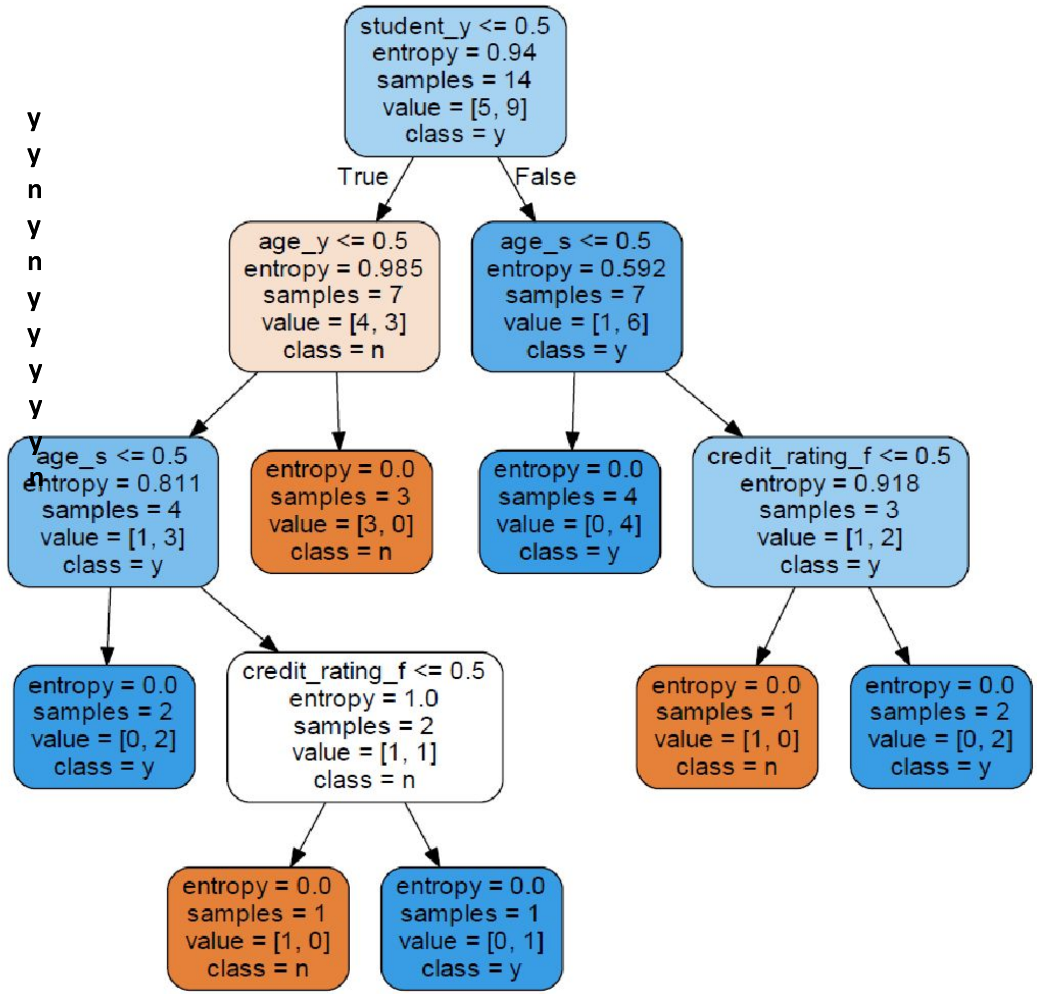
Pattern Recognition

- S. S. Samant

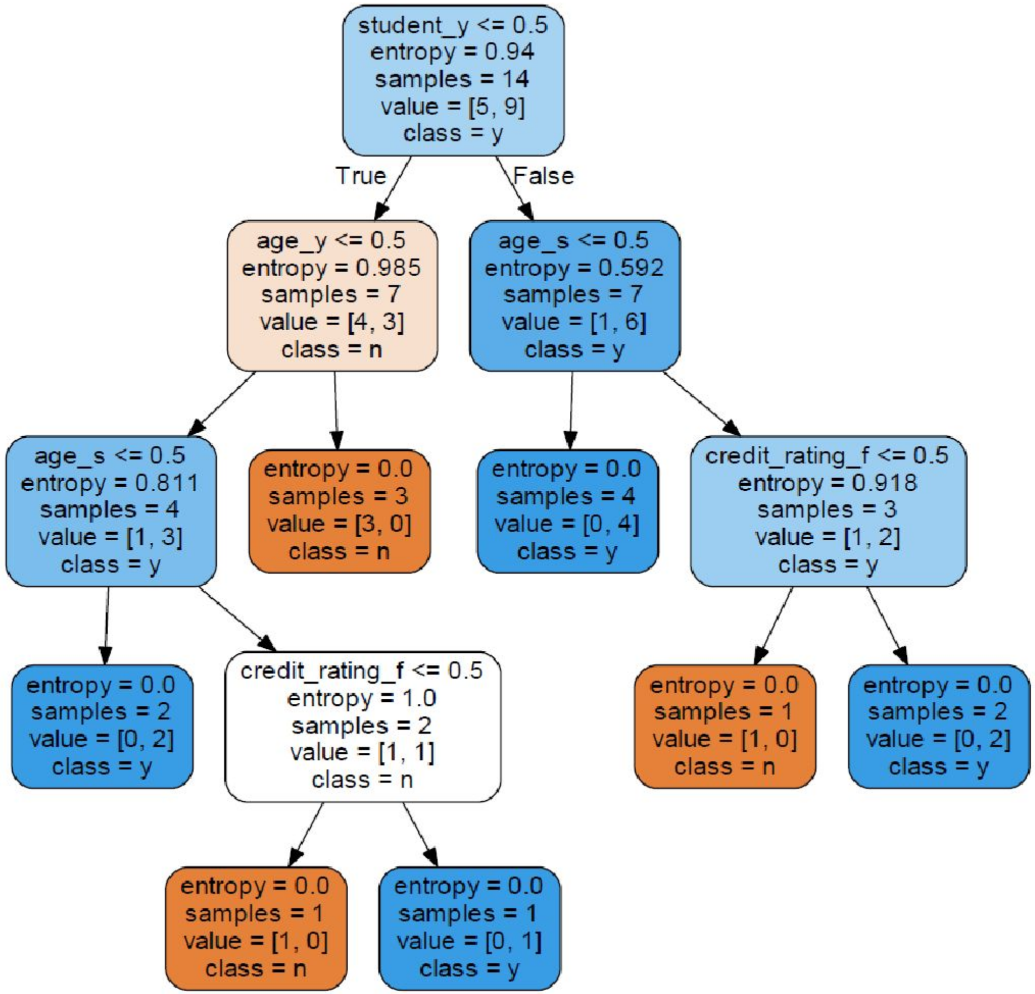
Attribute Selection Measures

	age_s	age_y	credit_rating_f	income_l	income_m	student_y	Class
0	0	1	1	0	0	0	n
1	0	1	0	0	0	0	n
2	0	0	1	0	0	0	y
3	1	0	1	0	1	0	y
4	1	0	1	1	0	1	y
5	1	0	0	1	0	1	n
6	0	0	0	1	0	1	y
7	0	1	1	0	1	0	n
8	0	1	1	1	0	1	y
9	1	0	1	0	1	1	y
10	0	1	0	0	1	1	y
11	0	0	0	0	1	0	y
12	0	0	1	0	0	1	y
13	1	0	0	0	1	0	n

RID	age	income	student	credit_rating	Class: buys_computer
1	youth	high	no	fair	no
2	youth	high	no	excellent	no
3	middle_aged	high	no	fair	yes
4	senior	medium	no	fair	yes
5	senior	low	yes	fair	yes
6	senior	low	yes	excellent	no
7	middle_aged	low	yes	excellent	yes
8	youth	medium	no	fair	no
9	youth	low	yes	fair	yes
