Programming and Algorithms

# COMP1038.PGA

# Week 8 – Lecture 3: Doubly linked list

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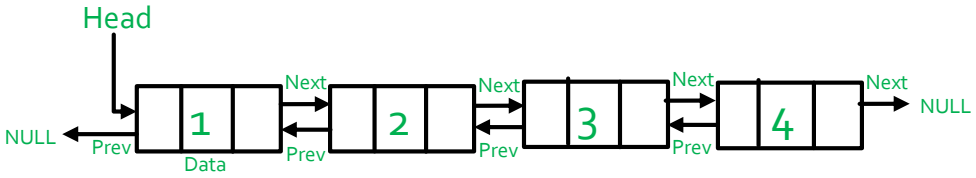
# Outline

- Doubly linked list
  - Introduction
  - Creation
  - Insertion
  - Deletion
  - Printing

# Introduction

- Pointer to next element as with singly-linked list.
- Pointer to previous element as well.
- Can access previous element just by using previous pointer.
- More efficient navigation but more complex algorithms and larger storage requirements



# Creation

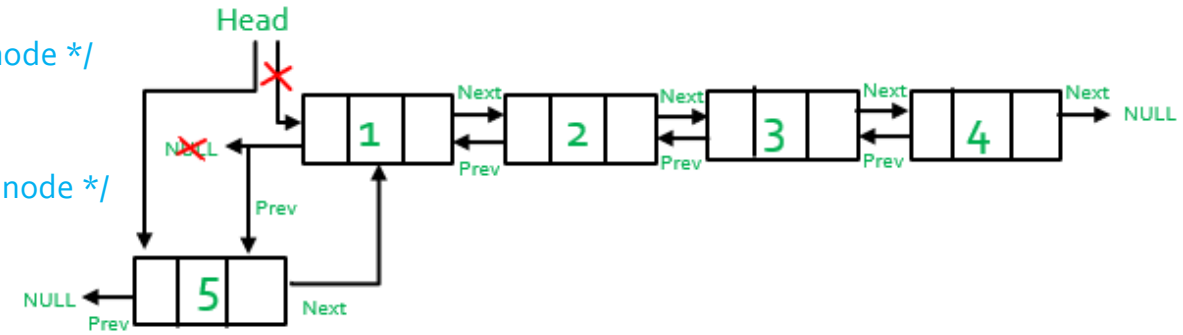
```
/* Node of a doubly linked list */
struct Node {
    int data;
    struct Node* next; // Pointer to next node in DLL
    struct Node* prev; // Pointer to previous node in DLL
};
```

# Insertion

- **Add a node at the front:**

```
void insertAtBegining(struct Node** head_ref, int new_data)
{
   /* 1. allocate node */
   struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));

   /* 2. put in the data  */
   new_node->data = new_data;

   /* 3. Make next of new node as head and previous as NULL */
   new_node->next = (*head_ref);
   new_node->prev = NULL;

   /* 4. change prev of head node to new node */
   if ((*head_ref) != NULL)
      (*head_ref)->prev = new_node;

   /* 5. move the head to point to the new node */
   (*head_ref) = new_node;
}
```

