# Exercise 4: Resource sharing

Kai Huang

November 18, 2014

## 1 Exercise 4.1

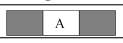
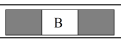
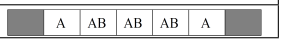
- Explain the difference between private, shared and exclusive resources and give an example of problems encountered in exclusive resources.
- **Solution:** Private resources are used exclusively by one process/thread, whereas shared resources can be used by at least two possibly competing processes/threads. Simultaneous use of a resource by multiple processes/threads without further countermeasures, for example, can raise inconsistencies or illegible spending on printer or monitor. Such resources are also called exclusive resources, there really should always just one process/thread exclusively take on it.
- Propose three ways such that the problem occurring in Resource Sharing Problem of mutual exclusion (mutual exclusion) can be solved.
- **Solution:** Non-preemptive tasks, interrupts disabled, static scheduling, Use of semaphores.
- Explain the application of a possible solution of the previous part.
- **Solution:** A (binary) semaphore S is a data structure that can be accessed only by the atomic commands, wait (s), bzw. P(s) and signal (s), bzw. V(S). Assume a process A want to enter a critical section, it executes a wait(s) on the semaphore and claims the right to entry into the critical section. If the process hears that the semaphore is free, he enters the critical section and releases the semaphore with signal(s) after he left its critical section. If the call of the semaphore wait(s) is occupied by another process B, A waits until B releases the semaphore.

## 2 Exercise 4.2 - Priority Inversion

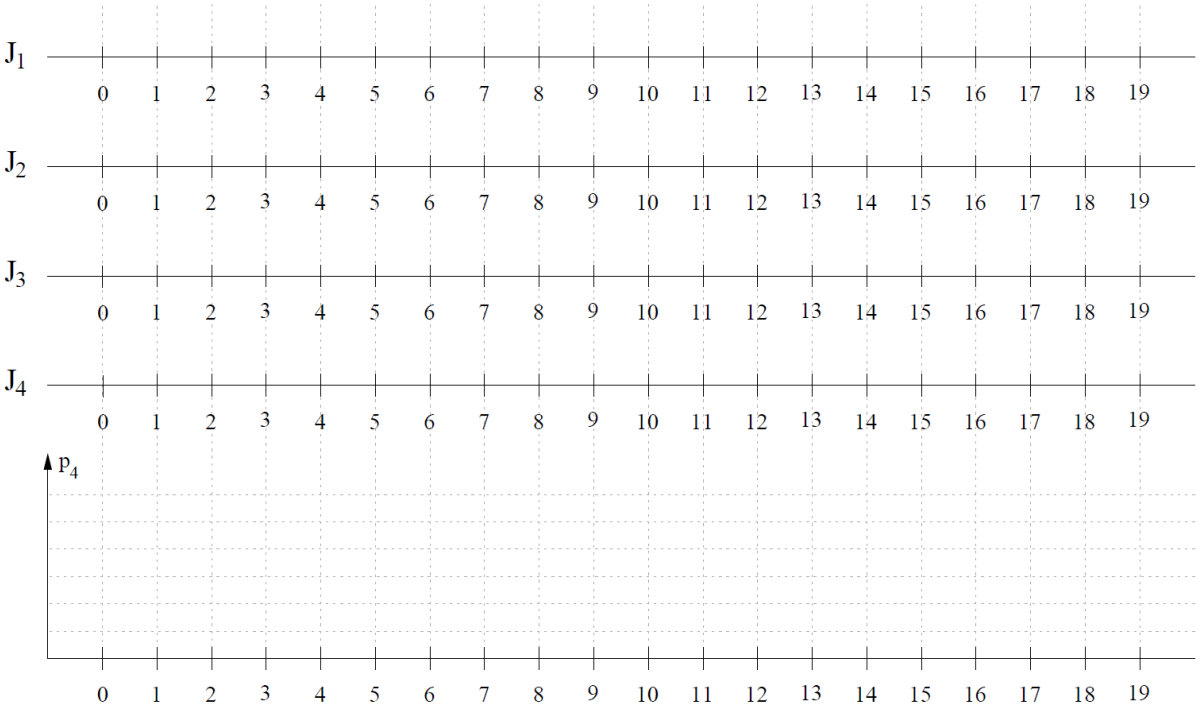
- In the lecture you learned about the Priority Inheritance Protocol (PIP). Does the PIP solve the problem of deadlocks? Give a brief explanation for your response.

