IMPLEMENTATION OF REINFORCEMENT LEARNING IN FREEWAY SCENARIO WITH VARIABLE SPEED LIMIT CONTROL (VSL)

Omar Hassan

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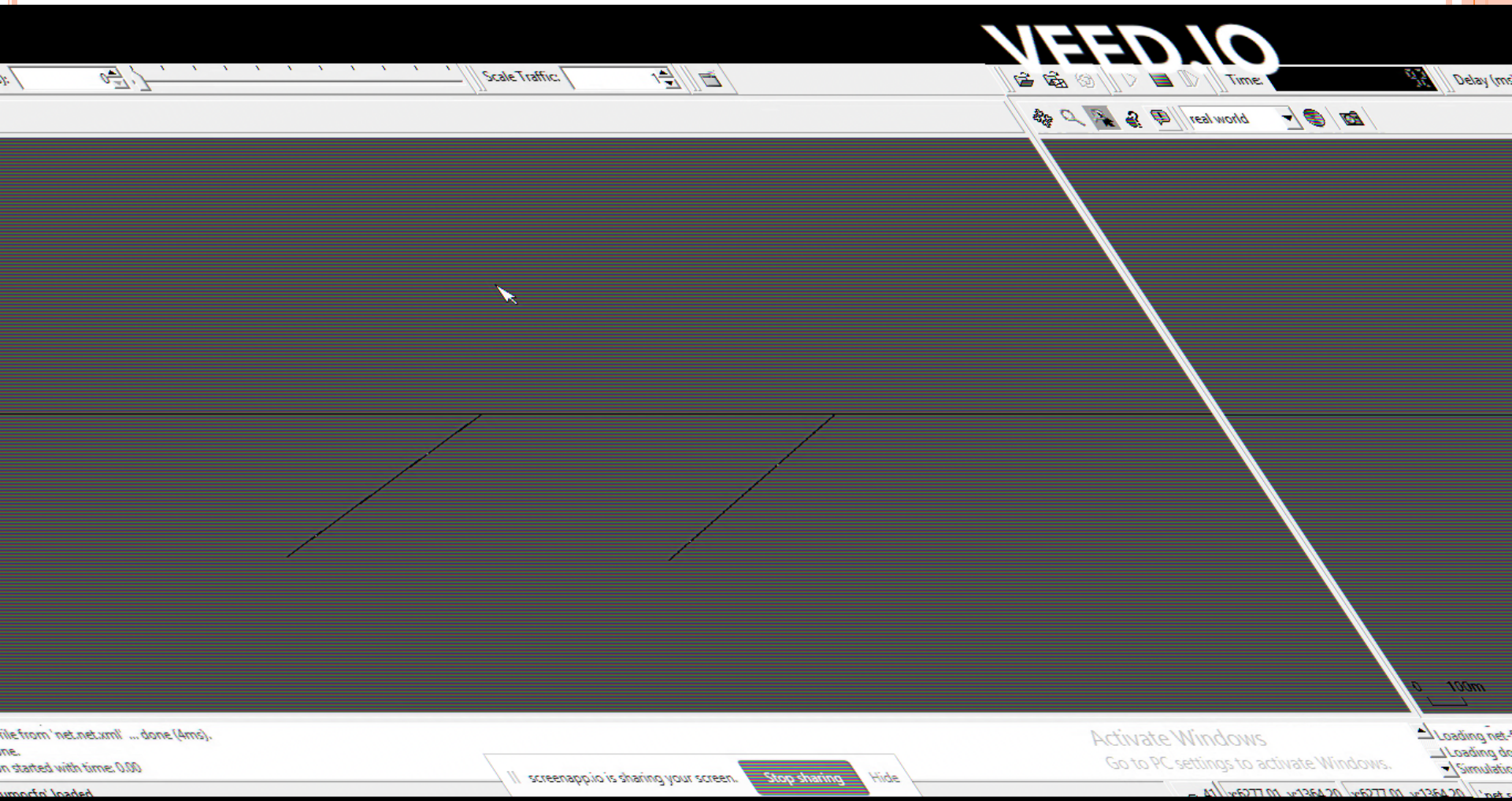
No Control

