岡山大学
OKAYAMA UNIVERSITY

Multi-Agent Drone Routing Problem

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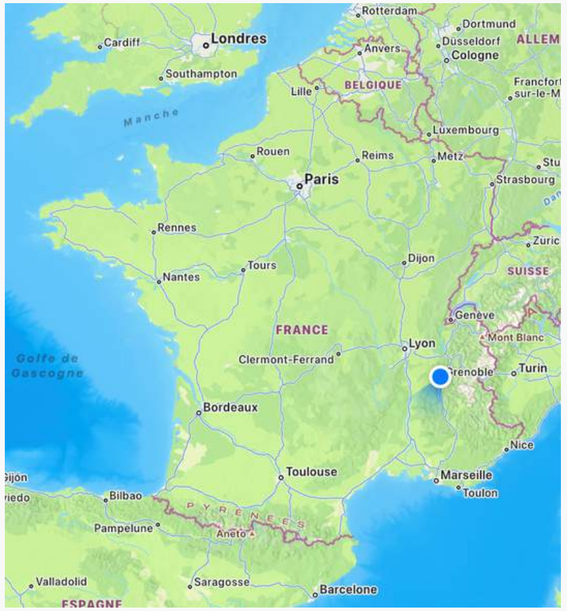
Under the supervision of: Professor Donghui LIN and Kaji MASAHIRO

GRENOBLE INP UGA Ense3

Contents

Introduction

About where I come from: Grenoble, France



- Grenoble is known as the capital of the French Alps
- Grenoble INP ENSE3, UGA (school of water, energy and environment) is ranked at 31/170 in the national engineering school ranking (2024)
- The school is affiliated with UGA (University of Grenoble Alps), which is ranked in the top 150 of the Shanghai ranking
- ~300 graduate students per year

Some majors at ENSE3

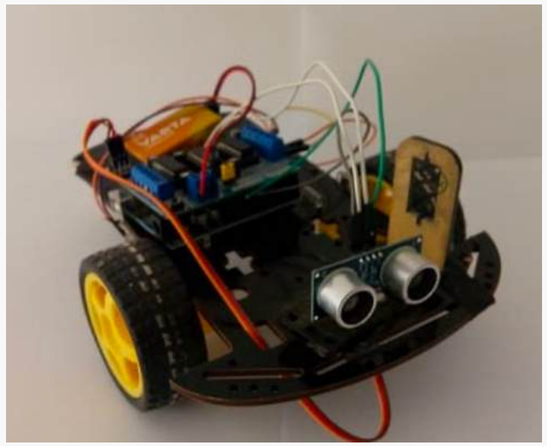
- Hydraulic & Fluid mechanics
- Energetic mechanics
- Automatic & Intelligent systems
- Electrical engineering
- Nuclear Engineering

Introduction

Some related projects I have done

Hackathon about safety and prevention

- The idea for this hackathon was to imagine sentinel drones that would scout forests to detect any start of fire
- Drones could detect them using thermic sensors and eventually prevent them with nitrogen projectiles
- They would also be able to exchange information between them to coordinate scouting and fire prevention
- This idea earned me and my team the 20th position (out of 200 teams)



Ense3's robotic competition

- A friendly competition between fellow students in order to master a robot's equipment (such as the above)
- The competition uses several exercices, including the robot's ability to follow a line using its light sensors, to avoid an obstacle and also to meet a designated point in space using coordinates.

Introduction

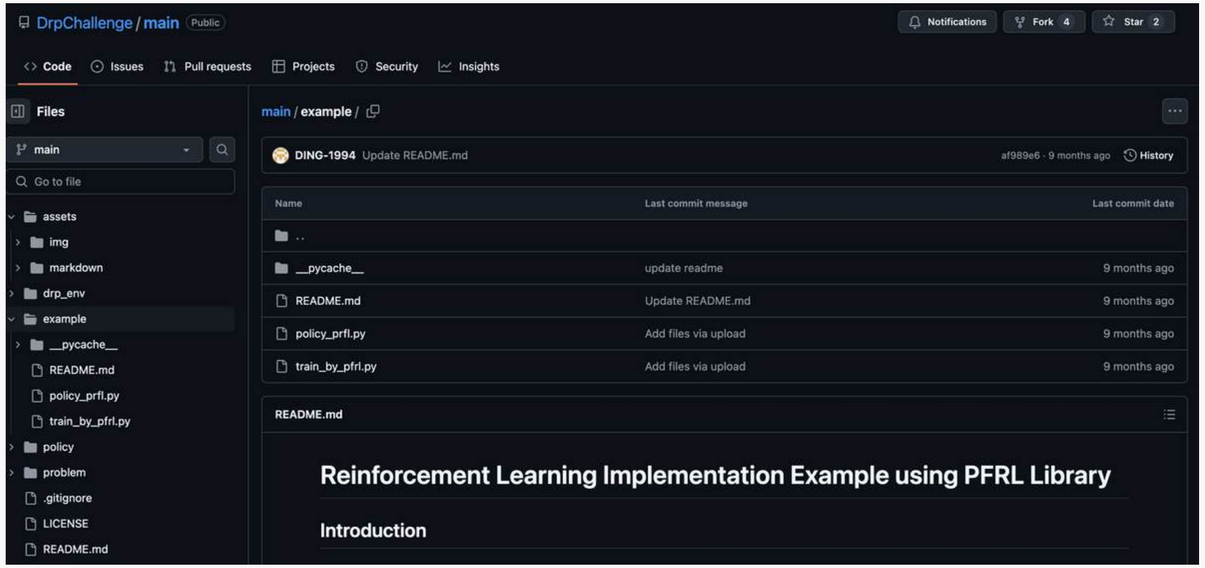
- Okayama University is ranked 21st in Japan (Time Higher Education)
- 11 Faculties
- 13 000 students & 1 700 faculties members
- Its international influence is growing through its exchange students programs but also its collaborative research. In 2024, 45 French students participated to those research internship and 60 are expected in 2025

