EAST WEST UNIVERSITY

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Documentation of Dental Clinic Problem

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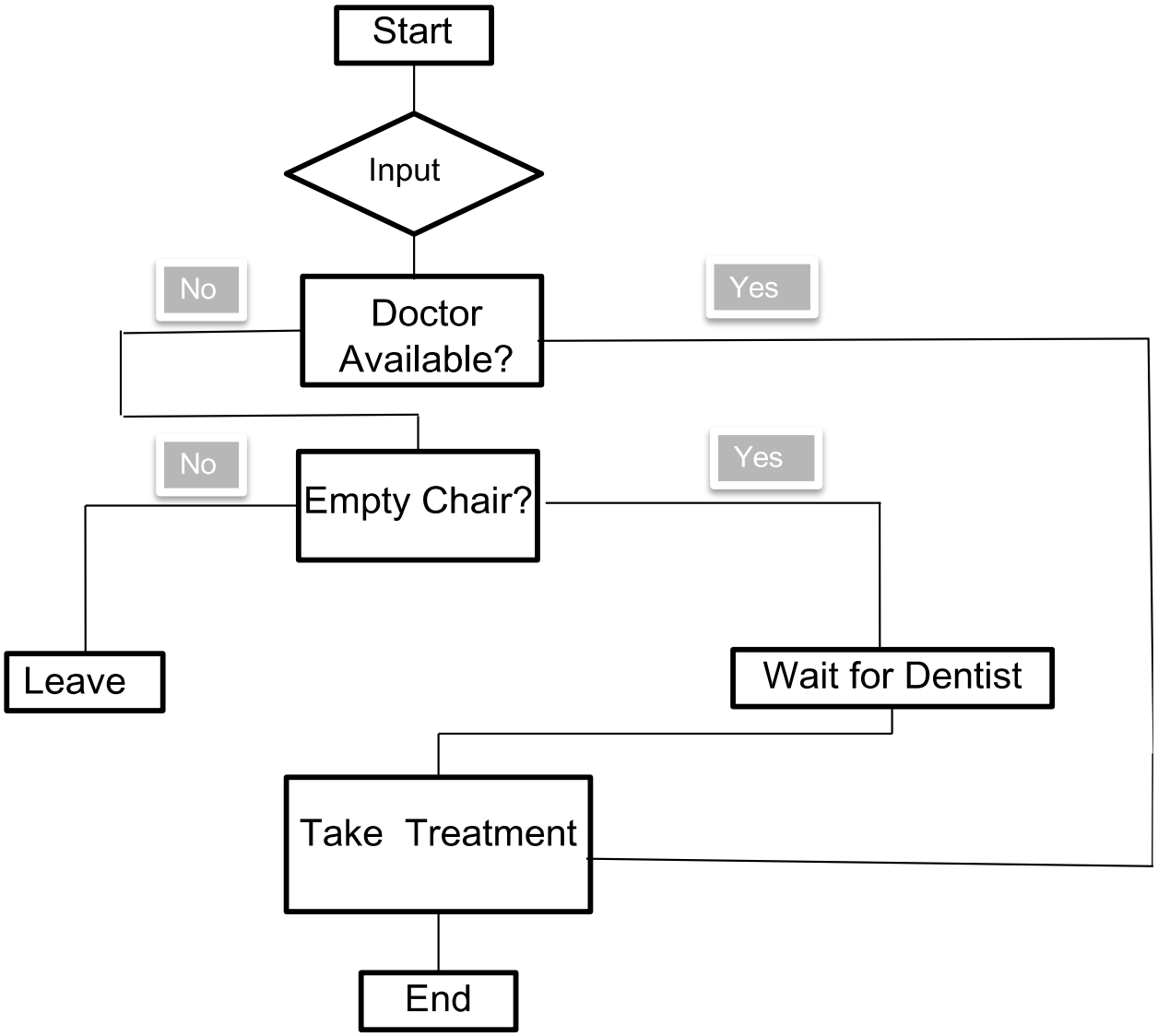
Abstract:

The name of our problem is Dental Clinic Problem. There is a dental clinic which has one dentist with one dental chair and n chairs for waiting. When there are no patients, the dentist sleeps in his chair. When a patient arrives, he has to wake up the dentist. Only one patient can take treatment from the dentist at a time. Other patients will wait if there are empty chairs. Otherwise, they will leave. Now, our task is to synchronize the activities of the patients and the dentist.

Introduction:

We have represented the dentist and the patients by threads. To create and initialize the threads we have used the pthread_create function. The pthread_join function will make the parent thread wait until the child thread is terminated. We have used the mutex lock to handle the critical section problem. Here the pthread_mutex_lock function locks the specified critical section. If the critical section is already locked, the calling thread blocks until the critical section becomes available. When the thread completes its function, it unlocks the critical section again. In this way, we handled the race condition or the critical section problem. We have used semaphores to synchronize the activities of the threads. We have used the sem_init function to initialize it. The sem_wait function decreases the value of the semaphore, and if the value is less than 0, then it puts the threads in the block. Finally, the sem_post function increases the value of the semaphore and unblocks the blocked threads.

