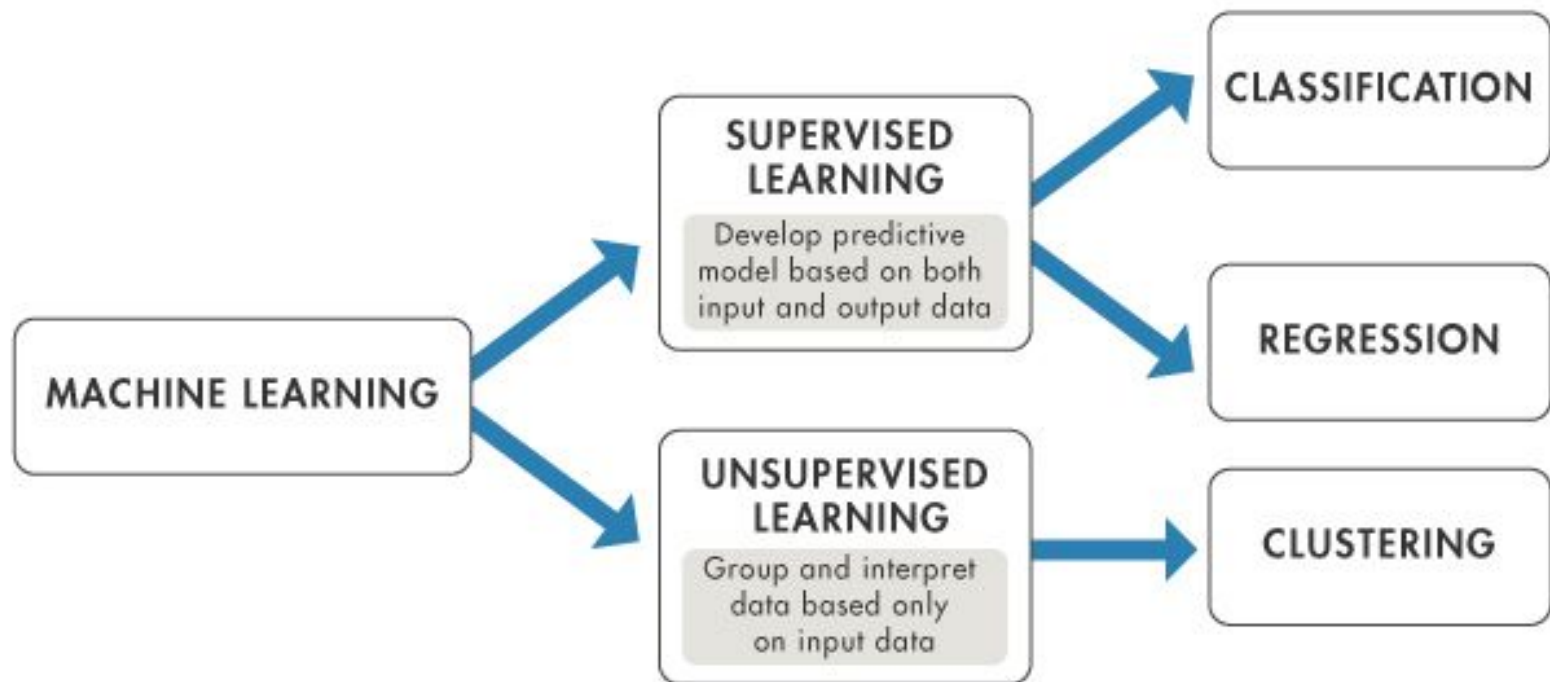


# Applied Machine Learning

Spring 2024

Week 4



## Regression



What will be the temperature tomorrow?

