Name: Sneha Roy , Section : B , Roll : 42

Enrollment No.: 12024006015099

Week 2 Assignment

Topic: Implementation of Array

1. Write a C program to read a 2D array (with most of the elements as 0s) and then represent the same array as Sparse Metrics.

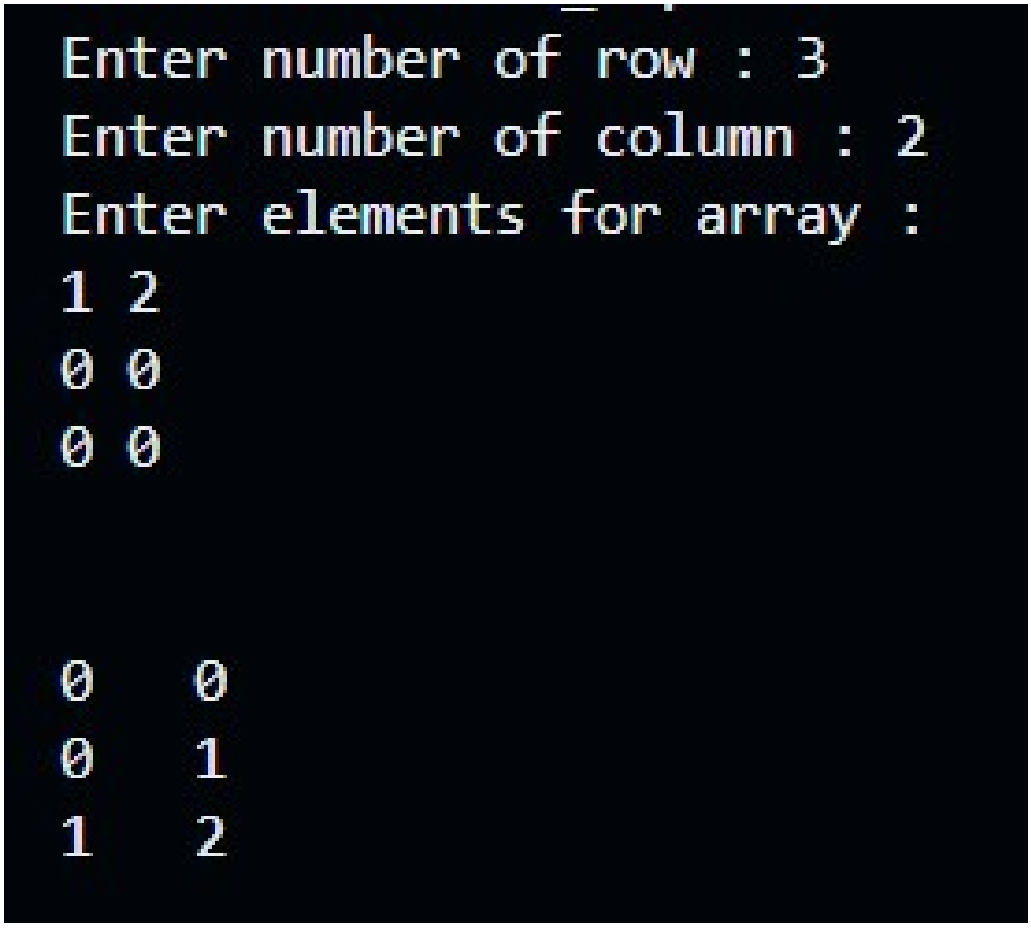
Answer:

```
#include<stdio.h>


int main(){
  int r, c, zeroCount = 0, count = 0;
  printf("Enter number of row : ");
  scanf("%d", &r);
  printf("Enter number of column : ");
  scanf("%d", &c);


  int arr[r][c];
  printf("Enter elements for array : \n");
  for(int i = 0; i < r; i++)
    for(int j = 0; j < c; j++)
      scanf("%d", &arr[i][j]);
```

```
for(int i = 0; i < r; i++)
  for(int j = 0; j < c; j++){
    if(arr[i][j] == 0) zeroCount++;
    else count++;
  }

if(zeroCount > count) {
  int ans[3][count], iCol = 0;
  for(int i = 0; i < r; i++)
  for(int j = 0; j < c; j++){
    if(arr[i][j] != 0) {
      ans[0][iCol] = i;
      ans[1][iCol] = j;
      ans[2][iCol] = arr[i][j];
      iCol++;
    }
  }

  printf("\n\n");
for(int i = 0; i < 3; i++){
  for(int j = 0; j < count; j++)
    printf("%d   ", ans[i][j]);
    printf("\n");
}
```

```
  }


  else printf("Not A Sparse Matrix");
  return 0;
}
```

Output:



2. Write a C program to pass an array to a function using Call by Value, update the array values in the function, print the array elements both in the function and in the calling function.

Answer:

```
#include<stdio.h>
void Change (int arr[], int n){
  for(int i = 0 ; i < n; i++) arr[i] += 10;
  for(int i = 0 ; i < n; i++) printf("%d  ,", arr[i]);
}

int main(){
  int n, arr[100];
  printf("Enter size of array : ");
  scanf("%d", &n);

  printf("Enter Elements : ");
  for(int i = 0 ; i < n; i++) scanf("%d", &arr[i]);

  for(int i = 0 ; i < n; i++) printf("%d ,  ", arr[i]);

  printf("\n\n");

  Change(arr, n);
```

```
  printf("\n\n");


  for(int i = 0 ; i < n; i++) printf("%d ,  ", arr[i]);


  return 0;
}
```

Output:

```
Enter size of array : 5
Enter Elements : 1 2 3 4 5
1 ,  2 ,  3 ,  4 ,  5 ,

11  ,12  ,13  ,14  ,15  ,

11 ,  12 ,  13 ,  14 ,  15 ,
```

4. Write a program that reads two 2D metrices from the console, verifies if metrics multiplication is possible or not. Then multiplies the metrices and prints the 3rd metrics.

