AI Midterm  (80)  Fall, 2010  Name___________________________

Constraint Satisfaction (15)

1. What is the immediate effect of propagating a constraint during search for solution? (5)

   Reducing the number of possible values for related variables

2. Describe the MRV (most restricted variable) heuristic and how it is used in backtrack-ing approaches to constraint satisfaction? (5)

   selecting the variable with the fewest possible values to try values

3. How does simulated annealing differ from the standard hill climbing method? (5)

   It will to move to states with a lower metric value (with decreasing probability)

Path Problems (15)

A search space is states interconnected by directed arcs representing operators.

1. Describe a finite search space and search method that could result in an infinite, unsuccessful search. (3)

   depth-first search in a search space having cycles (and no check for cycles)

2. How is iterative deepening better than breadth-first search? depth-first search? (6)

   less space than breadth-first search, guaranteed minimum-depth solution
   not guaranteed by depth-first search

3. What is an admissible heuristic function? (3)

   It is a heuristic function which never overestimates the cost (distance) to solution

4. What is true of a solution found by A* search using an admissible heuristic? (3)

   It will be an optimal solution (least cost path)
STRIPS and Planning (5)

Consider a robot world where a robot moves from room to room delivering boxes that are labeled by letters. Using the predicates \texttt{InRoom}(x, y), where \(x\) can be \texttt{robot} or a box label and \(y\) is a room number, \texttt{EmptyHands()}, and \texttt{Holding}(x), where \(x\) is a box label, represent the following operator reasonably in STRIPS form: (5)

Assumption: The robot can not hold more than one object.

\texttt{PickUp}(x, y) ;; the robot picks up box \(x\) that is in room \(y\)

\textit{Pre}: \texttt{InRoom}(x, y), \texttt{InRoom(robot, y)} \texttt{EmptyHands()}

\textit{Add}: \texttt{Holding}(x)

\textit{Delete}: \texttt{EmptyHands()}, \texttt{InRoom}(x, y)

Reasoning (10)

1. Find all most general resolvent(s) of the following two clauses. (5)

\[ [P(?x, \text{boat}, ?x), R(?x, \text{cat, dog})] \quad [\neg R(\text{boat, ?y, dog}), \neg P(?y, ?y, \text{cat})] \]

\[ [P(\text{boat, boat, boat}), \neg P(\text{cat, cat, cat})] \]

2. Backward Chaining on Propositional Rules (5)

Given the rules: 
\((a \ b \ c) \Rightarrow d)\)
\(((d \ e) \Rightarrow f)\)
\(((d \ g) \Rightarrow h)\)
\(((f \ h) \Rightarrow \text{yes})\)

Show the sequence of stack states (each stack as a list: (top .... bottom)) that occur when proving that yes follows from facts : \((a \ b \ c \ e \ g)\) by backward chaining:

\((\text{yes})\)
\((f \ h)\)
\((d \ e \ h)\)
\((a \ b \ c \ e \ h)\)
\((b \ c \ e \ h)\)
\((c \ e \ h)\)
\((e \ h)\)
\((h)\)
Knowledge Representation (5)

1. Present a representation to capture the temporal meaning of the following sentence, interrelating the event intervals: NOW (when the sentence is uttered), PROMISE, CALL, ASK, GO, GAME, SATURDAY:

   “John promised to call Harry to ask him if he will go with us to the football game next Saturday.”

   \[
   \begin{align*}
   &\text{BEFORE}(\text{PROMISE}, \text{NOW}) \quad \text{DURING}(\text{GAME}, \text{SATURDAY}) \\
   &\text{BEFORE}(\text{PROMISE}, \text{CALL}) \quad \text{BEFORE}(\text{NOW}, \text{SATURDAY}) \\
   &\text{DURING}(\text{ASK}, \text{CALL}) \quad \text{BEFORE}(\text{GO}, \text{GAME}) \\
   &\text{BEFORE}(\text{CALL}, \text{GO}) \\
   &\text{DURING}(\text{GO}, \text{SATURDAY})
   \end{align*}
   \]

Learning (25)

1. Suppose we are given the following data regarding whether students play intramural football at the U of O. (10)

   \[
   \begin{array}{cccccc}
   \text{Height} & \text{Weight} & \text{Major} & \text{Speed} & \text{Player} \\
   \text{Medium} & \text{Heavy} & \text{Physics} & \text{Slow} & \text{no} \\
   \text{Short} & \text{Medium} & \text{CIS} & \text{Fast} & \text{no} \\
   \text{Medium} & \text{Heavy} & \text{CIS} & \text{Slow} & \text{yes} \\
   \text{Medium} & \text{Medium} & \text{Physics} & \text{Medium} & \text{no} \\
   \text{Tall} & \text{Heavy} & \text{Math} & \text{Medium} & \text{yes} \\
   \text{Medium} & \text{Medium} & \text{Math} & \text{Fast} & \text{no} \\
   \text{Short} & \text{Heavy} & \text{Physics} & \text{Medium} & \text{yes} \\
   \text{Tall} & \text{Medium} & \text{Math} & \text{Slow} & \text{no} \\
   \text{Short} & \text{Heavy} & \text{CIS} & \text{Medium} & \text{yes}
   \end{array}
   \]

   Find 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.

   1. \(\text{WEIGHT(MEDIUM)} \Rightarrow \text{no}\)  
   2. \(\text{SPEED(MEDIUM)} \Rightarrow \text{yes}\)  
   3. \(\text{MAJOR(PHYSICS)} \Rightarrow \text{no}\)  
   4. \(\text{MAJOR(CIS)} \Rightarrow \text{yes}\)
2. We have records of people searching our web site in terms of the sets of pages they view during visits to the site. We would like to know if viewing any pages suggests they will view others. Is this an example of a supervised or unsupervised learning problem? (3)

unsupervised, no predetermined class or type of relationship

A common algorithm for this problem has two parameters: support and confidence. What are the meanings of these terms in this algorithm. (6)

support -- number (or percent) of training instances that must rule must be based on

certainty - percentage of instances of antecedent that include conclusion

3. When building a decision tree based on a given data set, what is the basic choice to be made by the algorithm and what heuristic value is typically used to decide that? (6)

must choose what instance feature to test (or if a decision node)

decision based on feature that best reduces expected information

Game Playing (5)

1. Describe a situation that would allow the alpha-beta searching method to prune part of a game tree during search. (5)

when the beta of a min node is already less than the alpha of its parent max node

when the alpha of a max node is already greater than the beta of its parent min node