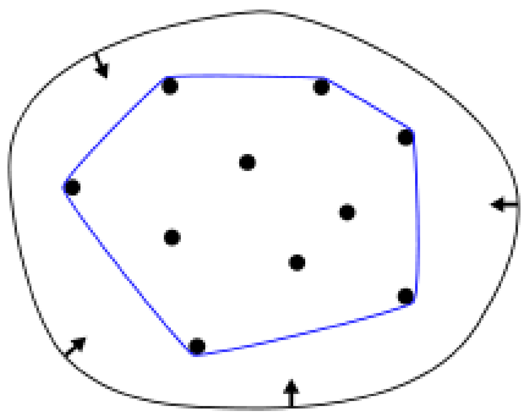
Multi Agent and One Goal

January 15, 2022
CS11428 Artificial Intelligence
Princess Sumaya University for Technology
Dr.Rawan Ghnemat
20180083 Ahmad Mashal
20180358 Mohammad Ibrahim Abu-Amara

Background and Motivation



The idea first came up from trying to solve the wildfires problem, which is basically finding a way to prevent them, as well as trying to fight it through a sub-optimal way. It first looked like an algorithmic problem, where finding a simple convex hull around the fire would get the job done and put that fire only inside the convex hull and cut it off.

However, that is not that case in many wildfires as they can get out of hand very quickly, in addition to the fact that a convex hull will damage everything inside it; we're only fighting the fire on the side of the convex hull.

So, finding a strategic plan to help firefighters navigate through the wildfires, while maintaining their own health, the health of others, and their assets such as water capacity, equipment, helicopters and other vehicles. This can be thought of as a game, where there are two teams, the wildfire team, which consist of the fire itself, the assets that the fires burn (trees, houses, grass, …, etc), and the firefighters teams, which consists of the firefighters themselves, their equipment, and any assets they rescue from the other team. So, basically this is a strategic game of who can control more assets first, furthermore, who can survive in this.
Moreover, this game can be implemented in any two or more team's games, where the goal is to handle or find a strategic way to protect/use some asset(s) in real-time, and many real-life situations can be abstracted to match this criteria.

Examples:

- The electric grid problem, where we need to optimize the energy production and conception dynamically and in real-time, where the players are the producers and consumers, and the asset is the electricity itself.
- Managing a set of bargaining business assets.
- Other natural disasters where the human factor can help.

Unfortunately, there is a lot of proof that must be conducted in order to prove that this game can be implemented efficiently. To give an example: How does one prove that the knowledge obtained from the agent's training is better than the human strategies in mathematical terms.

So we took a sub-problem from the wildfire problem, which is how does one rescue assets from the fire using simple robots, where these robots can only lift, push, or contain assets. This problem can be also translated into, How does one create a collaboration between multiple players with minimal information and training (communicate intention).

Goals and Objectives

- Game Reasoning: at least human intelligence strategies
- Adaptivity: Real time strategies and continuous learning.
- Creativity: Create more efficient strategies than human intelligence.

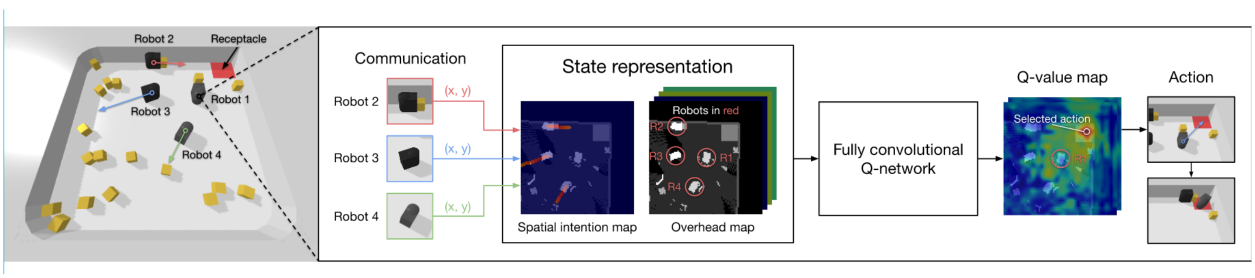
Expected Results

Decentralizing the agents as well as getting them to collaborate to achieve the same goal, identifying each other's strengths and weaknesses without colliding in actions. In addition to that, training is done efficiently with the power of reinforcement learning and minimal datasets used.

