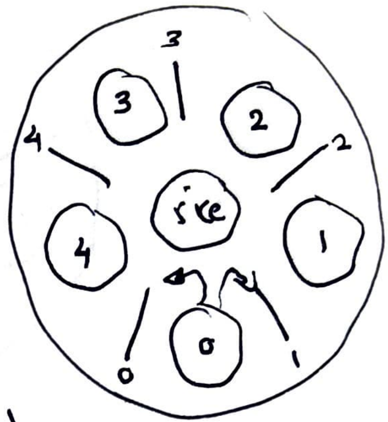
1 The Dining Philosophers problem

Five Philosophers who think and eat.

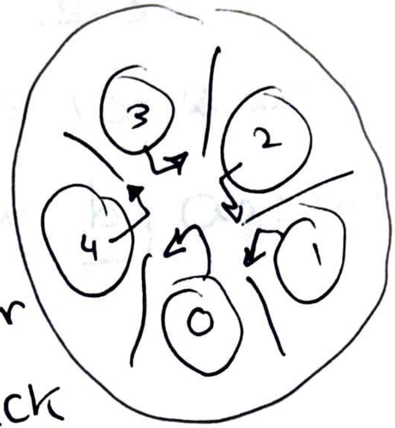


When a Philosopher gets hungry, they grab the 2 Chopstick (closet) and eat.

Semaphore Chopstick[5] initialized to 1

```
Pi: do {
        wait (Chopstick[i]);
        wait (choptick[(i+1) % 5]);
        eat();
        Signal (Chopstick [i]);
        Signal (chopStick [(i+1) % 5]);
        think ();
    } while (1);
```

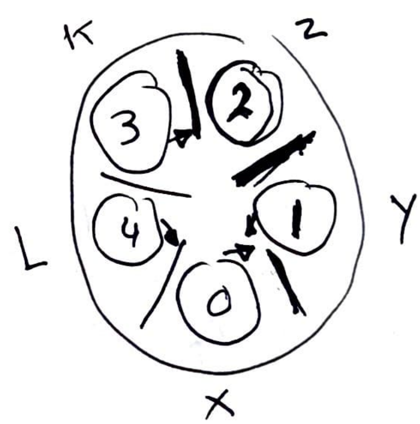
Deadlock ⇒



when every Philosopher grabs the chopstick on their left first.

Soln

[1] Odd Philosphers grab left first }
Even " " Right First }



[2] Pick both chopsticks at the same time

⇒ using one mutex

```
wait(mutex);
  grab both
signal(mutex);
  eat();
```

Deadlocks

A set of processes is in a deadlocked state if every process is waiting for an event that can only happen by another process in the set.

P_1	P_2
wait(s)	wait(q)
wait(q)	wait(s)
⋮	⋮

Dynamics of execution that determines if a deadlock happens or not.

1 System Model

Number of Processes (n)

Number of Resources (group by type).

A process requires a number of resources to finish (must be less than the total available).

1. Request : If a resource is not available process must wait
2. Use
3. Release

Conditions for a deadlock

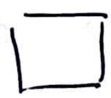
1. Mutual Exclusion : only 1 process can use a resource at a time
2. Hold and Wait : A process holds a resource while waiting for another
3. No-preemption : A resource cannot be taken from a process.
4. Circular Wait : A closed chain of waiting processes exists.

All 4 Conditions must be present for a deadlock to occur.

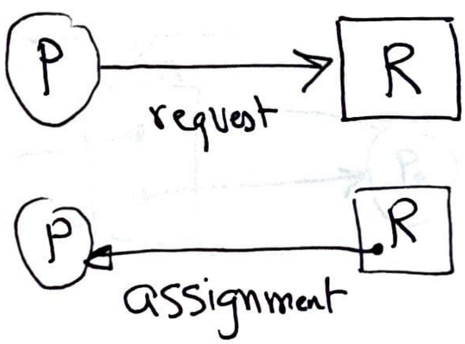
Resource Allocation Graphs

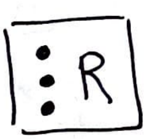
Directed graph that shows the allocation of resources to processes.

