Logistic Regression

→ Use cases for performing logistic Regression

→ Usage of sigmoid function & calculate probability.

→ Linear Regression Vs Logistic Regression

→ Uses of log loss instead of squared loss

⇒ Rainy today

Cake Consumption needed

Spam / not Spam

⇒ Model which gives the "Probability"

⇒ This curve sigmoid → 's shaped Curve"

Logistic Regression it used.

Calculating a propability with sigmoid function

⇒ Practically many problem requires probability estimate → Logistic regression is an extremely efficient Mechanism for calculating probabilities

Logistic Regression More about probability

logistic function → Sigmoid function

Example If spam - prediction model takes the an email as input and outputs 0.932

this implies it is 93% it is spam

↳ to convert to binary category

* Sigmoid function

→ logistic function whose characteristic make the result between 0 → 1

→ Standard logistic function is called sigmoid function

Sigmoid means → "S-shaped"

$$f(x) = \frac{1}{1+e^{-x}}$$

$$z = b + w_1 x_1 + w_2 x_2 + w_3 x_3 \cdots w_n x_n$$

- z → O/p → Linear Equation also called as log odds
- b → Bias
- w_1 → Model learned weights
- x_3 → feature values for particular Example

* To obtain logistic regression prediction z value is sent to sigmoid function which yield to a value of probability between 0 → 1

$$y' = \frac{1}{1+e^{-z}}$$ → is linear output

↳ output of logistic regression model

$$z = b + w_1 x_1 + w_2 x_2 + w_3 x_3 \cdots w_n x_n$$

- w_1 → learned weight from the model
- b → Bias
- x_2 → feature values

log odd

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

$$z = \log\left(\frac{y}{1-y}\right)$$

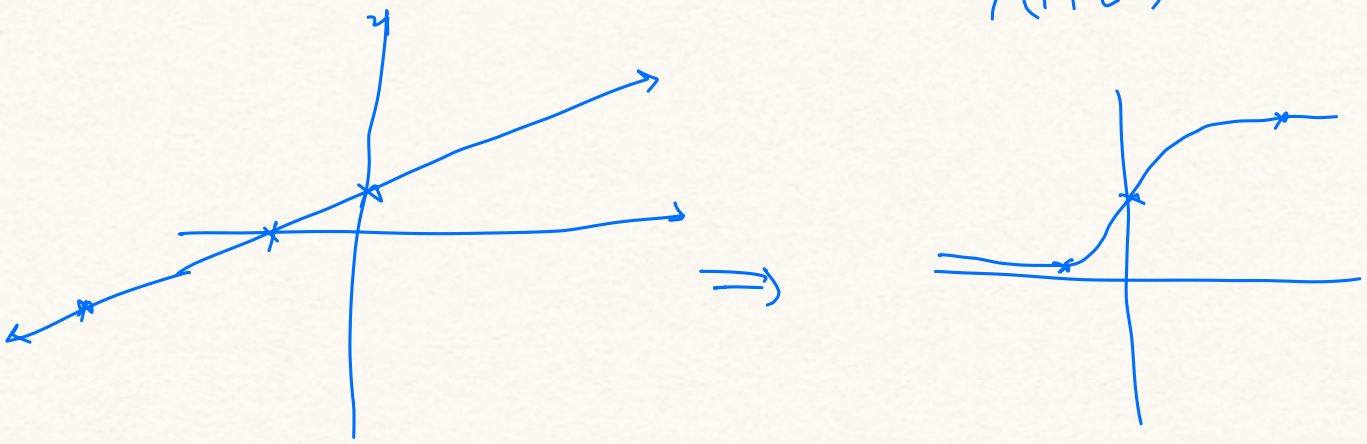
↳ z is represented/defined as log of ratio of probabilities of two possible outcomes

$\Rightarrow y \propto 1-y$

Linear Equation

$z = 2x + 5$

$\rightarrow y' = 1/(1+e^{-z})$



Logistic regression with 3 features

$b = 1$

$w_1 = 2$

$w_2 = -1$

$w_3 = 5$

Input values

$x_1 = 0$

$x_2 = 10$

$x_3 = 2$

$z = b + w_1 x_1 + w_2 x_2 + w_3 x_3 \ldots$

$z = 1 + 2 \times 0 + -1 * 10 + 5 * 2$

$= 1 + 0 - 10 + 10$

$= 1$

Logistic prediction value i.e $y' = \frac{1}{1+e^{z}} = \frac{1}{1+\phi} = \frac{1}{2} = 0.5$

$\frac{1}{1+e^{-z}} = \frac{1}{1+\frac{1}{1}} = \frac{1}{2}$

$y = \frac{1}{1-e^{-z}} = \frac{1}{1+e^{-1}} = \frac{1}{1+0.367} = \frac{1}{1.367} = 0.731$

Logistic Regression : Loss and regularization

⇒ Logistic Regression uses **Log loss** instead of **squared loss**

- Log loss → Logistic Regression
- squared loss → linear regression

⇒ Applying regularization is critical to prevent **Overfitting**

⇒ When rate of change of **loss** (output values) is constant, square loss works well. That is in Linear Model.

⇒ Linear Model $= y' = b + x_1 c$

↳ Increase input value $x = 1$

↳ output value y' increases by 3

Regularization

It is a mechanism for penalizing Model complexity during training, which is highly important.

Asymptotic nature of sigmoid is something it never reaches to any of 0 or 1

Here in context logistic regression asymptotic nature tends towards zero in case where the model has a large number of features, There are two strategies used by logistic regression model to decrease complexity

① L_2 Regression

② Early Stopping