Answer:

```
#include<stdio.h>
int main(){
  int r1, c1, r2, c2;
    printf("Enter row and column of the 1st matrix : ");
    scanf("%d %d", &r1, &c1);
    printf("Enter row and column of the 2nd matrix : ");
    scanf("%d %d", &r2, &c2);
    if(c1!=r2) printf("Given two matrices can't be multiplied.");

    else if (c1==r2){
       int arr[r1][c1], brr[r2][c2], crr[r1][c2];
       printf("Enter the 1st matrix : \n");
       for(int i = 0; i < r1; i++)//Taking Inputs
          for(int j = 0; j < c1; j++) scanf("%d", &arr[i][j]);

       printf("\nEnter the 2nd matrix : \n");
       for(int i = 0; i < r2; i++)//Taking Inputs
          for(int j = 0; j < c2; j++) scanf("%d", &brr[i][j]);
       for(int i = 0; i < r1; i++)//Assume all element in result matrix is '0'
          for(int j = 0; j < c2; j++) crr[i][j]=0;
       for(int i = 0; i < r1; i++)
```

```
        for(int j = 0; j < c2; j++)
            for(int k = 0; k<c1; k++)
                crr[i][j] = crr[i][j] + (arr[i][k] * brr[k][j]);
      printf("Result is : \n");
      for(int i = 0; i < r1; i++){//Print the result matrix
         for(int j = 0; j < c2; j++) printf("%d    ", crr[i][j]);
         printf("\n");
      }
   }
  return 0;
}
```

Output:

```
Enter row and column of the 1st matrix : 2 2
Enter row and column of the 2nd matrix : 2 3
Enter the 1st matrix :
1 2 3 4

Enter the 2nd matrix :
5 6 7 8 9 2
Result is :
21    24    11
47    54    29
```

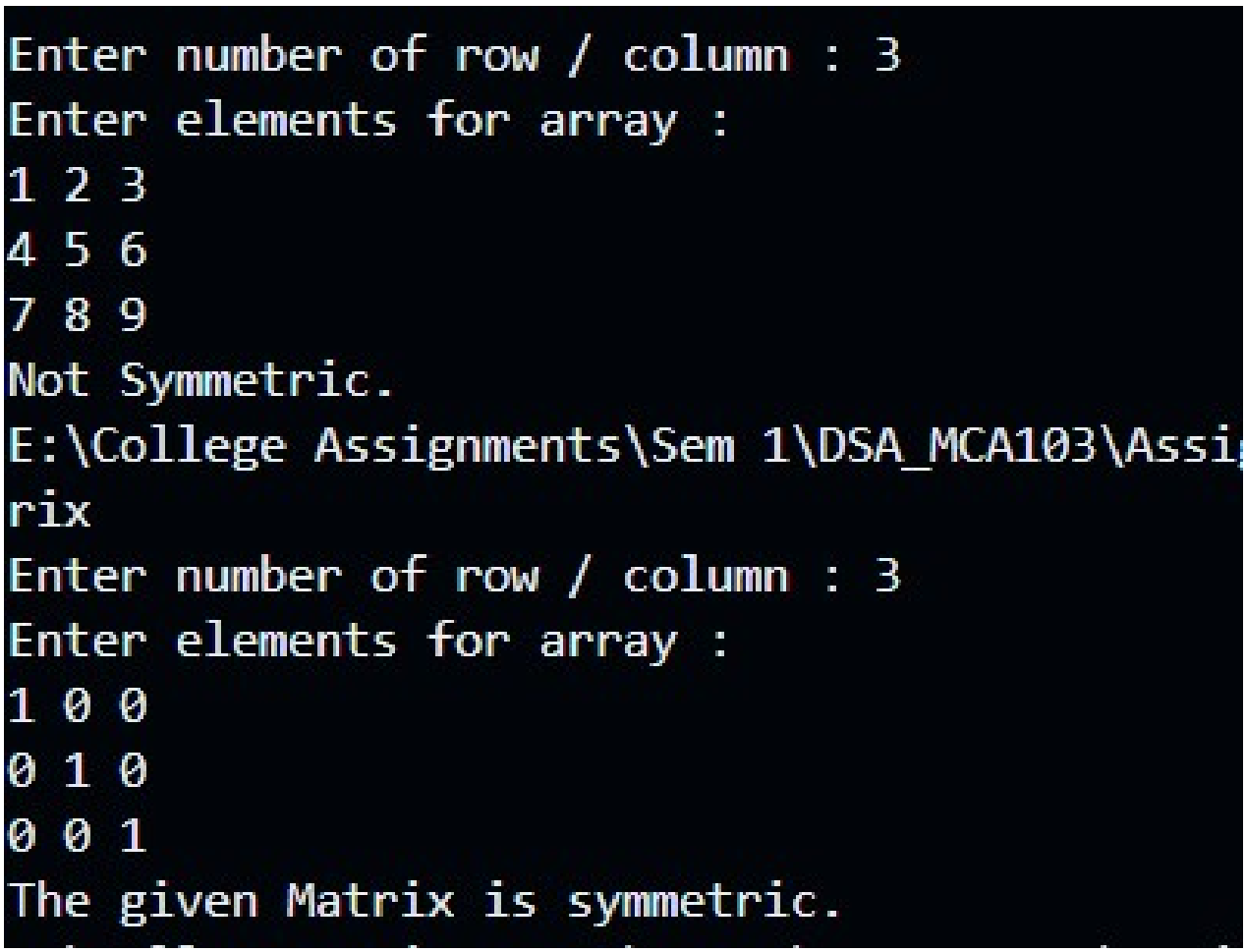
5. Write a program that reads a 2D metrics and checks if the metrics is a symmetric metrics or not.

