Open-Source Simulation with Ciw

"Modelling Deadlock in Queueing Systems"

Dr Geraint Palmer
Supervisors: Prof Paul Harper & Dr Vince Knight
www.geraintianpalmer.org.uk
@GeraintPalmer

Beale Lecture, February 2021

Reproducibility

- Automate!
- Readability
- Access
- Collaboration
- Testing
- Version control

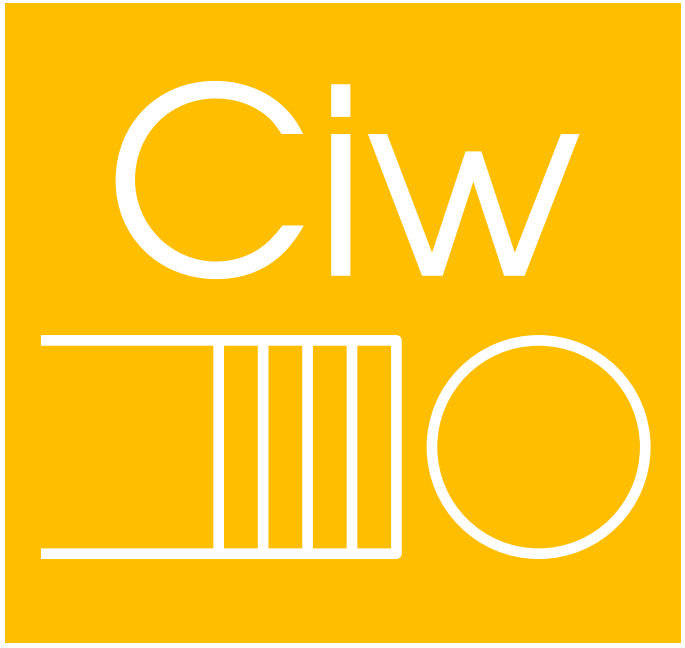
Readable

Modular

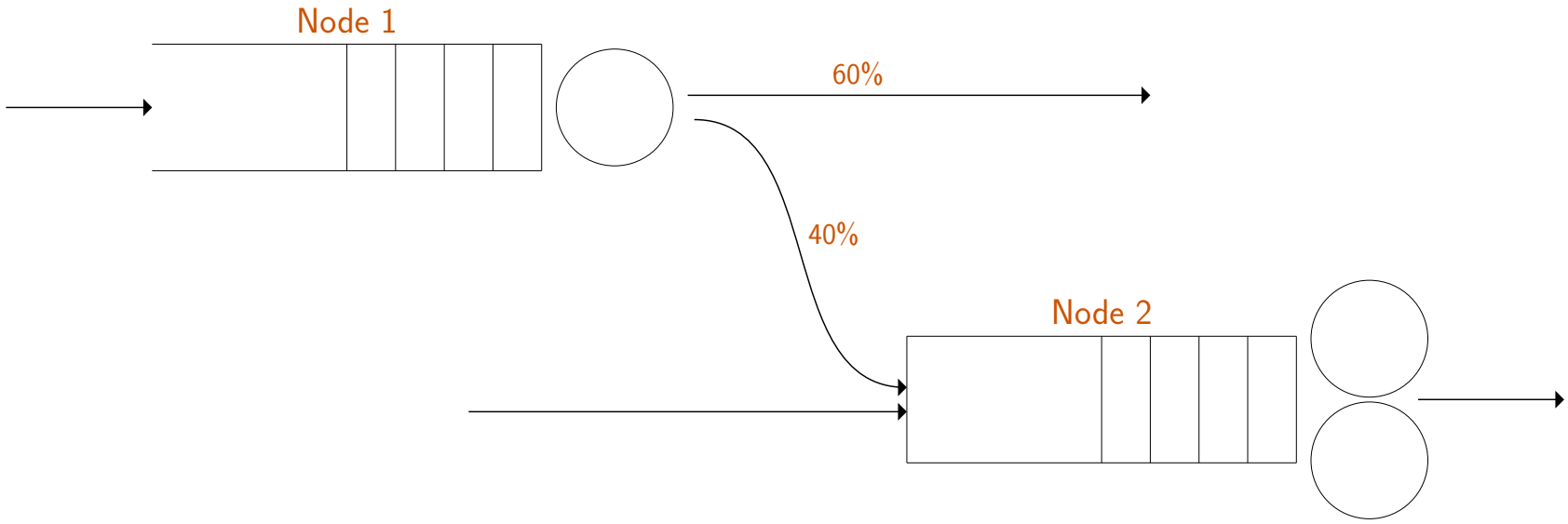
Extendible

• 2018. *Benureau, FCY., ac Rougier, NP.*. **Re-run, Repeat, Reproduce, Reuse, Replicate: Transforming Code into Scientific Contributions**. Frontiers in neuroinformatics.
• 2013. *Sandve, GK., et al.*, **Ten simple rules for reproducible computational research**. PLoS Comput Biol 9(10)
• 2014. *Wilson, G., et al.*, **Best practices for scientific computing**. PLoS Biol 21(1)
• 2001. *Kilgore, RA.*. **Open source simulation modeling language (sml)**. In Proceedings of the 33nd conference on Winter simulation (pp. 607–613).

https://ciw.readthedocs.io/
https://github.com/CiwPython/Ciw
`pip install ciw`

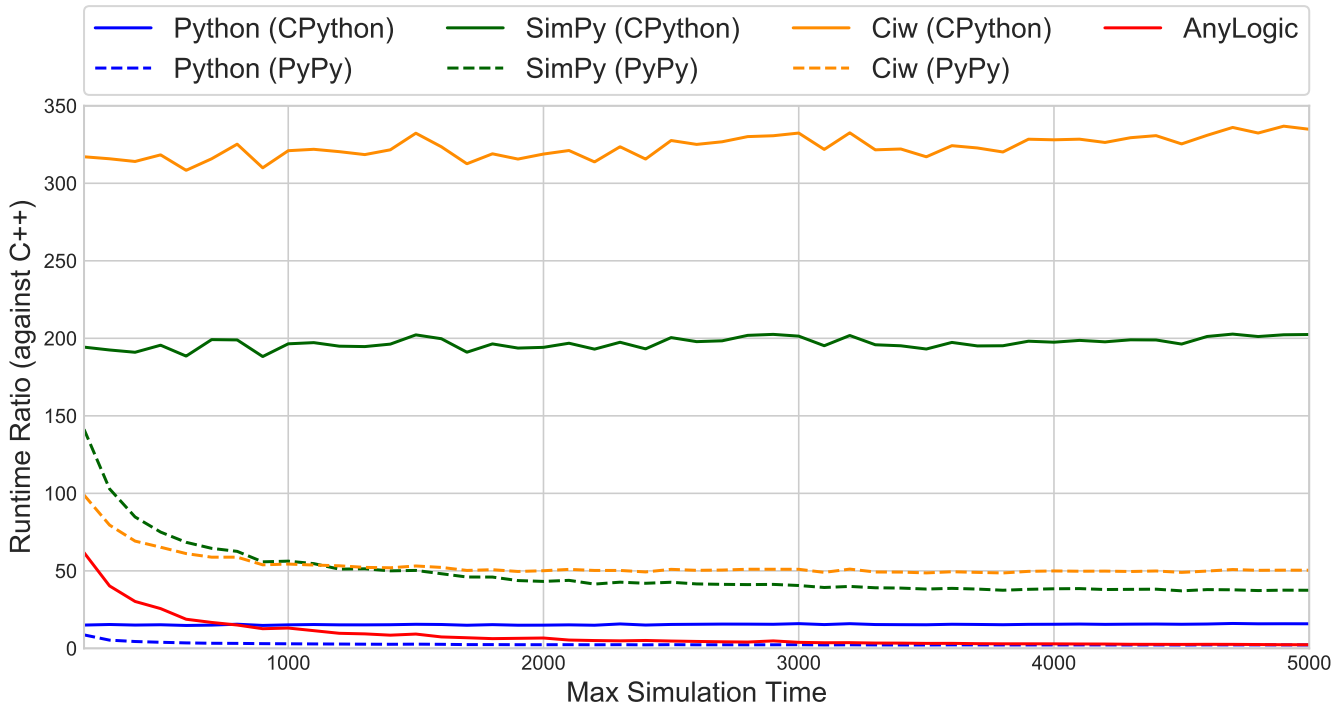


2019. *Palmer, GI., Knight, VA., Harper, PR., and Hawa, AL.*. **Ciw: An Open Source Discrete Event Simulation Library**. Journal of Simulation 13(1) (pp. 68-82).

