CS5400 SP2016 Exam 3 Key

This is a closed-book, closed-notes exam. The only items you are permitted to use are writing implements. Mark each sheet of paper you use with your name and the string “cs5400 sp2016 exam3”. If you are caught cheating, you will receive a zero grade for this exam. The max number of points per question is indicated in square brackets after each question. The sum of the max points is 42, but the max score will be capped at 40 (i.e., there are 2 bonus points, but you can’t score more than 100%). You have 75 minutes to complete this exam. Good luck!

Multiple Choice Questions - write the letter of your choice on your answer paper

1. Alice is trying to identify the global optimum in a state-space landscape with a single local optimum. Which of the following local search algorithms should she use? [2]
   (a) Stochastic beam search [1]
   (b) Simulated annealing [1/2]
   (c) Genetic algorithms [0]
   (d) Ant Colony Optimization [0]
   (e) any of the above [1/2]
   (f) none of the above

2. Which of the following local search algorithms disallow “downhill” moves? [2]
   (a) Stochastic Hill Climbing [1]
   (b) First-choice Hill Climbing [1]
   (c) Local Beam Search [1/2]
   (d) Stochastic Beam Search [1/2]
   (e) Simulated Annealing [0]
   (f) Genetic Algorithms [0]
   (g) Particle Swarm Optimization [0]
   (h) Answers a and b
   (i) Answers a, b, c [1/2]
   (j) Answers a, b, c, and d [1]
   (k) Answers a, b, c, d, and g [1]
   (l) Answers a, b, c, d, e, f, and g [1/2]
   (m) none of the above [0]
Regular Questions

3. The following question is about the following graph:

Assuming a bound of [-12,8] on the state eval values, calculate first the bound on node C before evaluating node D1, then after evaluating node D1, and finally after evaluating both node D1 and D2. Show all your calculations for full points! [7]

- Before evaluating any max node, the bound on C is [-12,8].
- After evaluating D1, the bound can be computed as follows:
  \[ \left[ \frac{1}{4} \cdot 4 + \frac{3}{4} \cdot -12, \frac{1}{4} \cdot 4 + \frac{3}{4} \cdot 8 \right] = [1 - 9, 1 + 6] = [-8, 7] \]
- After evaluating D2, the bound is tightened to:
  \[ \left[ \frac{1}{4} \cdot 4 + \frac{1}{4} \cdot -6 + \frac{1}{2} \cdot -12, \frac{1}{4} \cdot 4 + \frac{1}{4} \cdot -6 + \frac{1}{2} \cdot 8 \right] = [1 - 1.5 - 6, 1 - 1.5 + 4] = [-6.5, 3.5] \]

The final two questions are about the following state space graph. Note that the start state is B. Heuristic \( h(n) \) is defined by the values following the node labels in the state space graph. Step cost values follow the action labels. Nodes are expanded counter-clockwise, ending at exactly 9 o'clock; example: A generates first action c, then action d, and finally action e, while B generates first action f and then action g. When multiple actions with equal LRTA*-COST are found, use the one found first.
4. Give the LRTA* trace terminating either when the goal is found or after the 15th call to LRTA*-COST. 

<table>
<thead>
<tr>
<th>current state</th>
<th>last action</th>
<th>previous state</th>
<th>cost estimate</th>
<th>world knowledge</th>
<th>LRTA*-COST</th>
<th>min action, cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>-</td>
<td>-</td>
<td>H[B]=2</td>
<td>(B,f,-)=2</td>
<td>f,2</td>
<td>f,2</td>
</tr>
<tr>
<td>E</td>
<td>f</td>
<td>B</td>
<td>H[E]=5</td>
<td>(B,f,E)=4+5=9</td>
<td>f,9</td>
<td>f,9</td>
</tr>
<tr>
<td>B</td>
<td>i</td>
<td>E</td>
<td>H[E]=3</td>
<td>(E,i,B)=1+2=3</td>
<td>i,3</td>
<td>i,3</td>
</tr>
<tr>
<td>A</td>
<td>g</td>
<td>B</td>
<td>H[B]=6</td>
<td>(B,f,E)=4+3=7</td>
<td>f,7</td>
<td>f,7</td>
</tr>
</tbody>
</table>

LRTA*-COST call limit reached

5. What is the Competitive Ratio (CR) based on the final state of your LRTA* trace? Explain your answer and make sure to list the final state you are using. Note that in the case of call limit termination, if the LRTA*-COST call you terminated on returned an action, then for the purpose of computing the CR, the action is assumed to have been executed. [4]

\[
CR = \frac{c(B,f,E) + c(E,i,B) + c(B,g,A) + c(A,d,-) + c(A,e,-)}{c^*(B,B)} = \frac{9}{6} = \infty
\]