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GRENOBLE
UFR IM²AG

GINF41E0 - Second Midterm Exam
Year 2013-2014

Duration : 1h30.
Documents allowed. Electronic devices forbidden. Evaluation scale is only indicative.
For each question a part of the evaluation may take the presentation into account.

1 About synchronization (6 points)

1. (3 points) Describe three situations in which "mutual exclusion", "progress" or "bounded waiting" are respectively missing and explain the resulting issue in each case.

2. (3 points) What is the difference between semaphores and monitors ? Are they equivalent, or, in other words, is it possible to solve the same problems with both models ? Explain your answers.

2 Ice-cream Seller (14 points)

In this part, we consider an ice-cream seller and its customers that will be simulated by properly synchronized threads. Each customer, that will be a kid wishing to buy an ice-cream, will be simulated by a distinct thread. He will issue its order and wait for the seller to serve it. Then, he will wait for the next day and repeat the same process. The ice cream seller, which will be simulated by another thread, sleeps as long as no kid is willing to buy an ice cream. Otherwise, he can handle at most 5 requests at the same time, we will name this set of requests a batch. When kids are waiting for their ice-cream, the seller will constitute a batch as large as possible (while remaining within the limit of 5 requests), he will serve all the requests in this batch, then he will be able to handle a new batch if some kids are still waiting. There are 3 ice-cream flavors, strawberry, chocolate and vanilla, stored in 3 different fridges. All the requests in a batch are served at the same time, at the end of the batch, but, because of the different fridges, the time it takes to serve a batch depends on the number of different flavors in the requests of this batch : it takes 5 seconds per different flavor present in the set of requests.

Questions : In the following, at your convenience, you can answer each question separately or give a single implementation that answers all the questions. You are required to write your implementation in correct C using POSIX threads.

1. (3 points) Give an implementation of the main program, that will create the shared data structure (if any) and the theads involved by the simulation.

2. (5 points) Give an implementation of the threads conforming to the aforementionned behavior.

3. (3 points) Needless to say that, in order to serve requests as fast as possible, the ice-cream seller will try to minimize the number of different flavors in a single batch. Nevertheless, he should be careful not to let any kid starving, especially during warm summer days. Thus, he will handle in priority kids that have been waiting for more than 20 seconds and, among these kids, handle their request in the order of their arrival. Give a new implementation of the ice-cream seller thread that conforms to this new behavior. Notice that we assume that a call to `time(NULL)` which returns the value of time in seconds since 0 hours, 0 minutes, 0 seconds, January 1, 1970, Coordinated Universal Time, has a sufficient precision to measure the time.

4. (2 points) Some kids will (randomly) come accompanied with their mother. In this case they will order two ice creams at once (one for them and one for their mother). Because of the presence of the mother, the ice-cream seller will handle their order with the highest priority. Give a new implementation of the ice-cream seller thread that conforms to this new behavior. Is starvation possible with this new specification ?

5. (1 point) Does it change anything if you extend your program to n simultaneous requests and m flavors ?