Annual Review

Michalis Panayides

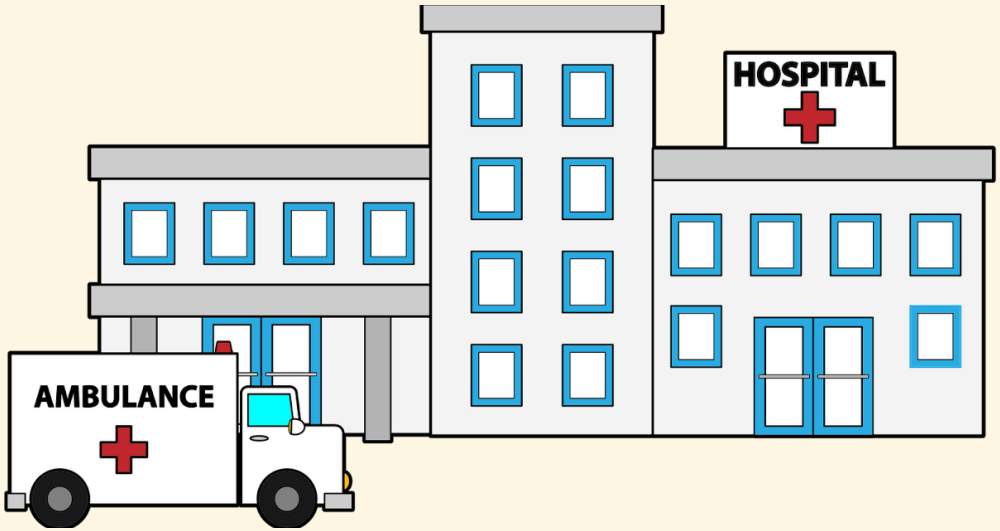
2021-06-11

Motivation

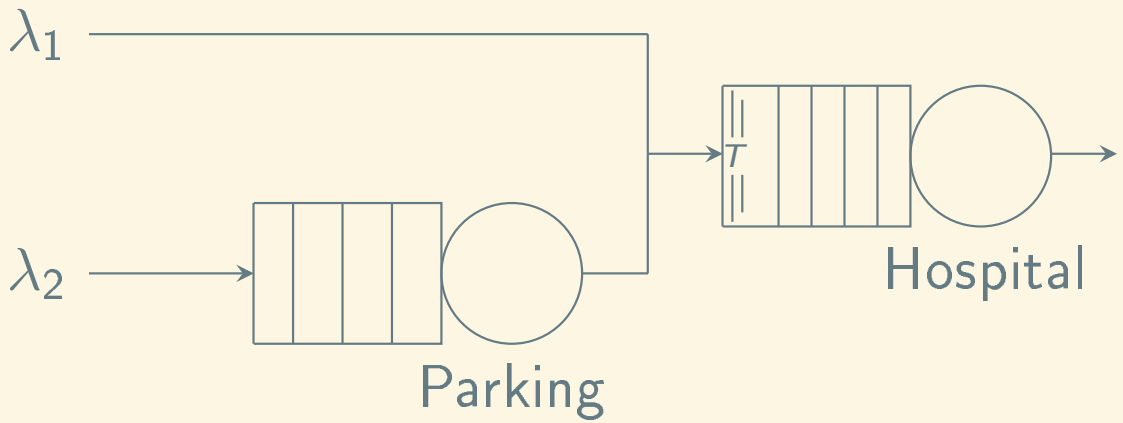

Queen Elizabeth Hospital Birmingham
EMERGENCY AMBULANCE


Emergency
Ambulance
LX64
DZK

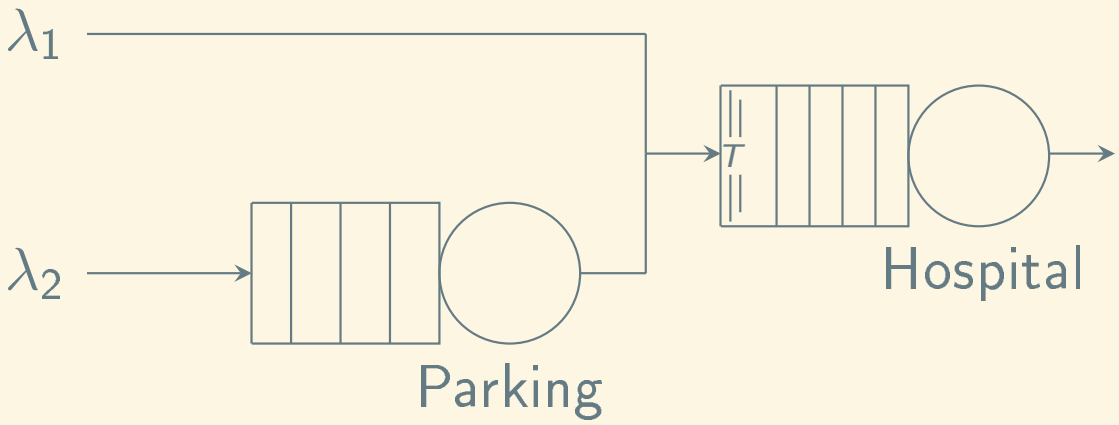
Motivation

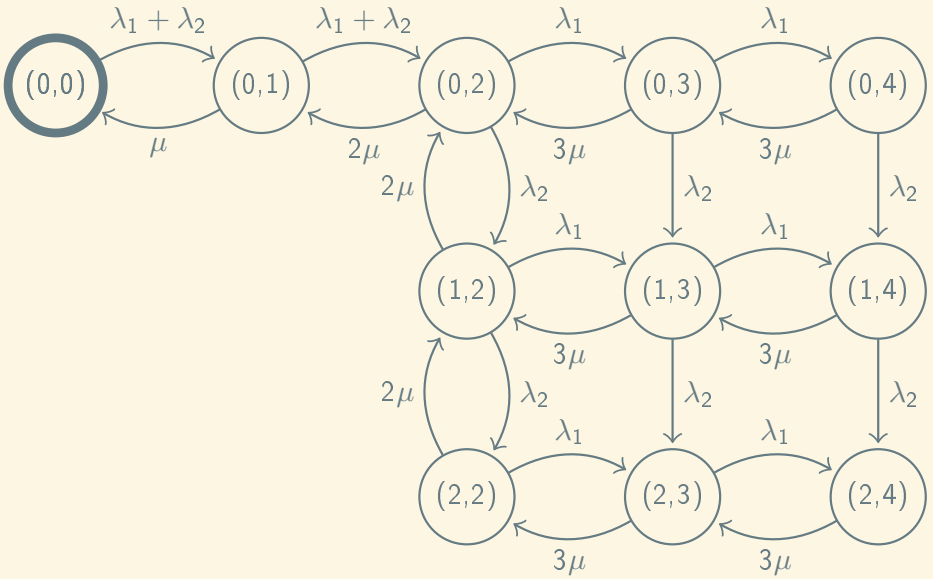


