

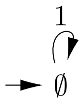
Quantitative Verification 9 - Solutions

Ex 1: Logic Modelling

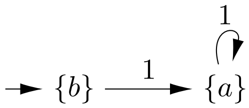
1. When there is a `send` in the first time step, with probability ≥ 0.95 there will be a deliver in the next 10 steps.
2. With probability ≤ 0.05, the system reaches a state which can reach `error` with probability ≥ 0.9.
3. The probability to remain `empty` until the system `receives` whenever there is a `send` is at least 0.5.
4. With probability ≥ 0.8 the system is `empty` until it reaches a state with `send` and never `receives` with probability ≤ 0.5.

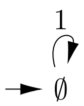
1. $\mathsf{G}_{=1}\, \neg(\texttt{crit}_1 \wedge \texttt{crit}_2)$
2. $\mathsf{G}_{=0.99}\, (\texttt{request} \implies \mathsf{F}_{\geq 0.95}\, \texttt{grant})$
3. $\mathcal{P}_{<0.4}\, [\neg\texttt{A\_fail}\ \mathsf{U}\ (\texttt{B\_fail} \wedge \neg\texttt{A\_fail})]$
4. $\neg\texttt{up} \implies \mathsf{F}_{=1}\, \mathsf{G}^{\leq 100}_{>0.99}\, \texttt{up}$

Ex 2: PCTL Satisfiability

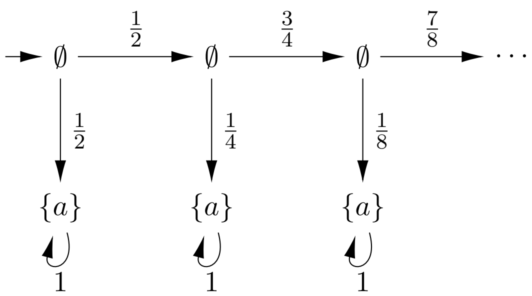
1. 

2. Not satisfiable. The formula requires to almost surely have a at every step and eventually reaching $\neg a$ with probability 1.

3. 

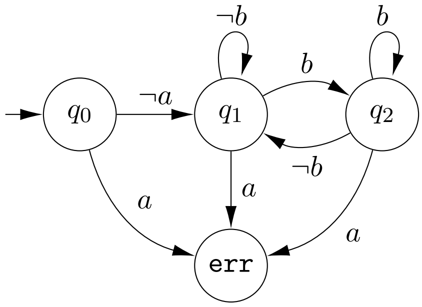
4. 

5. No finite Markov Chain can satisfy this formula, yet the following infinite state chain satisfies it:

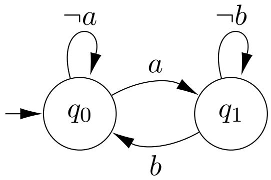


The "horizontal" run has probability $\prod(1 - \frac{1}{2}^n) \approx 0.289 > 0$.

Ex 3: Automata

1. 

   Acceptance: $\{(\{q_3\}, \{\texttt{err}\})\}$.

2. 

   Acceptance: $\{(\{q_0\}, \emptyset)\}$.