Principles of AI Planning

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Exercise Sheet 11

Due: Friday, January 19th, 2018

Exercise 11.1 (Cartesian abstractions, CEGAR, and abstract costs, 1+2+6+1 points)

Consider the SDAC planning task with variables $\mathcal{V} = \{x, y\}$ with domains $\mathcal{D}_x = \mathcal{D}_y = \{0, 1, 2\}$, initial state $I = \{x \mapsto 0, y \mapsto 0\}$, goal $\gamma = (x = 2)$, and actions $O = \{a, b, c\}$ such that

$$a = \langle x = 0,\ x := 1 \rangle \qquad cost_a = y + 2$$
$$b = \langle x = 1 \wedge y = 2,\ x := 2 \rangle \qquad cost_b = 5$$
$$c = \langle \top,\ y := 2 \rangle \qquad cost_c = 5 - x - y\ .$$

(a) Depict the induced transition system of this planning task.
(*Hint:* Laying out the states in an x-y-grid will greatly help you with the part (c) of this question.)

(b) Depict reduced ordered cost EVMDDs for the cost functions $cost_a$, $cost_b$, and $cost_c$ (for variable ordering x, y).

(c) Perform *two* steps of Cartesian counterexample-guided abstraction refinement for the given task, starting with the trivial one-state abstraction. For each step:

- Depict the abstract transition system before the step. Mark abstract initial and goal states. Label abstract transitions with their *abstract* cost values (which you can derive using the cost EVMDDs from part (b)).
- Specify an optimal (= cheapest) abstract plan.
- Identify possible flaws in that plan.
- Show how you resolve one of the flaws and depict the abstract transition system after resolving that flaw.

Hint: If more than one condition is violated, resolve the flaw involving variable y first (not x). When resolving a flaw, split the problematic abstract state into one part consisting of exactly those concrete states satisfying the previously violated condition, and one part consisting of the rest.

(d) Specify the abstraction heuristic that you obtain from the abstraction that you get after two refinement steps.

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