84°



Fahrenheit

## Classification



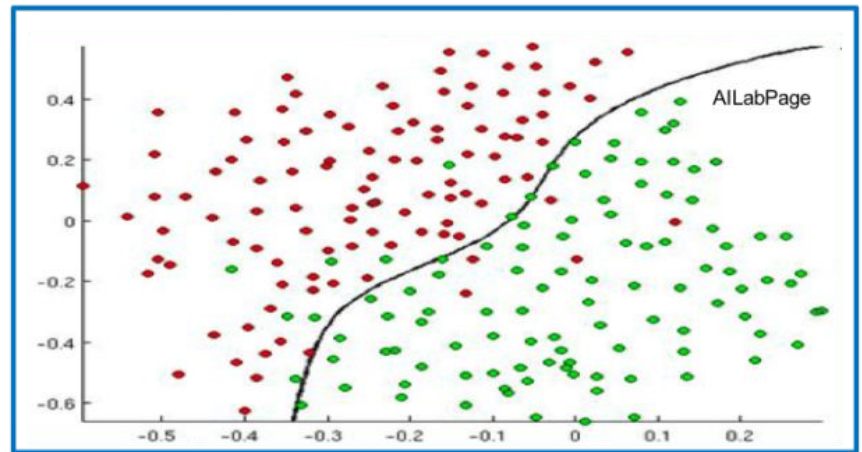
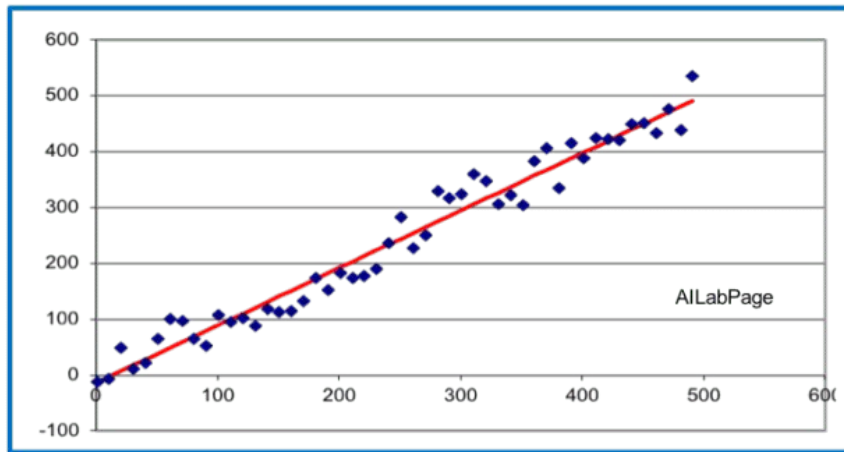
Will it be hot or cold tomorrow?

COLD

HOT



Fahrenheit



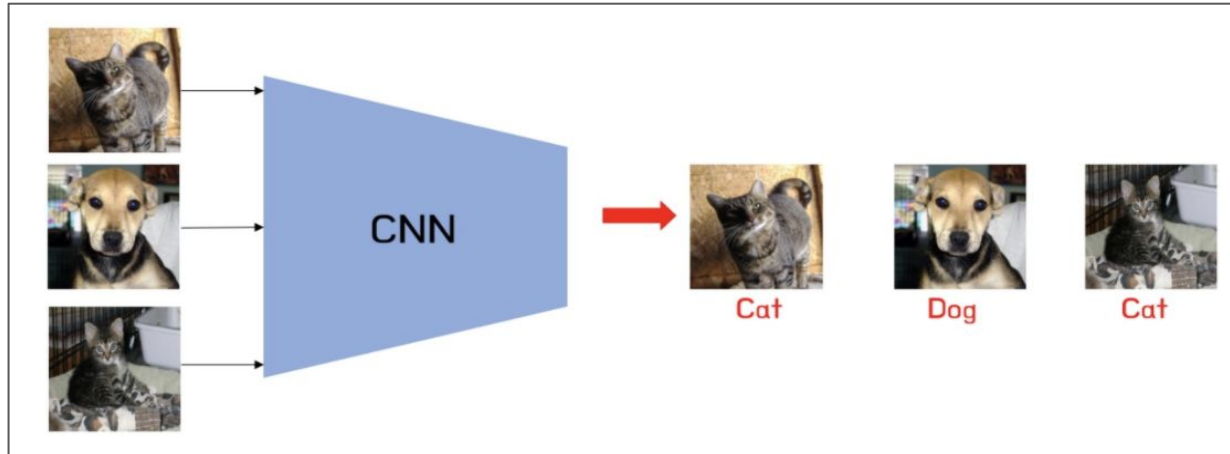
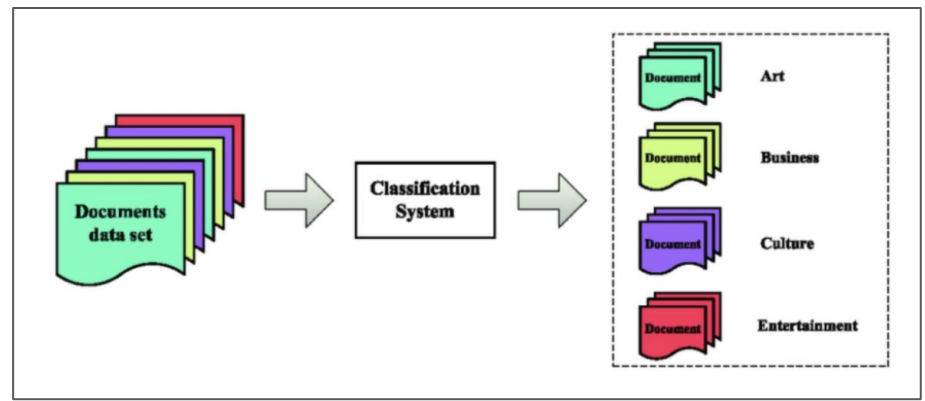
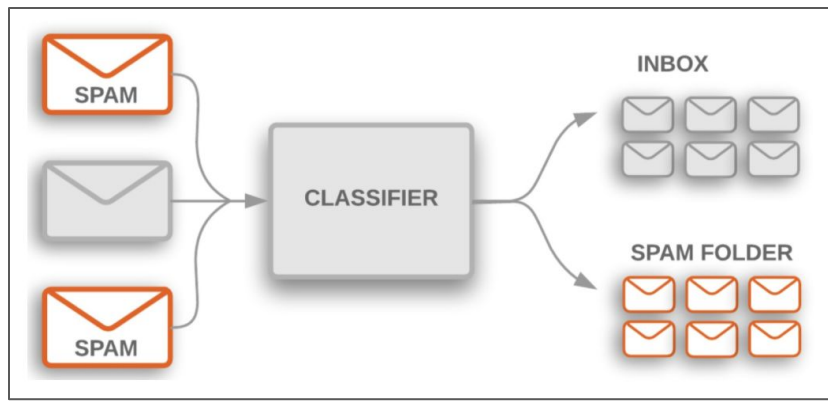
## Regression

