

CS314 Operating Systems Spring 2024

Exercise Questions on February 6th, 2024 (PART II)

EXERCISE #1

The following is the solution for “Producer & Consumer Problem” we built on February 6th (the one that prevents the race condition and spin-waits).

Problem: CFQ (Circular Fifo Queue)

BASE SOLUTION: “SOLUTION #2”

```
int Top = 0; // the “Top” pointer
int Tail = 0; // the “Tail” pointer
int empty = N; // the “Tail” counter
```

```
SEMAPHOR S = 1; // binary semaphore
SEMAPHOR EMPTY = N; // counting semaphore
SEMAPHOR FULL = 0; // counting semaphore
```

Shared memory (“shm”)

```
void producer (void)
{
    int new_item; // a place holder for a new item

    for (i = 0; i < NUM_REPEAT; i++)
    {
        new_item = rand(); // generate a piece of data
        wait(EMPTY);

        shm->CFQ[shm->Tail] = new_item; // insert the new item
        shm->Tail = (shm->Tail + 1) % N; // update the tail pointer
        wait(S);
        shm->empty = shm->empty - 1; // empty slots is decreased by one
        signal(S);
        signal(FULL);
    }
}
```

Producer Process

```
void consumer (void)
{
    int new_item; // a place holder for a new item

    for (i = 0; i < NUM_REPEAT; i++)
    {
        wait(FULL);

        new_item = shm->CFQ[shm->Top]; // remove the first item in the CFQ
        shm->Top = (shm->Top + 1) % N; // update the top pointer
        wait(S);
        shm->empty = shm->empty + 1 // empty slots is decreased by one
        signal(S);
        signal(EMPTY);
        do_something(new_item);
    }
}
```

Consumer Process

Assuming that we have only one producer and one consumer,

Question #1: Is it possible to eliminate “S” (mutex) semaphore?

- (a) If yes, explain “how” and why is it OK?
- (b) If no, explain why not?

Question #2: If it is possible to eliminate “S” (mutex) semaphore, is there any merit (advantage) in eliminating the semaphore?

- (a) If yes, explain “why” (or “how is it an advantage”).
- (b) If not, explain why not.

EXERCISE #2

For the same solution for the solution for “Producer & Consumer Problem” (shown for EXERCISE #1):

Assuming that we have more than one producer and more than one consumer,

Question #1: Is it possible to eliminate “S” (mutex) semaphore?

- (c) If yes, explain “how” and why is it OK?
- (d) If no, explain why not?

Question #2: If it is possible to eliminate “S” (mutex) semaphore, is there any merit (advantage) in eliminating the semaphore?

- (c) If yes, explain “why” (or “how is it an advantage”).
- (d) If not, explain why not.