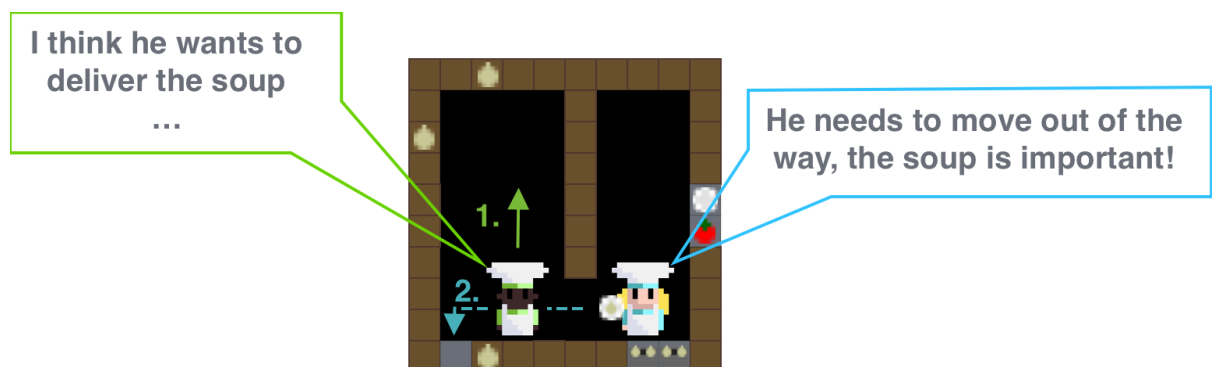


Partner Modeling in Deep MARL for Theory of Mind Tasks



Description: Theory of Mind (ToM) [11,10] is a crucial ability to correctly interact with other agents, especially in cooperative settings in which agents need to align their actions to achieve a common goal. Previous work has thus established the importance of ToM in such settings [3].

We are thus interested in building agents that have Theory of Mind capabilities. One idea is to take inspiration from research on opponent modeling in multi-agent reinforcement learning [6,7,9]. In this line of work, agents try to outcompete others by building and maintaining a model of their partner agents. Building such a model remains a challenge but recent progress in model-based reinforcement learning could hold the key to building models of others in MARL. This work is interested in exploring the line of work on latent imagination for this purpose which achieved state-of-the-art results in many important baselines starting with work on the Dreamer [1], DreamerV2 [2] and now R2I [5] agents. While all three of these methods have so far only been explored in single-agent settings to build a world model, we want to now use them to build partner agent models also. We hypothesize that these models can be used to mentalize (i.e. form a Theory of Mind) about other agents in the environment. This thesis explores this hypothesis by working on the following tasks:

Goal:

- Surveying the literature on opponent modeling (starting from [6,7,8,9])
- Integrate the works of model-based opponent modeling [9] with works on latent imagination [1,2,5]
- Build a model and algorithm capable of forming a model of other agents
- Test the resulting approach(es) in several cooperative MARL environments (Hanabi [12], Yokai [13], SymmToM [3]) based on the JaxMARL project [5]
- Perform additional analysis.

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Distribution: 20% literature review, 60% implementation, 20% analysis

Requirements: Good knowledge of deep learning and reinforcement learning, strong programming skills in Python and PyTorch and/or Jax, self management skills. The thesis requires to learn Jax along the way, experience in PyTorch will be sufficient to start.

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