Digital Assignment- 2

Data Structures (Lab)

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Link:https://drive.google.com/drive/folders/19gQ6qLNeWQu3_6CzPHfKICQrybHrqRk0?usp=sharing

Note: All programs can be downloaded from the link above.

Ques 1. Implement single linked list operation such as 1. Insertion at front, 2. Insertion in middle 3 insertion at the last 4. Deletion at front, 5. Deletion at last 6. deletion in the middle. 7. Sorting 8. Counting nodes.

Answer:

```
#include <stdio.h>
#include <malloc.h>
//Coded By Hari Krishna Shah
struct node{
        int data;
        struct node *next;
};
struct node *create_and_expand(struct node *);
struct node *insert_end(struct node *);
struct node *display(struct node *);
struct node *count(struct node *);
struct node *search(struct node *);
struct node *add_head(struct node *);
struct node *add_after(struct node *);
struct node *add_before(struct node *);
struct node *delete_head(struct node *);
struct node *delete_end(struct node *);
struct node *delete_with_data(struct node *);
struct node *delete_before_data(struct node *);
struct node *delete_after_data(struct node *);
struct node *delete_all(struct node *);
struct node *sort_acc(struct node *);
struct node *sort_des(struct node *);
struct node *add_in_search(struct node *);
```

```
struct node *add_in_middle(struct node *);
struct node *delete_the_middle(struct node *);
struct node *delete_except(struct node *);
int main(){
	int option = 0;
	struct node *start = NULL;

	while(option != -1){
		printf("\t\t\tThis program is created by Hari Krishna Shah.\n");
		printf("Welcome to the Main-Menu !\n\
		Enter 1 to create and expand linked list \n\
		Enter 2 to add node after end.\n\
		Enter 3 to display linked list.\n\
		Enter 4 to count the number of nodes in the linked list.\n\
		Enter 5 to search the linked list\n \
		Enter 6 to add node in the beginning\n \
		Enter 7 to add node after data\n \
		Enter 8 to add node before data\n \
		Enter 9 to delete the first node\n \
		Enter 10 to delete the last node\n \
		Enter 11 to delete the node with the searched data\n \
		Enter 12 to delete the node which is before the searched data.\n \
		Enter 13 to delete the node which is after the searched data\n \
		Enter 14 to delete the entire list\n \
		Enter 15 to sort the nodes in accesending ordr\n \
		Enter 16 to sort the nodes in decending order\n \
		Enter 17 to add a new data to a data node\n \
		Enter 18 to add a node in the middle\n \
		Enter 19 to delete the middle node \n \
		Enter 20 to delete all the list expect a specified node\n \
		Enter -1 to exit the program\n");
		printf("\nEnter your option here: ");
		scanf("%d", &option);

		switch(option){
			case 1:
				start = create_and_expand(start);
```

```
            break;

        case 2:
            start = insert_end(start);
            break;

        case 3:
            start = display(start);
            break;

        case 4:
            start = count(start);
            break;
        case 5:
            start = search(start);
            break;
        case 6:
            start = add_head(start);
            break;
        case 7:
            start = add_after(start);
            break;
        case 8:
            start = add_before(start);
            break;
        case 9:
            start = delete_head(start);
            break;
        case 10:
            start = delete_end(start);
            break;
        case 11:
            start = delete_with_data(start);
            break;
        case 12:
            start = delete_before_data(start);
            break;
        case 13:
            start = delete_after_data(start);
            break;
```

```
                case 14:
                        start = delete_all(start);
                        break;
                case 15:
                        start = sort_acc(start);
                        break;
                case 16:
                        start = sort_des(start);
                        break;
                case 17:
                        start = add_in_search(start);
                        break;
                case 18:
                        start = add_in_middle(start);
                        break;
                case 19:
                        start = delete_the_middle(start);
                        break;
                case 20:
                        start = delete_except(start);
                        break;
                case -1:
                        break;
                default:
                        printf("Please enter a valid option and try again
!!!\n\n");
                }
        }
        printf("Thank you for using the program.\n");
        printf("The program exited successfully.\n");
        return 0;
}

struct node *create_and_expand(struct node *start){
        struct node *new_node, *ptr, temp;
        int num;
        if(start == NULL){
                new_node = (struct node *) (malloc(sizeof(struct node)));
                start = new_node;
```

```
            printf("Enter the data to insert in the first node: ");
            scanf("%d", &num);
            start->data = num;
            start->next = NULL;
            printf("The linked list has been created.\n\n");
        }
        else{
            printf("The linked list already exists.\n");
        }
        printf("Enter the data below to expand it.\n");
        ptr = start;
        while(ptr->next !=NULL){
                    ptr = ptr->next;
        }
        printf("Enter -1 to stop expanding the list else enter the data to
store in the next node: ");
            scanf("%d", &num);
        while(num !=-1){
