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CMSC 471
Artificial Intelligence
Summer 2021
Quiz 3
Due: As long as it is 03-AUG-2021 anywhere on Earth (AOE)
https://time.is/Anywhere_on_Earth
20 points
5 questions
3 pages

1. Naïve Bayes turns $p(\texttt{easy}, \texttt{money} \mid \texttt{spam})$ into $p(\text{easy} \mid \text{spam}) \cdot p(\text{money} \mid \text{spam})$ 2

2. Which of these expressions are equal to 1, given no independence assumptions (circle all that apply): 2

$\sum_y p(Y = y \mid X)$ (a) $\quad \sum_x p(Y \mid X = x)$ b $\quad \sum_x \sum_y p(X = x, Y = y)$ (c) $\quad \sum_x \sum_y p(X = x \mid Y = y)$ d

3. A door can either be open or closed (random variable, D). A robot is fitted with a door sensor (random variable, Z). If the door is open (D=OPEN), the sensor detects that (Z=OPEN) with a probability of 0.60. If the door is closed, the sensor detects that with a probability of 0.80. The robot has no sense of the typical state of the door; hence, priors are equally likely.

a) What is the prior probability of the door being open? 1

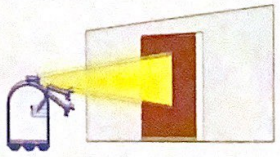
50%

b) What is the probability that the door is open if the sensor detects it to be open? 4

if door is open:

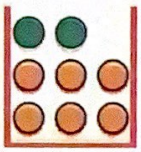
P(open) · P(correct open detect) = .5 · .6 = .3

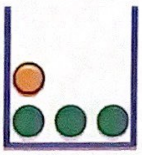
P(closed) · P(False close detect) = .5 · .2 = .1



$$\frac{P(\text{open} + \text{correct detect})}{P(\text{sensor detects open})} = \frac{.3}{.3 + .1} = \frac{3}{4} = 75\%$$

4. A red box contains two apples and six oranges. A blue box contains three apples and an orange. Let B be a random variable that denotes the choice of a box. Let F be a random variable that represents the choice of a particular fruit. Some probabilities are given:





$$p(B = r) = \frac{4}{10} \quad p(B = b) = \frac{6}{10}$$

a) What is the probability of picking an apple? 2

$\frac{4}{10} \cdot \frac{2}{8} + \frac{6}{10} \cdot \frac{3}{4} = \frac{1}{10} + \frac{9}{20} = \frac{11}{20}$

b) If an apple was picked, what is the probability of it coming from the blue box? 4

82%. $\frac{9}{20} \div \frac{11}{20}$

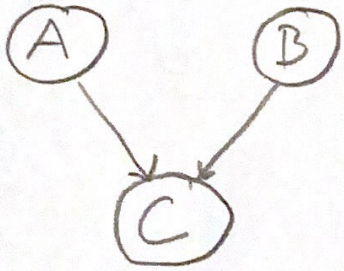
c) If an apple was picked, what is the probability of it coming from the red box? 2

18%.

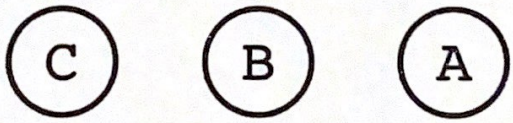
5. Research *Bayesian Belief Networks* and answer the following questions.

a) Draw the Bayesian network of three random variables A, B, and C where the factorization of their joint probability is: 1.5

$$p(A, B, C) = p(C \mid A, B)\, p(A)\, p(B)$$



b) Write the joint probability factorization of the following Bayesian network: 1.5



$$P(A, B, C) = P(C)\, P(B)\, P(A)$$

END