10	senior	medium	yes	fair	yes
11	youth	medium	yes	excellent	yes
12	middle_aged	medium	no	excellent	yes
13	middle_aged	high	yes	fair	yes
14	senior	medium	no	excellent	no



Decision Tree Pruning

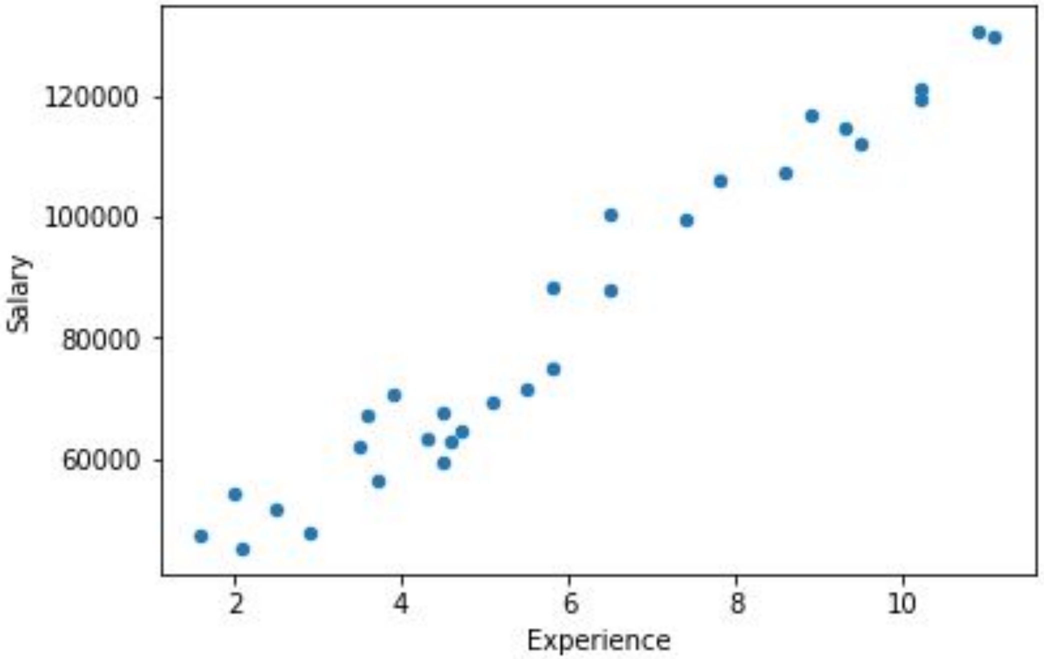


Logistic Regression

Let us briefly look at linear regression

In linear regression, we want to predict a number.

Ex. Given a training set containing *years of experience* and *salary*, fit a line and use it to predict the *salary* of a person given his/her years of experience. In this case, salary is the *dependent* variable and *years of experience* is *independent* variable.

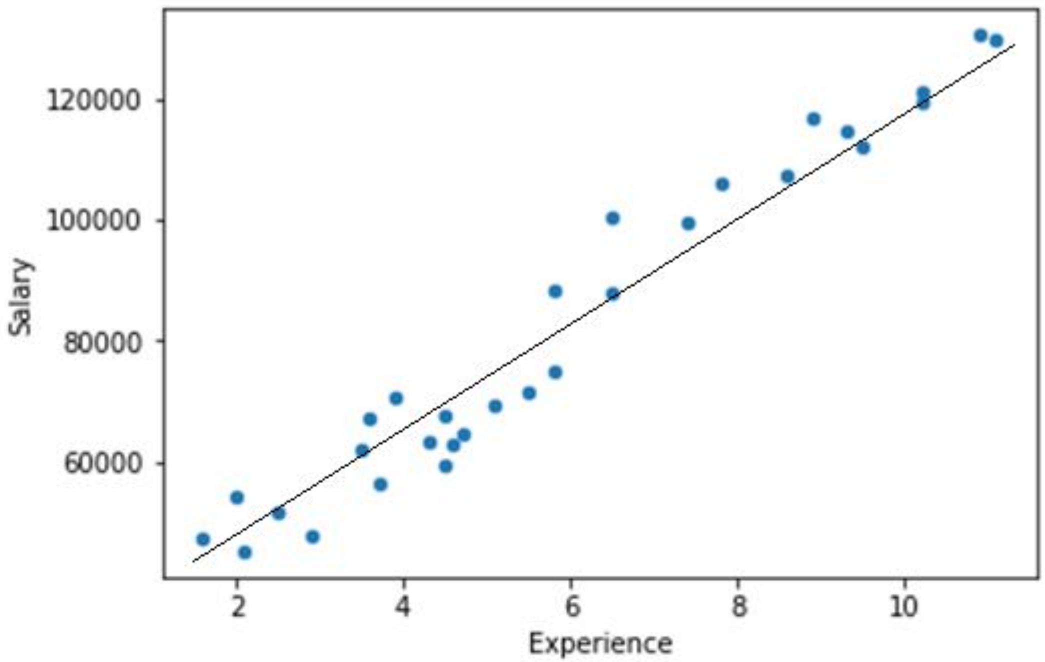


Logistic Regression

Let us briefly look at linear regression

In linear regression, we want to predict a number.

