Yrkes Akademin

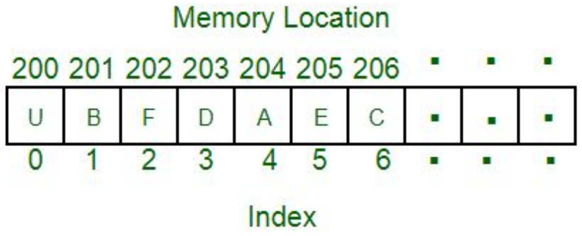
Vi hjälper dig att lyckas!

C Programming

Data Structures

Data Structure - Array

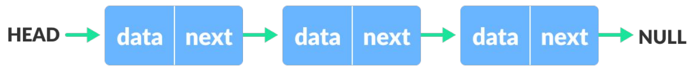
- Data structure: The way of organizing data for particular types of operation
- Some common data structures:
  - Array
  - Linked List
    - Singly linked list
    - Doubly linked list
  - Queue
    - Circular Buffer
  - Stack
  - Binary Tree

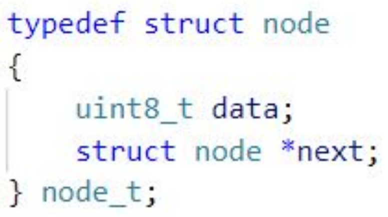


Array is a **fixed size** collection of items stored stored consecutively in a continuous piece of memory. Arrays allow random access of elements. Each element in an array can be accessed by its position in the array which is the **index** of the element.
The index of the first element is 0 and the index of the last element is the number of the elements - 1.
Arrays have a better **cache locality** that can make a big difference in **performance**.

Data Structure - Linked List

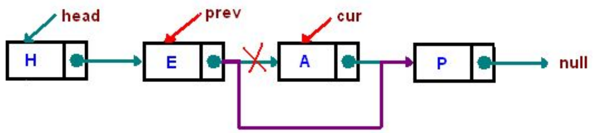
- A linked list is a way to make a **dynamic array** as a series of connected nodes using pointers.





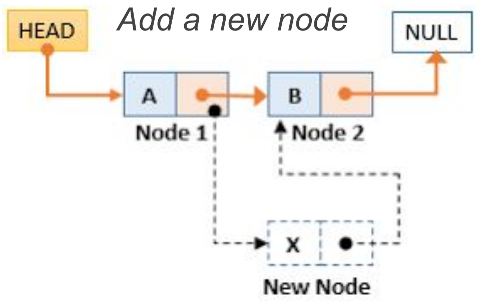
```
typedef struct node
{
    uint8_t data;
    struct node *next;
} node_t;
```

- The most common type is a **singly linked list**
  - Each node points to the next node

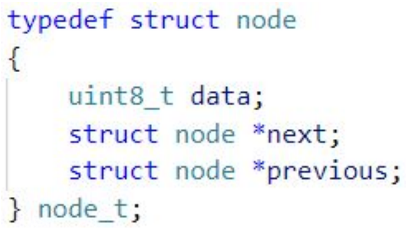


Delete a node (A) from a linked list

- We can dynamically add a new node



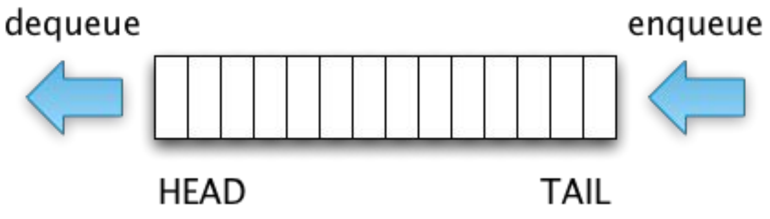
- We can delete any node in the list
- It does not allow random access to the nodes. To access a specific node we need to traverse the linked list usually starting from the **head** pointer which points to the first element.
- In a **doubly linked list** there is also a pointer to the previous node
  - This means we can traverse the list in any direction.

