Multi-Agent Systems

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Exercise Sheet 5

Due: June 19th, 2017, 10:00

Exercise 5.1 (BDI Agents with Communication, 3+2+2)

We want to improve coordination between our agents in the Domination World. E.g., important observations should be relayed to other agents and the agents should agree upon which agent is responsible for which checkpoints (they even might agree to change this assignment over time). As a starting point, we provide a working implementation containing agents that already perform practical reasoning with the ability to explore the map and activate known checkpoints. In contrast to what you were expected to implement in Exercise 4.1, the computation of shortest plans is now done repeatedly and on the fly using a breadth-first search over the cells that are known to be empty, thus making collision avoidance more reliable. It can be found in the `ex05` folder of your group's repository. However, you're also allowed to extend your own implementation from Exercise 4.1.

(a) Design a communication protocol to negotiate which agent is responsible for which checkpoint. Make a short presentation (maximally three or four slides for a three to five minute talk) describing your protocol and discussing its advantages and disadvantages. Be prepared to present your protocol in the exercise session.

(b) Implement the communication as defined in your protocol.[1] If you decide to base your implementation on your submission for Exercise 4.1, you are nevertheless allowed to use arbitrary parts of our implementation (e.g., the shortest path implementations in `utils.pl`).

(c) Adapt the agents' practical reasoning to comply with the assignment of checkpoints as agreed on with the other agents.

Exercise 5.2 (Public Announcement Logic, 2+2+2+2)

We want to model and solve a simple logics puzzle using Public Announcement Logic (PAL).[2] Consider the following situation with two agents. Both have a number written on their forehead, which can only be seen by the other agent. It is also common knowledge between the agents that both numbers have to be consecutive integers between 0 and 9. Furthermore, let us assume that Agent 1 sees the number 4 on Agent 2's forehead. Now consider the following sequence of truthful announcements:

Agent 1: *"I don't know my number!"*
Agent 2: *"I don't know my number!"*
Agent 1: *"I don't know my number!"*
Agent 2: *"I don't know my number!"*
Agent 1: *"I know my number!"*

(a) Model the initial situation (prior to the announcements) as epistemic model M. Identify the worlds that Agent 1 considers possible, given the problem description (but not the dialogue).

(b) Model the announcements from the dialogue as epistemic formulas $\alpha_1, \ldots, \alpha_5$.

(c) Compute all the updated models M_{α_1}, $M_{\alpha_1\alpha_2}$, $\ldots$, $M_{\alpha_1\ldots\alpha_5}$.

(d) What is Agent 1's number? Will Agent 2 know his number in the end? Justify your answers!

[1] Look into the GOAL manual for information on how to implement commincation in GOAL.

[2] Different versions of this puzzle and their origins are discussed in the book *One Hundred Prisoners and a Light Bulb* by Hans van Ditmarsch and Barteld Kooi, Springer, 2015.