PRACTICAL USE CASE

DATA STRUCTRES

Applications of linked list data structure

Difficulty Level : Easy

Last Updated : 28 Jun, 2021

A linked list is a linear data structure, in which the elements are not stored at contiguous memory locations. The elements in a linked list are linked using pointers as shown in the below image:

Applications of linked list in computer science –

Implementation of stacks and queues

Implementation of graphs : Adjacency list representation of graphs is most popular which is uses linked list to store adjacent vertices.

Dynamic memory allocation : We use linked list of free blocks.

Maintaining directory of names

Performing arithmetic operations on long integers

Manipulation of polynomials by storing constants in the node of linked list

representing sparse matrices

Applications of linked list in real world-

Image viewer – Previous and next images are linked, hence can be accessed by next and previous button.

Previous and next page in web browser – We can access previous and next url searched in web browser by pressing back and next button since, they are linked as linked list.

Music Player – Songs in music player are linked to previous and next song. you can play songs either from starting or ending of the list.

Applications of Circular Linked Lists:

Useful for implementation of queue. Unlike this implementation, we don’t need to maintain two pointers for front and rear if we use circular linked list. We can maintain a pointer to the last inserted node and front can always be obtained as next of last.

Circular lists are useful in applications to repeatedly go around the list. For example, when multiple applications are running on a PC, it is common for the operating system to put the running applications on a list and then to cycle through them, giving each of them a slice of time to execute, and then making them wait while the CPU is given to another application. It is convenient for the operating system to use a circular list so that when it reaches the end of the list it can cycle around to the front of the list.

Circular Doubly Linked Lists are used for implementation of advanced data structures like Fibonacci Heap.

An example problem:

Design a data structure that supports following operations efficiently.

getMin : Gets minimum

extractMin : Removes minimum

getMax : Gets maximum

extractMax : Removes maximum

insert : Inserts an item. It may be assumed that the inserted item is always greater than maximum so far. For example, a valid insertion order is 10, 12, 13, 20, 50.

Doubly linked list is the best solution here. We maintain head and tail pointers, since inserted item is always greatest, we insert at tail. Deleting an item from head or tail can be done in O(1) time. So all operations take O(1) time.

Real life application use of stack

To reverse a word. You push a given word to stack - letter by letter - and then pop letters from the stack.

An "undo" mechanism in text editors; this operation is accomplished by keeping all text changes in a stack.Undo/Redo stacks in Excel or Word.

Language processing :space for parameters and local variables is created internally using a stack.compiler's syntax check for matching braces is implemented by using stack.

A stack of plates/books in a cupboard.

Wearing/Removing Bangles.

Support for recursionActivation records of method calls.

Trees

Applications of tree data structure

Difficulty Level : Basic

Last Updated : 05 Dec, 2019

Why Tree?

Unlike Array and Linked List, which are linear data structures, tree is hierarchical (or non-linear) data structure.

One reason to use trees might be because you want to store information that naturally forms a hierarchy. For example, the file system on a computer:

file system

———–

/ <-- root

/ \

... home

/ \

ugrad course

/ / | \

... cs101 cs112 cs113

If we organize keys in form of a tree (with some ordering e.g., BST), we can search for a given key in moderate time (quicker than Linked List and slower than arrays). Self-balancing search trees like AVL and Red-Black trees guarantee an upper bound of O(Logn) for search.

We can insert/delete keys in moderate time (quicker than Arrays and slower than Unordered Linked Lists). Self-balancing search trees like AVL and Red-Black trees guarantee an upper bound of O(Logn) for insertion/deletion.

Like Linked Lists and unlike Arrays, Pointer implementation of trees don’t have an upper limit on number of nodes as nodes are linked using pointers.

Other Applications :

Store hierarchical data, like folder structure, organization structure, XML/HTML data.

Binary Search Tree is a tree that allows fast search, insert, delete on a sorted data. It also allows finding closest item

Heap is a tree data structure which is implemented using arrays and used to implement priority queues.

B-Tree and B+ Tree : They are used to implement indexing in databases.

Syntax Tree: Used in Compilers.

K-D Tree: A space partitioning tree used to organize points in K dimensional space.

Trie : Used to implement dictionaries with prefix lookup.

Suffix Tree : For quick pattern searching in a fixed text.

Spanning Trees and shortest path trees are used in routers and bridges respectively in computer networks

As a workflow for compositing digital images for visual effects.

**GRAPHS**

Applications of Graph Data Structure

Difficulty Level : Easy

Last Updated : 09 Dec, 2019

A graph is a non-linear data structure, which consists of vertices(or nodes) connected by edges(or arcs) where edges may be directed or undirected.

In Computer science graphs are used to represent the flow of computation.

Google maps uses graphs for building transportation systems, where intersection of two(or more) roads are considered to be a vertex and the road connecting two vertices is considered to be an edge, thus their navigation system is based on the algorithm to calculate the shortest path between two vertices.

In Facebook, users are considered to be the vertices and if they are friends then there is an edge running between them. Facebook’s Friend suggestion algorithm uses graph theory. Facebook is an example of undirected graph.

In World Wide Web, web pages are considered to be the vertices. There is an edge from a page u to other page v if there is a link of page v on page u. This is an example of Directed graph. It was the basic idea behind Google Page Ranking Algorithm.

In Operating System, we come across the Resource Allocation Graph where each process and resources are considered to be vertices. Edges are drawn from resources to the allocated process, or from requesting process to the requested resource. If this leads to any formation of a cycle then a deadlock will occur.

Thus the development of algorithms to handle graphs is of major interest in the field of computer science.

**HASH TABLE**

File System

The hashing is used for the linking of the file name to the path of the file. When you interact with a file system as a user, you see the file name, maybe the path to the file. But to actually store the correspondence between the file name and path, and the physical location of that file on the disk, the System uses a map, and that map is usually implemented as a hash table.

Password Verification

When you use some web service and enter your credentials to log in, it won’t send your password in plain-text through the network to the server to verify if the credentials are correct or not, because in that case message could be intercepted and then someone will know your password. Instead, a hash value of your password is computed on the client-side and then sent to the server which then compares that hash value with the hash value of the stored password. And if those are equal, you get authenticated. Special cryptographic hash functions are used for this purpose. It means that it is next to impossible to find another string that has the same hash value as your password. So you are secure. Nobody can actually construct a different string that has the same hash value as your password and then log in to your system, even if he intercepted the message with the hash value of your password going to the server.