Answer:

```
#include<stdio.h>


int main(){
  int n, check = 1 ;
  printf("Enter number of row / column : ");
  scanf("%d", &n);


  int arr[n][n];
  printf("Enter elements for array : \n");
  for(int i = 0; i < n; i++)
    for(int j = 0; j < n; j++)
      scanf("%d", &arr[i][j]);


  for(int i = 0; i < n; i++)
    for(int j = i; j < n; j++)
      if(arr[i][j] != arr[j][i]) {
        check = 0;
        break;
      }


  if(check) printf("The given Matrix is symmetric.");
```

```
  else printf("Not Symmetric.");


  return 0;
}
```

Output:



6. Write a program to display n number of elements. Memory should be allocated dynamically using malloc ( ).

Answer:

```
#include <stdio.h>
#include <stdlib.h>

int main(){
  int n;
  printf("Enter number of elements you want : ");
  scanf("%d", &n);

  int* ptr = (int*) malloc(n * sizeof(int));

  int* p = ptr;

  printf("Enter Elements : ");
  for(int i = 1; i <= n; i++){
    scanf("%d", &(*p));
    p++;
  }
  p = ptr;
  printf("\n\n");
  for(int i = 1; i <= n; i++){
    printf("%d \n",*p);
```

```
    p++;
  }
  free(ptr);
  ptr = NULL;

  return 0;
}
```

Output:

```
Enter number of elements you want : 5
Enter Elements : 1 2 3 4 5

1
2
3
4
5
```

7. Write a program to display n number of elements. Memory should be allocated dynamically using calloc( ).

Answer:

```
#include <stdio.h>
#include <stdlib.h>

int main(){
  int n;
  printf("Enter number of elements you want : ");
  scanf("%d", &n);

  int* ptr = (int*) calloc(n , sizeof(int));

  int* p = ptr;

  printf("Enter Elements : ");
  for(int i = 1; i <= n; i++){
    scanf("%d", &(*p));
    p++;
  }
  p = ptr;
  printf("\n\n");
  for(int i = 1; i <= n; i++){
    printf("%d \n",*p);
```

```
    p++;
  }

  free(ptr);
  ptr = NULL;

  return 0;
}
```

Output:

```
Enter number of elements you want : 5
Enter Elements : 1 2 3 4 5


1
2
3
4
5
```

8. Write a program to allocate memory using malloc ( ) and then reallocate the previously allocated memory using realloc( ). Display the elements which have been taken after reallocation.

Answer:

```
#include <stdio.h>
#include <stdlib.h>

int main(){
  int n, a;
  printf("Enter number of elements you want : ");
  scanf("%d", &n);

  int* ptr = (int*) malloc(n * sizeof(int));

  printf("Enter number you want to increase : ");
  scanf("%d", &a);

  n = n + a;
  ptr = realloc (ptr, n * sizeof(int));
  int* p = ptr;
  printf("Enter Elements : ");
  for(int i = 1; i <= n; i++){
    scanf("%d", &(*p));
    p++;
```

```
  }
  p = ptr;
  printf("\n\n");
  for(int i = 1; i <= n; i++){
    printf("%d \n",*p);
    p++;
  }
  free(ptr);
  ptr = NULL;


  return 0;
}
```

Output:

```
Enter number of elements you want : 5
Enter number you want to increase : 2
Enter Elements : 1 2 3 4 5 6 7


1
2
3
4
5
6
7
```

9. Write a program to allocate memory using calloc( ) and then reallocate the previously allocated memory using realloc( ). Display the elements which have been taken after reallocation.

Answer:

```
#include <stdio.h>
#include <stdlib.h>
int main(){
  int n, a;
  printf("Enter number of elements you want : ");
  scanf("%d", &n);

  int* ptr = (int*) calloc(n, sizeof(int));

  printf("Enter number you want to increase : ");
  scanf("%d", &a);

  n = n + a;
  ptr = realloc (ptr, n * sizeof(int));

  int* p = ptr;

  printf("Enter Elements : ");
  for(int i = 1; i <= n; i++){
    scanf("%d", &(*p));
    p++;
```

```
  }


  p = ptr;
  printf("\n\n");
  for(int i = 1; i <= n; i++){
    printf("%d \n",*p);
    p++;
  }


  free(ptr);
  ptr = NULL;
  return 0;
}
```

Output:

```
Enter number of elements you want : 5
Enter number you want to increase : 2
Enter Elements : 1 2 7 8 5 9 8


1
2
7
8
5
9
8
```

