Assignment #1

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Problem 1: Classical Planning

(a) Consider the 8 puzzle with the Slide schema. Consider (i) ignoring $Blank(s_2)$ in the precondition as a heuristic and (ii) ignoring $Blank(s_2) \wedge Adjacent(s_1, s_2)$ in the precondition as a heuristic. Which of (i) or (ii) will result in fewer nodes being explored when used with the A* algorithm? Explain why.

Both are admissible heuristics for 8 puzzle. The first case h_1 is actually the sum of Manhattan distance to goal for each tile; the second situation h_2 is the number of misplaced tiles. h_1 will always explore fewer nodes with A*. In other words, h_1 dominates h_2.

(b) Consider the Air Cargo problem. Describe how to modify the problem so that each plane can only carry one cargo.

We could add a precondition for action *Load* to ensure there are not other cargo on the plane.
$Action(Load(c,\ c',\ p,\ a),$
PRECOND: $At(c,\ a) \wedge At(p,\ a) \wedge \neg In(c', p) \wedge Cargo(c) \wedge Cargo(c') \wedge Plane(p) \wedge Airport(a)$
EFFECT: $\neg At(c,\ a) \wedge In(c,\ p))$

(c) In the Air Cargo problem, write the successor state axiom for the fluent $At(P_1, SFO)$.
$At(P_1, SFO)^{t+1} \Leftrightarrow Fly(P_1, JFK, SFO)^t \vee (At(P_1, SFO)^t \wedge \neg Fly(P_1, SFO, JFK)^t)$

Problem 2: Decision Theory

(a) Bob is risk adverse but rational. His utilities for A, B, and C are U(A) = 0, U(B) = 100 and U(C) = 40. He is given a choice between C and a lottery [0.4, A; 0.6, B]. Which would he choose and why?

The expected utility of the lottery is $U(lottery) = 0.4 * 0 + 0.6 * 100 = 60$ is bigger than $U(c)$. An agent is rationally by choosing an action that maximizes the expected utility; therefore, Bob would choose to the lottery within two choices.

(b) Alices utility function for money is $U(x) = x$. Argue that Alice is risk seeking. (Hint: $U(x)$ is a strictly convex function. Jensens inequality may be useful here.)

For any lottery p,
the expected value of the lottery would be $\bar{x_p} = E[x] = \sum_{x \in X} p(x) * x$;
the expected utility of the lottery would be $E[u(x)] = \sum_{x \in X} p(x) * U(x)$.
$f(x)$ is a strictly convex function, since $f'(x) = 2x,\ f''(x) = 2 > 0$.
According to Jensen equality, for any strictly convex function, we have $E[f(x)] >$

$f(E[x])$, which means $E[U(x)] > U(E[x]) = U(\bar{x_p})$. We could conclude that Alice is risk seeking.

(c) Cathy prefers A to B but prefers lottery C = [0.2, A; 0.8, B] to lottery D = [0.3, A; 0.7, B]. Argue that there is no utility function that satisfies Cathy's preferences.

Cathy prefers A to B, which means that $U(A) > U(B)$;
Cathy prefers lottery C to lottery D, showing that $U(lottery\ C) = 0.2 * U(A) + 0.8 * U(B) > U(lottery\ D) = 0.3 * U(A) + 0.7 * U(B)$. We get $U(A) < U(B)$ after simplification. The two formulas are actually contradicted, which indicates that there is no utility function that satisfies Cathy's preferences.