Programming techniques : Project 4

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1 Queue management

Queuing is done as follow :

- If the shower is empty, then anybody can go inside without any queuing ;
- If the showed is used by someone of the opposite sex, then the person will wait until the shower is empty ;
- If the shower is used by someone of the same sex and if there is nobody of the opposite sex waiting outside, then the person is allowed to immediately join the shower ;
- If the shower is used by someone of the same sex but if there is at least one person of the opposite sex waiting outside, then the person will be en-queued after people of the opposite sex.

The last condition is there to ensure that someone of sex A who arrives after someone of sex B doesn't bypass this last, avoiding any starvation, while other rules enforce mutual exclusion.
Once the shower is empty again, every person of the opposite sex, if any, is allowed to enter the shower. Waking up a group of people is done using a conditional variable.

We can easily prove that our queuing algorithm doesn't give any way for a person to be kept in the queue for more than the double of the shower length time.

2 Results

We've tested our queuing algorithm of two different ordering.

In the first case, both sexes are already grouped in two distinct groups, without any interlacing. This is the best case of our algorithm as there will only be two shower sessions. As expected, the first group of people doesn't wait to enter as a whole in the shower while the second group must wait until the last person of the first group has leaved the shower. **Giving N people of sex A and M people of sex B, the average waiting time will be $\frac{M}{N+M}$ times the defined shower length time** as only people of group B will have to wait outside the shower.

In the second test case, people enter the shower in a shuffled ordering. This is not far away from the worst case scenario of our algorithm as the first person of sex B will prohibit anybody of sex A to enter the shower, even if the shower is currently used by someone of sex A. Thus there will be three shower sessions. **Giving N people of sex A and M people of sex B, the worst average waiting time is given by the following formula :**

$$max\left(\frac{M+2(N-1)}{N+M},\frac{N+2(M-1)}{N+M}\right)$$

as in this scenario, only one person of either group A or group B will be allowed to enter the shower without waiting (because of being immediately followed by a person of the opposite group) whereas every remaining person of his group will have to wait for two shower length times.
Experiments confirm this theory by giving an average waiting time of between 1.35 and 1.46 time the shower length time while the theoretical maximum of the preceding formula is 1.5 for the same values of N and M.