Ex. Given a training set containing *years of experience* and *salary*, fit a line and use it to predict the *salary* of a person given his/her years of experience. In this case, salary is the *dependent* variable and *years of experience* is *independent* variable.



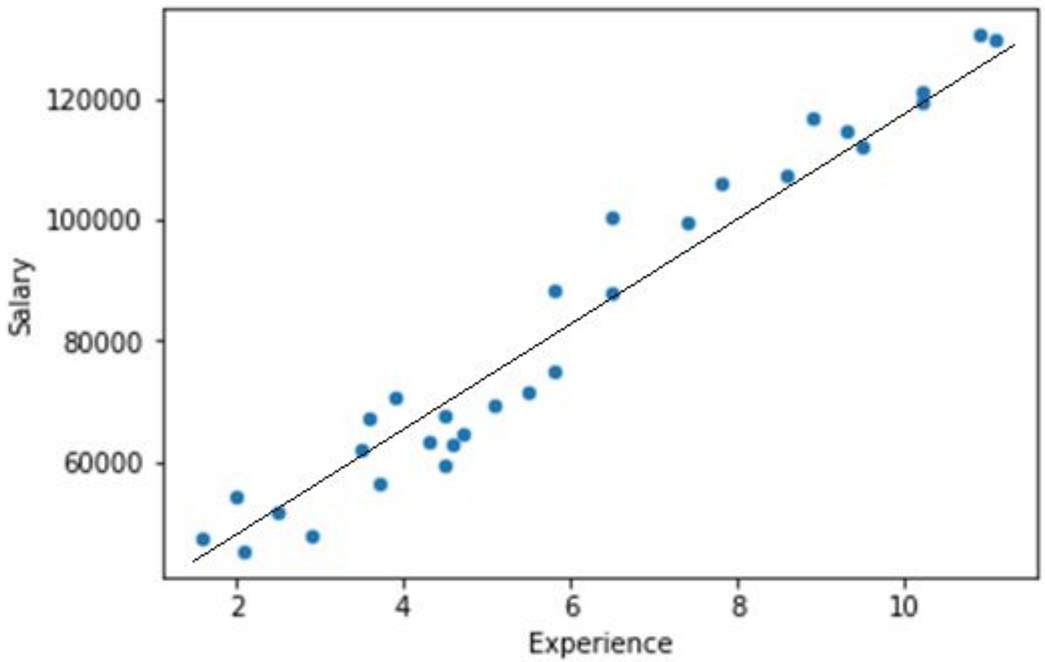
Birla Institute of Applied Sciences
बिरला इंस्टिट्यूट ऑफ़ अप्लाइड साइंसेस
Bhimtal, Distt: Nainital, Uttarakhand- 263136

Logistic Regression

Let us briefly look at linear regression

In linear regression, we want to predict a number.

Ex. Given a training set containing *years of experience* and *salary*, fit a line and use it to predict the *salary* of a person given his/her years of experience. In this case, salary is the *dependent* variable and *years of experience* is *independent* variable.



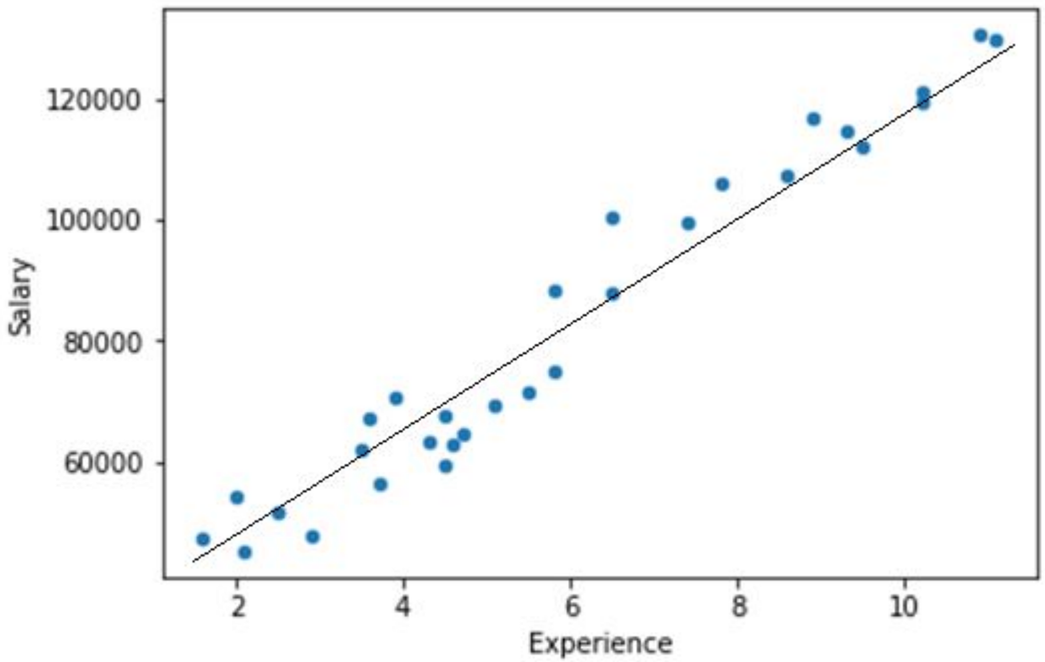
$$y = \beta_0 + \beta_1 x_1$$

Logistic Regression

Let us briefly look at linear regression

In linear regression, we want to predict a number.

Ex. Given a training set containing *years of experience* and *salary*, fit a line and use it to predict the *salary* of a person given his/her years of experience. In this case, salary is the *dependent* variable and *years of experience* is *independent* variable.



$$y = \beta_0 + \beta_1 x_1$$

Can we use linear regression for classification?