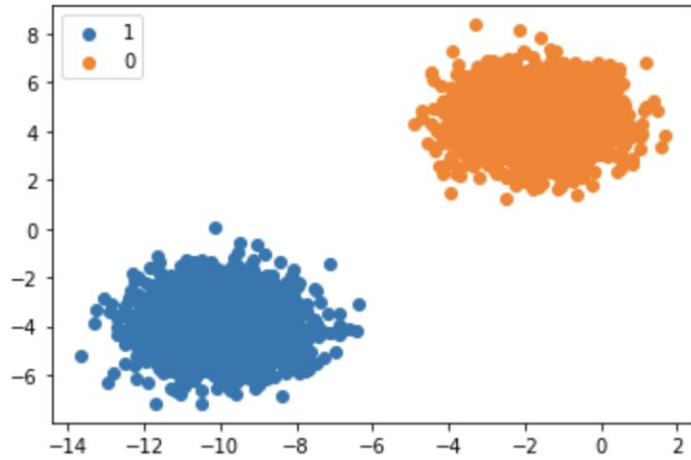
1. The system attempts to predict a value for an input based on past data.
2. Real number / Continuous numbers – Regression problem
3. Example – 1. Temperature for tomorrow



## Classification

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





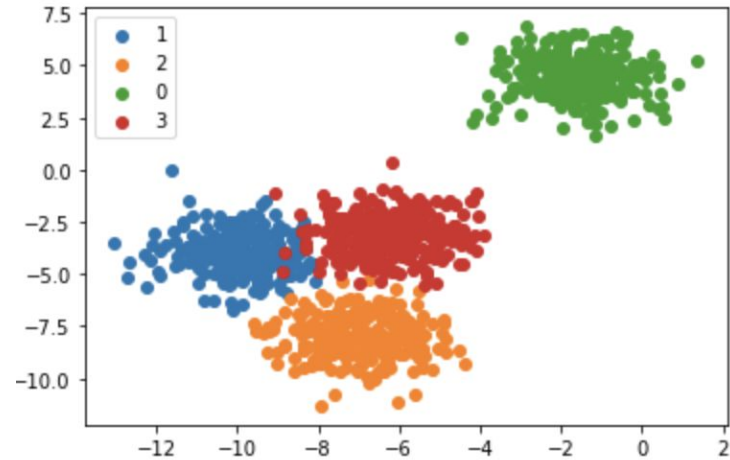
```
In [1]: import pandas as pd
```

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

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

Out[4]:

