Linked List

ADT Single Linked List

Objects:

Finite number of nodes having the same type. Nodes are linked together as in a chain with the help of a field in them. A special variable points to the first element of the chain.

ADT Single Linked List …

Operations:

init_l(cur) – initialise a list

empty_l(head) – boolean function to return true if list pointed to by head is empty

atend_l(cur) – boolean function to return true if cur points to the last node in the list

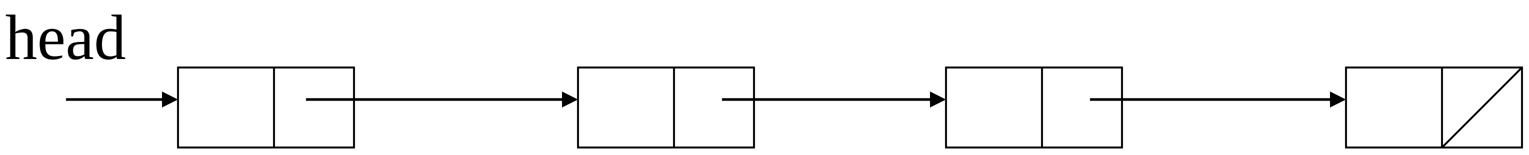
insert_front(target, head) – insert the node pointed to by target as the first node of the list pointed to by head

insert_after(target, prev) – insert the node pointed to by target after the node pointed to by prev

delete_front(head) – delete the first element of the list pointed to by head

delete_after(prev) – delete the node after the one pointed to by prev

ADT Single Linked List …



Linked List Problems

1. Read integers from a file and arrange them in a linked list
(a) in the order they are read, (b) in reverse order.

2. Search for a key in (a) an unordered list, (b) an ordered list. Return the node if key found and delete the element from original list.

3. Find the size of a list

4. Write a boolean function **equal_list**.

5. Print a list (a) in the same order, (b) in the reverse order.

6. Append a list at the end of another list.

7. Delete the n^{th} Node of a list.

Linked List Problems …

8. Write a boolean function **ordered** to return true if the information in the list are ordered.

9. Merge two sorted lists

10. Insert a target node before a specified node.

11. Delete a list.

12. Reverse a list.

13. Sort a list.

C pointer implementation of Single Linked List

```
typedef struct nodetag {
                              T            info;
                              struct nodetag * next;
                              }  nodetype;

    nodetype *head, *cur, *prev, *next, *target;

    nodetype * createnode(T   item) {
          nodetype    *head = NULL;
    if ((head = (nodetype *)malloc(sizeof (nodetype)) == NULL)
          perror(“malloc eror”);
    else {head-> info = item; head->next = NULL;}
    return head; }
```

Single Linked List Operations

```
nodetype * init_l() {return     NULL};

int  empty_l(nodetype *head) { return (head == NULL)};

int  atend_l(nodetype *cur) { if (cur == NULL)
                                  return 0;
                                  else return (cur->next == NULL);}

void  insert_front(nodetype *target, nodetype **phead) {
                                  target ->next = *phead;
                                  *phead = target;
                                  }
```

