

OS Assignment 3 Design Document

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1 The Way it Works

I used a total of 5 semaphores to apply synchronisation to the given problem. 1 semaphore called `class_limit` was used for restriction 1. 2 semaphores called `os` and `pfun` were used for restriction 2. 1 semaphore called `TA_break` was used for restriction 3. 1 last semaphore is used for mutual exclusion on the critical section. The flow of checking for this synchronisation is such that first it checks if the students from the other course are inside the office. Then it checks if the number of students inside the office is less than 3 or not. Then it checks how many students have been to the office since the last break. The reason I used semaphores is because they are easy to implement and can be used to implement both locks and condition variables.

Restriction 1: The semaphore called `class_limit` is initialised with the value `MAX_SEATS`. The function `sem_wait()` is called every time a student gets inside the office and the moment this value becomes 0 (which is when 3 students have entered the office) the next student to enter starts waiting outside the office. The function `sem_post()` is called on it every time a student leaves the office. So the moment the value becomes more than 0 another student can enter as there is room for 1 student now. The semaphore here is used as an ordering event as we could let at most 3 students inside the office at one instance.

Restriction 2: Both the semaphores `os` and `pfun` are initialised with the value 0. Reason for doing so is that if `sem_wait()` is called even one time on it the threads should stop right there. Every time a student tries to enter the office it checks if the amount of students of the other course in the office is more than 0. If the amount is 0 then it proceeds as usual otherwise it calls `sem_wait()` on the semaphore of that course (semaphore named `os` in case of an OS student entering the office and semaphore called `pfun` in case a PFUN student entering the office). While doing so it also counts the number of students (using an int variable called `pfun_waiting` for PFUN and another int variable called `os_waiting` for OS) waiting outside the office so when the amount of students of a course becomes 0 a for loop begins which calls `sem_post()` on the other course's semaphore `os_waiting` or `pfun_waiting` times. This relieves the other course student threads of their semaphore and lets them get inside the office. Both of these semaphores are used as condition variables here as the threads should stop the moment any thread from the other course gets inside the office.

Restriction 3: The semaphore called `TA_break` is initialised with the value `TA_LIMIT`. The function `sem_wait()` is called on it every time a student tries to enter a class. The moment the int variable `students_since_break` reaches the value `TA_LIMIT` (which is 10) and the int variable `students_in_office` reaches the value 0 (thus ensuring that students who entered the office have left) a for loop is started which calls `sem_post()` `TA_limit` times. This informs the student threads that the TA has taken his break. Before starting this for loop the int variable `students_since_break` is set to 0 thus telling the program that a new session is starting after the break and then the function called `take_break()` is called which sends the TA on a break. The semaphore here is used as an ordering event as we could let at most 10 students inside the office before the TA goes for a break.

Mutual Exclusion: The restrictions explained above follow mutual exclusion and maximise concurrency because of the way the flow is setup. The average real time it takes to run my implementation takes around 45 seconds on sample_input2.txt. Moreover, I have also used a semaphore called lock which acts as a lock to ensure mutual exclusion. The function sem_wait() is called on it when the thread is accessing the critical sections (where the values students_in_office, students_since_break, class_os_inoffice, and class_pfun are getting updated). The function sem_post() is called on it when the thread has left the critical section. This semaphore is used as a lock over here as that is what was needed.

2 Removal of Synchronization Overhead

Restriction 1 and 3 were already in a state where synchronization overhead was at its least. In restriction 2 though I had used bools to make the conditions but I later realised that it could be done without them and that would reduce the complexity of the conditions to some extent. This was causing an issue where the maximum amount of students in the office would fall to 2 because of the way the synchronisation was done.