CPE/CSC 480 ARTIFICIAL INTELLIGENCE

FALL 2008 FINAL EXAM

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This is the Fall 2008 final exam for the CPE/CSC 480 class. It is a take-home exam, and you may use textbooks, course notes, or other material, but you must formulate the text for your answers yourself. You are not allowed to discuss the questions and answers of the exam with other students or anybody else. The use of calculators or computers is allowed for numerical calculations, but not for the execution of algorithms or programs to compute solutions for exam questions.

If you need clarifications about questions, you can contact me via email (fkurfess@calpoly.edu) or see me during my office hours on Monday Dec. 8, 2-5 pm, and Tuesday, Dec. 9, 2-4 pm. The deadline for the exam is Tuesday, December 9, 2008, at 4:00 pm.

You can submit either a printed and signed copy of the exam, or an electronic version via Blackboard. You can leave the paper copy in the drop box in front of the CSC department office (it is emptied at 4:00 pm), or give it to me on Tuesday before 4:00 pm in my office.

Student Name:

Signature: **Date:**

PART 1: MULTIPLE CHOICE QUESTIONS

Mark what you think is the best answer for the questions below. I tried to formulate the questions and answers such that there is only one suitable answer, except where stated. Each question is worth 3 points, for a total of 30.

a) On December 3, 2008, Oliver Selfridge, one of the early influential figures in computer science and AI died. Among his major contributions to the field of Artificial Intelligence were (check all that apply):

- ❑ The organization of a workshop (together with others) in the summer of 1956 at Dartmouth that is generally considered the "birth" of AI.
- ❑ The development of the Lisp programming language in 1958.
- ❑ A device, "On-Line Interactive Vicarious Expediter and Responder" was named after him, honoring his contributions to interactive computing.
- ❑ He coined the term "intelligent agents".

b) What is the *contingency problem* in the context of game-playing programs?

- ❑ Choosing a poor heuristic for your search function.
- ❑ Uncertainty due to the moves and motivations of the player.
- ❑ The trade off between accuracy and time cost for an evaluation function.
- ❑ It is mostly an issue for human agents who can't find a bathroom in time.

c) Which of the following statements describes a two-player *zero-sum game*?

- ❑ the two players have to strictly alternate moves (a move by one player must be followed by a move by the other player)
- ❑ the term "zero-sum" is used to formally define a draw in games that use scores
- ❑ an advantage for one player results in an equivalent disadvantage for the other player
- ❑ instead of competing, the two opponents must collaborate and actively work at maintaining a balanced score; if one of them makes a move that leads to an unbalanced score, both lose

d) What is *pruning* in the context of game-playing programs?

- ❑ one opponent is denied the opportunity to make a move, often due to minor rule violations
- ❑ certain parts of the game tree are not investigated because they won't be considered by rational players
- ❑ the successor nodes are ranked according to some criterion, and are explored in the order determined by the ranking
- ❑ it is a heuristic that uses a simplified version of the game with a much smaller tree to identify promising moves

e) In which of the following games do players have to deal with *imperfect* (or incomplete) information?

- ❑ Solitaire
- ❑ Chess
- ❑ Checkers.
- ❑ Othello

f) A logical sentence is called *valid* if and only if
- ❑ it is constructed according to the syntactical specification of the language
- ❑ it is true under all possible interpretations in all possible worlds
- ❑ it can be used by an inference procedure to construct a proof
- ❑ there exists at least one interpretation for which the sentence is true.

g) What is the role of an *existential quantifier* ∃ in a predicate logic sentence?
- ❑ It allows statements about some objects in a collection of objects.
- ❑ It allows general statements about every object in a collection.
- ❑ It is used in the specification of the semantics for terms.
- ❑ It can be used to make statements about quantitative aspects of objects, such as length, weight, temperature, etc.

h) What is the purpose of developing a *ontology* for a knowledge-based system?
- ❑ It helps with a systematic description of objects and their relations in a domain.
- ❑ It is used to represent elementary, undisputed facts and rules of a domain.
- ❑ It is a method used to formalize the semantics of sentences in a domain.
- ❑ It greatly improves the efficiency of inference procedures by steering the selection of applicable inference rules.

i) What is the most important advantage of endowing an agent with *learning* capabilities?
- ❑ It is the only way of generating new knowledge from existing knowledge.
- ❑ Without learning, the agent would not be capable of storing percepts in its memory.
- ❑ Learning is necessary for the agent to explore its environment, and find out about consequences of actions performed by the agent.
- ❑ It allows the agent to improve its ability to select the most appropriate action in the future.

j) Artificial Neural Networks are in one of two operational modes, the *learning mode*, where new information is acquired, and the *recall mode*, where already learned information is used. Which aspect of artificial neurons is the most critical for their learning capabilities? In other words, which of the following aspects is essential during learning, but not during recall?
- ❑ The weight of connections between neurons can be changed.
- ❑ The different inputs to a neuron are accumulated through the activation function.
- ❑ Neurons usually only have one output, the axon.
- ❑ The propagation of signals from neuron to neuron.