Hospital queueing model

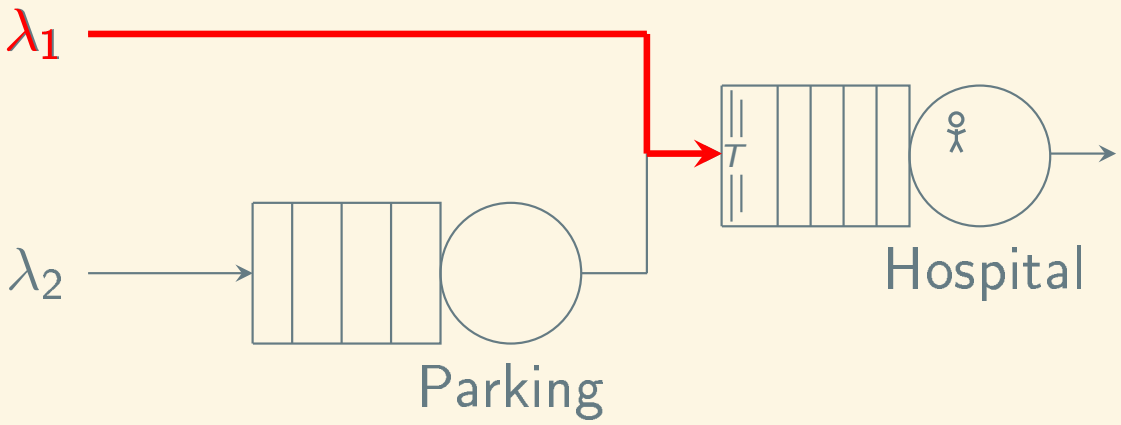


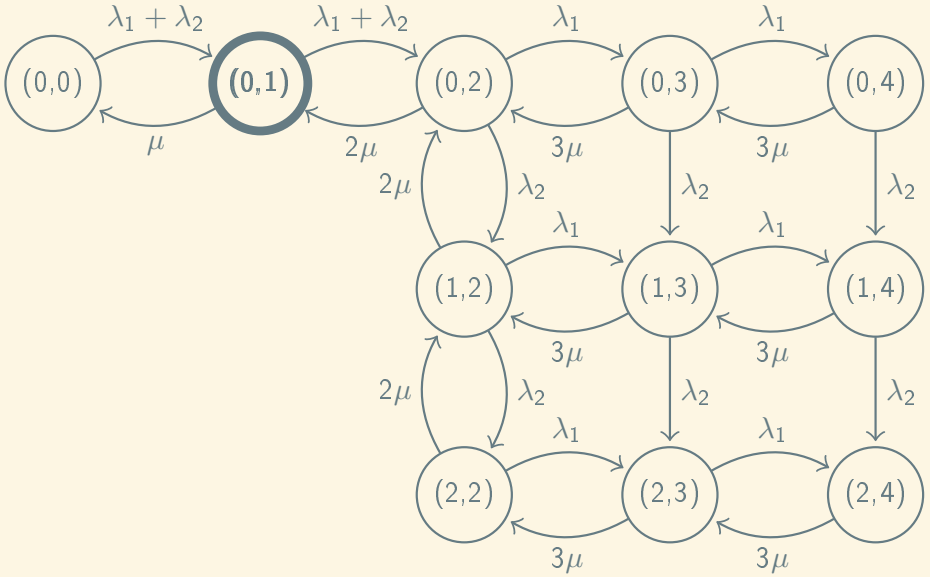
Hospital queueing model



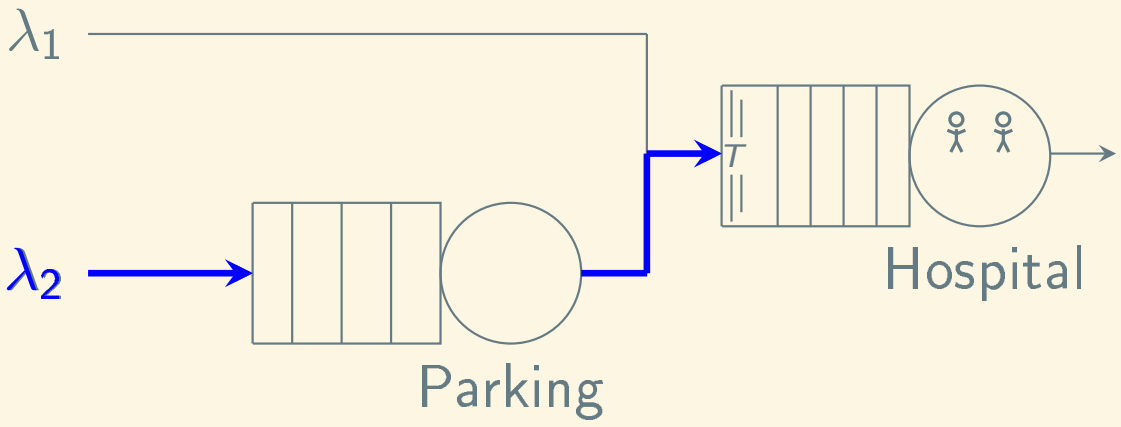


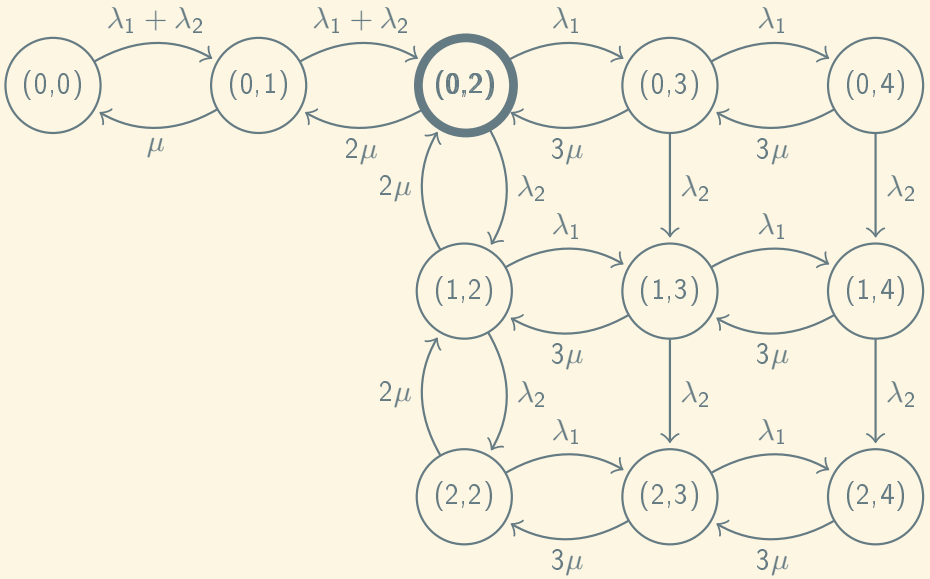
Hospital queueing model



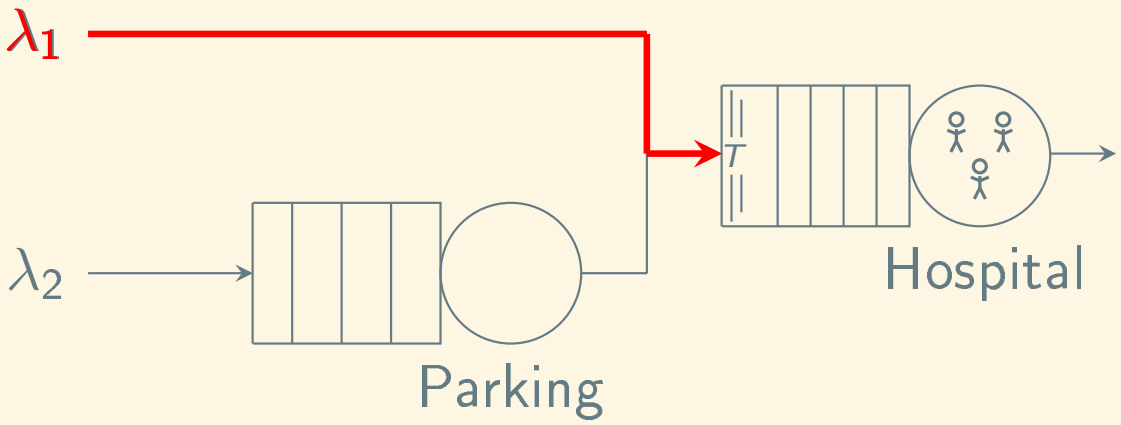


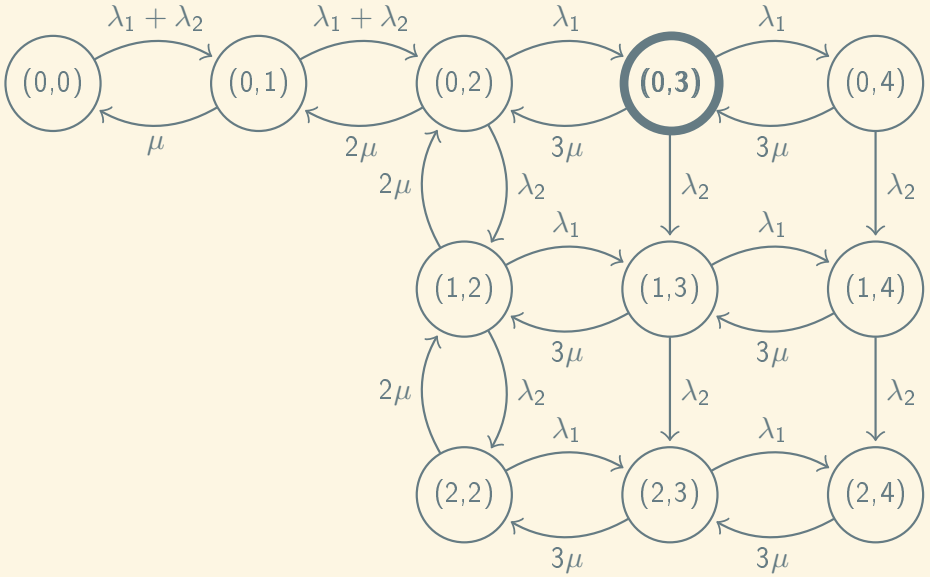
Hospital queueing model