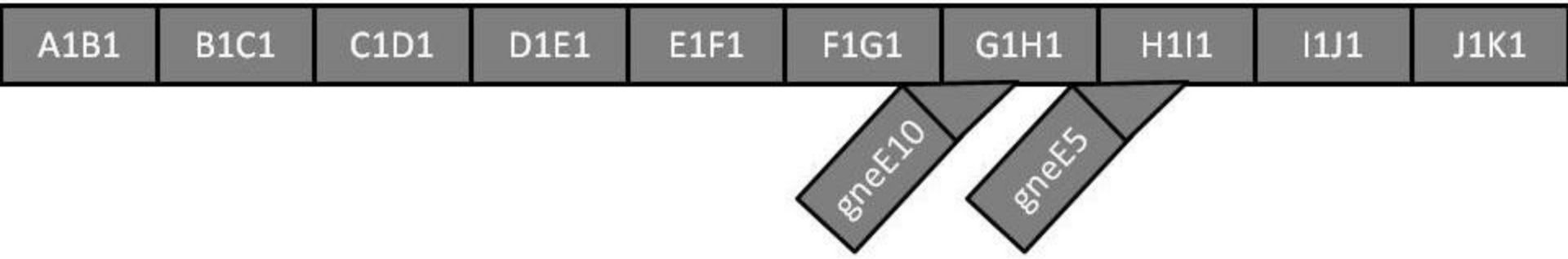

VEED.IO
Scale Traffic:
Time:
real world
100m
screenapp.io is sharing your screen.
Stop sharing
Hide
Activate Windows
Go to PC settings to activate Windows.

VSL Control


VEED.IO
Scale Traffic:
Time:
real world
1000m
0
screenapp.io is sharing your screen.
Stop sharing
Hide
Activate Windows
Go to PC settings to activate Windows.

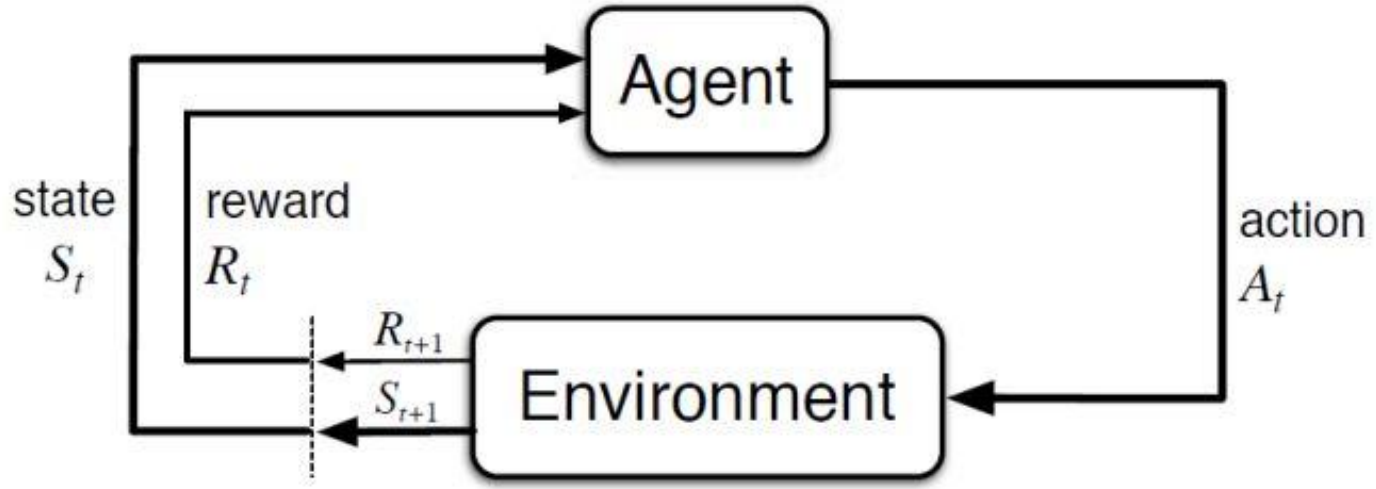
Objectives

- Implementing Variable Speed Limit (VSL) strategy on a freeway scenario in SUMO.
- Implementing reinforcement learning algorithm on a freeway scenario in SUMO.
- Harmonize occupancy rate on a freeway scenario in SUMO using developed algorithm.



