



(Bad) Product consumer using a smartphone

```
void producer () {  
    while(1) {  
        item := produce()  
        sem_wait(mutex)  
        sem_wait(not_full)  
        write(buffer, item)  
        sem_signal(not_empty)  
        sem_signal(mutex)  
    }  
}
```

```
void consumer () {  
    while(1) {  
        sem_wait(mutex)  
        sem_wait(not_empty)  
        item := read(buffer)  
        sem_signal(not_full)  
        sem_signal(mutex)  
        consume(item)  
    }  
}
```

- **Deadlock**: the producer waits for the consumer to release `mutex` while the consumer waits for producer to release `not_empty` (or vice versa)

```
sem_init(&not_full, 0, n)
```

```
sem_init(&not_empty, 0, 0)
```

```
sem_init(&mutex, 0, 1)
```

# (Bad) Producer consumer **using a semaphore**

```
sem_init(&not_full, 0, n)
sem_init(&not_empty, 0, 1)
sem_init(&mutex, 0, 1)
```

```
void producer () {
    while(1) {
        item := produce()
        sem_wait(&mutex)
        sem_wait(&not_full)
        write(buffer, item)
        sem_signal(&not_empty)
        sem_signal(&mutex)
    }
}
```

```
void consumer () {
    while(1) {
        sem_wait(&mutex)
        sem_wait(&not_empty)
        item := read(buffer)
        sem_signal(&not_full)
        sem_signal(&mutex)
        consume(item)
    }
}
```

- ⦿ **Deadlock** : the producer waits for the consumer to release `mutex` while the consumer waits for producer to release `not_empty` (or vice versa)



# Deadlock



**Deadlock** when one thread tries to access a resource that a second holds, and vice-versa

- They can never make progress

```
void thread1 () {  
    ...  
    sem_wait(sem1)  
    sem_wait(sem2)  
    /* critical section */  
    sem_signal(sem2)  
    sem_signal(sem1)  
    ...  
}
```

```
void thread2 () {  
    ...  
    sem_wait(sem2)  
    sem_wait(sem1)  
    /* critical section */  
    sem_signal(sem1)  
    sem_signal(sem2)  
    ...  
}
```