            struct node *new_node;
            new_node = (struct node *) (malloc(sizeof(node)));
            ptr->next = new_node;
            new_node->next = NULL;
            new_node->data = num;
            ptr = new_node;
            printf("Enter -1 to stop expanding the list else enter the
data to store in the next node: ");
            scanf("%d", &num);
        }
        printf("\n");
        return start;

}

struct node *insert_end(struct node *start){
        int num;
        struct node *ptr, *new_node;
        new_node = (struct node *) (malloc(sizeof(struct node)));
        ptr = start;
        printf("Enter the data to store at the last node: ");
        scanf("%d", &num);
```

```
        new_node->data = num;
        if(start == NULL){
                start = new_node;
                start->next = NULL;
                return start;
        }
        while(ptr->next != NULL){
                ptr = ptr->next;
        }
        ptr->next = new_node;
        new_node->next=NULL;
        printf("The node has been added at the end.\n\n");

        return start;
}

struct node *display(struct node *start){
        if(start == NULL){
                printf("The linked list is empty.\n\n");
                return start;
        }
        struct node *ptr;
        ptr = start;
        printf("The data are: ");
        while(ptr != NULL){
                printf("%d ", ptr->data);
                ptr = ptr->next;
        }
        printf("\n\n");
        return start;

}

struct node *count(struct node *start){
        struct node *ptr;
        ptr = start;
        int count = 0;
        while(ptr != NULL){
                count += 1;
                ptr = ptr->next;
```

```
        }
        printf("The number of nodes are %d.\n\n", count);

        return start;
}

struct node *search(struct node *start){
        if(start == NULL){
                printf("The linked list is empty. Add some nodes first.\n");
                return start;
        }
        struct node *ptr;
        ptr = start;
        int i = 0;
        int count = 0;
        int number;
        printf("Enter a number to check in the linked list: ");
        scanf("%d", &number);
        while(ptr!= NULL){
                if(ptr->data == number){
                        printf("The number %d is available in the linked list
at index %d.\n\n", number, i);
                        count = count + 1;
                }
                i = i+1;
                ptr = ptr->next;
        }
        if(count == 0){
                printf("The number %d is not available in the linked
list.\n\n", number);
        }
        return start;
}

struct node *add_head(struct node *start){
        struct node *new_node, *temp;
        int num;
        temp = start;
        new_node = (struct node *) (malloc(sizeof(struct node)));
        printf("Enter the data to insert in the first node: ");
```

```
        scanf("%d", &num);
        if(start == NULL){
                start = new_node;
                start->data = num;
                start->next = NULL;
        }

        else{
                new_node->next = temp;
                new_node->data = num;
                start = new_node;
        }
        printf("The data has been added to the head of the linked
list.\n\n");
        return start;

}

struct node *add_after(struct node *start){
        if(start == NULL){
                printf("The link is empty. Add some nodes to the list
first.\n\n");
                return start;
        }
        struct node *new_node, *ptr, *temp;
        new_node = (struct node *) (malloc(sizeof(struct node)));
        int num, check_data;
        printf("Enter the data after which the node is to be added: ");
        scanf("%d", &check_data);
        ptr = start;
        while(ptr->data != check_data){
                ptr = ptr->next;
                if(ptr == NULL){
                printf("The searched data couldn't be found. The process
terminated.\n\n");
                return start;
                }
        }
        printf("Enter the data to be stored: ");
        scanf("%d", &num);
```

```
        temp = ptr->next;
        ptr->next = new_node;
        new_node->data = num;
        new_node->next = temp;
        printf("The node has been added after the data %d.\n\n",
check_data);
        return start;
}

struct node *add_before(struct node *start){
        if(start == NULL){
                printf("The link is empty. Add some nodes to the list
first.\n\n");
                return start;
        }
        struct node *new_node, *ptr, *temp;
        int num, check_data;
        printf("Enter the data before which node is to be added: ");
        scanf("%d", &check_data);
        ptr = start;
        if(start->data == check_data){
                printf("The matched data was found to be in the first node
of data.\n");
                printf("Now we need to add a new head to our linked
list.\n");
                start = add_head(start);
                return start;
        }
        else{
                while(ptr->data != check_data){
                ptr = ptr->next;
                if(ptr == NULL){
                        printf("The searched data couldn't be found. The
process terminated.\n\n");
                        return start;
                }
        }
        new_node = (struct node *) (malloc(sizeof(struct node)));
        printf("Enter the data to be stored: ");
        scanf("%d", &num);
```

```
        temp = ptr;
        ptr = start;
        while(ptr->next != temp){
        ptr = ptr->next;
        }
        ptr->next = new_node;
        new_node->data = num;
        new_node->next = temp;
