SE assignment **Univ. Rennes 1**

Semaphores

The aim of this assignment is to practise the use of Semaphores in the context of multi-threading programming. Our setup will in general be an abstract one: the Semaphores we will use do not control the access to a particular computer device or memory resource, but only the flow of instructions in the concurrent threads.

Consider that some exercises are based on fictions that may not use much of the computer science vocabulary. However, do not hesitate to think of semaphores, deadlocks, resource allocation graphs, as well as of the Banker's algorithm, when attempting to solve the proposed problems.

Question 1

Consider the code for the three threads below. The two Semaphores are named `U` and `W`, and we can initially suppose that they both have only 1 permit:

```
// thread 1                   // thread 2                  // thread 3
while (true)                  while (true)                 while (true)
{                             {                            {
   W.acquire();                  U.acquire();                 W.acquire();
   print("AB");                  print("C");                  print("D");
   W.release();               }                               U.release();
}                                                          }
```

If only thread 1 is executed, how many times the letters A and B are printed?

Question 2

If only thread 2 is executed, how many times the letter C is printed?

Question 3

Suppose now that the threads 2 and 3 are executed simultaneously. What is the number of D's that will be printed? Is the number of printed C's infinite?

Question 4

Let us suppose now that all threads are executed. Can there be situations where no A's are printed? Answer by giving an example. Same question for the letter C.

Question 5

Can the sequence "DAB" be printed? Same question if both U and W have more than 1 permit.

Question 6

If 3 permits are available for both U and W, can the sequence "ABCCCDCC" be printed?

Question 7

If 3 permits are available for both U and W, can the sequence "CDABABAB" be printed?

Question 8

By using only one semaphore with 3 permits, can you modify the code of the 3 threads so that, once the two letters AB are printed, they will always be followed by a C?

Question 9

Consider the three threads below:

```
// thread 1                  // thread 2                // thread 3
x = 1;                       x = 2;                     z = x + y;
y = 2;                       z = 10;
z = 0;
print(z);
```

How many different values of `z` may be printed?

Question 10

By using only one semaphore with 1 permit, how to change the code of the three threads to make sure that the printed value is always 0?

Question 11

A famous pop star is about to organize a big event at *Le Liberté* music hall of Rennes. The day before the planned event, she's welcoming local journalists for interviews, but since she soon gets bored of answering journalist's questions, she asks to see some of her local fans at the same time. This request gives some troubles to the organizing stuff, because the journalists are undoubtedly going to have a hard time interviewing the pop star when several of her fans will be around.

Step 1 As a member of the local stuff, and with your fresh Master degree in Computer Science in your pocket, you are asked to find a valid solution to this problem. The main organizers would like you to come up with a ticket system capable of controlling the number of interactions that the pop star is supposed to have in parallel. Tickets will be distributed to journalists and fans at the entrance, and collected when they will leave. It will be required that maximum 5 fans can see the pop star at the same time, and that, when a journalist is present, this constraint decreases to 2. How to develop such a system? Just give the main idea; it is not necessary to write code here.

Step 2 Your system seems to satisfy the main organizers, and it actually works fine for about one hour of meetings with fans and journalists. However, the number of fans keeps growing with the time during the day, while the number of journalists remains the same and, after some time, it seems they are all stuck outside and no longer able to get access to the room where to meet the pop star. Can you explain what is going on?

Step 3 One journalist, who was waiting for his turn since long time, decides to cheat the system by moving to the fan line in order to get his tickets. After him, several journalists start to do the same. Is this behavior dangerous for your system?

Step 4 The system crashes after a while. All tickets are assigned to somebody, but nobody has the right to enter. Who are these people that hold the tickets? Journalists or fans? You start wondering whether, when distributing the tickets, it was necessary to verify the identity of the person asking for them.