ICS171
Fall 2006
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Homework-set 2
Due 10/12

1. Do question 4.1 in Russel and Norvig
2. Do question 4.2 in Russel and Norvig (Note that "objective function" means "evaluation function")
3. Let $h*(n)$ be the true shortest path cost from a state n to a goal state and let $c(n, n')$ be the cost of an arc between n and n' in the search graph and let $h(n)$ be the heuristic function estimating the shortest cost path from node n to a goal node. Prove that
   (a) If $h(n) \leq h*(n)$ then algorithm A* is guaranteed to find an optimal solution.
   (b) Prove that the "Manhattan distance" is an admissible heuristics for the 8-puzzle problem.
   (c) A heuristic function is defined as monotone if for every node n and its child node $n\prime$
   $$h(n) \leq h(n\prime) + c(n, n\prime)$$
   - Prove that the true shortest path function $h*$ is monotone
   - (extra credit) Prove that if h_1 and h_2 are both monotone, so also is $h = max(h_1, h_2)$.

(d) You are given the following search space graph with weighted arcs. Each node is associated with a heuristic function. Is the heuristic admissible? Is it monotone? Show the first 10 steps in node expansions for A* and IDA*.

```
      Start
      / | \          h(A)=5
   2 / 1|  \1        h(B)=9
    /   |   \        h(C)=10
   A    B    C       h(D)=3
   \    /            h(E)=11
  2 \  /3            h(F)=6
     \/              h(Goal)=0
     D
    / \
  1/   \3
  /     \
 F       E
 |
8|
 |
Goal
```

4. Do question 4.9 in Russel and Norvig.

5. (extra credit) In the sliding tile puzzle a possible heuristic for a given configuration is: "the sum of the number of black tiles which precede each white tile." Namely, if w_i is the number of black tiles to the left of the *ith* white tile then

$$h(n) \; = \; \sum_i w_i$$

Could you explain this heuristic as generated from a simplified model of the problem? Is the heuristic function admissible? Is it also monotone? Could you propose any other heuristic, (other then the above) for the sliding tile problem that can be explained as generated from a relaxed model?