

A 3-player game theoretic model of a choice
between two queueing systems with strategic
managerial decision making

Queues - Examples

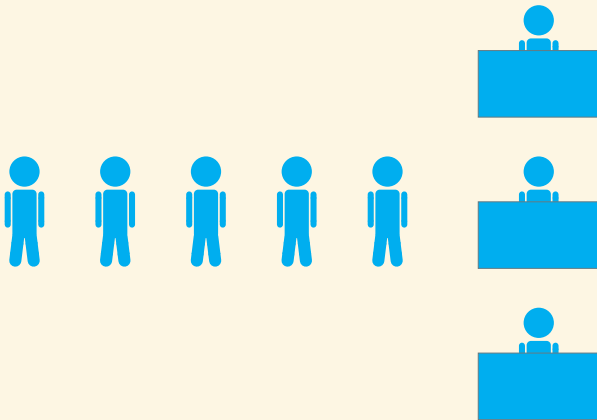


Queues - Examples

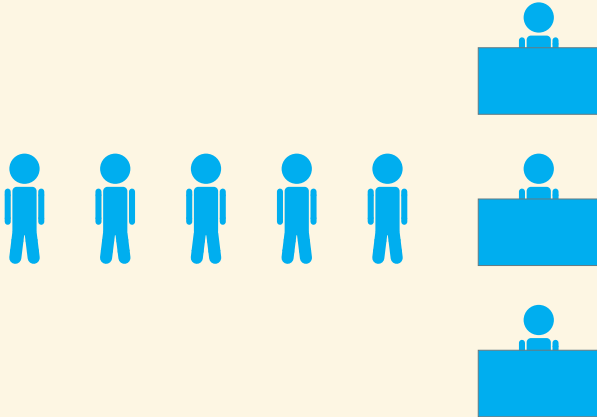


- ▶ Shone R, Knight VA, Williams JE. Comparisons between observable and unobservable M/M/1 queues with respect to optimal customer behaviour
- ▶ Kerner Y, Shmuel-Bittner O. Strategic behaviour and optimization in a hybrid M/M/1 queue with retrials.
- ▶ Gai Y, Liu H, Krishnamachari B. A packet dropping mechanism for efficient operation of M/M/1 queues with selfish users.

Queues - Examples



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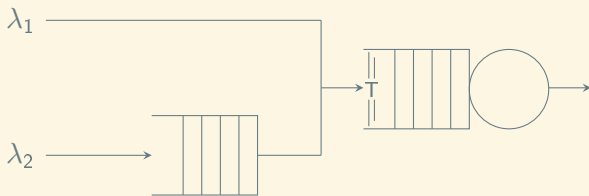


- ▶ Knight V, Harper P. The Impact of Choice on Public Services.
- ▶ Wang X, Song C, Zhuang J. Simulating a multi-stage screening network: A queueing theory and game theory application.

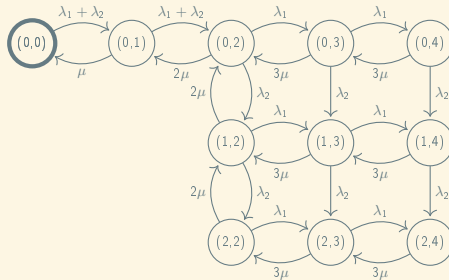
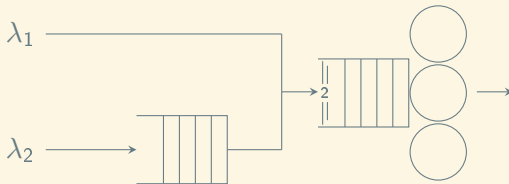
Queues - Examples



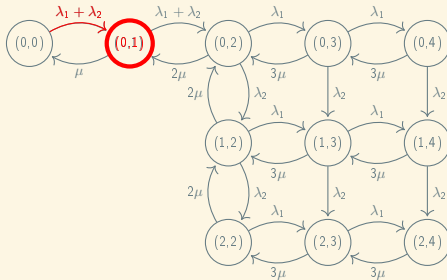
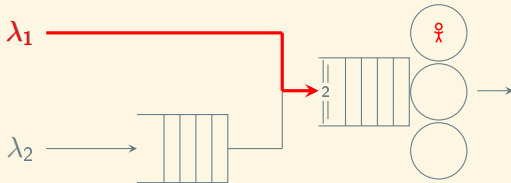
Queueing network structure



