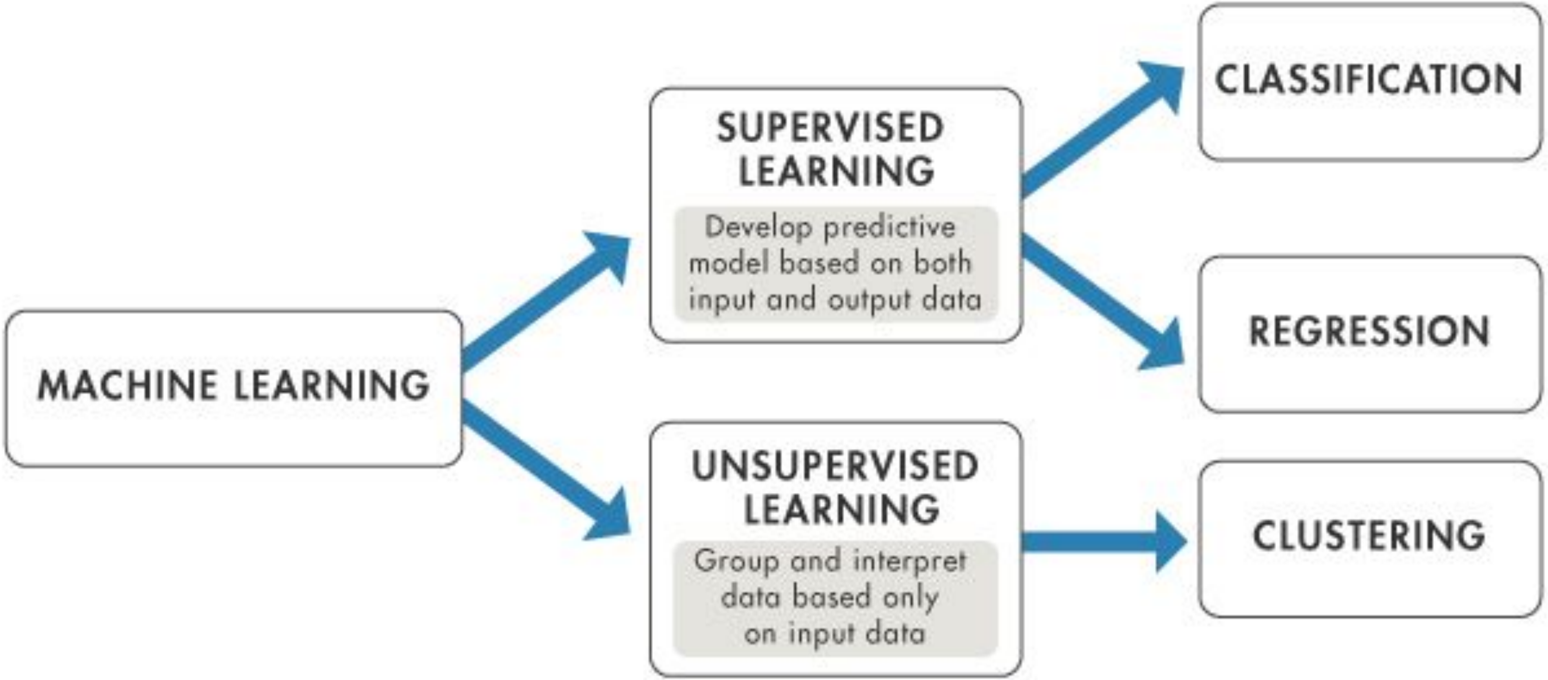
# Applied Machine Learning

Fall 2023

Week 4


MACHINE LEARNING
SUPERVISED LEARNING
Develop predictive model based on both input and output data
UNSUPERVISED LEARNING
Group and interpret data based only on input data
CLASSIFICATION
REGRESSION
CLUSTERING

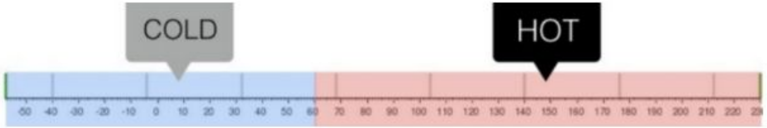
## Regression

What will be the temperature tomorrow?