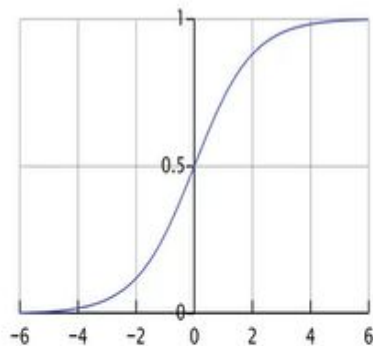
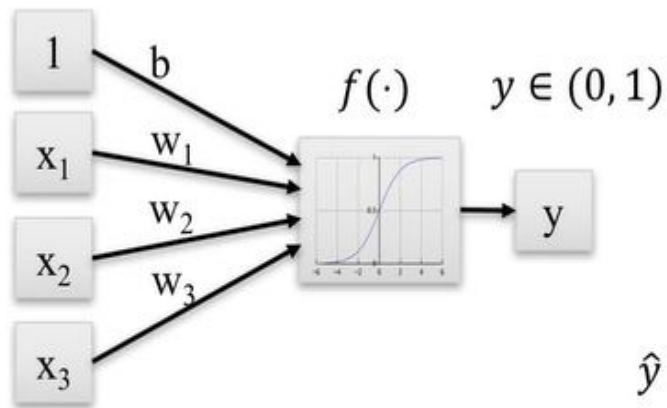
	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1



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

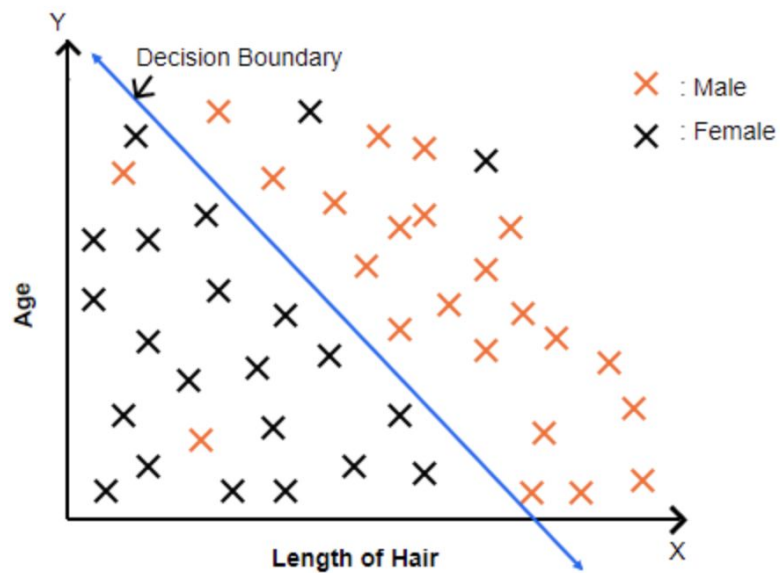
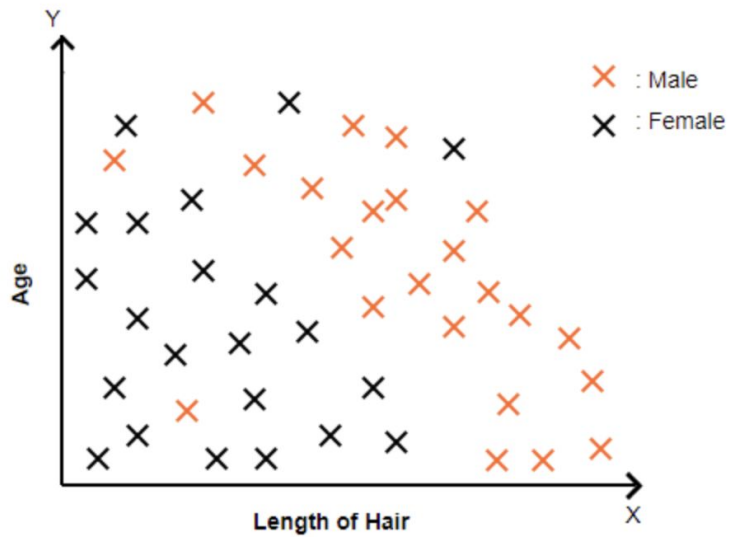
Fig.1: Iris dataset having three categories