10. Write a C program to search an element in an Array using dynamic memory allocation

Answer:

```
#include <stdio.h>
#include <stdlib.h>

int main(){
  int n, key, check = 0;
  printf("Enter number of elements you want : ");
  scanf("%d", &n);

  int* ptr = (int*) malloc(n * sizeof(int));

  int* p = ptr;

  printf("Enter Elements : ");
  for(int i = 1; i <= n; i++){
    scanf("%d", &(*p));
    p++;
  }

  printf("Enter the element you want to search : ");
  scanf("%d", &key);
  p = ptr;
```

```
 printf("\n\n");
 for(int i = 1; i <= n; i++){
  if(key == *p){
   check = 1;
   break;
  }
  p++;
 }

 free(ptr);
 ptr = NULL;

 if(check) printf("The Given Element Exist");
 else printf("The Given Element Exist");

 return 0;
}
```

Output:

```
Enter number of elements you want : 5
Enter Elements : 1 2 3 4 5
Enter the element you want to search : 2


The Given Element Exist
```

Week 3 Assignment

Topic: Linked List

1) Write a Menu driven C program to accomplish the following functionalities in single linked list.

a) Create a single linked list. b) Display the elements of a single linked list.

c) Insert a node at the beginning of a single linked list.

d) Insert a node at the end of a single linked list.

e) Insert a node before a given node of a single linked list.

f) Insert a node after a given node of a single linked list.

g) Delete a node from the beginning of a single linked list.

h) Delete a node from the end of a single linked list.

i) Delete a node after a given node of a single linked list.

j) Delete the entire single linked list.

Answer:

```
#include <stdio.h>
#include <stdlib.h>

struct Node {
   int data;
   struct Node* next;
};

struct Node* head = NULL;

// Function to create a single linked list
void createList(int data) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = data;
   newNode->next = NULL;

   if (head == NULL) {
      head = newNode;
   } else {
      struct Node* temp = head;
      while (temp->next != NULL) {
         temp = temp->next;
      }
      temp->next = newNode;
   }
```

```
}

// Function to display elements of a single linked list
void displayList() {
   struct Node* temp = head;
   if (temp == NULL) {
      printf("List is empty.\n");
      return;
   }
   while (temp != NULL) {
      printf("%d -> ", temp->data);
      temp = temp->next;
   }
   printf("NULL\n");
}

// Function to insert a node at the beginning
void insertAtBeginning(int data) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = data;
   newNode->next = head;
   head = newNode;
}

// Function to insert a node at the end
void insertAtEnd(int data) {
   struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
   newNode->data = data;
   newNode->next = NULL;

   if (head == NULL) {
      head = newNode;
      return;
   }
   struct Node* temp = head;
   while (temp->next != NULL) {
      temp = temp->next;
   }
   temp->next = newNode;
}

// Function to insert a node before a given node
void insertBeforeNode(int target, int data) {
```

```
    if (head == NULL) {
        printf("List is empty.\n");
        return;
    }

    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;

    if (head->data == target) {
        newNode->next = head;
        head = newNode;
        return;
    }

    struct Node* temp = head;
    while (temp->next != NULL && temp->next->data != target) {
        temp = temp->next;
    }

    if (temp->next == NULL) {
        printf("Node not found.\n");
    } else {
        newNode->next = temp->next;
        temp->next = newNode;
    }
}

// Function to insert a node after a given node
void insertAfterNode(int target, int data) {
    struct Node* temp = head;
    while (temp != NULL && temp->data != target) {
        temp = temp->next;
    }

    if (temp == NULL) {
        printf("Node not found.\n");
        return;
    }

    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = temp->next;
    temp->next = newNode;
```

```
}

// Function to delete a node from the beginning
void deleteFromBeginning() {
   if (head == NULL) {
      printf("List is empty.\n");
      return;
   }
   struct Node* temp = head;
   head = head->next;
   free(temp);
}

// Function to delete a node from the end
void deleteFromEnd() {
   if (head == NULL) {
      printf("List is empty.\n");
      return;
   }

   if (head->next == NULL) {
      free(head);
      head = NULL;
      return;
   }

   struct Node* temp = head;
   while (temp->next->next != NULL) {
      temp = temp->next;
   }

   free(temp->next);
   temp->next = NULL;
}

// Function to delete a node after a given node
void deleteAfterNode(int target) {
   struct Node* temp = head;
   while (temp != NULL && temp->data != target) {
      temp = temp->next;
   }

   if (temp == NULL || temp->next == NULL) {
```

```
        printf("Node not found or no node exists after the given node.\n");
        return;
    }

    struct Node* nodeToDelete = temp->next;
    temp->next = temp->next->next;
    free(nodeToDelete);
}

// Function to delete the entire list
void deleteList() {
    struct Node* temp;
    while (head != NULL) {
        temp = head;
        head = head->next;
        free(temp);
    }
    printf("Entire list deleted.\n");
}

// Main function with menu
int main() {
    int choice, data, target;

    while (1) {
        printf("\nMenu:\n");
        printf("1. Create a single linked list\n");
        printf("2. Display the elements\n");
        printf("3. Insert at the beginning\n");
        printf("4. Insert at the end\n");
        printf("5. Insert before a given node\n");
        printf("6. Insert after a given node\n");
        printf("7. Delete from the beginning\n");
        printf("8. Delete from the end\n");
        printf("9. Delete after a given node\n");
        printf("10. Delete the entire list\n");
        printf("11. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter data to insert: ");
```

```
            scanf("%d", &data);
            createList(data);
            break;
        case 2:
            displayList();
            break;
        case 3:
            printf("Enter data to insert at the beginning: ");
            scanf("%d", &data);
            insertAtBeginning(data);
            break;
        case 4:
            printf("Enter data to insert at the end: ");
            scanf("%d", &data);
            insertAtEnd(data);
            break;
        case 5:
            printf("Enter the target node data before which to insert: ");
            scanf("%d", &target);
            printf("Enter data to insert: ");
            scanf("%d", &data);
            insertBeforeNode(target, data);
            break;
        case 6:
            printf("Enter the target node data after which to insert: ");
            scanf("%d", &target);
            printf("Enter data to insert: ");
            scanf("%d", &data);
            insertAfterNode(target, data);
            break;
        case 7:
            deleteFromBeginning();
            break;
        case 8:
            deleteFromEnd();
            break;
        case 9:
            printf("Enter the target node data after which to delete: ");
            scanf("%d", &target);
            deleteAfterNode(target);
            break;
        case 10:
            deleteList();
```

```
            break;
        case 11: exit(0);
        default: printf("Invalid choice. Try again.\n");
      }
   }

   return 0;
}
```