Context

- Drone routing problems (DRP) have become popular for its possibilities in last-mile delivery usages.
- DRP holds the ability to be an ecological and economic solution for short distance deliveries.
- Several well-known companies took interest and have invested in drone technology, such a as Google, Amazon, UPS…
- Several literacy reviews regarding DRP have been published

Context

- Simulations such as the one used for this internship serve as models to study and find applicable solution to real cases
- The goal of this internship is to provide a new framework to work in order to do research on DRP, to make that framework more realistic and provide new possibilities
- The base code is from DRP Challenge: https://drp-challenge.com/#/



GitHub of DRP challenge's base code

Context

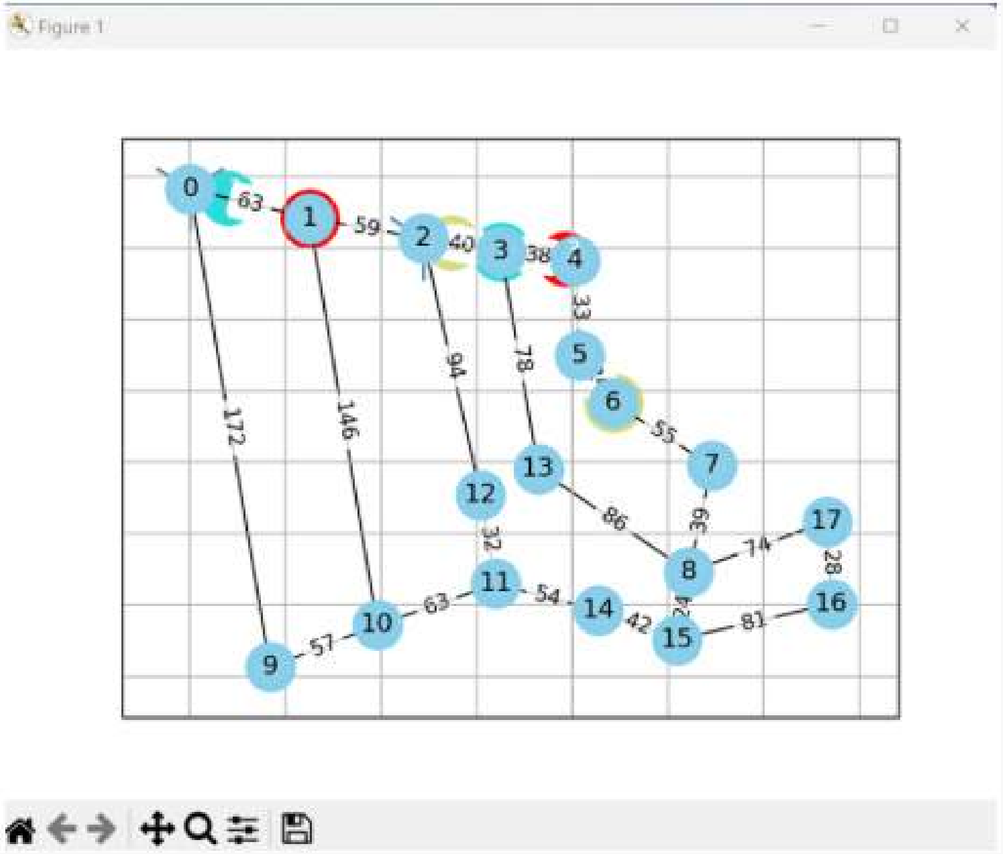
The code's structure

The code is separated in two main files:

- EDRP, which generates the graph from a csv file, updates the simulation and manages the agents' policy
- Epymarl, which trains the agents throughout the simulation and records the results of the simulation

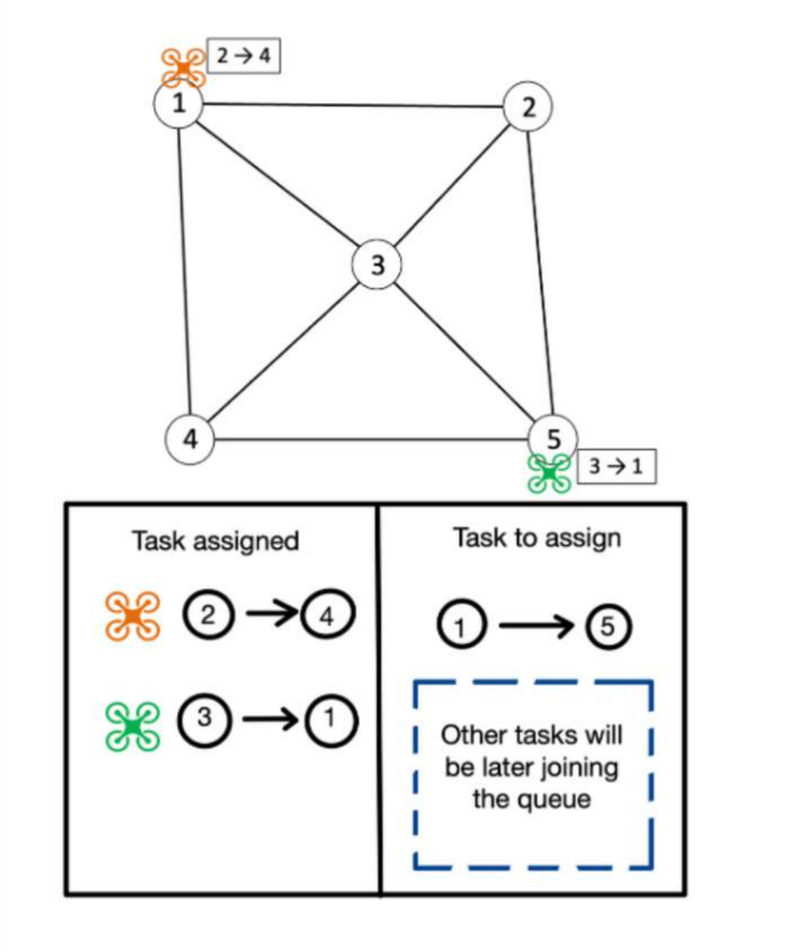
The agents follow some rules:

- When engaged in an edge, an agent can not go back
- A collision with 2 agents will immediately end the episode
- As of now, terminating a task will put immobilize an agent until the next episode



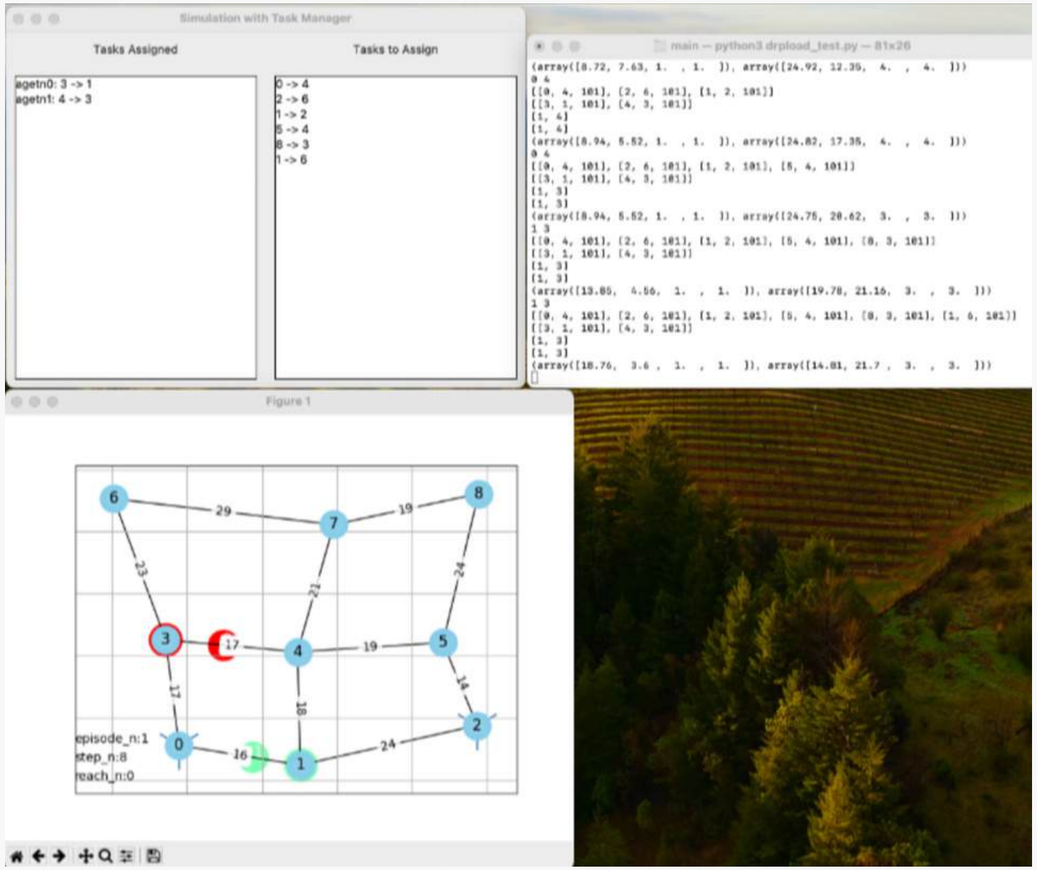
An example of a map used for simulations

Part one: improving the environment

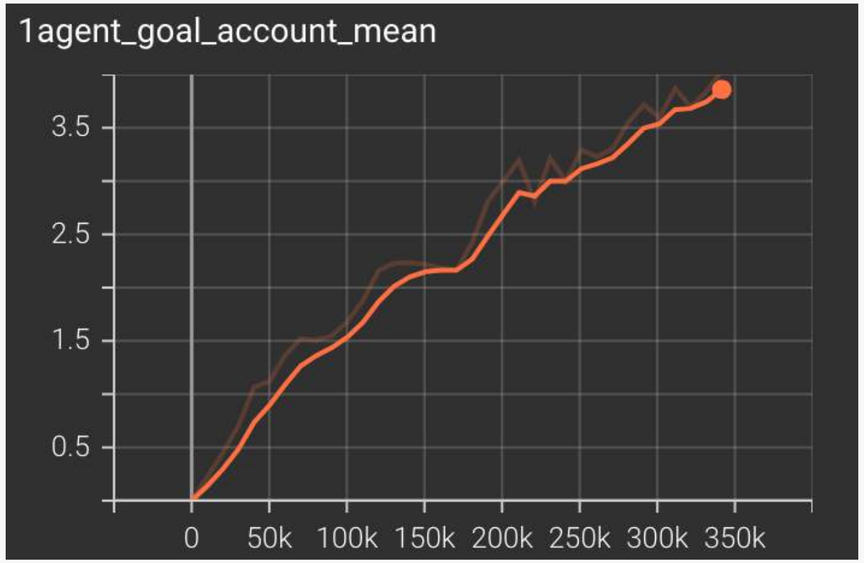


- The goal of this first internship is to improve the simulation’s environment; to make it more realistic
- One idea to do so is to enable agents to perform multiple tasks in one episode, to mimic last delivery systems.
- A task list would be created, where the non-assigned tasks are created and stored
- The task are generated randomly during each episode
- the agents would get assigned a new task when they finish their current one