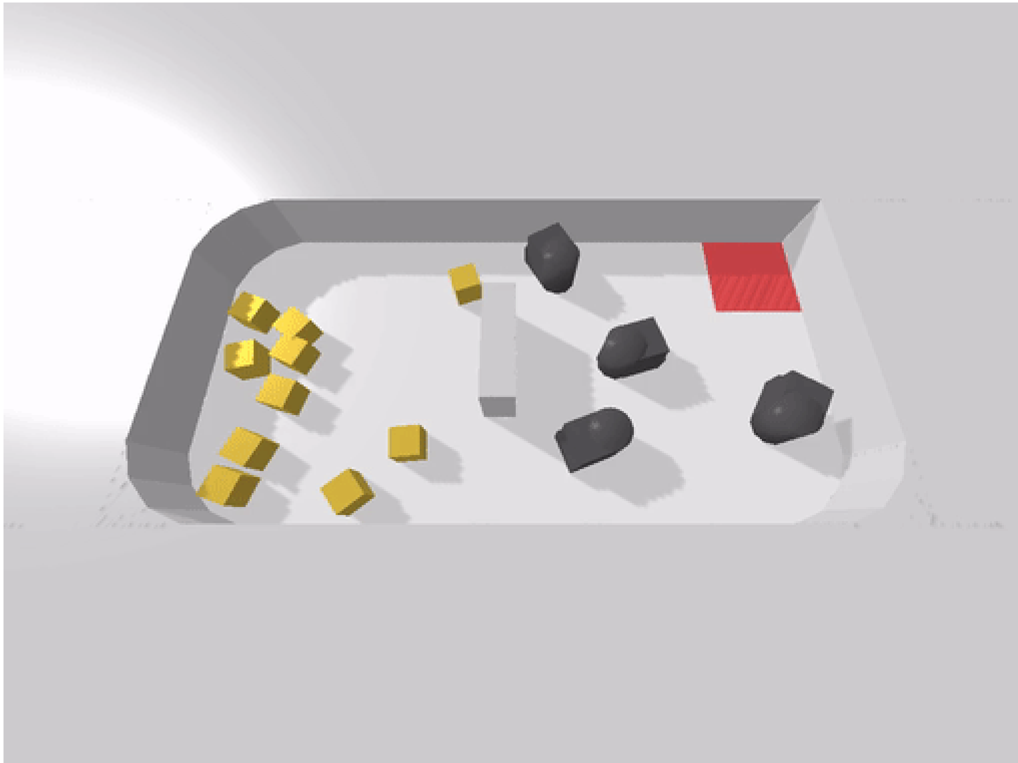
Test results

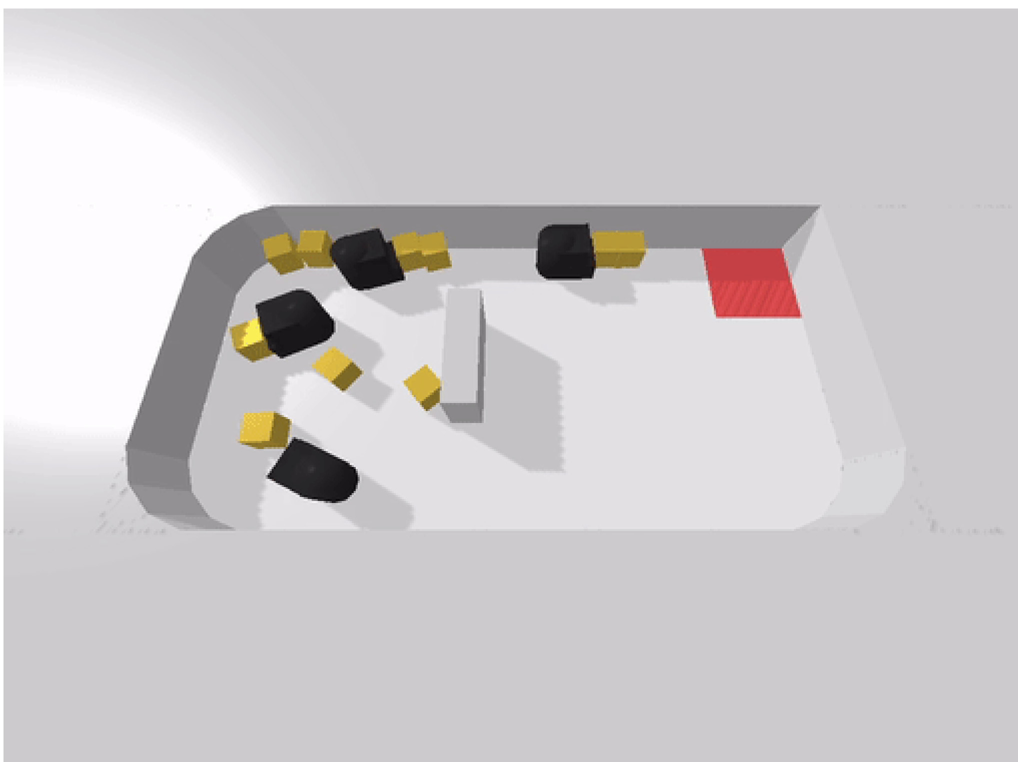
We used a pre-trained model and fine tuned it in order to generalize it more in order to make the multi-agents also solve different problems with the same wildfire abstractions (saving assets and targets, moving obstacles, …, etc), the results of our tuning can be represented by running the code, as we can't train the agents due to the lack of computing resources (12GB GPU for example :D), as for running the code having a normal CPU can get the job done.

