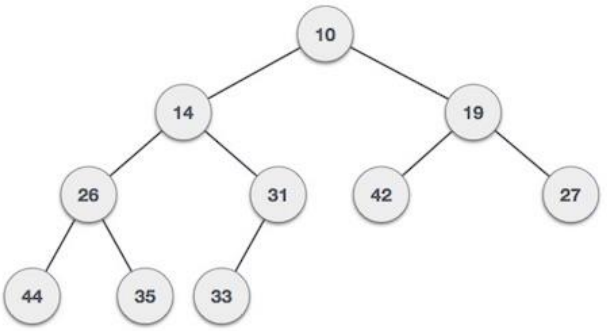
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The data stored in the database is usually in key-value format, which is done using hash tables. Every time you type what you're searching for in Google Chrome or another browser, it will produce the desired output according to the hashing principle. Message digest, a feature of encryption, also uses hashes to create output in such a way that it is almost impossible to reach the original input from the generated output. Various files are stored on our computer. Each file has two very important pieces of information, the file name and the file path, and a hash table is used to establish a connection between the file name and the corresponding file path.

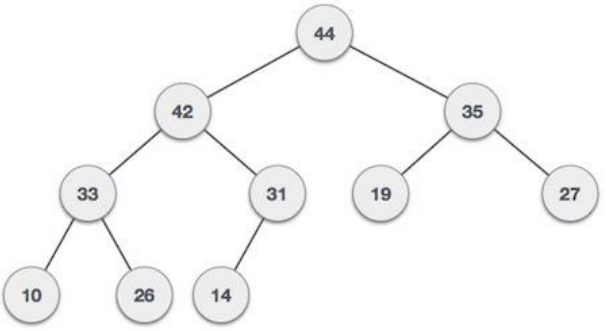
VIII. Heaps

The heap is a special case of balanced binary data structures where the root node key is compared to its children and placed accordingly. If α has a child node β,-

MinHeap – Where the value of the root node is less than or equal to either of its children.



MaxHeap-The value of the root node is one or more of its children.



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The heapsort algorithm is an algorithm for sorting items into either the minimum heap (parent key is less than or equal to the child key) or the maximum heap (parent key is greater than or equal to the child key). It is done by forming a pile. The heap is used to implement a priority queue based on the order of the heaps in which the priorities were created. Security-related systems and embedded systems such as the Linux kernel use heapsort for O (n log (n)). If you get stuck looking for the minimum (or maximum) value of a number, the heap is an easy and quick way to solve the problem.

Conclusion

Data structures play an important role in all fields of computer science today. As technology advances, so do software requirements, and wherever these data structure concepts are used, implementations must reduce complexity and be reliable. The concept of data structures is widely used in many modern technologies and devices. We have seen how they are used in current devices. In the future this concept will be in great demand wherever reliable devices are needed.

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