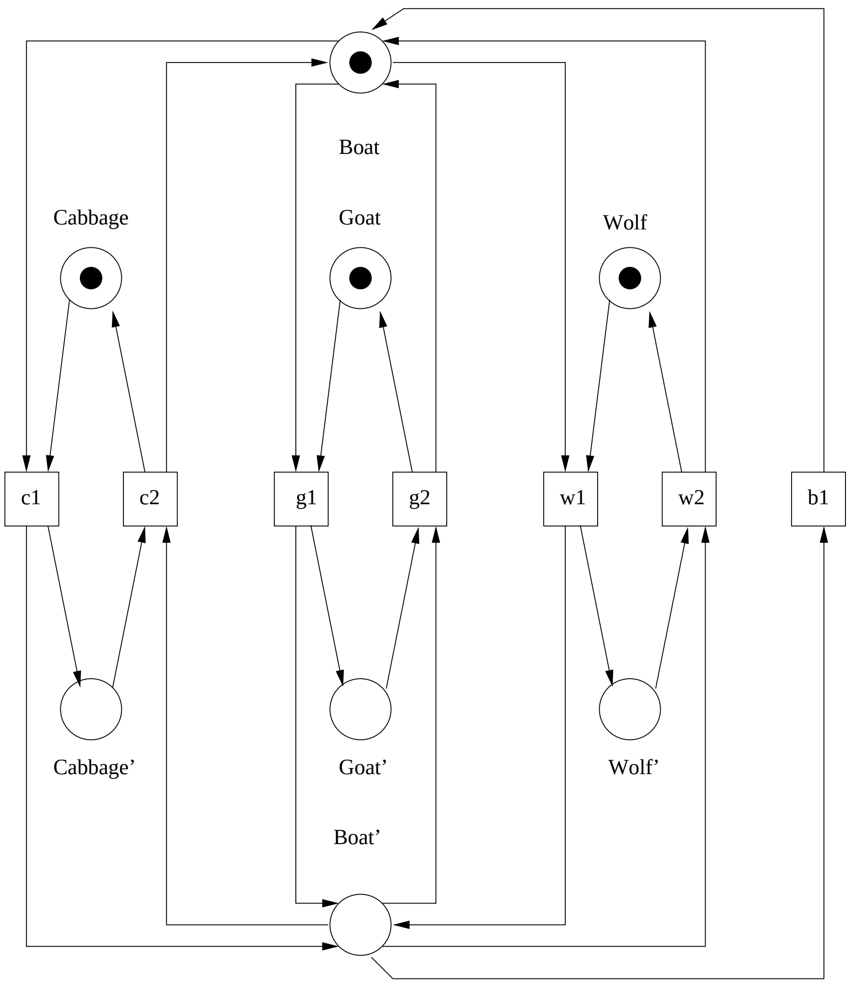
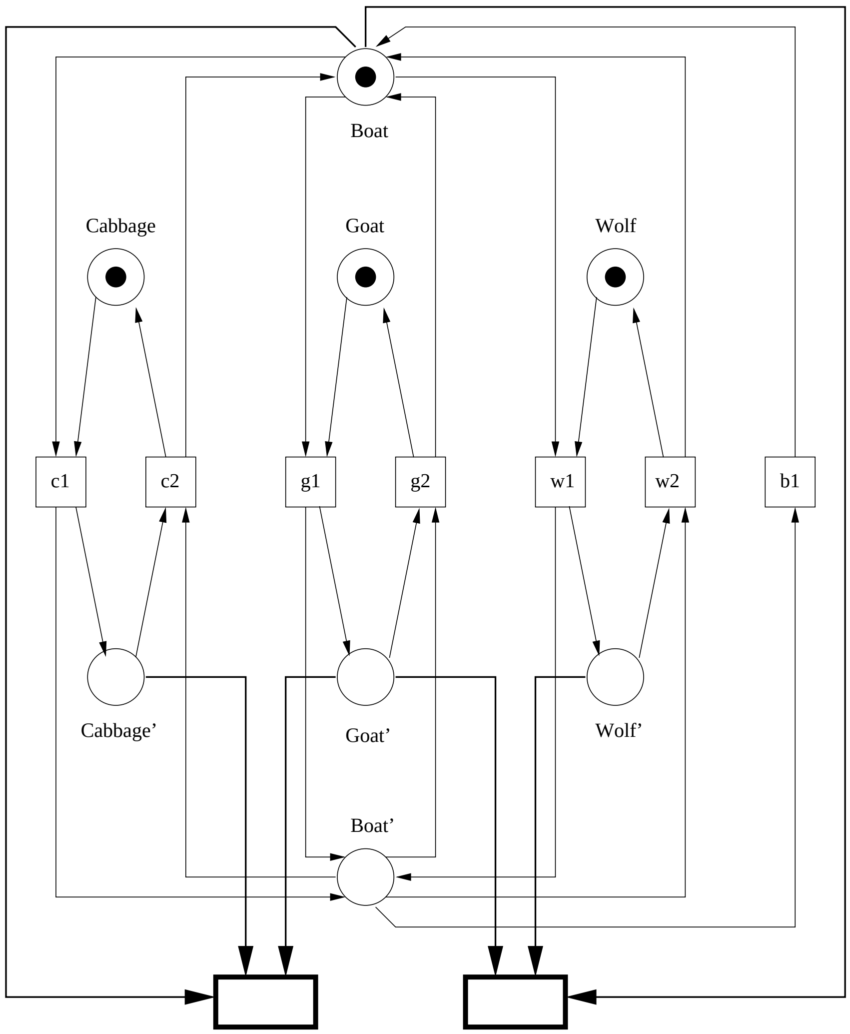
T-79.231 **Autumn 2002**
Parallel and Distributed Digital Systems
Answers for Tutorial 2
Sep 30th 2002

