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UCS 2312 Data Structures Lab

Assignment 5: QueueADT and its application

Date of Assignment: 10.10.2023

Create an ADT for the circular queue data structure using Singly Linked List with the following functions. Each node which consists of Job ID and Burst time. [CO1, K3]

a. createQueue(Q,size) – initialize size
b. enqueue(Q, data) – enqueue data into the queue
c. dequeue(Q)– returns the element at front
d. isEmpty(Q) – returns 1 if queue empty, otherwise returns 0
e. display(Q) – display the elements in queue

Test the operations of queueADT with the following test cases

Operation	**Expected Output**
dequeue(Q)	Empty
enqueue(Q, J1, 2)	(J1,2)
enqueue(Q, J2, 13)	(J1,2), (J2,13)
enqueue(Q, J3, 5)	(J1,2), (J2,13),(J3,5)
dequeue(Q)	(J1,2)
display(Q)	(J2,13),(J3,5)
dequeue(Q)	(J2,13)
display(Q)	(J3,5)

Best practices to be followed:

- Design before coding
- Usage of algorithm notation
- Use of multi-file C program
- Versioning of code

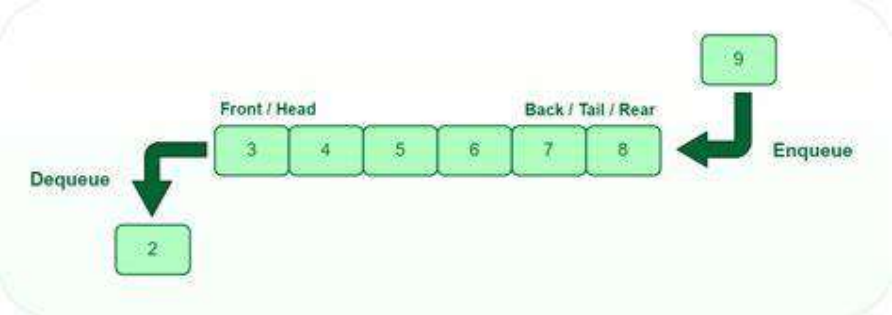
Application using Queue

1. Job scheduling

   Insert queue with the following contents
   (J1,2), (J2,4), (J3,8), (J4,5), (J5,2), (J6,7), (J7,4), (J8,3) (J9,6) & (J10,6)
   Insert the job into the queue whichever is empty. If it is not empty, insert the job into the queue whichever is having minimum average time
   Display the jobs waiting in both the queues along with their CPU burst time.

2. Build Queue using stacks

Data Structure – Queue:



Algorithm – Build Queue using Stacks

Algorithm: Enqueue

Input – Pointer to stack 1, pointer to stack 2, data to be added to queue
Output – void

```
1. if (queueIsFull(s1, s2))
        print Queue is Full
2. else
        push(s1, data)
```

Algorithm: Dequeue

Input – Pointer to stack 1, pointer to stack 2
Output – int

```
1. if (queueIsEmpty(s1, s2))
        print Queue is Empty
2. else
        if (isEmpty(s2))
                while (!isEmpty(s1))
                        push(s2, pop(s1))
        return pop(s2)
```

Algorithm: queueIsFull

Input – Pointer to stack 1, pointer to stack 2
Output – int

```
1. if (s1->top + s2->top < s1->size-2)
        return 0
2. return 1
```

Algorithm: queueIsEmpty

Input – Pointer to stack 1, pointer to stack 2
Output – int

```
1. if (s1->top == -1 && s2->top == -1)
        return 1
2. return 0
```

queue.h code:

```
struct emp
{
    char jid[100];
    int time;
};

struct queue
{
    struct emp e;
    struct queue *next;
};

int isEmpty(struct queue* ptr[])
{
    if(ptr[0]->next == NULL && ptr[1]->next == NULL)
        return 1;
    else
        return 0;
}

void display(struct queue *q[])
{
    for(struct queue* i = q[0]->next ; i!=NULL ; i = i->next)
        printf("%s ", i->e.jid);
}

void enqueue(struct queue* ptr[], struct emp e)
{
    struct queue *temp = (struct queue*)malloc(sizeof(struct queue));
    strcpy(temp->e.jid, e.jid);
    temp->e.time = e.time;
    temp->next = NULL;
    if(ptr[0]->next == NULL)
        ptr[0]->next = temp;
    else
        ptr[1]->next = temp;
    ptr[1] = temp;
}

struct emp* dequeue(struct queue* ptr[])
{
    struct queue *ptr1;
    struct emp *e = (struct emp *)malloc(sizeof(struct emp));
    if(ptr[0]->next != NULL)
    {
        ptr1 = ptr[0]->next;
        strcpy(e->jid, ptr1->e.jid);
        e->time = ptr1->e.time;
        ptr[0]->next = ptr1->next;
        free(ptr1);
        return e;
    }
    else
```

```
        return NULL;
}
```

main.c code:

