Zagazig University	**CSE 411**	**Midterm Solution**
Faculty of Engineering	**Artificial Intelligence**	**April 26th, 2017**
Mechatronics Engineering	**(Double-Sided)**	**1:00pm – 2:00pm**
400 Level, 2nd Term 2016/2017	**(Duration: 60 minutes)**	**4 pages, 3 questions, 30 points**

Question 1: MCQ's [10 points]

Select from among the given choices **the one** that best answers each of the following questions, and write in your answer sheet that choice beside the question number. **[1 point each]**

1. A neural network is an example of an AI agent that:
   (a) Thinks rationally
   (b) Acts rationally
   (c) Thinks humanly
   (d) Acts humanly
   (e) All of the above

2. For an AI agent to pass the Turing test, it should be able to:
   (a) Navigate a maze
   (b) Communicate successfully in English
   (c) Manipulate objects
   (d) All of the above
   (e) None of the above

3. The environment of an AI agent that controls the air traffic over an airport is:
   (a) Partially observable, dynamic, stochastic, episodic, continuous, multi-agent
   (b) Partially observable, dynamic, stochastic, sequential, continuous, multi-agent
   (c) Partially observable, dynamic, stochastic, episodic, continuous, single-agent
   (d) Fully observable, static, deterministic, sequential, discrete, single-agent
   (e) None of the above

4. An agent that has the ability to take exploratory actions is:
   (a) Goal-based agent
   (b) Utility-based agent
   (c) Learning agent
   (d) Model-based reflex agent
   (e) None of the above

5. Given a search problem in which two robots try to find each other in an $M \times N$ maze, which of the following is a minimal state representation for such problem?
   (a) The distance between the two robots
   (b) A list of all the moves taken by each robot
   (c) A list of all the positions visited by each robot
   (d) The position of each robot in the maze
   (e) None of the above

6. What is the size of the state-space of the two-robot-maze problem (from question 6)?
   (a) $(M*N)^2$
   (b) $M*N$
   (c) $2^{(M*N)}$
   (d) $2*(M*N)$
   (e) $2^{(M+N)}$

7. Let h_1 be an admissible heuristic, and h_2 be an inadmissible heuristic. Which of the following heuristic functions is necessarily admissible?
   (a) $max(h_1, h_2)$
   (b) $\underline{min(h_1, h_2)}$
   (c) $(h_1 + h_2)/2$
   (d) $\sqrt{h_1^2 + h_2^2}$
   (e) None of the above

8. Which of the following conditions must be satisfied in order for a node n to be expanded during an A^* graph search that uses a consistent heuristic h and finds a goal at node n^*?
   (a) $g(n) < g(n^*)$
   (b) $\underline{g(n) + h(n) < g(n^*)}$
   (c) $h(n) < g(n^*)$
   (d) Both (a) and (b)
   (e) Both (b) and (c)

9. Which of the following statements about α-β pruning is **true**?
   (a) It is always faster than minimax
   (b) It always consumes less memory than minimax
   (c) It always returns the same value as minimax for all nodes of the tree
   (d) All the above
   (e) <u>None of the above</u>

10. Consider an adversarial game in which each state s has a minimax value $v(s)$. Assume that MAX plays according to the optimal minimax policy π, but the opponent (MIN) plays according to an unknown, possibly sub-optimal policy π'. Which of the following statements is **false**?
   (a) The score at any state s under MAX's control could be greater than $v(s)$.
   (b) The score at any state s under opponent's control could be less than $v(s)$.
   (c) <u>Even if π' were known to MAX, MAX should play according to π</u>.
   (d) All of the above
   (e) None of the above

Question 2: Graph Search [12 points]

Each of the trees (G1 through G5) was generated by searching the graph (below, left) ....
For each tree, indicate:

1. **[5 points]** Whether it was generated with depth-first search, breadth-first search, uniform-cost search, or A* search. Algorithms may appear more than once.