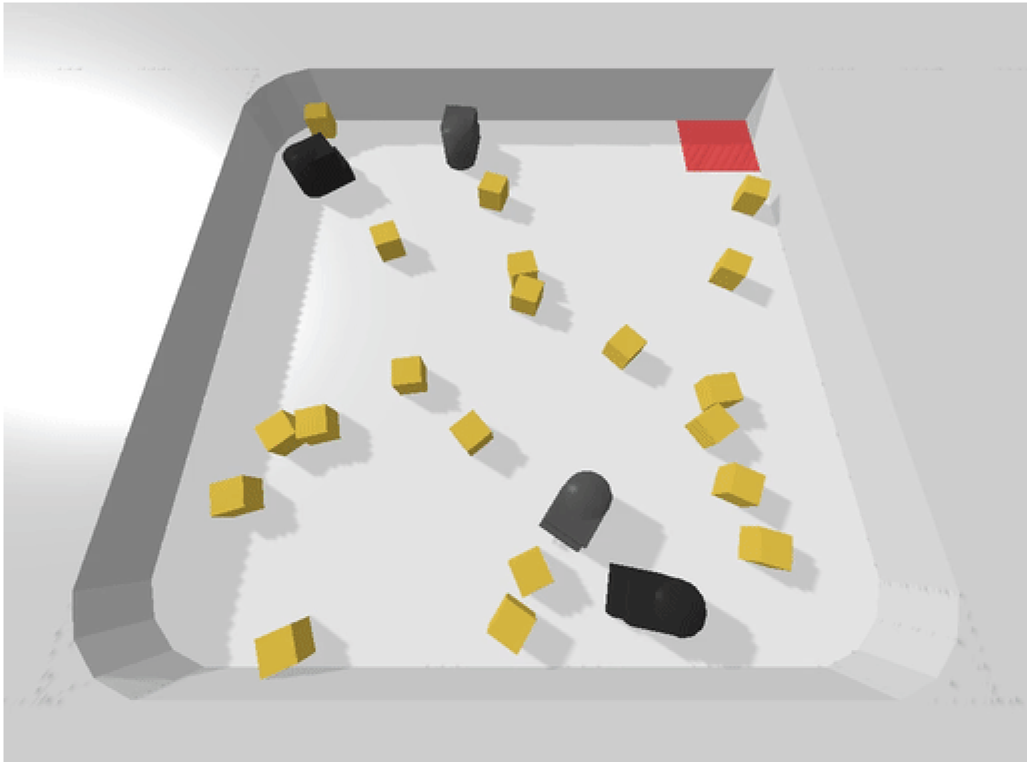
Pre-Trained Model architecture

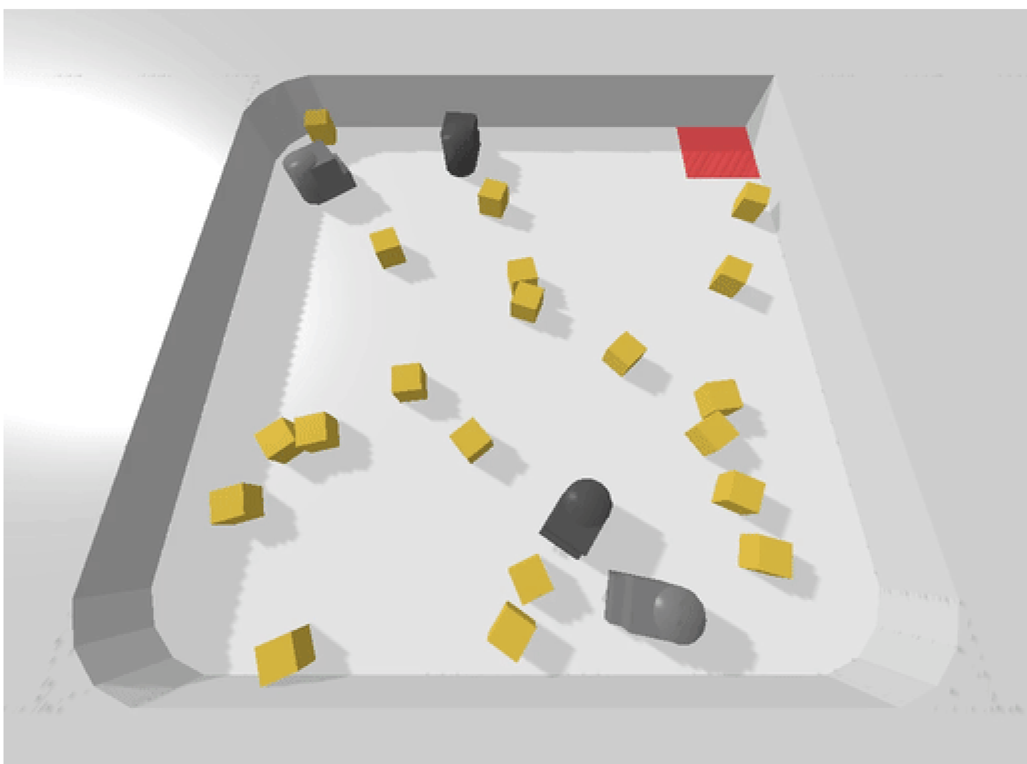


