

## Math for Deep Learning - Homework 03

Name: \_\_\_\_\_

1. Roll a fair four sided die twice.
  - (a) What is the sample space?
  - (b) What is the probability of getting at least one 3?
  - (c) What is the probability of getting a sum of 3?
  - (d) Let  $Y$  be th RV (random variable) equal to the count of the number of threes of the two rolls. Write down its pdf.
  - (e) Let  $X$  be th RV equal to the sum of the two rolls. Write down its pmf.
  - (f) Let  $X$  be th RV equal to the sum of the two rolls. Write down its pmf.
  - (g) Compute  $P(X = 3)$ ,  $P(Y = 2)$  and  $P(X = 3 \text{ and } Y = 2)$ .
  - (h) Are  $X$  and  $Y$  independent?
2. Let  $f(x) = C(x^2 + 1)$  over  $[0, 3]$ .
  - (a) Assume  $f$  is a pdf for a RV  $X$ . What is  $C$ ?
  - (b) Compute the  $P(X < 2)$ , and  $P(X > 2)$
3. Let  $f(x, y) = C(yx^2 + 1)$  where  $x \in [0, 3]$  and  $y \in [0, 3]$ .
  - (a) Assume  $f$  is a pdf for a RV  $X$ . What is  $C$ ?
  - (b) Compute the  $P(X < 2)$ ,  $P(Y > 2)$ , and  $P(X < 2 \text{ and } Y > 2)$ .
  - (c) Are  $X$  and  $Y$  independent?
4. Consider a set of 1000 emails and
  - $V$  be the event that an email has the word viagra in it
  - $S$  be the event that an email is spam

We have the following sample data:  $n = 1000$  the total nuber of emails,  $n(V) = 12$ ,  $n(S) = 203$ , and  $n(V \cap S) = 11$

- (a) What is  $P(S)$ ,  $P(V)$  and  $P(V \cap S)$ ?
- (b) Compute  $P(S|V)$  and  $P(S|V^C)$ ?
- (c) Use Bayes to compute  $P(V|S)$  and  $P(V|S^C)$ ?

5. Roll two fair 4-sided dice. Let  $X$  be the RV to represent the sum on the dice, and let  $Y$  be the RV that is the difference on the dice.
  - (a) What is the joint pmf?
  - (b) compute the marginal pmfs.
  - (c) What is the  $\Pr(X+Y|2)$ ?
6. Use the pdf  $f(x, y) = \frac{6x+2y}{7}$  for  $0 \leq x \leq 1$  and  $0 \leq y \leq 1$ .
  - (a) What is the joint pdf?
  - (b) compute the marginal pdfs.
  - (c) What is the  $\Pr(0 < X < 0.5, 0.5 < Y < 1)$ ?
  - (d) What is the  $\Pr(X + Y < 1)$ ?<sup>1</sup>
7. Are  $X$  and  $Y$  from Question 5 independent?
8. Are  $X$  and  $Y$  from Question 6 independent?
9. Compute covariance and correlation from Question 5.
10. Compute covariance and correlation from Question 5.
11. MLE Maximum Likelihood estimator question
12. Bayesian estimation question

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<sup>1</sup>May be challenging, we didnt do an example like this.