Timed & hybrid systems (2.8.2)
TD n° 2 : Timed regular languages

Reminder : two Alur’s theorems
1. Given a timed automaton A one can compute a finite automaton B such that $L(B) = \text{Untime}(L(A))$
2. Universality problem “Does a timed automaton A accept all the timed words?” is undecidable

Exercice 1 – Three languages

Are the following timed languages over \{a, b\} timed regular? Build a timed automaton or prove that it is impossible.
1. $L_1$ : timed words with the number of a being a prime integer.
2. $L_2$ : timed words with the duration being a prime integer.
3. $L_3 = \{ta1b\}$.
4. $L_4 = \{ta1asb|t + s = 2\}$. Also, is it recognizable with an one-clock automaton?

Exercice 2 – Folk’s theorems — S. Tripakis

Prove that there is no algorithm that given a timed automaton A
– answers YES or NO whether $\overline{L(A)}$ is timed regular;
– and if the answer is YES builds a timed automaton B such that $\overline{L(A)} = L(B)$.

Hint : suppose that such an algorithm exists and use it to decide Universality.
Remark : (O. Finkel) deciding whether $\overline{L(A)}$ is timed regular is also impossible.

Exercice 3 – Modeling and verification — easy exercise before Christmas

Romeo wakes up between 6 and 7 o’clock, learns Timed automata during 6 to 8 hours, then swims during 2 to 3 hours, makes a jogging during 2 to 4 hours (altogether he makes sport for less than 6 hours), and goes to “Chez Uppaal” bar for the rest of the day. He goes to bed at 22 hours.

Juliet is awake from 7 to 21, and during all that time she alternates 3 hours of learning Hybrid systems and 1 hour of hanging at “Chez Uppaal”.

The specification says that they should never meet “Chez Uppaal”.

1. Model Romeo and Juliet behaviours by timed automata.
2. Represent the verification of the specification as emptiness checking for an intersection of timed regular languages. Hint : you will need a special event for their rendez-vous.