

# Quantitative Verification 13

## Ex 1: Modelling a CTMC

Model the following scenario as a CTMC and uniformize it.

We consider a printer in a local network. Four printing jobs arrive consecutively with a rate of 2 and are placed in the printer's queue. It has a queue of size two. The jobs are handled with a rate of 1. If the queue overflows, the (buggy) firmware of the printer crashes.

## Ex 2: Two Views on CTMC

In the lecture, we switched between two views on CTMCs. First, waiting in a state for some time distributed exponentially with rate  $E(s) = \sum_{s'} R(s, s')$  and then randomly moving to a successor proportional to the respective rates. Second, running an exponential process for each successor separately and picking the first one. In this exercise, we show that the second view implies the first.

To this end, consider the following. Let  $X$  and  $Y$  be two independent, exponentially distributed variables with rates  $\lambda_X$  and  $\lambda_Y$ , respectively. How is  $Z := \min\{X, Y\}$  distributed?

## Ex 3: Self loops

Show that adding or removing a self loop to a state in a CTMCs does not change the probability distribution over its successors.