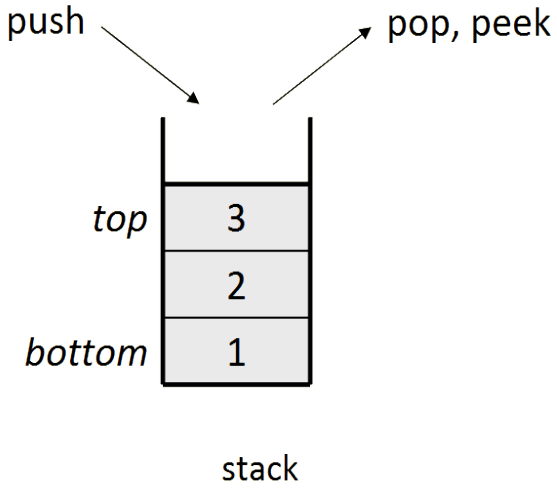
Data Structures

Stack

A linear data structure which acts similarly to a stack of books. The last item you added to the stack is the only item you can access/remove. One-ended meaning the data can only be added (**pushed**) or removed (**popped**) from one end. It is described as LIFO, or Last In First Out.



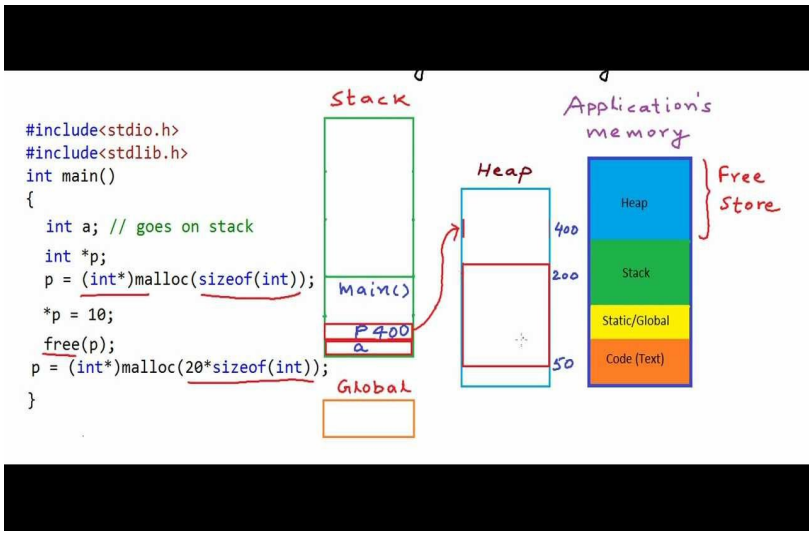
Real World Applications

- Compiler syntax check for matching brackets.

  {{{{ }}}}

  You can scan through each character in code and add each open bracket to the stack. When there's a close bracket, remove an item from the stack and it will be the corresponding bracket.

- Keeping track of previous function calls (stack trace)
- Used to do a Depth First Search (DFS) on a graph



In computers, memory is accessed and stored via data structures. A heap is used for free memory, as this allows the computer to quickly access the highest or lowest memory address.

