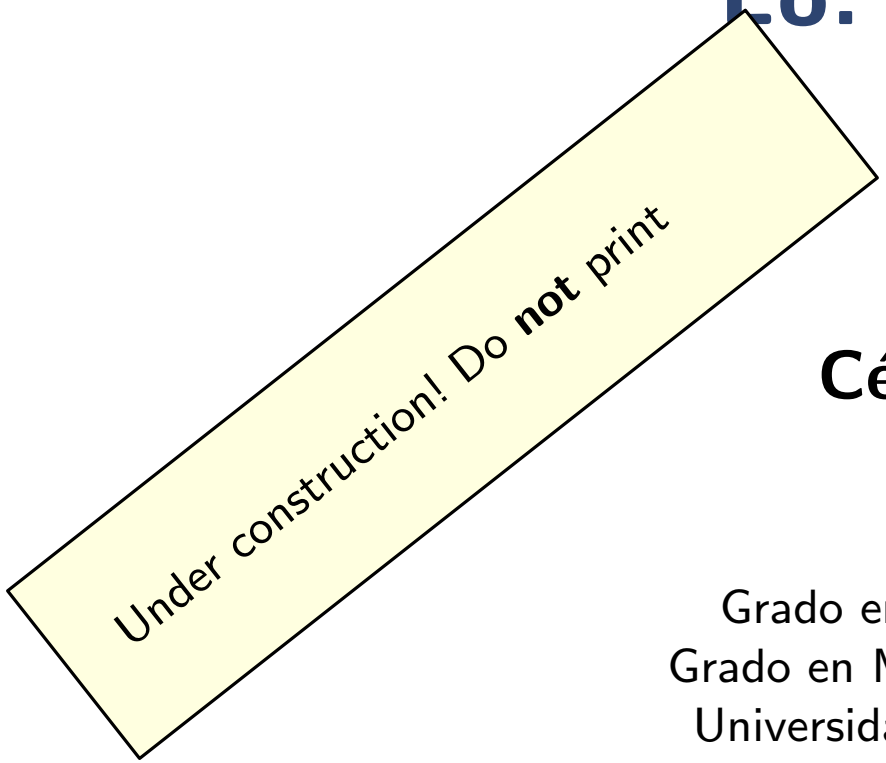
L8: Deadlocks



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Mapa Conceptual

$$\text{Concurrency} = \text{Simultaneous} + \text{Nondeterminism} + \text{Interaction}$$

$$\text{Interaction} = \text{Communication} \mid \text{Synchronization}$$

$$\text{Synchronization} = \text{Mutual Exclusion} \mid \begin{array}{l}\text{Conditional} \\ \text{Synchronization}\end{array}$$

- Terminology:

atomic	race condition
interleaving	busy-wait
mutual exclusion	critical section
deadlock	livelock
liveness	

Deadlock

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"When two trains approach each other at a crossing, both shall come to a full stop and neither shall start up again until the other has gone."

Statute passed by the Kansas State Legislature, early in the 20th century.

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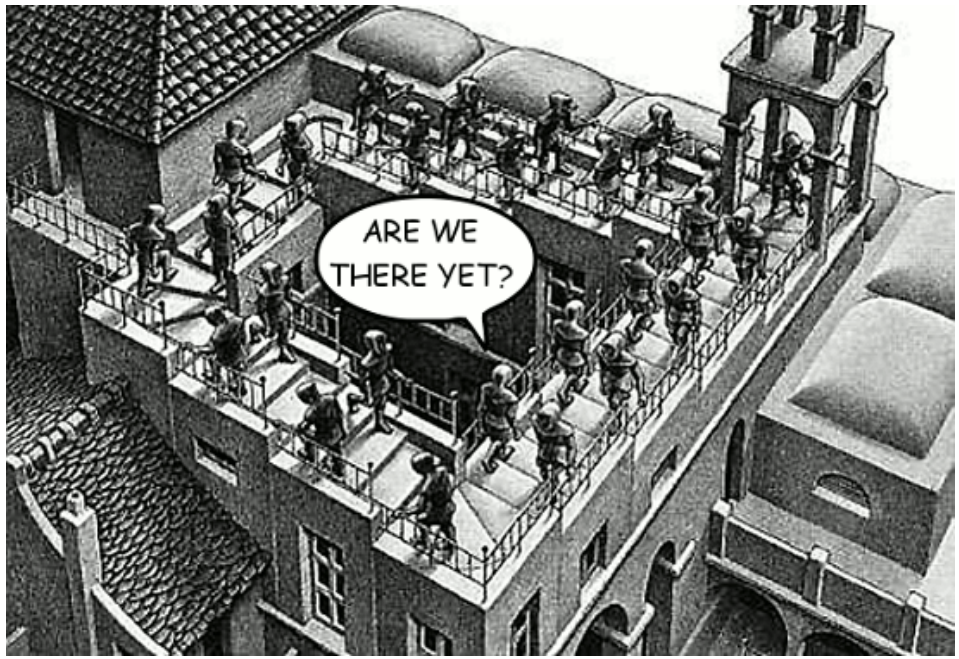