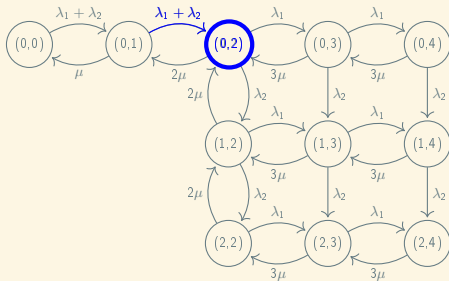
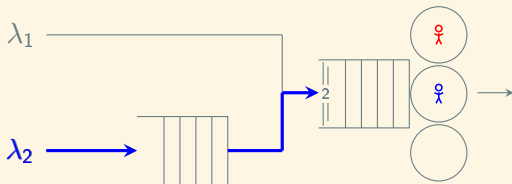
Markov Chain - Custom network



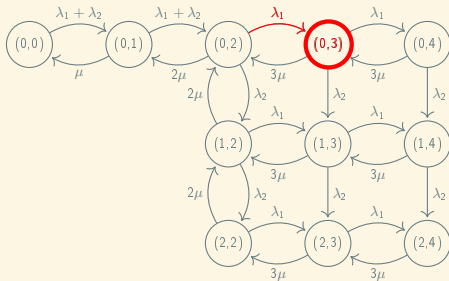
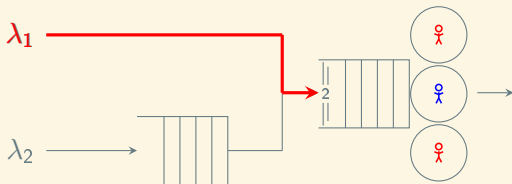
Markov Chain - Custom network



