Comp3620/Comp6320 Artificial Intelligence
Tutorial 1: Search

March 7, 2013

Exercise 1 (problem formulation)

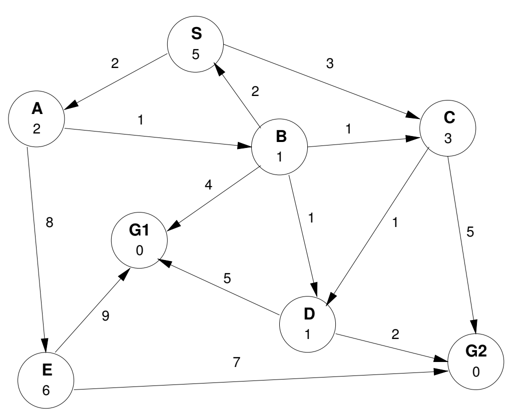
For each of the following problem, explain how states and actions can be represented, and give the initial state, goal test, successor function, and a plausible step cost function. Remember from the lectures that these elements constitute a search problem formulation.

1. Color a planar map using a minimum of colors in such a way that no two adjacent regions have the same color.
2. Measure exactly 1 liter as fast as possible, using 3 jugs, measuring 12 liters, 8 liters and 3 liters, respectively, and a water tap, by filling jugs up completely with the water tap, or emptying the content of one into anotheror onto the ground.
3. Three missionaries and three cannibals are on the side of a river, along with a boat which can hold one or two people. Find a way of getting them all to the other side, without ever leaving missionaries outnumbered by cannibals at any place.

Exercise 2 (search strategies)

Consider the search space below, where S is the initial state and $G1$ and $G2$ both satisfy the goal test. Arcs are labelled with the cost of traversing them and the estimated cost to a goal is reported inside nodes.

For each of the following search strategies: breadth-first, depth-first, iterative deepening, uniform cost, greedy search, and A*, indicate the goal state reached (if any) by graph-search and list, in order, all the states expanded — recall that a state is expanded when it is removed from the frontier. Everything else being equal, nodes should be removed from the frontier in alphabetical order. Assume that regardless of the strategy, the goal-test is performed when a node is dequeued from the fontier, and that newly generated nodes are not added to the frontier if they have already been explored or are on the frontier.



Exercise 3 (heuristics)

Consider the problem of moving k knights from k starting squares to k goal squares on an unbounded chess board, subject to the rule that no two knights can land on the same square at the same time.

1. Each action consists of moving **exactly** one knight.
   (a) What is the maximum branching factor in this state space?
   (i) $8k$ (ii) $9k$ (iii) 8^k (iv) 9^k
   (b) Suppose h_i is an admissible heuristic for the problem of moving knight i to the goal g_i by itself. Which of the following heuristics are admissible:
   (i) $\min_{i=1}^{k} h_i$ (ii) $\max_{i=1}^{k} h_i$ (iii) $\sum_{i=1}^{k} h_i$
   (c) Which of these is the best heuristic?
2. Now suppose that each action consists of moving **up to** k knights simultaneously. Answer (a) (b) (c) again.

Exercise 4 (game playing)

1. Approximately how many possible games of tic-tac-toe (sequences of moves) are there? Ignore symmetry and early wins.
2. Draw the whole game tree starting from an empty board down to depth 2 (one X and one O on the board). Exploit symmetry.
3. Define X_n as the number of rows, columns, or diagonals with exactly n X's and no O. Define O_n similarly for O. All non-terminal positions are evaluated using the following evaluation function: $Eval(s) = 3X_2(s) + X_1(s) - (3O_2(s) + O_1(s))$. Mark on the tree the evaluations of all the positions at depth 2.
4. Run the minimax algorithm to choose the best starting move.
5. Which nodes at depth 2 would not be evaluated if alpha-beta pruning was applied, assuming that the nodes are generated in the optimal order for alpha-beta pruning?

Recommended exercises from the book:

3.3, 3.6/b-c, 3.9, 3.10, 3.11, 3.13, 3.14, 3.23, 3.36, 5.3, 5.7, 5.8, 5.12, 5.16, 5.18, 5.21