Principles of AI Planning

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Exercise Sheet 2

Due: Friday, November 7th, 2014

Exercise 2.1 (Effect normal form, 2+2 points)

(a) Transform the operator

$$\langle \neg e \lor f, (a \rhd (b \rhd c)) \land (\neg d \rhd c) \land (\neg(\neg c \land \neg a) \rhd (d \land \neg e)) \land (d \rhd \neg e)\rangle$$

into effect normal form and simplify it as much as possible. For each step, state which one of the equivalences (3) to (9) from the lecture you use. To save you some writing, you may apply the equivalences (1) (commutativity) and (2) (associativity) without explicitly mentioning it.

(b) Transform the ENF operator

$$\langle \neg e \lor f, (((a \land b) \lor \neg d) \rhd c) \land ((c \lor a) \rhd d) \land ((c \lor a \lor d) \rhd \neg e)\rangle$$

into positive normal form. Again, in each step mark what you have done (e.g., "identify negative atom"). Remember that the transformation can destroy the ENF character!

Exercise 2.2 (PDDL and Fast Downward, 2+1+2+1 points)

The *set cover* problem can be formalized as follows: Given a finite set $\mathcal{U}$ and a collection of subsets $\mathcal{S} = \{S_1, \dots, S_n\}$ with $S_i \subseteq \mathcal{U}$ for all $S_i \in \mathcal{S}$, find a subcollection $\mathcal{C} = \{C_1, \dots, C_m\} \subseteq \mathcal{S}$ with $C_1 \cup \dots \cup C_m = \mathcal{U}$. The *minimum set cover* problem is about finding a *cardinality minimal* such subcollection $\mathcal{C}$. See `http://en.wikipedia.org/wiki/Set_cover_problem` for more details.

(a) Model the set cover problem as a PDDL domain using types `set` and `elem`, predicates `(contains ?s ?e)` for sets `?s` and elements `?e`, `(selected ?s)` for sets `?s`, and `(covered ?e)` for elements `?e`. Moreover, use a schematic operator `(select-set ?s)` for putting sets `?s` into subcollection $\mathcal{C}$, thus covering their elements. You will need universal and conditional effects for that. In order to be allowed to use them, specify the PDDL requirement `:adl`.

(b) Model the following set cover instance as a PDDL problem file: $\mathcal{U} = \{e_1, e_2, e_3, e_4\}$, and $\mathcal{S} = \{S_1, S_2, S_3, S_4, S_5\}$ with $S_1 = \{e_1\}$, $S_2 = \{e_2, e_3\}$, $S_3 = \{e_4\}$, $S_4 = \{e_1, e_2\}$, and $S_5 = \{e_3, e_4\}$.

(c) Solve the set cover instance from above using the Fast Downward planner (`http://www.fast-downward.org`). More specifically, make Fast Downward run A* search with the blind heuristic (i.e., basically breadth-first search) by specifying the search engine option `--search "astar(blind())"`. Report the plan found by Fast Downward and state to which set cover $\mathcal{C}$ this plan corresponds.

(d) Explain how the distinction between optimal and satisficing planning on the one hand and the distinction between arbitrary and cardinality minimal set covers are related, given the planning formalization of the set cover problem you used. Similarly, how are plan existence and existence of a set cover related in our setting?

You can and should solve the exercise sheets in groups of two. Please state both names on your solution.