

Queueing networks, deadlock & healthcare

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IMA and OR Society Conference on Mathematics of
Operational Research



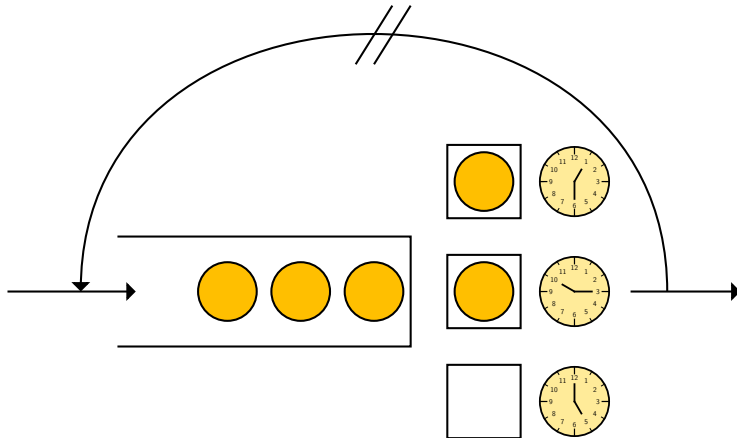
Open Source Python Library Discrete Event Simulation



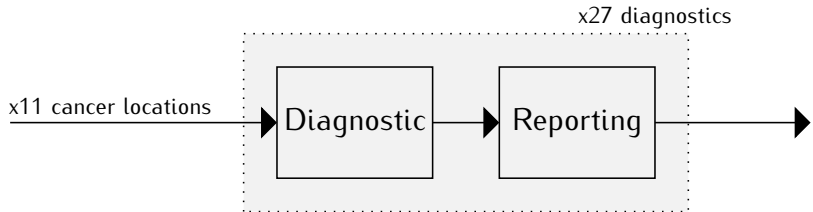
<https://github.com/CiwPython/Ciw>
<https://pypi.python.org/pypi/Ciw>
<http://ciw.readthedocs.io>

- Modelling an ophthalmology clinic
- Modelling cancer diagnostic pathways
- Investigating deadlock
- Evaluating Newport Stay Well Plans

