CS188 Spring 1993 | Intro to AI Stuart Russell

Midterm 2 Solutions

1. (12 pts.) Situation calculus and STRIPS

(a) (5 pts) i) ii) iv) (3 does not use *Result* in the standard way; v) says that anything that's face up after rotation must be a card.

(b) (3 pts) ii) iv) both need frame axioms to say that the other cards are unaffected; iii) has no state-dependent predicates in the LHS (even when written correctly).

(c) (1 pt) False: it's like *Toggle*, with conditioal outcome.

(d) (3 pts) Just iii). i) doesn't mention a situation variable, ii) is ill-formed since the second argument of *Result* is an action not a state description.

2. (18 pts.) Nonlinear planning

(a) (4 pts) Although this problem looks like the Sussman anomaly, there do exist action sequences that are linear. An action sequence is nonlinear if two actions designed to achieve the same subgoal are separated by an action achieving another (a sure sign of interleaving). In this case, as long as J and A are moved consecutively (each is part of achieving On(A,K)) the solution is linear, and will be found by a linear planner such as STRIPS. So, strictly speaking, this particular problem is linear. The question of whether *all* problems have a linear solution is still open, so we gave credit for either answer.

(b) (3 pts) i) and ii). iii) fails for the ordering Stack(Q,J), Stack(K,Q), Stack(A,K), Unstack(J).

(c) (3 pts) i) ii) iii)

(d) (3 pts) See above (full credit for any answer that included i).

(e) (5 pts) General idea: require a known location precondition for the card to be stacked and its destination card. Use LookAt as an observation action that generates a known location for the card looked at. Since the general plan will look at cards until the required card is found, it will have to be a conditional plan.

3. (12 pts.) Basic probability

(a) (6 pts) ii), since we cannot simplify the conjunctive probabilities obtained from appliction of Bayes' rule.

(b) (6 pts) i) ii) iii), since normalization also eliminates $P(E_1, E_2)$

4. (18 pts.) Belief networks

(a) (6 pts) ii) and iii). iii) is completely connected except for M2-F1 and M1-F2, and given M1 and N, F1 is exactly determined because if M1 and N are within 1 it's in focus, otherwise it's out of focus (similarly for F2). Hence iii) is correct. i) is wrong because M1 must depend on M2 if M2 precedes M1 in the ordering (and vice versa). This is because if one astronomer measures 25 stars, it's pretty likely the other will get about the same number. (Note that we are assuming the focus conditions are independent of each other; if both telescopes were made by the same manufacturer, or global warming caused mirror distortion, then we would get some dependence. This illustrates the general point that missing common causes can produce dependency links when the information is unavailable.)

(b) (3 pts) ii) is clearly much simpler than iii), and represents the actual causal ordering.

(c) (4 pts) Should be close to 1 on the diagonal (where M1=N), small values where they differ by 1; zero otherwise; for each N,the probabilities of the different M1's must sum to 1.

(d) (2 pts) Consider the possible focus conditions. If neither are out of focus, the true number can only differ by at most one from 1 and 3, hence must be **2**. If F1 is true, N must be between 2 and 4 to agree with M2; only **4** would agree with M1. If just F2 is true, there is no consistent solution, hence this cannot be the case. If both are out of focus, any number **6 or more** would be OK.

(e) (3 pts) The most likely condition is neither out of focus, so 2 is the most likely number.