Deadlock

Lab 07

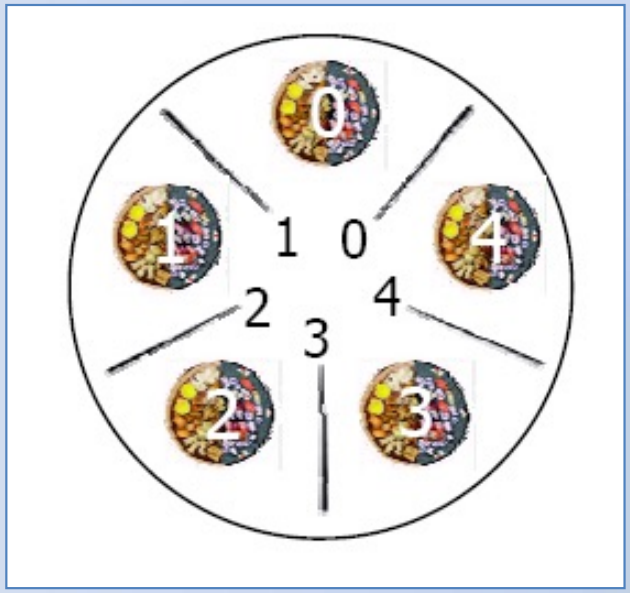
اللهم علمنا ما ينفعنا،، وانفعنا بما علمتنا،، وزدنا علماً

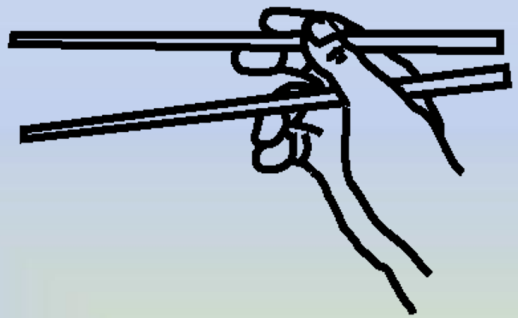
Lab Objective

- To practice resolving deadlock using Mutexes.

A Classic Example of Deadlock

- Dinning lawyers (philosophers)
- Each needs two chopsticks to eat





- If each first grabs the chopstick on their left before the one on their right, and all grab at the same time, we have a deadlock

Practice

- The following code implements the "*dinning lawyers*" deadlock example.
- Each lawyer needs two chopsticks to eat.
- The code creates 5 threads, one per lawyer, and it has five mutexes to represent the chopsticks.
- The `sleep(1)` in the code allows all threads (lawyers) to grab (lock) the chopstick on their left before the one on their right.
- The `sleep(2)` in the code represent the time taken for eating!
- Compile and run the program as shown then explain the output (Do we have deadlock?).

Practice (Cont.)

- Rewrite the code to resolve the deadlock problem.
- One way to solve the deadlock is to make every lawyer grab both chopsticks at the same time.
- To implement that, you need to define the following mutex:

```
pthread_mutex_t Chopstick_mutex =
PTHREAD_MUTEX_INITIALIZER;
```

- In the thread function you will need to lock the new mutex before grabbing the first chopstick and unlock it after grabbing the second chopstick.

To lock use: `pthread_mutex_lock(&Chopstick_mutex);`

To unlock use: `pthread_mutex_unlock(&Chopstick_mutex);`

- Re-compile and run the program then record the new results.

```
#include <iostream>
#include <stdlib.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/wait.h>
#include <cstdint>
#include "pthread.h"
using namespace std;

pthread_mutex_t Chopstick_mutex [5]=
{PTHREAD_MUTEX_INITIALIZER, PTHREAD_MUTEX_INITIALIZER,
PTHREAD_MUTEX_INITIALIZER, PTHREAD_MUTEX_INITIALIZER,
PTHREAD_MUTEX_INITIALIZER};

void *doit(void *);
```

Array

Define and initialize five Mutexes to represent the chopsticks

`doit` function declaration

```
int main()
{
   pthread_t Lawyer[5];
   int i;
    cout<<dec; // to display numbers in decimal format

    //Creating the Lawyers thread
    for(i=0;i<5;i++)
      pthread_create(&Lawyer[i], NULL, doit, (void *)(intptr_t)i);

   // wait for threads to terminate
    for(i=0;i<5;i++)
       pthread_join(Lawyer[i], NULL);

   //Leaving a mutex without destroying it can affect
performance
    for(i=0;i<5;i++)
       pthread_mutex_destroy(&Chopstick_mutex[i]);

    exit(0);
}
```

Creating 5 threads, one per lawyer

Waiting for threads termination

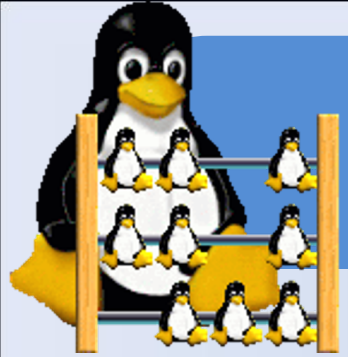
Destroying all Mutexes

```
void * doit(void *vptr)
{
   //Get the Left Chopstick
   pthread_mutex_lock(&Chopstick_mutex[(intptr_t)vptr]);
   cout<<"Lawyer " << (intptr_t)vptr << " got chopstick number ";
   cout <<(intptr_t) vptr << endl;

   sleep(1);

  //Get the Right Chopstick
   pthread_mutex_lock(&Chopstick_mutex[((intptr_t) vptr+1)%5]);
   cout<<"Lawyer " << (intptr_t)vptr << " got chopstick number ";
   cout << ((intptr_t)vptr+1)%5 << endl;

  //Eating
   cout<<"Lawyer " << (intptr_t) vptr << " is eating with
chopsticks ";
   cout << (intptr_t) vptr << " & "<< (((intptr_t)vptr+1)%5) <<
endl;
   sleep(2);
//Unlock both left and right Chopsticks
   pthread_mutex_unlock(&Chopstick_mutex[(intptr_t)vptr]);
   pthread_mutex_unlock(&Chopstick_mutex[((intptr_t)vptr+1)%5]);
   return(NULL);
} //end doit function
```



Check Off

1) Compile and run the above program as shown then record the output showing how deadlock happens.
2) Resolve the deadlock by making every lawyer grab both chopsticks at the same time.

   Re-compile and run the program then explain how the deadlock is resolved.

??? ANY QUESTIONS ???

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