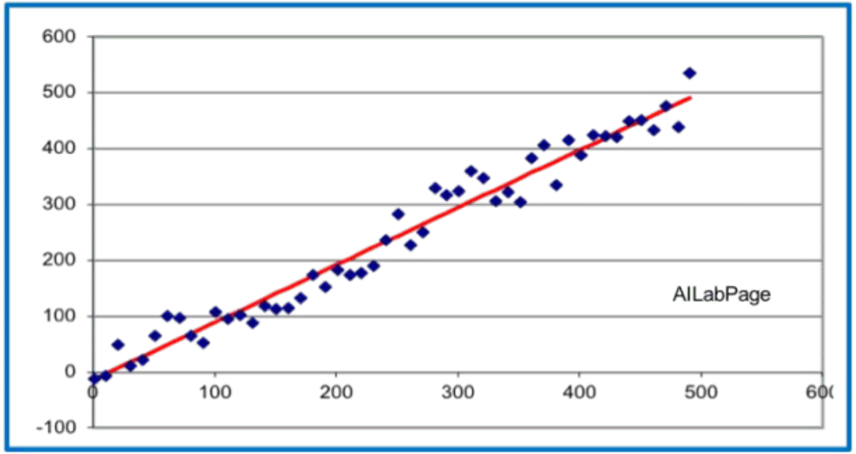

Fahrenheit

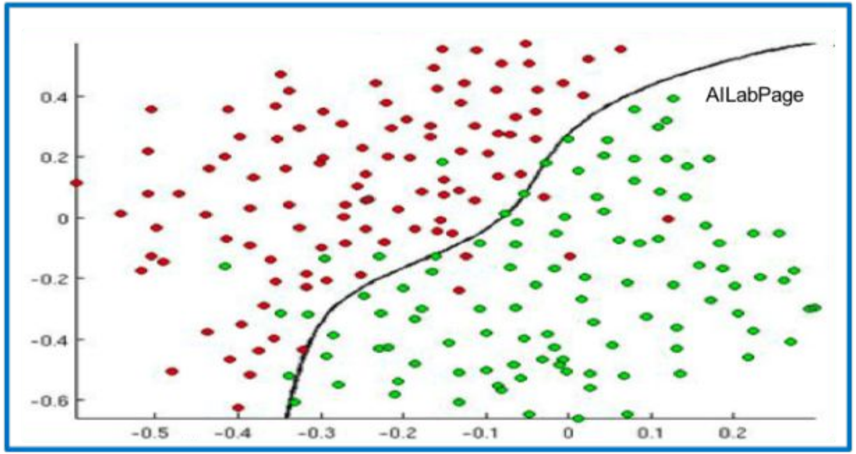
## Classification

Will it be hot or cold tomorrow?




Fahrenheit




## Regression

1. The system attempts to predict a value for an input based on past data.
2. Real number / Continuous numbers – Regression problem
3. Example – 1. Temperature for tomorrow

## Classification

1. In classification, predictions are made by classifying them into different categories.
2. Discreate / categorical variable – Classification problem
3. Example – 1. Type of cancer 2. Cancer Y/N

