Data Structure

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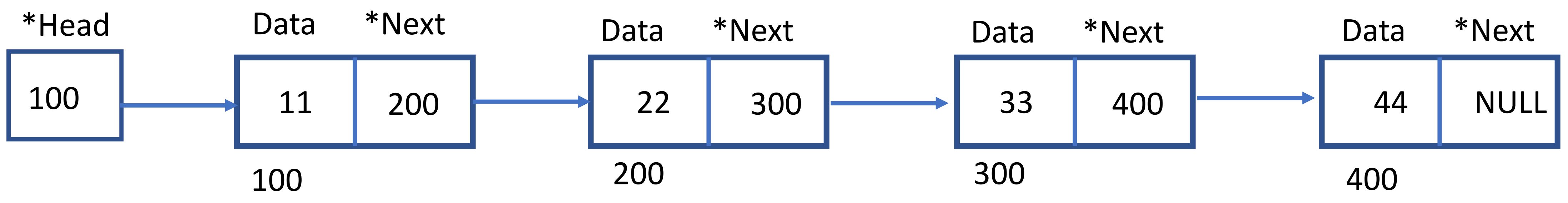
Linked List - Introduction :

- Like Arrays , Linked List is a LINEAR DATA STRUCTURE.
- But unlike arrays, Linked Lists are NOT stored in contiguous memory locations.
- The items in the linked lists are connected to one another using pointers.
- These items are called as NODES.
- Each node contains 2 parts :
  - Data part : it contains actual data (primitive or non-primitive data).
  - Next part : it is a pointer which contains the address of the next node.
- Address of the first node is stored in the Head pointer.



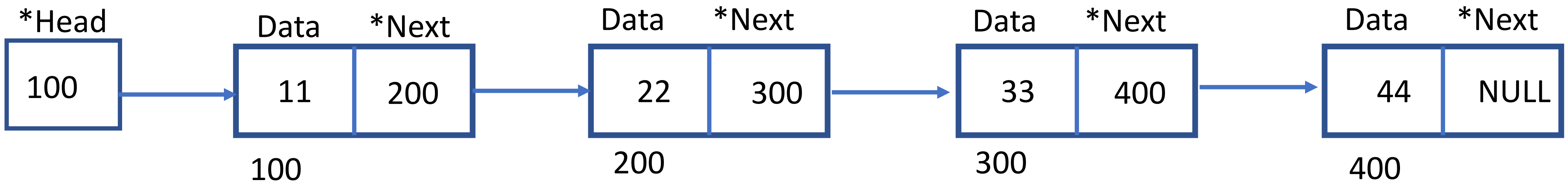
Linked Lists :

- Why Linked List ?
  - Linked Lists are dynamically allocated as and when required and released after it serves its purpose. so unlike arrays they can grow or shrink in size at runtime.
  - Adding or deleting an item in a linked list is much efficient and easier compared to arrays.

- Types of Linked Lists :
  1. Singly Linear Linked List
  2. Singly Circular Linked List
  3. Doubly Linear Linked List
  4. Doubly Circular Linked List

Singly Linear Linked List :

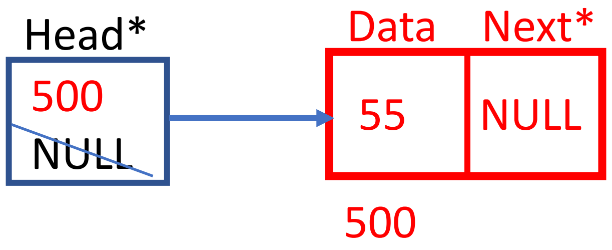
- This linked list is also called as simple linked list.
- It is a type of linked list in which the list can be traversed only in one direction.
- In this, the pointer of each node points to other nodes whereas the pointer of last node contains NULL.
- Address of first node is stored in the Head pointer.



