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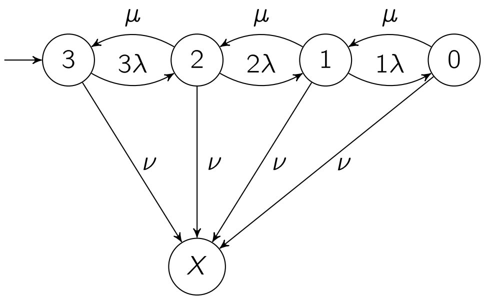
Exercise 1 (CTMC Model Checking): (4 points)

Consider the Example CTMC from the lecture (displayed below).



a) Compute $Pr(\Diamond^{\leq 3}\{1\})$ using $\lambda = \frac{1}{10}$, $\mu = \frac{1}{20}$ and $\nu = \frac{1}{100}$. You may cut off an infinite sum after three terms.

b) Give the closed form expression for $Pr(\Diamond^{\leq t}\{X\})$. *Hint: The closed form is not that large.*

Exercise 2 (The Erlang distribution): (2 points)

The cumulative distribution function (CDF) of an *Erlang distribution* with *shape* k and *rate* λ can be written as

$$F(t; k, \lambda) = 1 - \sum_{n=0}^{k-1} \frac{1}{n!} e^{-\lambda \cdot t} (\lambda \cdot t)^n$$

Construct a CTMC such that the transient probability for state x coincides with $1-$ the CDF for the Erlang distribution with $k = 3$ and $\lambda = 4$. Briefly explain your construction!

Exercise 3 (CTMC Model Checking for $I = (t_1, t_2)$): (4 points)

a) Show that for a CTMC with states S and $T \subset S$ and $0 < t_1 < t_2$ the following equation does **not** hold: $\Pr(\Diamond^{(t_1,t_2)} T) = \Pr(\Diamond^{\leq t_2} T) - \Pr(\Diamond^{\leq t_1} T)$.

b) Sketch an algorithm to compute for a given CTMC with states S and $T \subset S$ and $0 < t_1 < t_2$ the following property: $\Pr(\Diamond^{(t_1,t_2)} T)$