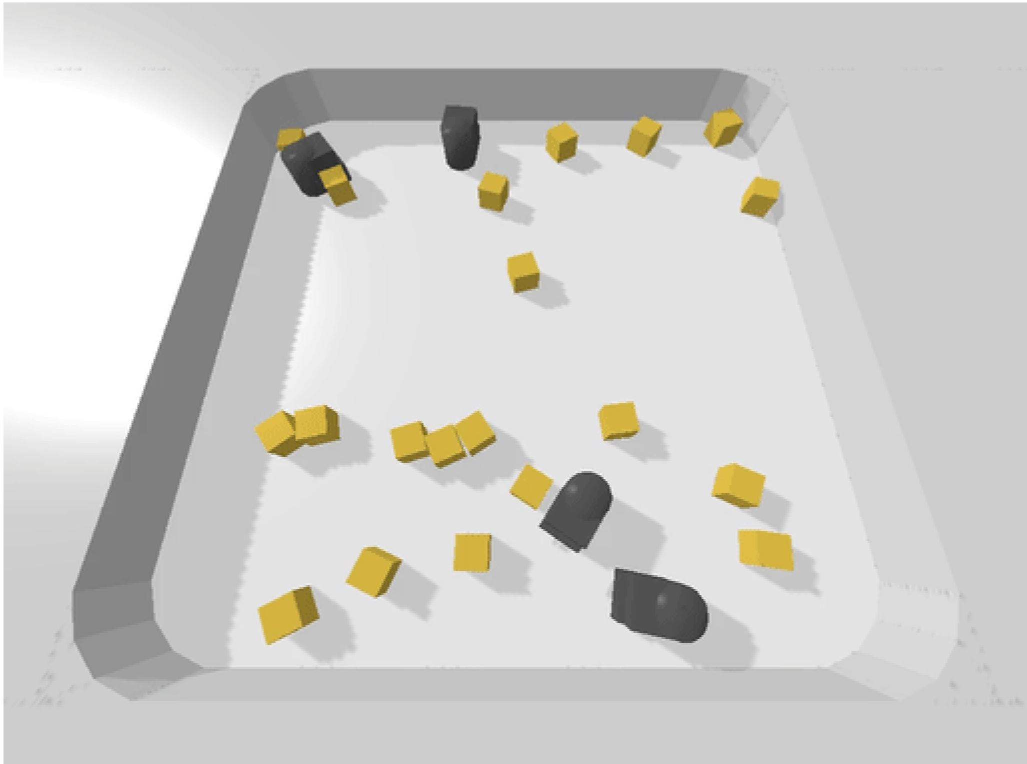
Here is a GIFs to show how well the agents do in a simulated environment:

