Principles of AI Planning

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Exercise Sheet 3

Due: November 16th, 2012

Exercise 3.1 (Correctness of STRIPS regression, 1 + 4 Points)

Prove that the STRIPS regression is correct:
Let φ be a conjunction of atoms, $o = \langle \chi, e \rangle$ a STRIPS operator making the atoms $a_1, \ldots, a_k$ true and making the atoms $d_1, \ldots, d_l$ false, and s an arbitrary state. Show the following:

(a) If o is *not* applicable in state s, then $s \not\models \mathit{sregr}_o(\varphi)$.

(b) If o is applicable in state s, then ($s \models \mathit{sregr}_o(\varphi)$ iff $\mathit{app}_o(s) \models \varphi$).

Exercise 3.2 (General regression, 5 Points)

Old Bilbo Baggins is joyfully celebrating his eleventy-first birthday in Hobbiton. Secretly however, he is tired of the boring provincial life around him... he dreams of leaving his home and resuming his travels, just like in the old days (Oh, how he wishes to see mountains again!). Unfortunately, the festivities are packed with relatives and friends, so simply walking away is out of the question: Someone is bound to notice him sneaking out, and that would make everyone angry, which Bilbo very much wants to avoid.

$$I(p) = 1 \text{ iff } p \in \{\text{at-party}, \text{visible}\}$$

Years ago, fate brought into his possession a powerful artifact; an unimpressivly plain gold *ring* which – when worn – renders the wearer perfectly invisible! Bilbo can put it on his finger and pull it off again in every situation (it is, after all, just a ring), toggling its effect. This is modelled by the operator

$$\text{toggle-ring} = \langle \top, (\text{visible} \rhd \neg\text{visible}) \wedge (\neg\text{visible} \rhd \text{visible}) \rangle.$$

If Bilbo decides to leave the party, the outcome depends on whether he can be seen or not:

$$\text{leave-party} = \langle \text{at-party}, \neg\text{at-party} \wedge (\text{visible} \rhd \text{guests-angry}) \rangle$$

Bilbo desperately wants to leave unnoticed[1]:

$$\gamma = \neg\text{at-party} \wedge \neg\text{guests-angry}$$

With this, we have the following planning problem $\langle A, I, O, \gamma \rangle$:

$$\langle \{\text{visible}, \text{at-party}, \text{guests-angry}\}, I, \{\text{toggle-ring}, \text{leave-party}\}, \gamma \rangle$$

Use the regression method (full regression without splitting) to solve the problem in a *breadth-first search*. Give the resulting **search tree** with the nodes' formulae, and the **solution plan**. In every tree node, simplify the state formula as much as possible. Do not further expand a node if the formula is unsatisfiable or equivalent to another (already expanded) node. In each node expansion, do **both** operator regressions, even if the first one is already fulfilled by the initial state!

Note: The exercise sheets may and should be worked on in groups of two students. Please state both names on your solution (this also holds for submissions by e-mail).

[1] For the sake of the exercise, let's just assume that Bilbo can find a quiet spot to become invisible without anyone noticing.