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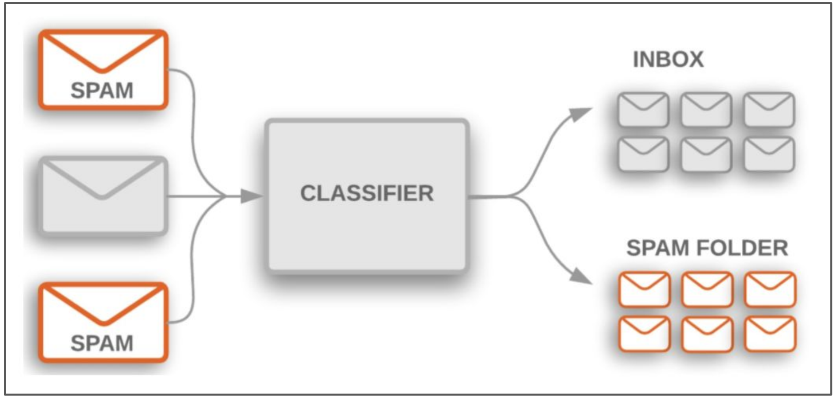
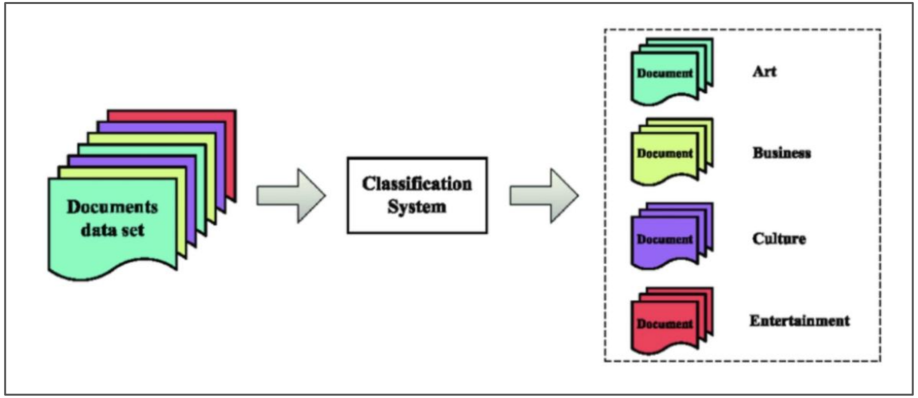
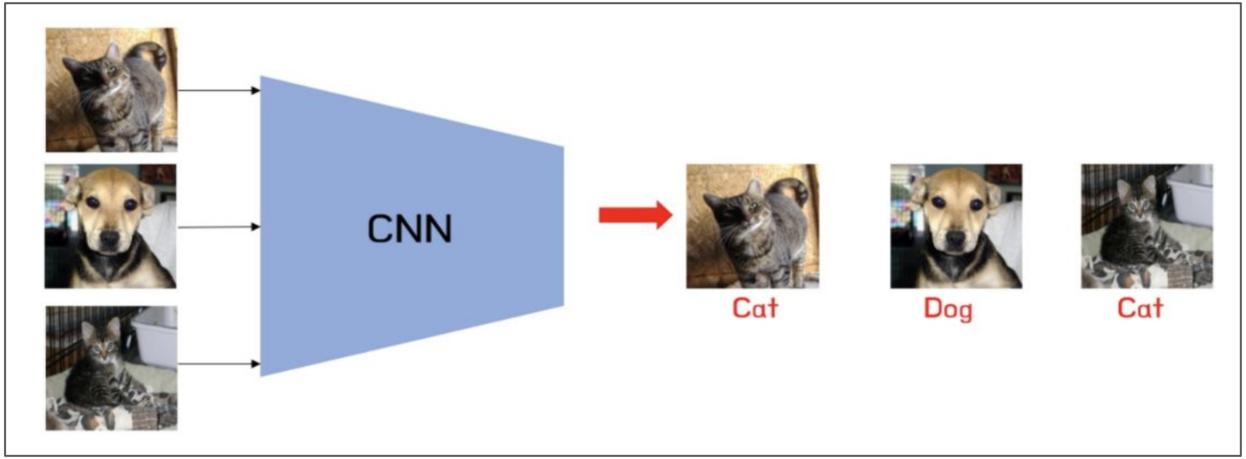
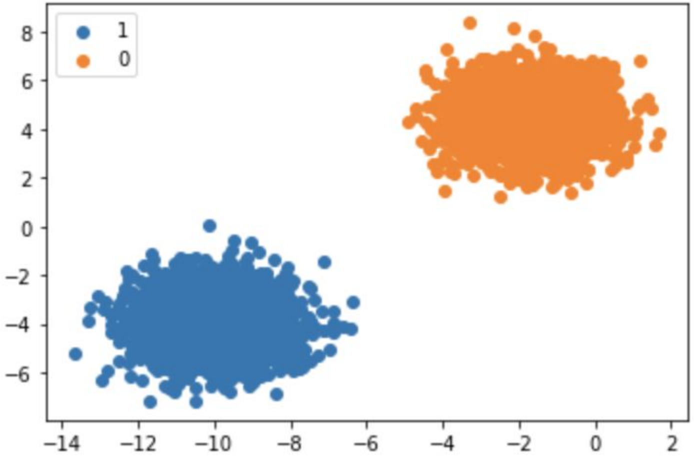
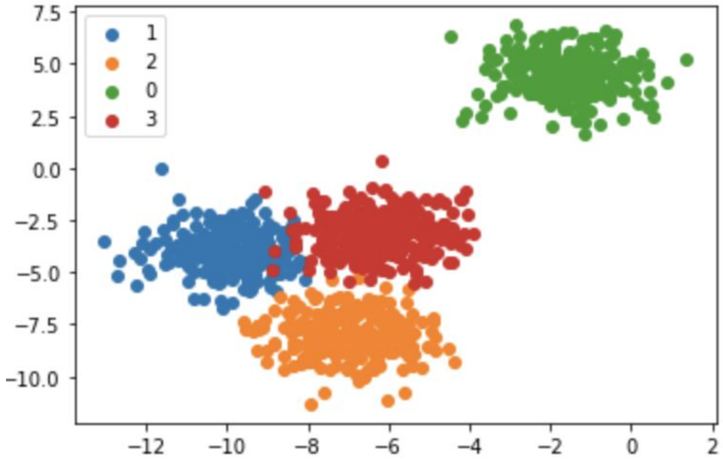

