

Name:
Student ID #:

CS 662 Midterm
Total: 150 pts

Instructions: You will have 105 minutes to complete this midterm. The test is closed book; no notes or computers are allowed. You may use a calculator. Please show all relevant work and calculations in order to receive partial credit (when appropriate). Many of the questions on this test are short answer, and are designed to get you to think about or explain the topics we have covered. You should answer these at an appropriate length and explain your reasoning when asked to do so. A one-word answer is usually too short; a one-page answer is usually too long. You may use the backs of the pages if you need extra space.

1 True/False, plus corrections

25 pts, 5 pts each

Each of the following statements is either true or false. If it is true, mark it true. If it is false, correct the statement so that it is true. **Note:** Adding “not” or otherwise negating the sentence is not acceptable. You must change the facts in the sentence if it is false. For example:

Question: The Turing Test is a test of whether a computer program is rational.

Bad answer, no credit: The Turing Test is *not* a test of whether a computer program is rational.

Good answer: The Turing Test is a test of whether a computer program is indistinguishable from a human.

- An inference method is sound if it only derives sentences that are actually correct.
- Backward chaining involves beginning with a set of rules and facts and repeatedly applying Modus Ponens to draw new conclusions.
- Resolution is a complete inference procedure.
- Two variables are conditionally independent if they never influence each other.
- The principle of Maximum Expected Utility says that an agent should pick the action that is easiest to achieve.

2 Logic

1.10 pts Prove the principle of contraposition, that $A \Rightarrow B$ is equivalent to $\neg B \Rightarrow \neg A$.

2. 15 pts, 3 pts each Write the following sentences in first-order logic: Use the following predicates: $\text{student}(x)$, $\text{likes}(x,y)$, $\text{worksAt}(x,y)$, $\text{childOf}(x,y)$, $\text{livesIn}(x,y)$

a. All the students like Bart.

b. Unless a person is a student, that person works at the power plant.

c. Marge Simpson has exactly two children: Bart and Lisa.

d. There is someone in Springfield who is liked by everyone.

e. Every student likes himself/herself.

3 Inference

Consider the following sentences:

- If it rains, Joe brings his umbrella.
- If Joe has his umbrella, he doesn't get wet.
- If it doesn't rain, Joe doesn't get wet.

1) **5 pts** Write propositional logic sentences for these sentences. Use R for "it rains", U for "Joe brings his umbrella", and W for "Joe gets wet."

2) **10 pts** Convert these sentences to CNF.

2) **10 pts** Use resolution with refutation to prove that Joe does not get wet.

4 Probability and Utility

1.20 pts First-grader Maggie has divided her books into two groups, those she likes and those she doesn't.

The five (5) books that Maggie likes contain (only) the following words: animal (5 times), mineral (15 times), vegetable (1 time), see(1 time)

The ten (10) books that Maggie does not like contain (only) the following words: animal (5 times), mineral (10 times), vegetable (30 times), spot(1 time)

Using the Naive Bayes assumption, determine whether it is more probable that Maggie likes a book containing only the following words than that she dislikes it. Show and explain your work.

see mineral vegetable

Note: You do not need to use the m-estimate to determine conditional probability. You may use the frequency of a word occurring, given the category.

2. You are designing an agent that travels from San Francisco to Oakland. The agent can take one of three routes: driving across the Bay Bridge, taking BART under the bay, or taking a ferry.

Your agent would like to maximize its utility, where utility = 1000 - minutes traveling. So, if it takes 30 minutes to get to Oakland, the agent's utility is 970.

a) **5 pts** 40% of the time, the Bay Bridge has a traffic jam. When it does, it takes 60 minutes to get across. When there is no jam, it takes only 15 minutes to get across. What is the expected utility of taking the Bay Bridge?

b) **5 pts** Taking the ferry will always take 35 minutes. When taking BART, 80% of the time BART is on time - in this case it takes 20 minutes to get to Oakland. the other 20% of the time, BART is 10 minutes late, and so it will take 30 minutes.

Give the expected utility for each route. Which action should the agent take?

c) **10 pts** Sometimes the Bay Bridge suffers from traffic jams due to construction. 30% of the time, the bridge is under construction, and 80% of the time that there is a traffic jam, construction is occurring.

What is the probability of a traffic jam given that construction is taking place?

d) **5 pts** Suppose you can use a satellite to tell you whether there is a traffic jam on the Bay bridge. The satellite is correct 90% of the time. If your agent thinks that there's a traffic jam, it will take an alternate route. Determine the probabilities that the satellite will and will not notice a traffic jam given that there is or is not a jam.

e) **5 pts** What is the value (in terms of utility) of the satellite information?

5 Decision Trees

25 pts

We're trying to build an agent that will determine whether we should study or go to the beach. Given the following data set, create a decision tree that will help us decide which to do. There are three attributes we can test: Weather (Sunny, Cloudy, Rainy), Wind (Strong, Weak), and Weekend (yes/no). Show all your work, including the entropy and information gain for each node.

Weather	Wind	Weekend	What to do?
Sunny	strong	yes	Beach
Rainy	weak	yes	Study
Sunny	strong	no	Beach
Cloudy	strong	yes	Beach
Rainy	weak	no	Study
Rainy	strong	yes	Study
Sunny	weak	yes	Beach
Cloudy	strong	no	Study
Sunny	weak	no	Beach
Sunny	weak	no	Beach
Cloudy	weak	yes	Beach
Cloudy	weak	no	Study