

Bayes Classifier

- A probabilistic framework for solving classification problems
- Conditional Probability:

$$P(C|A) = \frac{P(A, C)}{P(A)}$$

$$P(A|C) = \frac{P(A, C)}{P(C)}$$

- Bayes theorem:

$$P(C|A) = \frac{P(A|C)P(C)}{P(A)}$$

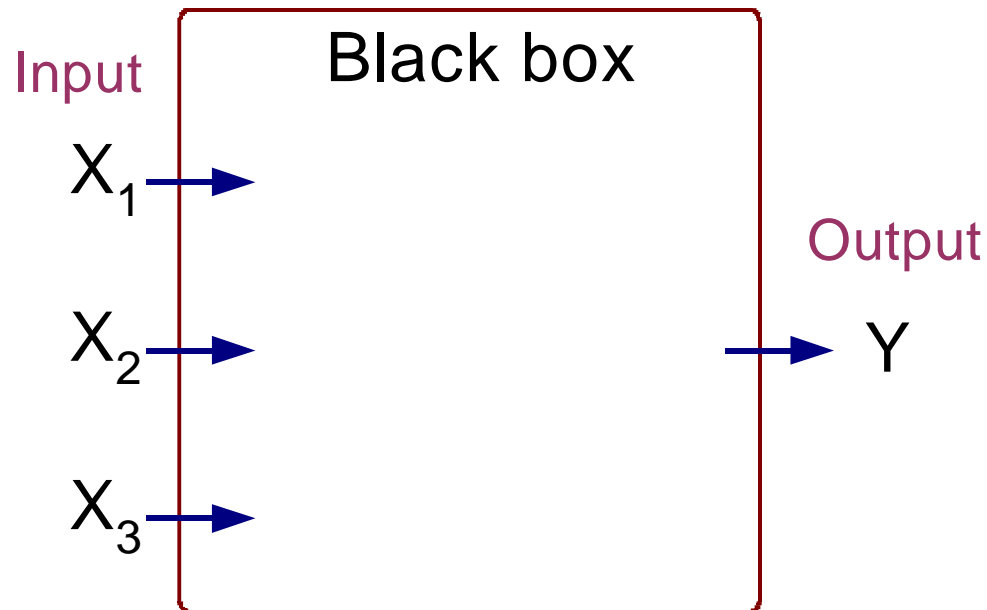
Example of Bayes Theorem

- Given:
 - A doctor knows that meningitis causes stiff neck 50% of the time
 - Prior probability of any patient having meningitis is 1/50,000
 - Prior probability of any patient having stiff neck is 1/20
- If a patient has stiff neck, what's the probability he/she has meningitis?

$$P(M|S) = \frac{P(S|M)P(M)}{P(S)} = \frac{0.5 \times 1/50000}{1/20} = 0.0002$$

Artificial Neural Networks (ANN)