Output:

```
Menu:
1. Create a single linked list
2. Display the elements
3. Insert at the beginning
4. Insert at the end
5. Insert before a given node
6. Insert after a given node
7. Delete from the beginning
8. Delete from the end
9. Delete after a given node
10. Delete the entire list
11. Exit
Enter your choice: 1
Enter data to insert: 2

Menu:
1. Create a single linked list
2. Display the elements
3. Insert at the beginning
4. Insert at the end
5. Insert before a given node
6. Insert after a given node
7. Delete from the beginning
8. Delete from the end
9. Delete after a given node
10. Delete the entire list
11. Exit
Enter your choice: 3
Enter data to insert at the beginning: 5

Menu:
1. Create a single linked list
2. Display the elements
3. Insert at the beginning
4. Insert at the end
5. Insert before a given node
6. Insert after a given node
7. Delete from the beginning
8. Delete from the end
9. Delete after a given node
10. Delete the entire list
11. Exit
Enter your choice: 2
5 -> 2 -> NULL
```

2) Write a Menu driven C program to accomplish the following functionalities in circular linked list.

a) Create a circular linked list.

b) Display the elements of a circular linked list.

c) Insert a node at the beginning of a circular linked list.

d) Insert a node at the end of a circular linked list.

e) Delete a node from the beginning of a circular linked list.

f) Delete a node from the end of a circular linked list.

g) Delete a node after a given node of a circular linked list.

h) Delete the entire circular linked list.

Answer:

```
#include <stdio.h>
#include <stdlib.h>

// Define the structure for a node in the circular linked list
struct Node {
  int data;
  struct Node *next;
};

// Function to create a circular linked list with a single node
struct Node* createNode(int data) {
  struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
  newNode->data = data;
  newNode->next = newNode;
  return newNode;
}

// Function to display all elements in the circular linked list
void display(struct Node* last) {
  if (last == NULL) {
    printf("List is empty.\n");
    return;
  }
  struct Node* temp = last->next;
  do {
    printf("%d -> ", temp->data);
    temp = temp->next;
  } while (temp != last->next);
```

```
  printf("\n");
}

// Function to insert a node at the beginning of the circular linked list
struct Node* insertAtBeginning(struct Node* last, int data) {
  struct Node* newNode = createNode(data);
  if (last == NULL) {
    last = newNode;
  } else {
    newNode->next = last->next;
    last->next = newNode;
  }
  return last;
}

// Function to insert a node at the end of the circular linked list
struct Node* insertAtEnd(struct Node* last, int data) {
  struct Node* newNode = createNode(data);
  if (last == NULL) {
    return newNode;
  }
  newNode->next = last->next;
  last->next = newNode;
  last = newNode;
  return last;
}

// Function to delete a node from the beginning of the circular linked list
struct Node* deleteFromBeginning(struct Node* last) {
  if (last == NULL) {
    printf("List is empty.\n");
    return NULL;
  }
  struct Node* temp = last->next;
  if (last == temp) {
    free(temp);
    return NULL;
  }
  last->next = temp->next;
  free(temp);
  return last;
}
```

```
// Function to delete a node from the end of the circular linked list
struct Node* deleteFromEnd(struct Node* last) {
  if (last == NULL) {
    printf("List is empty.\n");
    return NULL;
  }
  struct Node* temp = last->next;
  if (last == temp) {
    free(last);
    return NULL;
  }
  while (temp->next != last) {
    temp = temp->next;
  }
  temp->next = last->next;
  free(last);
  last = temp;
  return last;
}

// Function to delete a node after a given node in the circular linked list
struct Node* deleteAfterNode(struct Node* last, int value) {
  if (last == NULL) {
    printf("List is empty.\n");
    return NULL;
  }
  struct Node* temp = last->next;
  do {
    if (temp->data == value) {
      struct Node* nodeToDelete = temp->next;
      if (nodeToDelete == last) {
        last = temp;
      }
      temp->next = nodeToDelete->next;
      free(nodeToDelete);
      return last;
    }
    temp = temp->next;
  } while (temp != last->next);
    printf("Node with value %d not found.\n", value);
    return last;
}
```

```
// Function to delete the entire circular linked list
struct Node* deleteList(struct Node* last) {
  if (last == NULL) return NULL;
  struct Node* current = last->next;
  while (current != last) {
    struct Node* temp = current;
    current = current->next;
    free(temp);
  }
  free(last);
  printf("Entire list deleted.\n");
  return NULL;
}

int main() {
  struct Node* last = NULL;
  int choice, data, value;

  do {
    printf("\nCircular Linked List Operations:\n");
    printf("1. Create circular linked list\n");
    printf("2. Display elements\n");
    printf("3. Insert at beginning\n");
    printf("4. Insert at end\n");
    printf("5. Delete from beginning\n");
    printf("6. Delete from end\n");
    printf("7. Delete after a node\n");
    printf("8. Delete entire list\n");
    printf("9. Exit\n");
    printf("Enter your choice: ");
    scanf("%d", &choice);

    switch (choice) {
      case 1:
        printf("Enter data to create list: ");
        scanf("%d", &data);
        last = createNode(data);
        break;
      case 2:
        display(last);
        break;
      case 3:
        printf("Enter data to insert at beginning: ");
```

```
      scanf("%d", &data);
      last = insertAtBeginning(last, data);
      break;
    case 4:
      printf("Enter data to insert at end: ");
      scanf("%d", &data);
      last = insertAtEnd(last, data);
      break;
    case 5:
      last = deleteFromBeginning(last);
      break;
    case 6:
      last = deleteFromEnd(last);
      break;
    case 7:
      printf("Enter value after which to delete: ");
      scanf("%d", &value);
      last = deleteAfterNode(last, value);
      break;
    case 8:
      last = deleteList(last);
      break;
    case 9:
      printf("Exiting program.\n");
      break;
    default:
      printf("Invalid choice. Try again.\n");
   }
  } while (choice != 9);

  return 0;
}
```

