Homework Set 2

Michael Anderson

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CS533

Prof. Fern

1. a) Yes, because if the goal is reachable in some time T where $0 \leq T \leq T_{max}$, then g^T and consequently $g^0 \vee ... \vee g^T \vee ... \vee g^{T_{max}}$ will be satisfiable and the SATPLAN algorithm will return some plan.

b) Yes. Suppose some goal is reachable at some time t where $t \leq T_{max}$. Then all of the potential actions taken after t will be arbitrary and all of their possible combinations could be enumerated as solutions by the SAT solver. All of these combinations are irrelevant, because the only important information would be the set of actions occuring up to t to reach the goal.

c) Follow the approach of SATPLAN, and break apart the disjuctive goal into subgoals that are tackled as individual SAT problems within a loop. Iterate through each subgoal, until a satisficing assignment is found.

2. Any situation where three interchangeable actions can reach a goal, and two non-interchangeable actions can reach the same goal, is sufficient. Suppose a person wants to move three files from their computer to some other computer on the internet. Their OS shell allows them to take the following actions:

Move(x). Moves the file or directory x from the starting computer to the goal computer.

MoveAllFolder(x). Moves all three of the files to some directory x.

Now there are basically two ways to reach the goal. First, the Move() action can be executed three times, once for each individual file. This is a single layer of a layered plan, if the natural assumption is made that moving one file does affect the ability to move the other two.

Second, MoveAllFolder(f) can move all of the files into a single folder f, which can then be moved using Move(f). This is a two layer plan, because the ability to reach the goal using Move(f) is contingent upon the first action. Order matters here.

The first plan is layer-optimal, while the second plan is action-optimal.

3. F-F1 Here at(r1,l2,0) can be a true fluent, so that no move is required to get to produce at(r1,l2,1). This is not legal because this is inconsistent with the initial state and violates condition (a).

F-F2 Here at(r1,l1,1) can be a true fluent, so that no move is made from the initial state of {at(r1,l1,0) $\vee\neg$at(r1,l2,0)}. This is not legal because this is inconsistent with the goal state and violates condition (b).

F-F3 Here move(r1,l1,l2,0) and move(r1,l2,l1,0) can both be true, along with the initial and goal fluents. This is not legal because if both of these actions are taken in the given order, the robot will move back to where it started instead of moving to l2, which is presupposed by setting the goal fluent to true. Therefore, condition (c) is violated.

F-F4 Here all of the move fluents can be false, while the initial and goal fluents are true. This is not legal, because the robot simply jumps from the initial state to the goal state without taking an action, violating condition (c).

4. The distance to an optimal relaxed solution is an admissible heuristic for the distance to an optimal (or non-optimal) non-relaxed plan, because a relaxed problem has constraints that are a subset of the constraints of a non-relaxed problem. Since there could be less constraints to satisfy in a relaxed problem, its optimal solution could only be shorter (and never longer) than a solution to the corresponding non-relaxed problem.

A heuristic is admissible if it never overestimates the distance to a goal, so the distance to the optimal relaxed solution is an admissible heuristic for the distance to any non-relaxed solution.

5. (a). As an example, the set of actions will include something like the following:

MoveNorth(1,1):
PRE: at(1,1)
ADD: at(2,1)
DEL: at(1,1)

In other words, each legal move will alter the state of the robot by adding its new location fluent to the state, and removing the old one. In the relaxed problem, previous locations will not be removed as it traverses the grid, and it will "occupy" its current location as well as all of its previous locations simultaneously. This is ok, because if the robot follows the heuristic its distance to the goal will decrease with each action. Since an action will never take it further from the goal, its previous squares will never be closer to the goal than its current square, and its simultaneous occupation of all of those squares will be irrelevant. I.e., the distance to the goal in the relaxed problem will always be equal to the distance to the goal in the non-relaxed problem.