- **Solution:**No, the PIP does not prevent deadlocks.
- Given are the four tasks J1, J2, J3 and J4. The table below contains information on their arrival times, deadlines, their execution time and priorities. The tasks with fixed priorities should be executed by a priority-based scheduling processor that can tackle the tasks within their deadlines.

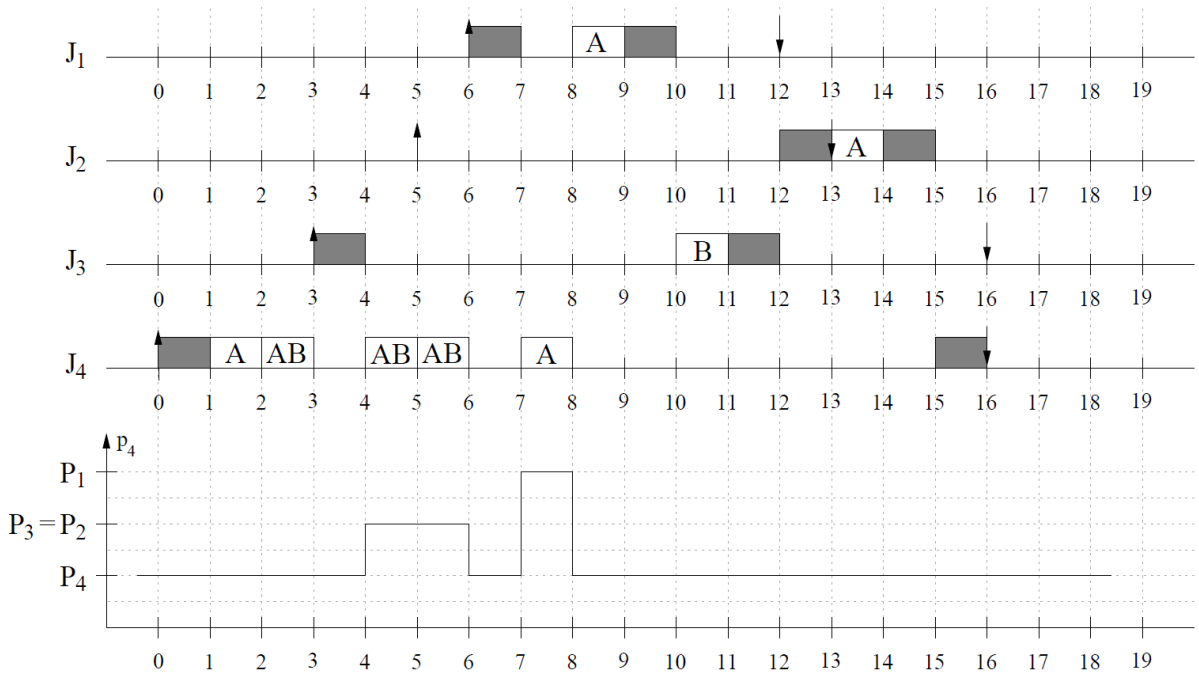
  The drawings in the last row of the table provide information about the sequence of individual tasks. Each task contains one or more critical sections, in which the system accesses the two exclusive resources A and B, respectively. In the drawings, each block has one unit of length and non-critical sections are shaded. The critical sections are marked with the corresponding letters A and B. For example, the seven time units long task J4 contains two critical sections, the five time periods long section A and the three time units long section B. A and B are nested here, ie during the periods 3-5 J4 must have access to both resource A and resource B.

| | J1 | J2 | J3 | J4 |
|---|---|---|---|---|
| Check in | 6 | 5 | 3 | 0 |
| Deadline | 12 | 13 | 16 | 16 |
| Execution time | 3 | 3 | 3 | 7 |
| Nominal priority | highest | medium | medium | lowest |
| Structure of tasks |  |  |  |  |

