Introd. to Artificial Intelligence, Winter 2011
Prof. Zanibbi

Midterm Examination

Name: _____

January 18, 2012, Duration: 60 minutes, Out of 100 points

Instructions

- No electronic devices (laptops, phones, calculators, etc.) may be used during the examination.
- Place all books and coats at the front of the exam room.
- You may write your answers using pen or pencil, and you may write on the backs of pages.
- **If you have a question, please remain seated and raise your hand.**
- Additional pages are provided at the back of the exam. Please raise your hand if you need additional pages to write on during the exam.

1. **(10 points) True-or-False**

T / F Claude Shannon developed one of the first checkers-playing programs, incorporating machine learning to tune the board evaluation function, and a minimax-like move selection algorithm while working at Bell Labs in the 1940's.

T / F For a search problem where solutions are reachable from the initial state in a finite number of steps, using A^* with an *admissable* and *consistent* heuristic will return an optimal solution.

T / F Greedy best-first search only uses a heuristic function to order states for visitation and expansion, ignoring the cost of operations used to generate a state. It may produce sub-optimal results, but is often used in practice.

T / F The decision tree induction algorithm studied in class can be modeled as a greedy best-first search algorithm.

T / F The normalization for $\mathbb{P}(A) = \alpha < 0.01, 0.05 >$ is $\mathbb{P}(A) =< 1, 5 >$.

T / F The *chain rule* is: $P(A, B, C) = P(A|B, C)P(B|C)P(C)$

T / F For problems where all actions have unit (identical) cost, iterative deepening search has the same time and space complexity (big 'O') as breadth-first search.

T / F All prior and conditional probabilities of interest for a probabilistic model may be computed from a joint probability distribution table.

T / F A *rational* agent is one which always selects and then executes the optimal solution to a problem.

T / F The term 'Artificial Intelligence' was first coined by John McCarthy at the Dartmouth workshop held in 1956.

2. **(10 points) History and Agents**

(a) (4 points) Give the definition for the acronymn PEAS, in the context of defining agents.

(b) (6 points) Describe the experimental set-up for the Turing test. How does the test quantify 'intelligence?'

3. **(28 points) Search**

(a) (8 points) Provide a formal search problem definition for the rolling die maze problem from Project 1.

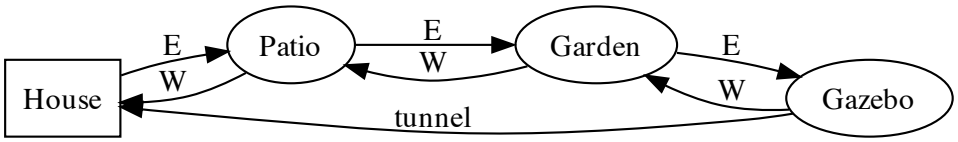
(b) (6 points) Define *admissable heuristic*, and give an example of how the rolling die maze problem definition in part (a) may be modified to obtain an admissable heuristic.

(c) (6 points) Provide the runtime and space complexity for each of the following algorithms, in terms of b (branching factor), m (maximum search tree depth), and d (depth of the optimal solution):

i. Uniform-Cost Search

ii. Depth-first search

iii. Iterative Deepening



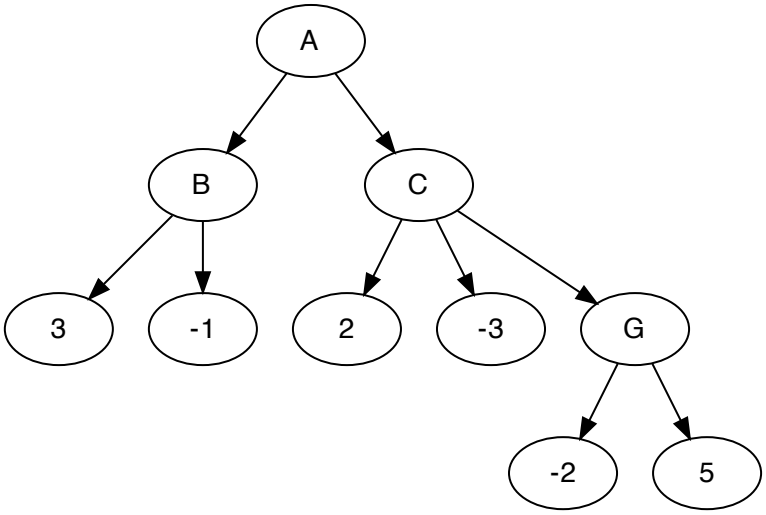
(d) (8 points) Answer the following questions about the state space shown above.

i. (3) Assume that our agent, Doctor Who, is currently on the Patio, and that he always considers available actions in the order (E)ast, (W)set or climb through a (tunnel). Draw the search tree produced using depth-first search, assuming that the Doctor seeks to enter the House and get a spot of tea.

ii. (5) Now assume the Doctor is in the Garden, and again seeks tea in the house. The House is 20 feet from the patio, the patio is 30 feet from the Garden, and the Gazebo is 40 feet from the garden. The tunnel bends time and space, and spans the distance from the Gazebo to the House in just 5 feet. Give a search tree for a uniform cost search, showing all states that will be generated during the search, and circling those states that will actually be visited during the search.

4. **(12 points) Minimax**

(a) (8 points) For the game tree shown below, write the minimax values on the internal nodes and the root of the tree, and then indicate which action is the minimax action.



Game Tree

(b) (4 points) Draw a line through the edges of the game tree that would be skipped when using the alpha-beta pruning algorithm.

5. **(26 points) Probability**

(a) (8) Use Venn diagrams (the diagrams that were used in class to represent sets) and a brief explanation to define each of the following probabilities.

i. $P(A = a)$

ii. $P(A = a \mid B = \neg b, C = c)$

(b) (12) Consider the probability model below, representing the probability that a consumer purchases a drink product from one of two different companies, brand X or brand Y. There are three variables, Brand (brand X or brand Y), Type of drink (tea or soda), and Temperature (hot or cold).

	brand X		brand Y	
	tea	soda	tea	soda
hot	1/16	0	2/16	4/16
cold	2/16	5/16	1/16	1/16

i. (4) Show how to compute $P(Type = soda, Temperature = hot)$ from the table.

ii. (4) Show how to compute the probability distribution $\mathbb{P}(Brand \mid Type = tea)$ from the table.

iii. (4) Are the variables Brand and Type *independent* of one another? Why or why not?

(c) (6) For each of the following distributions, provide the number of entries in the joint probability distribution table, and identify how many table entries are *independent*. Assume that each variable is binary.

i. $\mathbb{P}(A)$

ii. $\mathbb{P}(A, B, C)$

iii. $\mathbb{P}(A|B)\mathbb{P}(C|B)\mathbb{P}(\mathbb{B})$

6. **(14 points) Decision Trees**

(a) Decision trees are an algorithm for performing *inductive learning.*

i. (4) What is the goal of an inductive learning algorithm, and what type of data do these algorithms require?

ii. (6) Draw the minimal decision tree that will be created for the following data set, representing samples of whether Doctor Who has desert with his dinner, depending on the type of food he eats and the day of the week.

	Day			
	Fri		Sat	
English	T	T	T	T
Alien	T	F	F	

(b) (4) On what basis are attributes added to the decision tree, and why does this sometimes result in filtering (ignoring) available attributes?

Additional Space