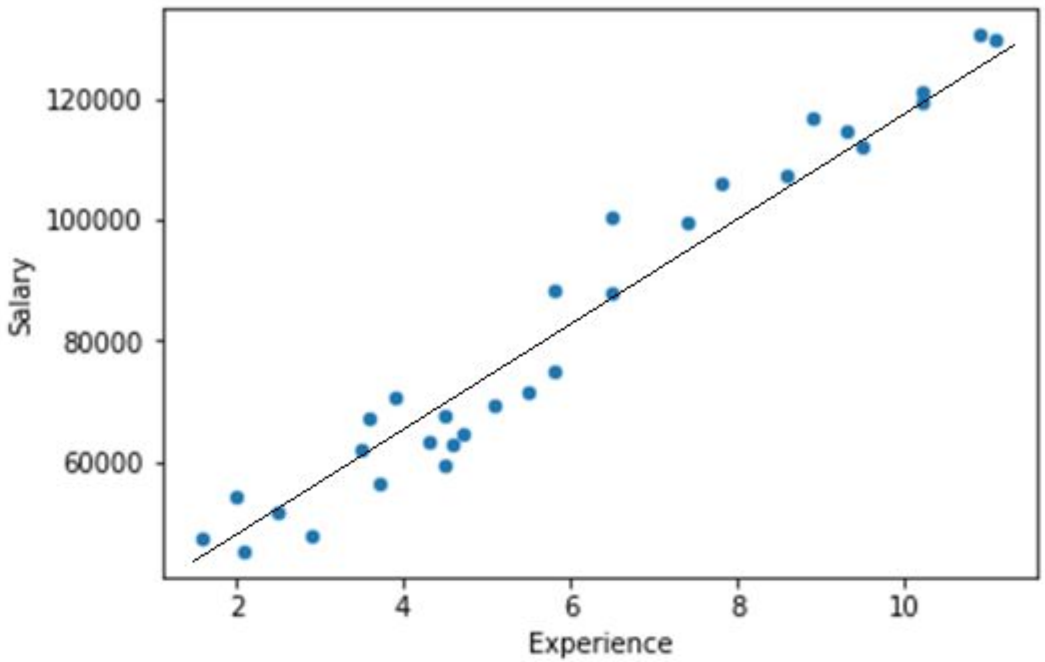
Problem: y has values greater than 1 or less than 0. For ex. we cannot use the above for binary classification

Logistic Regression

Let us briefly look at linear regression

In linear regression, we want to predict a number.

Ex. Given a training set containing *years of experience* and *salary*, fit a line and use it to predict the *salary* of a person given his/her years of experience. In this case, salary is the *dependent* variable and *years of experience* is *independent* variable.



$$y = \beta_0 + \beta_1 x_1$$

Can we use linear regression for classification?

Solution: Use a function that can bring any number to range (0,1). Then we can use the function to classification.

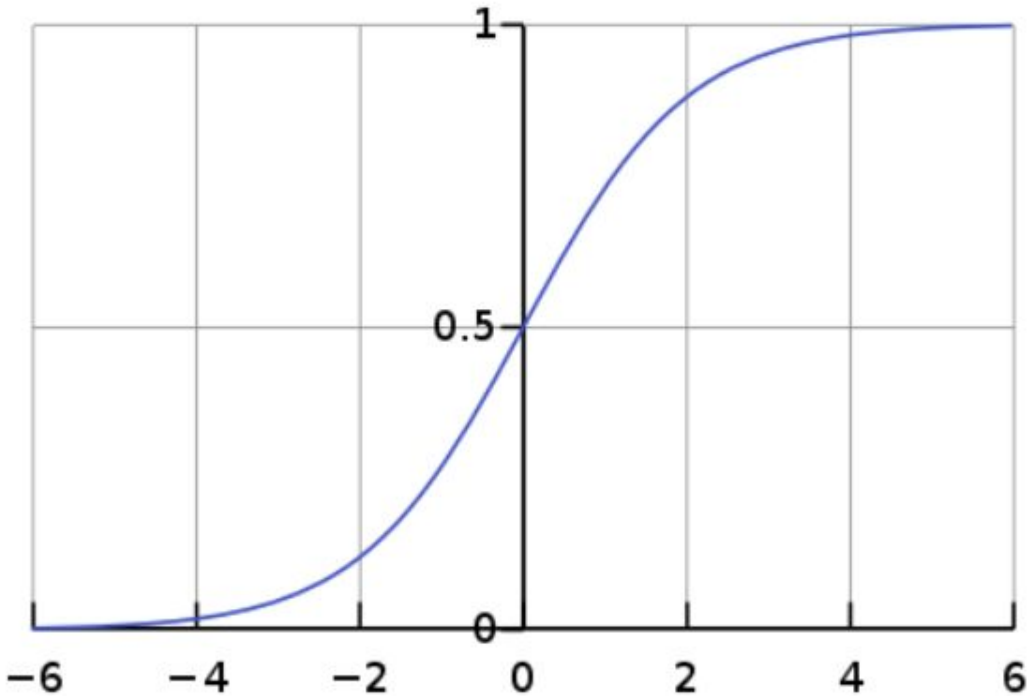
Logistic Regression

The function is called *logistic* function or *sigmoid* function.

