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## Homework - Assignment 4

### 1. What is the formal definition of the deadlock?

> Process in the set is waiting for an event that only another process in the set can cause.
>
> > **Analogous Example**:
> >
> > **An interviewer asks**: "What is Deadlock?"
> >
> > **You answer**: "Hire me and I'll tell you."

### 2. What are the four requirements for a deadlock?

> The four requirements for a deadlock are

> 1. Mutual Exclusion – not required for sharable resources (e.g., read-only files); must hold for non-sharable resources
> 2. Hold and Wait – must guarantee that whenever a process requests a resource, it does not hold any other resources
> 3. No preemption: if the process requests a resource that cannot be allocated immediately
> 4. Circular wait: impose a total ordering of all resource types, and require each process to request resources in an increasing order of enumeration.

## 3. Suppose that a resource allocation graph contains a cycle. Does this mean there is a deadlock?

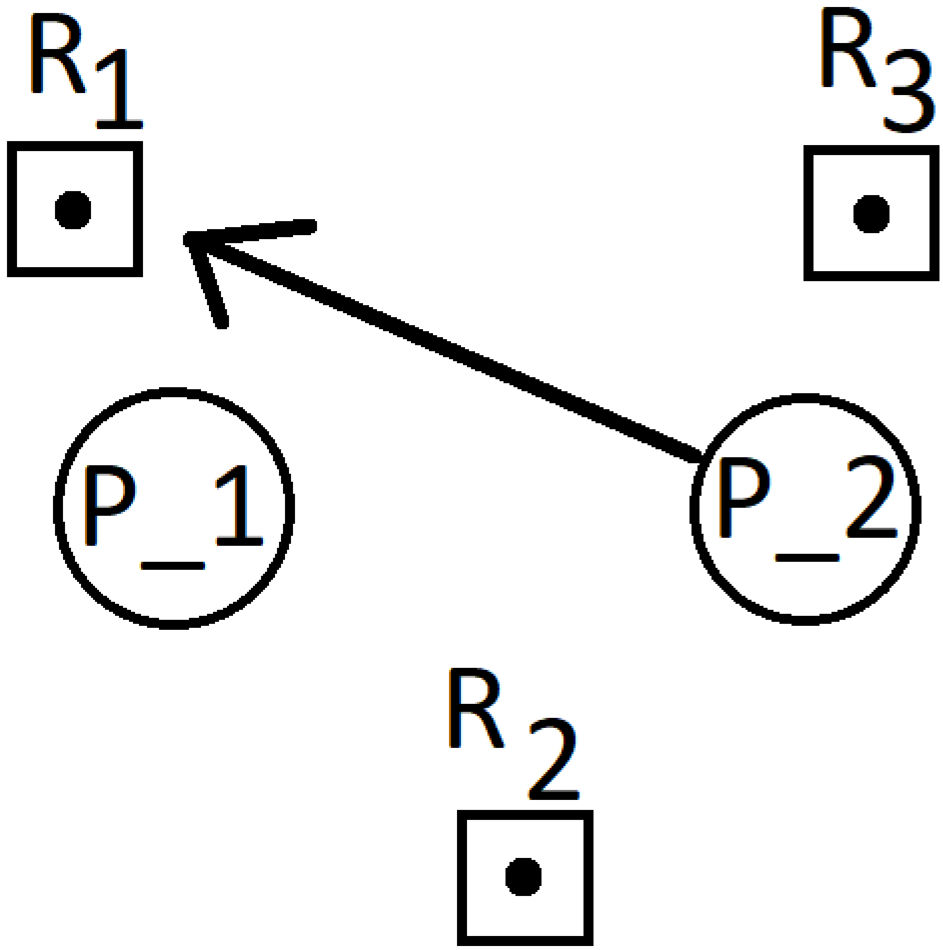
> If no cycle exists in the resource allocation graph, there is no deadlock; however, if there is a cycle in the graph and each resource has only one instance, then there is deadlock.
>
> A cycle is a necessary and sufficient condition for deadlock.