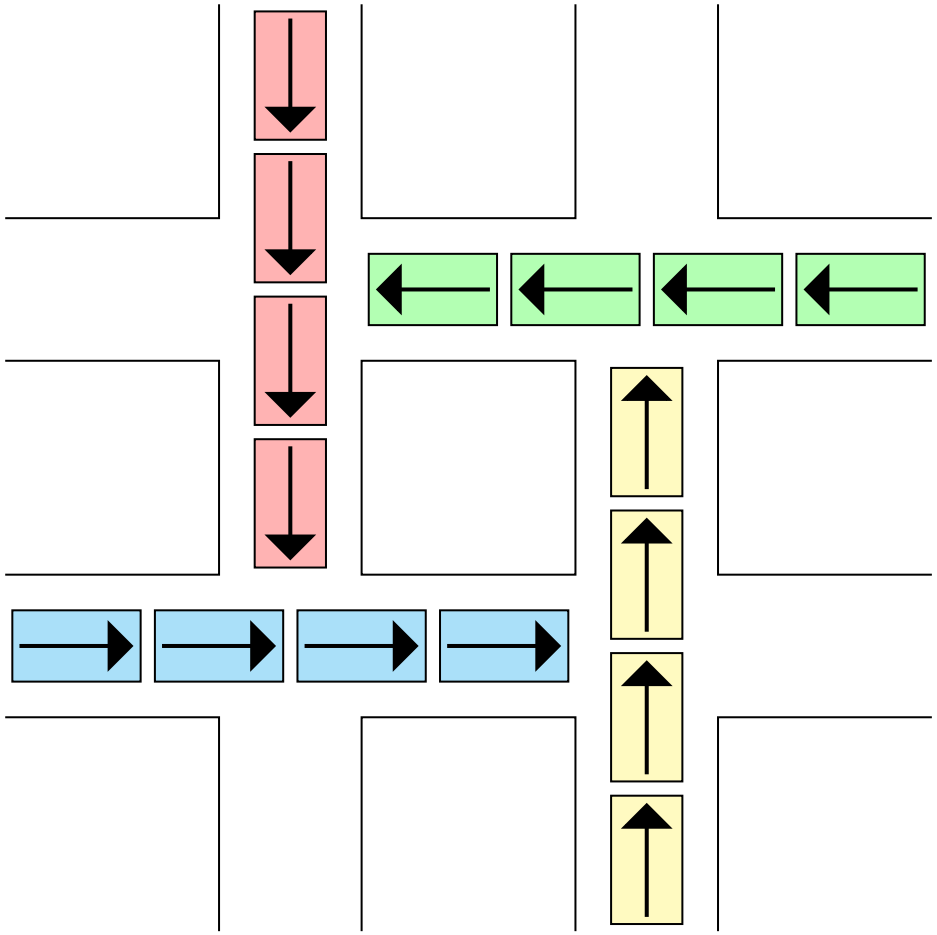


Node 1
External arrivals: Expon(4)
Services: Uniform(0.1, 0.3)
Number servers: 1
Queueing capacity: ∞

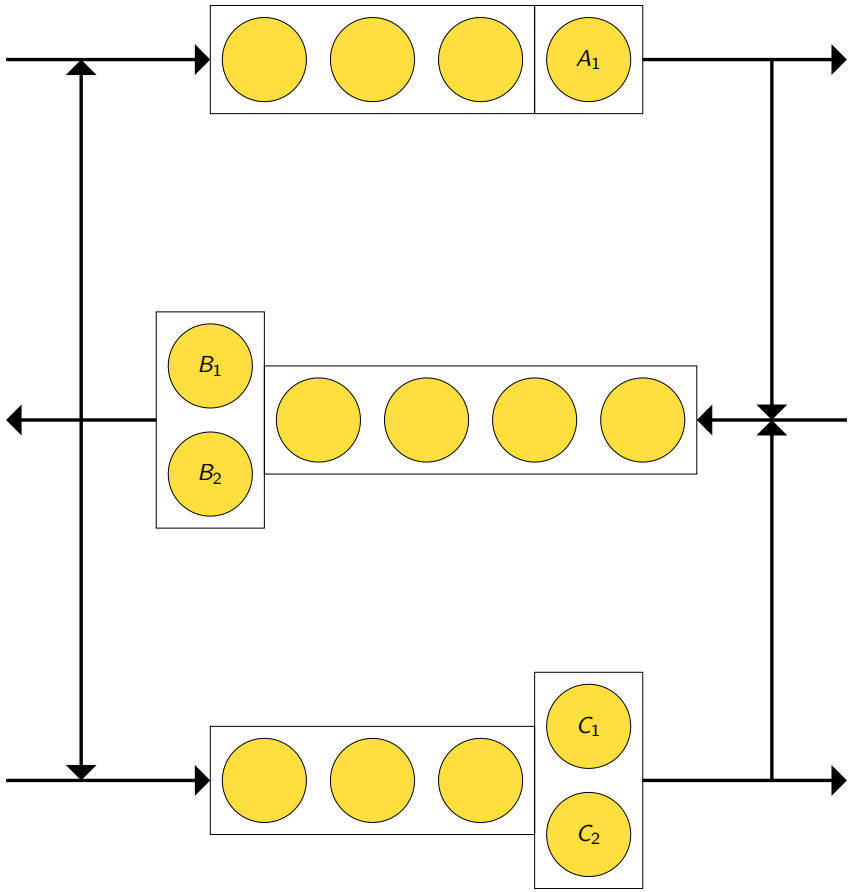
Node 2
External arrivals: Deterministic(1)
Services: Deterministic(1)
Number servers: 2
Queueing capacity: 1

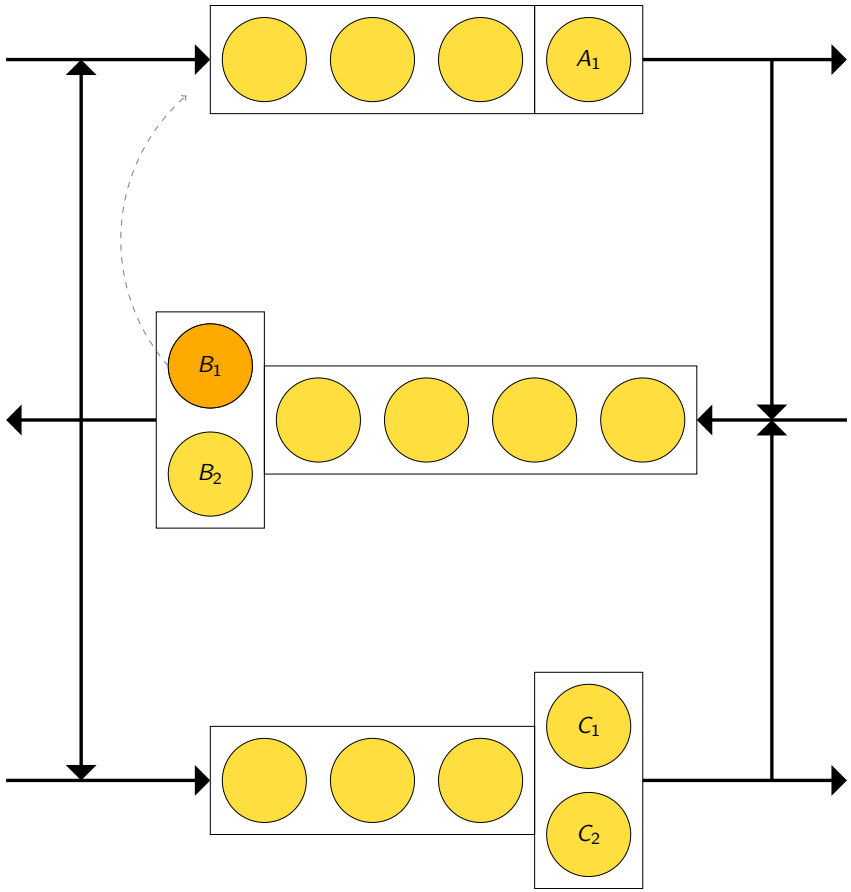

Python (CPython)
Python (PyPy)
SimPy (CPython)
SimPy (PyPy)
Ciw (CPython)
Ciw (PyPy)
AnyLogic
Runtime Ratio (against C++)
0
50
100
150
200
250
300
350
1000
2000
3000
4000
5000
Max Simulation Time