        }
        printf("The node has been added before the data %d.\n\n",
check_data);
        return start;

}

struct node *delete_head(struct node *start){
        struct node *temp1, *temp2;
        temp2 = start;
        if(start == NULL){
                printf("The linked list is empty.\n\n");
                return start;
        }
        temp1 = start->next;
        free(temp2);
        start = temp1;
        printf("The first node has been deleted sucessfully.\n\n");
        return start;
}

struct node *delete_end(struct node *start){
        if(start == NULL){
                printf("The linked list is empty.\n\n");
                return start;
        }
        if(start->next == NULL){
                printf("Currenlty, there is only one node in the linked list
so, the first node is also the last node.\n");
                start = delete_head(start);
                return start;
        }
```

```
        struct node *ptr, *temp;
        ptr = start;
        while(ptr->next != NULL){
                ptr = ptr->next;
        }
        temp = ptr;
        ptr = start;
        while(ptr->next != temp){
                ptr = ptr->next;
        }
        ptr->next = NULL;
        free(temp);
        printf("The last node has been deleted sucessfully.\n\n");
        return start;

}

struct node *delete_with_data(struct node *start){
        struct node *ptr, *temp1, *temp2;
        ptr = start;
        if(start == NULL){
                printf("The linked list is empty. Add some nodes first and
try again.\n");
                return start;
        }
        int num;
        printf("Enter the data of the node which you want to delete: ");
        scanf("%d", &num);
        if(start->data == num){
                start = delete_head(start);
                return start;
        }
        while(ptr->data != num){
                ptr = ptr->next;
                if(ptr == NULL){
                        printf("The searched data was not found in the linked
list.");
                        return start;
                }
        }
```

```
        temp1 = ptr;
        temp2 = ptr->next;
        ptr = start;
        while(ptr->next != temp1){
                ptr = ptr->next;
        }
        ptr->next = temp2;
        free(temp1);
        printf("The node containing the number %d has been deleted
successfully.\n\n", num);
        return start;
}

struct node *delete_before_data(struct node *start){
        if(start == NULL){
                printf("The linked list is empty.\n\n");
                return start;
        }
        struct node *ptr, *temp1, *temp2;
        int num;
        printf("Enter the data of whose before node is to be deleted: ");
        scanf("%d", &num);
        if(start->data == num){
                printf("The data is in the first node of the linked list.\nso,
its before node can't be deleted.\n\n");
                return start;
        }
        ptr = start;
        while(ptr->data != num){
                ptr = ptr->next;
                if(ptr == NULL){
                        printf("The searched data is not in the list.\n\n");
                        return start;
                }
        }
        temp1 = ptr;
        ptr = start;
        while(ptr->next != temp1){
                ptr = ptr->next;
        }
```

```
        temp2 = ptr;
        if(temp2 == start){
                start = delete_head(start);
                return start;
        }
        ptr = start;
        while(ptr->next != temp2){
                ptr = ptr->next;
        }
        ptr->next = temp1;
        free(temp2);
        printf("The node before the number %d has been deleted.\n\n",
num);
        return start;
}

struct node *delete_after_data(struct node *start){
        if(start == NULL){
                printf("The linked list is empty.\n\n");
                return start;
        }
        struct node *ptr, *temp1, *temp2;
        int num;
        printf("Enter the data of which suceeding node is to be deleted:
");
        scanf("%d", &num);
        ptr = start;
        while(ptr->data != num){
                ptr = ptr->next;
        }
        if(ptr->next == NULL){
                printf("The matched data is in the last node so its
succedding node cant be deleted.\n\n");
                return start;
        }
        temp1 = ptr;
        temp2 = temp1->next;
        ptr = temp2->next;
        temp1->next = ptr;
        free(temp2);
```

```
        printf("The node after the data %d has been deleted.\n\n", num);
        return start;

}
struct node *delete_all(struct node *start){
        struct node *ptr, *temp;
        ptr = start;
        if(start == NULL){
                printf("The linked list is empty.Add some nodes and try
again.\n");
                return start;
        }
        while(ptr != NULL){
                temp = ptr->next;
                free(ptr);
                ptr = temp;
        }
        printf("The entire linked list has been deleted.\n");
        start = NULL;
        return start;
}

struct node *sort_acc(struct node *start){
        struct node *ptr, *succedptr;
        int temp;
        ptr = start;
        int count = 0;
        if(start == NULL){
                printf("The linked list is empty. Add some nodes first.\n");
                return start;
        }
        succedptr = ptr->next;
        if(start->next == NULL){
                printf("The linked has only one element.So, it doesn't need
to be sorted.\n");
                return start;
        }


        while(ptr != NULL){
```

```
            succedptr = ptr->next;
            while(succedptr != NULL){