G1: BFS
G2: A*
G3: DFS
G4: A*
G5: UCS

2. **[2 points]** If the algorithm uses a heuristic function, say whether we used **H1** or **H2** where:
   H1 = $\{h(A)=3, h(B)=6, h(C)=4, h(D)=3\}$
   H2 = $\{h(A)=3, h(B)=3, h(C)=0, h(D)=1\}$

G1: N/A
G2: **H1** (because $f(D)=6$ & $g(D)=3$ ==> $h(D)=3$)
G3: N/A
G4: **H2** (because $f(D)=4$ & $g(D)=3$ ==> $h(D)=1$)
G5: N/A

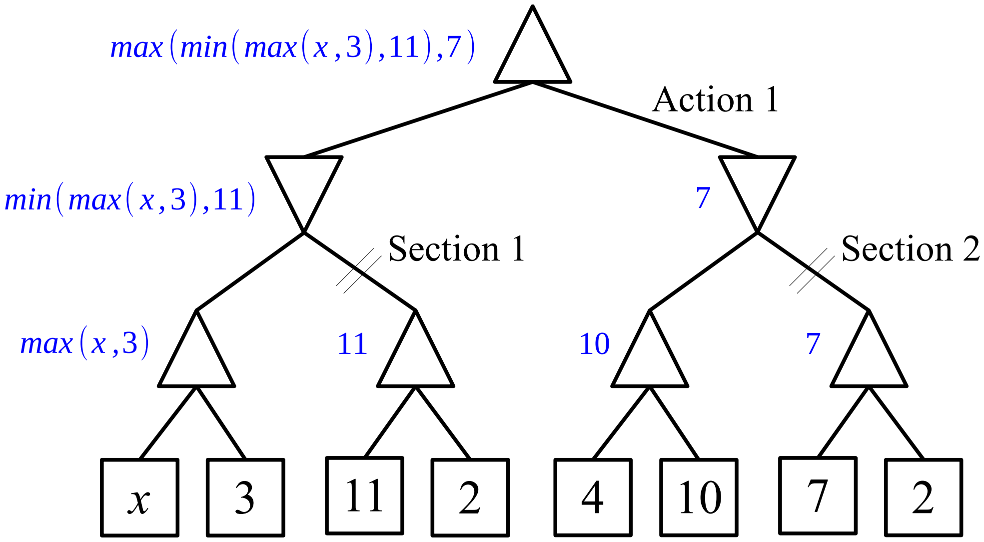
3. **[5 points]** For each algorithms, say whether the result was an optimal path (assuming we want to minimize the sum of step-costs). If the result was not optimal, state why the algorithm found a suboptimal path.

G1: A-B-G is not optimal because BFS returns the shallowest solution regardless of its cost.
G2: A-D-G is not optimal because **H1** is inconsistent (even inadmissible). **H1** overestimates the cost of the transition from C to G!
G3: A-B-C-G is not optimal because DFS returns the first solution it finds regardless of its cost.
G4: A-D-C-G is optimal because **H2** is consistent.
G5: A-D-C-G is optimal because UCS is guaranteed to return an optimal solution.

Question 3: Adversarial Search [8 points]

Consider the following minimax tree ...

1. **[2 points]** Redraw the tree in your answer sheet, and annotate each node with its minimax value (which could be an expression in terms of x).



2. **[2 points]** For what values of x is MAX guaranteed to choose **Action 1**? Justify your answer.

MAX chooses **Action 1** $\rightarrow$ $min(max(x,3),11)<7$ $\rightarrow$ $x<7$!

3. **[2 point]** For what values of x is the tree guaranteed to be alpha-beta-pruned at **Section 1**? Justify your answer.

To prune at **Section 1**, we need to choose a value for x such that: $\alpha\geq\beta$
Since $\alpha=-\infty$ and $\beta=max(x,3)$, there exists **no value for *x*** that makes $\alpha\geq\beta$!

4. **[2 point]** For what values of x is the tree guaranteed to be alpha-beta-pruned at **Section 2**? Justify your answer.

To prune at **Section 2**, we need to choose a value for x such that: $\alpha\geq\beta$
Since $\alpha=min(max(x,3),11)$ and $\beta=10$ $\rightarrow$ $min(max(x,3),11)\geq10$ $\rightarrow$ $x\geq10$!

**** End of Exam ****