Project Motivation and Scope

Context: Predator / Prey Behaviours in Pacman - Market-Based Multi-robot Coordination utilizing **Auction Method**

- Used in **Robotic Domains** such as: Mapping + Exploration, Warehouse Logistics, Robot Soccer

Problem: Designing a team of robots to achieve a task impossible for a single robot to solve. **2 Main strategies:**

- **Fully Centralised:** Single controlling Agent. **+:** Optimal Plan given full state info. **-:** Large not feasible, Single point of failure.
  - Best for: Smalls teams in Static environments with easily Accessible state information. E.g. a
- **Fully Distributed:** **+:** Fast, Flexible, Robust to failures. **-:** Can be highly suboptimal as best local solution **!=** global.
  - Best for: Large teams carrying out simple tasks. E.g.
- **Market-Based** is a **Hybrid** of these. **+:** Best of Both Methods. **-:** More complex to implement if not needed.

Idea: Team of robots given an objective to solve. **Definition**:

- **Team given an objective:** (e.g. Win a game of soccer / Capture Pacman), decomposed for each robot / subteam of robots.
- **Global Objective Function:** Quantifies **designers** prefs for solutions (e.g. Score more goals / Find + Capture Pacman)
- **Individual Utility Function:** Quantifies **robots** prefs for resource usage / contributions (e.g. Attack or Goalkeep / pathfinding)
  - Individual utilities can be combined into subteam utilities (e.g. Attacking subteam, Defending subteam / Team of n ghosts)
- **Mapping defined between: Team objective function & Individual / Subteam utilities.**
  - Addresses resource management to overall solution.
- **Auction Method:** Redistribution of Resources and Objective (Traded commodities)
  - Input: Teammate Utilities. Output: Outcome maximising utility of Controlling Agent.
  - Individuals plans the achievement of the tasks, computes its costs, and encapsulates the costs in its bids.

Beneficiaries:

- Complete tasks faster. Increase system robustness, improve solution quality and achieve tasks impossible for a single robot.
- Benefits: Mapping + Exploration (Maps, Disasters, Planetary), Logistics (Warehouse, Factories), Robot Sports, Drones.

Current Challenges

Learning:

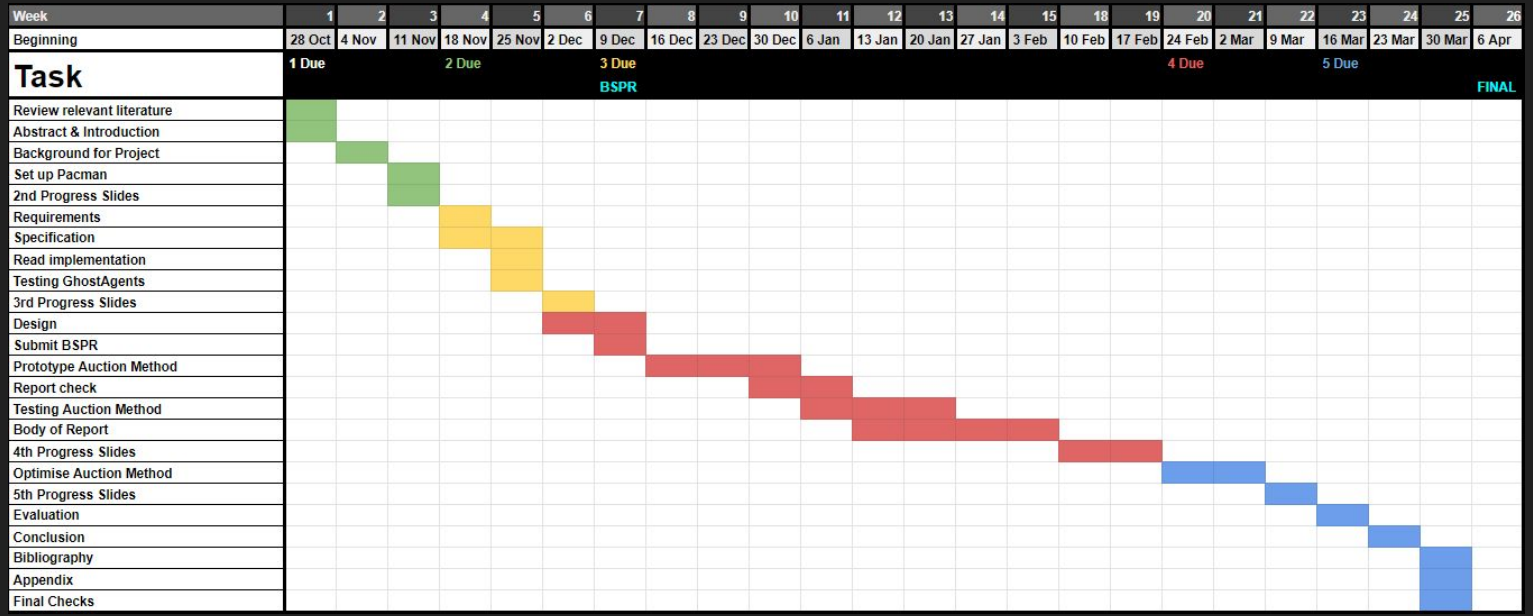
- Understanding history of Multi-robot Coordination.
  - How did people coordinate robots in a team environment?
- How is a global task defined algorithmically?
- Learning coordination algorithms used for robots.
- Pacman = Homogeneous team, not Heterogeneous, however “heterogeneity is a highly desirable in many teams”
  - Moreover, it is often simpler to design robots that specialize in a small set of skills than to design robots capable of all skills.
- Understand Planning with centralised approaches.
  - Understanding Allocate-then-decompose vs Decompose-then-allocate methods. How would I implement Task Trees?
- How would I implement the Auction Method in the pacman package.
  - Would it be recommended to use some existing api?
- Implementing the Auction Method algorithmically in python.
  - How would I start?

Reading:

- **Read:**
  - Market-Based Multirobot Coordination: A Survey and Analysis.
- **Current:**
  - Market-based Multirobot Coordination for Complex Tasks.
- **To read:**
  - A Survey and Analysis of Multi-Robot Coordination
  - Multi-robot Coordination with Counting Temporal Logics
  - TraderBots: A New Paradigm for Robust and Efficient Multirobot Coordination in Dynamic Environments.
  - Techniques for Multi-Robot Coordination and Navigation - Kai M. Wurm

Future Planning

Overall Planning:



Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	18	19	20	21	22	23	24	25	26
Beginning	28 Oct	4 Nov	11 Nov	18 Nov	25 Nov	2 Dec	9 Dec	16 Dec	23 Dec	30 Dec	6 Jan	13 Jan	20 Jan	27 Jan	3 Feb	10 Feb	17 Feb	24 Feb	2 Mar	9 Mar	16 Mar	23 Mar	30 Mar	6 Apr
Task	1 Due			2 Due			3 Due BSPR											4 Due			5 Due			FINAL
Review relevant literature																								
Abstract & Introduction																								
Background for Project																								
Set up Pacman																								
2nd Progress Slides																								
Requirements																								
Specification																								
Read implementation																								
Testing GhostAgents																								
3rd Progress Slides																								
Design																								
Submit BSPR																								
Prototype Auction Method																								
Report check																								
Testing Auction Method																								
Body of Report																								
4th Progress Slides																								
Optimise Auction Method																								
5th Progress Slides																								
Evaluation																								
Conclusion																								
Bibliography																								
Appendix																								
Final Checks																								

Next Steps:

- Read additional papers on Multi-robot Coordination.
- Start organising structure of the report.
- Write out the Abstract and Introduction of the report.
- Background research and report write up of Background section.
- Reviewing relevant literature, websites and videos on Multi-robot Coordination
- Setting up Pacman in VSCode and Github
- Work on 2nd Progress slides