COSC 159: Fundamentals of Artificial Intelligence

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Spring 2002, Final Exam
closed book, closed notes, calculators OK
100 points
20 multiple choice, 6 short answer
13 pages

Name: _____

Multiple Choice [2 pts each]

1. Which of the following searches is incomplete?
   (a) breadth-first search
   (b) iterative deepening search
   (c) A^* search
   (d) greedy search
   (e) uniform cost search
   (f) none of the above

2. Let A and B be boolean random variables. If $P(A) = 0.4, P(B) = 0.6$, and $P(A \vee B) = 0.2$, then $P(A \wedge B) =$
   (a) 0.2
   (b) 0.3
   (c) 0.4
   (d) 0.5
   (e) 0.6
   (f) 0.7
   (g) 0.8
   (h) 0.9
   (i) 1.0

3. A planner that constructs plans with a single sequence of steps is called
   (a) partial order planner
   (b) total order planner
   (c) linear planner
   (d) fully instantiated planner
   (e) wedding planner
   (f) none of the above

4. Which kind of agent would perform best in situations with uncertainty?
   (a) table-driven agent
   (b) problem solving agent
   (c) goal-based agent
   (d) decision theoretic agent
   (e) knowledge-based agent

5. The learning algorithm often applied to neural networks without hidden layers is
   (a) Bayesian learning
   (b) feed forward learning
   (c) optimal brain damage
   (d) perceptron learning
   (e) recurrent learning
   (f) none of the above

6. Suppose you are given the sentences p and q in first order logic, where

$$\begin{aligned} p &= Attached(BodyOf(x), x), \\ q &= Attached(y, HeadOf(z)). \end{aligned}$$

   If all of the variables are universally quantified implicitly, $\textsc{Unify}(p, q) =$
   (a) $\{y/x, x/HeadOf(z)\}$
   (b) $\{y/HeadOf(z), x/HeadOf(z)\}$
   (c) $\{x/HeadOf(z), y/BodyOf(x)\}$
   (d) $\{x/HeadOf(z), y/BodyOf(z)\}$
   (e) $\{x/HeadOf(z), y/BodyOf(HeadOf(z))\}$
   (f) $\{x/HeadOf(z), y/BodyOf(HeadOf(x))\}$
   (g) none of the above

7. The conjunction of literals that describes how te situation changes when a STRIPS operator is applied is called the
   (a) action description
   (b) precondition
   (c) effect
   (d) goal
   (e) none of the above

8. The best technique to use to implement a goal based agent is
   (a) informed searching
   (b) planning
   (c) probability
   (d) situation calculus
   (e) decision trees
   (f) neural networks

9. Let A and B be boolean random variables. If $P(A) = 0.4$, $P(B) = 0.6$, and $P(A \mid B) = 0.3$ what is $P(B \mid A)$?

   (a) 0.12

   (b) 0.18

   (c) 0.2

   (d) 0.45

   (e) 0.8

   (f) not enough information to calculate

   (g) none of the above

10. The process of removing the symbol $\exists$ from first order logic sentences when converting them to CNF is called

    (a) unification

    (b) negation

    (c) standardization

    (d) normalization

    (e) Skolemization

    (f) elimination

    (g) publication

    (h) none of the above

11. In machine learning, we validate (i.e. assess the accuracy of) a learned model of a concept using a

    (a) training set

    (b) test set

    (c) data set

    (d) infinite set

    (e) random number generator

    (f) none of the above

12. The action $CheckTire(x)$ which is used to determine if a tire x is intact is an example of a

    (a) replanning action

    (b) conditional step

    (c) maintenance goal

    (d) sensing action

    (e) none of the above

13. A neural network that contains cycles in the network is called

    (a) feed forward

    (b) cyclical

    (c) recurrent

    (d) Bayesian

    (e) broken

    (f) none of the above

14. $\forall$ and $\exists$ are examples of

    (a) predicates

    (b) terms

    (c) symbols

    (d) quantifiers

    (e) functions

    (f) none of the above

15. A *decision tree* is an example of which of the following in the model of machine learning covered in class

    (a) representation language

    (b) concept space

    (c) goal predicate

    (d) data

    (e) none of the above

16. The technique that generates new conclusions when a new fact is added to the knowledge base is called

    (a) forward chaining

    (b) forward inferencing

    (c) backward chaining

    (d) backward inferencing

    (e) none of the above

17. Which of the following searches uses only the heuristic function $h(x)$ to determine which node to expand next (i.e. to order the queue)?