SPAM
SPAM
CLASSIFIER
INBOX
SPAM FOLDER


Documents data set
Classification System
Document
Art
Document
Business
Document
Culture
Document
Entertainment


CNN
Cat
Dog
Cat




In [1]:
```
import pandas as pd
```

In [3]:
```
# Read a comma-separated values (csv) file into DataFrame.
# filepath_or_bufferstr, path object or file-like object
df = pd.read_csv("diabetes.csv")
```

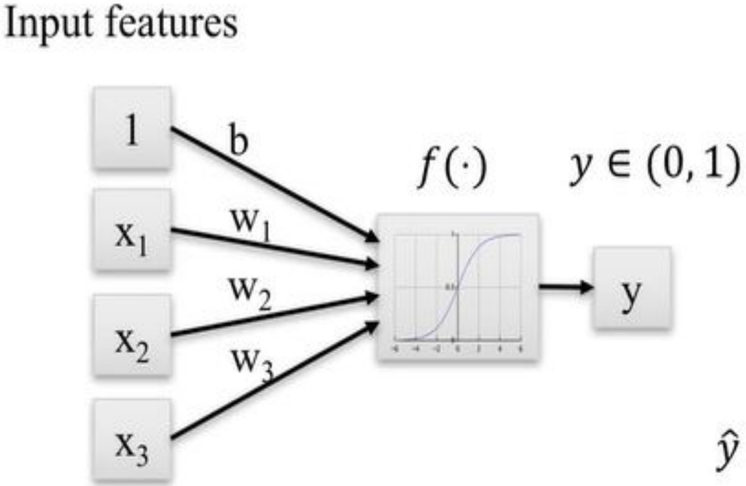
In [4]:
```
df.head(3)
```

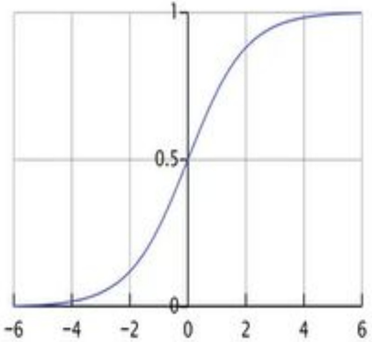
Out[4]:

| | Pregnancies | Glucose | BloodPressure | SkinThickness | Insulin | BMI | DiabetesPedigreeFunction | Age | Outcome |
|---|---|---|---|---|---|---|---|---|---|
| **0** | 6 | 148 | 72 | 35 | 0 | 33.6 | 0.627 | 50 | 1 |
| **1** | 1 | 85 | 66 | 29 | 0 | 26.6 | 0.351 | 31 | 0 |
| **2** | 8 | 183 | 64 | 0 | 0 | 23.3 | 0.672 | 32 | 1 |

| SepalLengthCm | SepalWidthCm | PetalLengthCm | PetalWidthCm | Species |
|---|---|---|---|---|
| 6.8 | 3.2 | 5.9 | 2.3 | Iris-virginica |
| 6.9 | 3.1 | 5.1 | 2.3 | Iris-virginica |
| 4.9 | 3.0 | 1.4 | 0.2 | Iris-setosa |
| 5.6 | 3.0 | 4.5 | 1.5 | Iris-versicolor |
| 4.8 | 3.1 | 1.6 | 0.2 | Iris-setosa |
| 5.8 | 2.8 | 5.1 | 2.4 | Iris-virginica |
| 7.2 | 3.6 | 6.1 | 2.5 | Iris-virginica |
| 5.1 | 3.5 | 1.4 | 0.3 | Iris-setosa |
| 4.7 | 3.2 | 1.6 | 0.2 | Iris-setosa |
| 6.6 | 3.0 | 4.4 | 1.4 | Iris-versicolor |

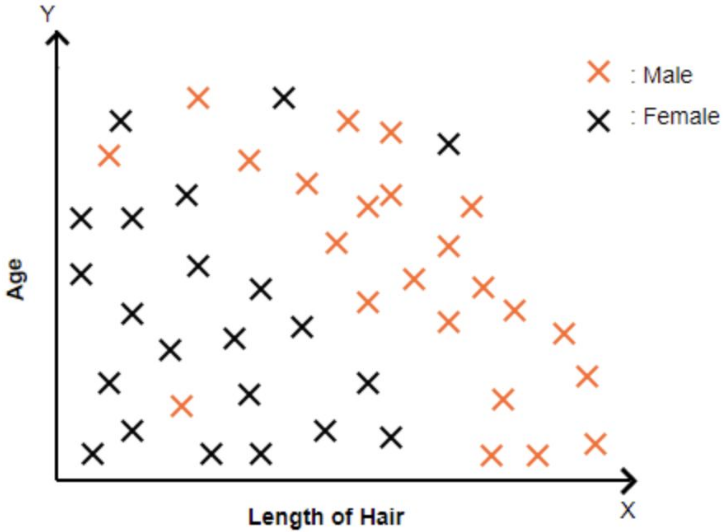
*Fig.1: Iris dataset having three categories*