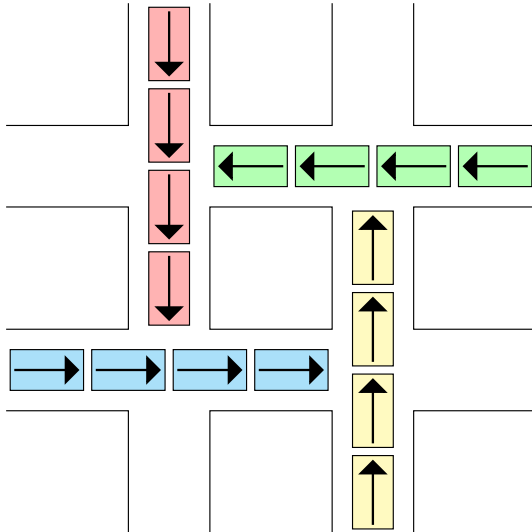
Modelling an ophthalmology clinic

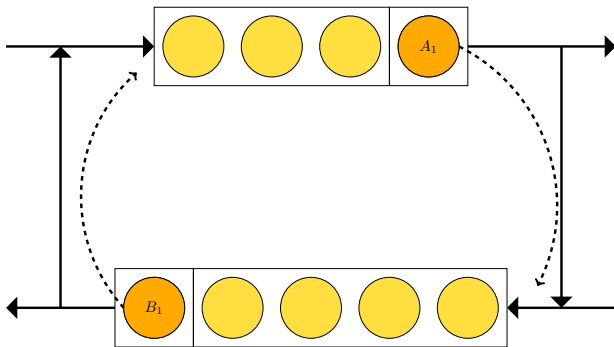


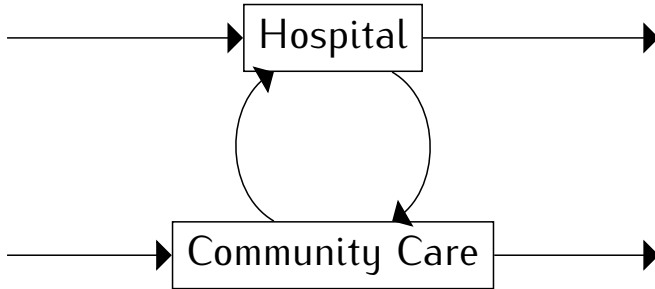
Modelling cancer diagnostic pathways



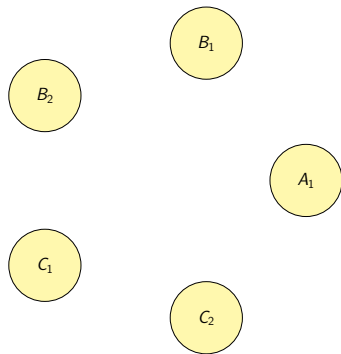
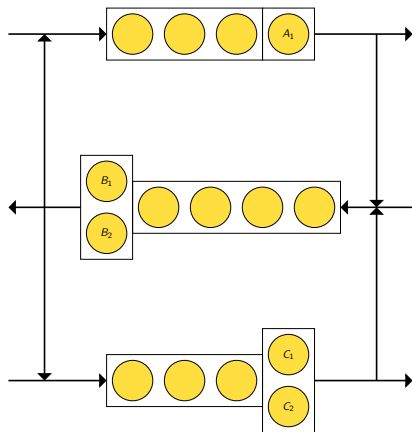
Investigating deadlock

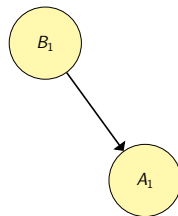
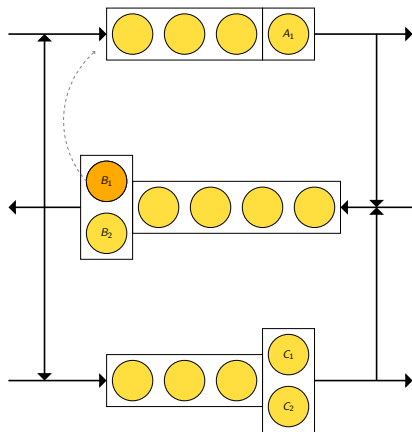


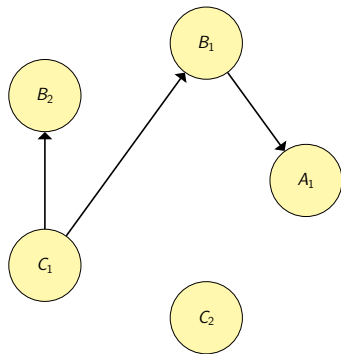
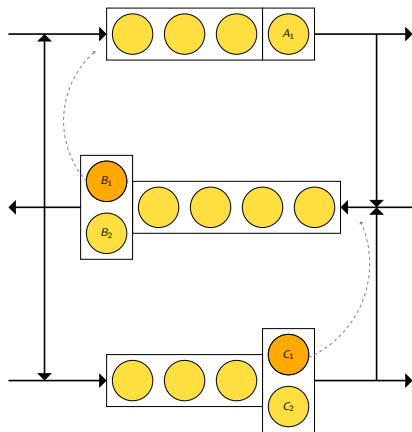


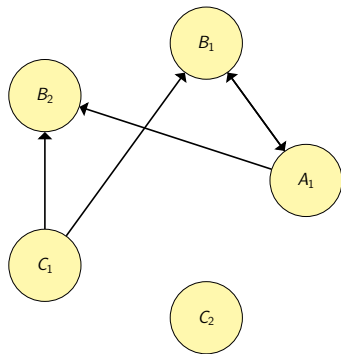
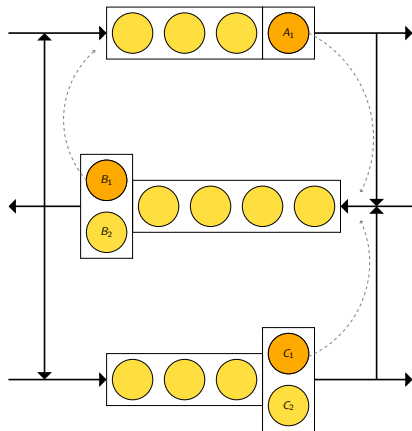


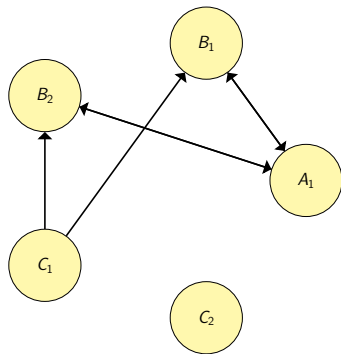
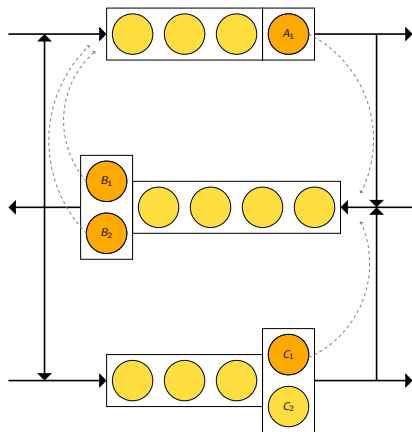
Osorio, C. & Bierlaire, M. *An analytic finite capacity queueing network model capturing the propagation of congestion and blocking*. European journal of operational research, 196(3):996–1007, 2009.

