Multi-Agent Systems

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Exercise Sheet 4

Due: June 05th, 2017, 10:00

Exercise 4.1 (DominationWorld II, 4+3)

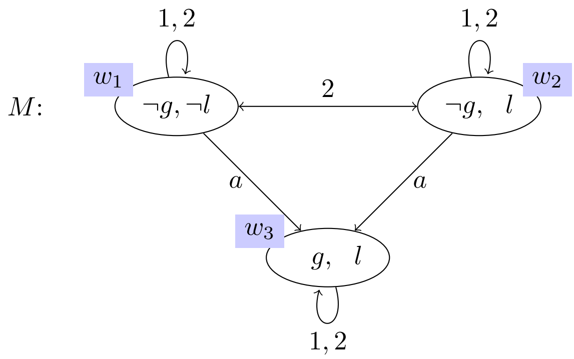
Your task in this exercise is to equip the DominationWorld agents both with the ability to find optimal paths and with a strategy to explore the map. You are allowed to extend your implementation from Exercise 3.1 or the sample solution provided in your repository.

(a) Implement the agents' ability to identify optimal paths from arbitrary cells on the map (which of course have to be at least accessible) to arbitrary checkpoints. To achieve this, you could, e.g., introduce a new predicate for memorizing the optimal known distances from arbitrary starting points to known checkpoints. In each knowledge update step you can then refine your knowledge about these distances from new observations and previous knowledge.

(b) Implement a reasonable exploration strategy. Your agents should always be aware of areas on the map that have still to be explored, if there are any. It might be useful to calculate optimal paths to fields that you plan to explore. To avoid agents blocking each other indefinitely you might want them to perform random actions from time to time. The goal of your agents is to completely explore the accessible part of the map. Afterwards, the agents should stop.

Exercise 4.2 (Model Checking, 2+2)

Consider the following Kripke model which contains two different kinds of accessibility relations. The equivalence relations 1 and 2 can be interpreted as *epistemic* indistinguishability relations for the knowledge of two different agents. The relation a can be interpreted as a *temporal* successor relation specifying the transitions resulting from the execution of an action a.



(a) Check whether or not the following is true. Remember that $K_i\varphi$ is a notation for $[i]\varphi$ and $\hat{K}_i\varphi$ is a notation for $\langle i\rangle\varphi$ (and equivalent to $\neg K_i\neg\varphi$). Write down all intermediate steps.

$$M, w_1 \models K_1(\neg l \wedge \hat{K}_2 l) \wedge [a](g \wedge K_1 l \wedge K_2 l)$$

(b) Assume that proposition g stands for "the garage door is open" and proposition l stands for "the light in the garage is on". Which story does the model tell us?

Exercise 4.3 (Tableaux, 2+2)

(a) Use the tableaux method from the lecture to prove that $\varphi_1 = K(p \wedge q) \rightarrow Kp$ is S5-valid.

(b) Use the tableaux method from the lecture to prove that $\varphi_2 = K(p \vee q) \wedge K\neg p$ is S5-satisfiable. Derive a S5 model M, w from your tableaux that satisfies φ_2.