CS440/ECE448 Fall 2015 Midterm Review

You need to be able to define the following terms and answer basic questions about them:

- **Intro to AI, agents and environments**
  - Turing test
  - Rationality
  - Utility, expected utility
  - PEAS
  - Environment characteristics: fully vs. partially observable, deterministic vs. stochastic, episodic vs. sequential, static vs. dynamic, discrete vs. continuous, single-agent vs. multi-agent, known vs. unknown

- **Search**
  - Search problem formulation: initial state, actions, transition model, goal state, path cost, state space
  - Tree search algorithm outline, frontier, search strategy
  - Evaluation of search strategies: completeness, optimality, time complexity, space complexity
  - Uninformed search strategies: breadth-first search, uniform cost search, depth-first search, iterative deepening search
  - Informed search strategies: greedy best-first, A*, weighted A*
  - Heuristics: admissibility, dominance
  - Optimality of A*

- **Constraint satisfaction problems**
  - Backtracking search
  - Heuristics: most constrained/most constraining variable, least constraining value
  - Forward checking, constraint propagation, arc consistency
  - Tree-structured CSPs
  - Local search
  - SAT problem, NP-completeness

- **Games**
  - Zero-sum games
  - Game tree
  - Minimax strategy, minimax search
  - Alpha-beta pruning
  - Evaluation function
  - Quiescence search
  - Horizon effect
  - Stochastic games, partial observability
  - Monte Carlo tree search

- **Game theory**
  - Normal form representation

- Dominant strategy
- Nash equilibrium (pure and mixed strategy)
- Pareto optimality
- Examples of games: Prisoner's Dilemma, Stag Hunt, Game of Chicken
- Mechanism design

- **Planning**
  - Situation space vs. plan space planners
  - Interleaved vs. non-interleaved planners
  - Partial order plan
  - Complexity of planning

Example test questions

1. Can an environment be both known and unobservable? Give an example.

2. What is the distinction between a world state and a search tree node?

3. In the tree search formulation, why do we restrict step costs to be non-negative?

4. What is the proper procedure for avoiding repeated states during tree search?

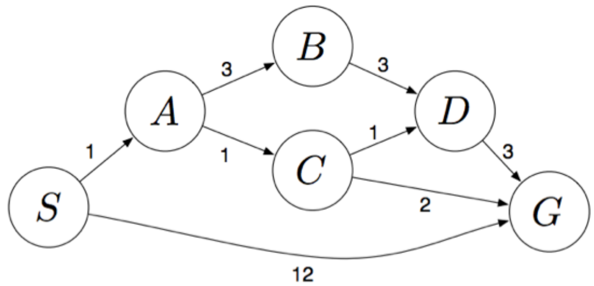
5. Discuss the relative strengths and weaknesses of breadth-first search vs. depth-first search for AI problems.

6. What is the difference between admissible and consistent heuristics?

7. Explain why it is a good heuristic to choose the variable that is *most* constrained but the value that is *least* constraining in a CSP search.

8. What is local search for CSPs? For which kinds of CSPs might local search be better than backtracking search? What about the other way around?

9. Consider the search problem with the following state space:



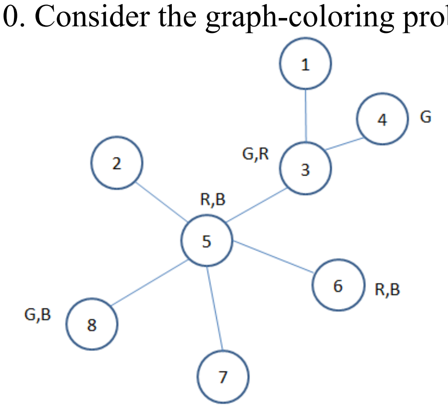
S denotes the start state, G denotes the goal state, and step costs are written next to each arc. Assume that ties are broken alphabetically (i.e., if there are two states with equal priority on the frontier, the state that comes first alphabetically should be visited first).

a. What path would BFS return for this problem?
b. What path would DFS return for this problem?
c. What path would UCS return for this problem?
d. Consider the heuristics for this problem shown in the table below.

State	h_1	h_2
S	5	4
A	3	2
B	6	6
C	2	1
D	3	3
G	0	0

Is h_1 admissible? Is it consistent?
Is h_2 admissible? Is it consistent?

10. Consider the graph-coloring problem on the following tree-structured CSP:

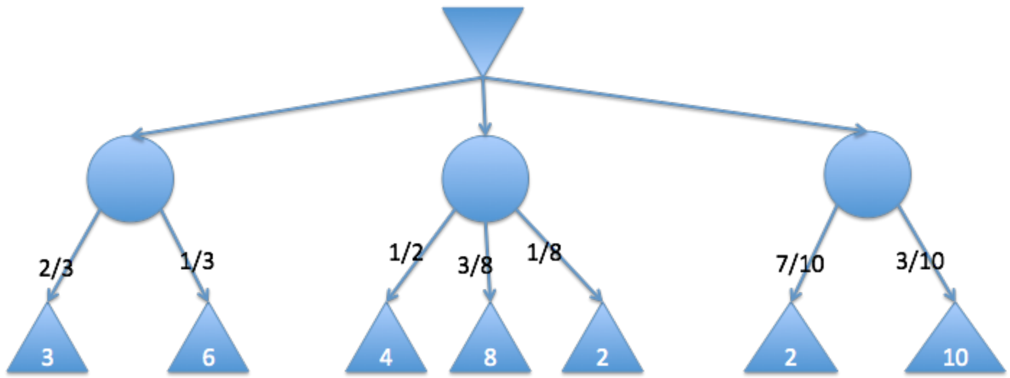


We assume there are three available colors (R,G,B) and some nodes are constrained to use only a subset of these colors, as indicated above. Show all the steps for applying the tree-structured CSP algorithm for finding a solution to this problem.

11. How can randomness be incorporated into a game tree? How about partial observability (imperfect information)?

12. Name a game for which state-of-the-art AI systems currently outplay the best humans, and another one for which they are worse than the top humans. What accounts for the relative "difficulty" of these games for AI?

13. Consider the following expectiminimax tree:



Circle nodes are chance nodes, the top node is a min node, and the bottom nodes are max nodes.

a. For each circle, calculate the node values, as per expectedminimax definition.
b. Which action should the min player take?

14. Give an example of a coordination game and an anti-coordination game. For each game, write down its payoff matrix, list dominant strategies and pure strategy Nash equilibria (if any).

15. Suppose that both Alice and Bob want to go from one place to another. There are two routes R1 and R2. The utility of a route is inversely proportional to the number of cars on the road. For instance, if both Alice and Bob choose route R1, the utility of R1 for each of them is 1/2.

a. Write out the payoff matrix.
b. Is this a zero-sum game?
c. Find dominant strategies (if any).
d. Find pure strategy equilibria (if any).
e. Find the mixed strategy equilibrium.