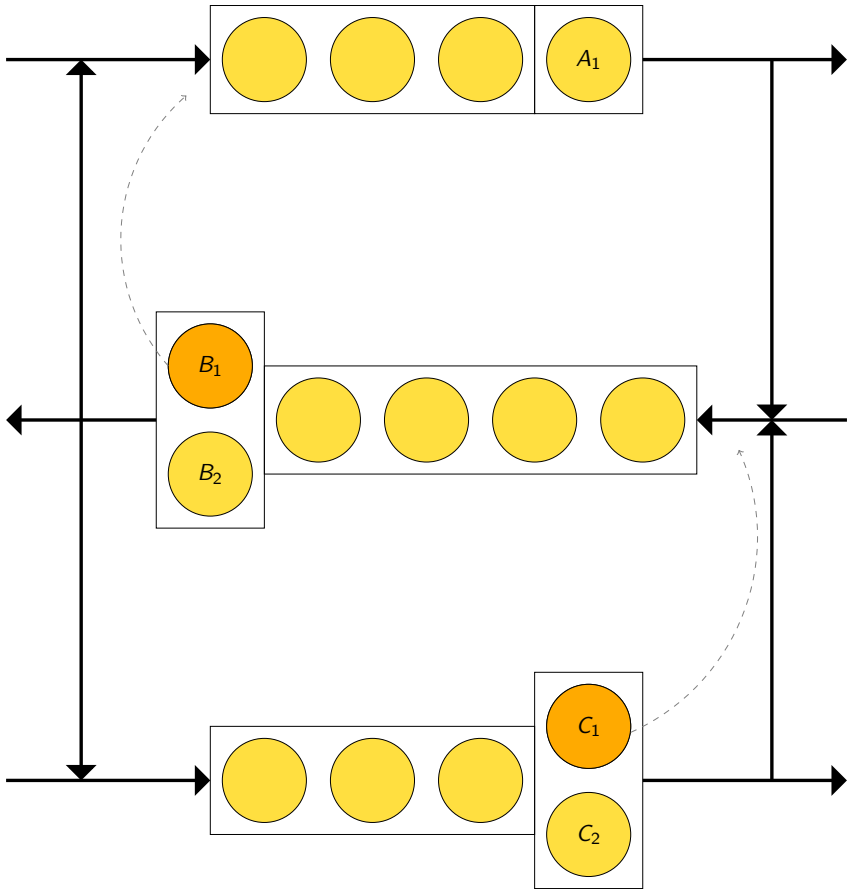
Deadlock

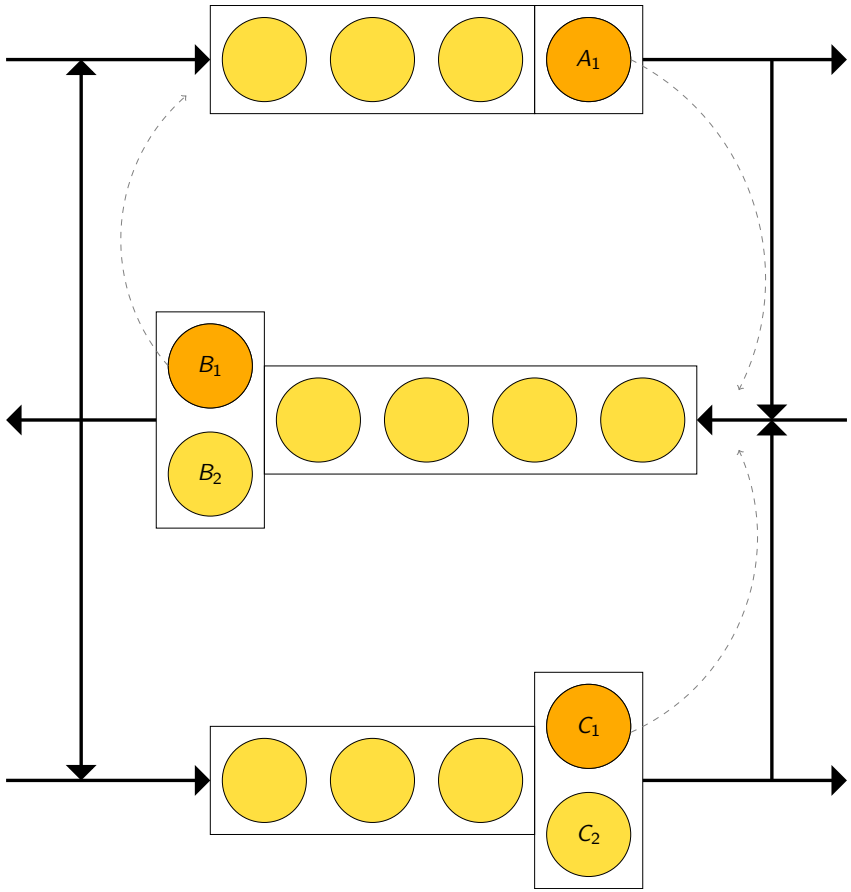


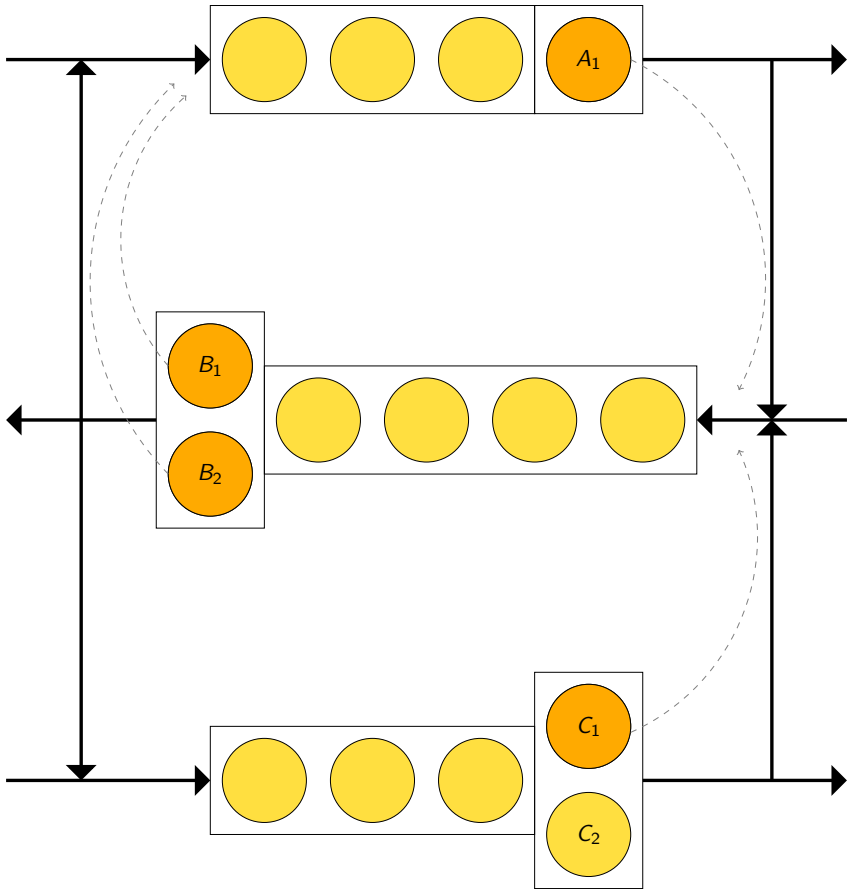
2018. *Palmer, GI., Harper, PR., and Knight, VA.*. **Modelling Deadlock in Open Restricted Queueing Networks**. European Journal of Operational Research 266(2) (pp. 609-621).