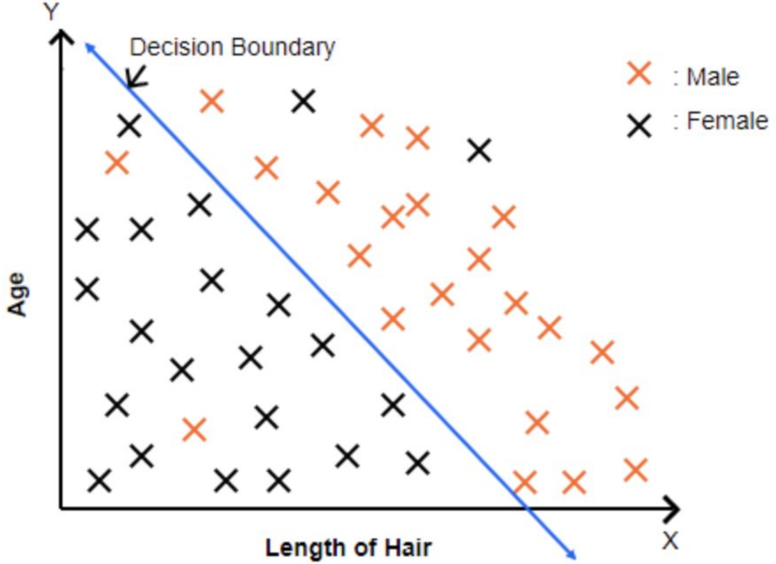



$$\hat{y} = \text{logistic}(\hat{b} + \hat{w}_1 \cdot x_1 + \cdots \hat{w}_n \cdot x_n )$$

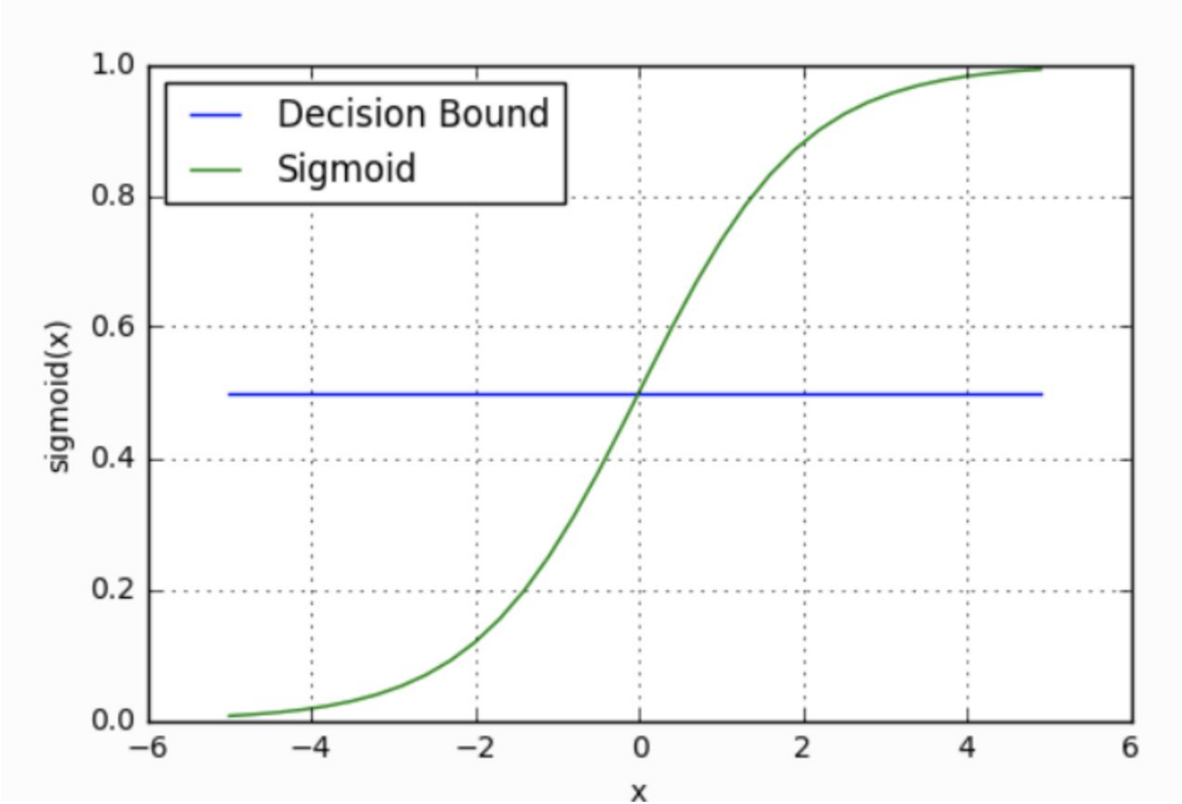
$$= \frac{1}{1 + \exp\left[-(\hat{b} + \hat{w}_1 \cdot x_1 + \cdots \hat{w}_n \cdot x_n)\right]}$$