$$\sigma(t) = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}}$$

Here, $y = t = \beta_0 + \beta_1 x_1$

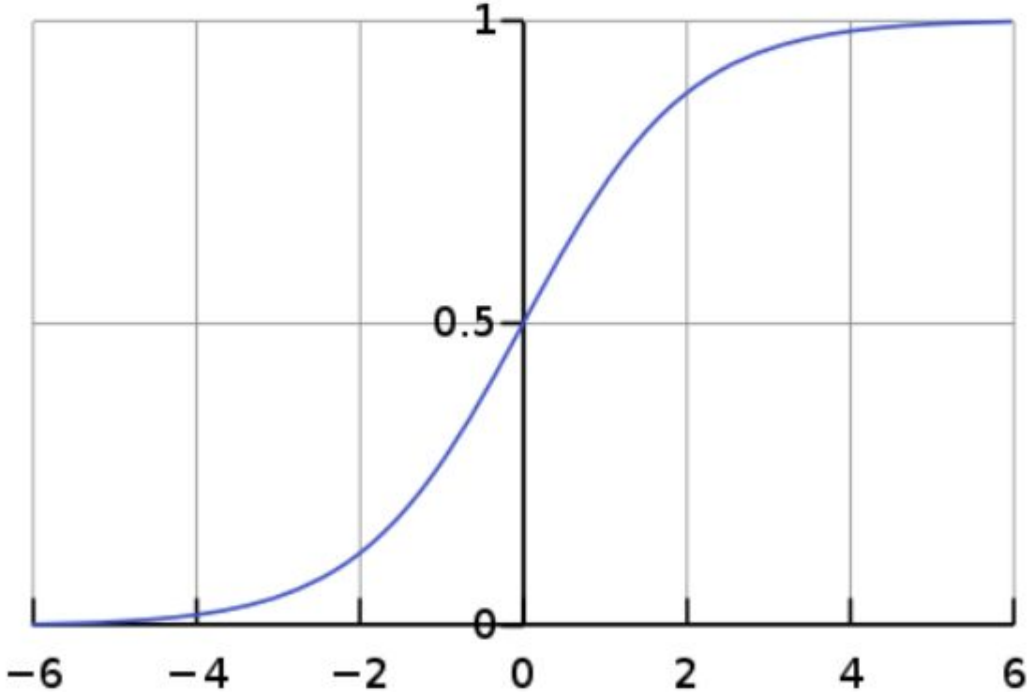
$$\sigma(t) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$



Logistic Regression

The function is called logistic function or sigmoid function.

$$\sigma(t) = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}}$$



Here, y = t = $\beta_0 + \beta_1 x_1$

$$\sigma(t) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$

How do you classify using the above function?

Birla Institute of Applied Sciences
बिरला इंस्टिट्यूट ऑफ़ अप्लाइड साइंसेस
Bhimtal, Distt: Nainital, Uttarakhand- 263136

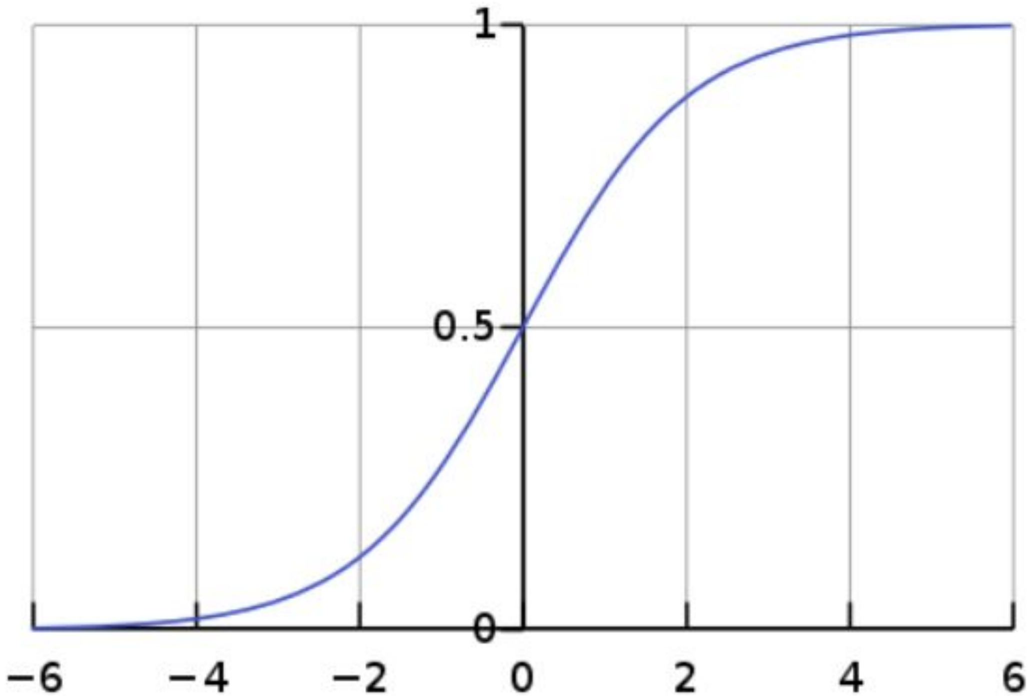
Logistic Regression

The function is called logistic function or sigmoid function.

$$\sigma(t) = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}}$$

Here, y = t = $\beta_0 + \beta_1 x_1$

$$\sigma(t) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$



How do you classify using the above function?

We will use the value of $\sigma(t)$ as probability of y=1 given input x, OR in other words:
P(y=1|β;**x**)

Birla Institute of Applied Sciences
बिरला इंस्टिट्यूट ऑफ़ अप्लाइड साइंसेस
Bhimtal, Distt: Nainital, Uttarakhand- 263136

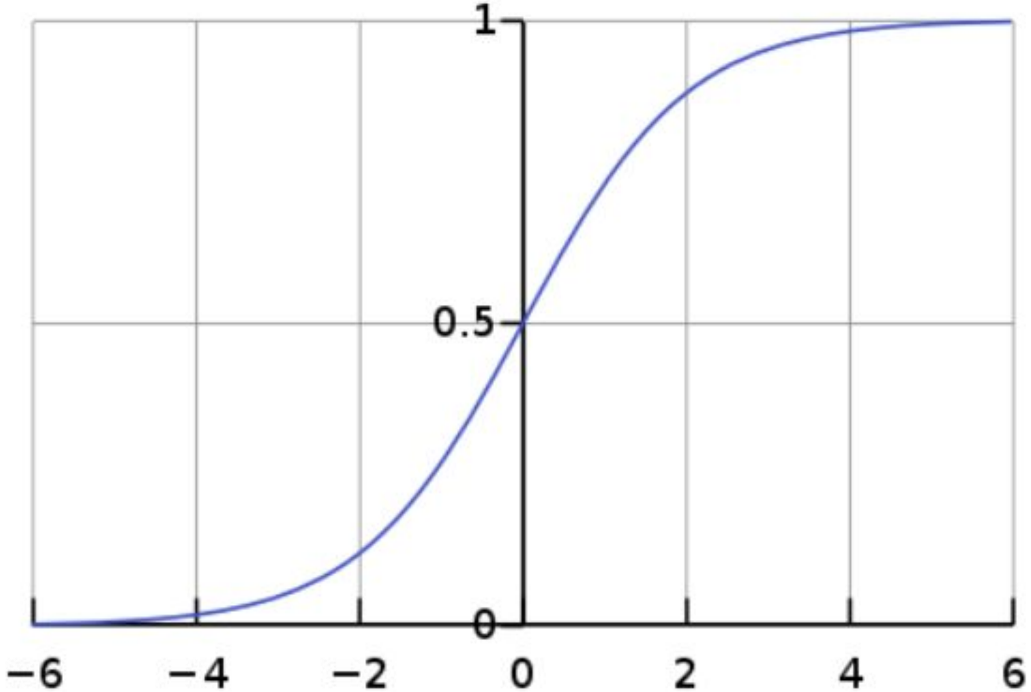
Logistic Regression

The function is called logistic function or sigmoid function.

$$\sigma(t) = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}}$$

Here, $y = t = \beta_0 + \beta_1 x_1$

$$\sigma(t) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$



How do you classify using the above function?