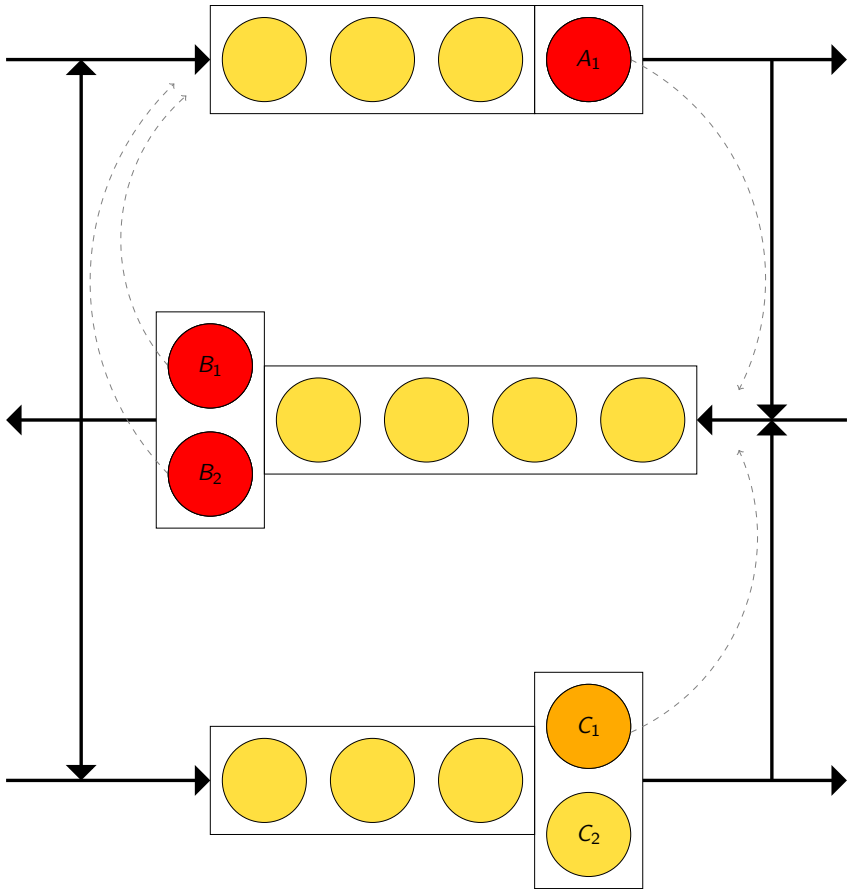

A_1
B_1
B_2
C_1
C_2

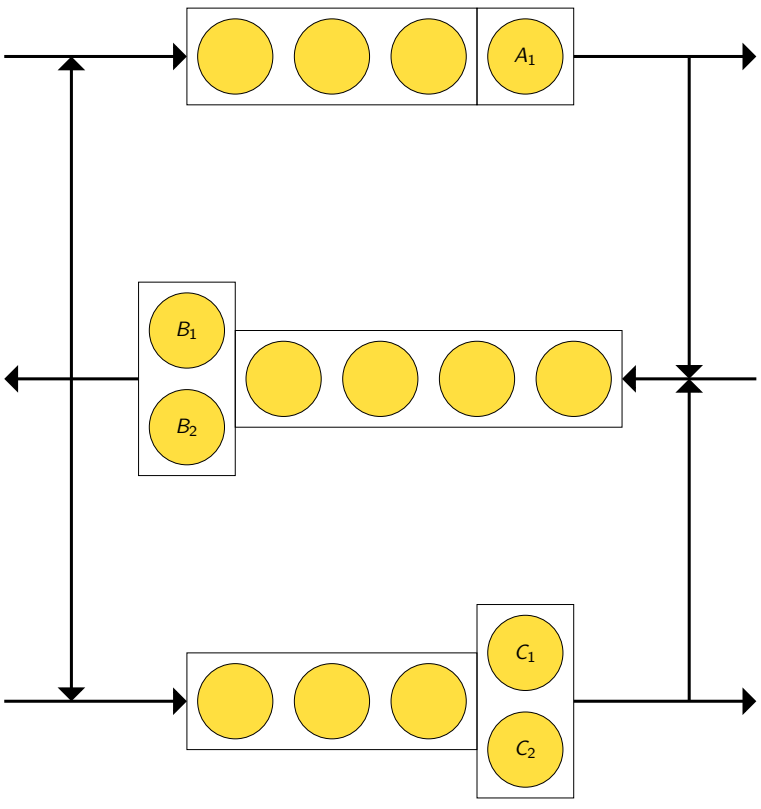

A_1
B_1
B_2
C_1
C_2

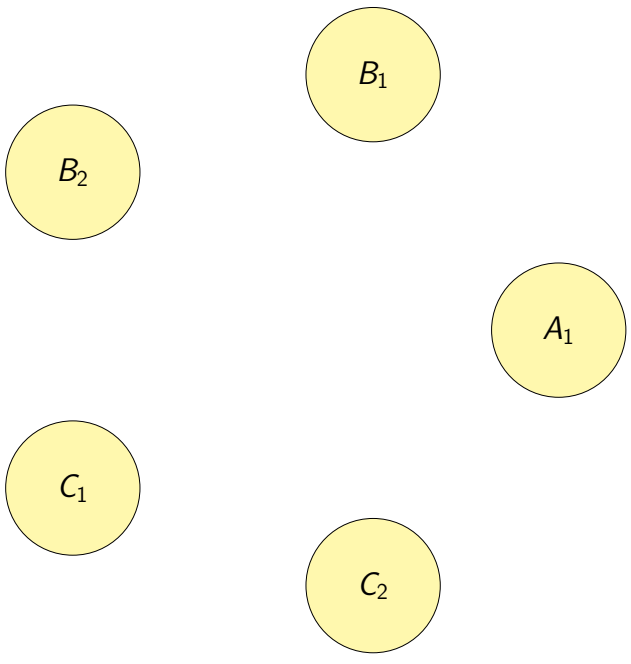

A_1
B_1
B_2
C_1
C_2

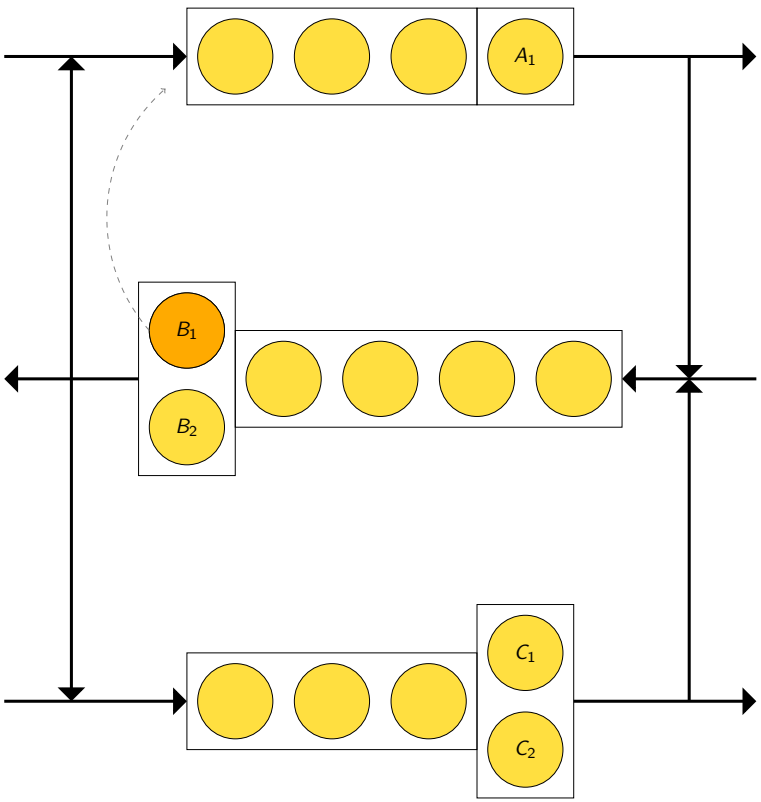

A_1
B_1
B_2
C_1
C_2

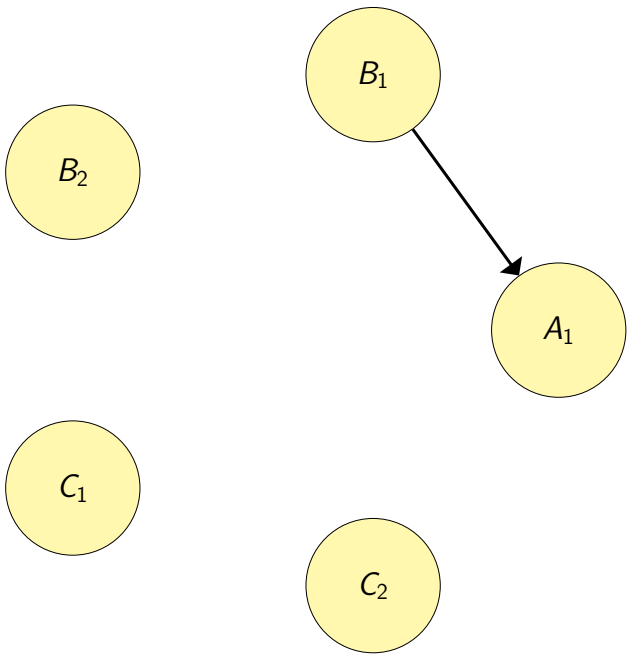

A_1
B_1
B_2
C_1
C_2