                if(ptr->data>succedptr->data){
                    temp = ptr->data;
                    ptr->data = succedptr->data;
                    succedptr->data = temp;
                }
                succedptr = succedptr->next;
            }
            ptr = ptr->next;
        }


        printf("The linked list has been sorted ascending order
successfully.\n");
        return start;

}
struct node *sort_des(struct node *start){
        struct node *ptr, *succedptr;
        int temp;
        ptr = start;
        int count = 0;
        if(start == NULL){
            printf("The linked list is empty. Add some nodes first.\n");
            return start;
        }
        succedptr = ptr->next;
        if(start->next == NULL){
            printf("The linked has only one element.So, it doesn't need
to be sorted.\n");
            return start;
        }


        while(ptr != NULL){
            succedptr = ptr->next;
            while(succedptr != NULL){
                if(ptr->data<succedptr->data){
                    temp = ptr->data;
```

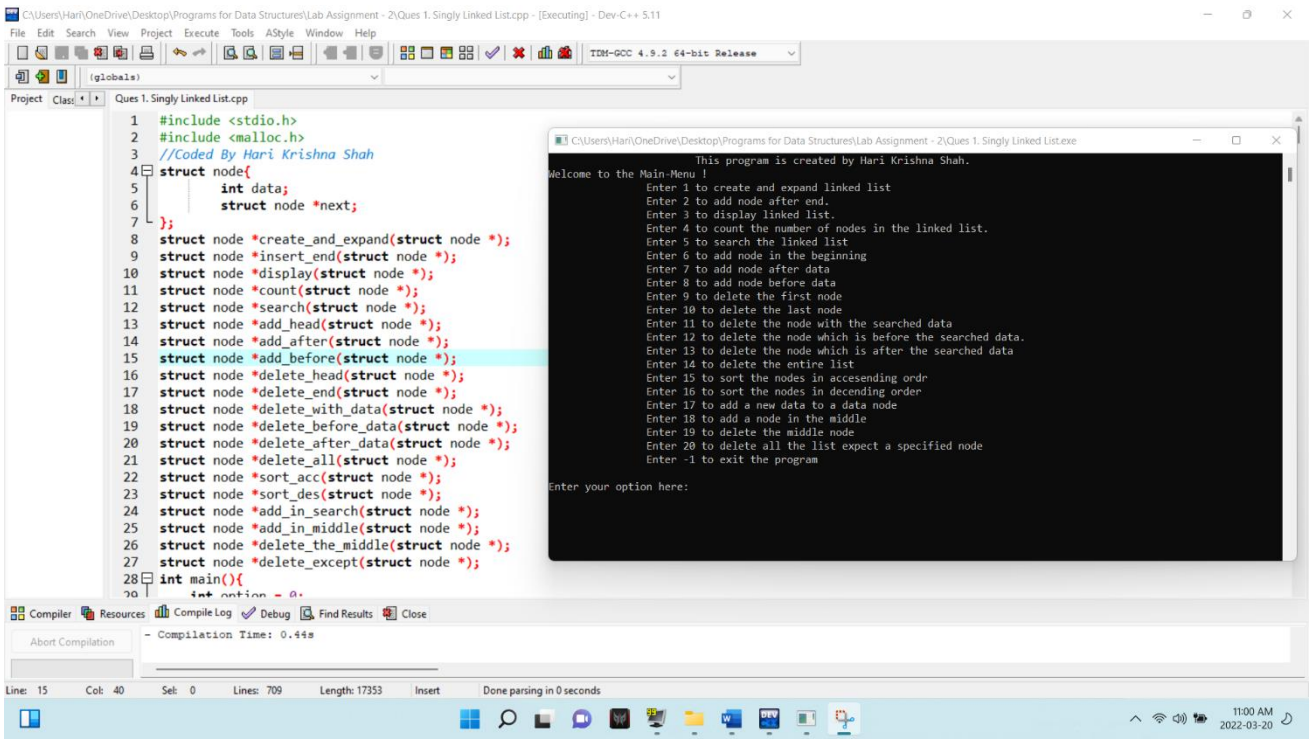
```
                        ptr->data = succedptr->data;
                        succedptr->data = temp;
                    }
                    succedptr = succedptr->next;
                }
                ptr = ptr->next;
        }

        printf("The linked list has been sorted in descending order
successfully.\n");
        return start;

}
struct node *add_in_search(struct node *start){
        int data;
        if(start == NULL){
                printf("The link is empty. Add some nodes to the list
first.\n\n");
                return start;
        }
        struct node *ptr, *succedptr, *preptr;
                ptr = start;
        int search;
        printf("Enter the data to number to search: ");
        scanf("%d", &search);

        while(ptr->data != search){
                ptr = ptr->next;
                if(ptr == NULL){
                printf("The searched data couldn't be found. The process
terminated.\n\n");
                return start;
                }
        }
        succedptr = ptr->next;
        printf("Enter the new data to be inserted in this node: ");
        scanf("%d", &data);
        ptr->data = data;
        ptr->next = succedptr;
        printf("The new data has been added to the searched data
```

```
successfully.\n");
        return start;
}

struct node *add_in_middle(struct node *start){
        if(start == NULL){
                printf("The linked list is empty. Add some nodes
first.\n\n");
                return start;
        }
        struct node *ptr, *new_node;
        new_node = (struct node *) (malloc(sizeof(struct node)));
        int count = 0, middle;
        ptr = start;
        int data;
        printf("Enter the data to store in the middle of the linked list: ");
        scanf("%d", &data);
        while(ptr != NULL){
                ptr = ptr->next;
                count += 1;
        }
        if(count % 2 == 0){
                middle = (count/2)-1;
        }
        else{
                middle = ((count-1)/2);
        }
        ptr = start;
        for(int i = 0; i<middle; i++){
                ptr = ptr->next;
        }
        new_node->data = data;
        if(start->next == NULL){
                start->next = new_node;
                new_node->next = NULL;
                return start;
        }
        new_node->next = ptr->next;
        ptr->next = new_node;
        return start;
```

```
}

struct node *delete_the_middle(struct node *start){
	if(start == NULL){
		printf("The linked list is empty. Add some nodes first.\n\n");
		return start;
	}
	if(start->next == NULL){
		printf("The linked list has only 1 node so it's middle node can't be deleted.\n");
		return start;
	}
	struct node *ptr, *succedptr, *mid_node;
	int count = 0, middle;
	ptr = start;
	while(ptr != NULL){
		ptr = ptr->next;
		count += 1;
	}
	if(count % 2 == 0){
		middle = (count/2);
	}
	else{
		middle = ((count-1)/2);
	}
	ptr = start;
	for(int i = 0; i<middle; i++){
		ptr = ptr->next;
	}
	mid_node = ptr;
	if(mid_node->next == NULL){
		ptr = start;
		while(ptr->next != mid_node){
			ptr = ptr->next;
		}
		ptr->next = NULL;
		free(mid_node);
		return start;
	}
```

```
        succedptr = ptr->next;
        ptr = start;
        while(ptr->next != mid_node){
                ptr = ptr->next;
        }
        ptr->next = succedptr;
        free(mid_node);
        return start;
}

struct node *delete_except(struct node *start){
        if(start == NULL){
                printf("The linked list is empty. Add some nodes first.\n");
                return start;
        }
        struct node *ptr, temp, *deltemp;
        int search;
        ptr = start;
        printf("Enter the data of the node which is to kept and other
nodes are to be deleted: ");
        scanf("%d", &search);
        while(ptr->data != search){
                ptr = ptr->next;
                if(ptr == NULL){
                        printf("The searched data was not found in the linked
list. Please try with another again data.\n");
                        return start;
                }
        }
        temp = *ptr;
        while(ptr != NULL){
                deltemp = ptr->next;
                free(ptr);
                ptr = deltemp;
        }

        start = (struct node *) ( malloc(sizeof(struct node )));
        *start = temp;
        start->next = NULL;
        return start;
```

}



Ques 2. Write a program to maintain the records of students in an effective dynamic structure. Search a particular record based on the roll number and display the previous and next values of that node.

