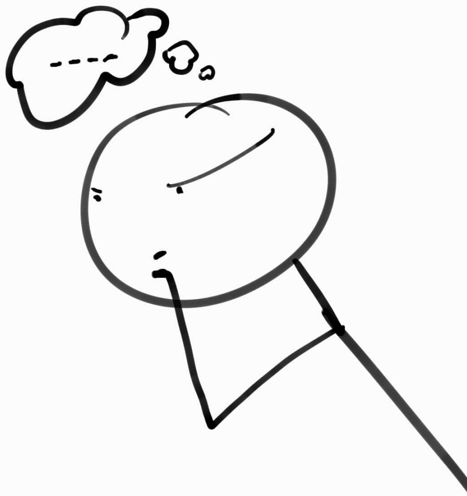
Classification

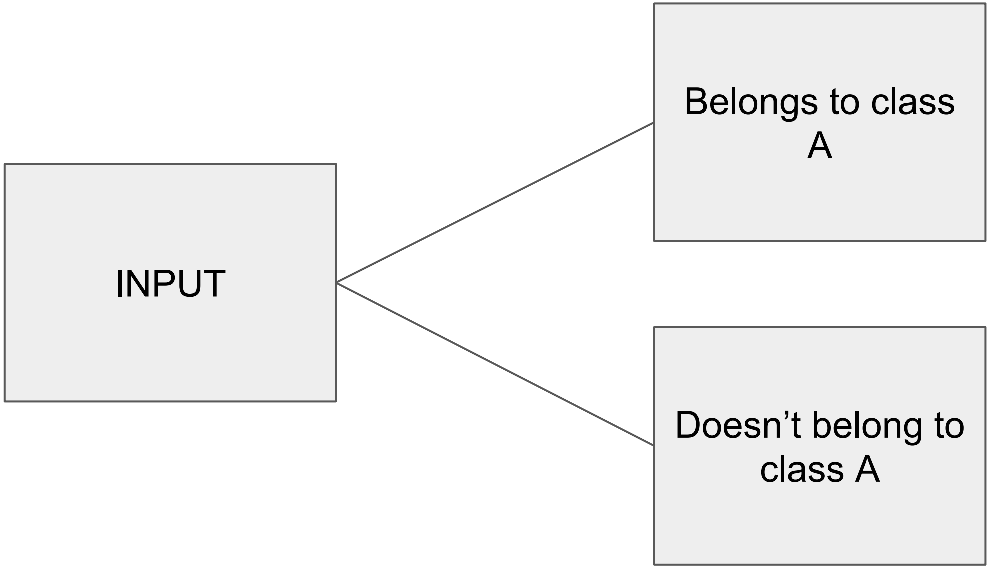
LOGISTIC REGRESSION



Logistic regression is a classification algorithm!!

Classification

Classifying input data into one of n classes.



Classification Vs Regression

- Classification: Maps data to discrete values.
  - Example: Classifying whether an input image is that of a cat or not.

- Regression: Maps data to any value in a continuous range of values.
  - Example: Predicting the price of a house given its area.

Classification Function

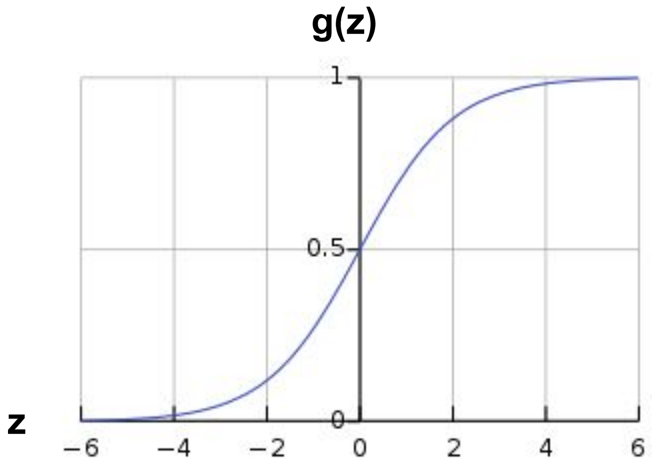
$$\mathrm{h}_\beta(x) = g(\beta x)$$

Hypothesis function

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

Logistic/Sigmoid function

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



$$0 \leq \mathrm{h}_\beta(x) \leq 1$$

Interpretation of hypothesis output

- h(x) is the estimated probability that y = 1 on input x.