PART 2: SHORT QUESTIONS

In this part of the exam, you should answer the questions in the space provided. Please note that the number of points differs for the questions.

1. In the context of games and AI, what is the difference between an *evaluation function* and a *utility function*?

10 points

- Utility Function:

- Evaluation Function:

2. Logical proofs can be constructed by a sequence of applications of inference rules. Is it possible to use search algorithms as discussed earlier this quarter (e.g. depth first, breadth first, greedy, A*) to identify a suitable sequence of proof steps? Explain your answer! Consider the usual concepts utilized in search methods, such as search tree with root, intermediate and leaf nodes, successor function, utility function, and explain how they apply or don't apply to the construction of a logical proof.

10 points

- ❑ Yes, search methods can be used for logical proofs.
- ❑ No, search methods are not suitable for logical proofs.

Explanation:

3. For many games, the search space is so large that it is beyond the scope of current computers to expand the whole tree, and the search has to be cut off at some level. Is it possible to use alpha-beta pruning in combination with such a cut-off? In other words, is it necessary to explore individual branches to the end points (leaves) for alpha-beta pruning to function? Explain your answer!

10 points

- ❑ Yes, alpha-beta pruning can be combined with cut-offs.
- ❑ No; it requires the full expansion of a branch.

Explanation:

PART 3: DECISION TREES FOR HOLIDAY GIFTS

At this time of the year, many people are spending a lot of money and energy on selecting and buying holiday gifts for friends, relatives, and associates. Instead of agonizing over this, one person decided to collect data and construct a decision tree for this. It is a first attempt, so there is room for improvement.

The data are based on last years decisions, and the person uses the following attributes and outcome to record the decision for the set of potential recipients P_1, …, P_{15}:

- *Gift-Received* {Great | So-So | Crummy | None}: Did I receive a gift from that person the year before, and how much did I like their gift?
- *Closeness* {Close | Medium | Distant}: How close am I to this person?
- *Gift-Given* {Expensive | Moderate | Cheap | Recycled | None}: What kind of gift did I give them the year before?
- *Still-Alive* {Yes | No}: No point in giving a gift to that great-granduncle who died last spring …
- *Outcome* {Gift | No-Gift}: Suggests what to do this year for that person.

Please note that the *Gift-Received* and *Gift-Given* attributes refer to the year before the outcome was recorded: Assuming you started collecting the data last year (2007), those attributes are about gifts from the year before that (2006).

Person	*Gift-Received*	*Closeness*	*Gift-Given*	*Still-Alive*	*Outcome*
P1	None	Close	Expensive	Yes	**No-Gift**
P2	Great	Distant	None	Yes	**No-Gift**
P3	Crummy	Close	Recycled	Yes	**Gift**
P4	So-So	Medium	Moderate	Yes	**Gift**
P5	Great	Distant	Expensive	No	**No-Gift**
P6	Crummy	Medium	Expensive	Yes	**Gift**
P7	Crummy	Close	Recycled	Yes	**Gift**
P8	None	Distant	None	Yes	**No-Gift**
P9	Crummy	Distant	None	No	**No-Gift**
P10	Great	Close	Moderate	Yes	**Gift**
P11	So-So	Close	Moderate	Yes	**Gift**
P12	None	Medium	Recycled	No	**No-Gift**
P13	None	Close	None	Yes	**No-Gift**
P14	So-So	Distant	Recycled	Yes	**Gift**
P15	Great	Medium	None	Yes	**No-Gift**

1. Construct the decision tree based on the sample set. Identify the attributes you select below, and list the outcomes for the respective values of the attribute.