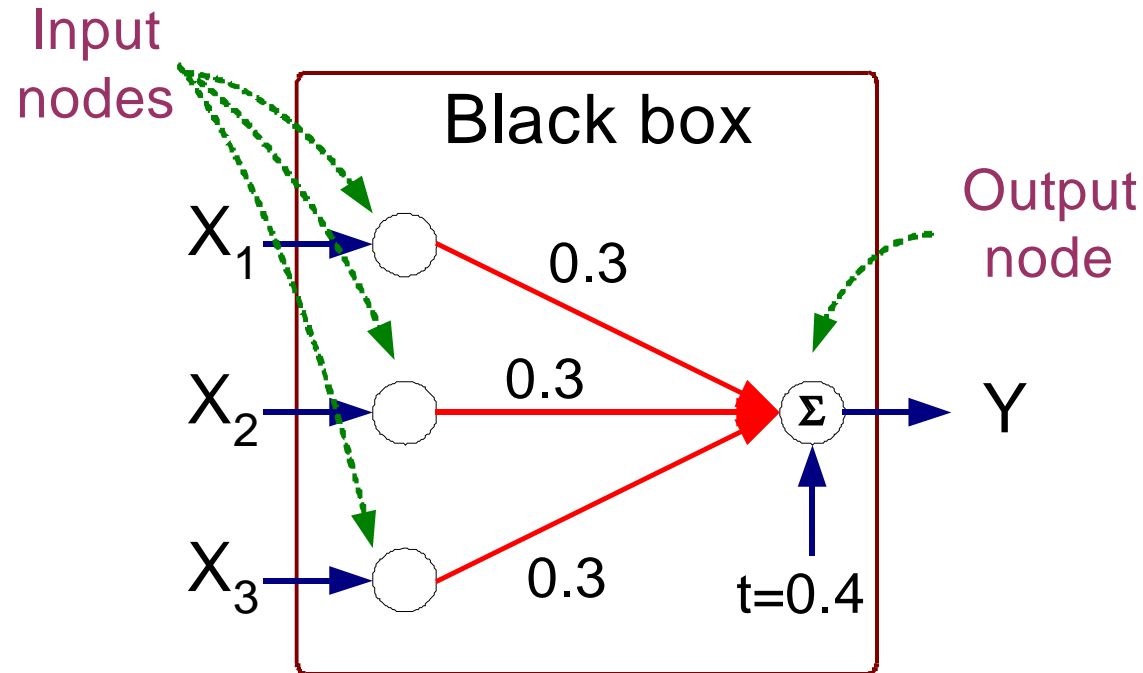
X_1	X_2	X_3	Y
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1
0	0	1	0
0	1	0	0
0	1	1	1
0	0	0	0



Output Y is 1 if at least two of the three inputs are equal to 1.

Artificial Neural Networks (ANN)

X_1	X_2	X_3	Y
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1
0	0	1	0
0	1	0	0
0	1	1	1
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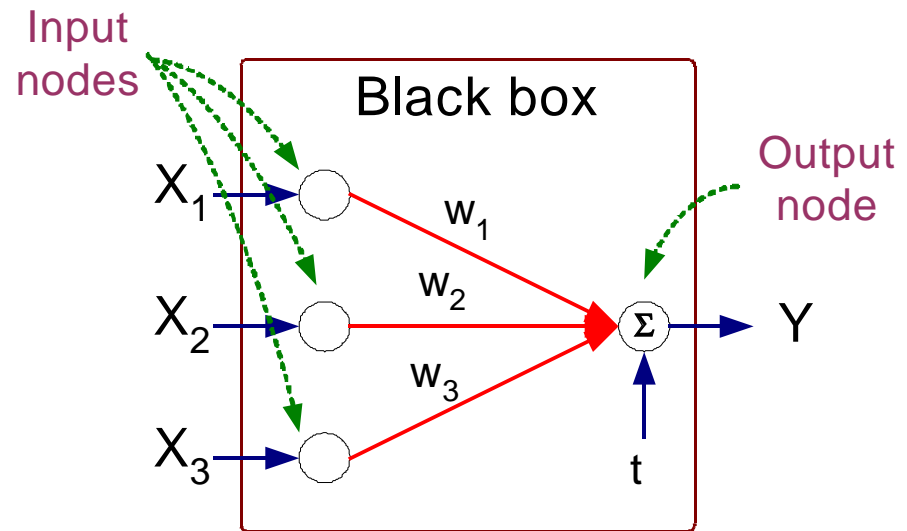


$$Y = I(0.3X_1 + 0.3X_2 + 0.3X_3 - 0.4 > 0)$$

$$\text{where } I(z) = \begin{cases} 1 & \text{if } z \text{ is true} \\ 0 & \text{otherwise} \end{cases}$$

Artificial Neural Networks (ANN)

- Model is an assembly of interconnected nodes and weighted links
- Output node sums up each of its input value according to the weights of its links
- Compare output node against some threshold t