Answer:

```
#include <stdio.h>
#include <malloc.h>
#include <string.h>
//Coded By Hari Krishna Shah
struct node{
        char name[50];
        int roll;
        char address[50];
        char course[50];
        struct birth_date{
                int day;
                int month;
                int year;
        }dob;
```

```
        float marks[5];
        float average;
        char grade[5];
        float total;
        struct node *previous;
        struct node *next;
};
struct node *create_and_add(struct node *);
struct node *display_all(struct node *);
struct node *search(struct node *);
struct node *delete_head(struct node *);
struct node *delete_end(struct node *);
struct node *delete_search(struct node *);
struct node *delete_before(struct node *);
struct node *delete_after(struct node *);
struct node *delete_all(struct node *);
struct node *delete_except(struct node *);
struct node *count(struct node *);
struct node *add_head(struct node *);
struct node *add_before(struct node *);
struct node *add_after(struct node *);
struct node *add_in_search(struct node *);
struct node *sort_ascend(struct node *);
struct node *sort_descen(struct node *);
struct node *insert_end(struct node *);
struct node *add_in_middle(struct node *);
struct node *delete_the_middle(struct node *);
void display(struct node *);

int main(){
        int option = 0;
        struct node *start = NULL;
        while(option != -1){
                printf("\t\t\tThis program is made by Hari Krishna Shah !!!\n");
                printf("Welcome to the Main Menu.\n");
                printf("Please choose an option from the menu below\n \
                Enter 1 to create and add student records to the end of the linked list\n \
                Enter 2 to display all the student's records\n \
```

```
            Enter 3 to search a student's record\n \
            Enter 4 to delete the first node\n \
            Enter 5 to delete the last node\n \
            Enter 6 to delete the student record of the searched roll
number of the student\n \
            Enter 7 to delete the node before a roll number\n \
            Enter 8 to delete the node after a roll number\n \
            Enter 9 to delete the entire student record except a
specified a student of specified roll number\n \
            Enter 10 to delete the entire student record\n \
            Enter 11 to count the number of nodes\n \
            Enter 12 to add student record in the first node\n \
            Enter 13 to add student record before searched roll
number\n \
            Enter 14 to add student record after searched roll
number\n \
            Enter 15 to add or edit student record of the searched roll
number \n \
            Enter 16 to sort the nodes in ascending order according to
roll number\n \
            Enter 17 to sort the nodes in descending order according to
roll number\n \
            Enter 18 to add student record at the end of the linked
list\n \
            Enter 19 to add a new student record at the middle node\n
\
            Enter 20 to delete the student record at the middle node\n \
            Enter -1 to quit the program\n");
            printf("Enter your option here: ");
            scanf("%d", &option);
            printf("\n");
            switch(option){
                  case 1:
                        start = create_and_add(start);
                        break;
                  case 2:
                        start = display_all(start);
                        break;
                  case 3:
                        start = search(start);
```

```
        break;
case 4:
        start = delete_head(start);
        break;
case 5:
        start = delete_end(start);
        break;
case 6:
        start = delete_search(start);
        break;
case 7:
        start = delete_before(start);
        break;
case 8:
        start = delete_after(start);
        break;
case 9:
        start = delete_except(start);
        break;
case 10:
        start = delete_all(start);
        break;
case 11:
        start = count(start);
        break;
case 12:
        start = add_head(start);
        break;
case 13:
        start = add_before(start);
        break;
case 14:
        start = add_after(start);
        break;
case 15:
        start = add_in_search(start);
        break;
case 16:
        start = sort_ascend(start);
        break;
```

```
                case 17:
                        start = sort_descen(start);
                        break;
                case 18:
                        start = insert_end(start);
                        break;
                case 19:
                        start = add_in_middle(start);
                        break;
                case 20:
                        start = delete_the_middle(start);
                        break;
                case -1:
                        break;
                default:
                        printf("Enter a valid option and try again.\n");

        }
        printf("\n");

}

        printf("This program was made with love by Hari Krishna
Shah.\nPlease drop a review or a feedback.\n");
}
struct node get_details(){
        struct node details;
        float temp_total = 0;
        printf("Enter the name: ");
        scanf("%s", &details.name);
        printf("Enter the roll number : ");
        scanf("%d", &details.roll);
        printf("Enter the address: ");
        scanf("%s", &details.address);
        printf("Enter the course: ");
        scanf("%s", &details.course);
        printf("Enter the birth date in the following order\n");
        printf("\tEnter the day for birth date: ");
        scanf("%d", &details.dob.day);
        printf("\tEnter the month for birth date: ");
```

```
        scanf("%d", &details.dob.month);
        printf("\tEnter the year for birth date: ");
        scanf("%d", &details.dob.year);
        printf("Enter the marks in five subjects: ");
        for(int i = 0; i<5; i++){
                scanf("%f", &details.marks[i]);
                temp_total += details.marks[i];
        }
        details.total = temp_total;
        details.average = temp_total/5;
        if(details.average >= 90){
                strcpy(details.grade, "A+");
        }
        else if(details.average >= 80){
                strcpy(details.grade, "A");
        }
        else if(details.average >= 70){
                strcpy(details.grade, "B+");
        }
        else if(details.average >= 60){
                strcpy(details.grade, "B");
        }
        else if(details.average >= 50){