    (a) breadth-first search

    (b) iterative deepening search

    (c) A^* search

    (d) greedy search

    (e) uniform cost search

    (f) none of the above

18. The generalized modus ponens inference rule is complete for

    (a) situation calculus

    (b) Horn sentences

    (c) lambda calculus

    (d) first order logic

    (e) STRIPS operators

    (f) none of the above

19. Suppose you are asked to compute the value $\mathbf{P}(A \mid B)$ using a Bayesian belief network. The variable A is called a

    (a) evidence variable

    (b) query variable

    (c) logic variable

    (d) probabilistic variable

    (e) diagnostic variable

    (f) none of the above

20. My favorite part of the class is

    (a) probability

    (b) monkeys and bananas

    (c) machine learning

    (d) logic

    (e) planning

    (f) searching

    (g) leaving

    (h) something else

Short Answer [10 pts each]

21. A *word ladder* is a word puzzle where the goal is transform one word to another by chaining together words that differ by only one letter. For example, the puzzle *does* $\rightarrow$ *none* is solved by

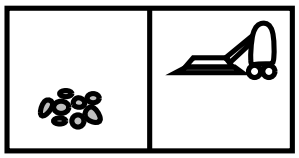
$$\text{does} \rightarrow \text{dots} \rightarrow \text{dote} \rightarrow \text{done} \rightarrow \text{none}$$

    a. Represent this problem as a search problem. Clearly identify: the states, the successor function, the goal test, and path cost.

    b. Could a depth-first search be used to solve the problem optimally? Why or why not?

    c. Suggest a heuristic function for selecting potentially better words during a search.

22. Suppose you are representing the 2-square vacuum world problem as a planning problem. You have defined the predicates $At(x, y)$ to represent that the object x is at the location y, and $Dirty(x)$ to represent that location x is dirty. The objects in the world are represented as $Vacuum$ for the vacuum cleaner, $Left$ for the left square, and $Right$ for the right square. Assume you are given the starting state represented in the following figure and that the goal state is for the vacuum to be in its original location and all squares are clean.

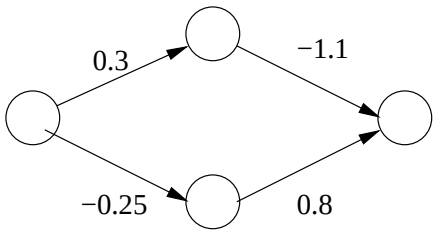


a. Give the STRIPS operators for $Go(x)$ which represents that the vacuum should move to location x, and $Suck(x)$ which represents that the vacuum should suck in location x.

b. Represent the initial and goal states as STRIPS operators.

c. Give a plan that will get the robot from the initial state to the goal state. You do not have to use POP, just give a valid plan.

23. You are given the following neural network:



The input function for all of the nodes is the weighted sum of the inputs. The activation function for the input and output nodes is the identity function. The activation function for the hidden nodes is the sigmoid function:

$$\frac{1}{1+e^{-x}}$$

a. How many layers are in the neural network?

b. How many hidden nodes are in the network?

c. Assuming that the input is 0.7, what is the output of the neural network?

