

CS 434 (Fall 2022): Machine Learning & Data Mining

HW #0 Exercising Prerequisite Knowledge

Date handed out: Sept 21, 2022

Date due: Sept 28, 2022, 11:59 pm on Canvas

Total: 15 points

1 Probability

1. Bayes Theorem and Marginalization [1 pt]: The weatherperson has predicted rain tomorrow, but we want to use probability. In recent years, it has rained only 73 days each year (no leap years, so every year is 364 days). When it actually rains, the weather person correctly forecasts rain 70% of the time. When it doesn't rain, she incorrectly forecasts rain 30% of the time. What is the probability that it will rain tomorrow?

ANSWER:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)}$$
$$P(A|B) = \frac{P(B|A)P(A)}{\sum [P(B|A_i)P(A_i)]}$$

If probability it actually rains is R.
The prediction of rain is

2. Computing Expected Values from Discrete Distributions [1 pt]: We are machine learners with a slight gambling problem (very different from gambler with a machine learning (very different from gamblers with a machine learning problem!). Our friend, Diane is proposing the following payout on the roll of a fair, 6-sided die:

ANSWER:

3. A random variable x distributed according to a standard normal distribution (mean zero and unit variance) has the following probability density function (pdf):

ANSWER:

4. Cumulative Density Function / Calculus [1 pt]: X is a continuous random variable over the interval $[0, 1]$ with the probability density function (PDF) shown below.

ANSWER:

2 Linear Algebra

1. Transpose and Associative Property [1 pt]: Define matrix $B = bb^T$, where $b \in \mathbb{R}^{d \times 1}$ is a column vector that is not all-zero. Show that for any vector $b \in \mathbb{R}^{d \times 1}$, $x^T B x \geq 0$.

ANSWER:

2. Solving Systems of Linear Equations with Matrix Inverse [1 pt]: Consider the following system of equations:

ANSWER:

c) Suppose that an agent selects randomly between two actions. There is a stochastic environment where the agent is rational. [2 points]

ANSWER:

d) An agent that is not rational in one task environment may be rational in another. [2 points]

ANSWER:

3 Proving Things

3. Consider a modified version of the vacuum environment:

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a) What is the optimal behavior for an agent in this environment? [2 points]

ANSWER:

b) Can a simple reflex agent with a *randomized* agent function be rational for this environment? Why or why not? [2 points]

ANSWER:

c) Consider the probability that a clean square will become dirty again. Is there a probability for which a simple reflex agent with a *deterministic* agent function can be rational? Explain why not or provide the probability and agent function. [2 points]

ANSWER:

4 Debriefing

1. Approximately how much hours did you spend on this assignment?

ANSWER:

2. Would you rate it as easy, moderate, or difficult?

ANSWER:

Difficult.

3. Did you work on it mostly alone or did you discuss the problems with others?

ANSWER:

Because I wanted to learn everything deeply and to test my knowledge, I wanted to work on this mostly alone.

4. How deeply do you feel you understand the material it covers (0%-100%)?

ANSWER:

5. Any other comments?

ANSWER:

This was an amazing review, especially after a summer's worth of outside industry work. I think that after doing this, I'll be able to pinpoint my weak spots and work on them.