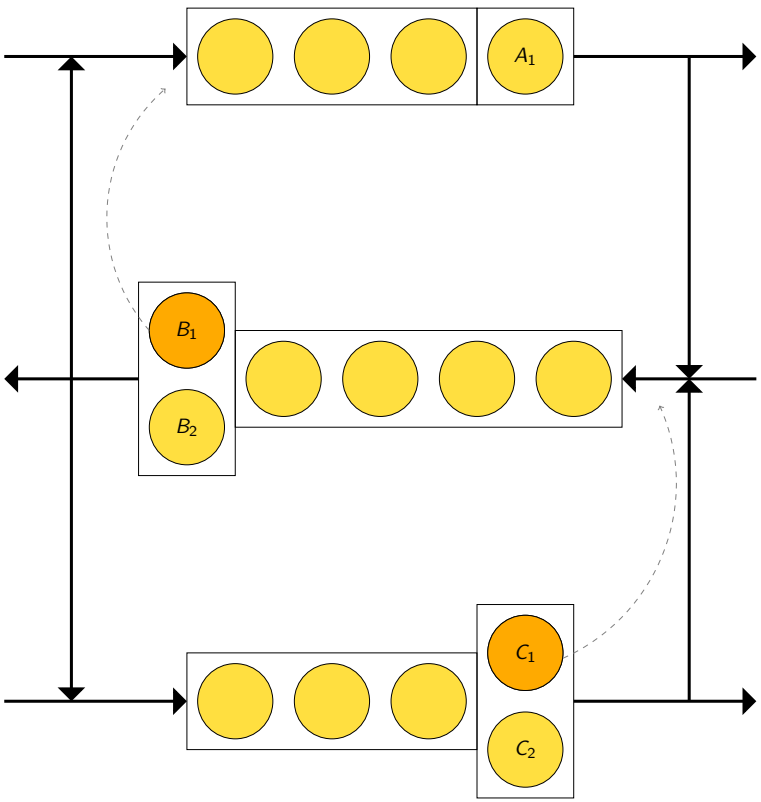

A_1
B_1
B_2
C_1
C_2

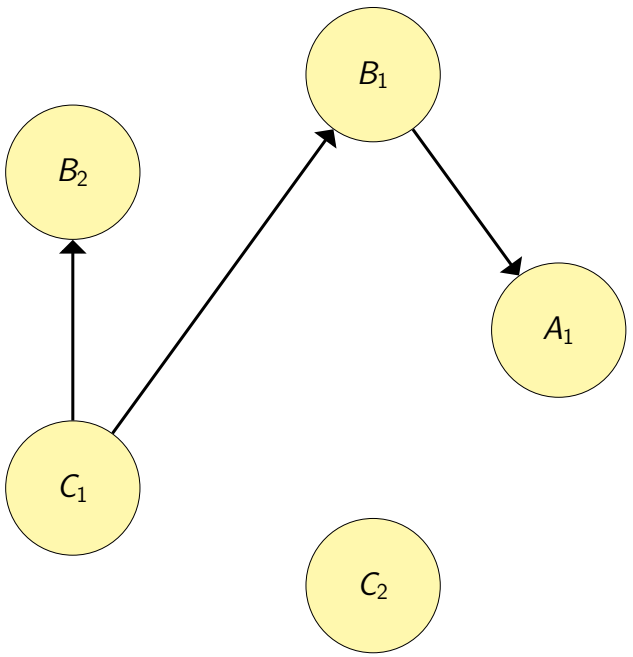

A_1
B_1
B_2
C_1
C_2

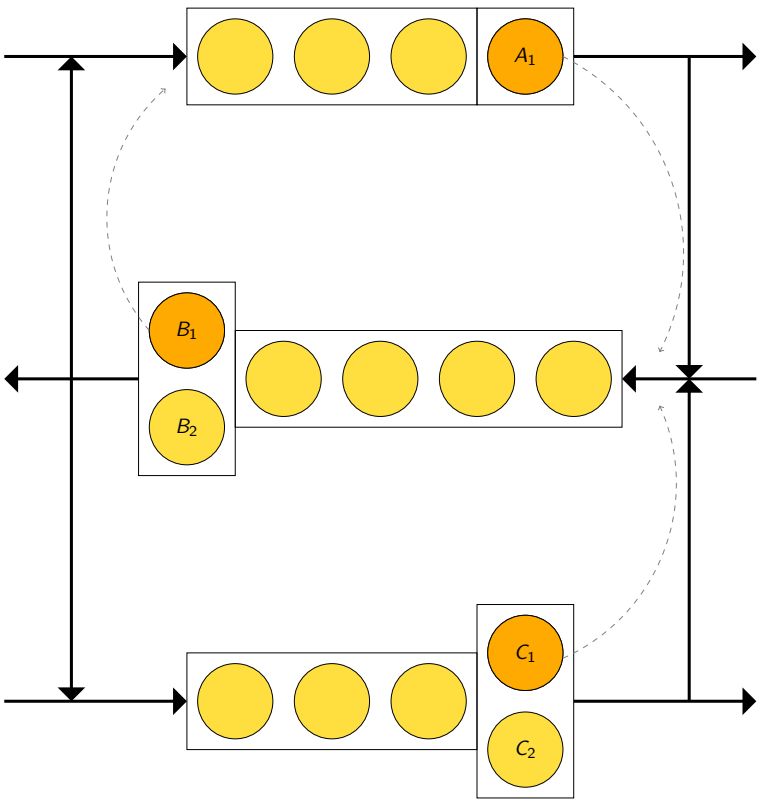

B_1
B_2
A_1
C_1
C_2

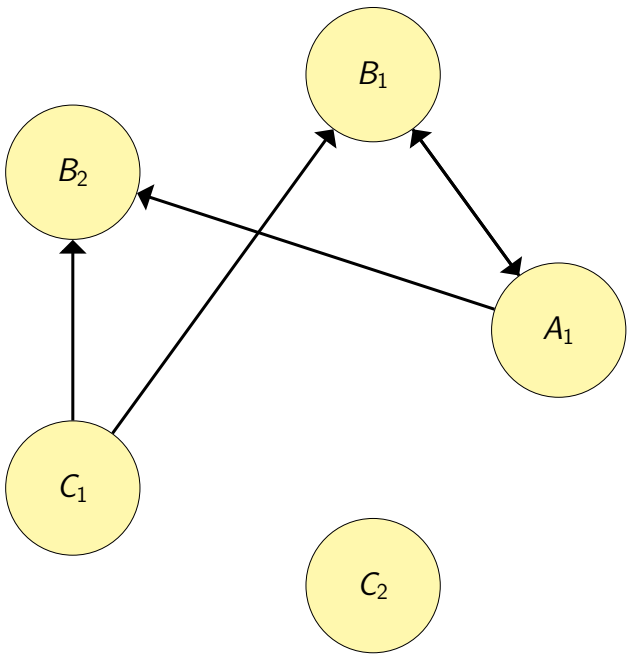

A_1
B_1
B_2
C_1
C_2

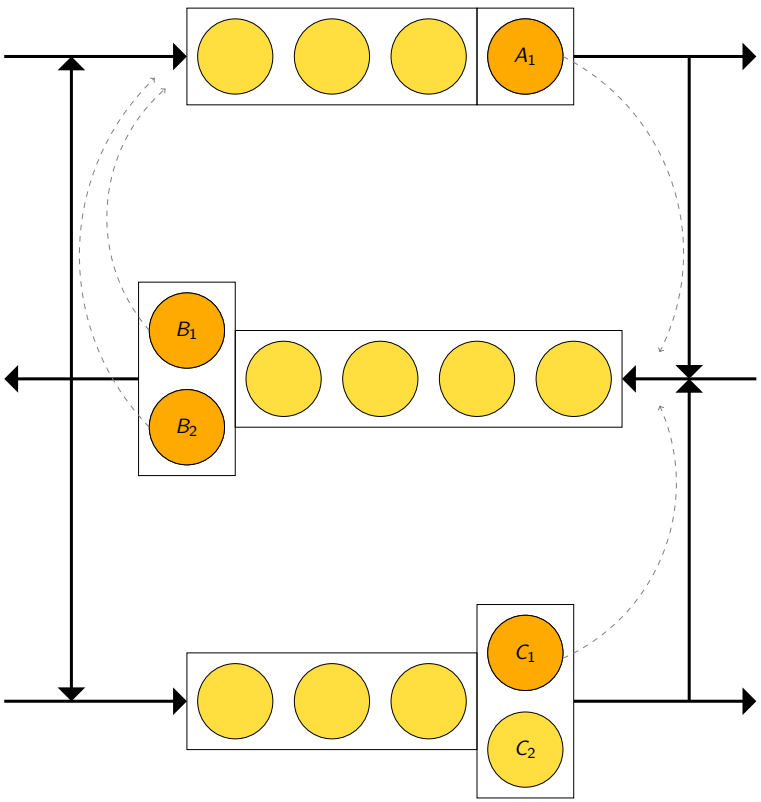

B_2
B_1
A_1
C_1
C_2