Flow Chart:



Code:

```
#include <stdio.h>
#include <pthread.h>
#include <semaphore.h>
#include <stdlib.h>
#include <stdbool.h>
sem_t sem1;
```

```
sem_t sem2;
sem_t sem3;
pthread_mutex_t mutex;
int limit = 0;
int x = 0, count = 0, temp_chair = 0, id, flag = 0;

void *Patients(void *arg)
{
   sem_wait(&sem1);
   int id = (int *)arg;
   pthread_mutex_lock(&mutex);
   if (count > temp_chair)
   {
      printf("\n");
      printf("No more chairs available. Patient %d is leaving\n", id);
      pthread_mutex_unlock(&mutex);
      pthread_exit(id);
   }
   if (count != 0)
   {
      printf("Patient %d is waiting in the chair.\n", id);
   }
   count++;
   pthread_mutex_unlock(&mutex);
   sem_wait(&sem2);
   flag++;
   sleep(1);
   if (flag == 1)
   {
      printf("\nPatient %d wakes up the dentist\n", id);
```

```
    }
    x = id;
    sem_post(&sem3);
}
void *Dentist(void *arg)
{
    while (true)
    {
        if (limit)
        {
            printf("\nTHE DENTIST TERMINATES\n");
            break;
        }
        sem_wait(&sem3);
        printf("\n");
        printf("The dentist is treating %d \n", x);
        printf("Patient %d is treated successfully.\n", x);
        printf("Patient %d is leaving.\n", x);
        sem_post(&sem2);
    }
}

int main()
{
    pthread_t dentist, *arr_patients;
    int patient, chair;
    printf("\n\n\tDENTAL CLINIC PROBLEM\n\n");
    printf("Number of patients: ");
    scanf("%d", &patient);
    printf("Number of chairs: ");
```

```
    scanf("%d", &chair);
    printf("\n");
    temp_chair = chair;
    int i;
    sem_init(&sem1, 0, patient);
    sem_init(&sem2, 0, 1);
    sem_init(&sem3, 0, 0);
    pthread_mutex_init(&mutex, 0);
    if (patient == 0)
    {
        printf("Dentist is sleeping\n");
    }

    arr_patients = (pthread_t *)malloc(patient * sizeof(pthread_t));

    pthread_create(&dentist, NULL, Dentist, NULL);

    for (int i = 0; i < patient; i++)
    {
        pthread_create(&arr_patients[i], NULL, Patients, (void *)i + 1);
    }
    for (int i = 0; i < patient; i++)
    {
        pthread_join(arr_patients[i], NULL);
    }
    limit = 1;
    sem_post(&sem3);
    pthread_join(dentist, NULL);
}
```

Results:

Case 01:

DENTAL CLINIC PROBLEM

Number of patients: 5

Number of chairs: 5

Patient 3 is waiting in the chair.

Patient 4 is waiting in the chair.

Patient 2 is waiting in the chair.

Patient 5 is waiting in the chair.

Patient 1 wakes up the dentist

The dentist is treating 1

Patient 1 is treated successfully.

Patient 1 is leaving.

The dentist is treating 3

Patient 3 is treated successfully.

Patient 3 is leaving.

The dentist is treating 4

Patient 4 is treated successfully.

Patient 4 is leaving.

The dentist is treating 2

Patient 2 is treated successfully.

Patient 2 is leaving.

The dentist is treating 5

Patient 5 is treated successfully.

Patient 5 is leaving.

THE DENTIST TERMINATES

Case 02:

DENTAL CLINIC PROBLEM

Number of patients: 15

Number of chairs: 7

Patient 2 is waiting in the chair.

Patient 3 is waiting in the chair.

Patient 4 is waiting in the chair.

Patient 5 is waiting in the chair.

Patient 6 is waiting in the chair.

Patient 7 is waiting in the chair.

Patient 8 is waiting in the chair.

No more chairs available. Patient 9 is leaving

No more chairs available. Patient 12 is leaving

No more chairs available. Patient 13 is leaving

No more chairs available. Patient 14 is leaving

No more chairs available. Patient 15 is leaving

No more chairs available. Patient 10 is leaving

No more chairs available. Patient 11 is leaving

Patient 1 wakes up the dentist

The dentist is treating 1

Patient 1 is treated successfully.

Patient 1 is leaving.

The dentist is treating 2

Patient 2 is treated successfully.

Patient 2 is leaving.

The dentist is treating 3

Patient 3 is treated successfully.

Patient 3 is leaving.

The dentist is treating 4

Patient 4 is treated successfully.

Patient 4 is leaving.

The dentist is treating 5

Patient 5 is treated successfully.

Patient 5 is leaving.

The dentist is treating 6

Patient 6 is treated successfully.

Patient 6 is leaving.

The dentist is treating 7

Patient 7 is treated successfully.

Patient 7 is leaving.

The dentist is treating 8

Patient 8 is treated successfully.

Patient 8 is leaving.

THE DENTIST TERMINATES

Case 03:

DENTAL CLINIC PROBLEM

Number of patients: 0

Number of chairs: 5

Dentist is sleeping

THE DENTIST TERMINATES

Case 04:

DENTAL CLINIC PROBLEM

Number of patients: 5

Number of chairs: 0

No more chairs available. Patient 2 is leaving

No more chairs available. Patient 4 is leaving

No more chairs available. Patient 3 is leaving

No more chairs available. Patient 5 is leaving

Patient 1 wakes up the dentist

The dentist is treating 1

Patient 1 is treated successfully.

Patient 1 is leaving.

The dentist is treating 1

Patient 1 is treated successfully.

Patient 1 is leaving.

THE DENTIST TERMINATES