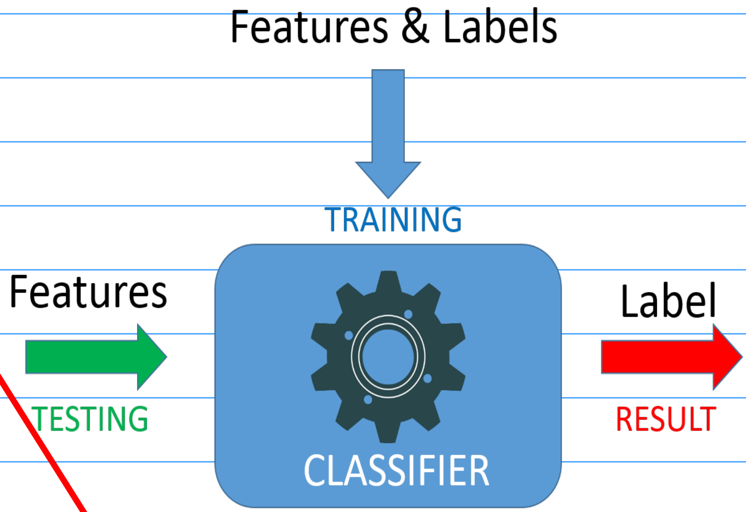
# Applying Deep Learning to a problem




1. Problem Definition : To predict whether it is going to rain today / not

2. Identify Features and labels

   * Labels : possible solutions for the problem
   * Features : Critical Factors which decide the labels

Labels - Rain (1)
- Not rain (0)

Features - Temp
- Hum
- wind/s

3. Create a dataset

| | Features | | | Labels |
|---|---|---|---|---|
| | Temp | Hum | wind/s | |
| Day 1 | 37°c | 80% | 20kmph | 0 |
| Day 2 | 23°c | 60% | 30kmph | 1 |
| Day 3 | 34°c | 40% | 20kmph | 0 |
| Day 4 | 32°c | 80% | 20kmph | 0 |
| | ⋮ | ⋮ | ⋮ | ⋮ |

# 4. Training the DL model (NN)

$X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$

X Y


① ②

30, 60, 15

$x'$

$x_1', x_2', x_3'$

$y = F(x)$

1/0

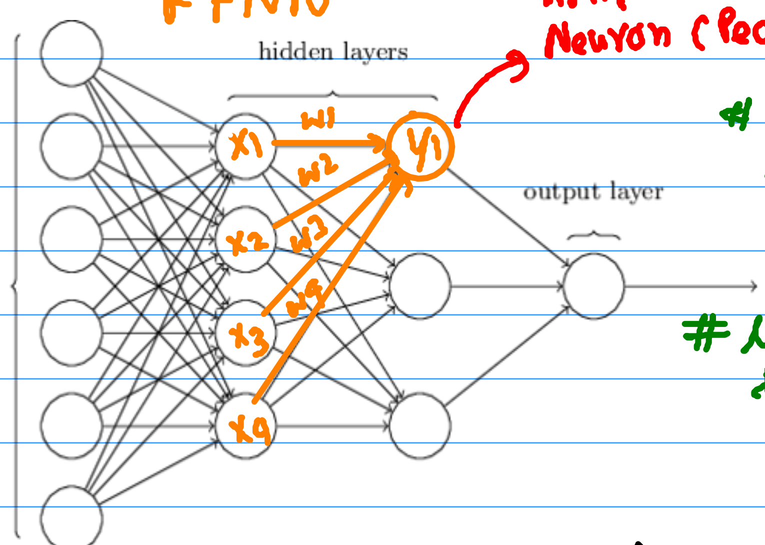
$y' = F(x')$

| Features | | | Labels |
|---|---|---|---|
| Temp | Hum | Wind/s | |
| 37°c | 80% | 20kmph | 0 |
| 23°c | 60% | 30kmph | 1 |
| 34°c | 40% | 20kmph | 0 |
| 32°c | 80% | 20kmph | 0 |
| ⋮ | ⋮ | ⋮ | ⋮ |
| $x_1$ | $x_2$ | $x_3$ | $y$ |

## Neural Network Architecture

FFNN

Artificial Neuron (Perceptrone)