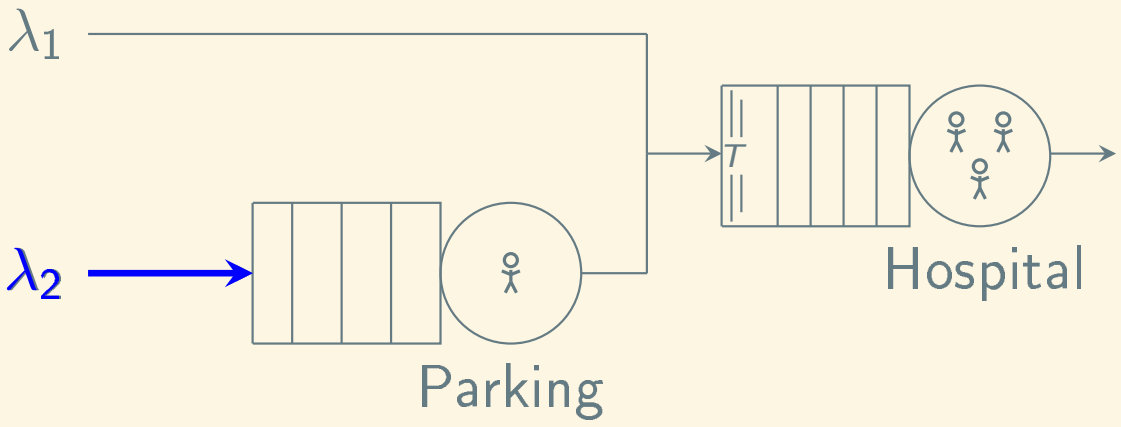


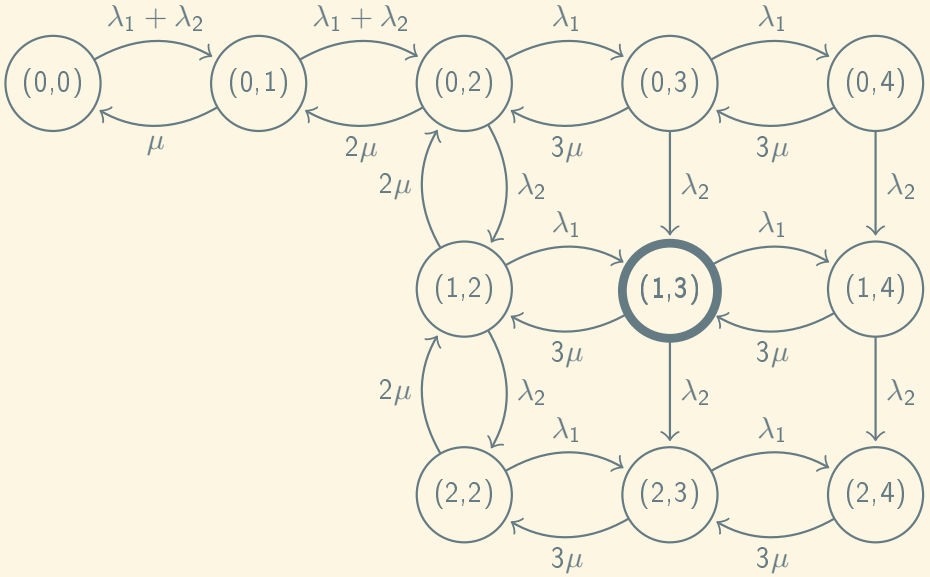
Hospital queueing model



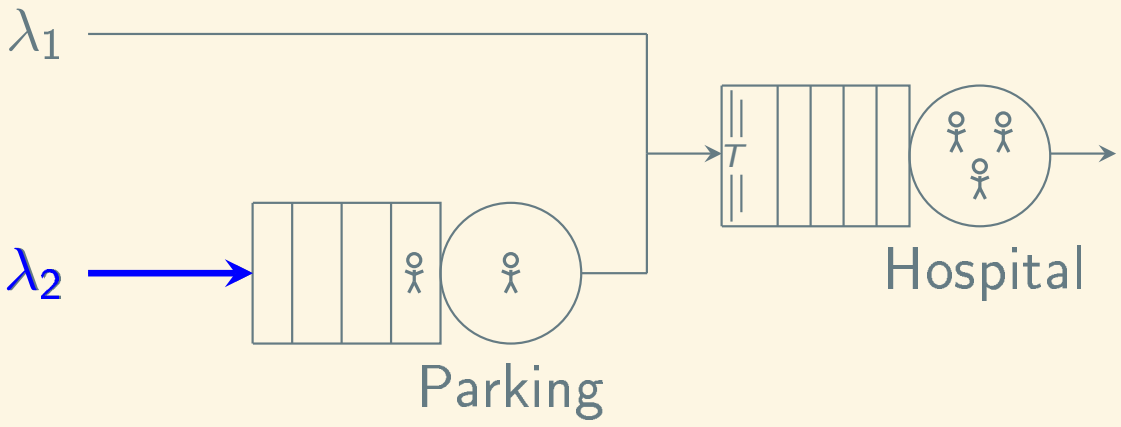


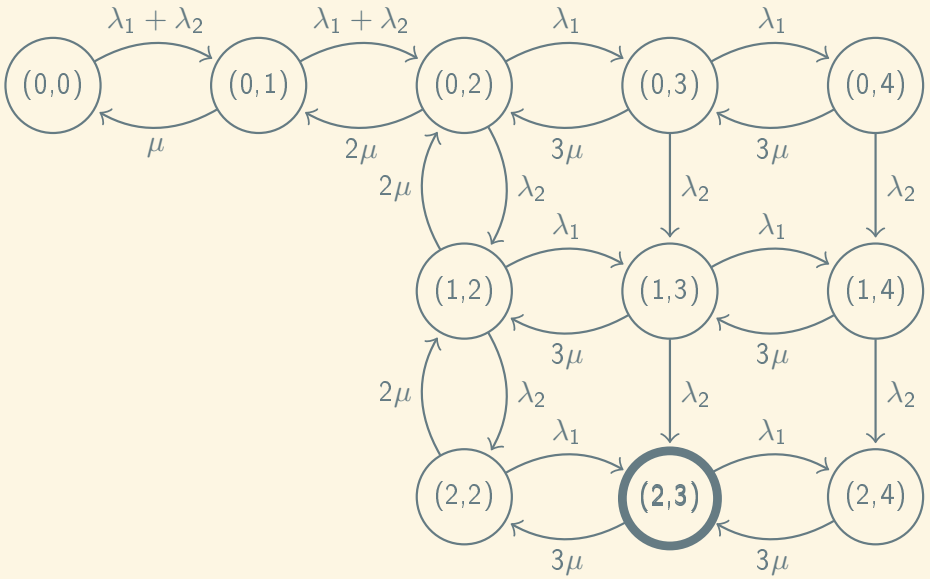
Hospital queueing model





Hospital queueing model





Performance Measures - Steady state vector

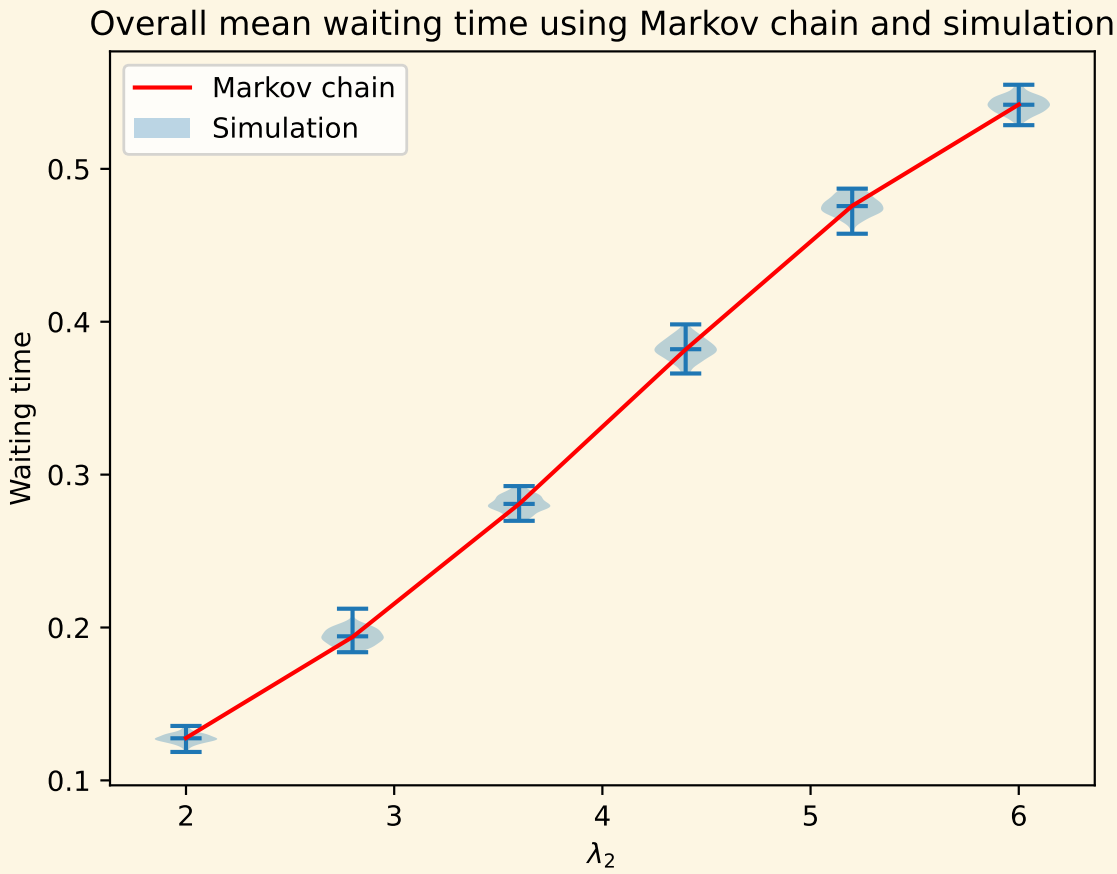
$$
Q = \begin{array}{c}
\begin{array}{ccccccc} (0,0) & (0,1) & (0,2) & & (2,3) & (2,4) & \end{array} \\
\begin{pmatrix}
-\lambda_1 - \lambda_2 & \lambda_1 + \lambda_2 & 0 & \dots & 0 & 0 & (0,0) \\
\mu & -\mu - \lambda_1 - \lambda_2 & \lambda_1 + \lambda_2 & \dots & 0 & 0 & (0,1) \\
0 & 2\mu & -2\mu - \lambda_1 - \lambda_2 & \dots & 0 & 0 & (0,2) \\
\vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \\
0 & 0 & 0 & \dots & -\lambda_1 - 3\mu & \lambda_1 & (2,3) \\
0 & 0 & 0 & \dots & 3\mu & -3\mu & (2,4)
\end{pmatrix}
\end{array}
$$

$$
\pi Q = 0
$$

$$
\pi = \left[\pi_{(0,0)}, \pi_{(0,1)}, \pi_{(0,2)}, \dots, \pi_{(2,3)}, \pi_{(2,4)}\right]
$$

