

STAT561 Lab 1

Spring 2019

January 14, 2019

1 Review

1.1 Probability

1.1.1 Law of total probability

Given two discrete random variables X and Y

1.1.2 Conditional probability

Given that discrete random variable X and Y takes values in $\{0, 1\}$, what is the complementary event of $P(X = 0|Y = 1)$?

$$P(X = 1|Y = 1) \quad \text{OR} \quad P(X = 0|Y = 0)$$

1.1.3 Expectations

Given that X is a discrete random variable

What about the expectation of a function $f(X)$?

The linearity of expectation

1.1.4 Variance

Given that X is a discrete random variable

1.1.5 Independence

Two random variables X and Y are independent if and only if

based on that property, we can prove that

1.1.6 Conditional Independence

Two random variables may become independent when conditioned on the third variable

1.1.7 Number of Parameters

Given that discrete random variable X and Y takes values in $\{0, 1\}$, how many independent parameters do you need to fully specify:

- the marginal probability of X ?
- the joint probability of $P(X, Y)$?
- the conditional probability of $P(X|Y)$?
- the joint probability of $P(X, Y)$ when X and Y are independent?

1.1.8 Maximum Likelihood Estimation

The **likelihood** $P(D|\theta)$ is evidence for observation/data D given model parameter $\theta \in \Theta$. MLE (Maximum likelihood estimation) is

1.2 Linear Algebra

1.2.1 Vector

(a) Inner Product

(b) Orthogonal

(c) Norm

The norm (length) of \mathbf{x}

(d) Distance

The distance between 2 vectors \mathbf{x} and \mathbf{y} is defined as

1.2.2 Matrix

(a) Determinant, Inverse

(b) Positive Definiteness and Positive Semi-Definiteness

A real valued squared matrix \mathbf{A} is positive definite if

Similarly, positive semidefinite has the condition

(c) Eigenvalue and Eigenvector

Given a squared matrix \mathbf{A} , its eigenvector \mathbf{u} is a solution ($\neq \mathbf{0}$) of the equation

1.3 Categorization of machine learning problems

Please categorize the following problems in terms of regression/classification and supervised/unsupervised.

- Stock price prediction
- Dog or cat
- Customer behavior study
- Diagnosis of disease