24. Suppose you are given the following statement: "Every philosopher has written a book."

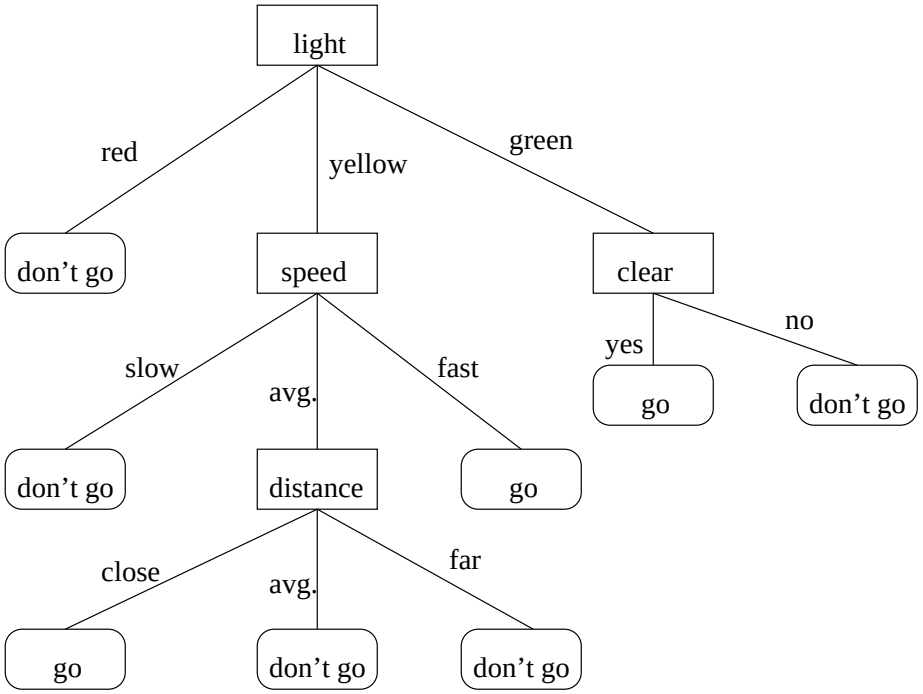
$$\forall p \; Philosopher(p) \Rightarrow \exists b \; Wrote(p, b) \wedge Book(b)$$

Using resolution, show that the following statement is true: "If Plato is a philosopher, then Plato has written something."

$$Philosopher(Plato) \Rightarrow \exists b \; Wrote(Plato, b)$$

Hint: remember, you must negate the conclusion and transform all sentences into CNF to use resolution.

25. Suppose you are given the following decision tree for deciding whether or not to go through an intersection while driving. The features represent the following concepts: *light* the color of the light, *speed* how fast the car is going, *distance* distance to the intersection, *clear* whether or not the intersection is clear.



a. If the light is yellow, the car is going an average speed, the intersection is clear, and the distance to the intersection is average, should the car go through the intersection?

b. Using the information in the following table and applying information theoretic techniques, determine if the light color or the distance to the intersection would be better choice for starting the decision tree.

Attribute	Value	Proportion of data	Don't go	Go
All items		1	1/2	1/2
Light	red	1/6	1	0
	yellow	1/3	2/3	1/3
	green	1/2	1/3	2/3
Distance	close	2/5	1/8	7/8
	avg.	2/5	1/2	1/2
	far	1/5	2/3	1/3

26. Suppose you are modeling the effectiveness of a home alarm system rigged to doors in the house. The alarm system is electrical, which may be a cause for concern of the home owner. Let B be a boolean random variable representing that the circuit breaker is on. Let T be a boolean random variable representing that the power transformer is working. Let D be a boolean random variable representing that someone attempts to open a door while the system is armed. Finally, suppose A is a boolean random variable representing that the alarm goes off.

    a. Draw a Bayesian belief network for this situation.

    b. Suppose we add a hidden boolean variable E representing that the electricity is on. Draw the modified Bayesian belief network.

    c. Suppose that the electricity is on if and only if the breaker is on and the transformer is working. Further suppose that if the electricity is on, that there is a probability of x that the alarm will not sound if a door is opened while the system is armed and a probability of y that the alarm will sound even if a door is not opened or the system is not armed. What are the conditional probability tables for E and A in this situation?

    d. Using your answer from the previous part and assuming that $P(B) = 0.8$, $P(T) = 0.9$, $P(D) = 0.2$, what is $P(A \wedge E \wedge \neg D \wedge B \wedge T)$?