Annual Review

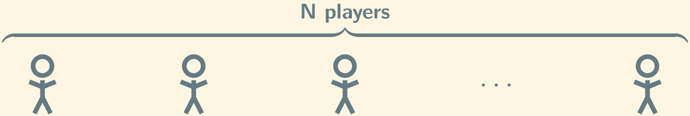
Michalis Panayides

2020-06-10

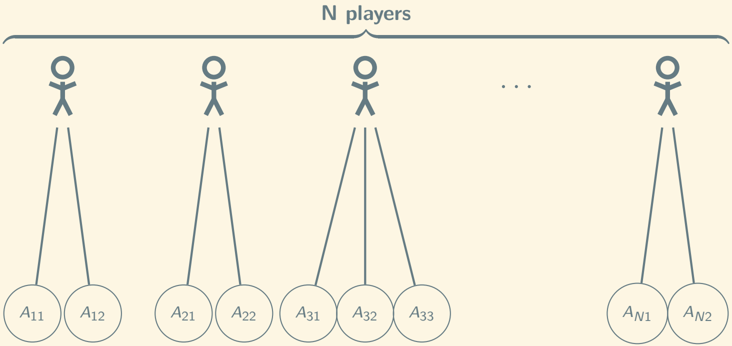
Game Theory - Syllabus

- Normal Form Games
- Mixed-Strategy Nash Equilibrium
- Alternate Solution Concepts
- Extensive-Form Games
- Repeated Games (TBC)
- Bayesian Games (TBC)
- Coalitional Games (TBC)

Normal Form Games



Normal Form Games



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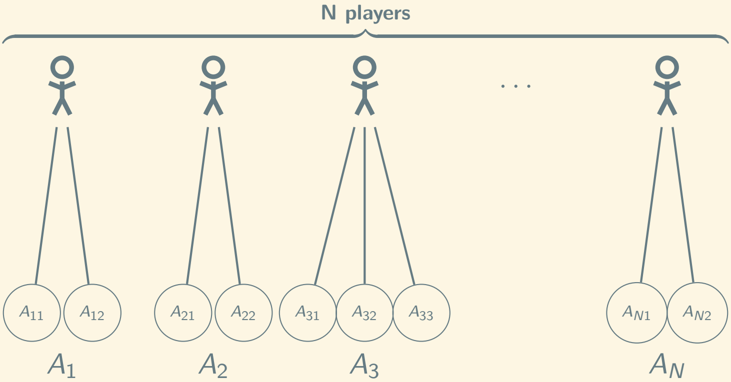
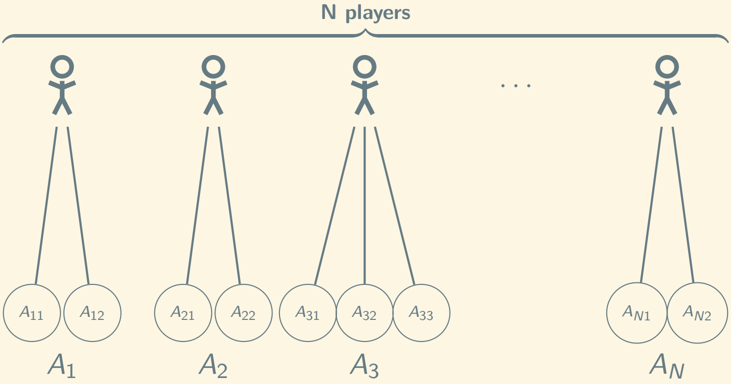


Normal Form Games



$$u_i = A_1 \times A_2 \times A_3 \times \cdots \times A_N \to \mathbb{R}$$

Rock-Paper-Scissors

$$\begin{array}{cc} & \begin{array}{ccc} ✊ & ✌ & ✋ \end{array} \\ \begin{array}{c} ✊ \\ ✌ \\ ✋ \end{array} & \begin{bmatrix} (0,0) & (1,-1) & (-1,1) \\ (-1,1) & (0,0) & (1,-1) \\ (1,-1) & (-1,1) & (0,0) \end{bmatrix} \end{array}$$

