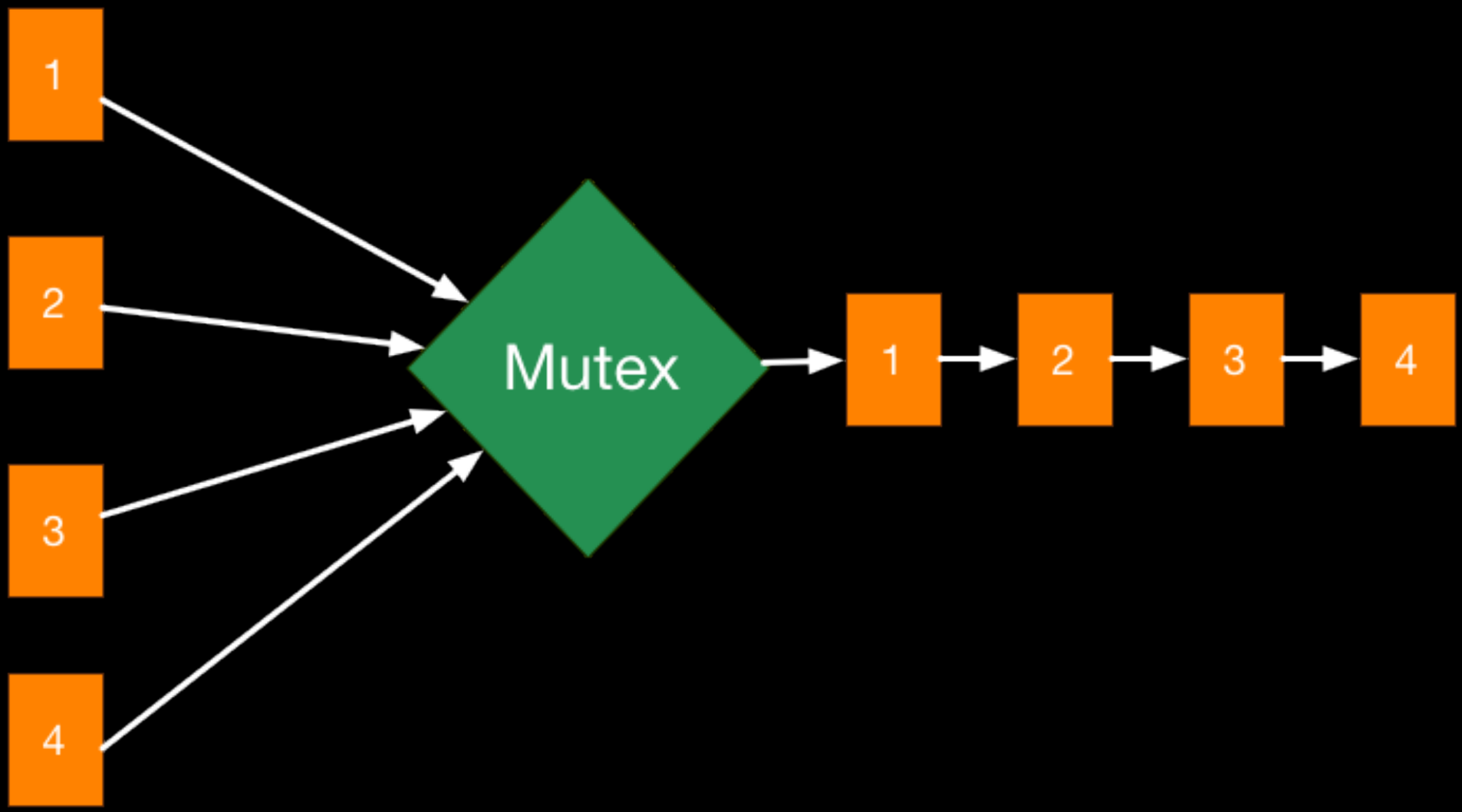
Mutex

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

Release

Acquire

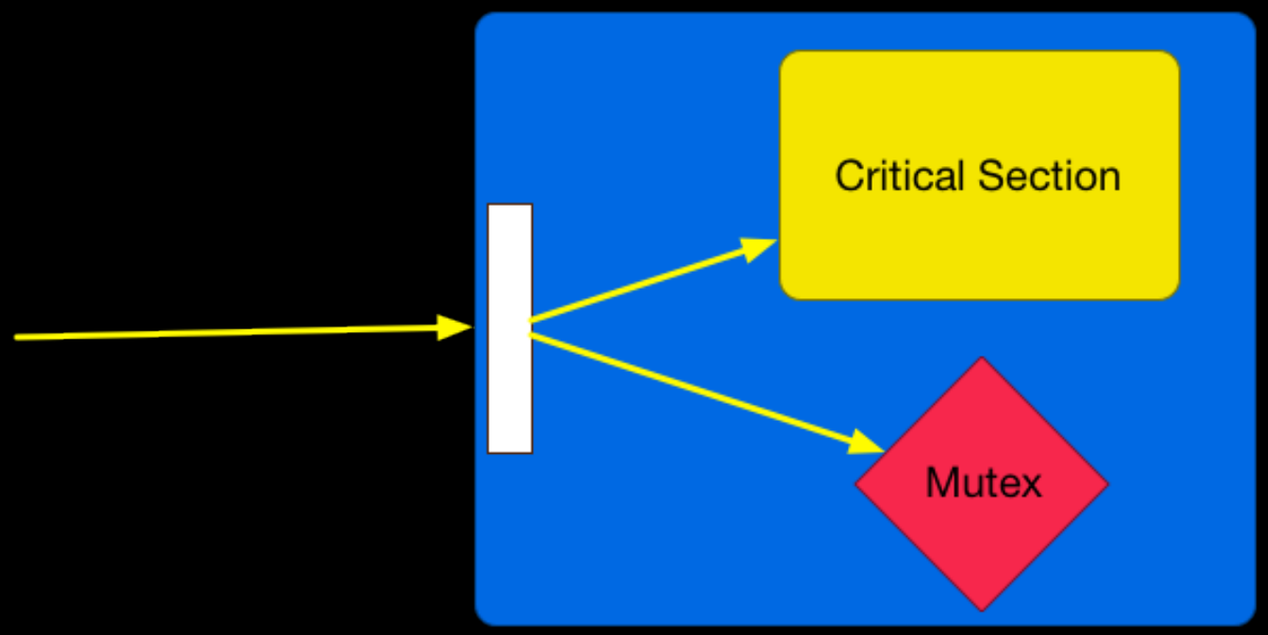
Mutex

Mutex <-> Critical Section

- No physicially 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

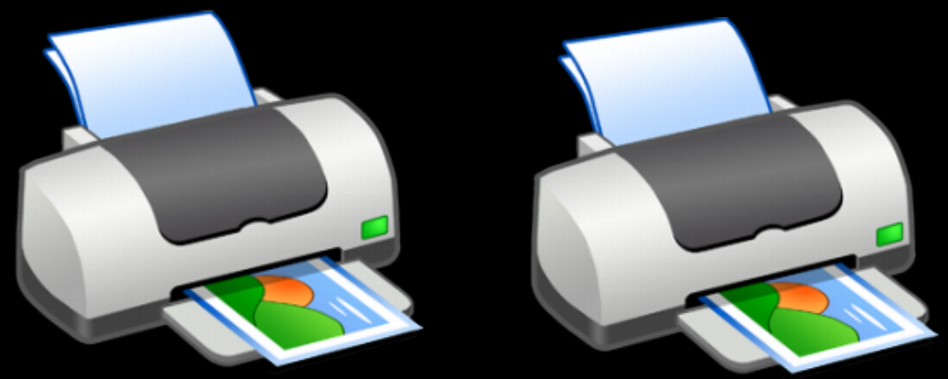
Built-in Lock

```
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;
    }
  }
}
```