Output:

```
Circular Linked List Operations:
1. Create circular linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Delete from beginning
6. Delete from end
7. Delete after a node
8. Delete entire list
9. Exit
Enter your choice: 1
Enter data to create list: 2

Circular Linked List Operations:
1. Create circular linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Delete from beginning
6. Delete from end
7. Delete after a node
8. Delete entire list
9. Exit
Enter your choice: 4
Enter data to insert at end: 5

Circular Linked List Operations:
1. Create circular linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Delete from beginning
6. Delete from end
7. Delete after a node
8. Delete entire list
9. Exit
Enter your choice: 2
2 -> 5 ->
```

Week 4 Assignment

Topic: Linked List

1) Write a Menu driven C program to accomplish the following functionalities in doubly linked list.

a) Create a doubly linked list.

b) Display the elements of a doubly linked list.

c) Insert a node at the beginning of a doubly linked list.

d) Insert a node at the end of a doubly linked list.

e) Insert a node before a given node of a doubly linked list.

f) Insert a node after a given node of a doubly linked list.

g) Delete a node from the beginning of a doubly linked list.

h) Delete a node from the end of a doubly linked list.

i) Delete a node after a given node of a doubly linked list.

j) Delete the entire doubly linked list.

Answer:

```
#include <stdio.h>
#include <stdlib.h>

// Define the structure for a node in the doubly linked list
struct Node {
    int data;
    struct Node *next;
    struct Node *prev;
};

// Function to create a node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = NULL;
    newNode->prev = NULL;
    return newNode;
```

```
}

// Function to display all elements in the doubly linked list
void display(struct Node* head) {
    if (head == NULL) {
        printf("List is empty.\n");
        return;
    }
    struct Node* temp = head;
    while (temp != NULL) {
        printf("%d ", temp->data);
        temp = temp->next;
    }
    printf("\n");
}

// Function to insert a node at the beginning of the doubly linked list
struct Node* insertAtBeginning(struct Node* head, int data) {
    struct Node* newNode = createNode(data);
    if (head != NULL) {
        head->prev = newNode;
    }
    newNode->next = head;
    return newNode;
}

// Function to insert a node at the end of the doubly linked list
struct Node* insertAtEnd(struct Node* head, int data) {
    struct Node* newNode = createNode(data);
    if (head == NULL) {
        return newNode;
```

```
    }
    struct Node* temp = head;
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->next = newNode;
    newNode->prev = temp;
    return head;
}

// Function to insert a node before a given node by value
struct Node* insertBeforeNode(struct Node* head, int value, int data) {
    struct Node* temp = head;
    while (temp != NULL && temp->data != value) {
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Node with value %d not found.\n", value);
        return head;
    }
    struct Node* newNode = createNode(data);
    newNode->next = temp;
    newNode->prev = temp->prev;
    if (temp->prev != NULL) {
        temp->prev->next = newNode;
    } else {
        head = newNode;
    }
    temp->prev = newNode;
    return head;
}
```

```
// Function to insert a node after a given node by value
struct Node* insertAfterNode(struct Node* head, int value, int data) {
    struct Node* temp = head;
    while (temp != NULL && temp->data != value) {
        temp = temp->next;
    }
    if (temp == NULL) {
        printf("Node with value %d not found.\n", value);
        return head;
    }
    struct Node* newNode = createNode(data);
    newNode->next = temp->next;
    newNode->prev = temp;
    if (temp->next != NULL) {
        temp->next->prev = newNode;
    }
    temp->next = newNode;
    return head;
}

// Function to delete a node from the beginning of the doubly linked list
struct Node* deleteFromBeginning(struct Node* head) {
    if (head == NULL) {
        printf("List is empty.\n");
        return NULL;
    }
    struct Node* temp = head;
    head = head->next;
    if (head != NULL) {
        head->prev = NULL;
```

```
    }
    free(temp);
    return head;
}

// Function to delete a node from the end of the doubly linked list
struct Node* deleteFromEnd(struct Node* head) {
    if (head == NULL) {
        printf("List is empty.\n");
        return NULL;
    }
    struct Node* temp = head;
    if (temp->next == NULL) {
        free(temp);
        return NULL;
    }
    while (temp->next != NULL) {
        temp = temp->next;
    }
    temp->prev->next = NULL;
    free(temp);
    return head;
}

