EC 414 Midterm 1 Practice Questions

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1 Probability

1) There are n people in a room. What is the probability that at least 2 people have the same birthday?

2) Suppose there is a disease-detecting test with the following statistics. Let:

A = event that a tested person has the disease

B = event that the test result is positive

We know that $P(B|A) = 0.99$, $P(B|$ not $A) = 0.005$, and 0.1% of the population definitely has the disease. Find the probability that, given a positive test result, the tested person indeed has the disease.

3) Let A, B, and C represent events. If the following is true, A and B are conditionally independent on C:

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

Show that the preceding conditional independence statement is equivalent to the following:

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

2 Maximum Likelihood (ML) and Maximum A Posteriori (MAP)

1) Assume that we are given n iid samples ($X = [x_1,...,x_n]^T$) from each $P(X|\theta)$ given below. Compute the ML estimates for the parameter of the distributions below:

a) $P(X|\theta) = \text{Poisson}(\theta)$

3 Linear Regression

1) Suppose instead of the Least Squares error normally used in Linear Regression, we use a sum of absolute values as the error function:

$$\sum_{i=1}^{n} |y_i - (\boldsymbol{w}^T \boldsymbol{x}_i + b)|$$

Describe an advantage and disadvantage of this type of error function.

2) Consider performing stochastic gradient descent with a batch size of 1 on the Least Squares objective function. Write a piece of code (can be pseudocode) for this algorithm (hint: it will need a for or while loop).

4 Classification

1) In class, we discussed some of the pros and cons of Nearest Neighbor classification. Describe a pro and a con for Decision Trees and for Linear Discriminant Analysis (LDA).

2) Show that the derivative of the sigmoid function σ is: $\sigma'(a) = \sigma(a)(1-\sigma(a))$.

3) Compute by hand the Fisher Linear Discriminant weights for a 2 class problem with the following sets of points:

Class 1 points: $\boldsymbol{x}_1 = [0,0]^T$, $\boldsymbol{x}_2 = [-1,0]^T$,$\boldsymbol{x}_3 = [1,1]^T$

Class 2 points: $\boldsymbol{x}_4 = [10,10]^T$, $\boldsymbol{x}_5 = [11,10]^T$

5 General

1) Describe a situation where one would use a validation set in addition to training and testing sets.