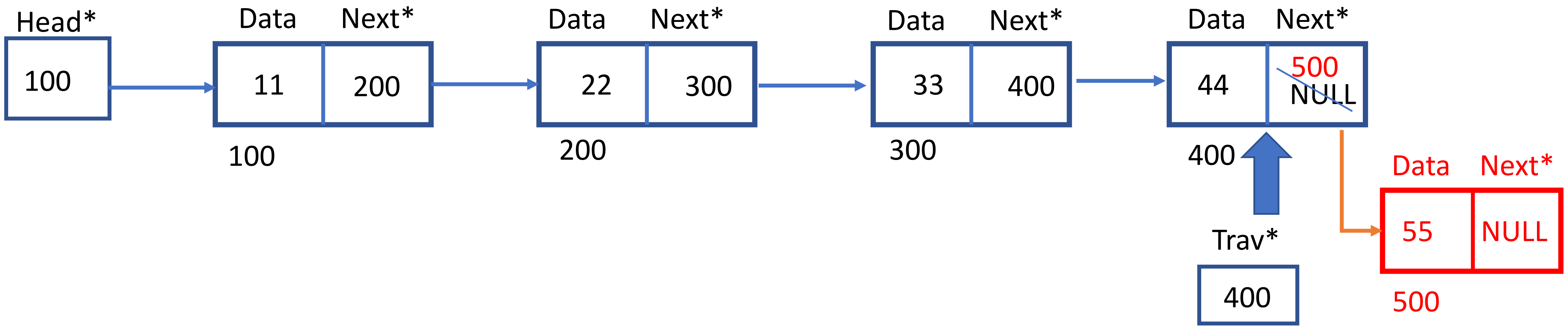
- Operations performed on linked list :
  - Add node at first position
  - Add node at last position
  - Add node at specific position
  - Delete node at first position
  - Delete node at last position
  - Delete node at specific position
  - Traverse the list

Singly Linear Linked List - Add at Last position :

- If Head is NULL, Add the new node to the Head.

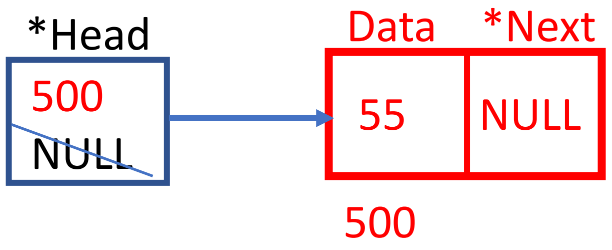


- Else, Traverse the list till the last node and add the address of new node to the next part of the last node.

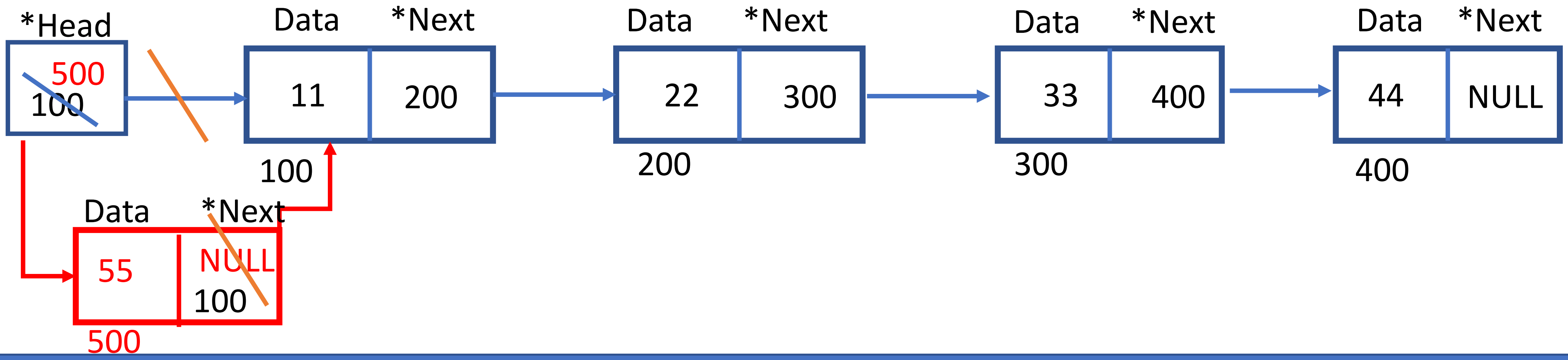


Singly Linear Linked List – Add at First position :