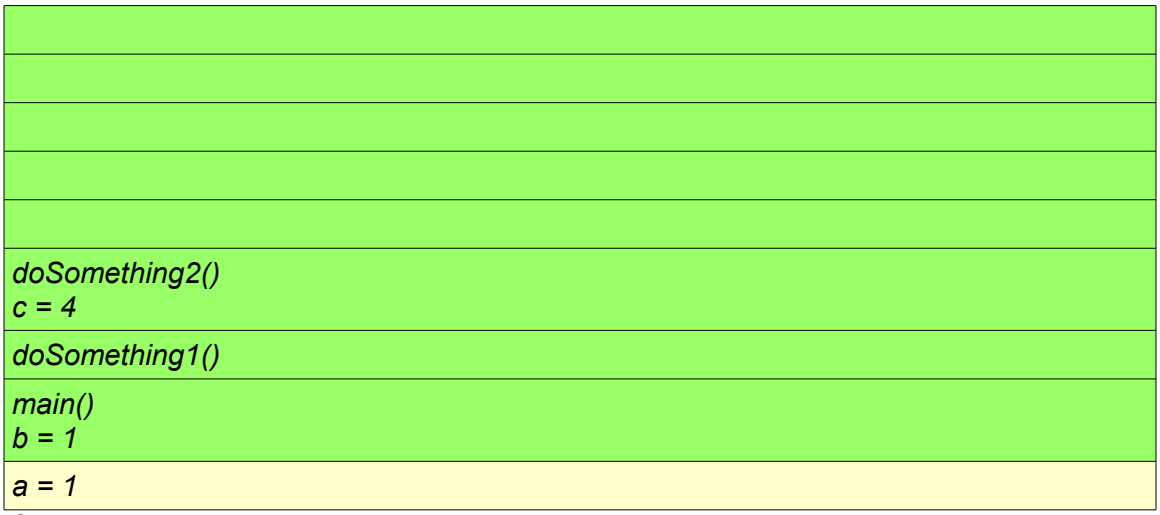
There are sections for instructions, global variables, in an application's memory and these are typically low addresses. Then in the stack resides function calls and local variables.

The stack is used for function calls because the natural order of function execution results in the program entry-point (main function) also being the program exit. So when a function is called, it is added to the top of the stack, until the function completes:

```
int a = 1;
void doSomething2() {
     int c = 4;
     return;
}
void doSomething1() {
     doSomething2();
}
int main() {
     int b = 1;
     doSomething1();
}
```

Stack

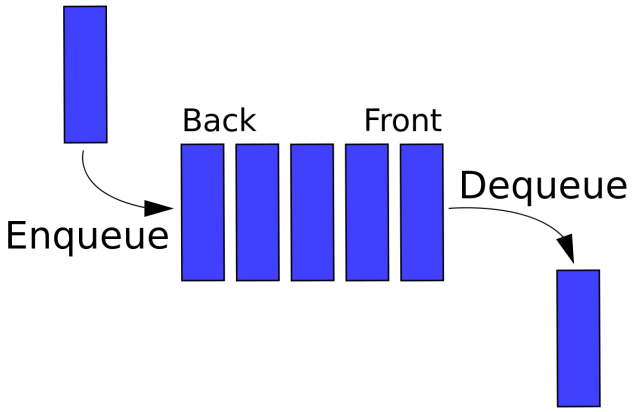
Static/Global



If your application takes up more memory than was allocated at compile time, e.g. you had an infinite recursion, you'll get Stack Overflow error.

Queue

The queue is another one-dimensional data structure, but is a FIFO accessed data structure. Meaning, the First item In is the First item Out. They are just like queues in real life, really. Adding to a queue is named **Enqueue**, and removing is called **Dequeue**.

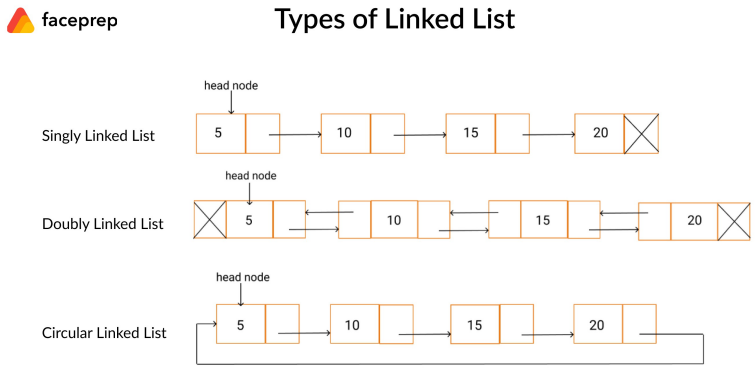


Real World Applications

- Used in a breadth first search (BFS) algorithm. Helps in traversing trees/graphs
- Request scheduling
- Any time you need a first-come first-served approach, e.g. song queue on spotify, wait list for selling digital products

Linked Lists

A sequence of objects which are linked by pointers… **Singly linked** meaning the nodes only point to one following or previous node, or **doubly linked** meaning each node points to their following and previous nodes. A doubly linked list, unlike the singly linked list is traversable back and forth.