Conditions for Deadlock (necessary and sufficient)

1. Mutual Exclusion

   The resource is only accessed by one thread at a time.

2. Hold and wait

   The resource is kept until the job is finished.

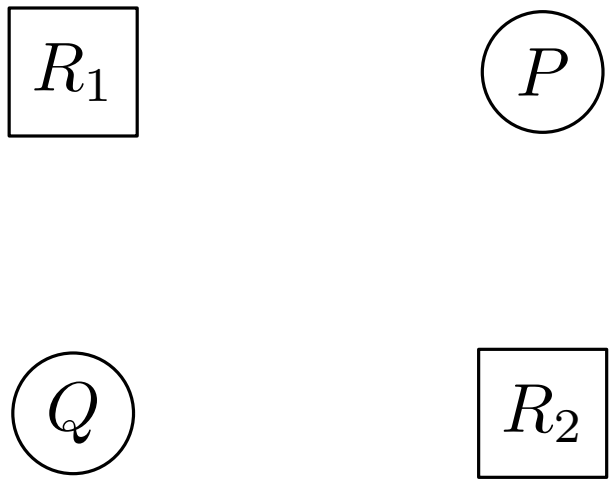
3. No preemption

   A resource is not stolen.

4. Circular wait

   There is a circular chain of processes waiting for resources held by the next process in the chain.

Resource allocation graph



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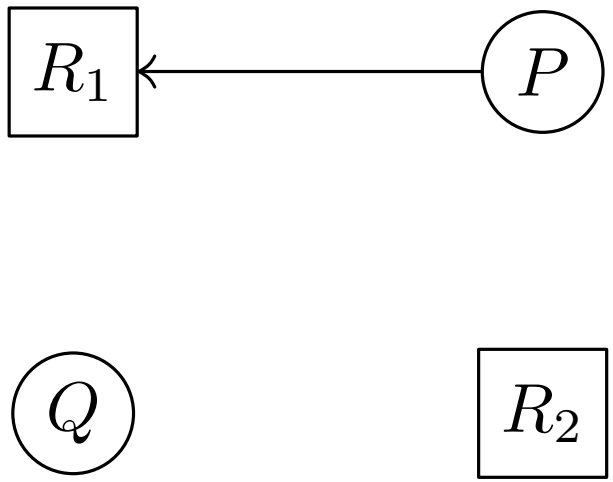

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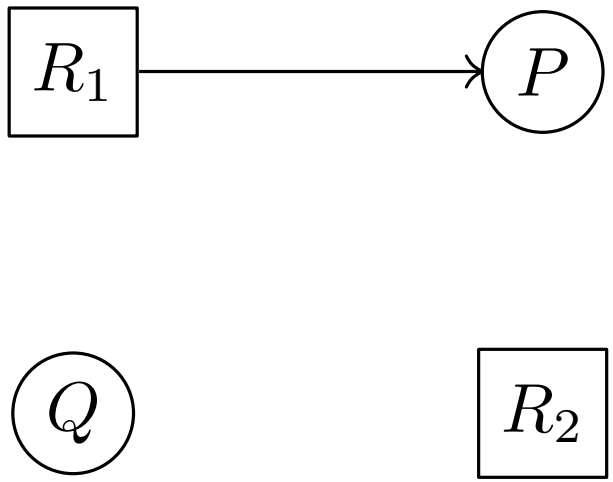

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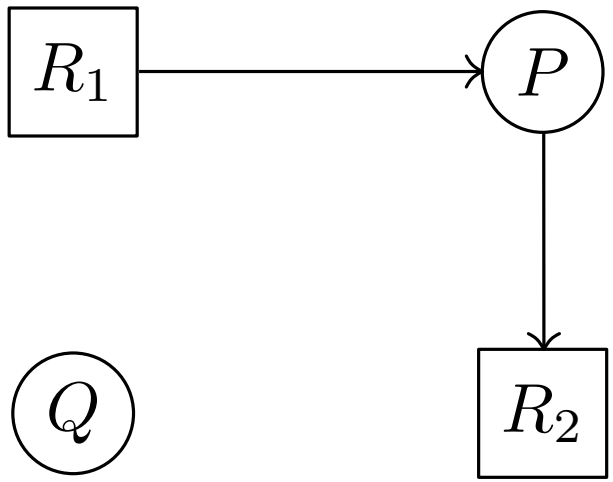