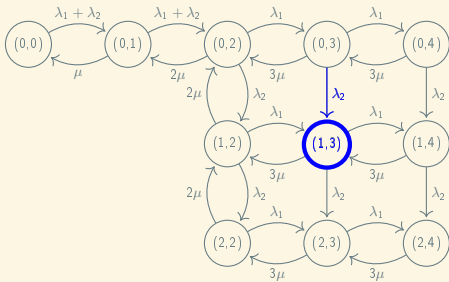
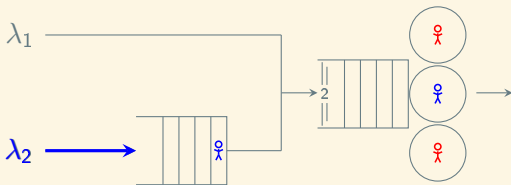
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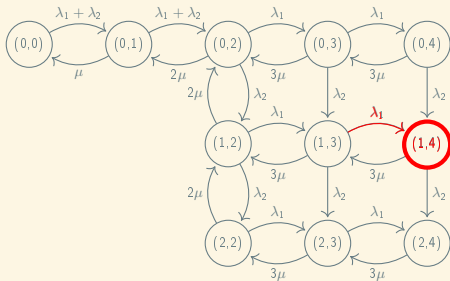
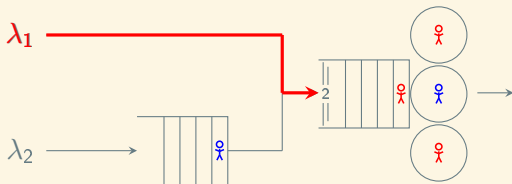
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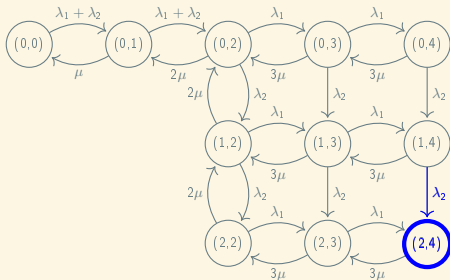
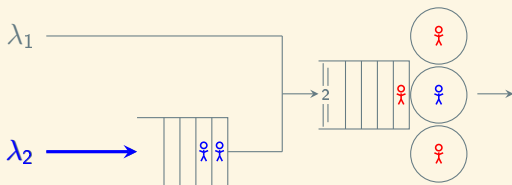
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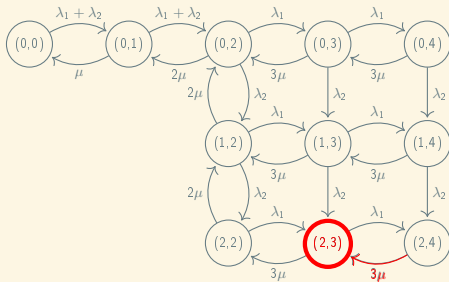
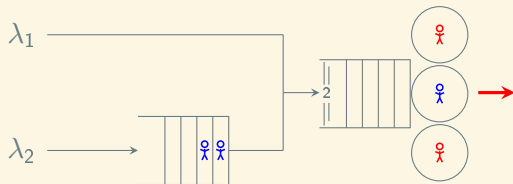
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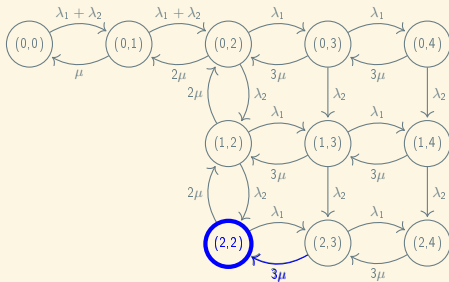
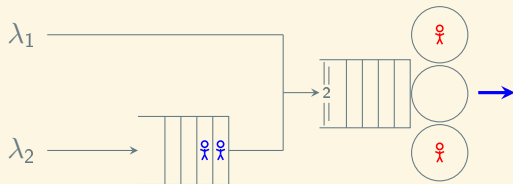
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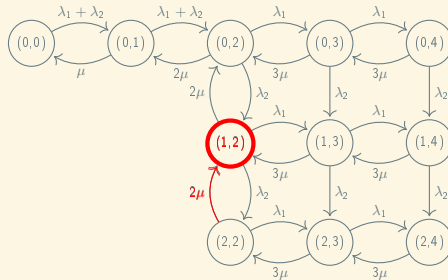
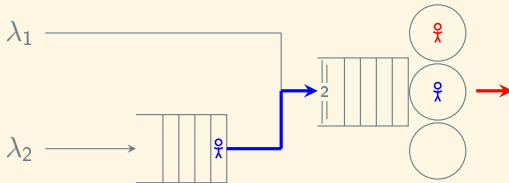
Markov Chain - Custom network



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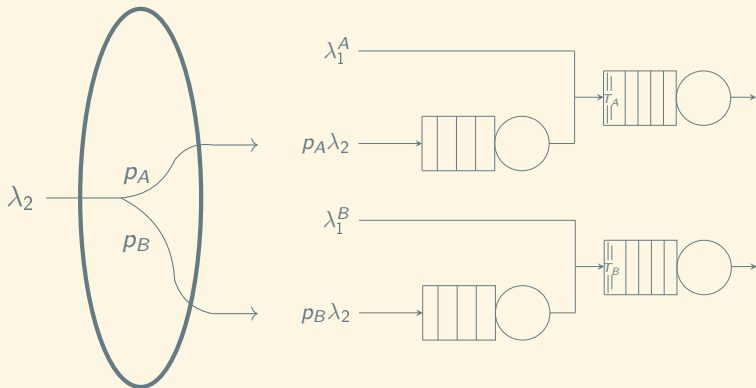
Markov Chain - Custom network



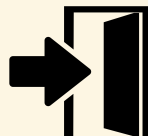
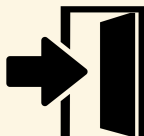
Game - Definition



