Problem Solving (25)

1. How does simulated annealing differ from basic hill climbing search? (5)
   It allows for decreasing probability of accepting a lesser state during search.

2. What is nonlinear about nonlinear planning? (5)
   The plan is not a linear sequence of steps, but a partial order of steps.

3. Describe means-ends analysis? (5)
   It is a problem solving method that selects an operator that will reduce the difference between the current state and a goal state.

4. What does the value of a heuristic function in heuristic (A*) search represent? (5)
   It represents an estimate of the length of solution from the current state to a goal state.

5. Describe the immediate effect of constraint propagation during search for a solution to a constraint satisfaction problem. (5)
   It reduces the size of possible value domains associated with related variables.
Game Playing (15)

1. Consider the game tree below. Arcs are labeled by moves. Below the leaf nodes, which are labeled by letters, are static evaluation values. Assume left-to-right generation of nodes under a parent. (12)

- O
- m1 m2 m3 m4
- O O O O
- m1 m3 m4 m2 m3 m4 m1 m3 m1 m2 m4
- A B C D E F G H I J K
- 8 9 3 4 1 3 6 5 1 9 8

a.) Which move is chosen, assuming the root is a maximizing node? __m3____

b.) Which is the first leaf node pruned by alpha-beta search? ___F____

c.) Which move is chosen, assuming the root is a minimizing node? __m2____

d.) Which is the first leaf pruned by alpha-beta now? ___H____

2. Given that humans can consider at most one or two moves per second while computers can consider more than a million, how are human experts able to remain competitive with computers in chess? (3)

Humans represent the board in terms of relevant patterns or configurations of pieces that reduce the branching factor of search and guides one toward relevant moves.
Reasoning (25)

1. Three knights (Able, Bold and Charlie) participated in a tournament. Two of the knights won their matches; one of the knights lost. Using A for Able won, B for Bold won, and C for Charlie won, place the following sentences in propositional clause form. Use resolution theorem proving to establish who did not win, trying possible goals.

If Able won, then Charlie did not win.       [~A, ~C]
If Charlie won, then Bold did not win.       [~C, ~B]
If Able did not win, then Bold won.          [A,  B]

See with a negated goal for Charlie not winning [C], we can derive the empty clause.

[C] [~A, ~C] => [~A]
[C] [~C, ~B] => [~B]
[~A] [A, B] => [B]
[~B][B] => []

2. Is the following wf in first-order predicate logic satisfiable? Explain (prove) your answer.

A(?x) (Even(?x) and Odd(?x))

Yes, let Even and Odd be interpreted as predicates that give true for any argument.

3. Show the result of resolving the following two clauses, presented in first order clause form:

[P(?z, ball, ?x), R(?x, glove, dog)]       [~R(ball, ?y, dog), ~S(?y, ?w, glove)]

[P(?z, ball, ball), ~S(glove, ?w, glove)]

4. What are Horn Clauses? How are they useful for (automated) reasoning?

Horn Clause are clauses with one positive literal, corresponding to rules of the form ((a1 and a2 ...) implies c). They allow backward or forward reasoning in polynomial time.
Learning (15)

1. We have records of people searching our web site in a sets of pages they view during visits to the site. We would like to know if viewing certain pages suggests they will view other pages on the site. (9)

Is this an example of a supervised or an unsupervised learning problem?

*unsupervised*

A common algorithm for this problem has two parameters: support and confidence. What are the meanings of these terms in this algorithm.

*support.. frequency of item sets in the data set*

*confidence .. percentage of the time a rule holds, given its antecedents hold.*

2. What is meant by bias in a learning algorithm? (3)

*It is a reduction in the set of concept hypotheses under consideration, usually realized by restricting the concept language.*

3. During online learning, when we see a positive instance and our concept classifies it as a negative instance, what must we do to our concept to correct the problem? (3)

*We must generalize (expand) the concept to include the new instance.*
Learning Problems (Take Home.. DUE WEDNESDAY MORNING, 9:00) (20)

NAME _______________________________________

Suppose we are given the following data regarding whether students play intramural football at the U of O (i.e., Player is the class feature).

<table>
<thead>
<tr>
<th>Height</th>
<th>Weight</th>
<th>Major</th>
<th>Speed</th>
<th>Player</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>Heavy</td>
<td>Physics</td>
<td>Slow</td>
<td>no</td>
</tr>
<tr>
<td>Short</td>
<td>Medium</td>
<td>CIS</td>
<td>Fast</td>
<td>no</td>
</tr>
<tr>
<td>Medium</td>
<td>Heavy</td>
<td>CIS</td>
<td>Slow</td>
<td>yes</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
<td>Physics</td>
<td>Medium</td>
<td>no</td>
</tr>
<tr>
<td>Tall</td>
<td>Heavy</td>
<td>Math</td>
<td>Medium</td>
<td>yes</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
<td>Math</td>
<td>Fast</td>
<td>no</td>
</tr>
<tr>
<td>Short</td>
<td>Heavy</td>
<td>Physics</td>
<td>Medium</td>
<td>yes</td>
</tr>
<tr>
<td>Tall</td>
<td>Medium</td>
<td>Math</td>
<td>Slow</td>
<td>no</td>
</tr>
<tr>
<td>Short</td>
<td>Heavy</td>
<td>CIS</td>
<td>Medium</td>
<td>yes</td>
</tr>
</tbody>
</table>

1. Show the discrimination tree that would be developed by EPAM, assuming the instances arrive in the order given above (top to bottom). Introduce tests in left to right order as needed. How would it classify the new instance: [Tall, Light, Physics, Slow]?

Yes

```
Height

M    T    S    o

Weight    Weight    yes    no

M    o    M    o

no    yes    no    yes
```
2. Show the concept for Player that would be developed by Naive Bayes learning applied to this data set, assuming all occurrence counts are initialized to 1 (assume there is the possibility of a Light weight person). How would it classify the new instance: [Tall, Light, Physics, Slow]?

<table>
<thead>
<tr>
<th>Height</th>
<th>Weight</th>
<th>Major</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
</tr>
<tr>
<td>M</td>
<td>2</td>
<td>4</td>
<td>M</td>
</tr>
<tr>
<td>T</td>
<td>2</td>
<td>2</td>
<td>H</td>
</tr>
<tr>
<td>S</td>
<td>3</td>
<td>2</td>
<td>L</td>
</tr>
</tbody>
</table>

Yes :: 5      No :: 6

For the new instance:

\[
P(\text{yes}) \approx \frac{5}{11} \cdot \frac{2}{7} \cdot \frac{1}{7} \cdot \frac{2}{7} \cdot \frac{2}{7} = 0.001515
\]

\[
P(\text{no}) \approx \frac{6}{11} \cdot \frac{2}{8} \cdot \frac{1}{8} \cdot \frac{3}{8} \cdot \frac{3}{8} = 0.0024 \quad \text{=== NO}... \quad \text{a bit over 60%}
\]

3. Show an ordered list of rules that categorize whether the person is a Player or not and that cover the given data. Each rule should involve only one condition. Select a rule that covers the most remaining instances. How would it classify the new instance: [Tall, Light, Physics, Slow]?

No

\[
\text{IF(}\text{weight::Medium}) \Rightarrow \text{no}
\]
\[
\text{IF(}\text{major::CIS}) \Rightarrow \text{yes}
\]
\[
\text{IF(}\text{speed::Medium}) \Rightarrow \text{yes}
\]
\[
\text{otherwise} \Rightarrow \text{no}
\]