Nash Equilibrium

$$\begin{array}{cc} & \begin{array}{cc} \mathsf{C} & \mathsf{D} \end{array} \\ \begin{array}{c} \mathsf{C} \\ \mathsf{D} \end{array} & \begin{bmatrix} (3,3) & (0,5) \\ (5,0) & (1,1) \end{bmatrix} \end{array}$$

Nash Equilibrium

$$\begin{array}{c} \text{C} \longrightarrow \\ \text{D} \longrightarrow \end{array} \begin{bmatrix} (3, -) & (0, -) \\ (\underline{5}, -) & (\underline{1}, -) \end{bmatrix}$$

Nash Equilibrium

$$\begin{array}{c}
\begin{array}{cc} \quad\text{C} & \qquad\text{D} \\ \quad\downarrow & \qquad\downarrow \end{array} \\
\begin{bmatrix} (-, 3) & (-, \underline{5}) \\ (-, 0) & (-, \underline{1}) \end{bmatrix}
\end{array}$$

Nash Equilibrium

$$\begin{array}{cc} & \begin{matrix} & D \end{matrix} \\ \begin{matrix} \\ D \end{matrix} & \begin{bmatrix} (3,3) & (0,\underline{5}) \\ (\underline{5},0) & (\underline{1},\underline{1}) \end{bmatrix} \end{array}$$

Pareto Optimality

$$\begin{bmatrix} (3,3) & (0,5) \\ (5,0) & (1,1) \end{bmatrix}$$

$$\overbrace{(3,3),\ (0,5),\ (5,0),\ (1,1)}$$

Pareto Optimality

$$\begin{bmatrix} (3,3) & (0,5) \\ (5,0) & (1,1) \end{bmatrix}$$

$$\overbrace{(3,3),\ (0,5),\ (5,0),\ (1,1)}$$

$$(\underline{3},\underline{3}) > (1,1)$$

Computing the Nash Equilibria

- Lemke-Howson Algorithm
- Support Enumeration
- Iterative removal of strictly dominated strategies

Iterative Removal of Strictly Dominated Strategies

$P1 \setminus P2$	L	C	R
U	$(3,0)$	$(2,1)$	$(0,0)$
M	$(1,1)$	$(1,1)$	$(5,0)$
D	$(0,1)$	$(4,2)$	$(0,1)$

Iterative Removal of Strictly Dominated Strategies

$P1 \setminus P2$	L	C	R
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Iterative Removal of Strictly Dominated Strategies

$P1 \setminus P2$	L	C
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Iterative Removal of Strictly Dominated Strategies

$P1 \setminus P2$	L	C
U	$(3, 0)$	$(2, \underline{1})$
D	$(0, 1)$	$(4, \underline{2})$

Iterative Removal of Strictly Dominated Strategies

$P1 \setminus P2$	C
U	$(2, 1)$
D	$(4, 2)$

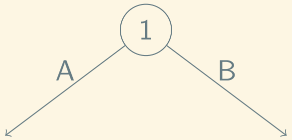
Iterative Removal of Strictly Dominated Strategies

$P1 \setminus P2$	C
U	$(2, 1)$
D	$(\underline{4}, 2)$

Iterative Removal of Strictly Dominated Strategies

$P1 \setminus P2$	C
D	$(4, 2)$

Perfect Information Extensive Form Games



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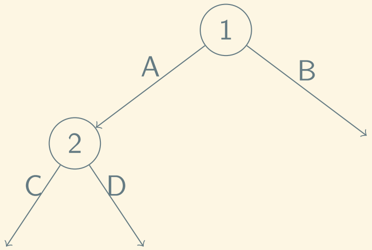

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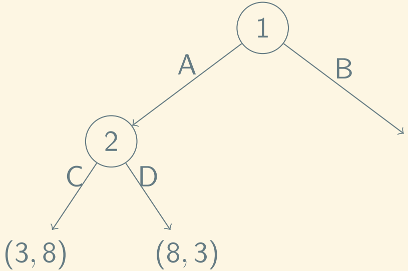

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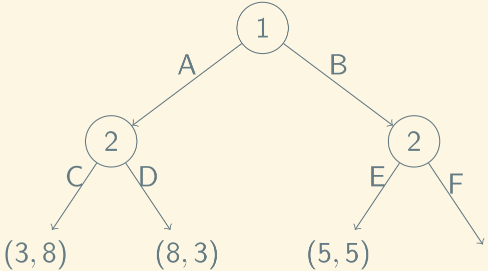

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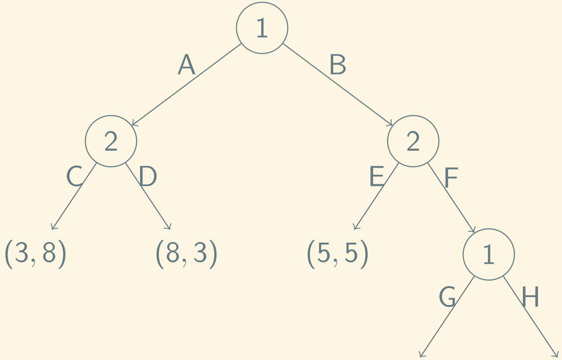

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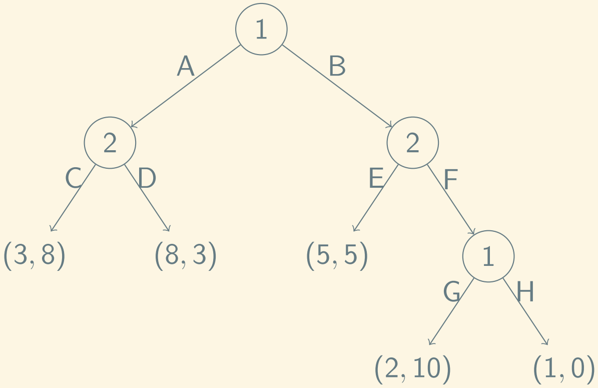
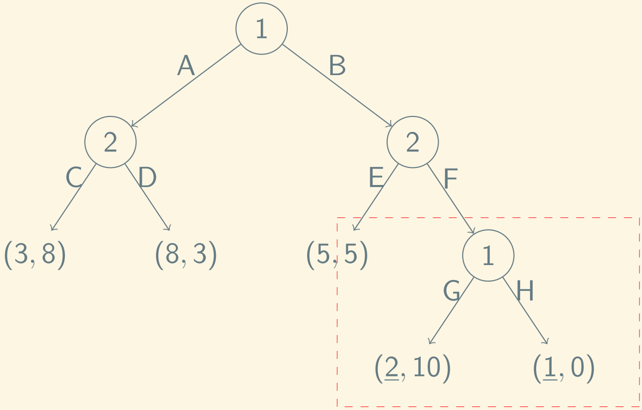


Backwards Induction



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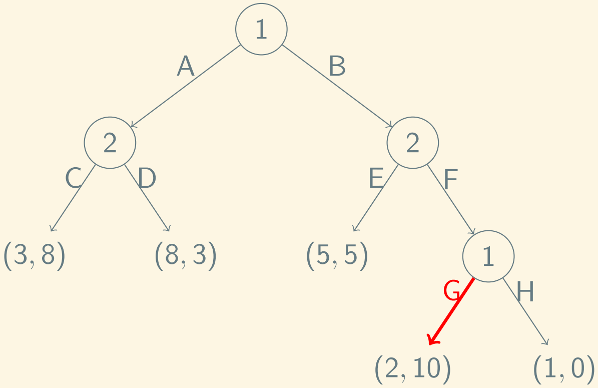

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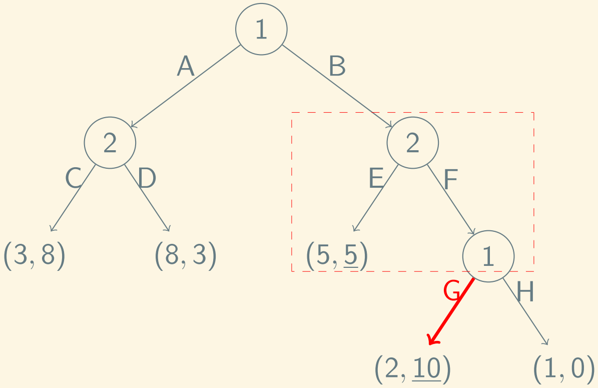

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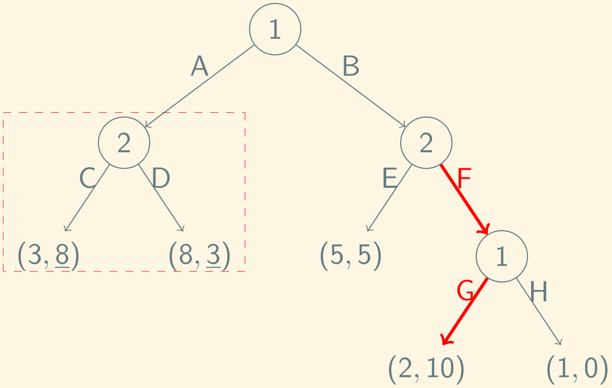

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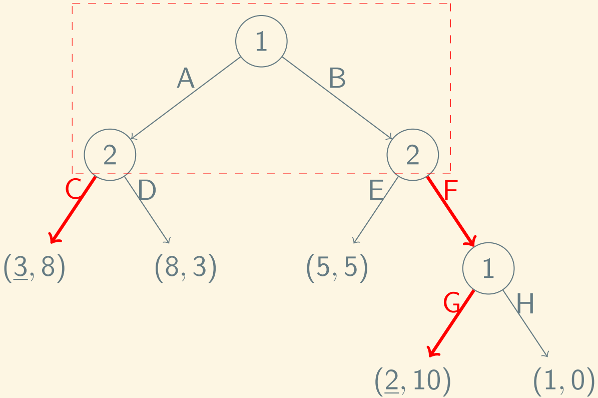

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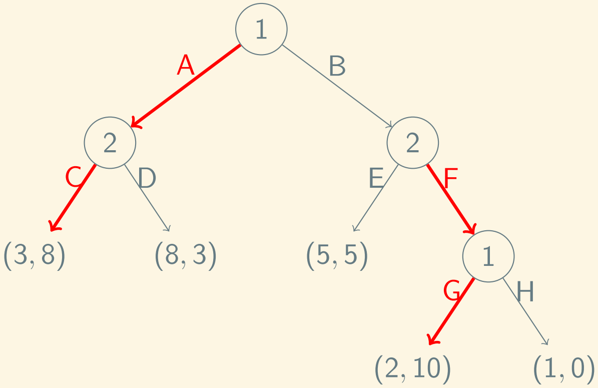

Imperfect Information Extensive-form Games

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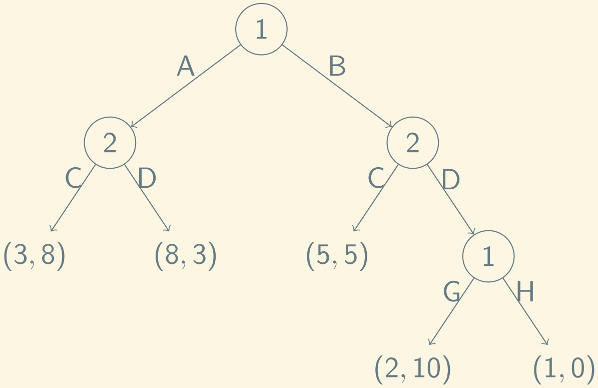
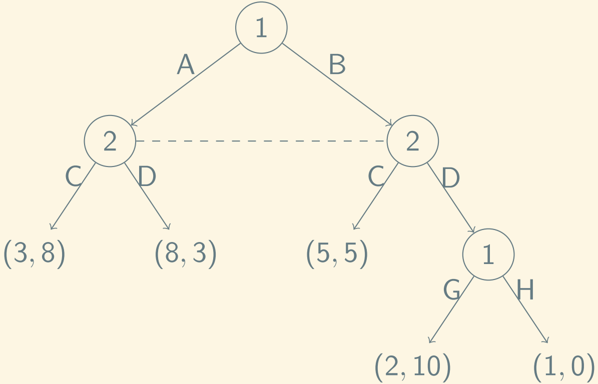
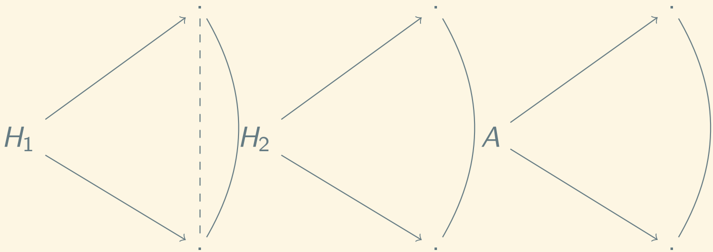


Imperfect Information Extensive-form Games



PhD - Motivation



PhD - Motivation

NHS Wales: A&E record low performance as ambulance service struggles

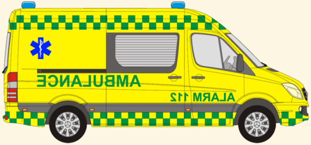
By Owain Clarke
BBC Wales health correspondent

19 December 2019

Share

Ambulances outside Morriston Hospital in Swansa this week

PhD - Motivation



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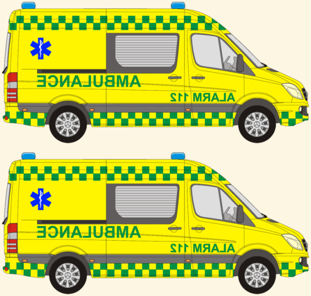

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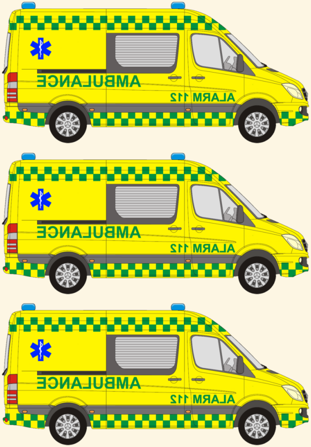
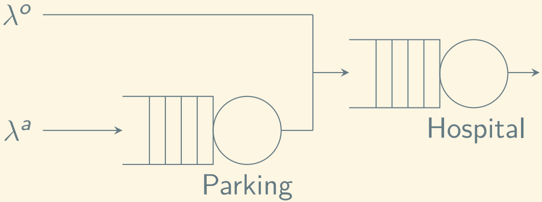
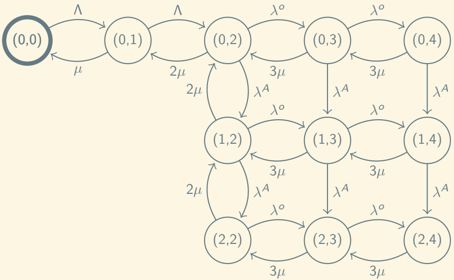


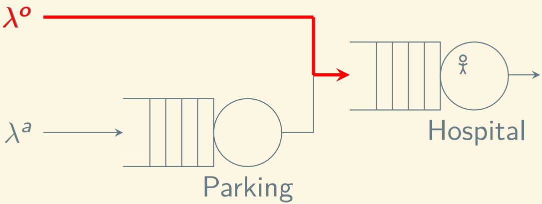
Hospital Formulation

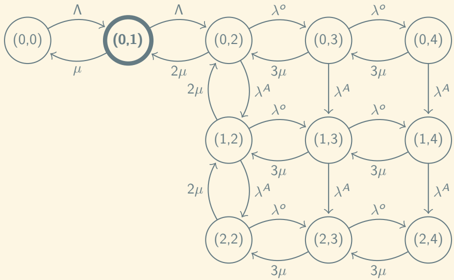




C=3, T=2, N=4, M=2

Hospital Formulation





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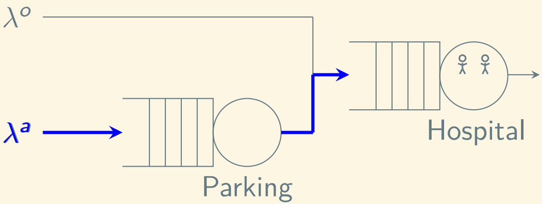

