Exercise 2.1

Consider the scenario of traffic lights (green and red) at a T-junction between a highway and a local road. The lights on the highway will always be green and light on the local road will always be red unless a vehicle is detected by a sensor in the local road. The sensor on the local road will be turned off when the light there is green. The following points describe the complete behaviour of the traffic lights:

- Assume that the vehicles do not go from highway to local road.
- When the sensor detects a vehicle on the local road, the light there should become green within 30 seconds and should stay green for at least 20 seconds.
- The lights on the highway should be green for at least 30 seconds in each cycle.

1. Model this scenario using Timed Automata.
2. Model your automaton in UPPAAL and check that both the lights should never be green at the same time. (Hint: Use different automata for highway traffic light and local road traffic light, and synchronize them.)

Exercise 2.2

1. Compute the set of reachable states in the TA shown in figure 1.
2. Draw the region automaton for the TA shown in figure 2.

Exercise 2.3

We assume a slightly different definition of TA for the following exercises. Along with the definition of the timed automata shown in lectures, we also assume that there is a set $F \subseteq$ of accepting states and whenever a run ends in an accepting state, we say that it is an accepting run. The set of all timed-words $(w, \tau)$ for which an accepting run exists, is called the language of the TA. Here, $w \in \Sigma^*$ and $\tau$ is a sequence of valuations of the clocks such that $|w| = |\tau|$.

1. Find the language of the TA shown in figure 3 (Assume $\Sigma = \{a\}$ and $F = \{s_2\}$).
2. Given a timed automaton for the timed language of all words in \((a + b)^*\) such that there exist two \(a\)-s which are at distance 1 apart and there exist two \(b\)-s which are at distance 2 apart.

---