Methodology

- Reinforcement learning
  → No labeled data to be used as input.
- Markov decision processes



Methodology

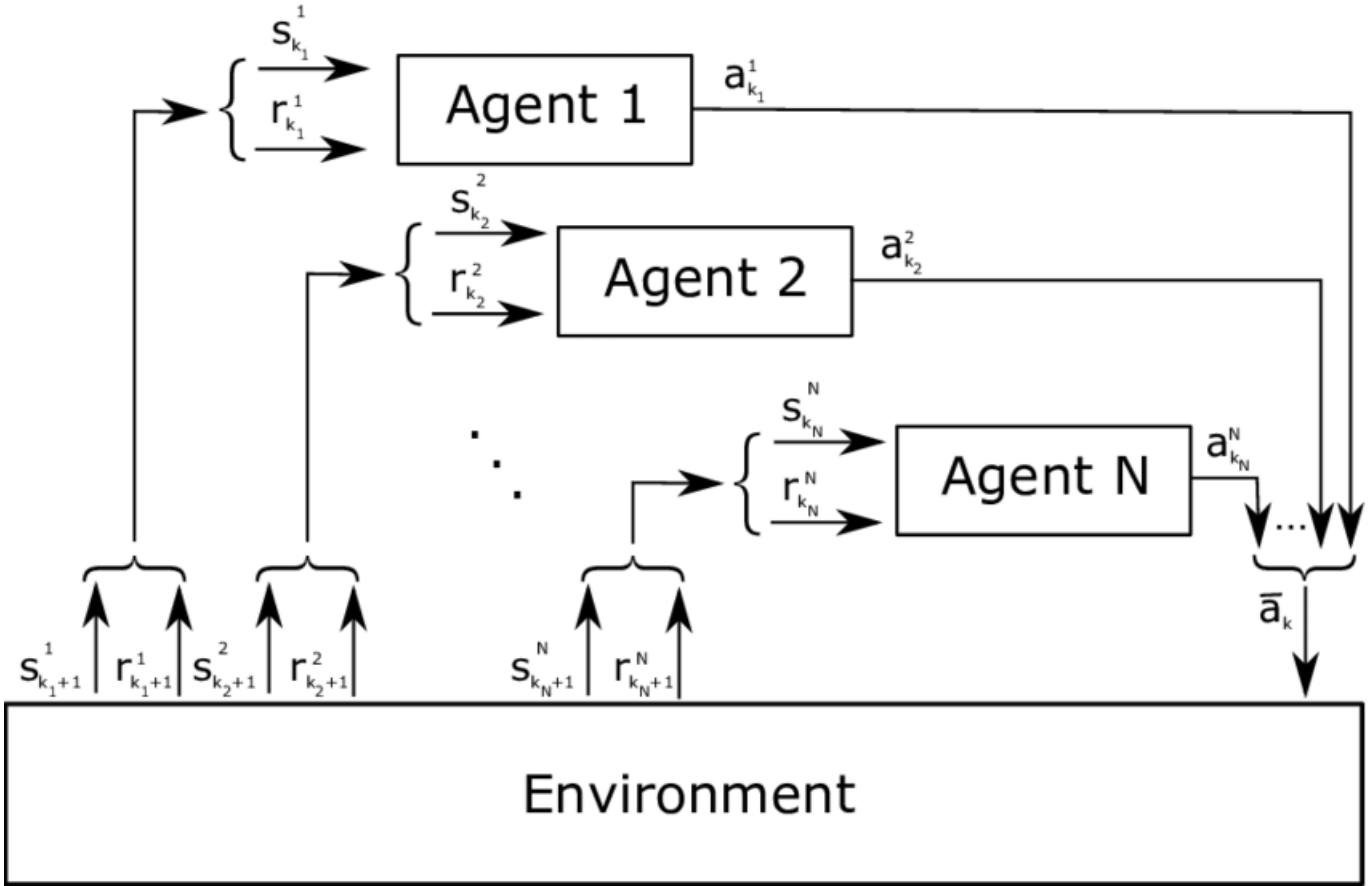
- Exploration vs. Exploitation
  → $A_t \doteq argmax Q_t(a)$

- Q-Learning
  → $q^{n}ew(s,a) = (1-\alpha)q(s,a) + \alpha(R_{t+1} + \lambda max q(s',a'))$

States	a1	a2	a3	an
s1	Q-value 11	Q-value 12	Q-value 13	...
s2	Q-value 21	Q-value 22	Q-value 23	...
s3	Q-value 31	Q-value 32	Q-value 33	...
sn	...	...	...	...