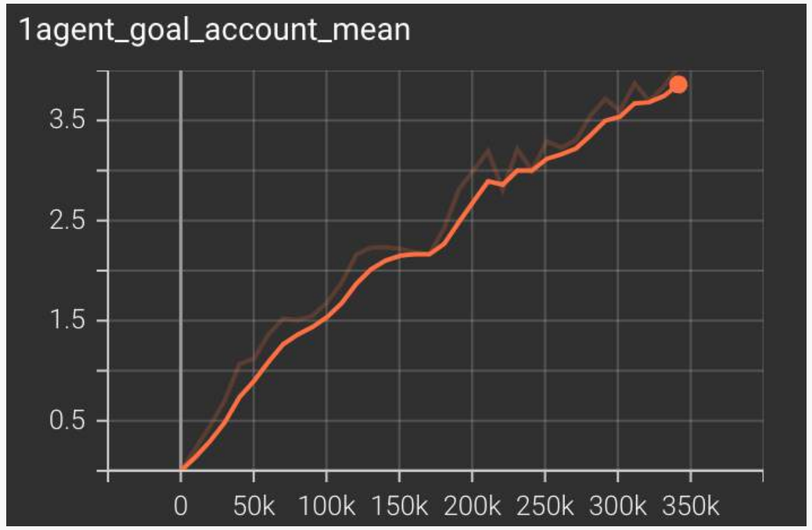
Results



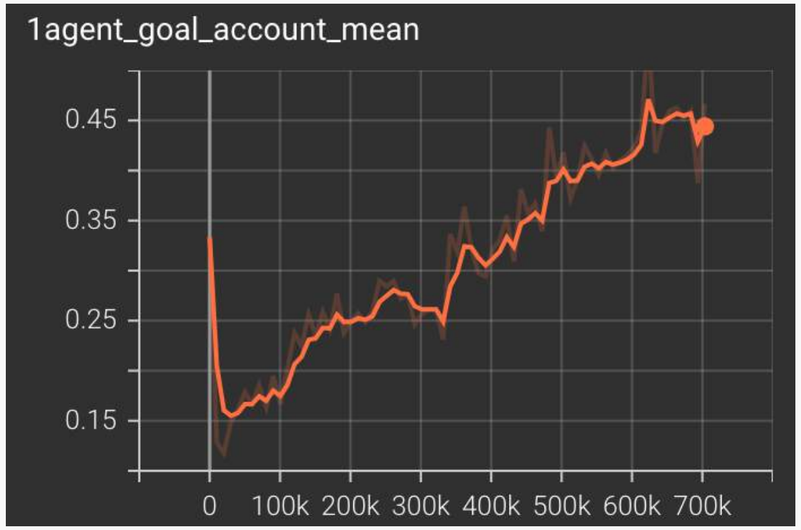
Final Result for the first internship



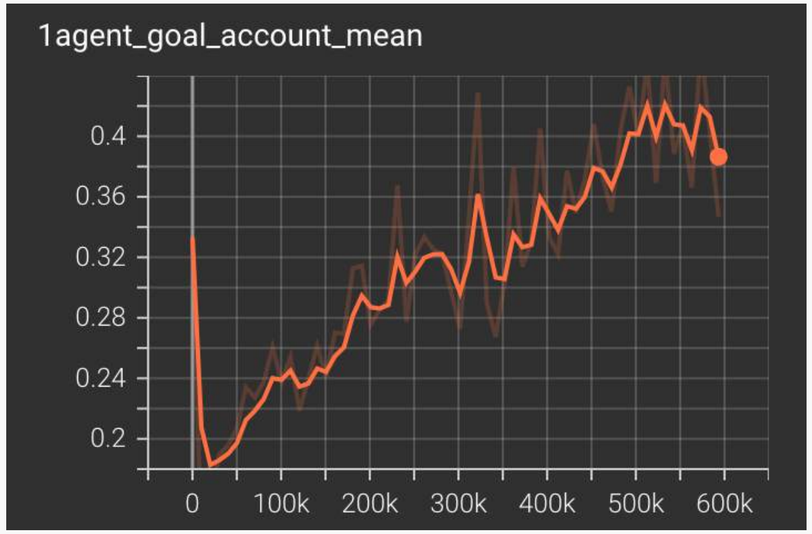
- The simulation now has three windows: the environment window, the GUI window for the task list and a text box to manually input tasks.
- Some secondary features could not be implemented in time.
- Currently, the tasks get assigned randomly between the agents.