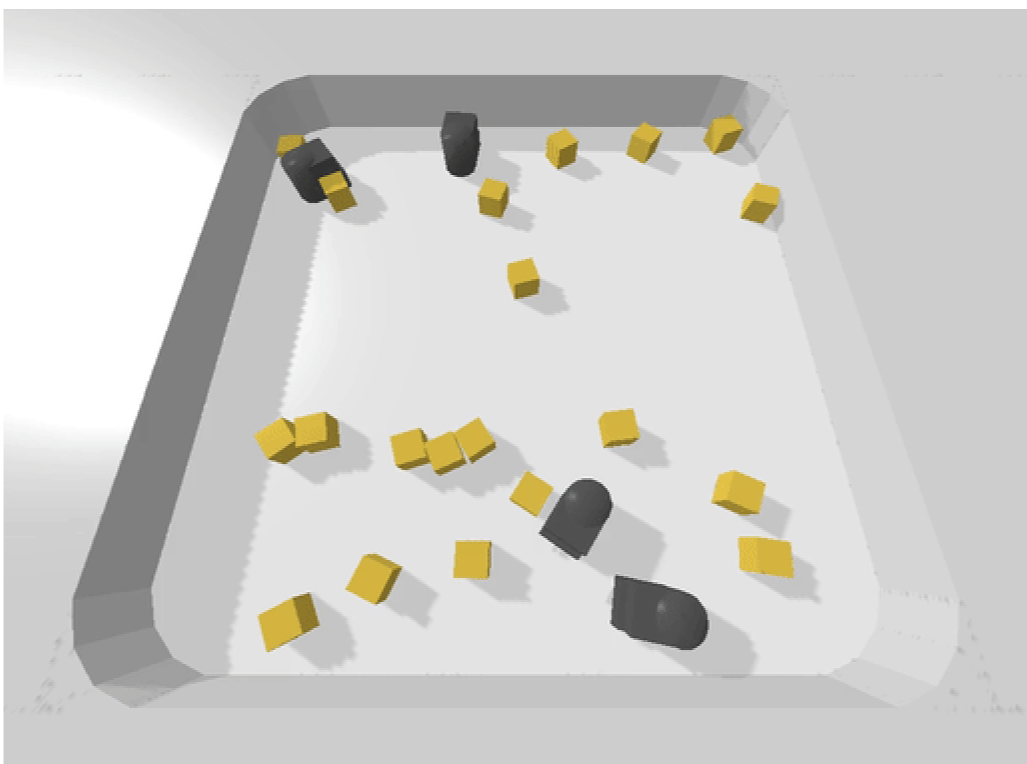












References

- https://spatial-intention-maps.cs.princeton.edu/paper.pdf
- Spatial Intention Maps for Multi-Agent Mobile Manipulation
- GitHub - jimmyyhwu/spatial-intention-maps: Learning multi-agent robotic mobile manipulation with deep reinforcement learning
- Spatial Intention Maps for Multi-Agent Mobile Manipulation
- Multi-agent Robotic Systems in Collaborative Robotics | SpringerLink
- EMERGENT TOOL USE FROM MULTI-AGENT AUTOCURRICULA
- AlphaStar: Grandmaster level in StarCraft II using multi-agent reinforcement learning | DeepMind
- Convolutional Neural Networks for Automatic State-Time Feature Extraction in Reinforcement Learning Applied to Residential Load Control
- An Aircraft Detection Framework Based on Reinforcement Learning and Convolutional Neural Networks in Remote Sensing Images
- Spatial Action Maps for Mobile Manipulation