new_data = 5

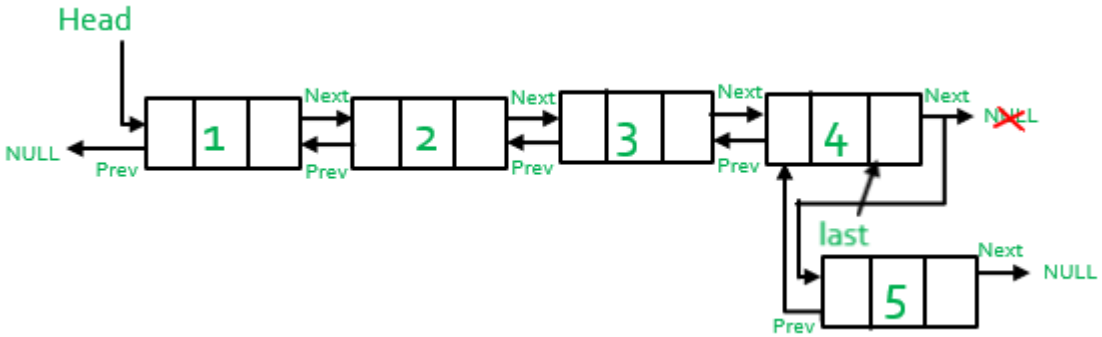


# Insertion cont…

- **Add a node at the end:**

```
void InsertEnd(struct Node** head_ref, int new_data)
{   /* 1. allocate node */
   struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));

   struct Node* last = *head_ref; /* used in step 5*/

   /* 2. put in the data  */
   new_node->data = new_data;

   /* 3. This new node is going to be the last node, so
         make next of it as NULL*/
   new_node->next = NULL;

   /* 4. If the Linked List is empty, then make the new
         node as head */
   if (*head_ref == NULL) {
      new_node->prev = NULL;
      *head_ref = new_node;
      return;
   }
   /* 5. Else traverse till the last node */
   while (last->next != NULL)
      last = last->next;

   /* 6. Change the next of last node */
   last->next = new_node;

   /* 7. Make last node as previous of new node */
   new_node->prev = last;

   return;
}
```

new_data = 5

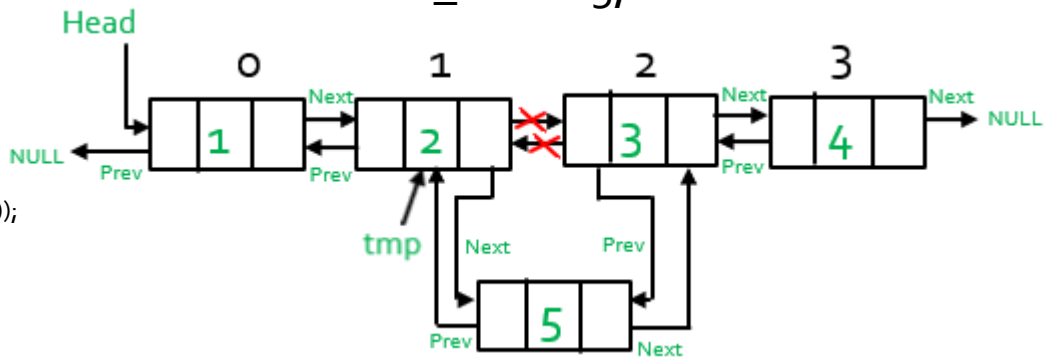


# Insertion cont…

- **Add a node after a given index:**

```
/* Given a reference (pointer to pointer) to the head
of a DLL and an int index, inserts a new node after the index */
void insertAfterIndex(struct Node** head_ref, int new_data, int index)
{
    /* 1. if list in NULL or invalid position is given */
    if (*head_ref== NULL || index < 0)
        return;

    struct Node* tmp = *head_ref;
    int i;

    /* 2. traverse up to the node at position 'index' from the beginning */
    for (i= 0; tmp != NULL && i< index; i++)
      tmp = tmp->next;

    /* 3. if 'index' is greater than the number of nodes in the doubly
          linked list */
    if (tmp == NULL)
      return;

    /* 4. allocate new node */
    struct Node* new_node = (struct Node*)malloc(sizeof(struct Node));

     /* 5. put in the data */
    new_node->data = new_data;

    /* 6. Make next of new node as next of prev_node */
    new_node->next = tmp->next;

    /* 7. Make the next of prev_node as new_node */
    tmp->next = new_node;

    /* 8. Make prev_node as previous of new_node */
    new_node->prev = tmp;

    /* 9. Change previous of new_node's next node */
    if (new_node->next != NULL)
          new_node->next->prev = new_node;
}
```