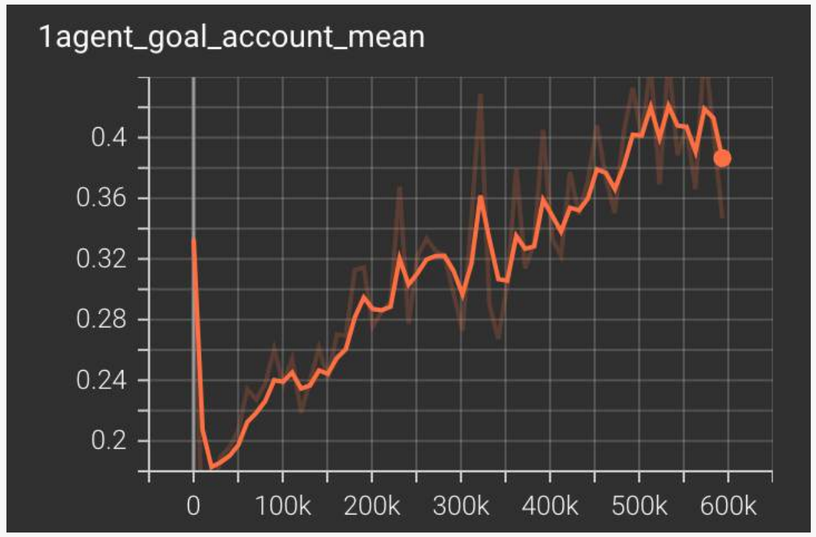
Map 5x4



Map Kyodai



Map Shibuya

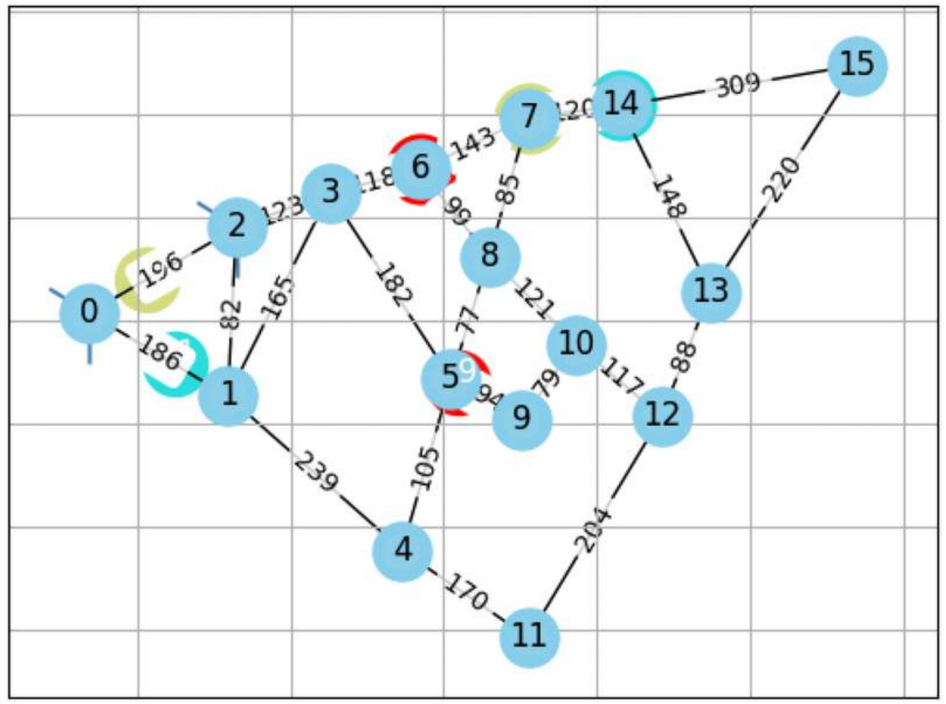


Map Paris

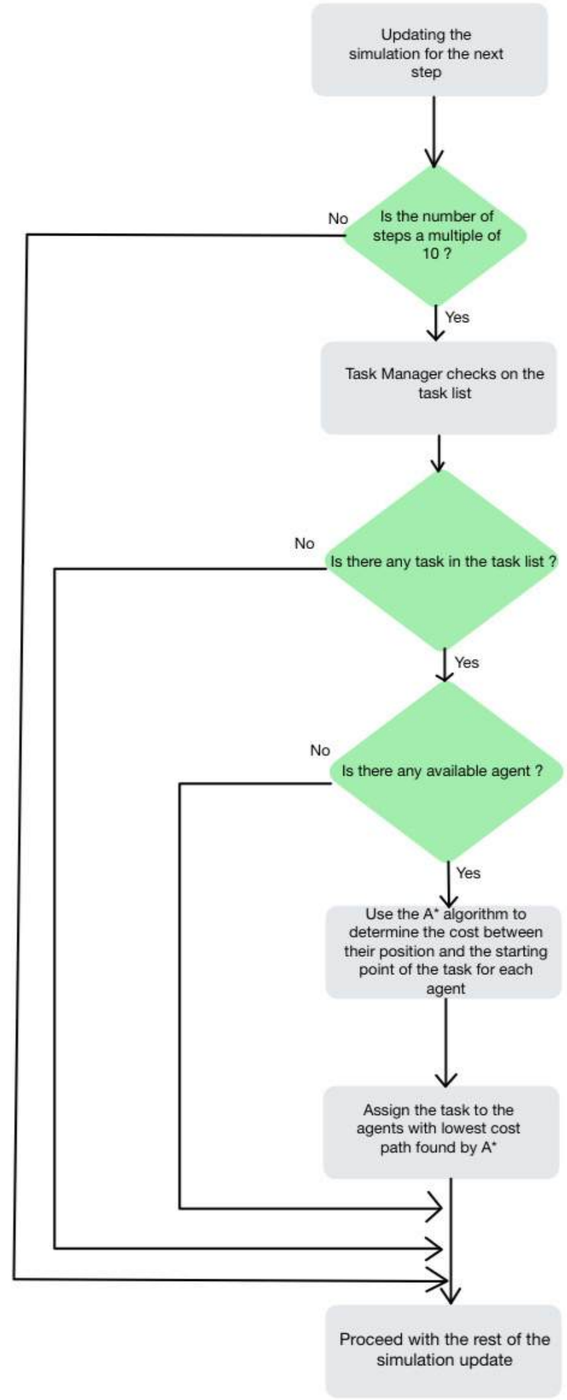
Part two: How to improve the task manager ?