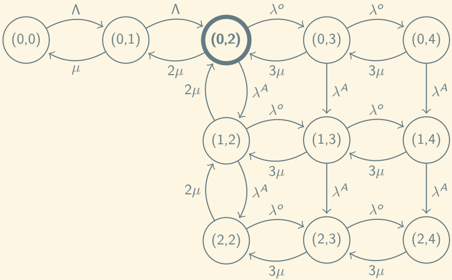

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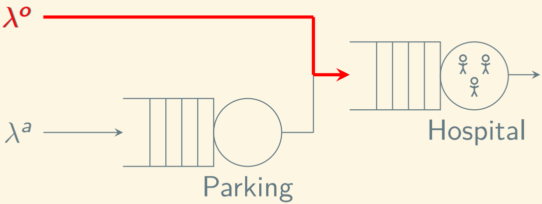

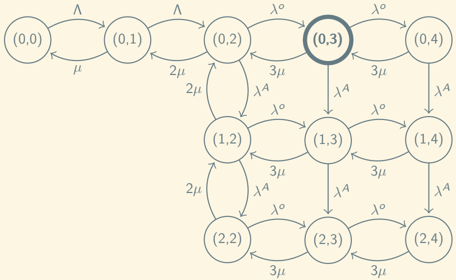

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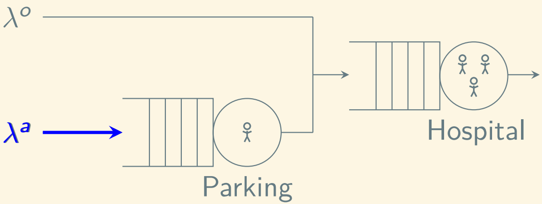

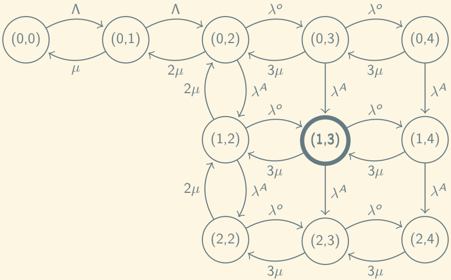

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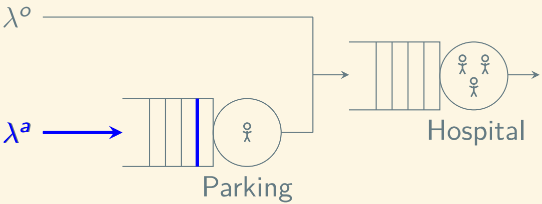

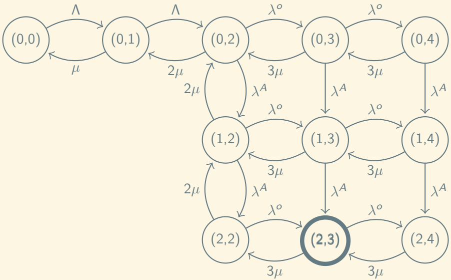

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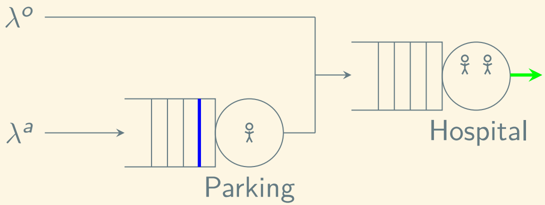

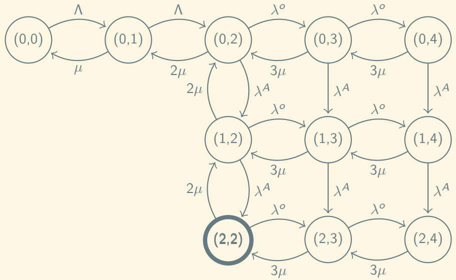

C=3, T=2, N=4, M=2

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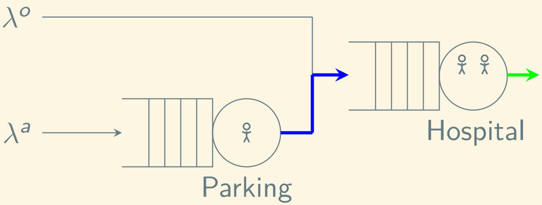