## 4. Suppose that a resource allocation graph does not contain a cycle. Does this mean there is no deadlock?

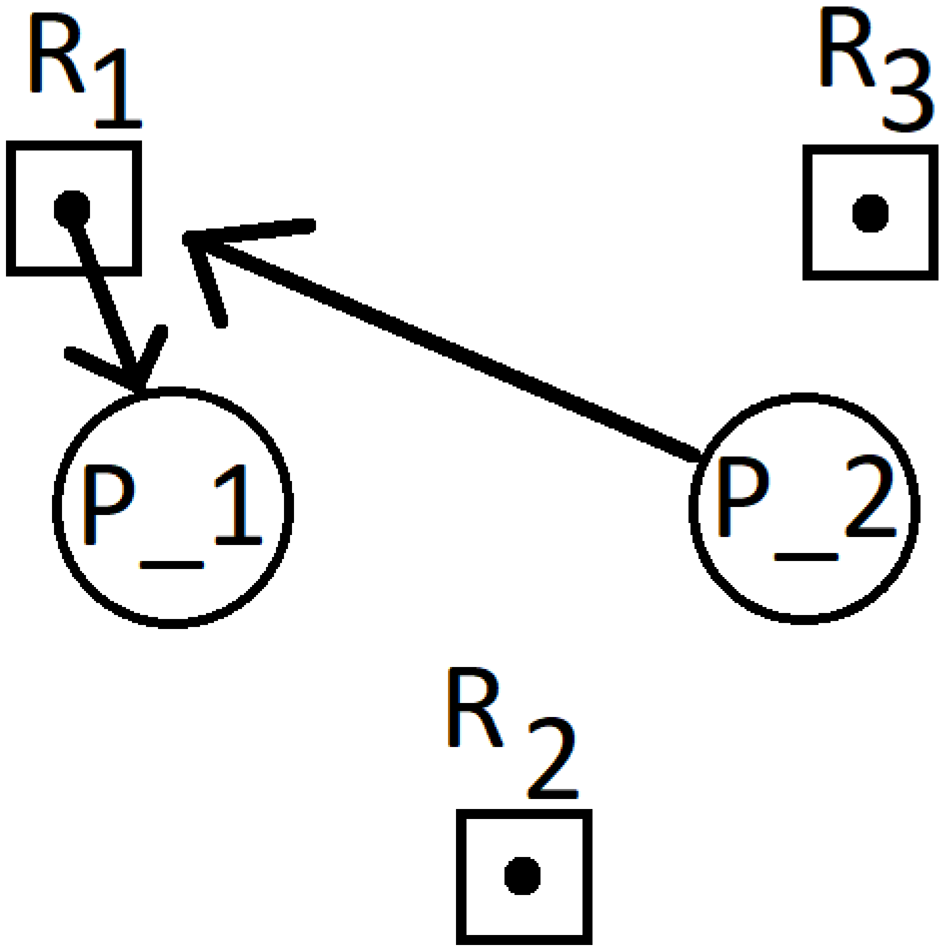
> If a resource-allocation graph contains no cycles, then the system is not deadlocked.

## 5. Consider a system with processes P1 and P2 and resources R1, R2, R3 (where each resource has a single instance). Draw a resource allocation graph for each of the following steps in the sequence and answer the following questions

