Université
Joseph Fourier
GRENOBLE
UFR IM^{2}AG

GINF41E0 - Second midterm
Year 2014

Duration : 1h30.
Any document allowed. Electronic devices forbidden.
For each question, a part of the evaluation could take the presentation into account.

1 No more system bankrupt ?

Comment in a few lines the following sentences, the banker algorithm :

1. helps the system scheduler in its task of deciding which thread to schedule next.
2. is used to restore a safe state in the system.
3. can detect deadlocks in a running system.
4. is used for resources acounting in the system.
5. has a running time linear in the number of threads running in the system.
6. is executed at each clock interrupt.
7. is necessary, otherwise the system eventually enters into deadlocks and ceases to function properly.
8. is a part of most libraries that let users create and manage threads.

2 Painting session at the nursery school

Tomorrow, at the nursery school, a painting activity is planned. You are in charge of the coordination of teachers that will take care of the young children while they proceed with their work of art. Before trying to handle the situation in the real life, you decide to write a multithreaded simulation of this activity. In this simulation, each child is modeled as a thread that occupies one location in front of a single flat painting wall and that will chaotically ask teachers for resources. In the classroom, resources are brushes and pots of paint, there are B brushes and $P_1, \ldots, P_n$ pots of paint of respective color $C_1, \ldots, C_n$. Children gather their resources by asking for one resource at a time, for instance, a child might ask for one pot of paint of color C_i, then one brush, then another pot of paint of color C_j, but not for two pots of paint and one brush at once.

Teachers are modelized by functions called by threads to ask for brushes and pots of paint and to return them. Teachers are in charge of synchronizing accesses to resources performed by the children, a child can only use a resource if she has asked for it to a teacher and has obtained a positive answer. Furthermore, when a child asks for some resource, either this resource is available and a teacher gives it to the child, or it is not available and the child has to wait for its availability. As a general rule, if the teachers want to avoid cries and screams, resources cannot be taken from a child who uses it before it has been gracefully returned. Rules regarding resources depend on their type :

— a brush can only be used by the child who has acquired it.

— a pot of paint is placed inbetween two children and, thus, can be used by two adjacent children. Although a pot of paint can be shared between two children, teachers cannot move a pot of paint that is used by at least a single child to another position, they have to wait for the complete release of the pot by all the children to whom it has been allocated. Notice, also, that a given child has no use of several pots of paint of the same color, if she asks several times for pots of paint of the same color, extraneous demands have to be ignored.

Questions : All implementation you provide in your answer has to be in C using the POSIX API.

1. write the declaration of the shared data structures required to modelize the problem and write a function that will be called once to initialize these structures. Of course, you are expected to explain your code, comment it, or both.
2. write the functions associated to the children and to the teachers according to the previous specification. Once again, needless to say that you are expected to explain your code, comment it, or both.
3. in this setup, deadlocks are possible, give an example of such a deadlock.
4. do you think it is better to avoid or to detect deadlocks ? Explain why.
5. what algorithm presented during lectures seems appropriate to handle deadlocks in your simulation ? Explain why. If none seems appropriate, also explain why and explain how to adapt one of them.