We can predict like:

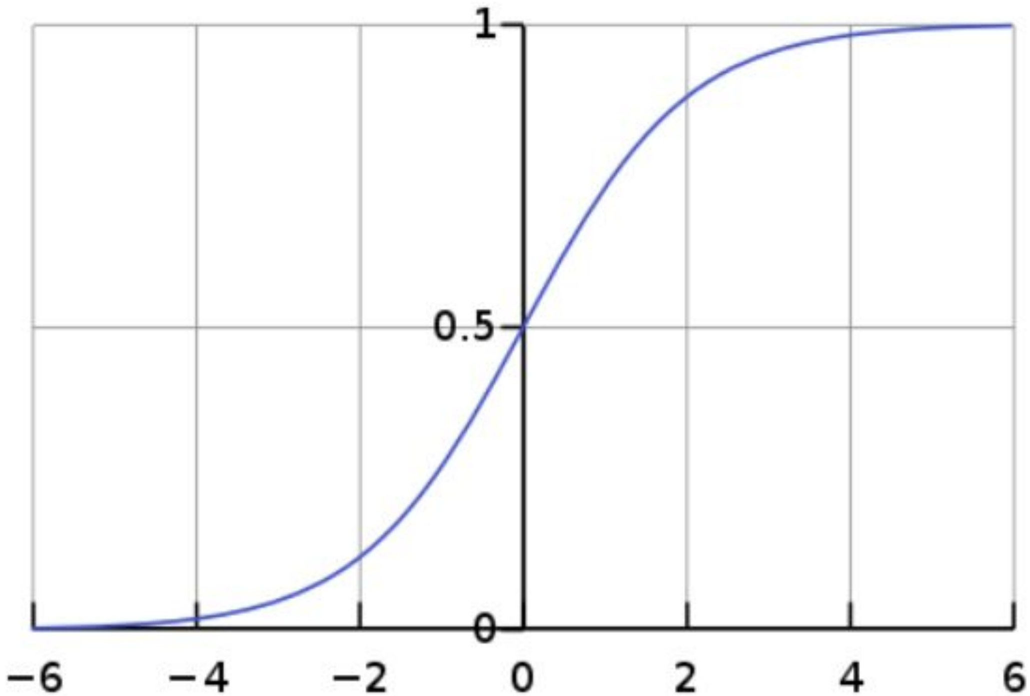
y=1, when $\sigma(t) \geq 0.5$

y=0, when $\sigma(t) < 0.5$

Logistic Regression

The function is called logistic function or sigmoid function.

$$\sigma(t) = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}}$$



Here, $y = t = \beta_0 + \beta_1 x_1$

$$\sigma(t) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$

How do you classify using the above function?

We can predict like:

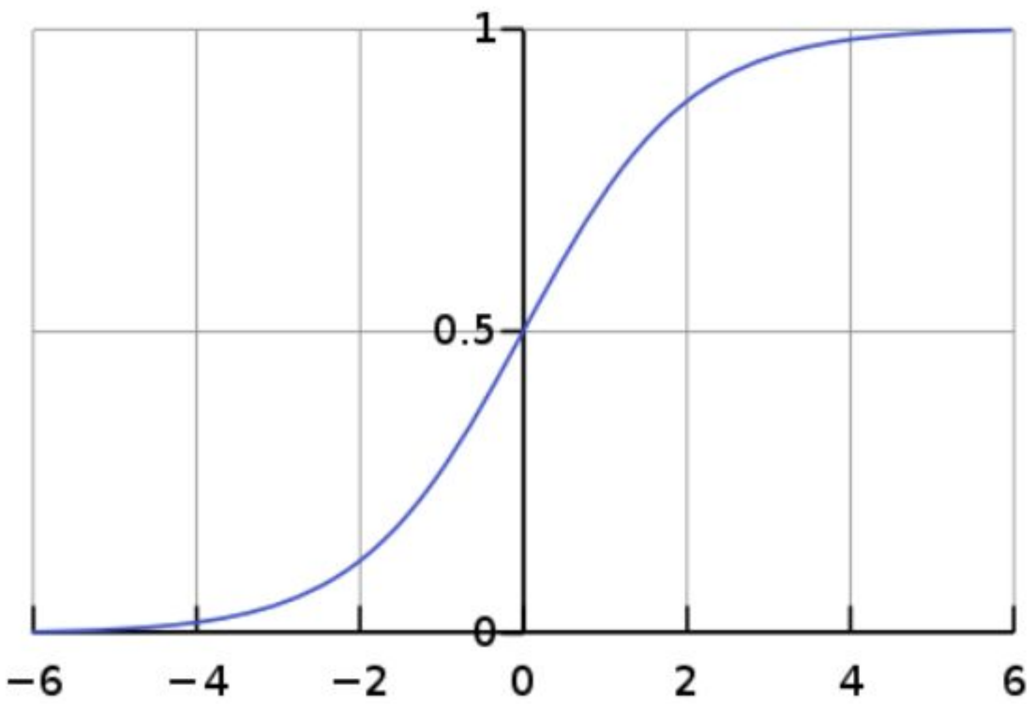
$y=1$, when $\sigma(t) \geq 0.5$ $(y \geq 0)$

$y=0$, when $\sigma(t) < 0.5$ $(y < 0)$

Logistic Regression

The function is called logistic function or sigmoid function.

$$\sigma(t) = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}}$$



Here, $y = t = \beta_0 + \beta_1 x_1$

$$\sigma(t) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x)}}$$

How do you classify using the above function?