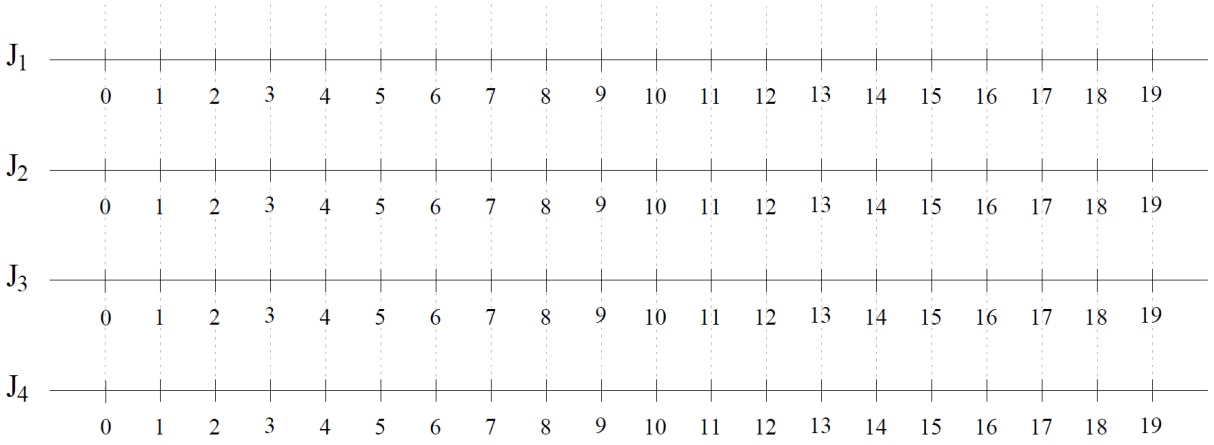
  **Task:** Now create a scheduling with the Priority Inheritance Protocol and fill out the chart prepared below. Highlight the critical Portions of the tasks with the letters A and B as specified in the last line of the table . Please also characterized p4 which is the active priority of Task J4 in the given diagram. Note: Pay close attention to the priorities of the individual tasks!



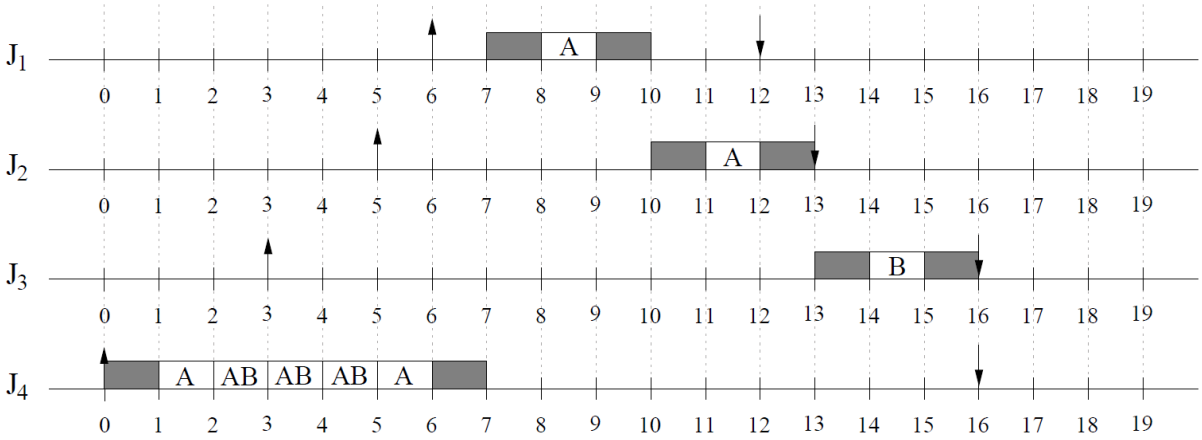

- **Solution:**




- Are all deadlines satisfied through the application of the PIP? If not, how big is the maximum delay (maximum lateness) in units of time?
- **Solution:** No, J2 violated its deadline by two time units.
- Is there a schedule for the tasks specified J1 to J4 that meets all deadlines? What changes should be made to the priority? If there is a correct schedule, please show it in the graph provided below. Otherwise, explain why there can be no correct schedule.




- **Solution:** Yes, there is a flow chart such that all deadlines can be met. However, one have to change the priority of at least one task. If PIP is to meet all deadlines, for example, the priority order $J4 > J1 > J2 > J3$ is a good choice.


J1
A
J2
A
J3
B
J4
A
AB
AB
AB
A
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19