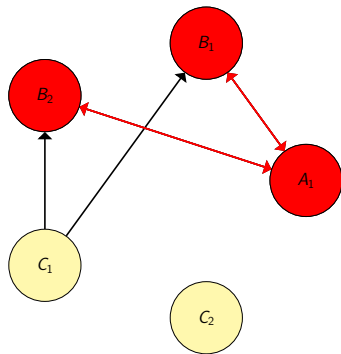
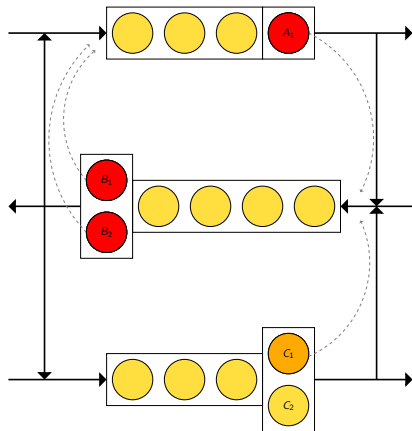












Theorem

A deadlocked state arises at time t if and only if $D(t)$ contains a knot.

Theorem

For queueing networks:

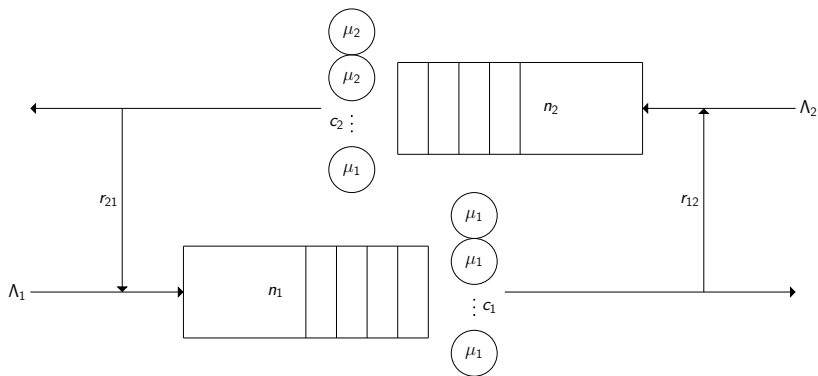
- 1. with one node*
- 2. with two nodes, each with two or fewer parallel servers*
- 3. with a finite amount of nodes, each with a single-server*

a deadlocked state arises if and only if there exists in $D(t)$ a weakly connected component without a sink node.

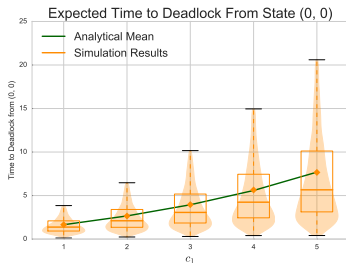
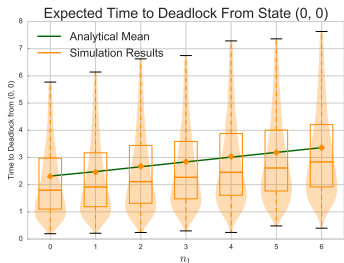
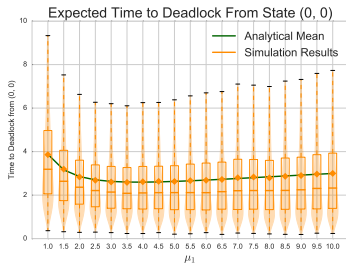
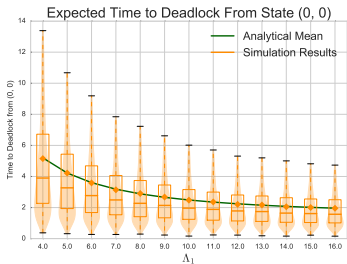
```
import ciw

N = ciw.create_network(
    Arrival_distributions=[['Exponential', 6.0]],
    Service_distributions=[['Exponential', 3.0]],
    Transition_matrices=[[0.5]],
    Number_of_servers=[3],
    Queue_capacities=[2]
)

ciw.seed(1)
Q = ciw.Simulation(N, deadlock_detector='StateDigraph')
Q.simulate_until_deadlock()
Q.times_to_deadlock
```

Times to Deadlock



Evaluating Newport Stay Well Plans

- Risk stratification
- Personal Stay Well Plans - low and no cost services
- Pro-active patient centred coordinated care
- As well and as independent as possible