$$w_0 + w_1 x_1 + w_2 x_2 = 0$$

# Decision Boundary



# Log Loss with Gradient Descent

$$y = g(z) = \frac{1}{1+e^{-z}} = \frac{e^z}{1+e^z}$$

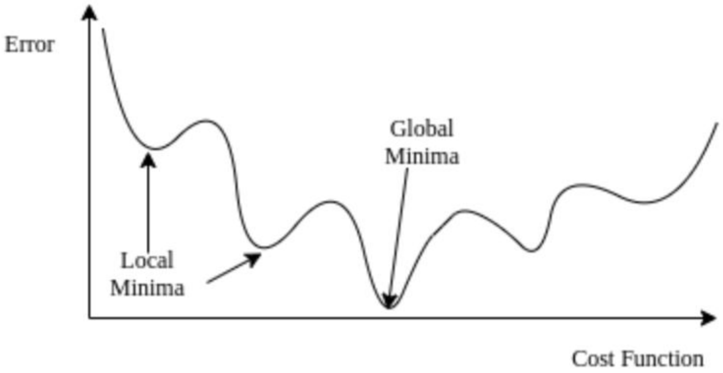
$$h_\theta(x) = \frac{1}{1+e^{-\theta^T x}}$$

$$P(y=1|\theta,x) = g(z) = \frac{1}{1+e^{-\theta^T x}}$$

$$P(y=0|\theta,x) = 1 - g(z) = 1 - \frac{1}{1+e^{-\theta^T x}} = \frac{1}{1+e^{\theta^T x}}$$

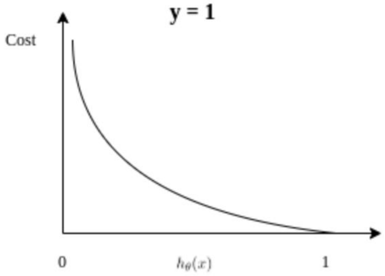
$$P(y|\theta,x) = \left(\frac{1}{1+e^{-\theta^T x}}\right)^y \times \left(1 - \left(\frac{1}{1+e^{\theta^T x}}\right)\right)^{1-y}$$

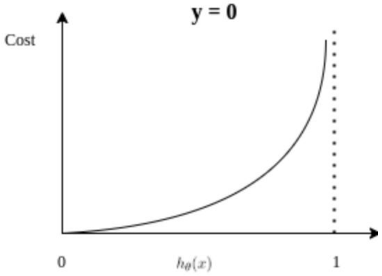
$$cost(h_\theta(x), y) = \begin{cases} -log(h_\theta(x)) & , \text{if } y = 1 \\ -log(1 - h_\theta(x)) & , \text{if } y = 0 \end{cases}$$




$$cost(h_\theta(x), y) = -y^{(i)} \times log(h_\theta(x^{(i)})) - (1 - y^{(i)}) \times log(h_\theta(x^{(i)}))$$

$$J(\theta) = -\frac{1}{m} \sum_{i=1}^{m} \left[ y^{(i)} \times log(h_\theta(x^{(i)})) + (1 - y^{(i)}) \times log(h_\theta(x^{(i)})) \right]$$



$$\theta_j \leftarrow \theta_j - \alpha \frac{\partial}{\partial \theta_j} J(\theta)$$

$$\frac{\partial}{\partial \theta_j} J(\theta) = \frac{1}{m} \sum_{i=1}^{m} \left( h_\theta(x^{(i)}) - y^{(i)} \right) x_j^{(i)}$$

$$\theta_j \leftarrow \theta_j - \alpha \frac{1}{m} \sum_{i=1}^{m} \left( h_\theta(x^{(i)}) - y^{(i)} \right) x_j^{(i)}$$

# Code Review