We can predict like:
y=1, when $\sigma(t) \geq 0.5$ ($y \geq 0$)
y=0, when $\sigma(t) < 0.5$ ($y < 0$)

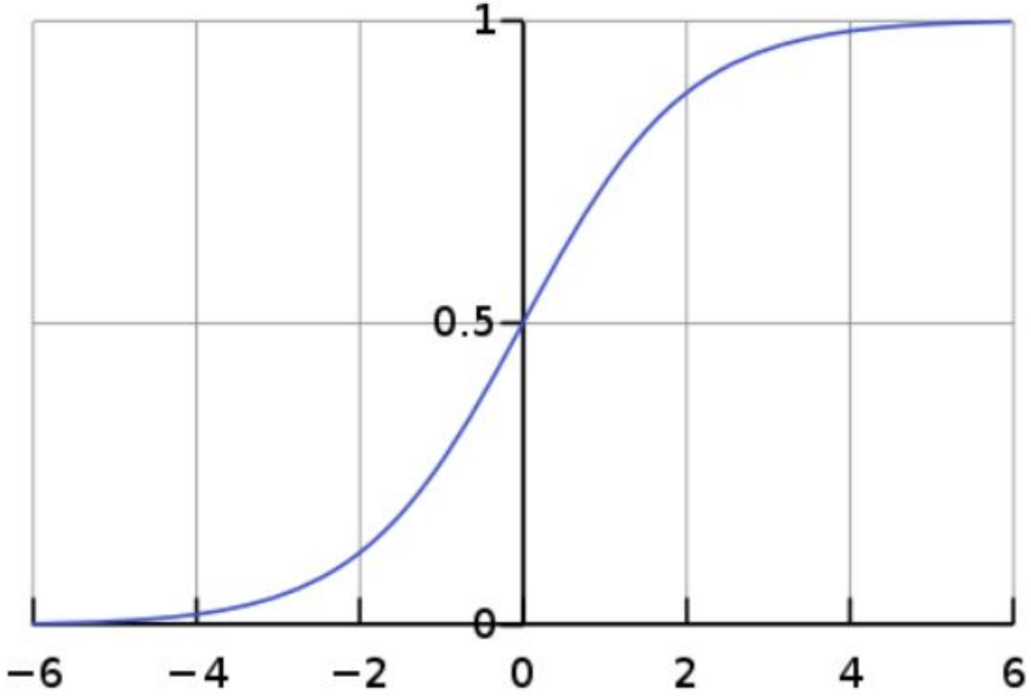
OR, y=1, when $\boldsymbol{\beta_0 + \beta_1 x_1 \geq 0}$
y=0, when $\boldsymbol{\beta_0 + \beta_1 x_1 < 0}$

Logistic Regression

The function is called logistic function or sigmoid function.

$$\sigma(t) = \frac{e^t}{e^t + 1} = \frac{1}{1 + e^{-t}}$$

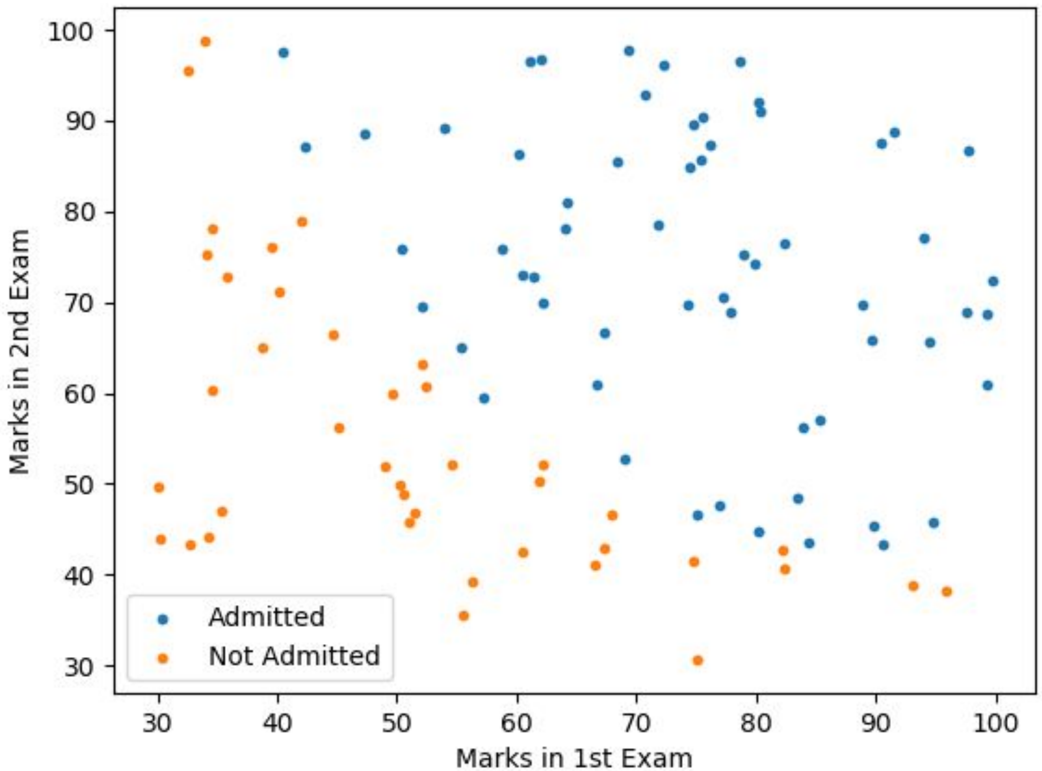
Here, $y = \beta_0+\beta_1 x_1+ \beta_2 x_2+\ldots = \beta^T\mathbf{x}$