                strcpy(details.grade, "C+");
        }
        else if(details.average >= 40){
                strcpy(details.grade, "C");
        }
        else{
                strcpy(details.grade, "F");
        }
        printf("The details saved successfully for this node.\n\n");

        return details;
}

void display(struct node *ptr){
        printf("The details are given below.\n");
        printf("Name: %s\n", ptr->name);
        printf("Roll Number: %d\n", ptr->roll);
```

```
        printf("Address: %s\n", ptr->address);
        printf("Course: %s\n", ptr->course);
        printf("Date of Birth in format day/month/year :
%d/%d/%d.\n", ptr->dob.day, ptr->dob.month,ptr->dob.year);
        printf("Marks Details are below.\n");
        for(int i = 0; i<5; i++){
                printf("Marks for subject %d: %.2f\n", i+1, ptr->marks[i]);
        }
        printf("Total: %.2f\n", ptr->total);
        printf("Average: %.2f\n", ptr->average);
        printf("Grade: %s\n", ptr->grade);
}

struct node *create_and_add(struct node *start){
        int node_count = 0;
        struct node *new_node, *ptr;
        ptr = start;
        printf("Enter the number of nodes you want to add: ");
        scanf("%d", &node_count);
        if(start == NULL){
                new_node = (struct node *) (malloc(sizeof(struct node)));
                new_node->previous = NULL;
                new_node->next = NULL;
                printf("Enter the details of student below.\n");
                *new_node = get_details();
                node_count = node_count - 1;
                start = new_node;
        }
        for(int i = 0; i<node_count; i++){
                ptr = start;
                while(ptr->next != NULL){
                        ptr = ptr->next;
                }
                new_node = (struct node *) (malloc(sizeof(struct node)));
                printf("Enter the details of student below.\n");
                *new_node = get_details();
                new_node->previous = ptr;
                new_node->next = NULL;
                ptr->next = new_node;
        }
```

```
        printf("All the data saved successfully.\n");
        return start;
}

struct node *display_all(struct node *start){
        struct node *ptr;
        ptr = start;
        int count = 0;
        if(ptr == NULL){
                printf("The linked list is empty. Add some nodes first and
try again.\n");
                return start;
        }
        printf("All the student's detail are given below.\n\n");
        while(ptr != NULL){
                printf("For student number %d:\n", count+1);
                display(ptr);
                printf("\n");
                ptr = ptr->next;
                count+=1;
        }
        return start;
}

struct node *search(struct node *start){
struct node *ptr, *match, *succedptr, *preptr;
        ptr = start;
        if(start == NULL){
                printf("The linked list is empty. Add some nodes first and
try again.\n");
                return start;
        }
        int search;
        printf("Enter a roll number to search in the linked list: ");
        scanf("%d", &search);
        printf("\n");
        while(ptr->roll != search){
                ptr = ptr->next;
                if(ptr == NULL){
                        printf("The searched roll number doesn't exist in the
```

```
linked list.\n");
                        return start;
                }
        }
        match = ptr;
        succedptr = match->next;
        preptr = match->previous;
        printf("\n\nHere is the record of the searched student.\n");
        display(match);

        if(match == start){
                printf("\nThe searched roll number is the first student in
the list.\nSo, the detail of student before it can't be displayed.\n");
        }
        else if(match != start){
                printf("\nThe detail of previous student of searched student
is given below.\n");
                display(preptr);
                printf("\n");
        }

        if(start->next == NULL){
                printf("\nThe searched roll number is the last student in
the list.\nSo, the detail of student after it can't be displayed.\n");
        }
        else if(match->next != NULL){
                printf("\nHere is the record of student after the searched
student\n");
                display(succedptr);
                printf("\n");
        }
        printf("\n");
        return start;
}

struct node *delete_head(struct node *start){
        struct node *temp1, *temp2;
        temp2 = start;
        if(start == NULL){
                printf("The linked list is empty.\n\n");
```

```
            return start;
        }
        if(start->next == NULL){
            start = NULL;
            printf("The linked list contains only one element.\nSo,the
first node is also the last node.\nThe first node deleted
successfuly.\n");
            free(temp2);
            return start;
        }
        temp1 = start->next;
        temp1->previous = NULL;
        free(temp2);
        start = temp1;
        printf("The first node has been deleted sucessfully.\n\n");
        return start;
}

struct node *delete_end(struct node *start){
        if(start == NULL){
            printf("The linked list is empty.\n\n");
            return start;
        }
        if(start->next == NULL){
            printf("Currenlty, there is only one node in the linked list
so, the first node is also the last node.\n");
            start = delete_head(start);
            return start;
        }
        struct node *ptr, *temp;
        ptr = start;
        while(ptr->next != NULL){
            ptr = ptr->next;
        }
        temp = ptr;
        ptr = ptr->previous;
        ptr->next = NULL;
        free(temp);
        printf("The last node has been deleted sucessfully.\n\n");
        return start;
```

```
}

struct node *delete_search(struct node *start){
	struct node *ptr, *preptr;
	int search;
	if(start == NULL){
		printf("The linked list is empty. Add some nodes first and try again.\n");
		return start;
	}
	printf("Enter the roll number of the student whose record is to be deleted: ");
	scanf("%d", &search);
	ptr = start;
	if(start->roll == search){
		start = delete_head(start);
		return start;
	}
	ptr = start;
	while(ptr->roll != search){
		ptr = ptr->next;
		if(ptr == NULL){
			printf("The searched data was not found in the linked list. The process aborted.\n");
			return start;
		}
	}
	if(ptr->next == NULL){
		printf("The found data is in the last node so last node will be deleted.\n");
