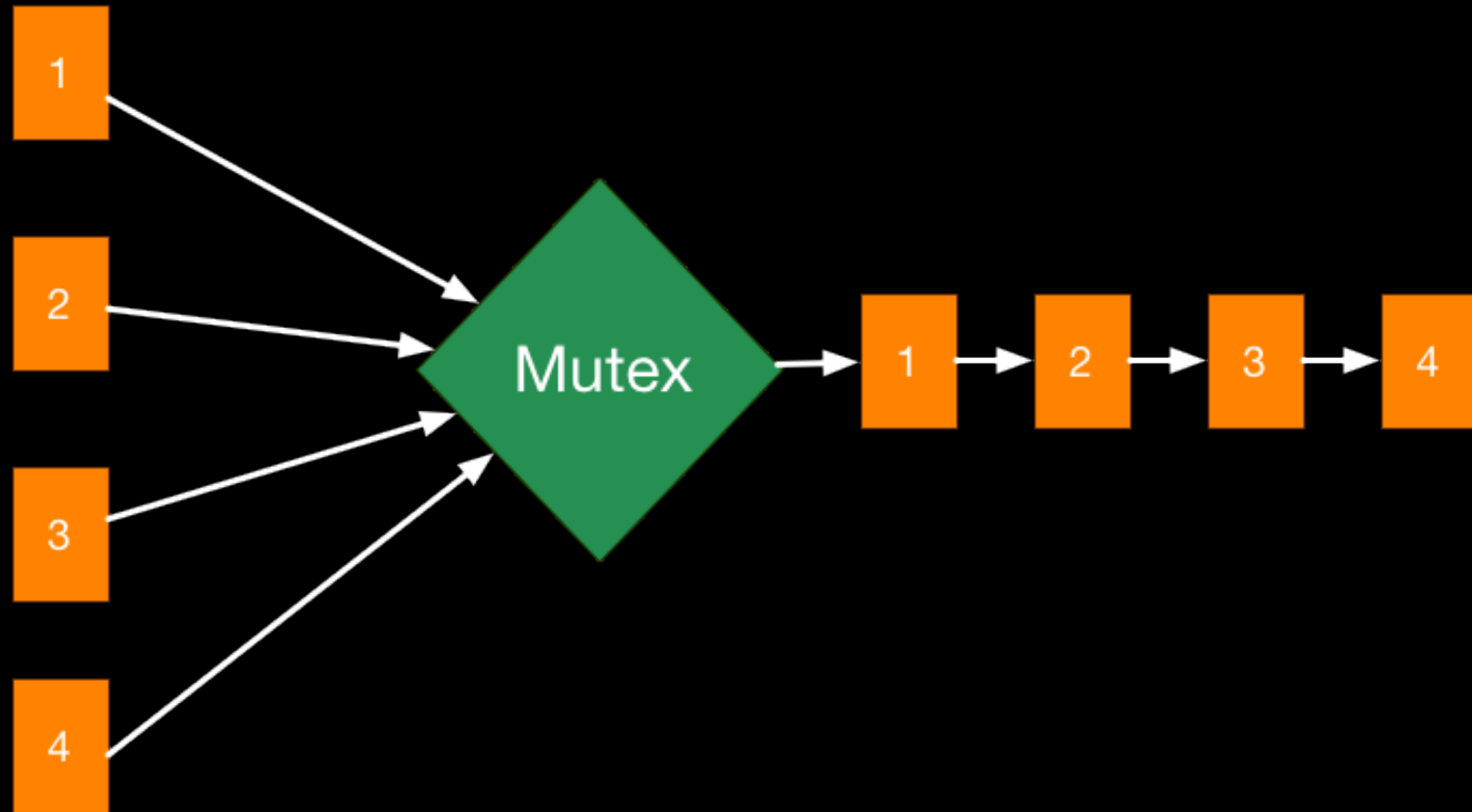


Mutex

Mutex = Mutual Exclusive



Mutex serializes accesses to a critical section

Critical Section

Critical section will be corrupted if executed concurrently by more than one thread