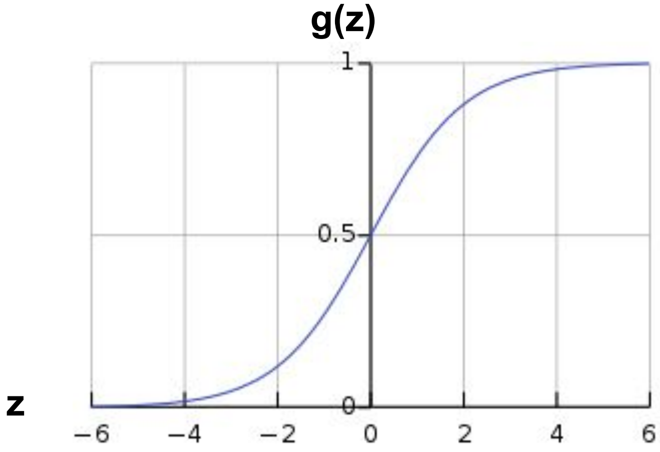
- Example: The problem of classifying whether an animal is a cat or not given the size of its paw where y = 1 means the animal is indeed a cat.
- Assume h(x) = 0.7 -> 70% chance that this animal x is a cat.

- $h(x) = P(y=1 \mid x, B)$
- $P(y=0 \mid x,B) + P(y=1 \mid x,B) = 1$
- $P(y=0 \mid x,B) = 1 - P(y=1 \mid x,B)$

Decision Boundary

Assume we apply a threshold where:

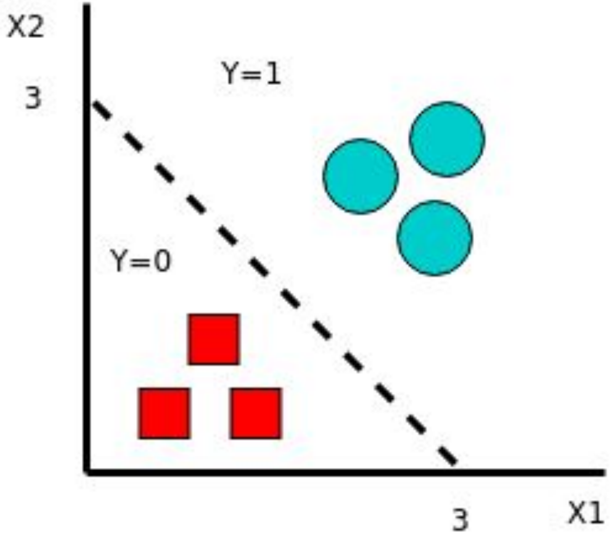
- Y = 1 if $h_\beta(x)$ **>=** 0.5
- Y = 0 if $h_\beta(x)$ **<** 0.5



Decision Boundary

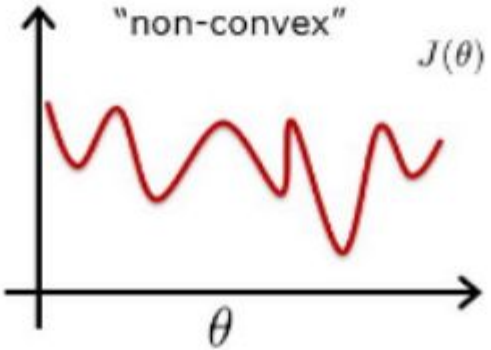
$$h_\beta(x) = g(\beta_0 + \beta_1 x_1 + \beta_2 x_2)$$

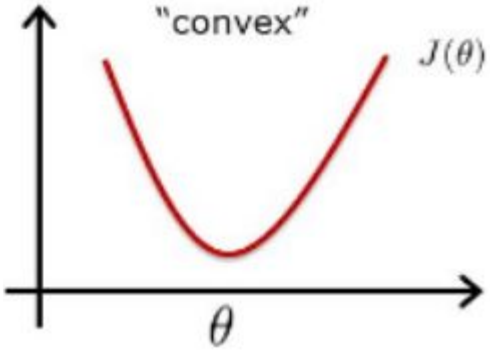
According to our threshold, y = 1 if -3+ x1 + x2 >= 0



Cost Function

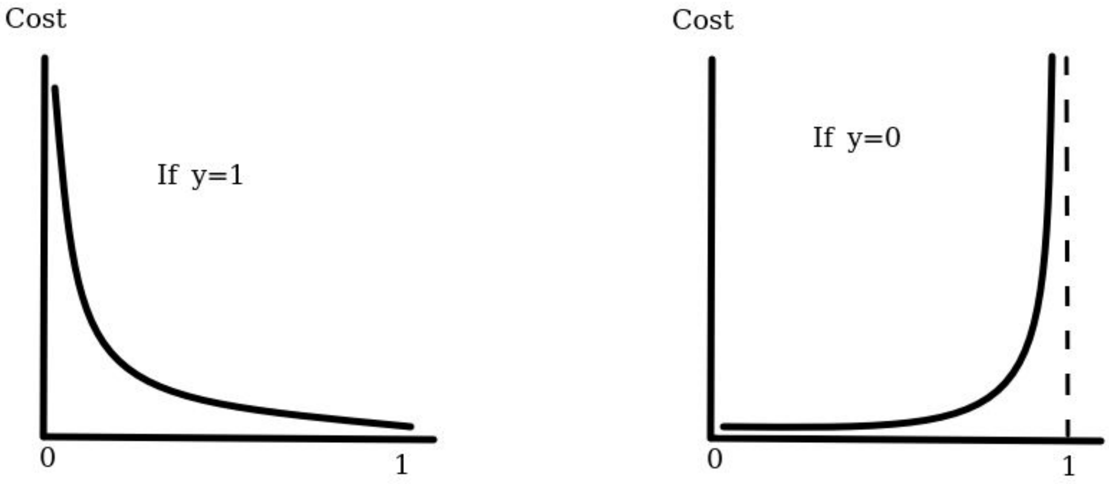
$$cost(h_\beta(x), y) = \frac{1}{2}\sum\left(h_\beta(x) - y\right)^2$$



