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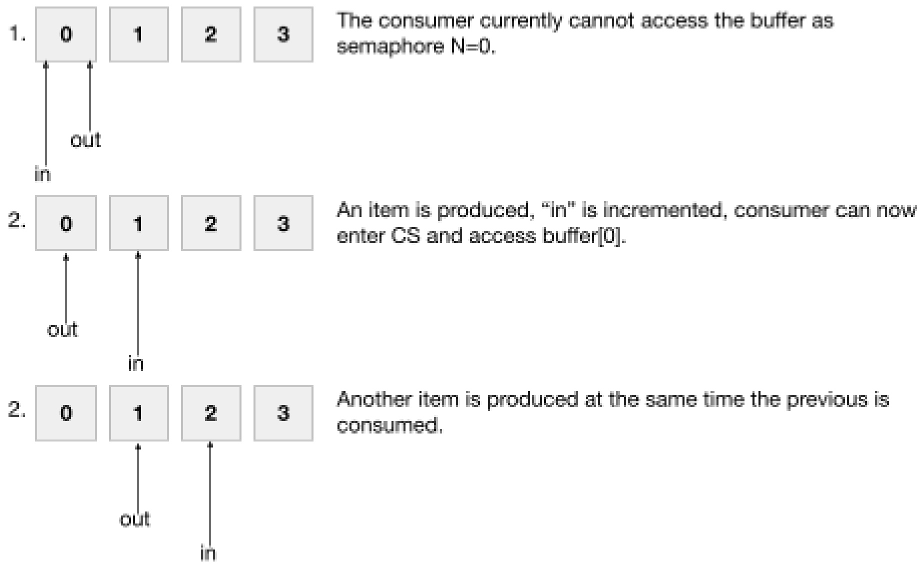
Assignment 2: Semaphore Analysis in the P/C Problem

Is each semaphore required?

When dealing with 1 Producer and 1 Consumer, no. The reason for this is, the “in” and “out” pointers can never point to the same memory address and be accessed at the same time because of Semaphore N. Since the buffer consists of an array with unique memory addresses and Semaphore N prevents the consumer from requesting access to the buffer if “in” = “out”, then Semaphore S (the mutual exclusion semaphore) can be omitted.



The consumer currently cannot access the buffer as semaphore N=0.

An item is produced, “in” is incremented, consumer can now enter CS and access buffer[0].

Another item is produced at the same time the previous is consumed.

Does this hold if there are >1 Consumers and 1 Producer (and vice versa)?

Each semaphore is required for if there is more than 1 Producer or more than 1 Consumer. For example, given “x” number of Consumers where “x” > 1 and Semaphore S is still excluded, each of their “out” pointers will point to the same spot, so if given the chance (i.e an item is produced) Semaphore N will allow Consumer #1 to go, and if a process switch to Consumer #2 occurs during its CS then Semaphore N will still allow Consumer #2 to enter its CS, thus breaking mutual exclusion. The same is true for multiple Producers and their “in” pointers. Semaphore S is needed to maintain mutual exclusion. However, it only needs to be shared between the process with multiple instances, not the singular process.

How about >1 Consumer and >1 Producer?

The same issue occurs here but to a larger extent. Semaphore S is still necessary as now both the Producer and Consumer can break mutual exclusion, since both processes have multiple instances. The solution to this is to have a “Consumer_S” and “Producer_S” semaphore to be shared between processes of the same type. “Producer_S” would behave separately from “Consumer_S” but each process would still have to wait for their respective S semaphore to free up before accessing their CS.