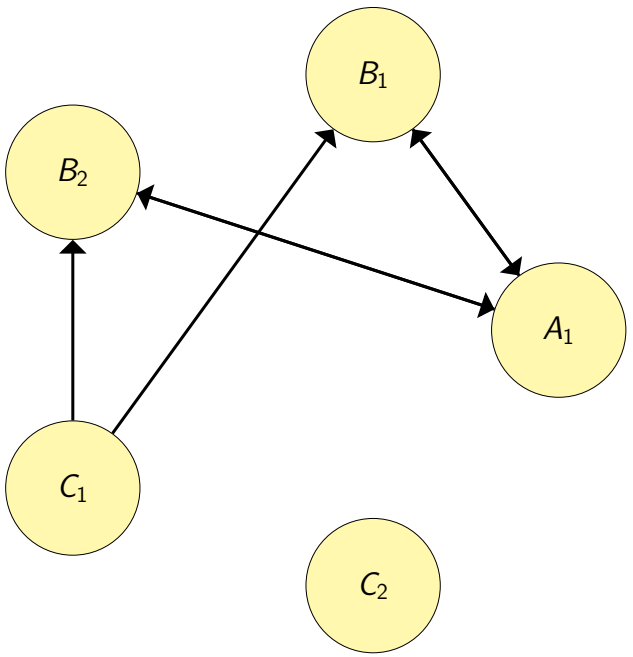

A_1
B_1
B_2
C_1
C_2

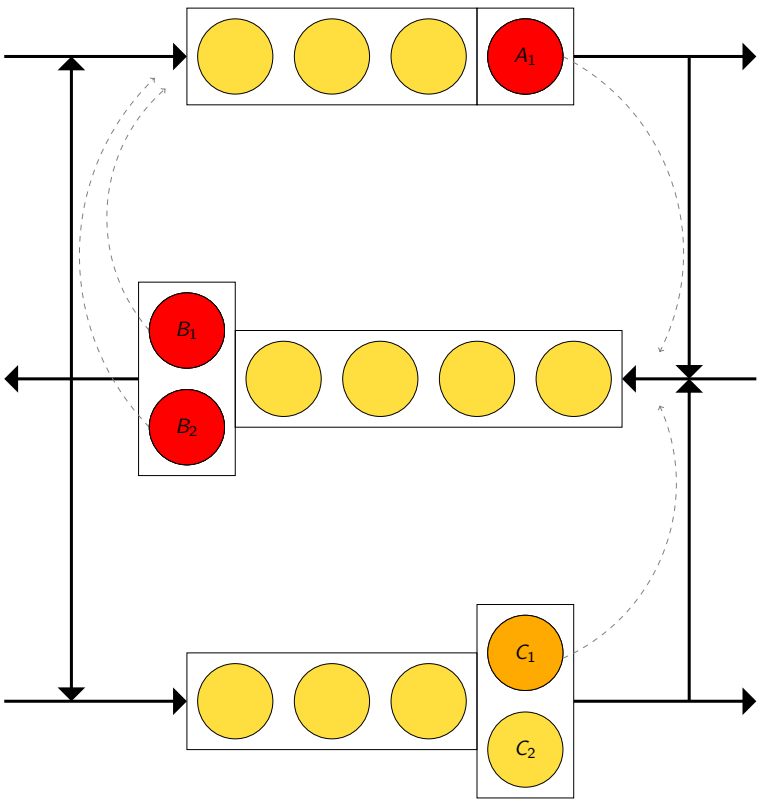

B_1
B_2
A_1
C_1
C_2

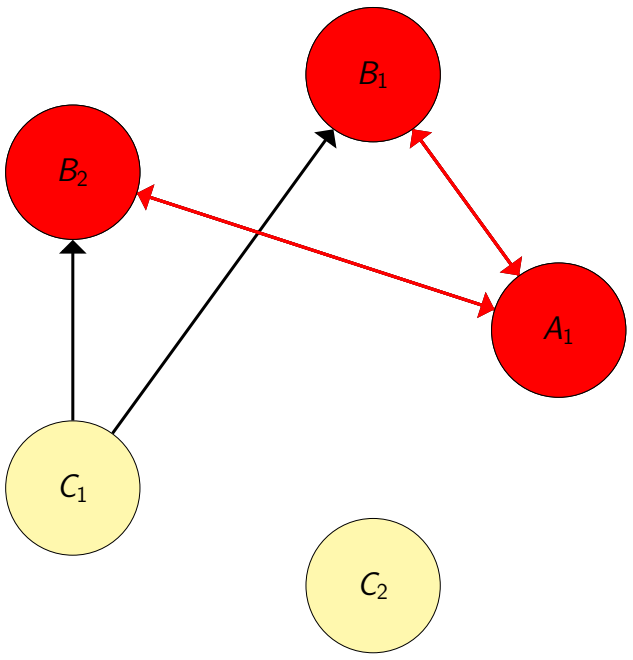

A_1
B_1
B_2
C_1
C_2

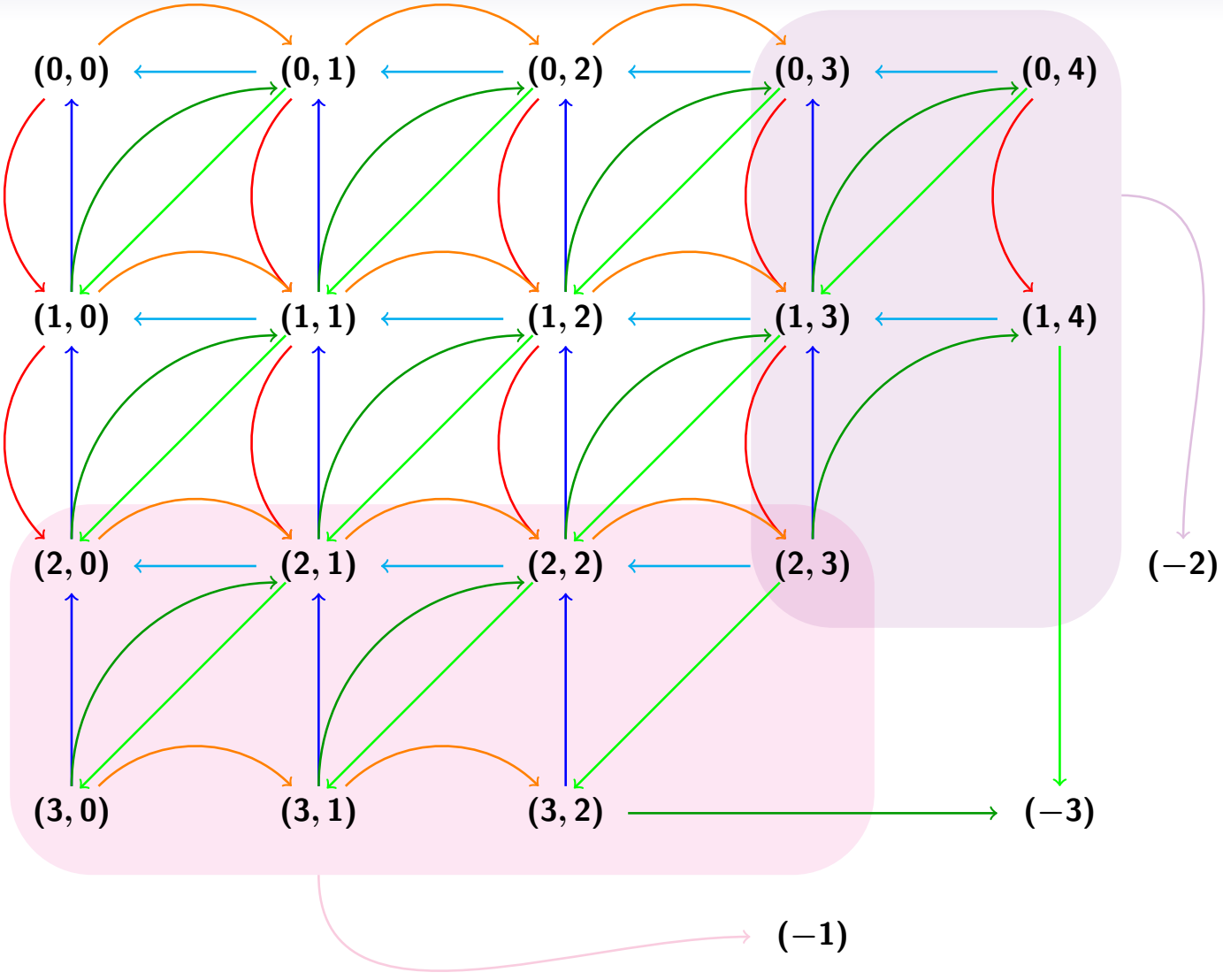

B_1
B_2
A_1
C_1
C_2


A_1
B_1
B_2
C_1
C_2

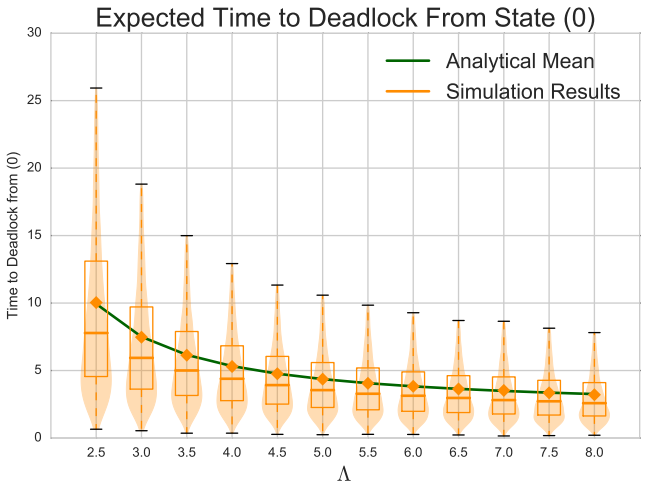

B_1
B_2