Linked List Operations …

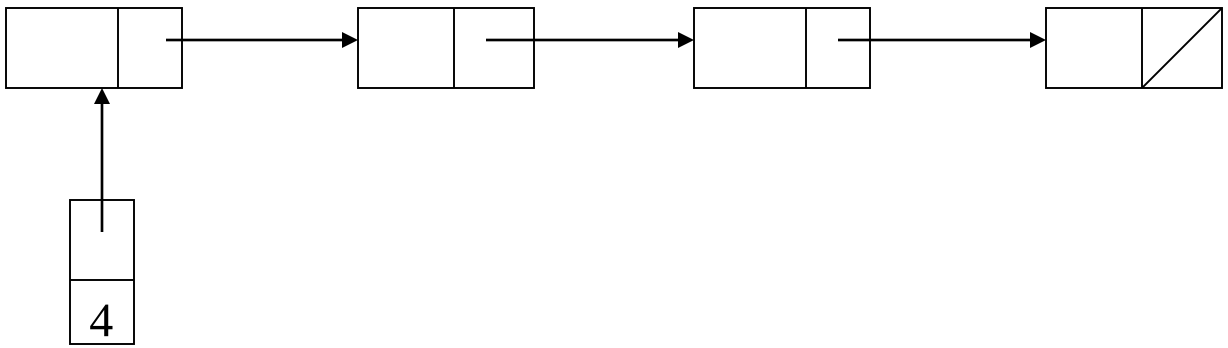
```
void  insert_after (nodetype  *target, nodetype  *prev) {
        nodetype  *cur;
        cur = prev -> next;
        target -> next = cur;
        prev -> next = target;}

void  delete_front( nodetype **phead) {
        nodetype *cur;
        cur =  *phead;
        *phead = (*phead)->next;
        free(cur);
        }
```

Linked List Operations …

```
void delete_after (nodetype *prev) {
        nodetype *cur;
        if ( !(atend_l(prev)){
                cur  =  prev -> next;
                prev -> next = cur ->next;
                free(cur);
                }}
```

The concept of Linked List is applied in all linked structures.

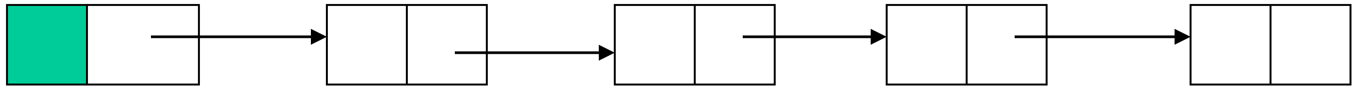
Variations of SLL



•List with a special head node containing the length of the list as info.

•One can also store the max, min and other statistics if required.