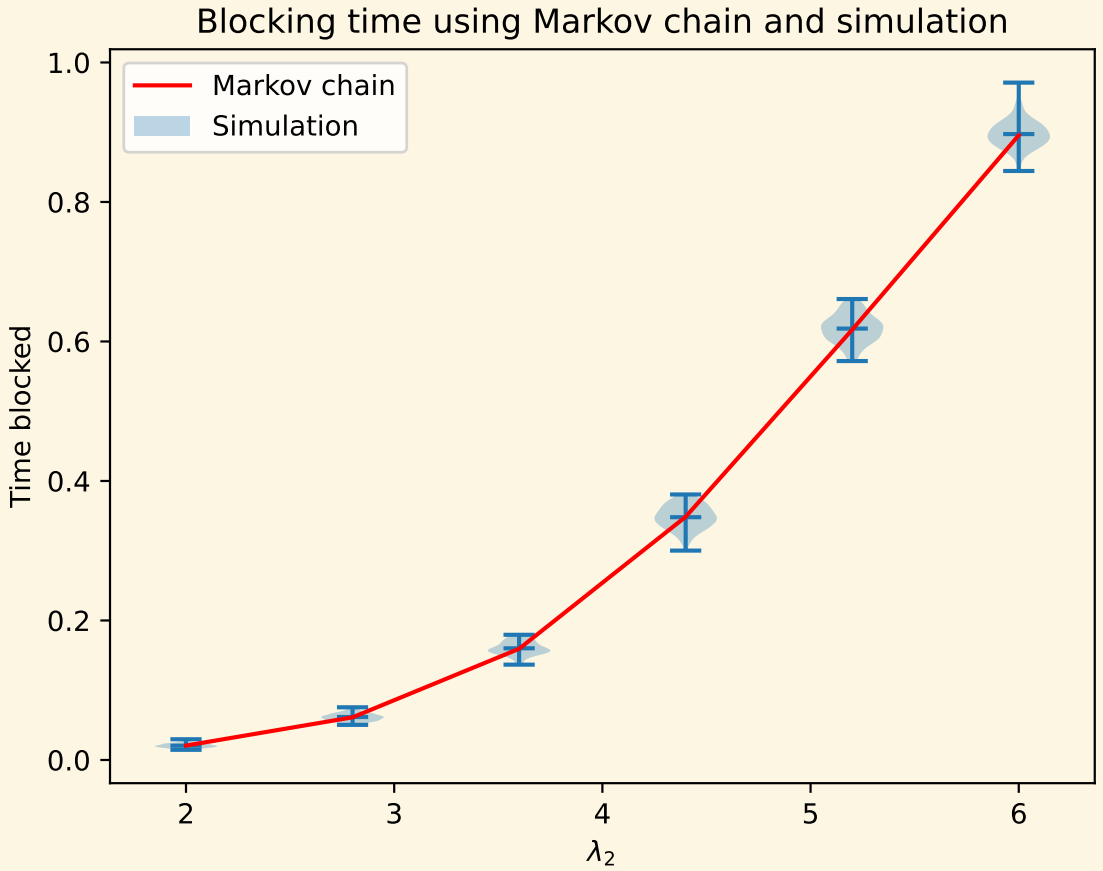
Performance Measures - Waiting time

$$W = \frac{\lambda_1 P_{L_1'}}{\lambda_2 P_{L_2'} + \lambda_1 P_{L_1'}} W^{(1)} + \frac{\lambda_2 P_{L_2'}}{\lambda_2 P_{L_2'} + \lambda_1 P_{L_1'}} W^{(2)} \qquad (1)$$