Corrupted means race condition happens

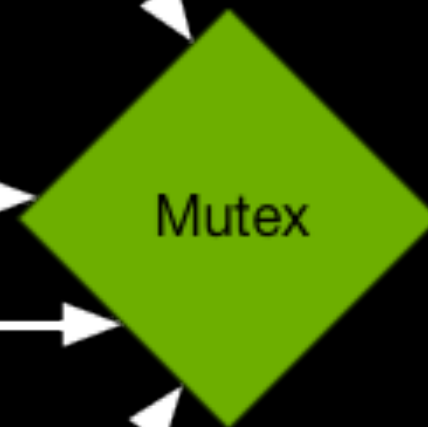
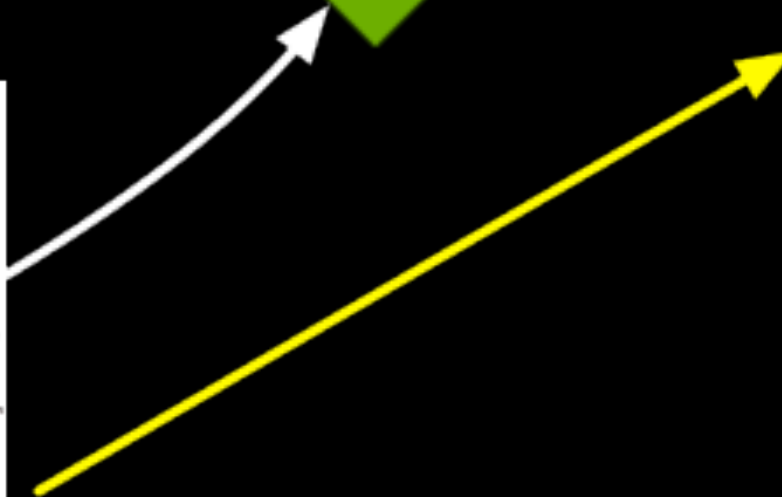
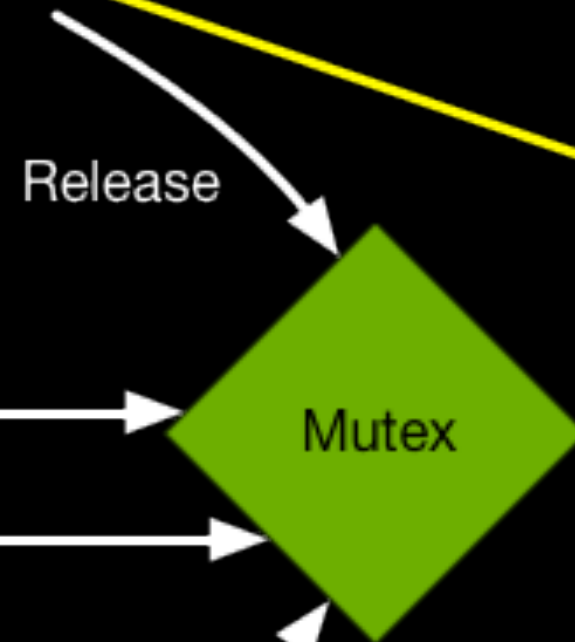


?



