Project Proposal - DD2380 Artificial Intelligence

Group “Project 22”		
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Brief description

In this exercise, the aim is to create a program that let a set of robots to paint floor tiles in a predetermined pattern. From the original description of the problem (please find it here), we learned that robots can move around in four directions (right, left, up, down), alternate (and paint) between two colors (black and white). The constraint (which ultimately makes the domain hard) is first, that the robots themselves should only paint tiles in front of them and second, that they cannot stand on tiles once painted. At first glance, this sounds like an easy planning exercise, however the reader should note that the problem remained unsolvable for three years; it was not until 2014 researchers managed to solve it.

Although we personally find the problem of great interest, we also note that a proper implementation could serve relevant elsewhere. For instance, in the context of air defense, we note that similar algorithmic solutions have proved influential in efforts of optimizing planning of missiles (here).

Method/ case study

Formulated as a PDDL (Planning Domain Definition Language) i.e. encapsulating initial state, actions, constraints and goal(s), the focus will be to conduct an empirical study, examining the influencing factors contributing to the so-called “dead-ends”. For this, we will experiment by varying a predetermined set of parameters and thus achieve a better understanding of the performance limits of the domain at hand. Naturally, there is plentiful of parameters to try, where we have initially decided to focus on painting patterns, # of robots, size of grid, moving patterns. Additionally, we will consider extreme cases, that is, for example, when above mentioned variables are tested in exaggeration. We aim to vary different subgoals that could be desirable by the domain as well, e.g. minimise CPU time vs minimise # of moves of robots.

Concepts

To successfully execute this problem, we plan to study a set of topics. Most broadly, we believe that “multi-agent systems”, defined as “a computerized system composed of multiple interacting intelligent agents within an environment “ is highly relevant for our project. While we will start off by writing action schemas as if the agents, or robots if you will, acted fully independently (decentralized motion planning), we admit that concepts of coordination/ and communication will become important, if only for our understanding. Subsequently, these areas will also be subjected to review.

In previous successful attempts (here), we additionally learned that specific algorithms such as depth-unbounded search was used. Thus, this will be another area of study. Ideas from ordering or “forced Goal Ordering” will also be examined in the heart of this project.

References

Please find core literature listed below;

- Jiangfeng et al (2013) “Heuristic Search for Planning with Different Forced Goal-Ordering Constraints” (here).
- Zhou et al (2015) “Planning as tabled logic programming” (here).
- “Planning with Multi Step Forward Search with Forced Goal-Ordering Constraints” (here).
- Russell, Norvig (2013) "Artificial Intelligence: A Modern Approach" (here).

Evaluation aim

For this project, please find summary of ambition level as follows: Technical depth (Dp): **2** (needed), Technical breadth (Br): **2** (needed), Implementation (Im): **2**, Analysis and Discussion (An): **3**.

Tasks at completion

At 50%:

- Translate the problem to a PDDL planning
- Fully conducted research, literature review and methods included
- Design prototype of the final implementation
- Limited set of test cases, parameters for investigation of performance limits

At 100%

- Complete implementation of the project, optimization included
- Visualisation using an identified simulation tool
- Full evaluation of tests cases, analysis of influencing variables
- Complete the written report

Workplan

The following table explains the estimated time spent at each of the listed tasks, contributing this project.

Tasks	Time (ph)	Who
Complete project proposal and find literature relevant to concepts identified.	10	All
Read up on the articles identified in literature review	10	All
Formulate the problem as a planning problem.	5	Anna
Research simulators and custom built graphics.	5	Sandra, David
Design specification (languages, environment,...)	5	David
Formulate parameters for test cases.	5	Anna, Sandra
Implement formulated planning problem.	25	All
Try to formulate problem as an optimization problem.	5	Antoine
Try to solve this optimization problem using an appropriate implementation.	8	Antoine
Test different cases on both implementations	8	All
Suggest possible improvements, extensions etc.	4	All
Write project report	20	All
Prepare presentation	10	All
Total	120	