

1. The dining philosophers problem states that there are 5 philosophers sharing a circular table and they eat and think alternatively. There is a bowl of rice for each of the philosophers and 5 chopsticks. A philosopher needs both their right and left chopstick to eat. A hungry philosopher may only eat if there are both chopsticks available. Otherwise a philosopher puts down their chopstick and begin thinking again. The dining philosopher is a classic synchronization problem as it demonstrates a large class of concurrency control problems.

2. The readers-writers problem relates to an object such as a file that is shared between multiple processes. Some of these processes are readers i.e. they only want to read the data from the object and some of the processes are writers i.e. they want to write into the object. The readers-writers problem is used to manage synchronization so that there are no problems with the object data. For example - If two readers access the object at the same time there is no problem. However if two writers or a reader and writer access the object at the same time, there may be problems. To solve this situation, a writer should get exclusive access to an object i.e. when a writer is accessing the object, no reader or writer may access it. However, multiple readers can access the object at the same time.

3. Santa Claus sleeps in his shop at the North Pole and can only be awakened by either (1) all nine reindeer being back from their vacation in the South Pacific, or (2) some of the elves having difficulty making toys; to allow Santa to get some sleep, the elves can only wake him when three of them have problems. When three elves are having their problems solved, any other elves wishing to visit Santa must wait for those elves to return. If Santa wakes up to find three elves waiting at his shop's door, along with the last reindeer having come back from the tropics, Santa has decided that the elves can wait until after Christmas, because it is more important to get his sleigh ready. (It is assumed that the reindeer do not want to leave the tropics, and therefore they stay there until the last possible moment.) The last reindeer to arrive must get Santa while the others wait in a warming hut before being harnessed to the sleigh.

4. There are two kinds of threads, oxygen and hydrogen. In order to assemble these threads into water molecules, we have to create a barrier that makes each thread wait until a complete molecule is ready to proceed. As each thread passes the barrier, it should invoke bond. You must guarantee that all the threads from one molecule invoke bond before any of the threads from the next molecule do. In other words:

- If an oxygen thread arrives at the barrier when no hydrogen threads are present, it has to wait for two hydrogen threads.
- If a hydrogen thread arrives at the barrier when no other threads are present, it has to wait for an oxygen thread and another hydrogen thread.