		start = delete_end(start);
		return start;
	}
	preptr = ptr->previous;
	ptr = ptr->next;
	preptr->next = ptr;
	ptr->previous = preptr;
	printf("The searched student's record deleted successfully.\n");
	return start;
}
```

```
struct node *delete_before(struct node *start){
	struct node *ptr, *succedptr, *match;
	int search;
	if(start == NULL){
		printf("The linked list is empty. Add some nodes first and try again.\n");
		return start;
	}
	printf("Enter the roll number of the student whose record is to be deleted: ");
	scanf("%d", &search);
	ptr = start;
	while(ptr->roll != search){
		ptr = ptr->next;
		if(ptr == NULL){
			printf("The searched data was not found in the linked list. The process aborted.\n");
			return start;
		}
	}
	if(ptr == start){
		printf("The searched data is in the first node so, the node before it can't be deleted as it doesn't exist.\n");
		return start;
	}
	if(ptr->previous == start){
		start = delete_head(start);
		return start;
	}
	match = ptr;
	succedptr = ptr->next;
	ptr = ptr->previous;
	ptr->next = succedptr;
	succedptr->previous = ptr;
	free(match);
	printf("The student's record which is previous of searched student has been deleted successfully.\n");
	return start;
}
```

```
struct node *delete_after(struct node *start){
	struct node *ptr, *match, *succedptr;
	int search;
	if(start == NULL){
		printf("The linked list is empty. Add some nodes first and try again.\n");
		return start;
	}
	printf("Enter the roll number of the student whose record is to be deleted: ");
	scanf("%d", &search);
	ptr = start;
	while(ptr->roll != search){
		ptr = ptr->next;
		if(ptr == NULL){
			printf("The searched data was not found in the linked list. The process aborted.\n");
			return start;
		}
	}
	if(ptr->next == NULL){
		printf("The searched data was found to be in the last node of the linked list.\nSo, the node after it can't be deleted.\n");
		return start;
	}
	match = ptr;
	succedptr = ptr->next;
	if(succedptr->next == NULL){
		start = delete_end(start);
		return start;
	}
	ptr = succedptr->next;
	ptr->previous = match;
	match->next = ptr;
	free(succedptr);
	printf("The student's record which is after the searched student has been deleted successfully.\n");
	return start;
}
```

```
struct node *delete_all(struct node *start){
	struct node *ptr, *temp;
	ptr = start;
	if(start == NULL){
		printf("The linked list is empty. Add some nodes first.\n");
		return start;
	}
	while(ptr != NULL){
		temp = ptr->next;
		free(ptr);
		ptr = temp;
	}
	printf("The entire student record has been deleted
successfully.\n");
	start = NULL;
	return start;
}
struct node *delete_except(struct node *start){
	struct node *ptr;
	if(start == NULL){
		printf("The linked list is empty. Add some nodes first.\n");
		return start;
	}
	struct node *temp;
	temp = (struct node *) (malloc(sizeof(struct node)));
	ptr = start;
	int search;
	printf("Enter the roll number whose record is to be kept and all
other is to be deleted: ");
	scanf("%d", &search);
	while(ptr->roll != search){
		ptr = ptr->next;
		if(ptr == NULL){
			printf("The searched data wasn't found in the linked
list. The process aborted.\n");
			return start;
		}
	}
	*temp = *ptr;
```

```
        start = delete_all(start);
        start = (struct node *) (malloc(sizeof(struct node)));
        *start = *temp;
        start->next = NULL;
        start->previous = NULL;
        return start;
}
struct node *count(struct node *start){
        struct node *ptr;
        ptr = start;
        int count = 0;
        while(ptr != NULL){
                count += 1;
                ptr = ptr->next;
        }
        printf("The number of nodes are %d.\n\n", count);

        return start;
}
struct node *add_head(struct node *start){
        struct node *new_node, *temp , *temp_details;;
        int num;
        temp = start;
        new_node = (struct node *) (malloc(sizeof(struct node)));
        printf("Enter the data for structure to be inserted in the first
node\n");
        *new_node = get_details();
        if(start == NULL){
                start = new_node;
                start->next = NULL;
                start->previous = NULL;
        }

        else{
                new_node->next = temp;
                new_node->previous = NULL;
                start = new_node;
        }
        printf("The data has been added to the head of the linked
list.\n\n");
```

```
        return start;

}

struct node *add_after(struct node *start){
        struct node *new_node, *ptr, *temp;
        if(start == NULL){
                printf("The link is empty. Add some nodes to the list
first.\n\n");
                return start;
        }
        new_node = (struct node *) (malloc(sizeof(struct node)));
        int num, check_data;
        printf("Enter the roll number of the node after which the node is
to be added: ");
        scanf("%d", &check_data);
        ptr = start;
        while(ptr->roll != check_data){
                ptr = ptr->next;
                if(ptr == NULL){
                printf("The searched data couldn't be found. The process
terminated.\n\n");
                return start;
                }
        }
        printf("Enter the data to be stored in the node\n");
        *new_node = get_details();
        temp = ptr->next;
        ptr->next = new_node;
        new_node->next = temp;
        new_node->previous = ptr;
        printf("The node has been added after the data %d.\n\n",
check_data);
        return start;
}

struct node *add_before(struct node *start){
        struct node *new_node, *ptr, *temp;
        if(start == NULL){
                printf("The link is empty. Add some nodes to the list
```

```
first.\n\n");
                return start;
        }
        int num, check_data;
        printf("Enter the roll number before which node is to be added:
");
        scanf("%d", &check_data);
        ptr = start;
         if(start->roll == check_data){
                printf("The matched data was found to be in the first node
of data.\n");
                printf("Now we need to add a new head to our linked
list.\n");
                start = add_head(start);
                return start;
        }
        while(ptr->roll != check_data){
        ptr = ptr->next;
        if(ptr == NULL){
                printf("The searched data couldn't be found. The process
terminated.\n\n");
                return start;
        }
        }
        new_node = (struct node *) (malloc(sizeof(struct node)));
        printf("Enter the data to be stored in the new node store.\n");