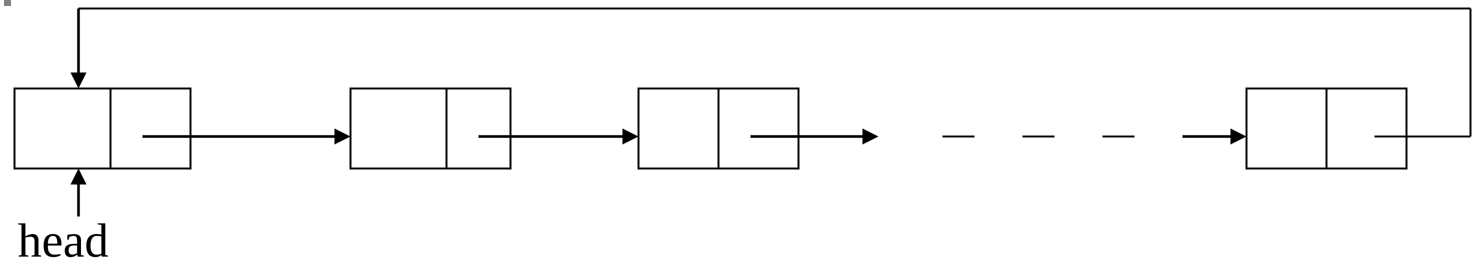
Variations of SLL …



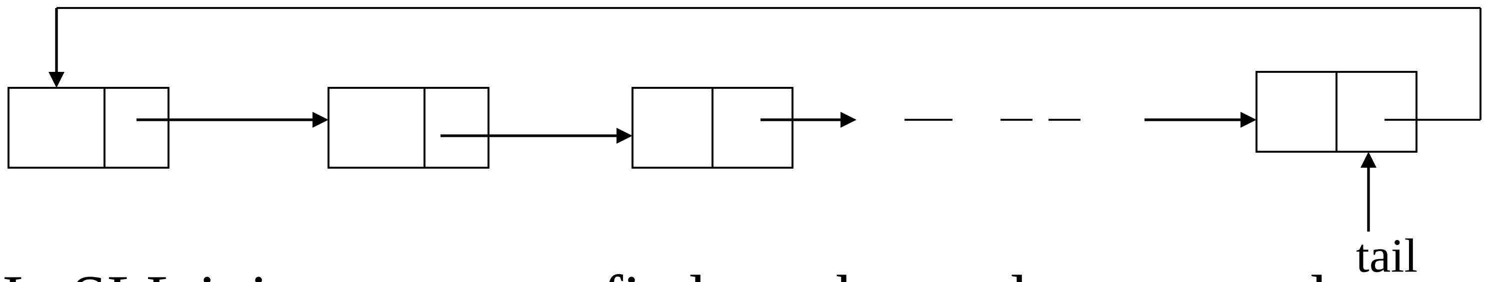
•List with a dummy first node.

•Uniform insertion and deletion operation – insert_front and delete_front are not necessary.

Circular SLL

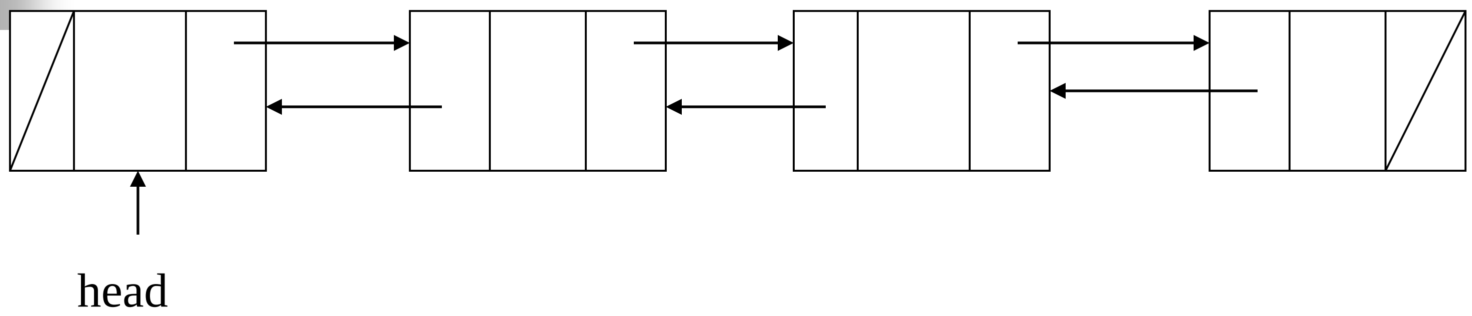


- Any node to any node traversal is possible
- But to enter a node after the last element, one has to traverse the whole list
- Using a tail pointer instead of a head pointer may be useful



- In SLL it is not easy to find out the predecessor node
- Solution is Doubly Linked List

Doubly Linked List



typedef struct nodetag {

T info;

struct nodetag *prev, *next;