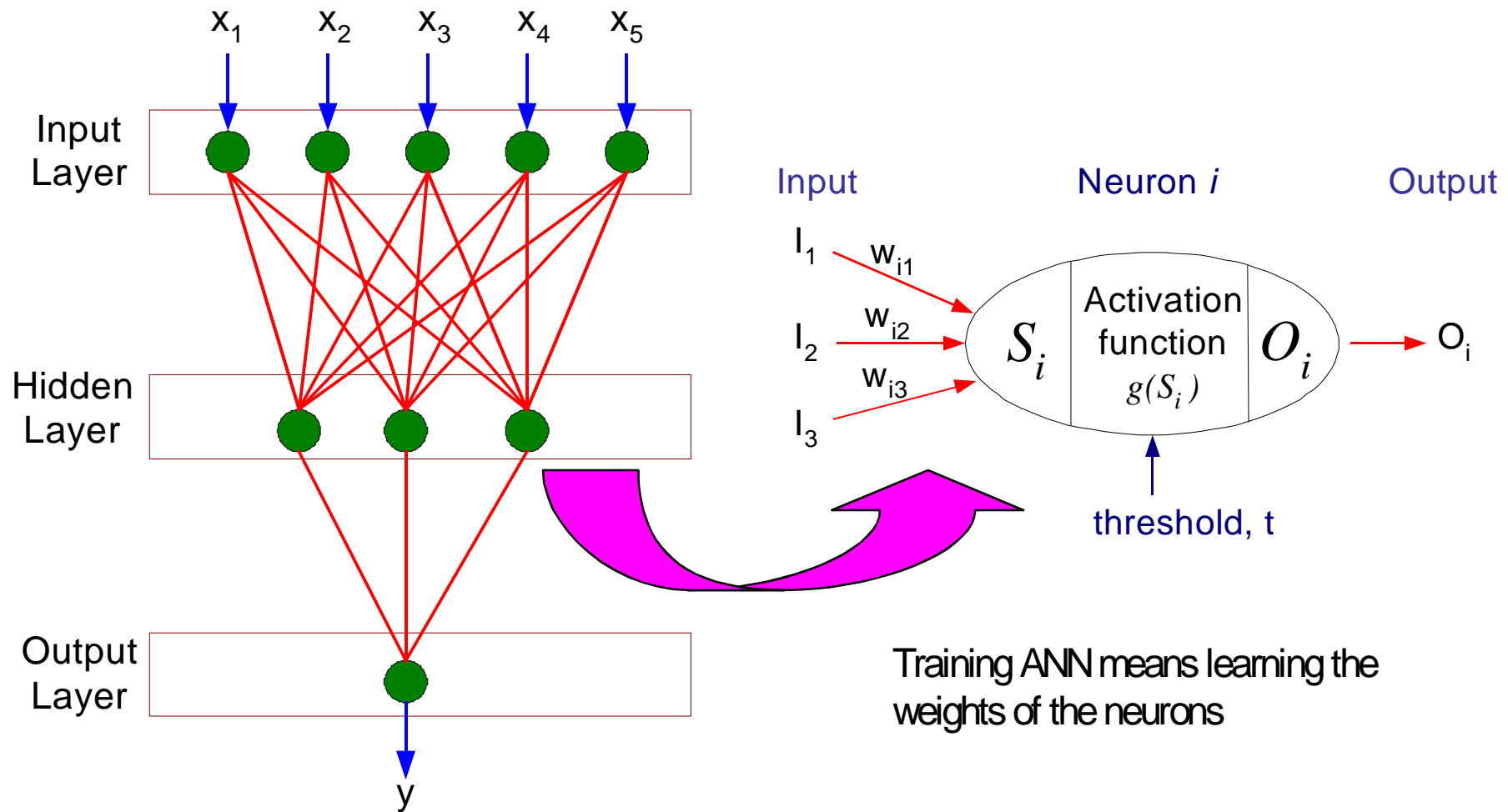


Perceptron Model

$$Y = I\left(\sum_i w_i X_i - t\right) \quad \text{or}$$

$$Y = \text{sign}\left(\sum_i w_i X_i - t\right)$$

General Structure of ANN



Algorithm for learning ANN

- Initialize the weights (w_0, w_1, \dots, w_k)
- Adjust the weights in such a way that the output of ANN is consistent with class labels of training examples

- Objective function:

$$E = \sum_i [Y_i - f(w_i, X_i)]^2$$

- Find the weights w_i 's that minimize the above objective function

- ◆ e.g., backpropagation algorithm (see lecture notes)