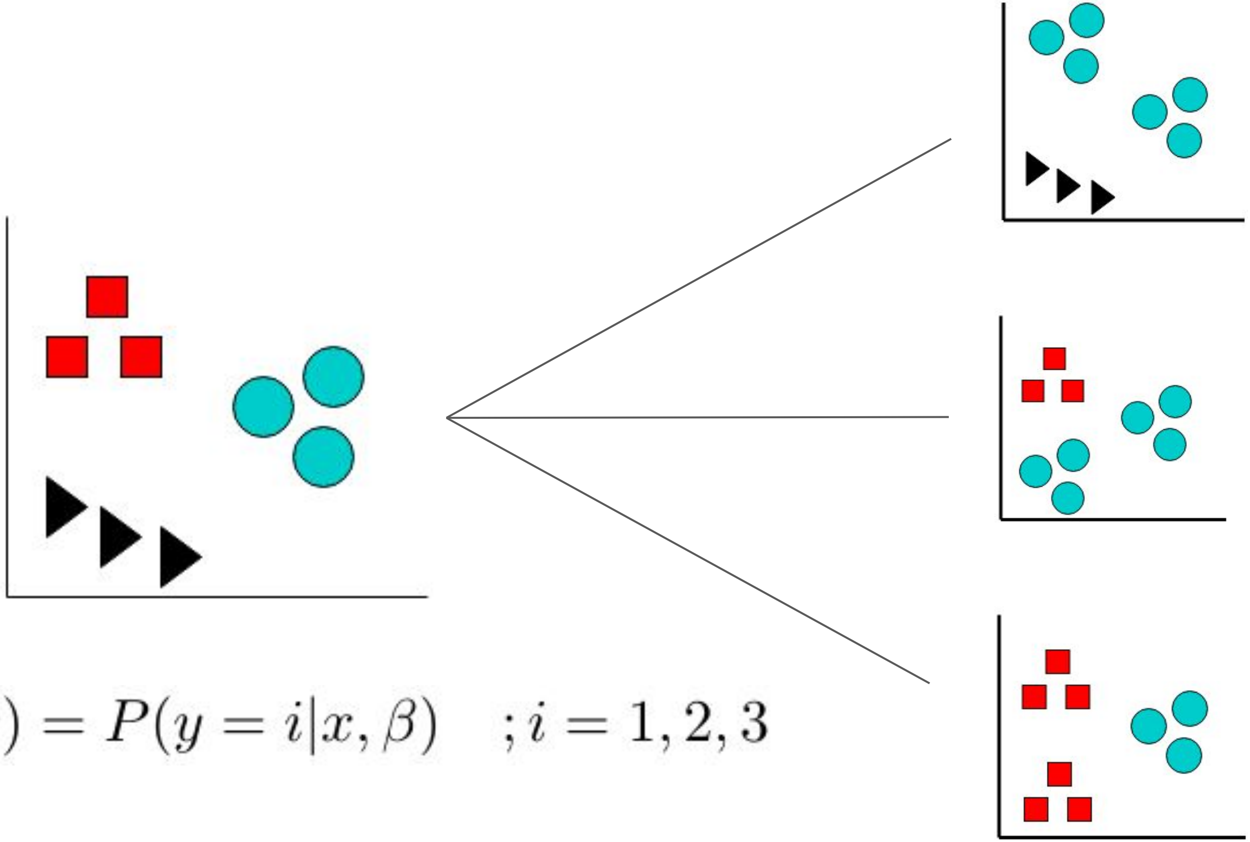


Cost Function

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



Multi-class Classification



Class 1:

h1(x)

Class 2:

h2(x)

Class 3:

h3(x)

$$h_i(x) = P(y = i | x, \beta) \quad ; i = 1, 2, 3$$

Multi-class Classification

Train a classifier for every class i and for each new input, take the prediction of the classifier with maximum value.

$$max(h_i(x))$$

Thank You!