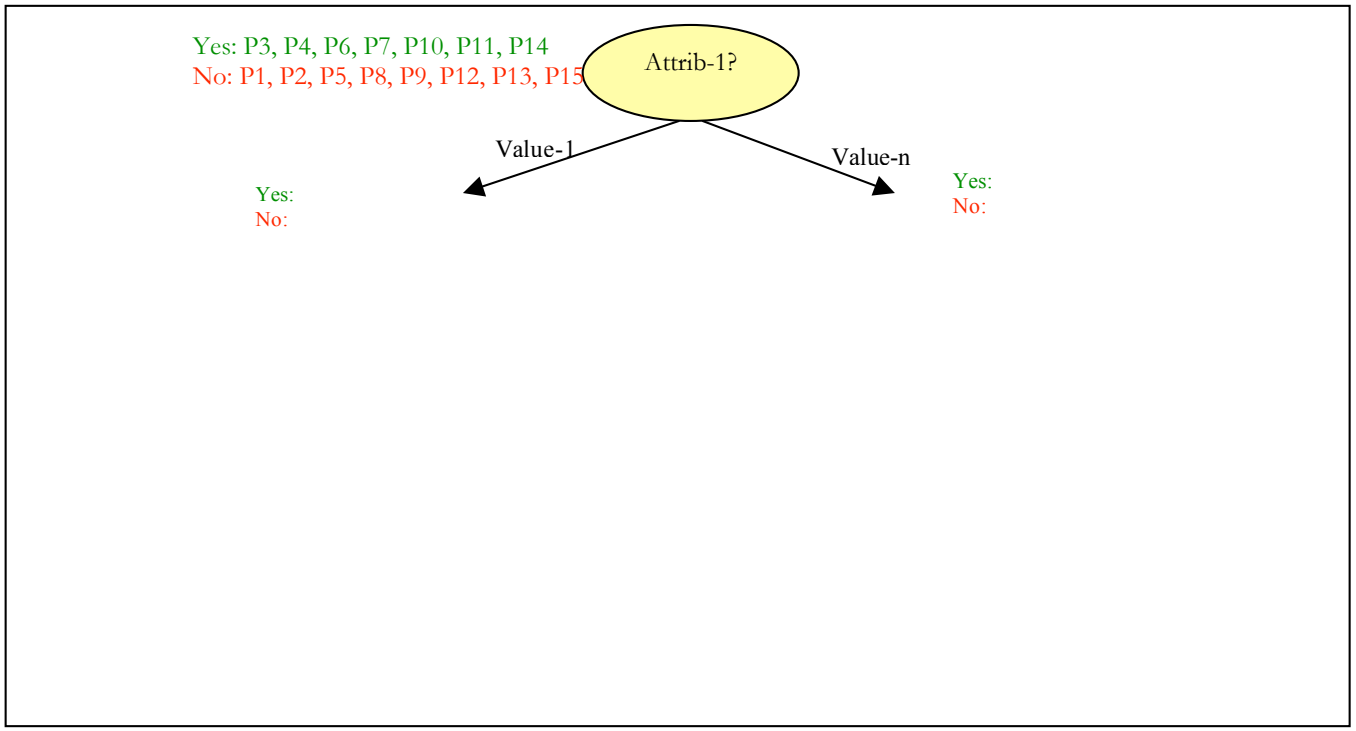
   a) Identify the attributes in the sequence they are selected, and describe the reason for the selection of each attribute (e.g. "complete agreement of Value-1 with *Outcome-Gift*").

   5 points

Attribute	*Reason:*
A1	
A2	
A3	
A4	

   b) Draw the decision tree based on the attributes identified above. Write the samples that need to be considered next to each node in the decision tree, and separate them according to the outcome ("Yes" on top, "No" below). The root node is given below; replace "Attrib-1" with your first attribute, and complete the tree.

   10 points



a) To test the decision tree before it goes into production for this season, here are a few samples. Based on your decision tree, what is the predicted outcome? What is your explanation for the prediction? Does the outcome correspond to "common sense"?

10 points

Test Case	*Gift-Received*	*Closeness*	*Gift-Given*	*Still-Alive*	*Outcome*
T1	None	Medium	Recycled	Yes	**Yes/No?**
T2	Great	Close	Expensive	Yes	**Yes/No?**
T3	So-So	Medium	Recycled	Yes	**Yes/No?**
T4	Crummy	Distant	Moderate	Yes	**Yes/No?**
T5	So-So	Distant	Moderate	No	**Yes/No?**

Explanation Test Case T1:

-

Explanation Test Case T2:

-

Explanation Test Case T3:

-

Explanation Test Case T4:

-

Explanation Test Case T5:

-

4. The example given above is rather simplistic. It does not distinguish between types of gifts to be given this year, for example. If you were to use the same values for the outcome as for the Gift-Given (i.e. {Expensive | Moderate | Cheap | Recycled | None}), would it still be possible to use a decision tree? Explain your answer!

5 points

2. The art of gift giving is often based on the history of gifts given to and received from a particular person. Are decision trees suitable for dealing with such information? Explain your answer!

5 points

3. Overall, do you think it is a good idea to use a decision tree for this problem? Explain your answer!

5 points

Total Points: