University of TEHRAN

Machine Learning

Problem Set 5

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Problem 1: Review Questions
Write a summary of the lectures of this week. Write down all formulas we discussed in the lectures and explain in detail each step of derivations. As a guideline, you may consider the following topics:

(a) Exponential family; Generalized Linear Models; Discriminative vs Generative models

(b) Linear discriminant analysis; Naïve Bayes classifier

Problem 2: Generalized linear models
Give some examples of bioinformatic applications where GLM framework with the following distributions for response variable can be used:

(a) Gaussian

(b) Binomial

(c) Negative Binomial

(d) Poisson

(e) Beta

(f) Weibull

You may co-submit this question with another student as long as you understand and can explain what you have submitted.

Problem 3: Conceptual questions
[ISL] chapter 4: questions 2, 3, 5

question 10 (programming)

Problem 4: Maximum likelihood estimation of multinomial distribution
Suppose X is a multinomial random variable that takes values $x^1, x^2, \dots x^K$. The multinomial distribution has K parameters $\Pi = (\pi_1, \dots, \pi_K)$ such that $P(X = x^k) = \pi_k$ subject to $\sum_k \pi_k = 1$. Let the observed data is $(n_1, \dots, n_K)$ where n_k is the number of times the value x^k appears in the data. Prove the ML estimate for π_k is $\frac{n_k}{n}$ where $n = \sum_k n_k$ (hint: use Lagrange multiplier).

Problem 5: Stochastic gradient ascent rule for Poisson regression
Poisson regression is a GLM where the response variable is assumed to have Poisson distribution:

(a) Write the Poisson distribution in an exponential family form.

(b) Derive the stochastic gradient ascent rule for Poisson regression.

We encourage discussing the problems with other students, however, similarity between solutions is not allowed. (**Important**) Studying any online solution, no matter to what extent, is strictly forbidden and is considered as a violation of the academic honor code. Please write in the first page of your submission whom you have brainstormed the questions. Submit your solutions (using Easyclass) by Aban 11, 1398.