1. Below is presented the place/transition net which models the problem. The places **cabbage**, **goat** and **wolf** model the situation where the corresponding passengers have not yet crossed the river. The places **cabbage'**, **goat'** and **wolf'** model the situation where the passengers have crossed the river. The places **boat** and **boat'** represent the location of the boat.



One way to find the unwanted states from the system is to use *fact transitions*. A fact transition is constructed in such a way that it is enabled only if the system is in unwanted state. In this case we need four separate fact transitions, one for each of the unwanted states. The fact transition 1 gets the places cabbage', goat' and boat as its preplaces; fact transition 2 gets goat', wolf' and boat as its preplaces. Similarly for the fact transitions 3 and 4. Below is presented the net with the fact transitions 1 and 2 added.

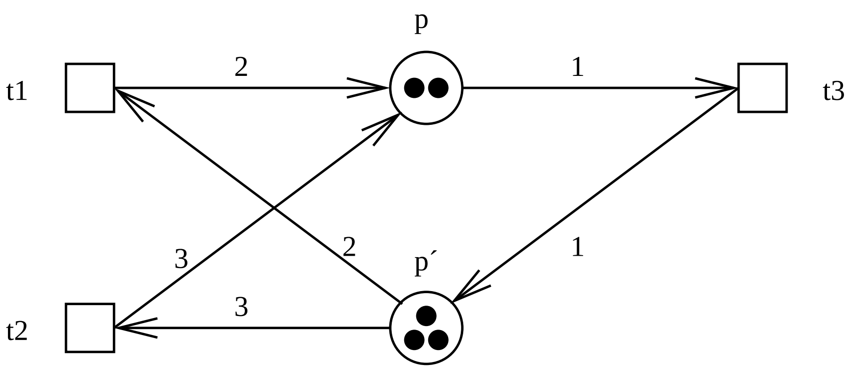


Another possibility is to write the net in Maria's net description language and use the `reject` statement in Maria. The `reject` statement takes a boolean formula which specifies when to reject a state. If, when generating the reachability graph, we encounter a state which causes the formula to evaluate to true, Maria will report the number of the state that is rejected. In this case we could use the formula

$$(cabbage' \wedge goat' \wedge boat) \vee (goat' \wedge wolf' \wedge boat) \vee (cabbage \wedge goat \wedge boat') \vee (goat \wedge wolf \wedge boat')$$

In the formula the names of the places are taken as atomic propositions. The interpretation of the atomic propositions is that the proposition is true iff there is a token in the corresponding place.

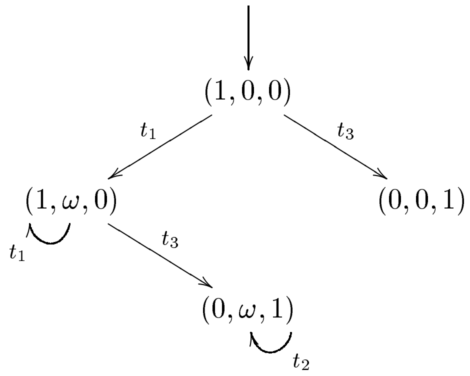
2. Build the complement construction as per definition. You should not forget the initial marking of the complement place.



3. The coverability graphs of the nets are identical. The net N_1 cannot deadlock after it has fired the transition t_1 even once. The net N_2, however, can deadlock in the same situation, e.g. with the firing sequence t_1, t_3, t_2.

   Our conclusion is that the coverability graph does not maintain all information about the reachability of markings.

   Joint coverability graph:



4. a) Let us abstract away the information which pump is being used. We will obtain the following P/T net:

   b) Another cashier is added to the net by modifying the initial marking of the place *free cashiers* to contain 2 tokens. Correspondingly, two waiting slots can be added by modifying the initial marking of the place *free spaces* to contain 4 tokens.