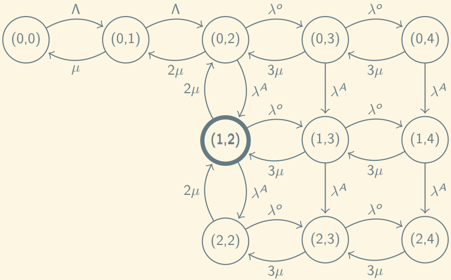

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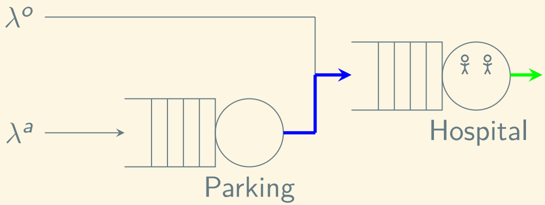

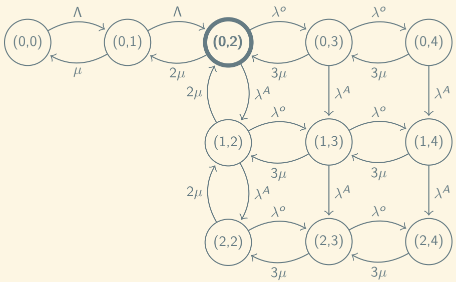

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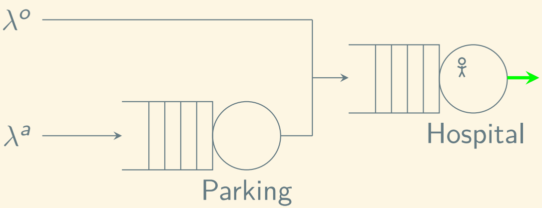

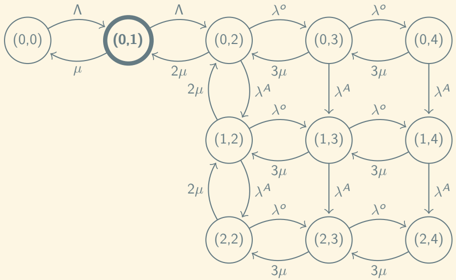

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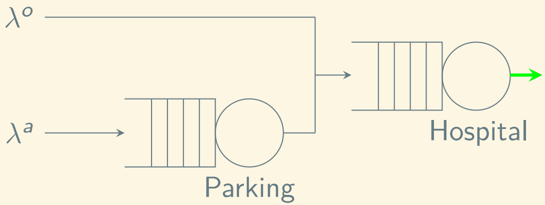
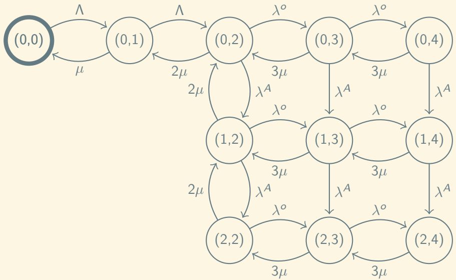