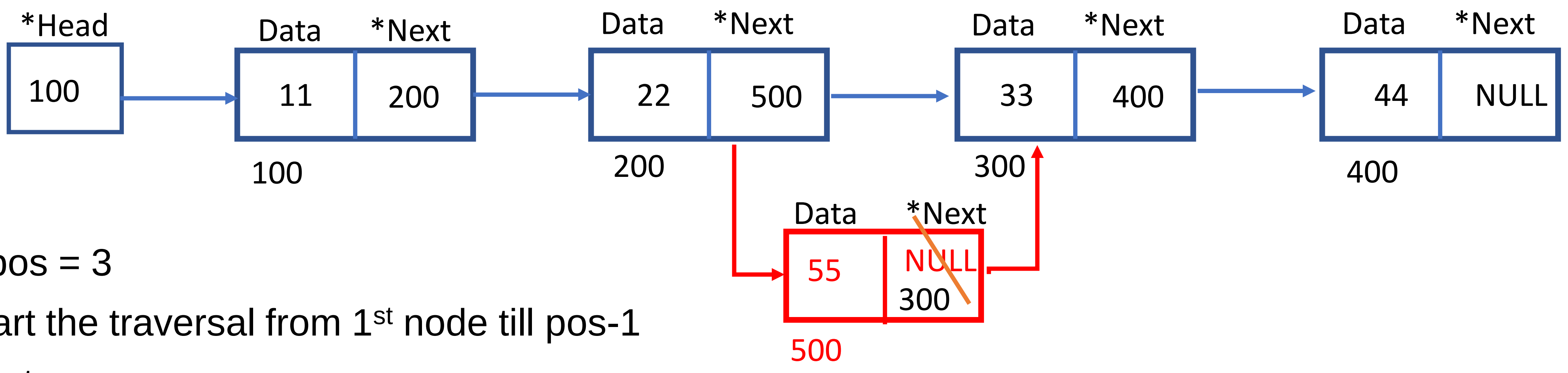
- If Head is NULL, Add the new node to the Head.



- To add a new node at the first position always create a new connection first between the new node and the already existing first node. Then change the address inside head pointer to point to the new node. So the Rule is MAKE BEFORE BREAK.



Singly Linear Linked List – Add at Specific position



If pos = 3

Start the traversal from 1st node till pos-1

Next,

Store address of current pos node into next part of newnode

newnode->next=trav->next

Store an address of newly created node into next part of (pos-1)th node

Trav->next = newnode;

SLLL Time Complexity :

- add node into the linked list at last position (slll): -
  - we can add as many as we want number of nodes into slll in O(n)
  - Best Case : Ω(1)
  - Worst Case : O(n)
  - Average Case : θ(n)
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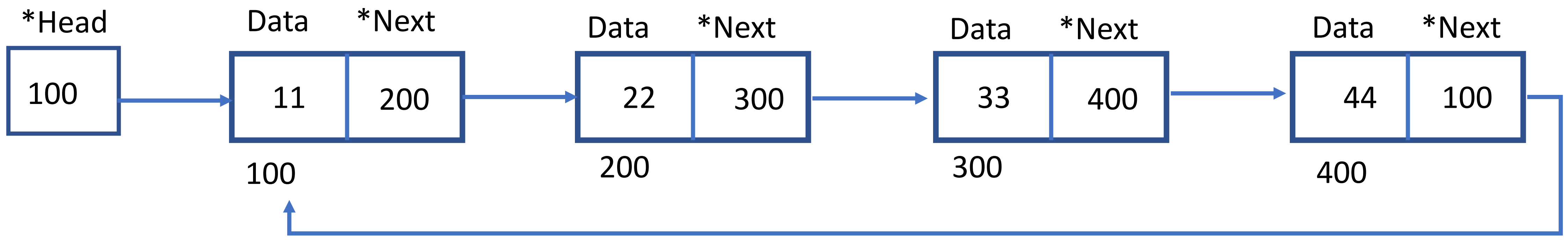
  - we can add as many as we want number of nodes into slll in O(1)
  - Best Case : Ω(1)
  - Worst Case : O(1)
  - Average Case : θ(1)
- add node into the linked list at specific position (in between pos) (slll): -
  - we can add as many as we want number of nodes into slll in O(n)
  - Best Case : Ω(1) => if pos == 1
  - Worst Case : O(n)
  - Average Case : θ(n)

SLLL Time Complexity :

- delete node from the linked list at first position –
    - we can delete node which is first pos from slll in O(1) time.
    - Best Case : Ω(1)
    - Worst Case : O(1)
    - Average Case : θ(1)
- delete node from the linked list at last position: -
    - we can delete node which is last pos from slll in O(n) time.
    - Best Case : Ω(1) => if list contains only one node
    - Worst Case : O(n)
    - Average Case : θ(n)
- delete node from the linked list at specific position (in between position) –
    - we can delete node which is first pos from slll in O(n) time.
    - Best Case : Ω(1) => if pos == 1
    - Worst Case : O(n) => if pos == max+1
    - Average Case : θ(n)