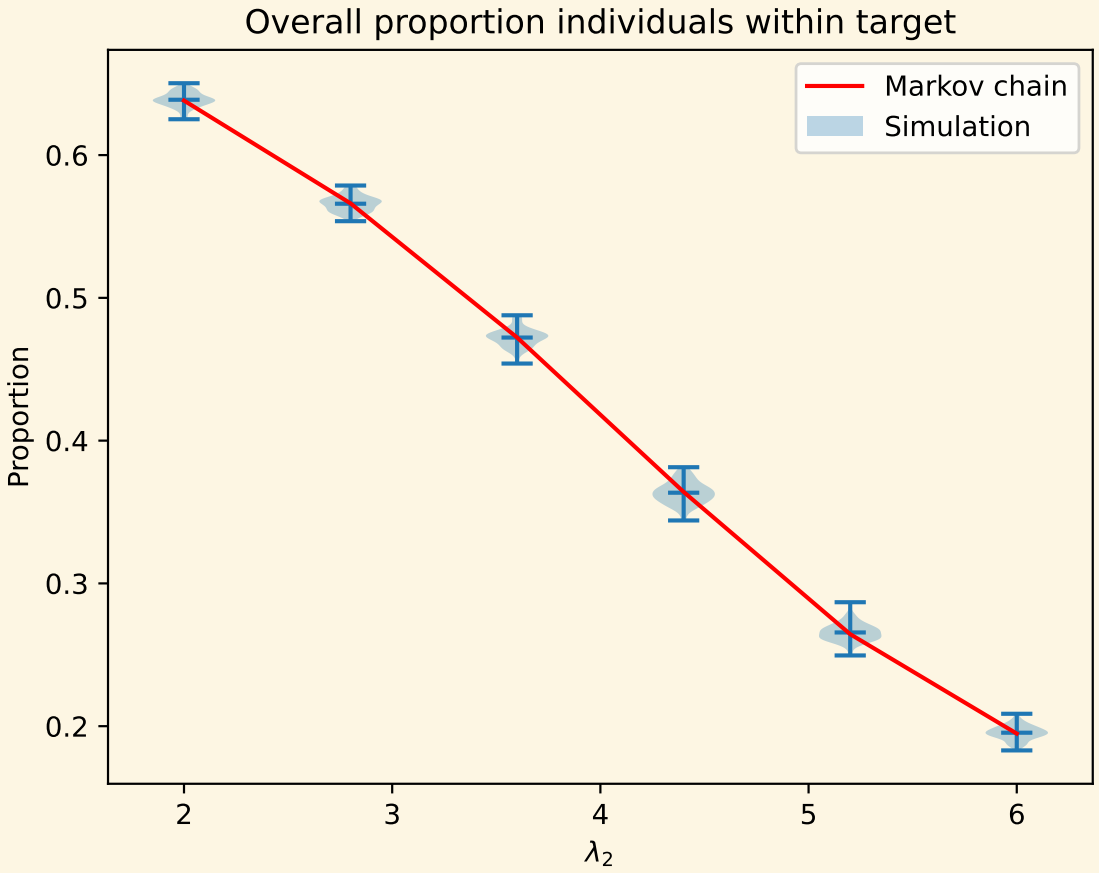
Performance Measures - Blocking time

$$B = \frac{\sum_{(u,v)\in S_A^{(2)}} \pi_{(u,v)}\ b(u,v)}{\sum_{(u,v)\in S_A^{(2)}} \pi_{(u,v)}} \tag{2}$$

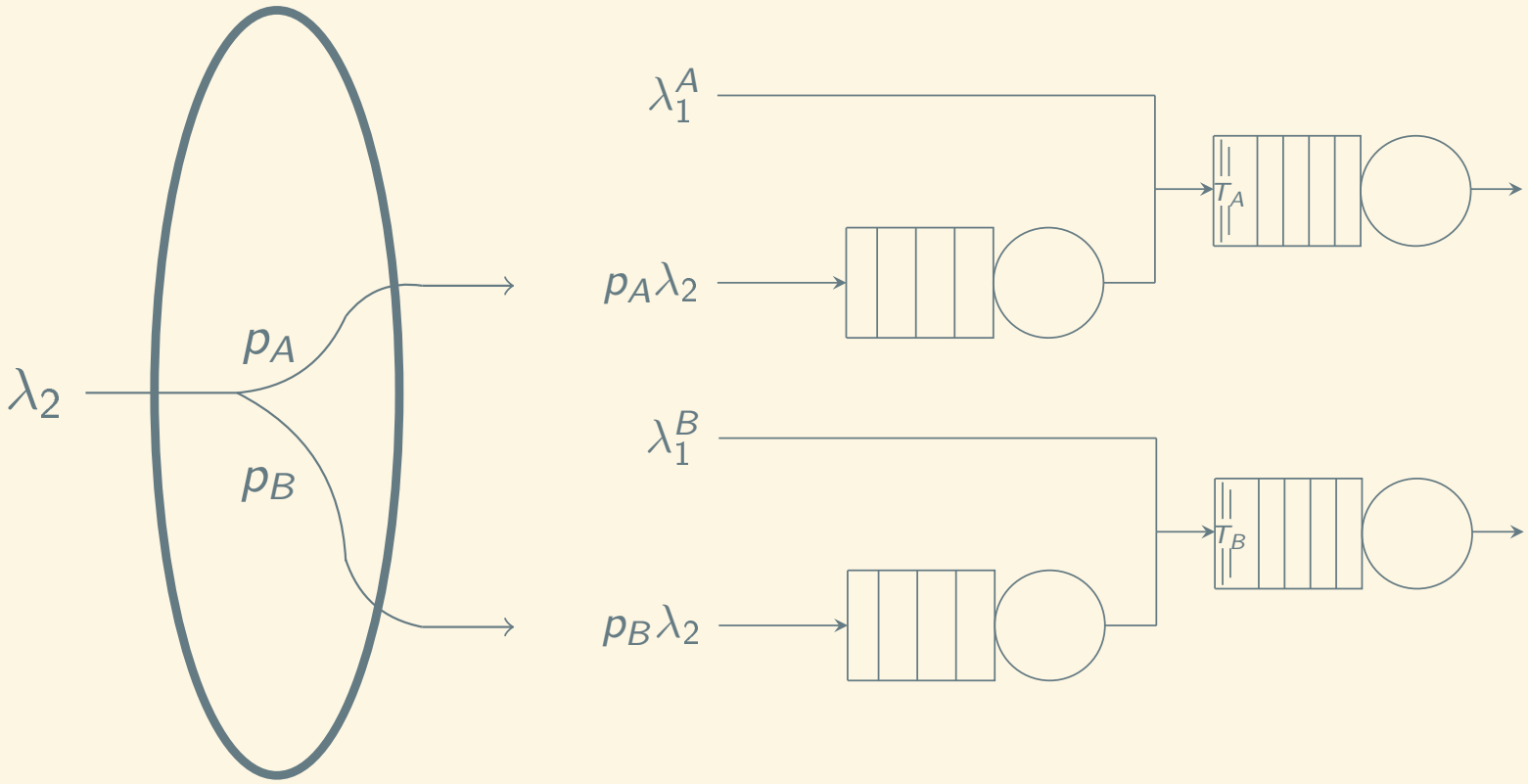


Performance Measures - Proportion within time

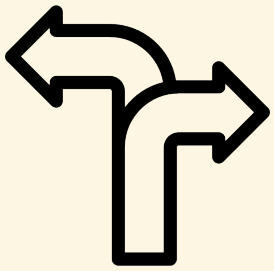
$$P(X < t) = \frac{\lambda_1 P_{L_1'}}{\lambda_2 P_{L_2'} + \lambda_1 P_{L_1'}} P(X^{(1)} < t) + \frac{\lambda_2 P_{L_2'}}{\lambda_2 P_{L_2'} + \lambda_1 P_{L_1'}} P(X^{(2)} < t) \tag{3}$$