// Function to delete a node after a given node by value
struct Node* deleteAfterNode(struct Node* head, int value) {
    struct Node* temp = head;
    while (temp != NULL && temp->data != value) {
        temp = temp->next;
    }
    if (temp == NULL || temp->next == NULL) {
```

```
        printf("Node with value %d not found or has no next node.\n", value);
        return head;
    }
    struct Node* nodeToDelete = temp->next;
    temp->next = nodeToDelete->next;
    if (nodeToDelete->next != NULL) {
        nodeToDelete->next->prev = temp;
    }
    free(nodeToDelete);
    return head;
}

// Function to delete the entire doubly linked list
struct Node* deleteList(struct Node* head) {
    struct Node* temp = head;
    while (temp != NULL) {
        struct Node* next = temp->next;
        free(temp);
        temp = next;
    }
    printf("Entire list deleted.\n");
    return NULL;
}

int main() {
    struct Node* head = NULL;
    int choice, data, value;

    do {
        printf("\nDoubly Linked List Operations:\n");
        printf("1. Create doubly linked list\n");
```

```
    printf("2. Display elements\n");
    printf("3. Insert at beginning\n");
    printf("4. Insert at end\n");
    printf("5. Insert before a node\n");
    printf("6. Insert after a node\n");
    printf("7. Delete from beginning\n");
    printf("8. Delete from end\n");
    printf("9. Delete after a node\n");
    printf("10. Delete entire list\n");
    printf("11. Exit\n");
    printf("Enter your choice: ");
    scanf("%d", &choice);

    switch (choice) {
        case 1:
            printf("Enter data to create list: ");
            scanf("%d", &data);
            head = insertAtEnd(head, data);
            break;
        case 2:
            display(head);
            break;
        case 3:
            printf("Enter data to insert at beginning: ");
            scanf("%d", &data);
            head = insertAtBeginning(head, data);
            break;
        case 4:
            printf("Enter data to insert at end: ");
            scanf("%d", &data);
            head = insertAtEnd(head, data);
```

```
            break;
        case 5:
            printf("Enter value before which to insert: ");
            scanf("%d", &value);
            printf("Enter data to insert: ");
            scanf("%d", &data);
            head = insertBeforeNode(head, value, data);
            break;
        case 6:
            printf("Enter value after which to insert: ");
            scanf("%d", &value);
            printf("Enter data to insert: ");
            scanf("%d", &data);
            head = insertAfterNode(head, value, data);
            break;
        case 7:
            head = deleteFromBeginning(head);
            break;
        case 8:
            head = deleteFromEnd(head);
            break;
        case 9:
            printf("Enter value after which to delete: ");
            scanf("%d", &value);
            head = deleteAfterNode(head, value);
            break;
        case 10:
            head = deleteList(head);
            break;
        case 11:
            printf("Exiting program.\n");
```

```
            break;
        default:
            printf("Invalid choice. Try again.\n");
    }
  } while (choice != 11);
  return 0;
}
```

Output:

```
Doubly Linked List Operations:
1. Create doubly linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Insert before a node
6. Insert after a node
7. Delete from beginning
8. Delete from end
9. Delete after a node
10. Delete entire list
11. Exit
Enter your choice: 3
Enter data to insert at beginning: 5

Doubly Linked List Operations:
1. Create doubly linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Insert before a node
6. Insert after a node
7. Delete from beginning
8. Delete from end
9. Delete after a node
10. Delete entire list
11. Exit
Enter your choice: 3
Enter data to insert at beginning: 8

Doubly Linked List Operations:
1. Create doubly linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Insert before a node
6. Insert after a node
7. Delete from beginning
8. Delete from end
9. Delete after a node
10. Delete entire list
11. Exit
Enter your choice: 2
8 5
```

2) Write a Menu driven C program to accomplish the following functionalities in circular doubly linked list.

a) Create a circular doubly linked list.

b) Display the elements of a circular doubly linked list.

c) Insert a node at the beginning of a circular doubly linked list.

d) Insert a node at the end of a circular doubly linked list.

e) Delete a node from the beginning of a circular doubly linked list.

f) Delete a node from the end of a circular doubly linked list.

g) Delete a node after a given node of a circular doubly linked list.

h) Delete the entire circular doubly linked list.