Solution

- Put a Manager to manage printer
- For each person wants to print, follows steps:
 1. P requests Manager the **exclusive token** to print
 - If token is available, Manager gives token
 - Otherwise P has to wait until Manager calls
 2. Prints
 3. Returns the exclusive token to Manager

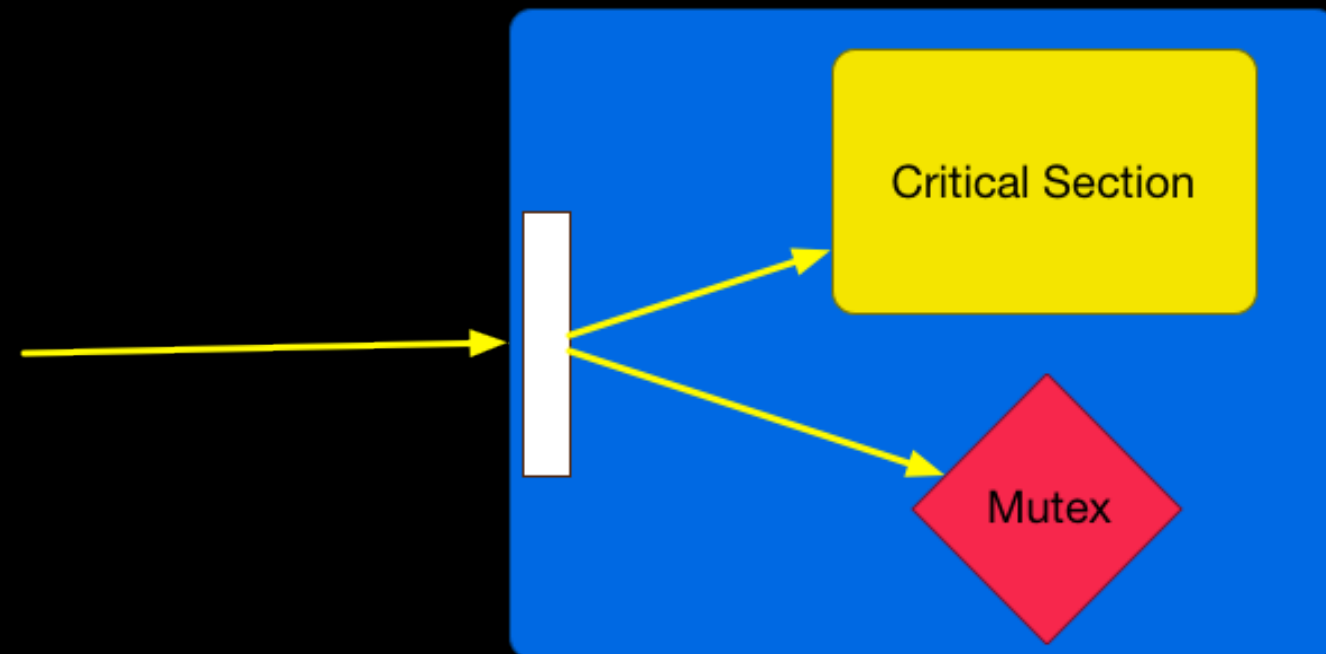


Mutex <-> Critical Section

- No physically connection
- Only logically connection

Manager is put to manage printer

**Critical
Section
should not
be accessed
directly**



Java Mutex

```
import java.util.concurrent.locks.*;
class X {
    private final ReentrantLock lock = new ReentrantLock();

    public void fooMethod() {
        //Do not access Critical Section

        lock.lock();
        try {
            //Access Critical Section
        } finally {
            lock.unlock()
        }

        //Do not access Critical Section
    }
}
```

But every Java Object has built-in lock

Built-in Lock

```
class X {  
    private final Object lock = new Object();  
  
    public void fooMethod() {  
        //Do not access Critical Section  
  
        synchronized(lock){  
            //Access Critical Section  
        }  
  
        //Do not access Critical Section  
    }  
}
```

synchronized is a built-in mutex



Mutex

Mutex



What happen if only one mutex is used?

What's wrong?

```
public class Queue {  
    private int[] es = new int[10];  
    private int index = 0;  
    private final Object lockArray = new Object();  
    private final Object lockIndex = new Object();  
  
    public void enqueue(int e) {  
        synchronized(lockArray) {  
            es[index] = e;  
        }  
        synchronized(lockIndex) {  
            index = index + 1;  
        }  
    }  
}
```