

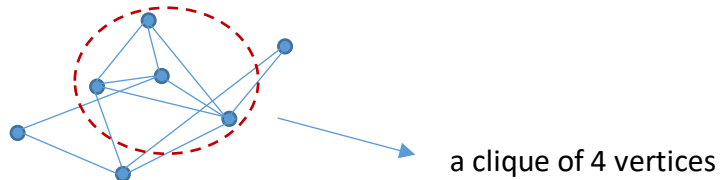
In the name of God, the Merciful, the Compassionate

## Artificial Intelligence Midterm Exam

Fall 2018 – Group 1

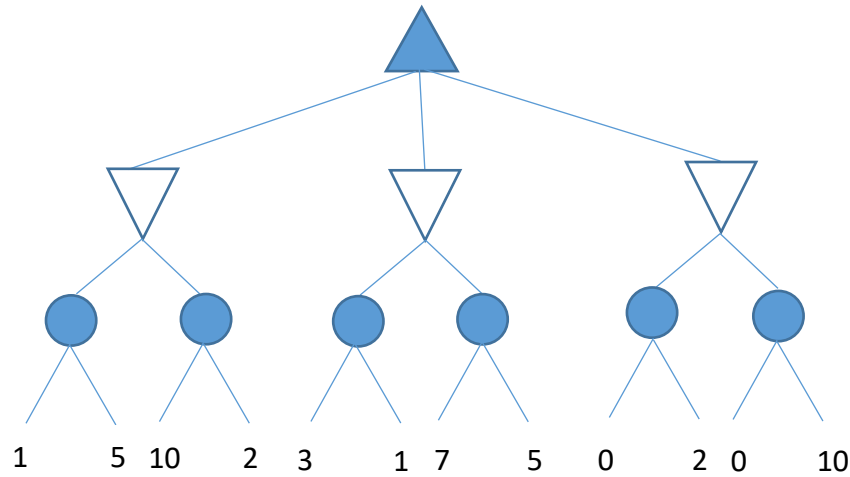
Note: There are 20 bonus points in the exam.

- 1) **[24 pts.]** Indicate which of the following statements are true or false. You should justify your answer with sufficient explanation. Provide a counterexample if the sentence is false, and prove it otherwise.
  - a. Constraint propagation through arc consistency is always able to find dead-ends in performing search in constraint satisfaction problems.
  - b. Gradient descent is guaranteed to decrease (or maintain) the function value in each iteration.
  - c. Minimax value at all the nodes stay unchanged in the minimax tree if alpha-beta pruning is used.
  - d. In a minimization problem, simulated annealing would always decrease (or maintain) the function value in each iteration after the temperature reaches zero.
- 2) **[36 pts.]** A clique in a graph is a subset of vertices of an undirected graph such that every two distinct vertices in the clique are adjacent. Suppose that we are given an arbitrary unweighted and undirected graph  $G$ . Suppose that we want to find a clique that contains  $k$  nodes.



- a. **[10 pts.]** Propose a partial state search formulation along with a search algorithm to solve this problem.
- b. **[10 pts.]** Propose a complete state search formulation along with a search algorithm to solve this problem.
- c. **[16 pts.]** How can you solve this problem using a constraint satisfaction formulation? What are the variables and constraints? What each of the heuristics in CSP would correspond to?

- 3) [25 pts] Suppose that the utility function is known to be bounded between 0 and 10 in the following search tree and the probabilities in the expectation nodes are all 0.5.



Suppose that we scan the nodes from left to right and we want to prune subtrees, whenever possible, to find the value of the root. Determine which subtrees would be pruned.

- 4) [35 pts.] Execute tree search through the following graph. Step costs are given next to each arc. Heuristic values are given next to each node (as  $h = x$ ). The successors of each node are indicated by the arrows out of that node. Successors are returned in left-to-right order.
- [26 pts.] For each search strategy below, indicate the order in which the nodes are expanded (i.e., its children are generated): Uniform cost search, and A\* search.
  - [9 pts.] Why are the goal state, which are found by the two methods, different?