Answer:

```
#include <stdio.h>
#include <stdlib.h>

// Define the structure for a node in the circular doubly linked list
struct Node {
    int data;
    struct Node *next;
    struct Node *prev;
};

// Function to create a new node
struct Node* createNode(int data) {
    struct Node* newNode = (struct Node*)malloc(sizeof(struct Node));
    newNode->data = data;
    newNode->next = newNode;
    newNode->prev = newNode;
    return newNode;
```

```
}

// Function to display all elements in the circular doubly linked list
void display(struct Node* last) {
    if (last == NULL) {
        printf("List is empty.\n");
        return;
    }
    struct Node* temp = last->next;
    do {
        printf("%d ", temp->data);
        temp = temp->next;
    } while (temp != last->next);
    printf("\n");
}

// Function to insert a node at the beginning of the circular doubly linked list
struct Node* insertAtBeginning(struct Node* last, int data) {
    struct Node* newNode = createNode(data);
    if (last == NULL) {
        return newNode;
    }
    newNode->next = last->next;
    newNode->prev = last;
    last->next->prev = newNode;
    last->next = newNode;
    return last;
}
```

```
// Function to insert a node at the end of the circular doubly linked list
struct Node* insertAtEnd(struct Node* last, int data) {
    struct Node* newNode = createNode(data);
    if (last == NULL) {
        return newNode;
    }
    newNode->next = last->next;
    newNode->prev = last;
    last->next->prev = newNode;
    last->next = newNode;
    last = newNode;
    return last;
}

// Function to delete a node from the beginning of the circular doubly linked list
struct Node* deleteFromBeginning(struct Node* last) {
    if (last == NULL) {
        printf("List is empty.\n");
        return NULL;
    }
    struct Node* temp = last->next;
    if (last == temp) {
        free(temp);
        return NULL;
    }
    last->next = temp->next;
    temp->next->prev = last;
```

```
    free(temp);
    return last;
}

// Function to delete a node from the end of the circular doubly linked list
struct Node* deleteFromEnd(struct Node* last) {
    if (last == NULL) {
        printf("List is empty.\n");
        return NULL;
    }
    struct Node* temp = last;
    if (last->next == last) {
        free(last);
        return NULL;
    }
    last->prev->next = last->next;
    last->next->prev = last->prev;
    last = last->prev;
    free(temp);
    return last;
}

// Function to delete a node after a given node by value
struct Node* deleteAfterNode(struct Node* last, int value) {
    if (last == NULL) {
        printf("List is empty.\n");
        return NULL;
    }
```

```
    struct Node* temp = last->next;
    do {
        if (temp->data == value) {
            struct Node* nodeToDelete = temp->next;
            if (nodeToDelete == last) {
                last = temp;
            }
            temp->next = nodeToDelete->next;
            nodeToDelete->next->prev = temp;
            free(nodeToDelete);
            return last;
        }
        temp = temp->next;
    } while (temp != last->next);
    printf("Node with value %d not found.\n", value);
    return last;
}

// Function to delete the entire circular doubly linked list
struct Node* deleteList(struct Node* last) {
    if (last == NULL) return NULL;
    struct Node* current = last->next;
    while (current != last) {
        struct Node* temp = current;
        current = current->next;
        free(temp);
    }
    free(last);
```

```
    printf("Entire list deleted.\n");
    return NULL;
}

int main() {
    struct Node* last = NULL;
    int choice, data, value;

    do {
        printf("\nCircular Doubly Linked List Operations:\n");
        printf("1. Create circular doubly linked list\n");
        printf("2. Display elements\n");
        printf("3. Insert at beginning\n");
        printf("4. Insert at end\n");
        printf("5. Delete from beginning\n");
        printf("6. Delete from end\n");
        printf("7. Delete after a node\n");
        printf("8. Delete entire list\n");
        printf("9. Exit\n");
        printf("Enter your choice: ");
        scanf("%d", &choice);

        switch (choice) {
            case 1:
                printf("Enter data to create list: ");
                scanf("%d", &data);
                last = createNode(data);
                break;
```

```
        case 2:
            display(last);
            break;
        case 3:
            printf("Enter data to insert at beginning: ");
            scanf("%d", &data);
            last = insertAtBeginning(last, data);
            break;
        case 4:
            printf("Enter data to insert at end: ");
            scanf("%d", &data);
            last = insertAtEnd(last, data);
            break;
        case 5:
            last = deleteFromBeginning(last);
            break;
        case 6:
            last = deleteFromEnd(last);
            break;
        case 7:
            printf("Enter value after which to delete: ");
            scanf("%d", &value);
            last = deleteAfterNode(last, value);
            break;
        case 8:
            last = deleteList(last);
            break;
        case 9:
```

```
            printf("Exiting program.\n");
            break;
        default:
            printf("Invalid choice. Try again.\n");
    }
  } while (choice != 9);

  return 0;
}
```

Output:

```
Circular Doubly Linked List Operations:
1. Create circular doubly linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Delete from beginning
6. Delete from end
7. Delete after a node
8. Delete entire list
9. Exit
Enter your choice: 3
Enter data to insert at beginning: 5

Circular Doubly Linked List Operations:
1. Create circular doubly linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Delete from beginning
6. Delete from end
7. Delete after a node
8. Delete entire list
9. Exit
Enter your choice: 3
Enter data to insert at beginning: 8

Circular Doubly Linked List Operations:
1. Create circular doubly linked list
2. Display elements
3. Insert at beginning
4. Insert at end
5. Delete from beginning
6. Delete from end
7. Delete after a node
8. Delete entire list
9. Exit
Enter your choice: 2
8 5
```