$y=1$ when $\beta^T\mathbf{x} \geq \mathbf{0}$

$y=0$ when $\beta^T\mathbf{x} < \mathbf{0}$

Logistic Regression - Example



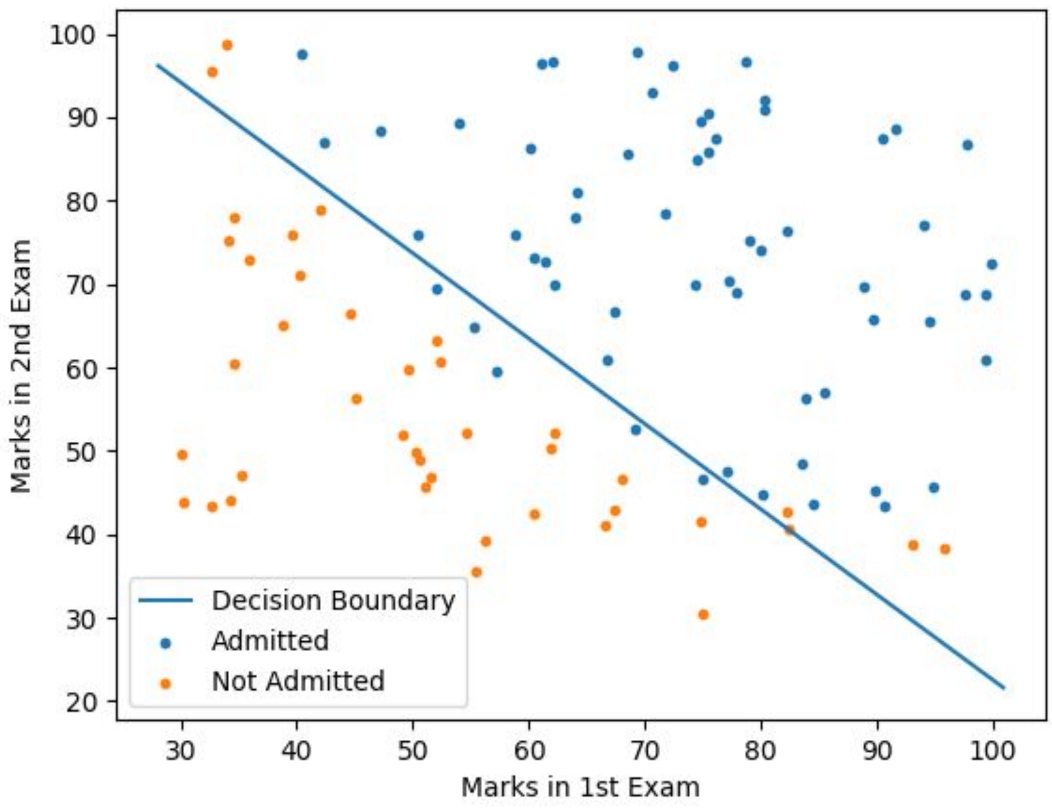
Here, $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$

$y=1$ when $\beta^T \mathbf{x} \geq \mathbf{0}$

$y=0$ when $\beta^T \mathbf{x} < \mathbf{0}$

Logistic Regression - Example

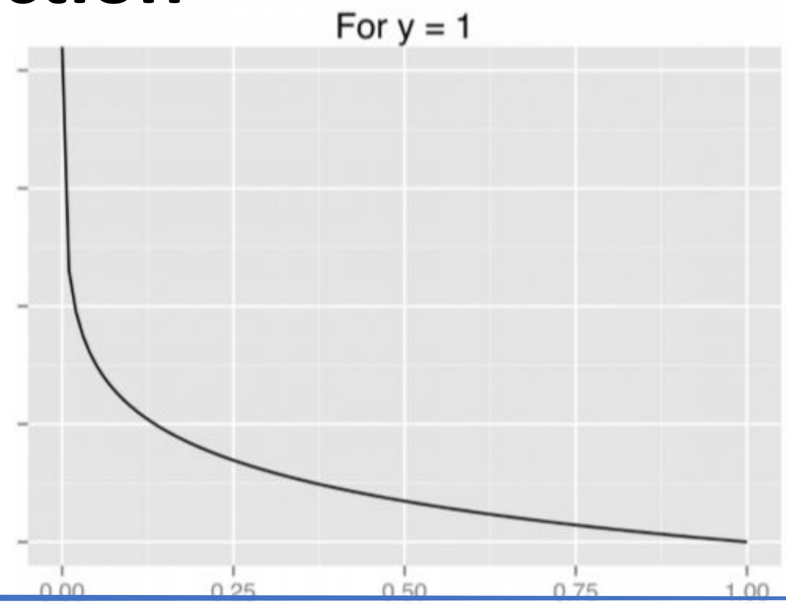
Here, $y = \beta_0+\beta_1 x_1+ \beta_2 x_2$



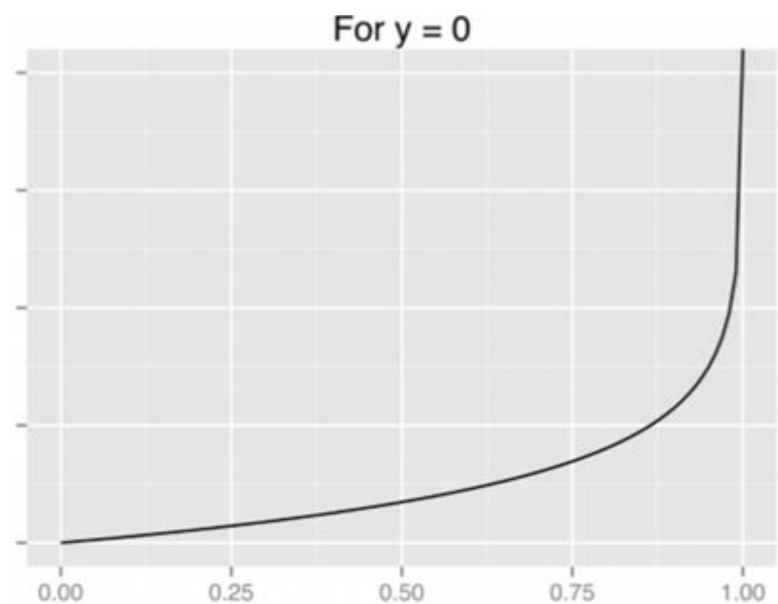
y=1 when $\beta^T\mathbf{x} \geq \mathbf{0}$

y=0 when $\beta^T\mathbf{x} < \mathbf{0}$

Logistic Regression – Cost function



Cost function = $\begin{cases} -\log(\sigma(t)) & \text{if } y = 1 \\ -\log(1-\sigma(t)) & \text{if } y = 0 \end{cases}$



Thank You!