        *new_node = get_details();
        temp = ptr;
        ptr = ptr->previous;
        ptr->next = new_node;
        new_node->previous = ptr;
        new_node->next = temp;
        temp->previous = new_node;
        printf("The node has been added before the data %d.\n\n",
check_data);
        return start;
}
struct node *add_in_search(struct node *start){
        if(start == NULL){
                printf("The link is empty. Add some nodes to the list
```

```
first.\n\n");
                return start;
        }
        struct node *ptr, *succedptr, *preptr;
                ptr = start;
        int search;
        printf("Enter the roll number to search: ");
        scanf("%d", &search);

        while(ptr->roll != search){
                ptr = ptr->next;
                if(ptr == NULL){
                printf("The searched data couldn't be found. The process
terminated.\n\n");
                return start;
                }
        }
        succedptr = ptr->next;
        preptr = ptr->previous;
        *ptr = get_details();
        ptr->next = succedptr;
        ptr->previous = preptr;
        printf("The new data has been added to the searched roll
number successfully.\n");
        return start;
}
struct node *sort_ascend(struct node *start){
        if(start == NULL){
                printf("The linked list has no nodes. Add some data and try
again.\n");
                return start;
        }
        if(start->next == NULL){
                printf("The linked list has only one node so it can't be
sorted.\n");
                return start;
        }
        struct node *ptr, *succedptr;
        struct node ptrtemp, succtemp;
        ptr = start;
```

```
        while(ptr != NULL){
                succedptr = ptr->next;
        while(succedptr != NULL){
                ptrtemp = *ptr;
                succtemp = *succedptr;
                if(ptr->roll > succedptr->roll){
                        *succedptr = *ptr;
                        succedptr->next = succtemp.next;
                        succedptr->previous = succtemp.previous;
                        succtemp.next = ptrtemp.next;
                        succtemp.previous = ptrtemp.previous;
                        *ptr = succtemp;
                }
                succedptr = succedptr->next;
        }
        ptr = ptr->next;

        }
        printf("The linked list has been sorted in ascending order
successfully.\n");
        return start;
}
struct node *sort_descen(struct node *start){
        struct node *ptr, *succedptr;
        struct node ptrtemp, succtemp;
        ptr = start;
 if(start == NULL){
                printf("The linked list has no nodes. Add some data and try
again.\n");
                return start;
        }
        if(start->next == NULL){
                printf("The linked list has only one node so it can't be
sorted.\n");
                return start;
        }

        while(ptr != NULL){
                succedptr = ptr->next;
```

```
        while(succedptr != NULL){
                ptrtemp = *ptr;
                succtemp = *succedptr;
                if(ptr->roll < succedptr->roll){
                        *succedptr = *ptr;
                        succedptr->next = succtemp.next;
                        succedptr->previous = succtemp.previous;
                        succtemp.next = ptrtemp.next;
                        succtemp.previous = ptrtemp.previous;
                        *ptr = succtemp;
                }
                succedptr = succedptr->next;
        }
        ptr = ptr->next;

        }
        printf("The linked list has been sorted in descending order
successfully.\n");
        return start;
}
struct node *insert_end(struct node *start){
        if(start == NULL){
                printf("The linked list is empty.\nAdd some nodes
first.\n");
                start = add_head(start);
                return start;
        }
        struct node *ptr, *new_node;
        new_node = (struct node *) (malloc(sizeof(struct node)));
        ptr = start;
        while(ptr->next != NULL){
                ptr = ptr->next;
        }
        *new_node = get_details();
        new_node->next=NULL;
        new_node->previous = ptr;
        ptr->next = new_node;
        printf("The node has been added at the end.\n\n");

        return start;
```

```
}


struct node *add_in_middle(struct node *start){
	if(start == NULL){
		printf("The linked list is empty. Add some nodes first.\n\n");
		return start;
	}
	struct node *ptr, *new_node, *temp;
	new_node = (struct node *) (malloc(sizeof(struct node)));
	int count = 0, middle;
	ptr = start;
	while(ptr != NULL){
		ptr = ptr->next;
		count += 1;
	}
	if(count % 2 == 0){
		middle = (count/2)-1;
	}
	else{
		middle = ((count-1)/2);
	}
	ptr = start;
	for(int i = 0; i<middle; i++){
		ptr = ptr->next;
	}
	printf("Enter the details of the student to add at the middle node below.\n");
	*new_node = get_details();
	if(start->next == NULL){
		start->next = new_node;
		new_node->next = NULL;
		new_node->previous = start;
		return start;
	}
	temp = ptr->next;
	new_node->next = ptr->next;
	new_node->previous = ptr;
	ptr->next = new_node;
```

```
        temp->previous = new_node;
        printf("The middle node has been added succesfully.\n");
        return start;
}

struct node *delete_the_middle(struct node *start){
        if(start == NULL){
                printf("The linked list is empty. Add some nodes
first.\n\n");
                return start;
        }
        if(start->next == NULL){
                printf("The linked list has only 1 node so it's middle node
can't be deleted.\n");
                return start;
        }
        struct node *ptr, *succedptr, *mid_node;
        int count = 0, middle;
        ptr = start;
        while(ptr != NULL){
                ptr = ptr->next;
                count += 1;
        }
        if(count % 2 == 0){
                middle = (count/2);
        }
        else{
                middle = ((count-1)/2);
        }
        ptr = start;
        for(int i = 0; i<middle; i++){
                ptr = ptr->next;
        }
        mid_node = ptr;
        if(mid_node->next == NULL){
                ptr = mid_node->previous;
                ptr->next = NULL;
                free(mid_node);
                return start;
        }
```

```
        succedptr = ptr->next;
        ptr = ptr->previous;
        ptr->next = succedptr;
        succedptr->previous = ptr;
        free(mid_node);
        printf("The middle node has been deleted succesfully.\n");
        return start;
}
```