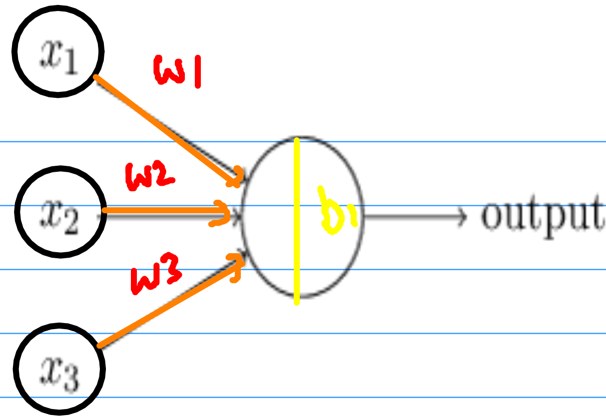



# neurons in input layer = # Features of the problem

# neurons in output layer = # labels of the problem

layers

Perceptrone

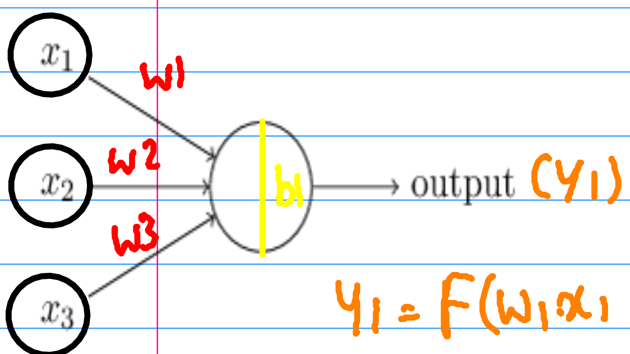



* Weights - All the nets in a NN have a weight
* Biases - All the neurons in the NN other than the input layer have biases.

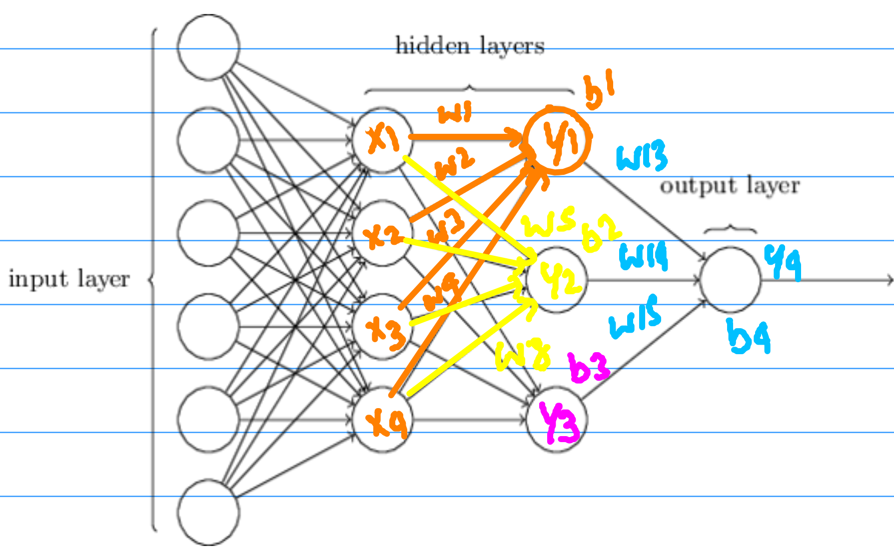
** All Ws, bs in the NN are called the trainable parameters

