

COSC 159: Fundamentals of Artificial Intelligence

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Spring 2002, Midterm Exam

closed book, closed notes, calculators OK

100 points

20 questions

1 extra credit

14 pages

Name: _____

Multiple Choice [3 pts each]

1. The Turing test is an example of which approach to Artificial Intelligence:
 - (a) acting humanly
 - (b) thinking humanly
 - (c) acting rationally
 - (d) thinking rationally
 - (e) none of the above
2. The property of a search strategy to find the highest-quality solution when several solutions exist is
 - (a) completeness
 - (b) time complexity
 - (c) space complexity
 - (d) optimality
 - (e) none of the above
3. The collection of nodes waiting to be expanded during a search is called the
 - (a) queue
 - (b) depth
 - (c) fringe
 - (d) leaves
 - (e) tree
 - (f) none of the above
4. Search strategies are defined by their
 - (a) heuristic function
 - (b) successor function
 - (c) path cost function
 - (d) queueing function
 - (e) goal test
 - (f) none of the above
5. The biggest problem with the iterative deepening depth-first search is
 - (a) that it is incomplete
 - (b) that it is not optimal
 - (c) its time complexity
 - (d) its space complexity
 - (e) none of the above

6. If the branching factor of a search space is 7, the solution depth is 23, and the maximum depth of the tree is 31, approximately how many nodes will be in memory in a worst case execution of the A^* search?
- (a) $7 \cdot 23$
 - (b) 7^{23}
 - (c) $7 \cdot 31$
 - (d) 7^{31}
 - (e) $23 \cdot 31$
 - (f) 23^{31}
7. The function $f(n)$ defined for the best-first search represents the _____ of a node n .
- (a) depth
 - (b) path cost
 - (c) heuristic value
 - (d) desirability
 - (e) frontier
 - (f) none of the above
8. An agent modifies the environment it participates in with its
- (a) sensors
 - (b) effectors
 - (c) actions
 - (d) goals
 - (e) percepts
 - (f) environment
9. We determine how successful an agent is in its environment by using a
- (a) utility function
 - (b) heuristic function
 - (c) path cost
 - (d) performance measure
 - (e) percept sequence

10. Which agent type will have the highest quality behavior when the agent has to balance several, potentially conflicting goals?
 - (a) table-driven agent
 - (b) reflex agent
 - (c) problem solving agent
 - (d) goal based agent
 - (e) utility based agent
 - (f) model based agent
11. Hill-climbing, simulated annealing, and genetic algorithms are all examples of
 - (a) uninformed search algorithms
 - (b) informed search algorithms
 - (c) random search algorithms
 - (d) iterative improvement algorithms
12. Truth tables for propositional logic are an example of which of the following in a formal logic system:
 - (a) syntax
 - (b) semantics
 - (c) proof theory
 - (d) model
13. Which of the following is true if a logical sentence is unsatisfiable?
 - (a) the sentence is true under some interpretation
 - (b) there is no model for the sentence
 - (c) the sentence is not well formed (i.e., syntax error)
 - (d) the sentence is entailed by a consistent knowledge base
14. A benefit of using first-order logic instead of propositional logic to develop a knowledge base is
 - (a) a general inferencing technique for answering queries
 - (b) a formal syntax for representing knowledge in a domain
 - (c) a formal semantics relating sentences to facts
 - (d) the ability to represent infinite sets with finite sentences
15. A way to represent change in first-order logic is
 - (a) multivariate calculus
 - (b) situation calculus
 - (c) location calculus
 - (d) action calculus
 - (e) reflex calculus

Short Answer [11 pts each]

16. Consider the problem of constructing crossword puzzles: fitting words into a grid of intersecting horizontal and vertical squares. Assume that a list of words (i.e., a dictionary) is provided, and that the task is to fill in the squares using any subset of this list. Provide a complete PAGE description for this domain. Classify the environment in terms of the 5 standard properties for environments (e.g., accessible, ...).

17. Given the following initial state for the 8-puzzle, carry out breadth-first and greedy searches with $h(n) =$ the number of tiles out of position.

- Draw the resulting search trees assuming that repeated states are NOT included.
- Make sure nodes in the search trees include all appropriate information for the search.
- Label each node in the search tree with a number in a circle indicating the order in which the node is expanded.
- Do not label nodes that are not expanded.

1	2	3
6		4
8	7	5

Answer space for question 17.

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18. Answer the following two questions regarding Prolog

- (a) Implement the `merge` relation in Prolog. The `merge` relation has arity 3, the first two parameters are two sorted lists and the third parameter is the sorted list obtained from merging the first two together. You may assume the lists contain only numbers.

(b) Consider the following Prolog program:

```
likes(craig, green_eggs).  
likes(craig, ham).  
likes(craig, bacon).  
likes(sam_i_am, green_eggs).  
likes(sam_i_am, ham).  
likes(sam_i_am, spam).
```

```
who_would_eat_them(X, Y)  
    :- likes(X, green_eggs), !,  
       likes(X, Y).
```

Give all responses to the query `who_would_eat_them(X, Y)`. assuming that the user backtracks until no further responses are available. If you want partial credit, you must show your work by tracing the execution.

19. Represent the following sentences in first-order logic:

(a) Either Marquette wins or I'm out ten dollars.

(b) The worst score in Operating Systems was lower than the worst score in Artificial Intelligence.

(c) Not all students take both Artificial Intelligence and Operating Systems.

20. Translate the following paragraph into propositional logic and provide a conditional proof that the conclusion does indeed hold. The 7 standard inference rules are given on the next page.

If I am dancing, then I am happy. There is a mouse in the house or I am happy. I am sad. Therefore, there is a mouse in the house and I am not dancing.

Below are the 7 standard inference rules and their names.

Modus ponens

$$\frac{\alpha \Rightarrow \beta, \quad \alpha}{\beta}$$

And-elimination

$$\frac{\alpha_1 \wedge \alpha_2 \wedge \dots \wedge \alpha_n}{\alpha_i}$$

And-introduction

$$\frac{\alpha_1, \alpha_2, \dots, \alpha_n}{\alpha_1 \wedge \alpha_2 \wedge \dots \wedge \alpha_n}$$

Or-introduction

$$\frac{\alpha_i}{\alpha_1 \vee \alpha_2 \vee \dots \vee \alpha_n}$$

Double-negation elimination

$$\frac{\neg\neg\alpha}{\alpha}$$

Unit resolution

$$\frac{\alpha \vee \beta, \quad \neg\beta}{\alpha}$$

Resolution

$$\frac{\alpha \vee \beta, \quad \neg\beta \vee \gamma}{\alpha \vee \gamma}$$

or equivalently

$$\frac{\neg\alpha \Rightarrow \beta, \quad \beta \Rightarrow \gamma}{\neg\alpha \Rightarrow \gamma}$$

Another rule that will be useful is the disjunctive form of implication

$$\frac{\alpha \Rightarrow \beta}{\neg\alpha \vee \beta}$$

which is derived from the equivalence $(\alpha \Rightarrow \beta) \Leftrightarrow (\neg\alpha \vee \beta)$.

21. *Extra Credit:* Is the following statement true, false, or neither? Explain your answer.

This sentence is false.