CS2023 - Data Structures and Algorithms
Take Home Assignment

Week 5 - Basic Data Structures

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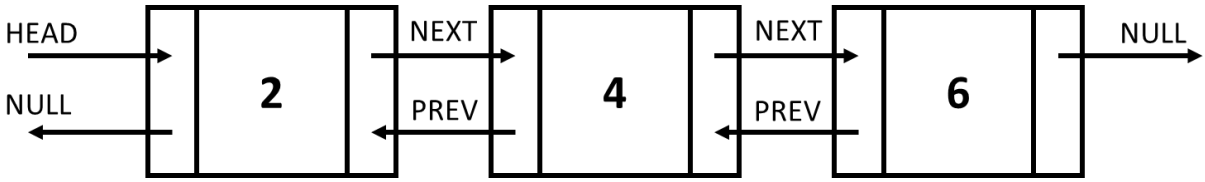
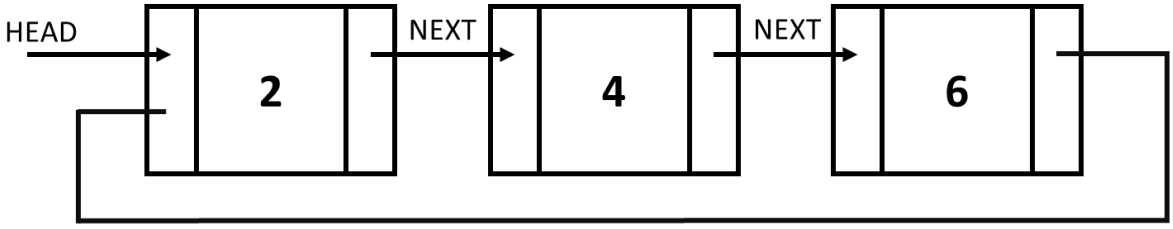
Question 1

Explain briefly what a double linked list and a circular linked list is?
Note: Please use diagrams in your explanations

- Double linked list
  - it is a linked list where each node contains two pointers.
    - next → points to the next element's address
    - previous → points to the previous element's address
  - this allows efficient traversal in both directions.



- Circular linked list
  - unlike linked list, the nodes in circular linked list only have one pointer which points the next element's address.
  - but the last element points to the first element in the list which makes it circular.
  - there's no start or end in circular linked lists.



Question 2

Write pseudo codes for the operations of a single linked list.

Insert element at the front →

```
Insert (list, value):
      newNode <= new Node(value)
      newNode.next <= list.head
      list.head <= newNode
```

Insert element at a position →

```
Insert_at_position (list, position, value):
      newNode <= new Node(value)
      if position = 0 then:
            newNode.next <= list.head
            list.head <= newNode
      else:
            current_position <= 0
            current_node <= list.head
            while current_node is not NULL:
                  if current_position + 1 <= position:
                        newNode.next <= current_node.next
                        current_node.next <= newNode
                        return
                  current_node <= current_node.next
                  current_position <= current_position + 1
            print("invalid position")
```

Search element by value →

```
search (list, value):
      index <= 0
      current_node <= list.head
      while current_node is not NULL:
            if current_node.data = value:
                  return index
            current_node <= current_node.next
            index <= index + 1
      return -1
```

Delete element by value →

```
delete (list, value):
      current_node <= list.head
```

```
if list.head.data = value:
      list.head <= list.head.next
            return true
while current_node.next is not NULL:
      if current_node.next.data = value:
            current_node.next <= current_node.next.next
            return true
return false
```

Question 3

How can you implement a stack and a queue using a linked list?
Note: Explain how you would do it and also write pseudo codes for all the operations.

Implementing stack using linked list

stack is a LAST IN FIRST OUT data structure. since we are adding and removing from one end of the list we can maintain a single pointer. we can create a node called top and use new node as top each time we push an element to the stack.

```
push(list, value):
      new_node <= new Node(value)
      new_node.next <= list.head
      list.head <= new_node

pop(list):
      if list.head is NULL:
            return -1
      current_val <= list.head.data
      list.head <= list.head.next
      return current_val

peak(list):
      if list.head is NULL:
            return -1
      return list.head.data

is_empty(list):
      if list.head is NULL:
            return true
      else:
            return false
```

implementing a queue using linked list

queue is a FIRST IN FIRST OUT data structure. we add elements to the queues from one side and remove elements from the other side. so we have to maintain two pointers to implement a queue using linked lists. to enque data we have to use the rear pointer and to deque the data we have to use the front pointer.

```
enqueue(list, value):
      new_node <= new Node(value)
      if list.rear is NULL:
            list.rear <= new_node
            list.front <= list.rear
      else:
            list.rear.next <= new_node
            list.resr <= new_node

dequeue(list):
      if list.front is NULL:
            return -1
      removed_value <= list.front.data
      list.front <= list.front.next
      return removed_value

front(list):
      if list.front is NULL:
            return -1
      else:
            return list.front.data

is_empty(list):
      if list.front is NULL:
            return true
      else:
            return false
```