2018 PL Midterm

Statistics, Machine Learning

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Statistics

1. Hand-Writing

1. Prove that
$$V[x] = E[x^2] - E[x]^2 \quad \text{where pdf of x is continuous}$$

2. Prove that
$$Cov(x, y) = E[xy] - E[x]E[y] \quad \text{where pdf of x,y are continuous}$$

3. Find ACC, TPR, TNR, PPV of next table :

Actual \ Predicted	Cat	Dog	Rabbit
Cat	5	3	0
Dog	2	3	1
Rabbit	0	2	11

4. Denote F-measure, and explain meaning of F-measure.

5. Write full name of each objects :
   - ROC
   - AUC
   - MCC
   - MAP

6. Denote Mahalanobis distance and pdf of higher dimension Gaussian distribution.

2. Programming

You have data for five people about weight, score and age.

Weight	Score	Age
64.0	580.0	29.0
66.0	570.0	33.0
68.0	590.0	37.0
69.0	660.0	46.0
73.0	600.0	55.0

1. Find covariance matrix

2. Find correlation coefficient between weight and score.

$$\rho(x, y) = \frac{\sum_i (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_i (x_i - \bar{x})^2} \sqrt{\sum_i (y_i - \bar{y})^2}}$$

3. Now you have another person data:

Weight	Score	Age
66.0	640.0	44.0

   Calculate Mahalnobis distance of this person from above data set.

Machine Learning

1. Hand-Writing

1. Prove that β minimize RSS. (X is input, t is answer)

$$\beta = (\mathbf{X^T X})^{-1}\mathbf{X^T t}$$

2. Why we use sigmoid or $\tanh$ as activation function?

3. Denote forward process of Multi Layer Perceptron.

4. Denote whole Error Back-Propagation process of Multi Layer Perceptron.

5. Find derivatives of below functions (represent derivative as original function).
   - $\sigma_\beta(x) = \dfrac{1}{1+e^{-\beta x}}$
   - $\tanh(x) = \dfrac{e^x - e^{-x}}{e^x + e^{-x}}$
   - $softmax(x_k) = \dfrac{e^{x_k}}{\sum_k e^{x_k}}$

6. Rewrite Error Back-Propagation as vectorized form.

2. Programming

First, type below code.

```
wget https://github.com/Axect/ML_Project/raw/master/Lecture/Midterm/data.csv
```

And let's see `data.csv`

1. Can we use SLP or linear regression to this data? If not, explain why.

2. Implement MLP code using $\tanh$ as activation function from input to hidden and sigmoid as activation function from hidden to output.

3. Predict Z when $X = \sqrt{0.5}, Y = 0.5$.

4. Predict Z when $X = \sqrt{0.5}, Y = \sqrt{0.5}$.