new_data = 5, index = 1

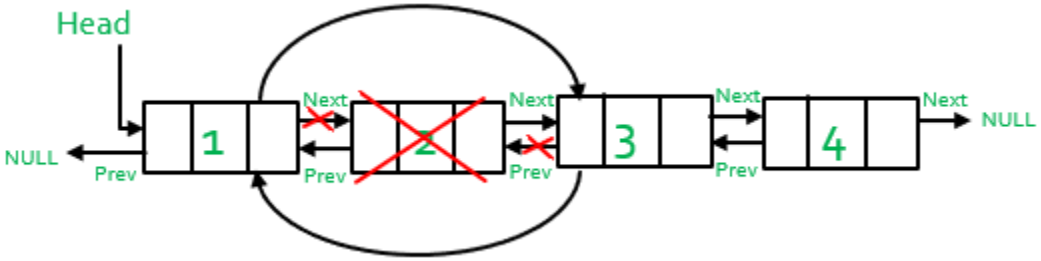


# Deletion

- **Deletion at the at the given node pointer:**

```
/* Function to delete a node in a Doubly Linked List.
  head_ref --> pointer to head node pointer.
  del  -->  pointer to node to be deleted. */
void deleteNode(struct Node** head_ref, struct Node* del)
{
   /* base case */
   if (*head_ref == NULL || del == NULL)
      return;

   /* If node to be deleted is head node */
   if (*head_ref == del)
      *head_ref = del->next;

   /* Change next only if node to be deleted is NOT the last node */
   if (del->next != NULL)
      del->next->prev = del->prev;

   /* Change prev only if node to be deleted is NOT the first node */
   if (del->prev != NULL)
      del->prev->next = del->next;

   /* Finally, free the memory occupied by del*/
   free(del);
   return;
}
```

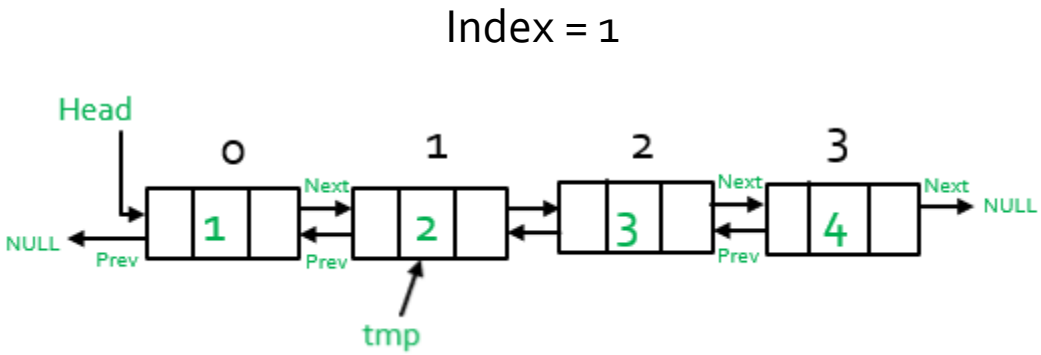
del -> pointing to node 2



# Deletion cont...

- **Deletion at the given node index:**

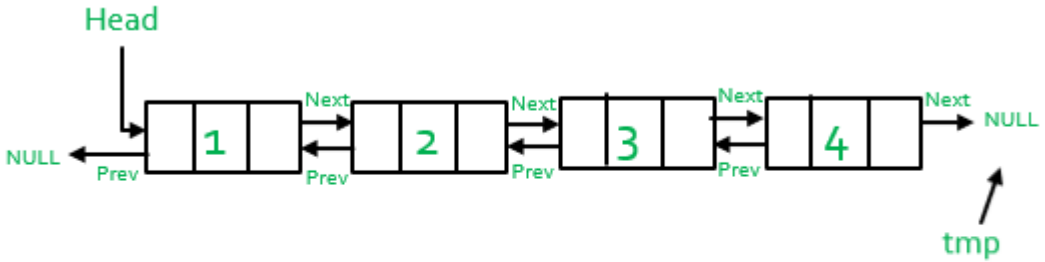
```
/* Function to delete the node at the given node index
  in the doubly linked list */
void deleteNodeAtGivenIndex(struct Node** head_ref, int index)
{
   /* if list in NULL or invalid index is given */
   if (*head_ref == NULL || index < 0)
      return;

   struct Node* tmp = *head_ref;
   int i;

   /* traverse up to the node at position 'index' from
     the beginning */
   for (int i = 0; tmp != NULL && i < index; i++)
       tmp = tmp ->next;

   /* if 'index' is greater than the number of nodes
     in the doubly linked list */
   if (tmp == NULL)
      return;

   /* delete the node pointed to by 'tmp' */
   deleteNode(head_ref, tmp);
}
```




Call the 'deleteNode' function from the last slide where del = tmp

# Printing

```
void printList(struct Node** head_ref)
{   struct Node* tmp = *head_ref;
    while (tmp != NULL) {
       printf ("%d ", tmp->data);
       tmp = tmp->next;
   }
}
```




1 2 3 4

# Applications

- Doubly linked list can be used in navigation systems where both front and back navigation is required.
- It is used by browsers to implement backward and forward navigation of visited web pages i.e. back and forward button.
- It is also used by various application to implement Undo and Redo functionality.

# The End