activation function

$$y_1 = F\left[\left(\sum_{i=1}^{n} w_i x_i\right) + b\right]$$

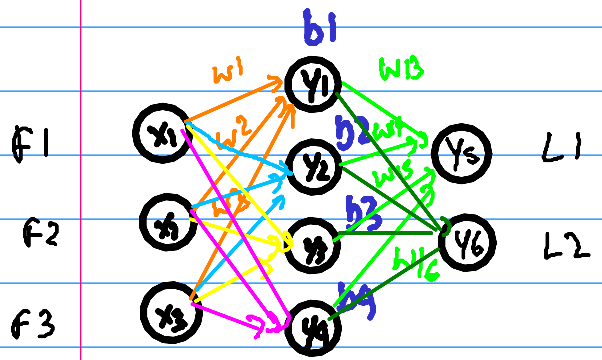



$$y_1 = F(w_1 \cdot x_1 + w_2 x_2 + w_3 \cdot x_3 + b_1)$$




$$y_4 = F(w_{13} \cdot y_1 + w_{14} \cdot y_2 + w_{15} \cdot y_3 + b_4)$$

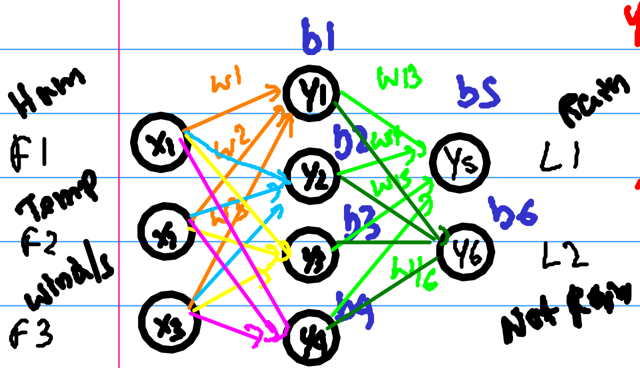
# Simple NN




$$y_1 = F(w_1 \cdot x_1 + w_2 \cdot x_2 + w_3 x_3 + b_1)$$
$$y_2 = F(w_4 \cdot x_1 + w_5 \cdot x_2 + w_6 x_3 + b_2)$$
$$y_3 = F(w_7 \cdot x_1 + w_8 \cdot x_2 + w_9 \cdot x_3 + b_3)$$
$$y_4 = F(w_{10} \cdot x_1 + w_{11} x_2 + w_{12} x_3 + b_4)$$

- W4, W5, W6
- W7, W8, W9
- W10, W11, W12

- W17, W18, W19, W20




$$y_5 = F(w_{13} \cdot y_1 + w_{14} \cdot y_2 + w_{15} \cdot y_3 + w_{16} \cdot y_4 + b_5)$$

$$y_6 = F(w_{17} \cdot y_1 + w_{18} \cdot y_2 + w_{19} \cdot y_3 + w_{20} \cdot y_4 + b_6)$$

# Iris Flower Dataset

labels – 0, 1, 2

setosa, verginica, versicolor

Features

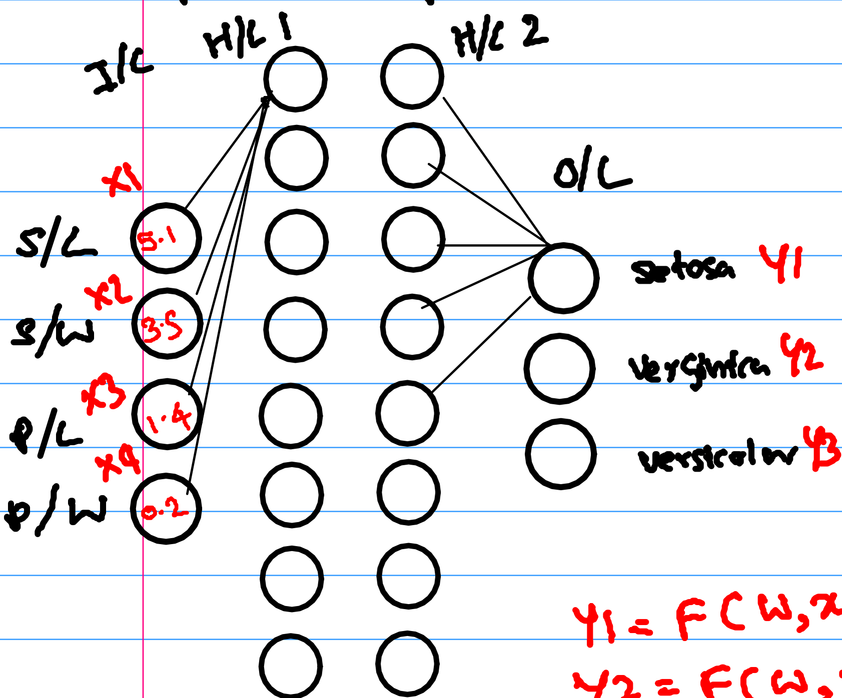
Fisher's *Iris* Data [hide]