Methodology

- Multi-Agent RL



VSL Implementation

- Sumo Simulation Environment
  - → TraCI using python for controlling driving behaviors in the simulation.
  - → Two tests: With/without ramp metering
- Learning Process

Parameter	Value
Epsilon (ϵ)	1
Epsilon decay rate	0.9995
Learning rate (α)	0.15
Discount rate (λ)	0.9

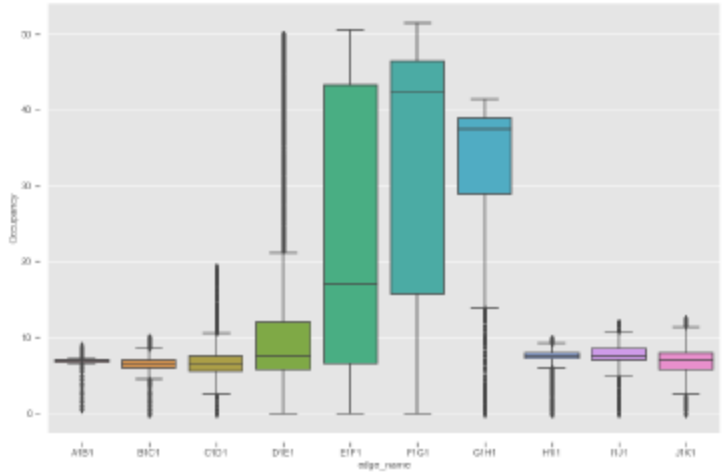
RL learning parameters

- Filling Q-Table with Q-values

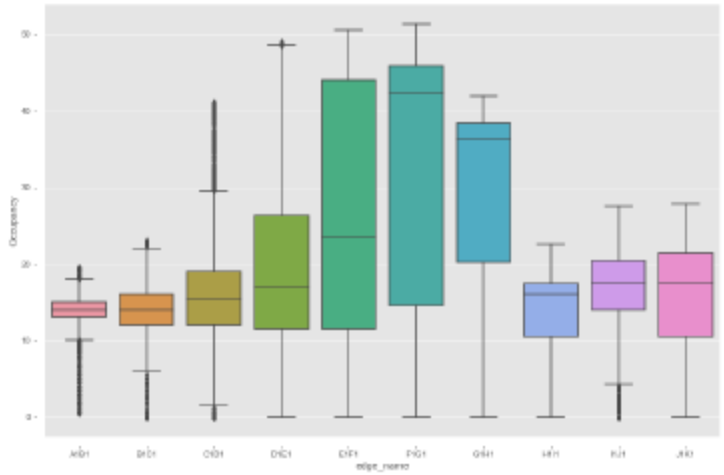
$$q^{n}ew(s,a) = (1-\alpha)q(s,a) + \alpha(R_{t+1} + \lambda maxq(s',a'))$$