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include"queue.h"

int main()
{
    int choice = 1;
    struct queue *Q[2];
    for(int i = 0 ; i < 2 ; i++)
        Q[i] = (struct queue*)malloc(sizeof(struct queue));
    Q[0]->next = NULL;
    Q[1]->next = NULL;
    struct emp e;
    printf("Dequeued %s", dequeue(Q)->jid);
    display(Q);
    printf("\n");
    strcpy(e.jid, "J1");
    e.time = 2;
    enqueue (Q, e);
    display(Q);
    printf("\n");
    strcpy(e.jid, "J2");
    e.time = 13;
    enqueue(Q, e);
    display(Q);
    printf("\n");
    strcpy(e.jid, "J3");
    e.time = 5;
    enqueue(Q, e);
    display(Q);
    printf("\n");
    printf("Dequeued %s\n", dequeue(Q)->jid);
    display(Q);
    printf("\n");
    printf("Dequeued %s\n", dequeue(Q)->jid);
    display(Q);
    printf("\n");
}
```

Output Screen:

```
PS D:\College\Sem 3\Data Structures\Queue> gcc main.c
PS D:\College\Sem 3\Data Structures\Queue> ./a.exe
Dequeued (null)
J1
J1 J2
J1 J2 J3
Dequeued J1
J2 J3
Dequeued J2
J3
PS D:\College\Sem 3\Data Structures\Queue>
```

APPLICATIONS:

1. Job Scheduling

empMain.c code:

```
#include<stdio.h>
#include<stdlib.h>
#include<string.h>
#include"empqueueAdt.h"

int waitingTime(struct queue* ptr[])
{
      if(isEmpty(ptr)) return 0;
      int sum = 0;
      struct queue *temp = ptr[0]->next ;
      while(temp != NULL){
            sum += temp->e.time;
            temp = temp->next;
      }
      return sum;
}

void allocateJob(struct queue* ptr1[], struct queue* ptr2[], struct emp
job)
{
      if(waitingTime(ptr1) <= waitingTime(ptr2)) enqueue(ptr1, job);
      else enqueue(ptr2, job);
}

int main()
{
      int choice = 1;
      struct queue *ptr1[2];
    for(int i = 0 ; i < 2 ; i++)
        ptr1[i] = (struct queue*)malloc(sizeof(struct queue));
    ptr1[0]->next = NULL;
    ptr1[1]->next = NULL;
      struct queue *ptr2[2];
    for(int i = 0 ; i < 2 ; i++)
        ptr2[i] = (struct queue*)malloc(sizeof(struct queue));
    ptr2[0]->next = NULL;
    ptr2[1]->next = NULL;
      while(choice)
      {
            printf("\n\n1. Enqueue\n2. Dequeue queue 1\n3. Dequeue queue
2\n0. Exit\nEnter choice: ");
            scanf("%d", &choice);
            switch(choice)
            {
                  case 1:
                  {
                        struct emp job;
                        printf("Enter job ID: ");
                        scanf("%s", &job.jid);
                        printf("Enter time: ");
                        scanf("%d", &job.time);
```

```
                        allocateJob(ptr1, ptr2, job);
                        printf("QUEUE1 > ");
                        display(ptr1);
                        printf("\nQUEUE2 > ");
                        display(ptr2);
                        break;
                  }
                  case 2:
                  {
                        struct emp *deq = dequeue(ptr1);
                        if(deq != NULL){
                              printf("%s is removed", deq->jid);
                        }
                        printf("\nQUEUE1 > ");
                        display(ptr1);
                        printf("\nQUEUE2 > ");
                        display(ptr2);
                        break;
                  }
                  case 3:
                  {
                        struct emp *deq = dequeue(ptr2);
                        if(deq != NULL){
                              printf("%s is removed", deq->jid);
                        }
                        printf("\nQUEUE1 > ");
                        display(ptr1);
                        printf("\nQUEUE2 > ");
                        display(ptr2);
                        break;
                  }
            }
      }
}
```

empQueueAdt.h code:

```
struct emp
{
      char jid[100];
      int time;
};

struct queue
{
      struct emp e;
      struct queue *next;
};

int isEmpty(struct queue* ptr[])
{
      if(ptr[0]->next == NULL && ptr[1]->next == NULL) return 1;
      else return 0;
}

void display(struct queue *q[])
```

```
{
      for(struct queue* i = q[0]->next ; i!=NULL ; i = i->next){
            printf("%s ", i->e.jid);
      }
}

void enqueue(struct queue* ptr[], struct emp e)
{
    struct queue *temp = (struct queue*)malloc(sizeof(struct queue));
    strcpy(temp->e.jid, e.jid);
     temp->e.time = e.time;

    temp->next = NULL;

    if(ptr[0]->next == NULL){
        ptr[0]->next = temp;
     }
    else
        ptr[1]->next = temp;
    ptr[1] = temp;
}

struct emp* dequeue(struct queue* ptr[])
{
    struct queue *ptr1;
     struct emp *e = (struct emp *)malloc(sizeof(struct emp));
    if(ptr[0]->next != NULL){
        ptr1 = ptr[0]->next;
           strcpy(e->jid, ptr1->e.jid);
           e->time = ptr1->e.time;
        ptr[0]->next = ptr1->next;
        free(ptr1);
        return e;
    }
    else{
        return NULL;
    }

}
```

2. Queue using Stack

queue.h code:

```
struct stack
{
       int top;
       int a[100];
       int size;
};
void create(struct stack *s,int size)
{
      s->size=size;
      s->top=-1;
}
int isFull(struct stack *s)
{
      if(s->top<(s->size-1))
            return 0;
      return 1;
}
void push(struct stack *s,int data)
{
      s->a[++s->top]=data;
}
int isEmpty(struct stack *s)
{
      if(s->top==-1)
            return 1;
      return 0;
}
int pop(struct stack *s)
{
      return(s->a[s->top--]);
}
int peek(struct stack *s)
{
      if(isEmpty(s))
            return -1;
      else
            return s->a[s->top];
}

int queueIsFull(struct stack *s1, struct stack *s2)
{
      if(s1->top + s2->top < s1->size-2)
            return 0;
      return 1;
}

int queueIsEmpty(struct stack *s1, struct stack *s2)
{
      if(s1->top == -1 && s2->top == -1)
            return 1;
      return 0;
}
```

```
void enqueue(struct stack *s1, struct stack *s2, int data)
{
      if(queueIsFull(s1, s2))
            printf("QUEUE IS FULL\n");
      else
            push(s1, data);
}

int dequeue(struct stack *s1, struct stack *s2)
{
      if(queueIsEmpty(s1, s2))
            printf("QUEUE IS EMPTY\n");
      else
      {
            if(isEmpty(s2))
            {
                  while(!isEmpty(s1))
                        push(s2, pop(s1));
            }
            return pop(s2);
      }
}
```

queue.c code:

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

void  main()
{
      struct stack *s1=(struct stack *)malloc(sizeof(struct stack));
      struct stack *s2=(struct stack *)malloc(sizeof(struct stack));
      int size,choice,data;
      printf("Enter size : ");
      scanf("%d",&size);
      create(s1,size);
      create(s2,size);
      while(choice+1)
      {
            printf("\n-1: EXIT\n1: ENQUEUE\n2: DEQUEUE\nChoice : ");
            scanf("%d",&choice);
            switch(choice)
            {
                  case -1:
                  break;
                  case 1:
                  printf("Enter element : ");
                  scanf("%d",&data);
                  enqueue(s1,s2, data);
                  break;
                  case 2:
                  if(!queueIsEmpty(s1, s2))
                  printf("Element Removed = %d\n",dequeue(s1, s2));
```

```
                    else printf("QUEUE IS EMPTY");
                    break;
                    default:
                    printf("Invalid choice\n");
                }
        }
}
```

Output Screen:

Job Scheduling –

```
PS D:\College\Sem 3\Data Structures\Queue> gcc empMain.c
PS D:\College\Sem 3\Data Structures\Queue> ./a.exe


1. Enqueue
2. Dequeue queue 1
3. Dequeue queue 2
0. Exit
Enter choice: 1
Enter job ID: J1
Enter time: 2
QUEUE1 > J1
QUEUE2 >

1. Enqueue
2. Dequeue queue 1
3. Dequeue queue 2
0. Exit
Enter choice: 1
Enter job ID: J2
Enter time: 4
QUEUE1 > J1
QUEUE2 > J2

1. Enqueue
2. Dequeue queue 1
3. Dequeue queue 2
0. Exit
Enter choice: 1
Enter job ID: J3
Enter time: 8
QUEUE1 > J1 J3
QUEUE2 > J2

1. Enqueue
2. Dequeue queue 1
3. Dequeue queue 2
0. Exit
Enter choice: 1
Enter job ID: J4
Enter time: 5
QUEUE1 > J1 J3
QUEUE2 > J2 J4

1. Enqueue
2. Dequeue queue 1
3. Dequeue queue 2
0. Exit
Enter choice: 1
Enter job ID: J5
Enter time: 2
QUEUE1 > J1 J3
QUEUE2 > J2 J4 J5

1. Enqueue
2. Dequeue queue 1
3. Dequeue queue 2
0. Exit
Enter choice: 1
Enter job ID: J6
Enter time: 7
QUEUE1 > J1 J3 J6
QUEUE2 > J2 J4 J5

1. Enqueue
2. Dequeue queue 1
3. Dequeue queue 2
0. Exit
Enter choice: 1
Enter job ID: J7
Enter time: 4
QUEUE1 > J1 J3 J6
QUEUE2 > J2 J4 J5 J7
```

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Queue Using Stack –

```
PS D:\College\Sem 3\Data Structures\Stack> gcc queue.c
PS D:\College\Sem 3\Data Structures\Stack> ./a.exe
Enter size : 3

-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice : 1
Enter element : 1

-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice : 1
Enter element : 2

-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice : 1
Enter element : 3

-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice : 1
Enter element : 4
QUEUE IS FULL

-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice : 2
Element Removed = 1

-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice : 2
Element Removed = 2

-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice : 2
Element Removed = 3

-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice : 2
QUEUE IS EMPTY
-1: EXIT
1: ENQUEUE
2: DEQUEUE
Choice :
```

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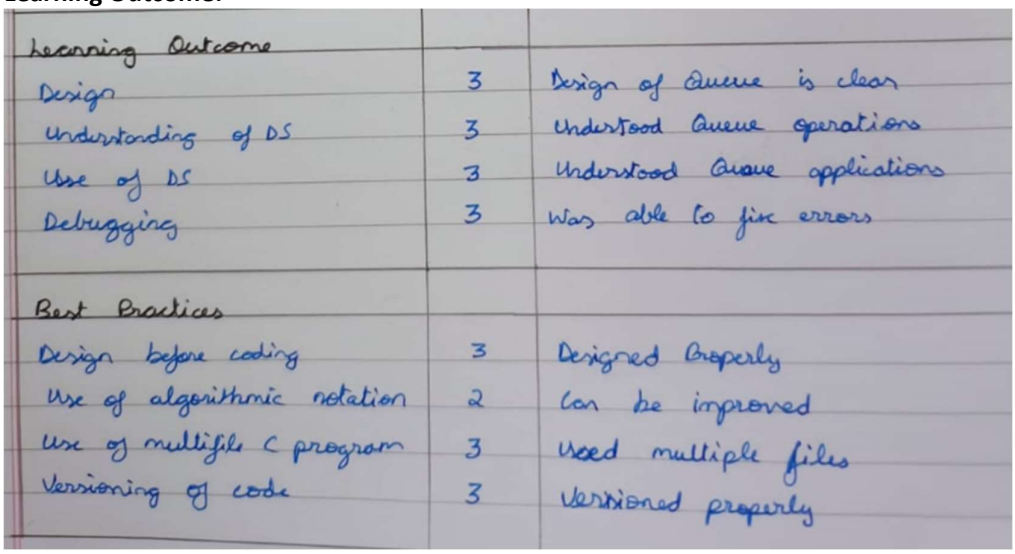
Learning Outcome:



Learning Outcome		
Design	3	Design of Queue is clear
Understanding of DS	3	Understood Queue operations
Use of DS	3	Understood Queue applications
Debugging	3	Was able to fix errors
Best Practices		
Design before coding	3	Designed Properly
Use of algorithmic notation	2	Can be improved
Use of multiple C program	3	Used multiple files
Versioning of code	3	Versioned properly