- The agents are now able to perfrom multiple tasks in one episode. However the decision-making related to the Task Manager can still be improved since it is only randomly assigning tasks so far.
- The goal of the second internship is to improve the Task Manager in its decision making in order to have optimal decisions when it comes to agents and their respective optimal paths
- Evaluation criterion regarding a simulation will this time not only be focused on average collision, but also the average tasks completed per agent
- The overall of the simulation is the same: to improve the environment the agents are training in

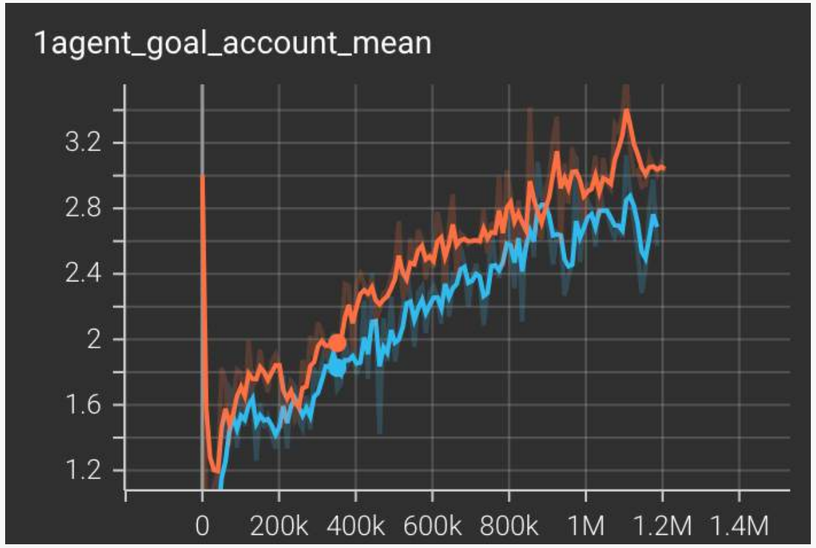
- Some algorithms from Multi-Agents Pick-Up & Delivery research papers were considered, but the A* star algorithm was chosen for the decision making.
- Although the A* algorithm calculates the optimal path for each available agent, it does not communicate said path to any agent since the main goal is to train those agents
- The Task Manager is being activated every 10 steps