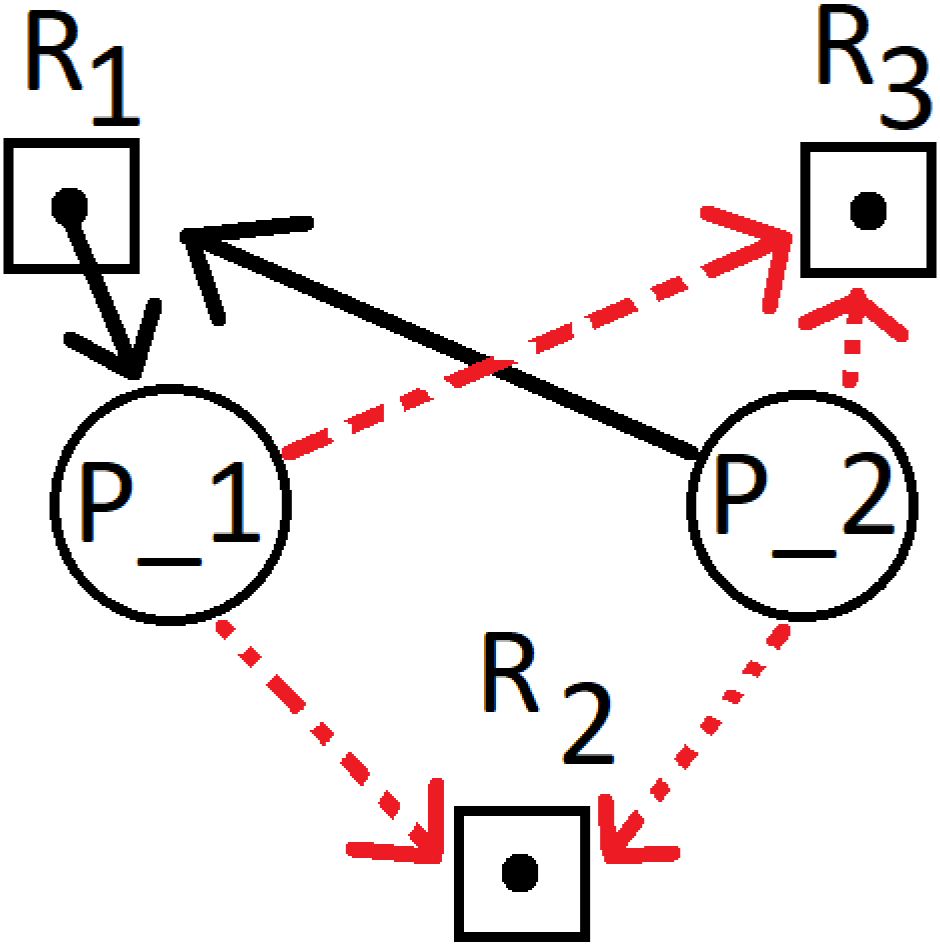
### a. Process P2 requests resource R1




b. Process P1 is granted access to R1




c. Processes both P1 and P2 claim both resources R2 and R3




6. Consider a three process system in which processes may request any of 12 drives. Suppose the allocation state given below. Show that the allocation state is unsafe. Will this system deadlock?

| | Allocation | Max | Need | Available |
|---|---|---|---|---|
| P0 | 5 | 10 | 5 | 12 |
| P1 | 2 | 4 | 2 | - |
| P2 | 3 | 9 | 6 | - |

## Step 1 - Always use a top-down scan

Because $P_0$'s $Need \leq Available = 12$, $P_0$ can run and returns its allocated 5, making the new $Available = 12 + 5 = 17$.

| | Allocation | Max | Need | Available |
|---|---|---|---|---|
| P0 | - | 10 | - | 17 |
| P1 | 2 | 4 | 2 | - |

| | Allocation | Max | Need | Available |
|---|---|---|---|---|
| P2 | 3 | 9 | 6 | - |

## Step 2

Then, $P_1$ can run because its $Need = 2 \leq Available = 17$.
After $P_1$ finishes its work, its $Allocation = 2$ is returned to Available,
and the new $Available = 17 + 2 = 19$.

| | Allocation | Max | Need | Available |
|---|---|---|---|---|
| P0 | - | 10 | - | 19 |
| P1 | - | 4 | - | - |
| P2 | 3 | 9 | 6 | - |

## Step 3

> $P_2$'s $Need = 3 \leq Available = 17$, $P_2$ can run with no blocks...
>
> For this reason, this system is in a safe state and < $P_2, P_1, P_0$ > is a safe sequence

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Note to self: When not given the Need array we need to calculate it
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| | Allocation | Max | Need | Available |
|---|---|---|---|---|
| P0 | 5 | 10 | - | 12 |
| P1 | 2 | 4 | - | - |
| P2 | 3 | 9 | - | - |

| | Allocation | Max | Need | Available |
|---|---|---|---|---|
| P0 | 5 | 10 | *5* | 12 |
| P1 | 2 | 4 | *2* | - |
| P2 | 3 | 9 | *6* | - |