Results

Minimum speed limit 50 km/h

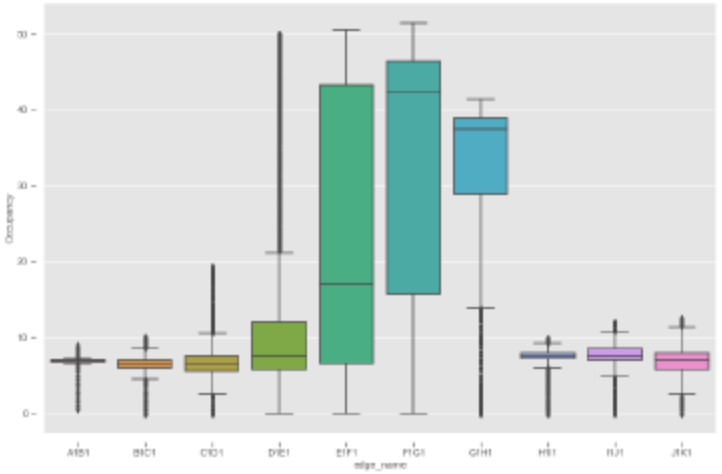


(a) No VSL implementation

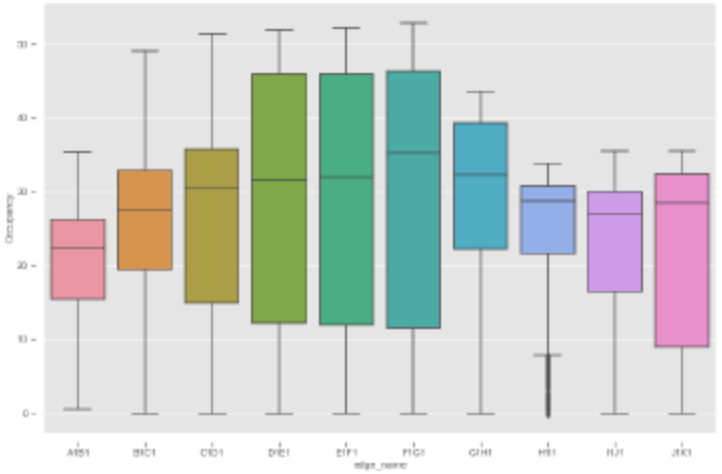


(b) VSL implementation 18000 iteration

Minimum speed limit 30 km/h



(a) No VSL implementation



(b) VSL implementation 18000 iteration

Conclusion and Future Work

- Conclusion
  - → Proposed strategy could improve the traffic flow and the distribution of the vehicles across the whole freeway.
  - → The use of reinforcement learning reduces the complexity of the optimization process.

- Future Work:
  - → Training time: the amount of time spent training might be enhanced.
  - → Learning iterations: increasing the number of learning iterations is suggested.

Review Questions:

- 1. In figure 4.3, depicts only C1D1 and D1E1. So are the other edges potentially related to the situation described here?

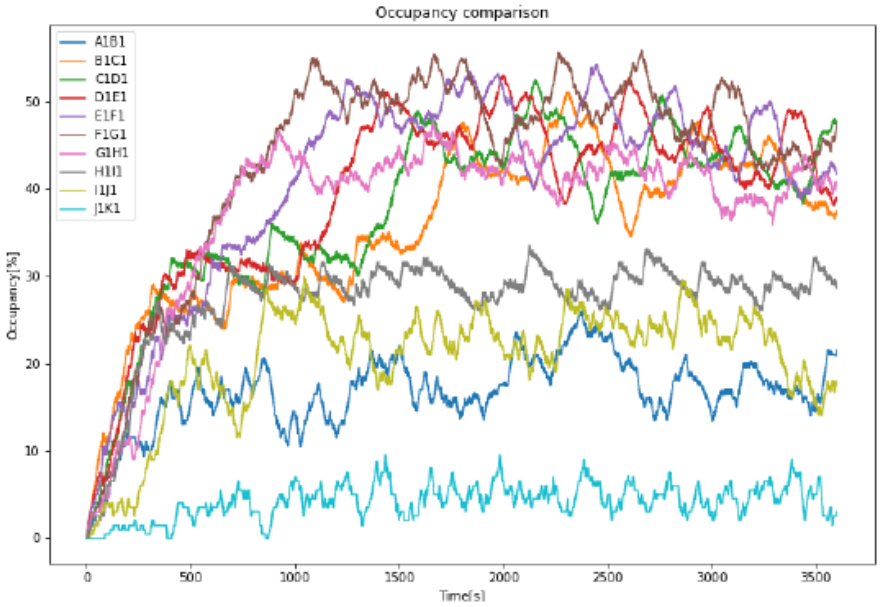


Figure 4.3: Occupancy comparison between different segments after implementing control theory approach

