TP 6 : Modelling an intersection

Cours de modélisation numérique

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1 Automatic red light

The model of a red light seen in class can be specified as follows :

1.1 State

— Light state (red or green) : represented by a Boolean.
— Counter of waiting cars (V) : represented by an integer.

1.1.1 Initial condition

— Red light.
— $V = 0$.

1.2 Constants

— T_c : waiting time for the red → green light change, after the arrival of the first car at the red light.
— T_p : time it takes for a car to pass.

1.3 Events and Actions

1.3.1 CAR(t)

A car arrives :

1. `if(` $V = 0$ `and red light) insert R2G(` $t + T_c$ `)`
2. `if( green light ) pass otherwise` $V = V + 1$

1.3.2 R2G(t)

The light turns green :

1. `light` := `green`
2. $V := 0$
3. `insert G2R(` $t + V \times T_p$ `)`

1.3.3 G2R(t)

The ligh turns red :

1. `light` := `red`

2 Exercise

2.1 Modelling an intersection with two traffic lights

Once you have read and made sure you understand the example above, you will need to model an intersection with **two automatic traffic lights**. The constraints are the following :

— There are two traffic lights (A and B)
— Cars can arrive at either the A light, or the B light.
— The two lights should **never** be green at the same time.
— When one light turn red, the other can instantly turn green.
— When a light turns green, it must remain green for a time at least equal to $V \times T_p$, where V is the number of cars waiting at the red light and T_p the mean time required to get a car through.
— If more cars arrive at light A, it should be green more often than it is red. (Consequence)

You must implement this model in Python. To do so :

1. Download the file `carrefour.py` which is the beginning implementation of the example seen in the course, for a single traffic light. Read the code and make sure you understand everything
2. Complete the missing functions in the code.
3. Next, modify the provided file to implement the model discussed here, with two lights.
4. Finally, display a graph of the number of cars waiting at each traffic light as a function of time. Vary the parameters T_c and T_p, as well as the arrival of cars at the lights. Plot the discrete events of the red$rightarrow$green traffic light and vice versa.

2.2 More realistic condition of passage

In the previous example, we considered that when the light turns green, all cars would pass at the same time. This is certainly realistic for pedestrians, but not for cars which pass one at a time. In this exercise, you will need to improve the two-light intersection model regarding the passage of vehicles waiting at the red light.

The problem is modified as follows :

— It takes on average T_p for a car to pass the light.
— The light stays green only for a fixed time : T_v.
— The light must remain red for a fixed time equal to T_r.

Implement this second version of the model and represent the same graphs as before, varying T_v and T_r. To do this, choose a given list of arrival of cars and a T_p that give rise to relevant graphs ($T_c = T_v + T_r$ is no longer necessary in this case).