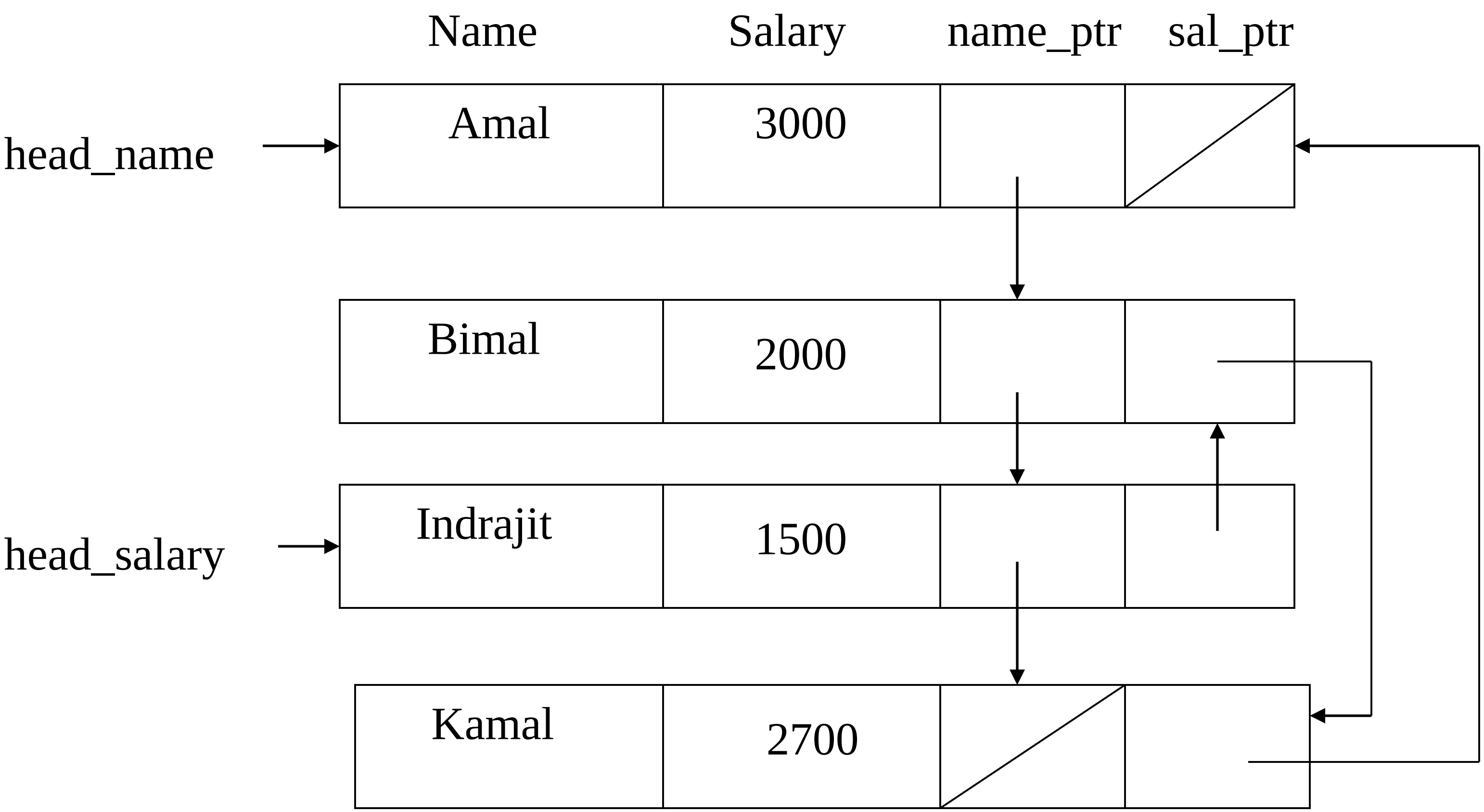
} nodetype;

- Two-way movement becomes easy
- Current node can be deleted.
- DLL with special head node is possible.
- DLL with two dummy nodes at the two ends is also a possible configuration.
- Circular DLLs are also useful
- Find the operations possible for ADT DLL and implement them

Multi-way Linked List

When different links can be used to traverse different nodes in a list, we call it a multi-way linked list or simply, multi-list.

Example:

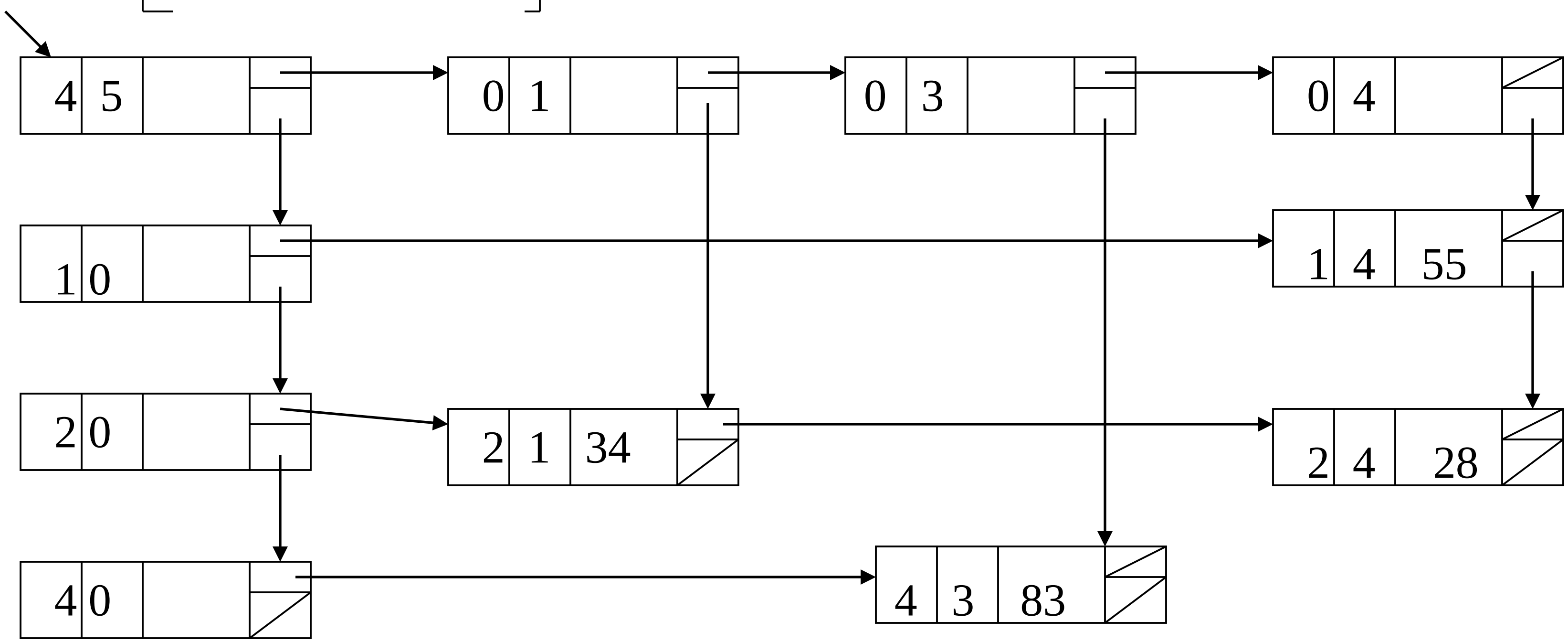


Representation of Polynomials

- Each term may be represented by a two-component structure consisting of the exponent and coefficient
- These structures are to be linked by pointers
- Each polynomial will be represented by a linked list

Sparse Matrix using Multi-list

$$\begin{bmatrix} 0 & 0 & 0 & 55 & 0 \\ 34 & 0 & 0 & 28 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 83 & 0 & 0 \end{bmatrix}$$



Implementation of Single Linked List using Array

- Nodes consist of an info field and a cursor field.
- Cursors represent the array index of the next node.
- There is a node-pool of such nodes.
- All the linked lists are stored in the same node-pool.
- An "*available-nodes*" list maintains all the unused nodes.

Implementation of Single Linked List using Array

```
#define  mne    <max no. of nodes>

typedef  struct  { T        info;
                   int      cursor;
                   } nodetype;

nodetype        node_pool [mne];

int   head1, head2,  head3,  cur, prev, avail;
```

Write all the ADT operations of ADT Single Linked List for the implementation using array.

Summary

- Arrays, Structures and Linked structures constitute the base data structures

- All other advanced data structures can be implemented using these base data structures as building blocks

- While arrays are used for implementing Static Data structures, Linked structures along with memory allocation and de-allocation operations are used to implement Dynamic data structures