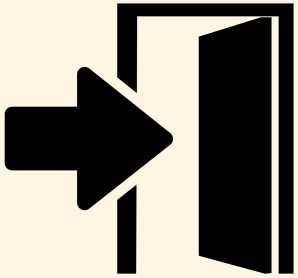


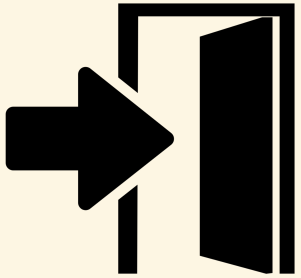
Game - Players



Game - Strategies







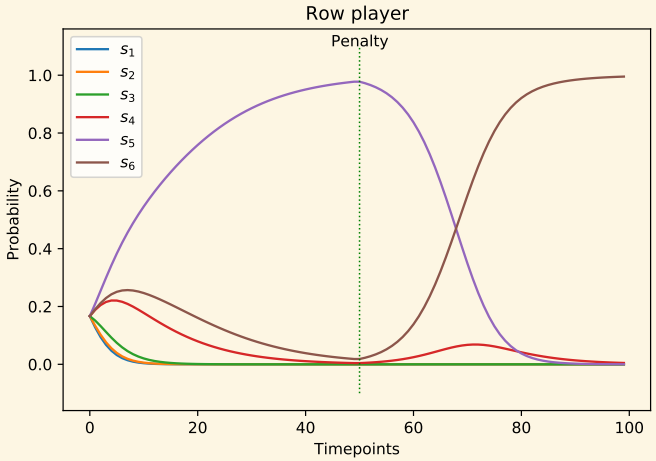
$p_A, p_B \in [0, 1]$

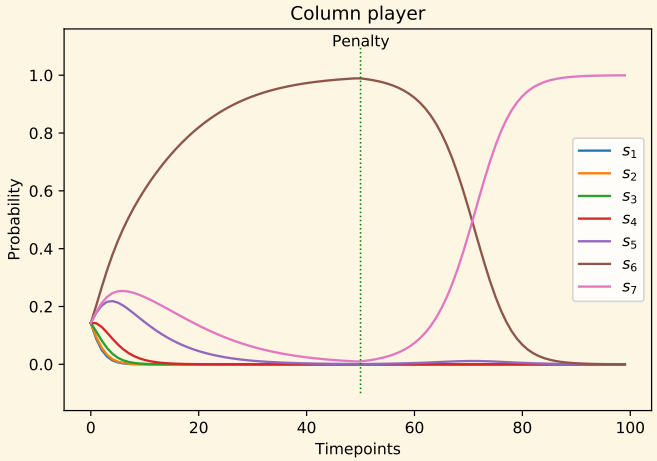
$T_A \in [1, N_A]$

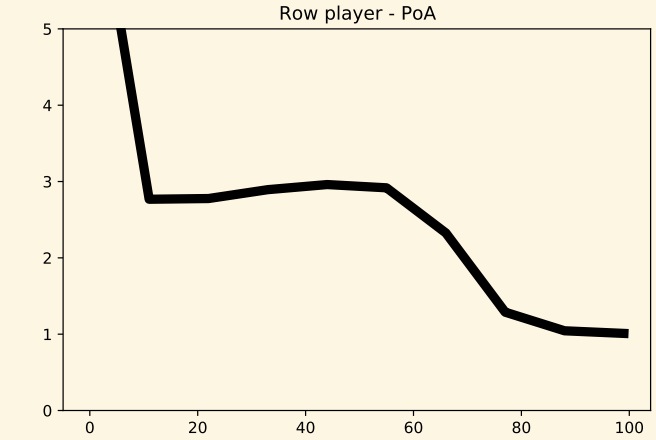
$T_B \in [1, N_B]$

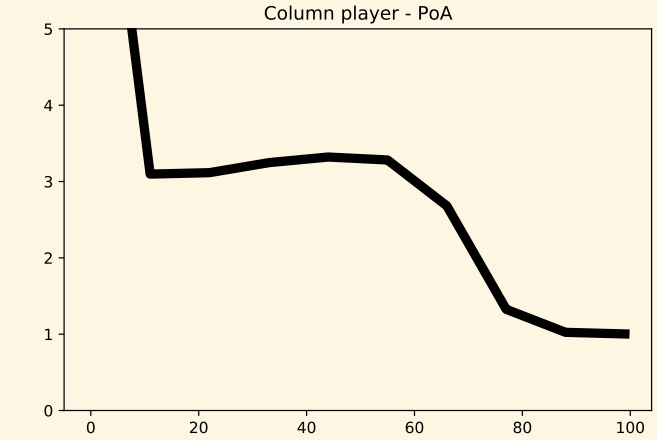
$p_A + p_B = 1$

Incentivised game









Future Plans

- Panayides, M., Harper, P., Knight, V. 2021. *A game theoretic model of the behavioural gaming that takes place at the ED-EMS interface.*
- Panayides, M., Harper, P., Knight, V. 2021. *On a queueing model with two waiting rooms*.