Real World Applications

- Great foundation for other data structures, e.g.
  - Stacks, queues, binary trees are essentially linked lists with more/less complexity
- Browser cache will use data structures similar to doubly linked lists along with a currentIndex property to access the history and go back/forth between cached pages

Reverse a singly linked list

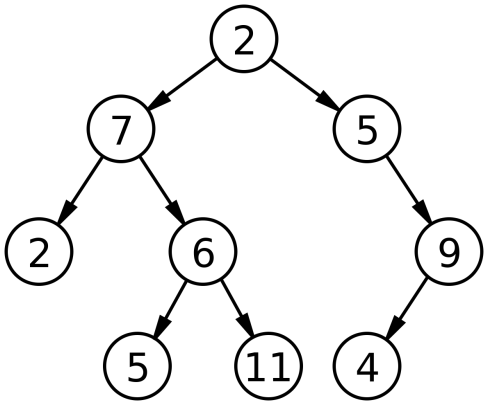
```
void reverse(struct Node** head)
{
	struct Node* prev = NULL;
	struct Node* currentNode = *head;
	struct Node* next = NULL;

	while (currentNode != NULL)
	{
		// Store next node in the temp pointer
		next = currentNode->next;
		// Reverse the current node's pointer
		current->next = prev;

		// Move temp pointers one position ahead
		prev = currentNode;
		currentNode = next;
	}
}
```

Trees

A hierarchal set of linked nodes. There is always a root node in a tree structure. The below tree shows 2 at the top as the root node.



- The node at the top is known as the **root** of the tree.
- All nodes with children are called **parents**.
- A node with no children is a **leaf.**
- In standard trees, there may be as many children as necessary.

Real World Applications

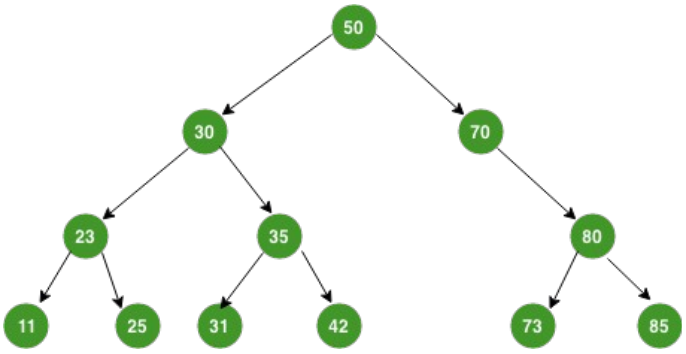
- A file system is a tree. You can think of directories, folders and subfolders as parent nodes, and files as leaves.

Binary Search Tree (BST)

Is an “ordered” binary tree. Meaning the nodes to the left cannot have a higher value than the nodes to the right. The root node cannot be the smallest value.

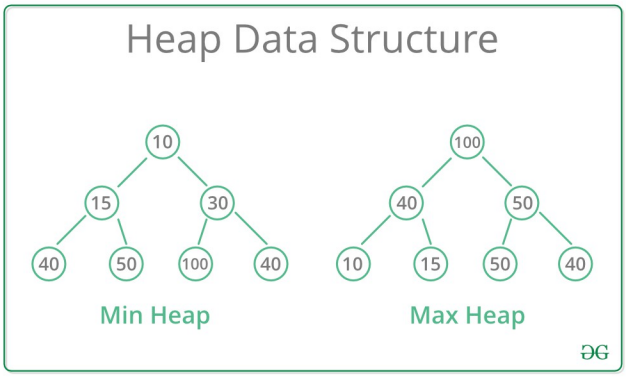
The left subtree has smaller elements and the right subtree has larger elements.

- Can only ever have at most 2 children.



Real World Applications

Heap



A tree-based data structure, which essentially orders it's nodes.

In a Max Heap, the parent node must always be **greater then or equal** to either of their child nodes.

In a Min Heap, the parent node is always **less than or equal** to their child nodes.

Real World Applications

- Used in djikstra's algorithm
- When you need quick access to the max/min value of data