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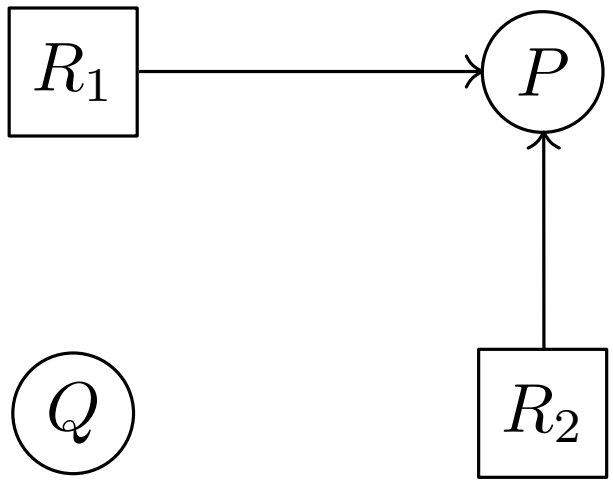
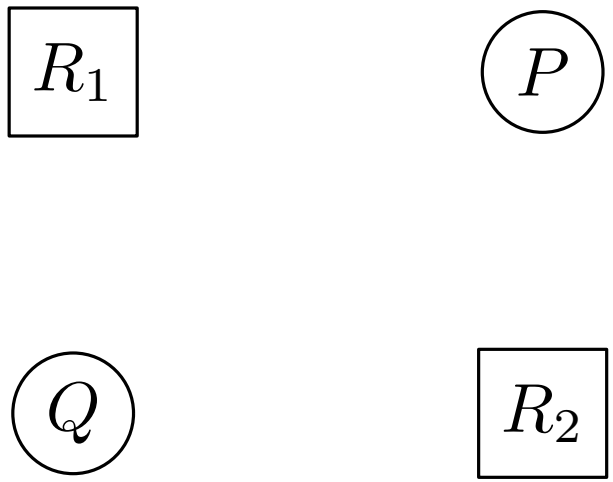


Resource allocation graph (Deadlock Example)



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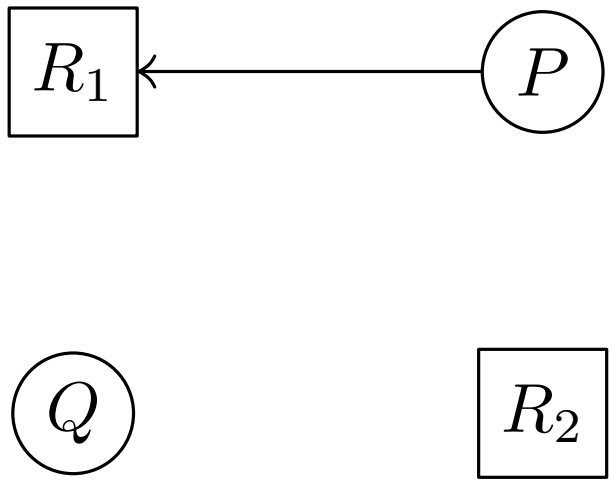

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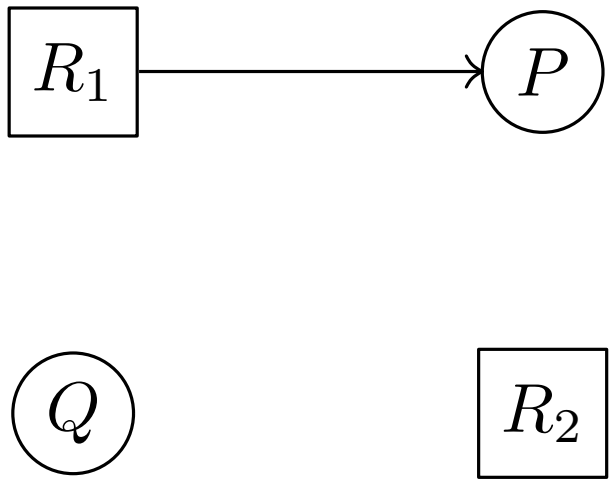