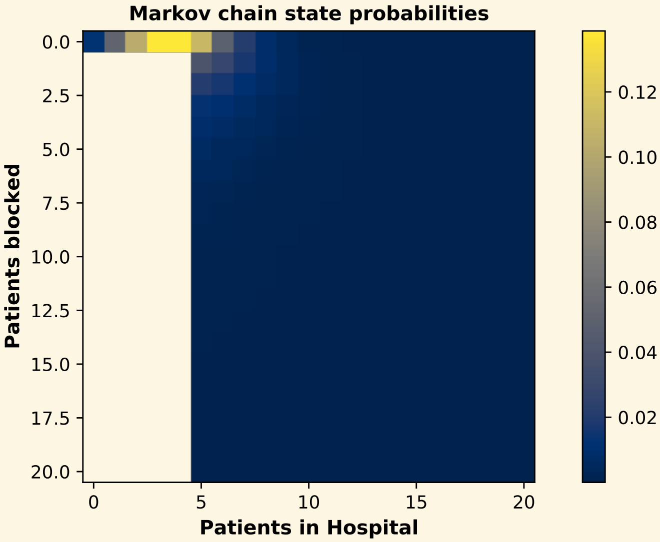
C=3, T=2, N=4, M=2

State Probabilities

$$\pi Q = 0$$

$$\sum_i \pi_i = 1$$

State Probabilities

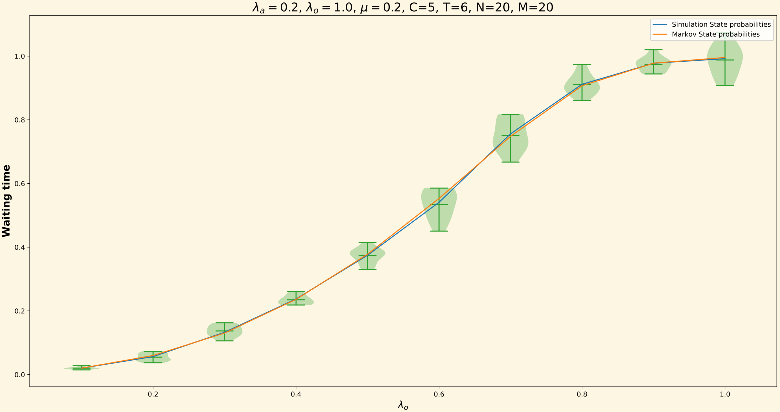


Waiting Times

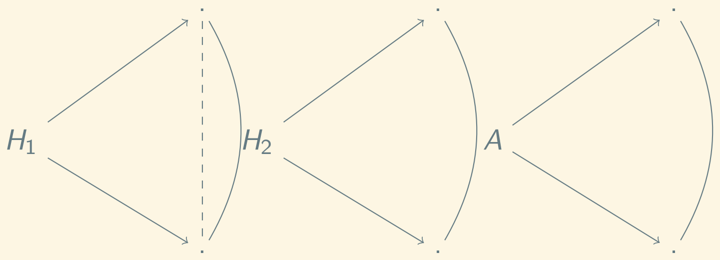
$$W = \frac{\sum_{(u,v)\in S_A} w(u,v)\pi_{(u,v)}}{\sum_{(u,v)\in S_A} \pi_{(u,v)}}$$

$$W = \frac{\lambda_o P(L'_o)}{\lambda_a P(L'_a) + \lambda_o P(L'_o)} W^{(o)} + \frac{\lambda_a P(L'_a)}{\lambda_a P(L'_a) + \lambda_o P(L'_o)} W^{(a)}$$

Waiting Times



Future Plans



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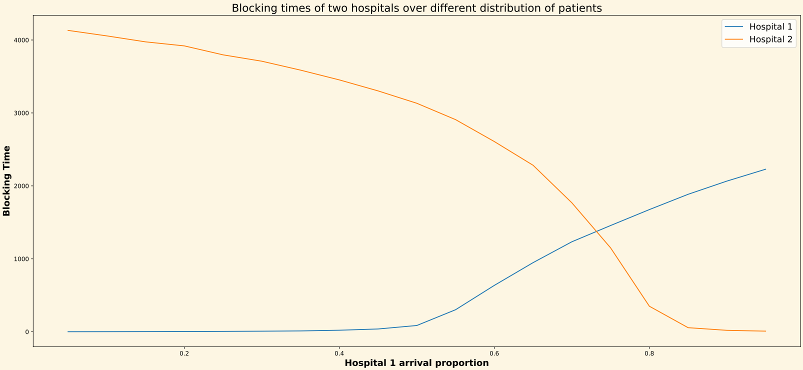

Future Plans

- Panayides, M., Knight, V. and Harper, P., 2020. *On a queueing model with two waiting rooms*.
- Panayides, M., Knight, V. and Harper, P., 2020. *A game theoretic model of the ED-EMS interface.*