A_1
C_1
C_2

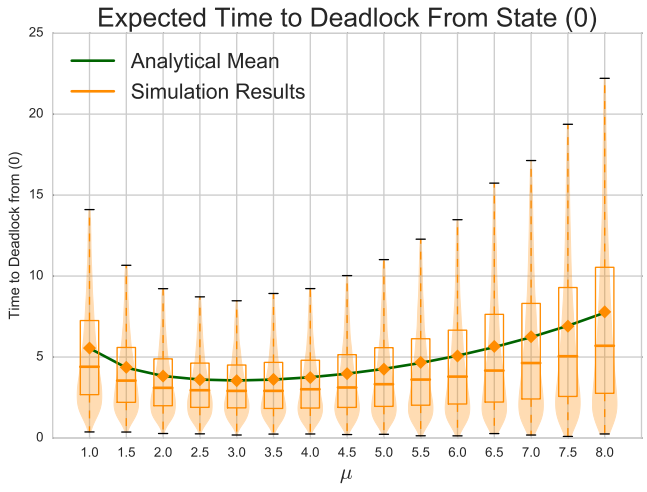

A_1
B_1
B_2
C_1
C_2

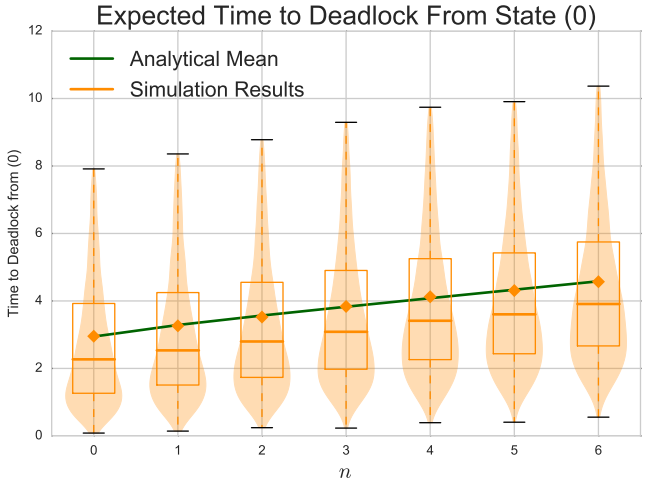

B_1
B_2
A_1
C_1
C_2

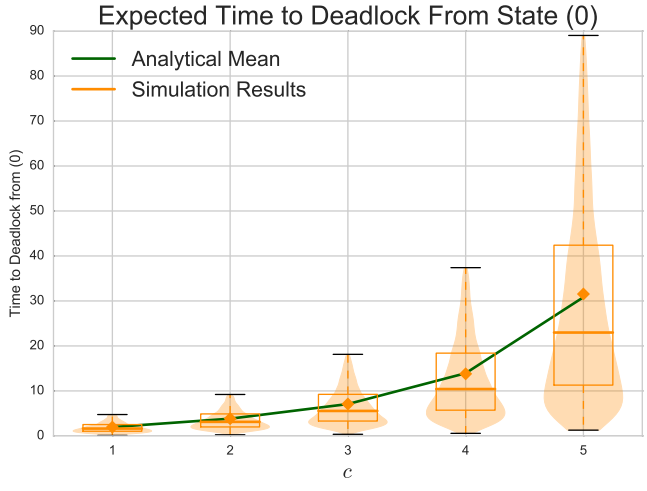

(0, 0)
(0, 1)
(0, 2)
(0, 3)
(0, 4)
(1, 0)
(1, 1)
(1, 2)
(1, 3)
(1, 4)
(2, 0)
(2, 1)
(2, 2)
(2, 3)
(3, 0)
(3, 1)
(3, 2)
(−2)
(−3)
(−1)

