Obligatory assignment 2 in TEK5010 Multiagent systems 2023

Report delivery date November 8 by e-mail to hjmoen@its.uio.no.

The report should contain answers to all the questions, include discussions on simulation results in the form of graphs, tables or figures, and an appendix with the simulation program code. The report should be delivered as a pdf file. You can use any programming language of your choosing for this oblig.

Search and task allocation in multiagent systems: Game theory

Background

In the obligatory assignments this year we are going to explore Search, Task Allocation and Completion (STAC) problems in multiagent systems (MAS). STAC problems are considered a general class of problems in MAS and many real-world problems could be formulated as a STAC problem. See Ijspeert et al. for an example of STAC experimenting in swarm robotics [1] and Minos-Stensrud et al. for a generalized analysis of STAC problems [2].

In the first oblig we are going to study STAC in relation to reactive agents, i.e. swarm intelligence, and in the second oblig we are going to employ interactive agents, i.e. game theory, for solving the same STAC problem. The goal is to analyze how these two MAS concepts differ and to understand when it is appropriate to employ the different algorithms under varying STAC conditions. The main focus will be to analyze how the agents' ability to share information affects system performance in STAC problems.

Definition of the search and task allocation problem:

The *search area A* is a bounded square spanned by the two points (0, 0) and (1000, 1000).

The *tasks T* are randomly distributed over the search area. As soon as a task is completed a new task is spawned at a random position in the search area. The tasks have a task capacity Tc indicating how many agents that are required to solve a task, e.g. Tc=3 means that 3 agents are required to solve the task. The task is automatically completed if Tc agents are within the task radius Tr.

The *agents R* move randomly around the search area at a speed Rv. When an agent is inside the task radius Tr of a task, the agent will stop and wait for other agents to complete the task. The agent could also call for help by engaging in communication with nearby agents. The communication distance Rd determines the information sharing process between agents, e.g. Rd=250 means that any agent that is within distance of less than 250 from the agent will hear the communication signal. The information communicated and corresponding response will depend on the STAC condition and choice of MAS algorithm employed.

Questions

a) In this oblig 2 a simple auction is to be implemented in the STAC problem. Every time a new task is discovered an auction is to take place among the agents within communication range. The agent who discovered the task is the auctioneer and the bidders are the helping agents. The helping agents use the distance to the newly discovered task as their bid in the auction. The auctioneer will recruit helping agents based on their bid in order to have enough agents to solve the task (including the auctioneer). Could you implement such a simple auction and test it using parameters T=2, Tr=50, Tc=3, R=30 for communication distance Rd=0, 100, 200, 300, 400, 600, 1000 and 1400?

b) Compare your results to the results obtained in oblig 1 e) and f). Comment on your findings.

c) If an interactive agent cost twice as much as a reactive agent, could you plot a graph comparing the two system designs? Comment on your findings.

References

[1] Auke Jan Ijspeert, Alcherio Martinoli, Aude Billard and Luca Maria Gambardella, "Collaboration through the exploitation of local interactions in autonomous collective robotics: the stick pulling experiment", Autonomous Robots 11, 149–171, 2001. https://doi.org/10.1023/A:1011227210047 or http://people.idsia.ch/~luca/AR2001.pdf

[2] M. Minos-Stensrud, H. Jonas Fossum Moen and J. Dyre Bjerknes, "Information sharing in multi-agent search and task allocation problems," 2021 IEEE Symposium Series on Computational Intelligence (SSCI), Orlando, FL, USA, 2021, pp. 1-7, doi: 10.1109/SSCI50451.2021.9660121.