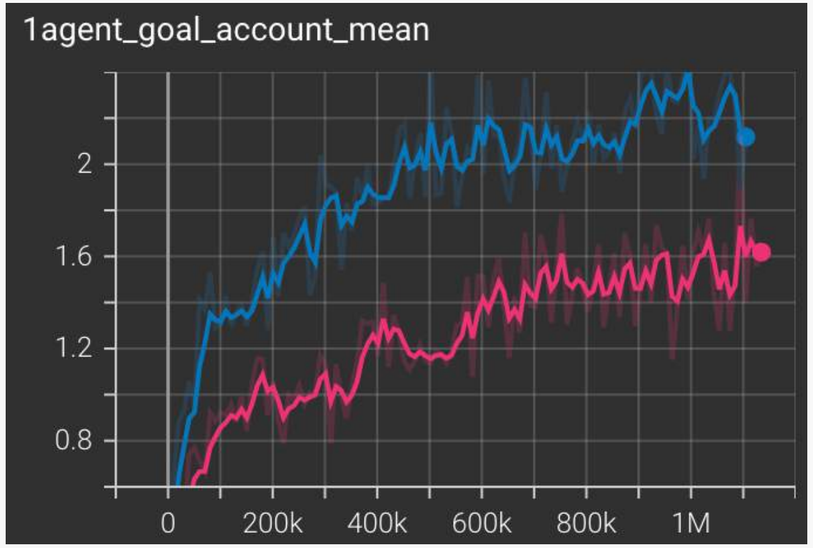


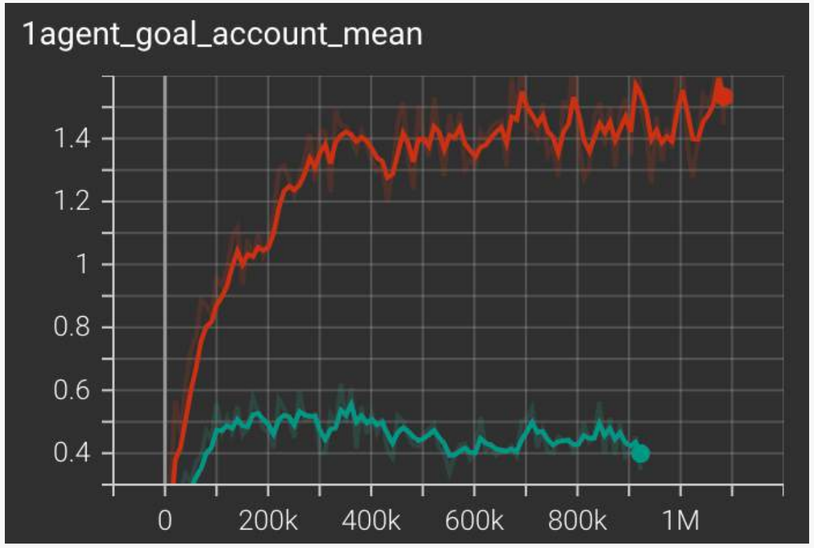
map of Paris



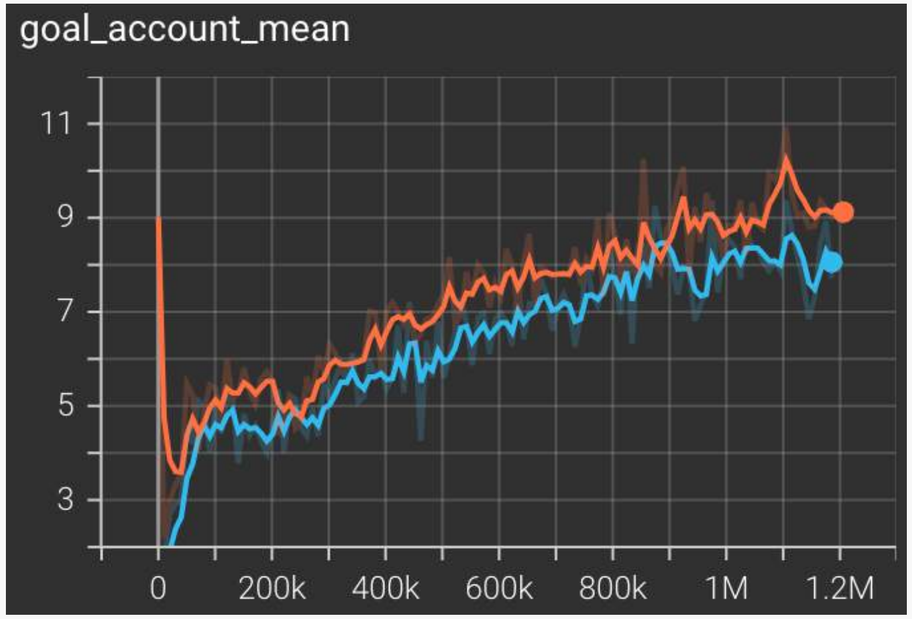
Task assignment algorithm structure







- The simulations shows that implementing the A* algorithm increase the average number of tasks accomplished per agent.
- The higher the number of agents (i.e of candidates) the higher the wider the gap between the simulation with and without A*.


goal_account_mean
11
9
7
5
3
0
200k
400k
600k
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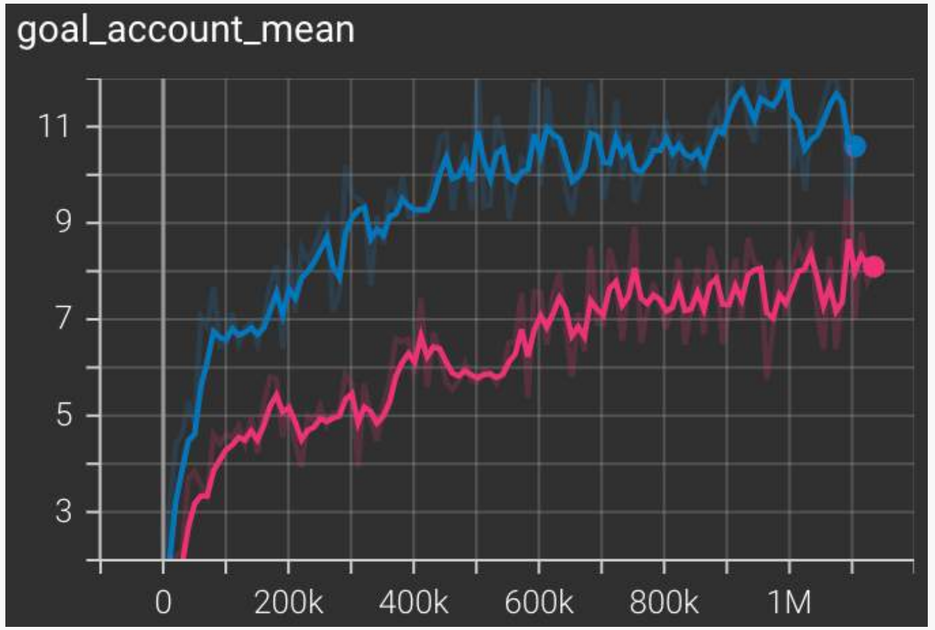
1M
1.2M