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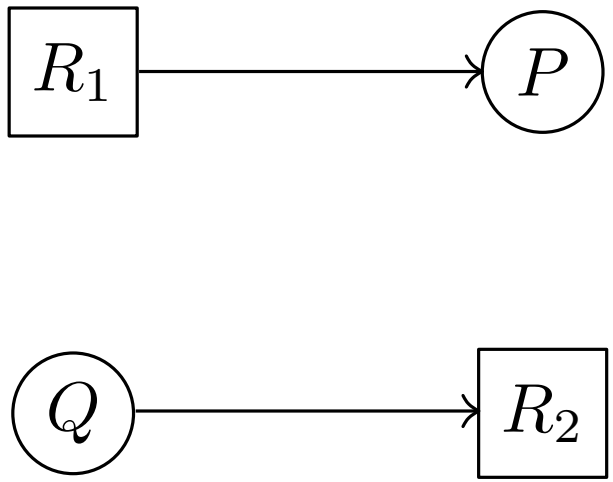

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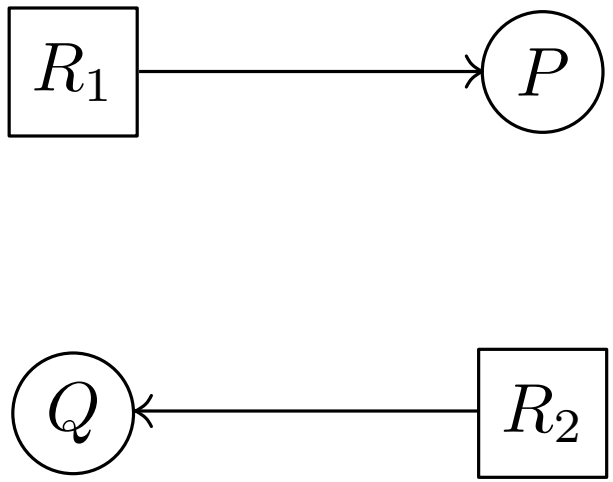

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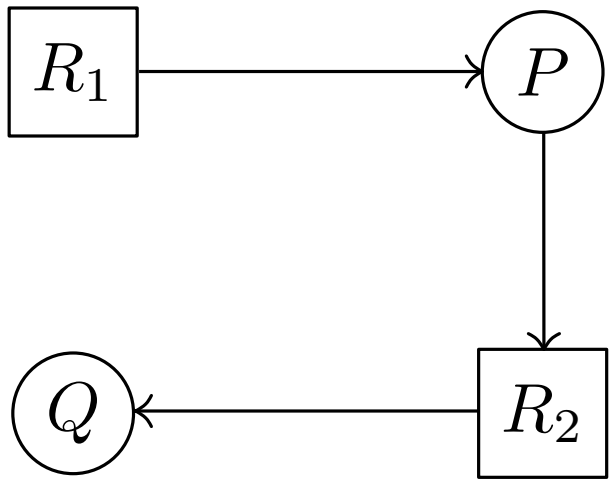

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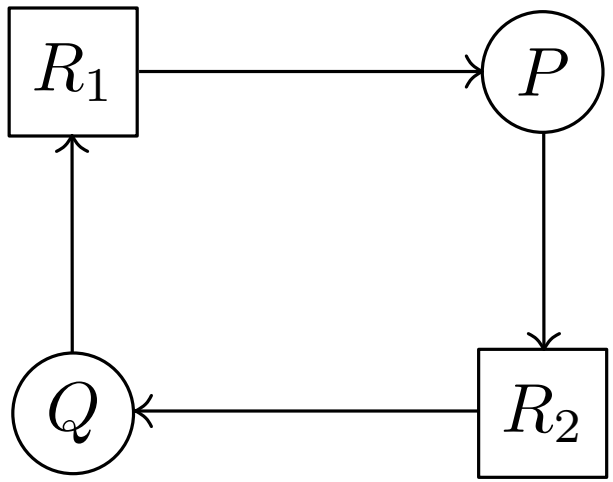

Deadlock.java

```
public void run () {
   for (int n = 1; n <= Dining.ROUNDS; ++ n) {
      //think();
      left.take();
      System.out.println(me+" takes fork "+left.me);
      right.take();
      System.out.println(me+" takes fork "+right.me);
      eat();
      right.put_back();
      left.put_back();
   }
   System.out.println(me+" leaves");
}
```

Starvation

Starvation:

> *Starvation describes a situation where a thread is unable to gain regular access to shared resources and is unable to make progress. This happens when shared resources are made unavailable for long periods by "greedy" threads.*