Singly Circular Linked List :

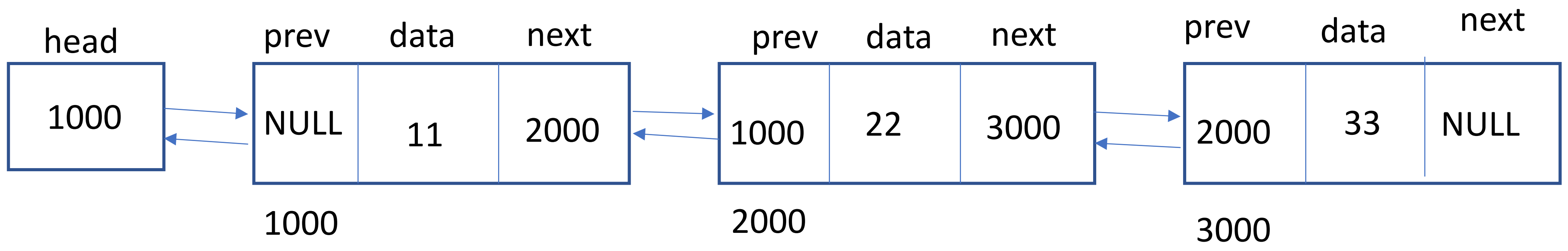
- In this list the last node is linked to the first node. The address of first node is stored in the pointer of the last node.



- Limitations :
  - It is considered as the most inefficient linked list as the add and delete operations on first position also require the traversal till last node to update the pointer.
  - We can traverse only in forward direction.
  - All the operations on this list require O(n) time.

Doubly Linear Linked List :

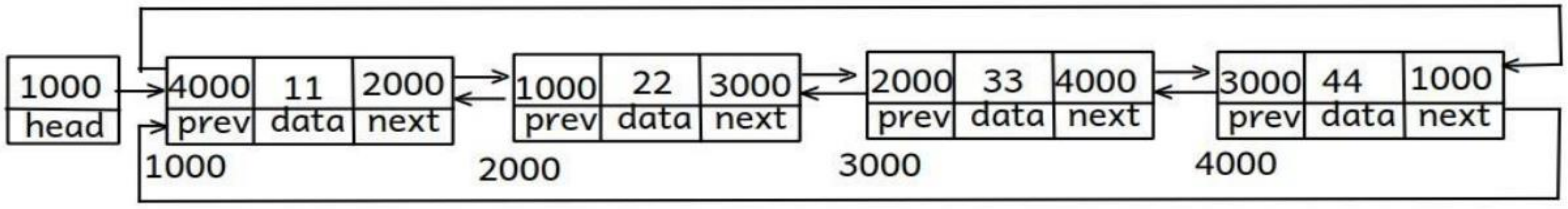
- It is a linked list in which head always contains an address of first element, if list is not empty.
- Each node has three parts:
  - data part: contains data of any primitive/non-primitive type.
  - pointer part(next): contains an address of its next element/node.
  - pointer part(prev): contains an address of its previous element/node.
- next part of last node & prev part of first node point to NULL.



- Limitations :
  - Add last and delete last operations are not efficient as it takes O(n) time.
  - We can starts traversal only from first node, and hence to overcome these limitations Doubly Circular Linked List has been designed.

Doubly Circular Linked List :

- It is a linked list in which head always contains an address of first node, if list is not empty.
- each node has three parts:
  - data part: contains data of any primitive/non-primitive type.
  - pointer part(next): contains an address of its next element/node.
  - pointer part(prev): contains an address of its previous element/node.
- next part of last node contains an address of first node & prev part of first node contains an address of last node.



Linked List :

Advantages of Doubly Circular Linked List:

- DCLL can be traverse in forward as well as in a backward direction.

-Add last, add first, delete last & delete first operations are efficient as it takes O(1) time and are convenient as well.

- Traversal can be start either from first node or from last node.

- Any node can be revisited.

- Previous node of any node can be accessed from it

Array v/s Linked List:

- Array is **static** data structure whereas linked list is dynamic data structure.

-Array elements can be accessed by using **random access** method which is efficient than linked list elements which can be accessed by **sequential access** method.

- Addition & Deletion operations are efficient on linked list than on an array.

- Array elements gets stored into the **stack section**, whereas linked list elements gets stored into **heap section.**

-In a linked list extra space is required to maintain link between elements, whereas in an array to maintain link between elements is the job of **compiler**.

Thank You !!