| Dataset Order | Sepal length | Sepal width | Petal length | Petal width | Species |
|---|---|---|---|---|---|
| 1 | 5.1 | 3.5 | 1.4 | 0.2 | *I. setosa* |
| 2 | 4.9 | 3.0 | 1.4 | 0.2 | *I. setosa* |
| 3 | 4.7 | 3.2 | 1.3 | 0.2 | *I. setosa* |
| 4 | 4.6 | 3.1 | 1.5 | 0.2 | *I. setosa* |
| 5 | 5.0 | 3.6 | 1.4 | 0.3 | *I. setosa* |
| 6 | 5.4 | 3.9 | 1.7 | 0.4 | *I. setosa* |
| 7 | 4.6 | 3.4 | 1.4 | 0.3 | *I. setosa* |
| 8 | 5.0 | 3.4 | 1.5 | 0.2 | *I. setosa* |
| 9 | 4.4 | 2.9 | 1.4 | 0.2 | *I. setosa* |
| 10 | 4.9 | 3.1 | 1.5 | 0.1 | *I. setosa* |
| 11 | 5.4 | 3.7 | 1.5 | 0.2 | *I. setosa* |
| 12 | 4.8 | 3.4 | 1.6 | 0.2 | *I. setosa* |
| 13 | 4.8 | 3.0 | 1.4 | 0.1 | *I. setosa* |
| 14 | 4.3 | 3.0 | 1.1 | 0.1 | *I. setosa* |
| 15 | 5.8 | 4.0 | 1.2 | 0.2 | *I. setosa* |
| 16 | 5.7 | 4.4 | 1.5 | 0.4 | *I. setosa* |
| 17 | 5.4 | 3.9 | 1.3 | 0.4 | *I. setosa* |
| 18 | 5.1 | 3.5 | 1.4 | 0.3 | *I. setosa* |
| 19 | 5.7 | 3.8 | 1.7 | 0.3 | *I. setosa* |
| 20 | 5.1 | 3.8 | 1.5 | 0.3 | *I. setosa* |
| 21 | 5.4 | 3.4 | 1.7 | 0.2 | *I. setosa* |

target

Data

## FFNN for Iris Flower




| Actual | Predicted |
|---|---|
| 1 | 0.2 |
| 0 | 0.1 |
| 0 | 0.7 |

$$y_1 = F(w, x, b)$$
$$y_2 = F(w, x, b)$$
$$y_3 = F(w, x, b)$$

$$e = y_A - y_P$$
$$= \begin{vmatrix} y_1 \\ y_2 \\ y_3 \end{vmatrix}_A - \begin{vmatrix} y_1 \\ y_2 \\ y_3 \end{vmatrix}_P$$

Error / Loss → classification – cross entropy loss

Regression – mean squared error (mse)

optimiser → minimise the error
w, b adjustment

1. Gradient Decent Optimizer
(Stochastic Gradient Decent)

$$\Delta W = W - \eta \frac{\partial L}{\partial W}$$

← loss

↑ weight adjustment

↑ learning rate

$$W = \begin{bmatrix} w1 \\ w2 \\ w3 \\ \vdots \\ b1 \\ b2 \\ \vdots \end{bmatrix}$$

trainable parameters

train test split.

data ←

train data ←

test data ←

→ target

→ train target

→ test target

Fisher's *Iris* Data [hide]

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|---|---|---|---|---|---|
| 1 | 5.1 | 3.5 | 1.4 | 0.2 | I. setosa |
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| 5 | 5.0 | 3.6 | 1.4 | 0.3 | I. setosa |
| 6 | 5.4 | 3.9 | 1.7 | 0.4 | I. setosa |
| 7 | 4.6 | 3.4 | 1.4 | 0.3 | I. setosa |
| 8 | 5.0 | 3.4 | 1.5 | 0.2 | I. setosa |
| 9 | 4.4 | 2.9 | 1.4 | 0.2 | I. setosa |
| 10 | 4.9 | 3.1 | 1.5 | 0.1 | I. setosa |
| 11 | 5.4 | 3.7 | 1.5 | 0.2 | I. setosa |
| 12 | 4.8 | 3.4 | 1.6 | 0.2 | I. setosa |
| 13 | 4.8 | 3.0 | 1.4 | 0.1 | I. setosa |
| 14 | 4.3 | 3.0 | 1.1 | 0.1 | I. setosa |
| 15 | 5.8 | 4.0 | 1.2 | 0.2 | I. setosa |
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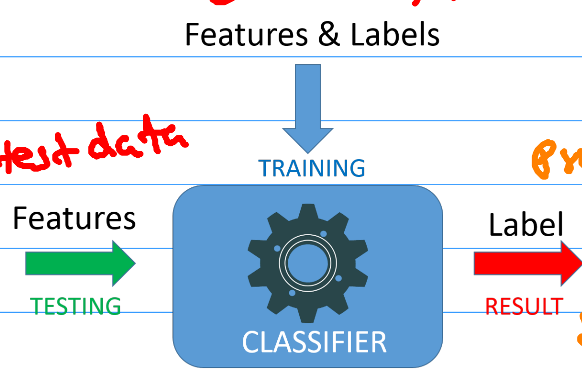
| 18 | 5.1 | 3.5 | 1.4 | 0.3 | I. setosa |
| 19 | 5.7 | 3.8 | 1.7 | 0.3 | I. setosa |
| 20 | 5.1 | 3.8 | 1.5 | 0.3 | I. setosa |

train data, train target




test data

predicted targets.

~~test target~~
~~(actual target)~~