Vertices (nodes) : processes 

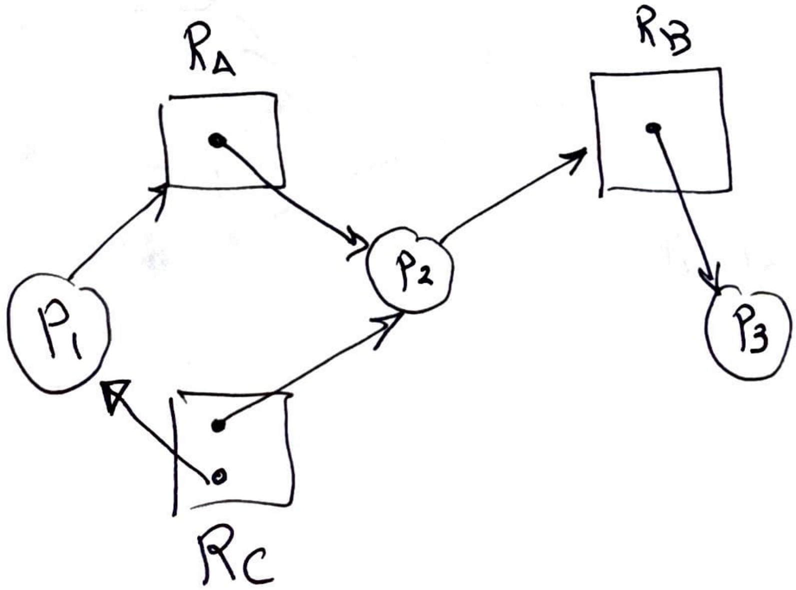
resource 

Edges : requests and assignments.





dots represent instants of a resources

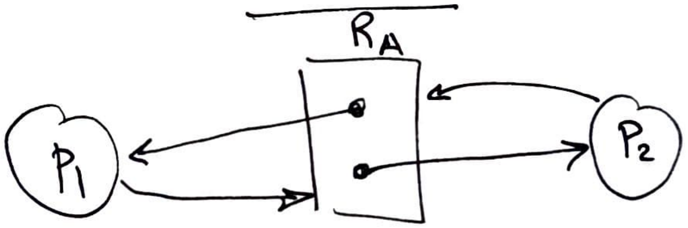


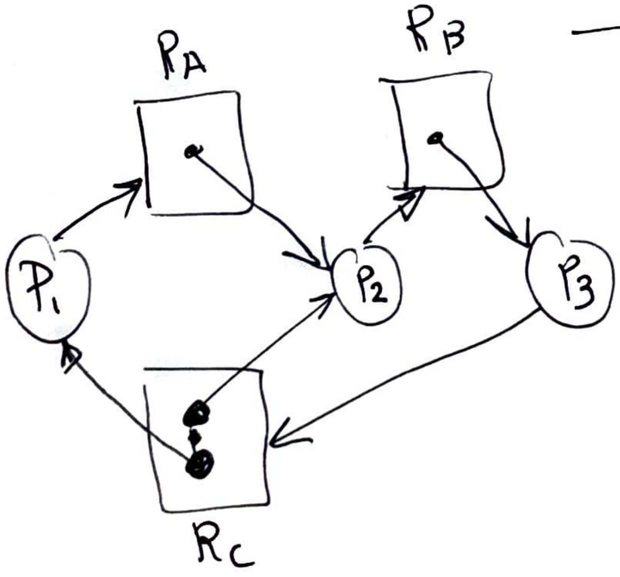
If graph has no cycle (no process is deadlocked)

else
A deadlock may exist

If each resource has exactly 1 instant
⇒ a cycle means a deadlock.

Otherwise
⇒ " may mean a deadlock.

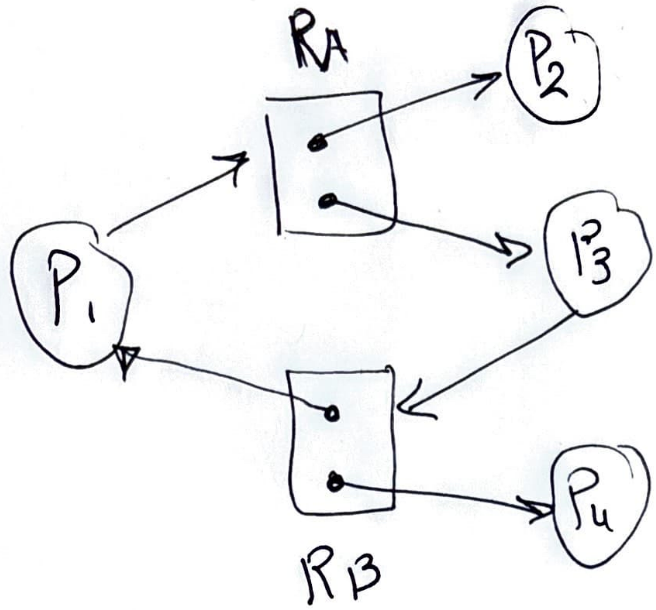




P_3 R_C P_1 R_A P_2 R_B P_3

R_B P_3 R_C P_2 R_B

P_1 P_2 P_3 are deadlocked



P1 RA P3 RB P1

Cycle

No deadlock.