Input features



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

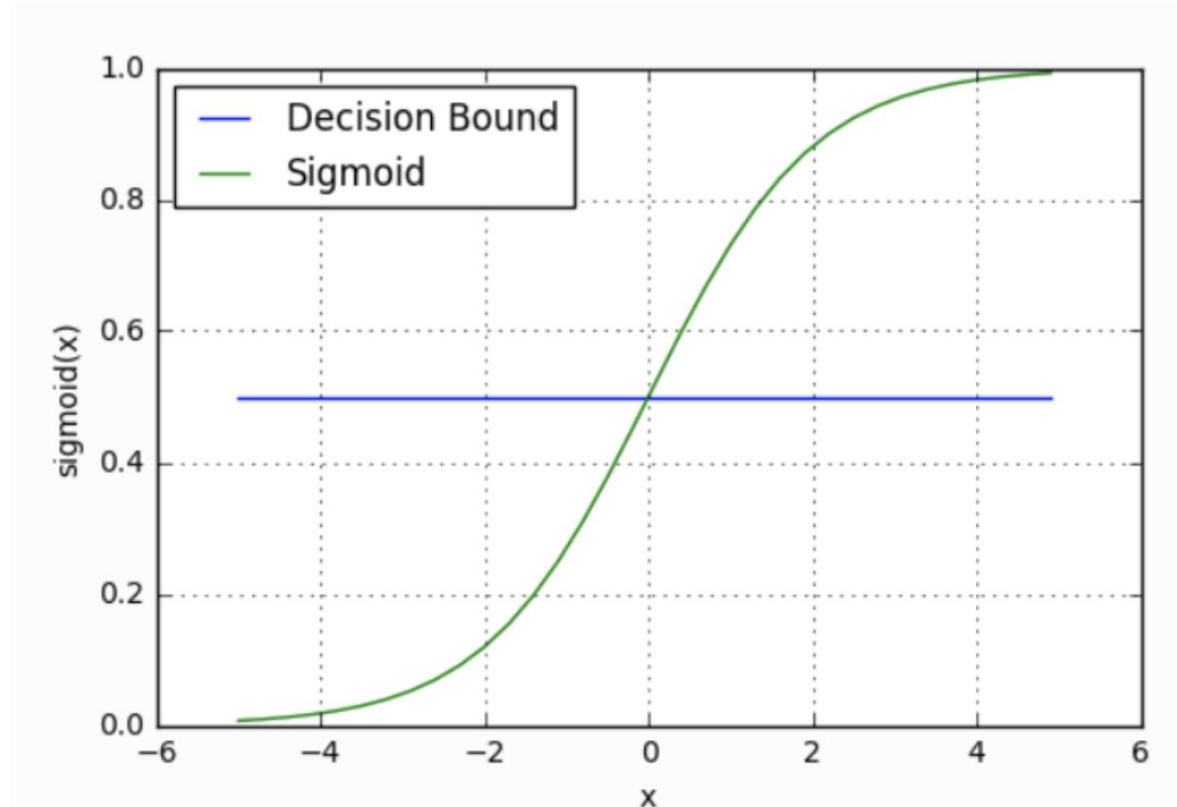
$$= \frac{1}{1 + \exp [-(\hat{b} + \hat{w}_1 \cdot x_1 + \cdots \hat{w}_n \cdot x_n)]}$$



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



# Decision Boundary



# Log Loss with Gradient Descent

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

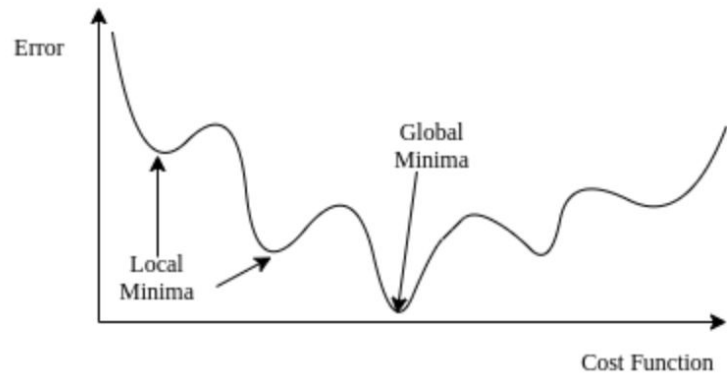
$$h_{\theta}(x) = \frac{1}{1 + e^{-\theta^T x}}$$

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

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

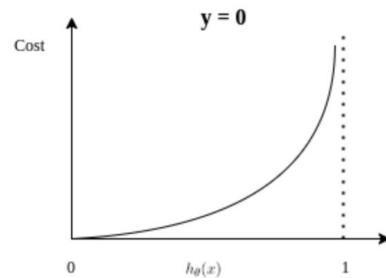
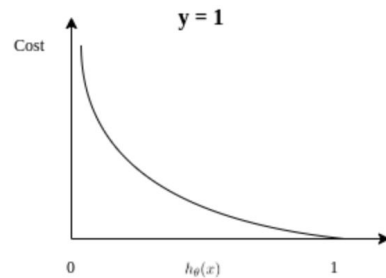
$$P(y|\theta, x) = \left( \frac{1}{1 + e^{-\theta^T x}} \right)^y \times \left( 1 - \left( \frac{1}{1 + e^{\theta^T x}} \right) \right)^{1-y}$$

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



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

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



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

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

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

# Code Review