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1 Supervised Machine Learning: Regression and Classification

1.1 Week 1 linear Regression with One Variable

1.1.1 Learning Objectives

- Define machine learning
- Define supervised learning
- Define unsupervised learning
- Write and run Python code in Jupyter Notebooks
- Define a regression model
- Implement and visualize a cost function
- Implement gradient descent
- Optimize a regression model using gradient descent

Some notations

- In the training set, there are features (x) and targets (y)
- x is the input variable (feature)
- y is the output variable (target)
- m = number of training examples
- (x, y) = single training example
- $(x^{(i)}, y^{(i)}) = i^{th}$ training example ($1^{st}, 2^{nd}, 3^{rd} \dots$)
- \hat{y} means prediction(estimated y)
- f is the function (model)(hypothesis)
- $f_{w,b}(x) = wx + b$
- Parameters: w, b
- Squared error cost function: $J(w, b) = \frac{1}{2m} \sum_{i=1}^m (\hat{y}^{(i)} - y^{(i)})^2$
- Find w, b : $\hat{y}^{(i)}$ is close to $y^{(i)}$ for all $(x^{(i)}, y^{(i)})$

$$J(w, b) = \frac{1}{2m} \sum_{i=1}^m (f_{w,b}(x^{(i)}) - y^{(i)})^2$$

- Goal: *minimize* $J(w, b)$

1.1.2 Gradient Descent

repeat until convergence{

$$w = w - \alpha \frac{\partial}{\partial w} J(w, b)$$

$$b = b - \alpha \frac{\partial}{\partial b} J(w, b)$$

}

Simultaneously update w and b

α is the learning rate (usually between 0 and 1, maybe 0.01)

$\frac{\partial}{\partial w} J(w, b)$ and $\frac{\partial}{\partial b} J(w, b)$ are derivative terms

Near a local minimum,

- Derivative becomes smaller
- Update steps become smaller

1.1.3 Gradient descent for linear regression

$$\frac{\partial}{\partial w} J(w, b) = \frac{1}{m} \sum_{i=1}^m (f_{w,b}(x)^{(i)} - y^{(i)}) x^{(i)}$$

$$\frac{\partial}{\partial b} J(w, b) = \frac{1}{m} \sum_{i=1}^m (f_{w,b}(x)^{(i)} - y^{(i)})$$

repeat until convergence{

$$w = w - \alpha \frac{1}{m} \sum_{i=1}^m (f_{w,b}(x)^{(i)} - y^{(i)}) x^{(i)}$$

$$b = b - \alpha \frac{1}{m} \sum_{i=1}^m (f_{w,b}(x)^{(i)} - y^{(i)})$$

}

1.1.4 Lab notes

Deep copy is a process in which the copying process occurs recursively. It means first constructing a new collection object and then recursively populating it with copies of the child objects found in the original. In case of deep copy, a copy of object is copied in other object. It means that any changes made to a copy of object do not reflect in the original object. In python, this is implemented using “deepcopy()” function.

0.3e : example: 1.949e+02 (Three decimal places are reserved before e)

8.4f : example: 199.9929 (Including the decimal point, there are eight decimal places, and four decimal places are reserved after the decimal point)

1.2 Week 2 Regression with multiple input variables

1.2.1 Learning Objectives

- Use vectorization to implement multiple linear regression
- Use feature scaling, feature engineering, and polynomial regression to improve model training
- Implement linear regression in code

Some notations

- $x_j = j^{th}$ feature
- n = number of features
- $\vec{x}^{(i)}$ = features of i^{th} training example
- $\vec{x}_j^{(i)}$ = value of feature j in i^{th} training example
- $f(w, b) = w_1x_1 + w_2x_2 + \dots + w_nx_n + b$
 $\vec{x} = [x_1, x_2, x_3, \dots, x_n]$
 $\vec{w} = [w_1, w_2, w_3, \dots, w_n]$
 b is a number
 \vec{w} and b are parameters of the model

•

$$f_{\vec{w}, b}(\vec{x}) = \vec{w} \cdot \vec{x} + b$$

1.2.2 Multiple Linear Regression

$$2^2 + 2^2 = 8 \text{ and } 2 \times 2 = 4$$

$$\cos^2 \theta + \sin^2 \theta = 1$$

The union of two sets A and B is denoted as $A \cup B = \{x \in A \text{ or } x \in B\}$

We are learning fractions $\frac{a}{\frac{b}{c}} \times \frac{\frac{d}{e}}{f} \geq 1$ which is good.

$$\frac{a}{\frac{b}{c}} \times \frac{\frac{d}{e}}{f} \geq 1$$

$$\left\{ \left(\frac{a}{b} \right) + \left(\frac{c}{d} \right) \right\}$$

$$\sum_{i=a}^b g(i) = 0, \text{ for } b < a$$

$$\sum_{i=1}^n i = \frac{n(n+1)}{2}$$

2 More in Mathematics

$$\int_2^4 \lim_{2 \rightarrow 4}$$

$$\int_0^\infty f(x)dx$$

$$\lim_{x \rightarrow c} f(x) = L$$

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} + \begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix} = \begin{bmatrix} 6 & 8 \\ 10 & 12 \end{bmatrix}$$

3 Equations

$$3x + 5y = 2 \tag{1}$$

$$5x + 8y = 3 \tag{2}$$

$$x^2 - y^2 = (x + y)(x - y) \tag{3}$$

$$3x - 6 = 9 \tag{4}$$

$$3x = 9 + 6$$

$$x = \frac{9 + 6}{3}$$

$$x = 5$$