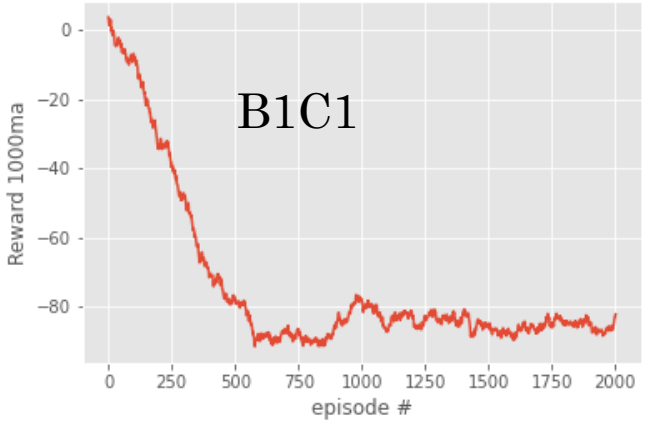
Review Questions:

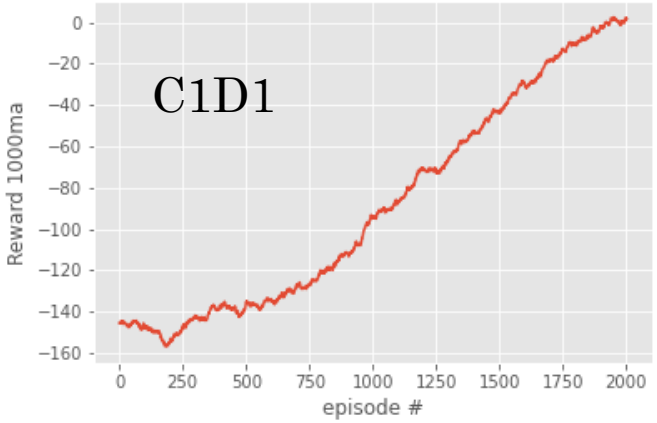
- 2. Does the author consider it necessary to have a separate subsection for describing the bar chart? This section could serve as a summary of the chapter and show a flowchart of the entire approach, which would make the structure more holistic.

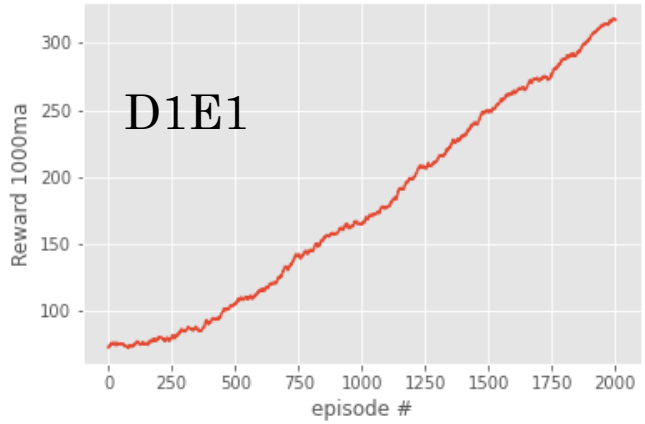
- 3. I presume the simulation is performed in Discrete-Time, so what is the sampling time used in the simulations? Is the RL model robust to disturbances and noises?

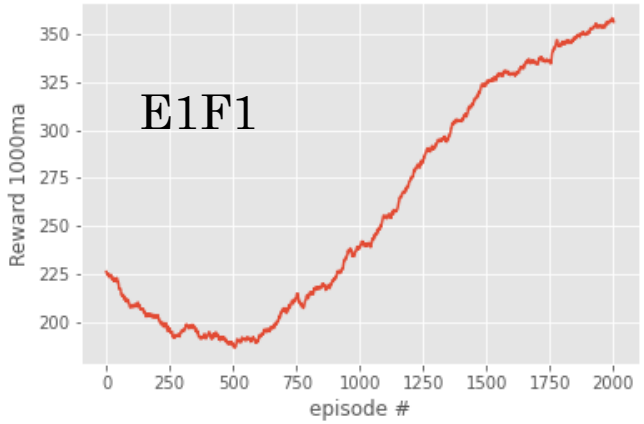
Review Questions:

- 4. The authors should show the results of the model training in chapter 5.