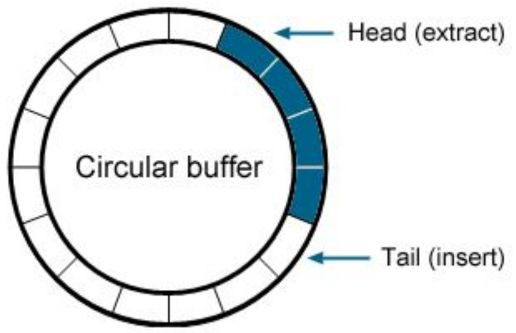


```
typedef struct node
{
    uint8_t data;
    struct node *next;
    struct node *previous;
} node_t;
```

Data Structure - Queue

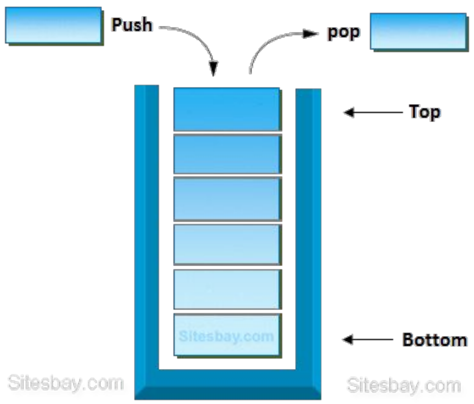
- A queue is a linear data structure to store and retrieve the data elements.
- It follows the order of First In First Out (FIFO).
- In a queue, the first entered element is the first one to be removed from the queue.
- Typical Operations Associated with a Queue
  - is_empty(): To check if the queue is empty or not
  - is_full(): To check whether the queue is full or not
  - dequeue(): Removes the element from the frontal side of the queue
  - enqueue(): It inserts elements to the end of the queue
- A queue can be implemented using
  - A fixed size array - It is called ring or circular queue/buffer.
  - A dynamic size array or even using a linked list.





Data Structure - Stack

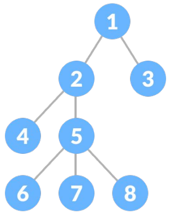
- A stack is a linear data structure to store and retrieve the data elements.
- It follows the order of Last In First Out (LIFO).
- In a stack, the first entered element is the last one to be retrieved from the stack.
- Typical Operations Associated with a Stack
  - is_empty(): To check if the stack is empty or not
  - is_full(): To check if the stack is full or not
  - pop(): Removes an item from the top of the stack.
    - If the stack is empty we have an underflow condition
  - push(): Inserts an item in the stack.
    - If the stack is full we have an overflow condition.



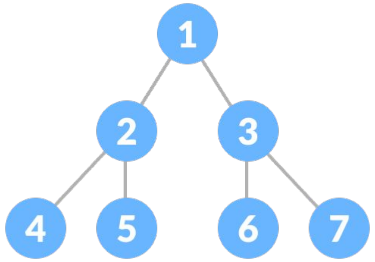
- A stack can be implemented using an array (fixed or dynamic size) or a linked list

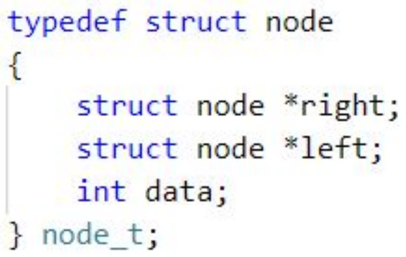
Data Structure - Binary Tree

- A tree is a nonlinear hierarchical data structure that consists of nodes connected by edges (pointers)



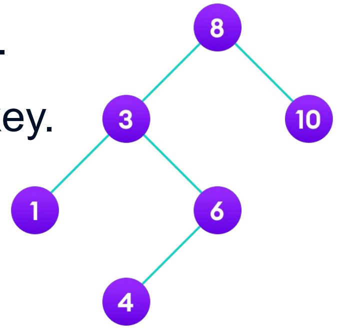
- A binary tree is a tree data structure in which each parent node can have at most two children.





```
typedef struct node
{
    struct node *right;
    struct node *left;
    int data;
} node_t;
```

- Binary Search Tree (**BST**) is a binary tree data structure which has the following properties:
  - The left subtree of a node contains only nodes with keys lesser than the node’s key.
  - The right subtree of a node contains only nodes with keys greater than the node’s key.
  - The left and right subtree each must also be a binary search tree.



- Typical operations on a BST: insert, edit, delete, search and traverse
- A BST is automatically sorted. It provides quicker access/search than than linked lists

C Programming - Data Structure

- Some useful links
  - Linked List Data Structure
  - Linked List Tutorial
  - C Linked List
  - Stack Data Structure
  - Queue Data Structure
  - Circular Buffer Structure
  - Ring Buffer (Circular Buffer)
  - Binary Tree Data Structure
  - Binary Search Tree (BST)
  - Data Structures Easy to Advanced Course