Game - Players



Game - Strategies



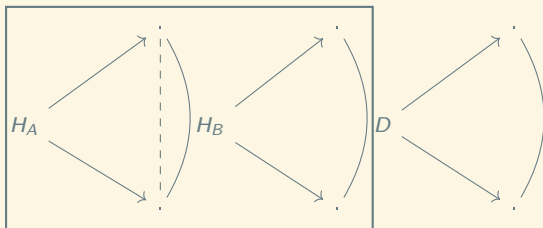
$$p_A, p_B \in [0, 1]$$

$$T_A \in [1, N_A]$$

$$T_B \in [1, N_B]$$

$$p_A + p_B = 1$$

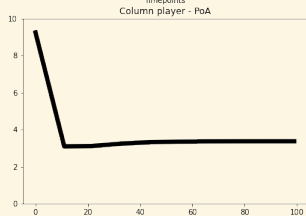
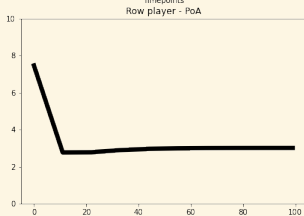
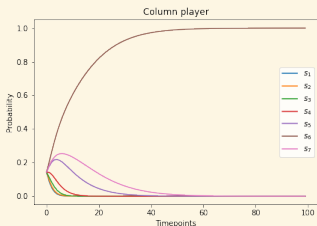
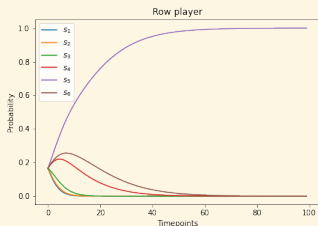
Game - Formulation



$$A = \begin{pmatrix} U_{1,1}^A & U_{1,2}^A & \cdots & U_{1,N_B}^A \\ U_{2,1}^A & U_{2,2}^A & \cdots & U_{2,N_B}^A \\ \vdots & \vdots & \ddots & \vdots \\ U_{N_A,1}^A & U_{N_A,2}^A & \cdots & U_{N_A,N_B}^A \end{pmatrix}, \quad B = \begin{pmatrix} U_{1,1}^B & U_{1,2}^B & \cdots & U_{1,N_B}^B \\ U_{2,1}^B & U_{2,2}^B & \cdots & U_{2,N_B}^B \\ \vdots & \vdots & \ddots & \vdots \\ U_{N_A,1}^B & U_{N_A,2}^B & \cdots & U_{N_A,N_B}^B \end{pmatrix}$$

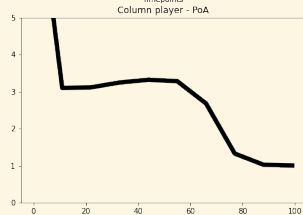
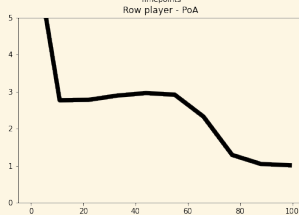
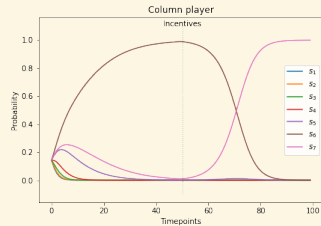
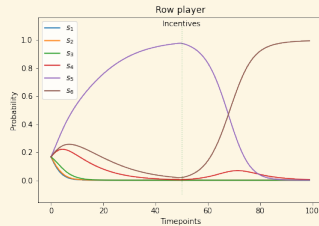
$$R = \begin{pmatrix} p_{1,1} & p_{1,2} & \cdots & p_{1,N_B} \\ p_{2,1} & p_{2,2} & \cdots & p_{2,N_B} \\ \vdots & \vdots & \ddots & \vdots \\ p_{N_A,1} & p_{N_A,2} & \cdots & p_{N_A,N_B} \end{pmatrix}$$

Learning algorithms - Asymmetric replicator dynamics



“Inefficiencies can be learned
and emerged naturally in an
interactive system”

Learning algorithms - Asymmetric replicator dynamics



“Targeted incentivisation of behaviours can help escape learned inefficiencies”

Ethnography?

Future model