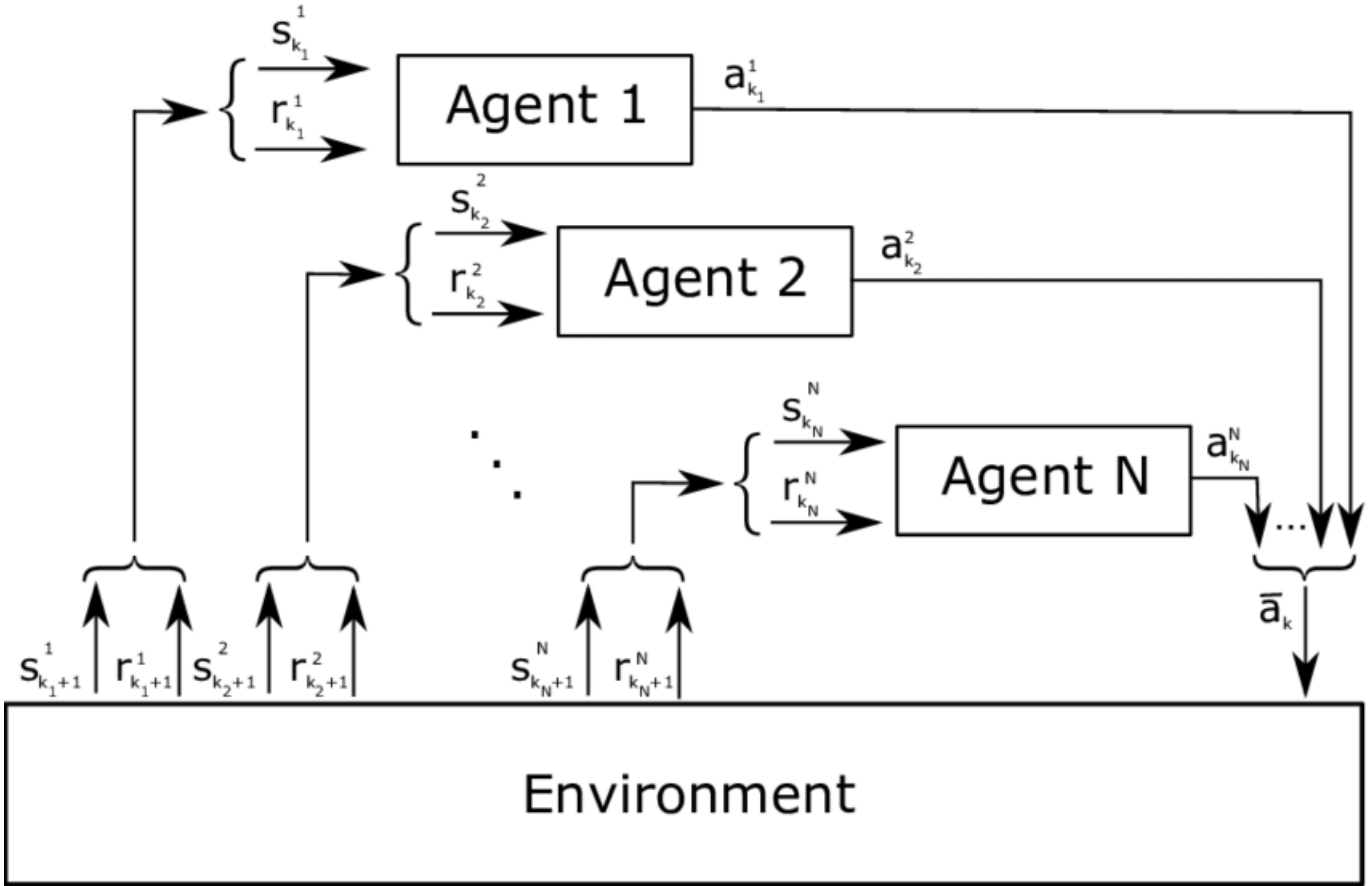
Review Questions:

- 5. The authors need to explain the input quantities further and whether they influence the results empirically or through the selection algorithm

- 6. The author needs to consider the diagram to describe the whole process. Especially for the RL model.

Review Questions:

- Multi-Agent RL




thank
you