Times to Deadlock

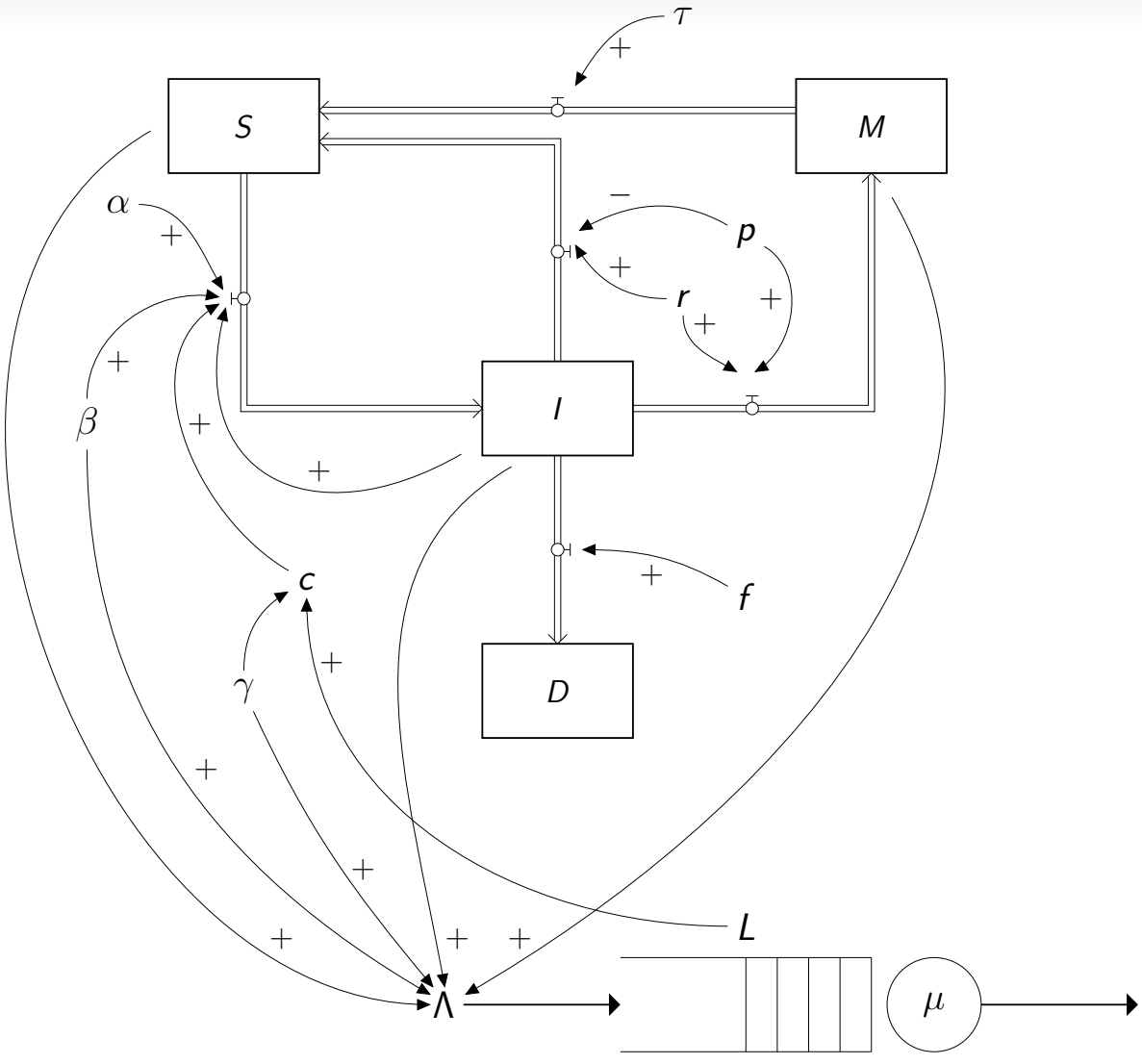




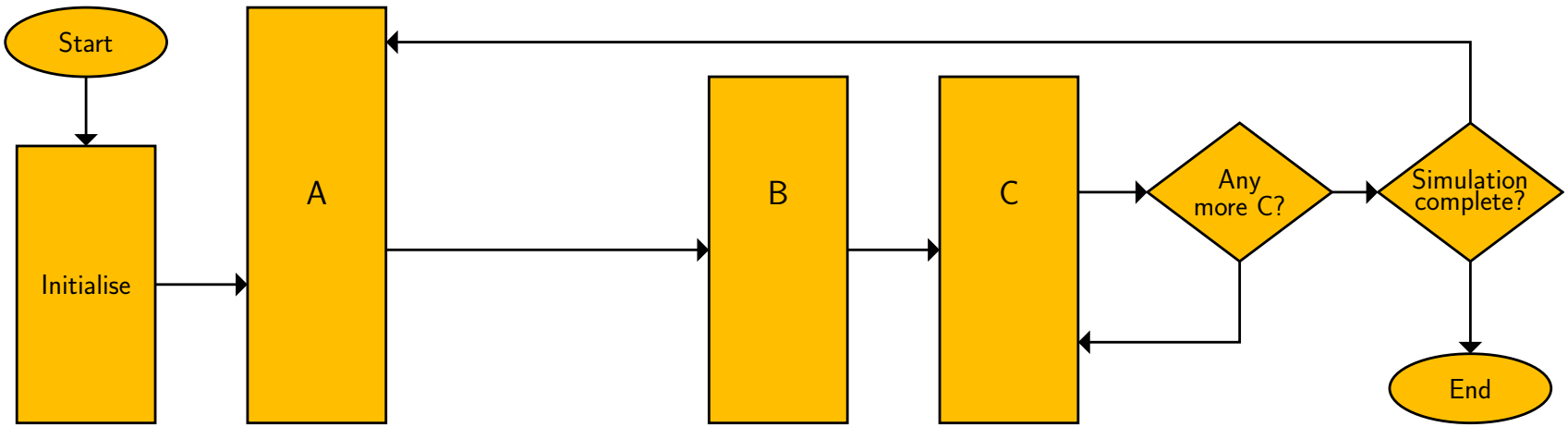


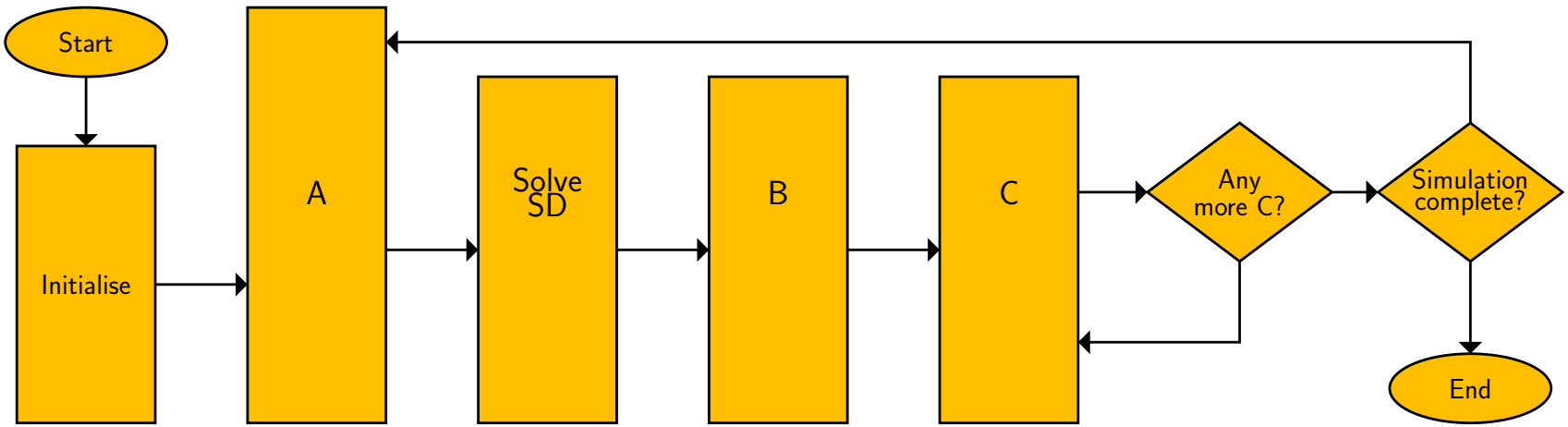


Extendible

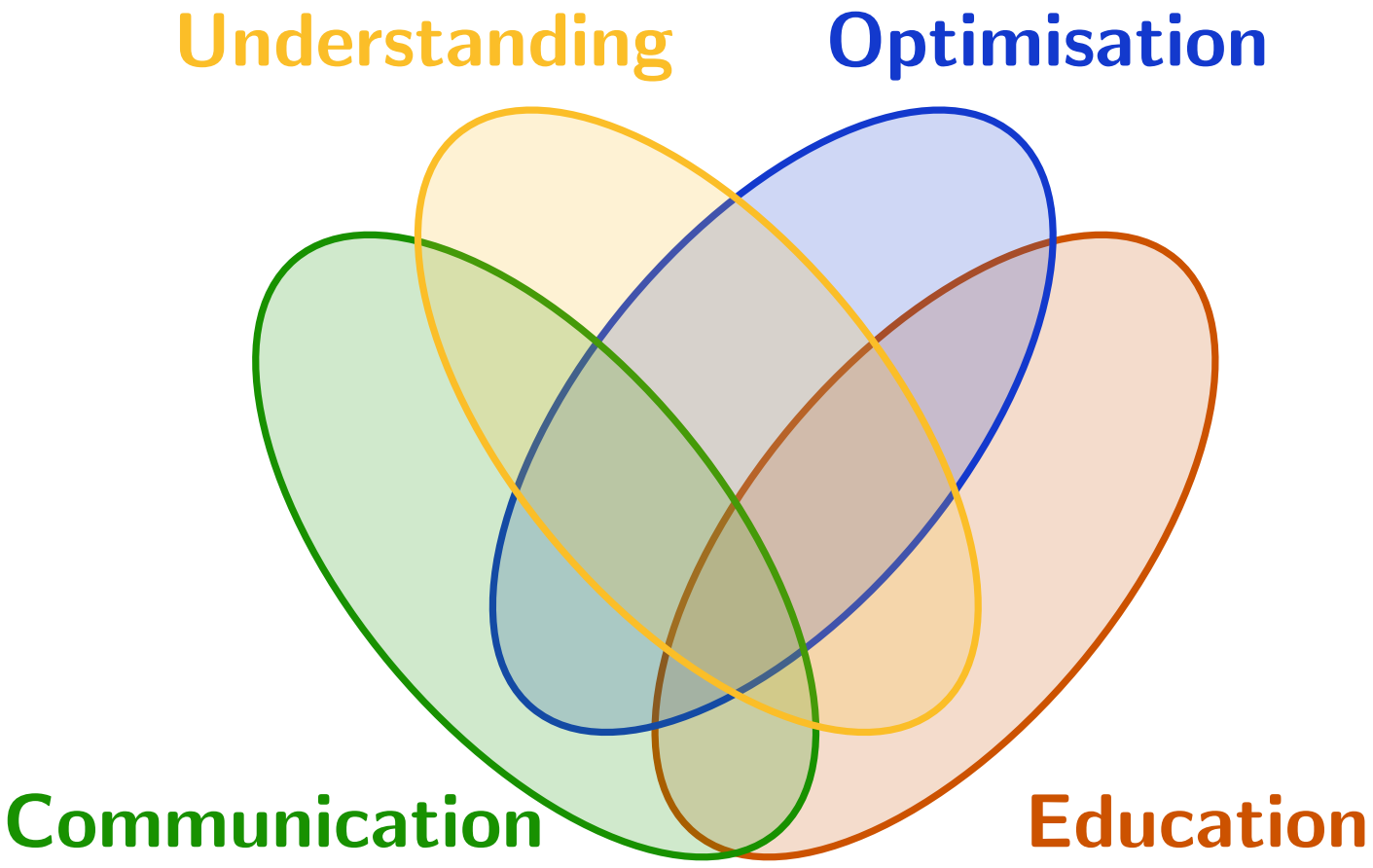


Palmer, GI. and Tian, Y.. **Two Approaches for Implementing Integrated DES+SD Hybrid Simulation in an Open Framework**. Paper under review.


Start
Initialise
A
B
C
Any more C?
Simulation complete?
End


Start
Initialise
A
Solve SD
B
C
Any more C?
Simulation complete?
End

Applications of Ciw



Palmer, GI., Harper, PR., Knight, VA. and Brooks, C.. **Modelling changes in healthcare demand through geographic data extrapolation**. Revised paper under review.

Open-Source Simulation with Ciw

"Modelling Deadlock in Queueing Systems"

Dr Geraint Palmer
Supervisors: Prof Paul Harper & Dr Vince Knight
www.geraintianpalmer.org.uk
@GeraintPalmer

Beale Lecture, February 2021