

COMP0036-Interim Report:

Multiagent Reinforcement Learning for Noised Communication in Fully Cooperative MPEs

Jeffrey Li, supervised by Professor Mirco Musolesi

BSc Computer Science, UCL

WC1E 6BT

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Progress made to date:

The project is on multi-agent reinforcement learning (MARL) where I would design a MARL algorithm such that agents could effectively cooperate and achieve coordinative behaviours under the constraint of having to communicate with noises.

To date, I have done a great amount of reading and have managed to conduct an in-depth literature review going through the background knowledge of Reinforcement Learning and Deep Reinforcement Learning as well as its mathematical underpinnings. I have also surveyed the field of MARL broadly and discussed the usage of communication in producing state-of-the-art Comm-MARL algorithms as well as work that has similar goals to my project.

As part of the expected deliverables, I have completed the implementation of novice Reinforcement Learning algorithms (Value Iteration, Policy Iteration, Q Learning) as well as the deep Q-Learning algorithms, all of which were trained and tested in OpenAI gym's environments, and training/testing data has also been obtained.

To be able to test and evaluate my MARL algorithm, I have implemented an Observer-Explorer grid-world environment along with the visualization of the current status of the environment at each timestep.

In this environment, the Observer has full observation over the grid but could not move, and the explorer has no observation over the grid but can move around, and the two agents can communicate over a shared communication channel with noises. The position of the observer and the explorer are randomly initialized, and the goal is for the explorer to retrieve all treasures that are randomly placed in the grid through the observer communicating its observations to the explorer. This cooperative scenario emphasizes the importance of communication and would best be a great testbed for my algorithm.

As an essential component of this problem, I have also finished implementing the communication channel that "connects" the agents. This includes methods for encoding and decoding messages into my desired formats, methods for forwarding and receiving messages,

and the method for adding noises to the message of which currently has the Binary Symmetric channel implemented.

Finally, I have completed implementing a prototype Communication-MARL algorithm in the scenario of having one Observer and one Explorer. This has successfully converged while communicating under a channel with no noise added and the agents have learned to coordinate effectively, and I aim to further test this algorithm's effectiveness by adding additional Explorers to the environment. I have also completed implementing a structural framework for training and testing Comm-MARL algorithms following similar interfaces to PettingZoo such that further improvements to the existing prototype as well as state-of-the-art algorithms can be easily trained and evaluated, and the environment could be easily customised.

Remaining work and work plan:

List of work to be done:

- Implement remaining noises to the communication channel
- Add in capability to the environment for a flexible number of agents to be added
- Adapt my prototype algorithm with the implemented noised communication channel
- Implement selected state-of-the-art Comm-MARL algorithms
- Train my algorithm and state-of-the-art algorithms, obtain training and testing results and evaluate my algorithm

Work plan:

- Mid-Jan – Early Feb:
 - Refactor code to allow flexible number of agents to be added to the environment and trained
 - Complete implementation of noised communication channels
- Early Feb – Mid-Mar:
 - Implement my current idea of how to tackle communication under noises
 - Iteratively improve the idea with further reading and experimentation
 - Obtain training and testing results of the final version of my designed algorithm.
- Mid-Mar to Late-Mar:
 - Implement selected state-of-the-art Comm-MARL algorithms.
 - Obtain training and testing results for these algorithms.
- Late-Mar to 26th April:
 - Evaluate my designed algorithm
 - Work on completing the Final Project report
- **26th April - Project Submission**