goal_account_mean
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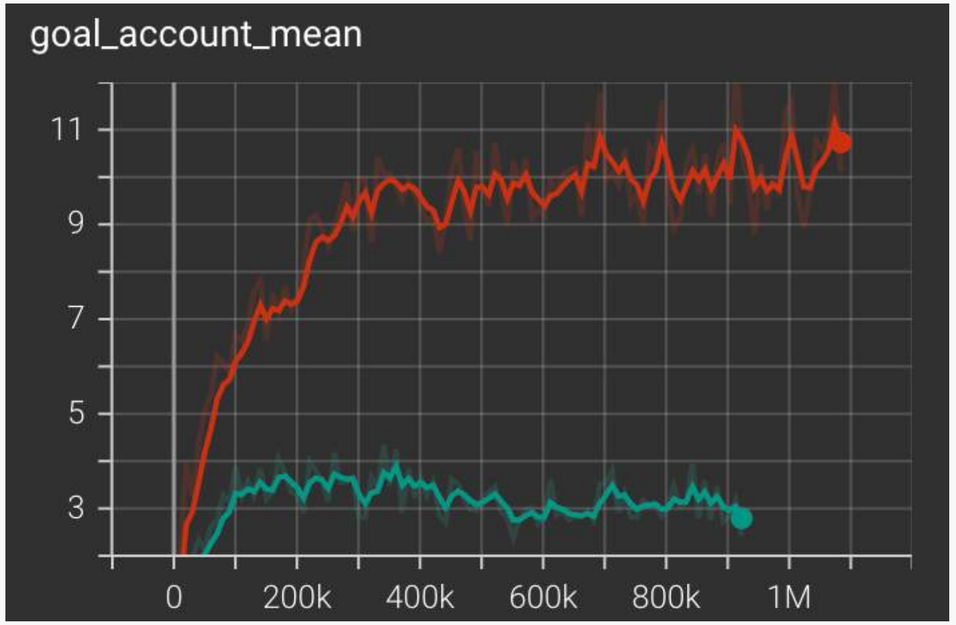
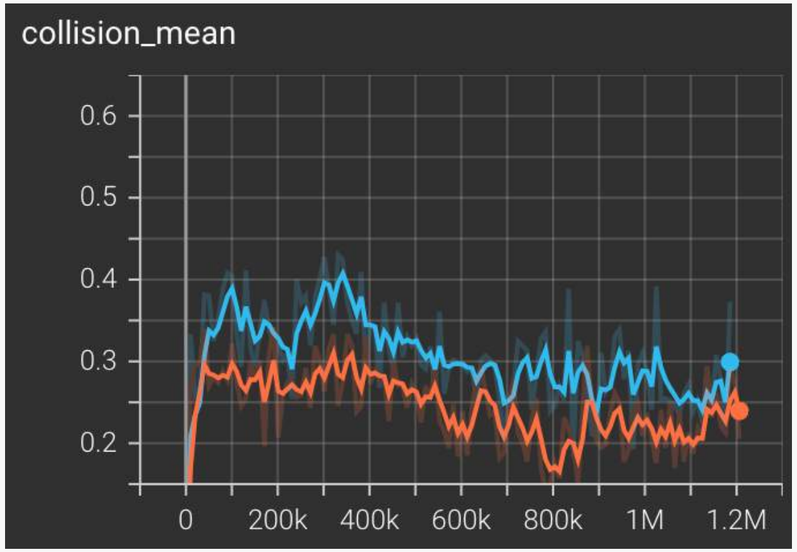
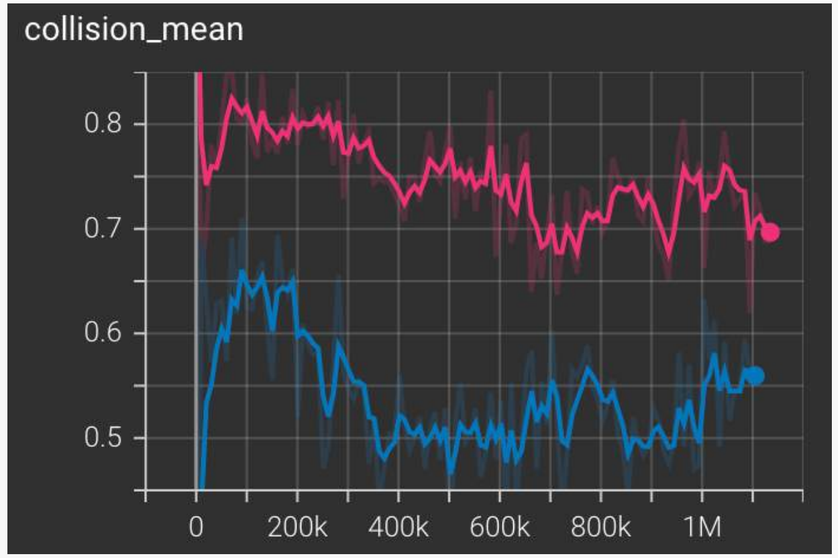
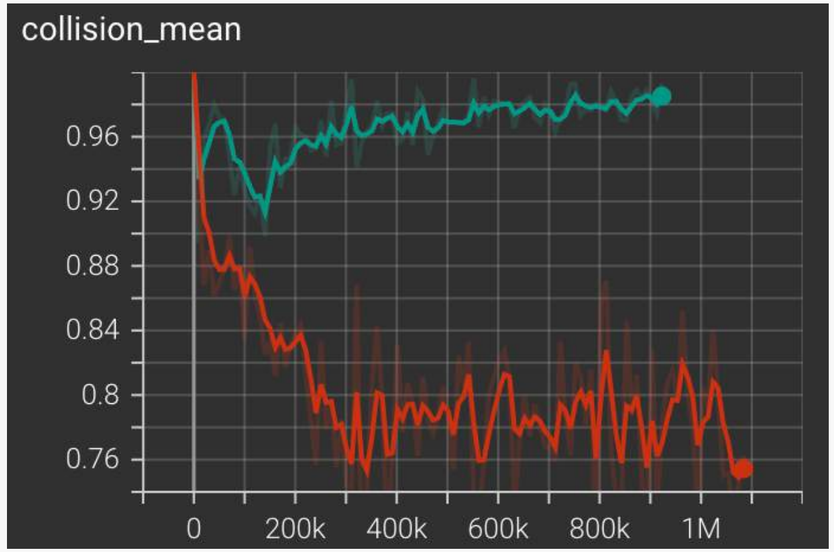

goal_account_mean
11
9
7
5
3
0
200k
400k
600k
800k
1M


3 agents, A star
5 agents, A star
7 agents, A star
3 agents, random assignment
5 agents, random assignment
7 agents, random assignment







- Since the Task Manager is supposed to assign the task to the agent with the shortest optimal path to the starting point of the task, the risk of a collision should also be lowered.

Conclusion

- Throughout those six months of internship, a task list and a Task Manager have been implemented in order to enable the agents to perform multiple tasks in one episode.
- The Task Manager has been furthermore improved to reduce delivery and make better decisions when it comes to task assignment.
- The improvement of this simulation serves as a base framework for other researchers in MADRP.


宝永第一火口縁
First Crater Rim of Hoei
宝永第一火山口边缘 호에이 제1화구 가장자리
富士宮口五合目
Fujinomiya Trail 5th Station 45分
富士宮口

Thank You

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