

# Project 2016/17

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Reactive Systems Verification

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## Description

Consider the traffic flow of some cars on a one-lane bridge that has two traffic lights (left and right) to regulate the access. The following information is given for this scenario:

- the bridge cannot sustain more than  $n$  cars at the same time;
- each traffic light has two colours: red and green;
- a car may decide, at a certain point (including the initial time), to stay at its idle (active waiting) state and never cross the bridge again;
- from the idling state a car may decide at any time to approach the bridge at one of the two sides;
- if a car approaches a bridge it signals it to the controller through a sensor on the road on the side it is on;
- after approaching the bridge a car starts waiting until it is given access to it by the controller with the green light on its side;
- after a car has accessed the bridge, the corresponding traffic light turns immediately red to stop the next car, if any;
- if no car is approaching the bridge both traffic lights are red;
- a car exiting the bridge is signalled to the controller by another sensor on the road;
- after exiting the bridge a car goes to its idling state;
- if no cars are on the bridge and there are cars approaching on both sides, then the access is given to the side whose turn is active;
- if there are cars on the bridge and there are cars approaching on both sides, then the access is not given to any side until all the cars currently on the bridge exited it;
- whenever a side uses its turn, then the turn is given to the other side;
- if no cars are on the bridge and if there are cars waiting only on one side, they are given access to the bridge no matter which side the turn is of; this does not change the turn;
- if there are cars on the bridge and if there are cars waiting only on one side, they are given access to the bridge only if there is room and their flow is equal to that of the one(s) currently on the bridge; otherwise they have to wait at least until the bridge becomes empty;

- the flow of a car (left to right or right to left) on the bridge cannot change;

Your tasks are:

1. Model the above scenario in SPIN; instantiate  $n$  with 2 and ensure the presence of at least 3 cars.
2. Write the following properties as LTL formulas and model check them with SPIN on the given model:
  - (a) it is never the case that more than  $n(= 2)$  cars are on the bridge;
  - (b) it is never the case that  $n(= 2)$  cars with different flows are on the bridge;
  - (c) whenever a car approaches the bridge from the left side, it will eventually leave the bridge on the right side;
  - (d) if a car approaches the bridge from the right side infinitely many times, it will cross the bridge infinitely many times;
  - (e) whenever a car is on the bridge, it eventually will leave it;
  - (f) if from a certain time on no cars approach the right traffic light, then eventually the turn stops changing between sides;

## Submission

Prepare a written report describing your model of the scenario and how you expressed the properties. Then send by email to the teacher the SPIN files and the report in pdf. The exam is passed when both the following conditions are satisfied:

1. the project has been sent and has been approved;
2. the written test has been passed;

The final grade is a combination of the grades of the two tasks.