Perceptron:
A Classification Method

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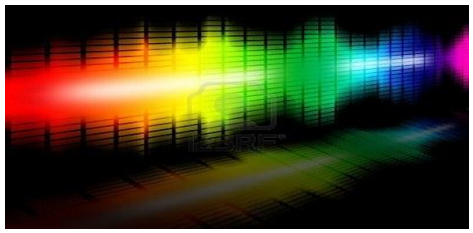
Why Is Classification Important?



In organizing information and object,

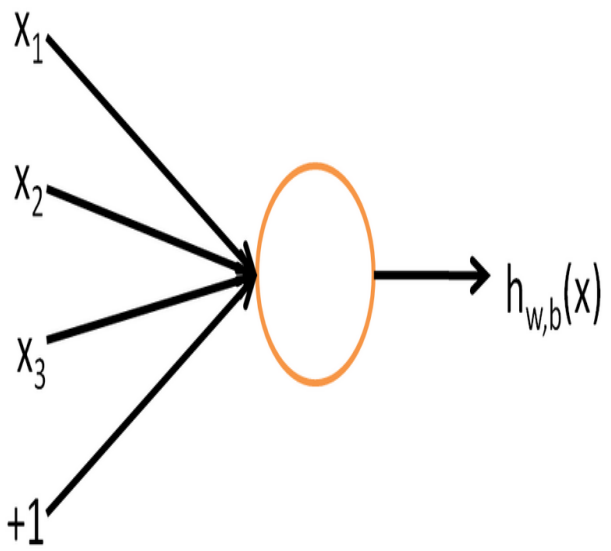
- Music Classification: {Pop, Jazz, Folk,...}
- News Classification: {Sports, Politics, Finance,...}
- ……

In research,

- Classification (Recognition) of Images/voices:

--Scientists build an intelligent machine that can perceive the world as humans do

Why is Perceptron Important? (Let computers do the classification for you!)

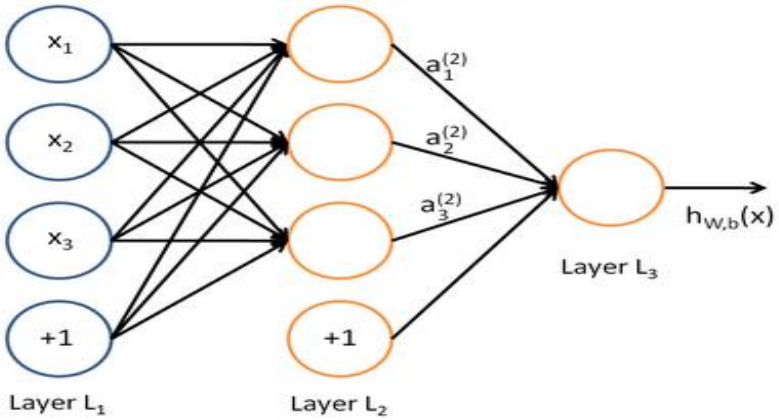


- Very simple algorithm

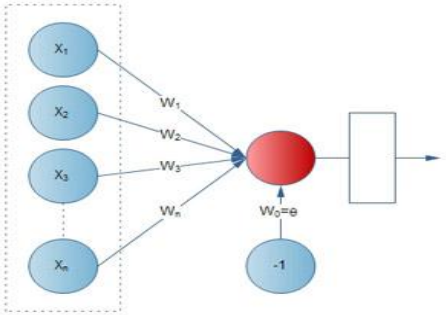
--for simple classification Problem

- Basic component

--for a more advanced algorithm Neural Network, e.g



Definition And Applications



- Perceptron is a binary classifier

--Receive object features as input

In image recognition, features could be pixel values;

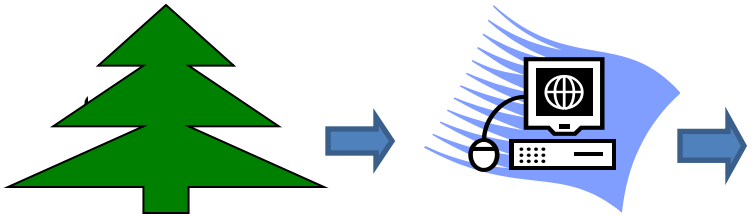
In document classification, features could be words in one document

--Output the category of the object

- Applicable to image recognition, document classification etc.

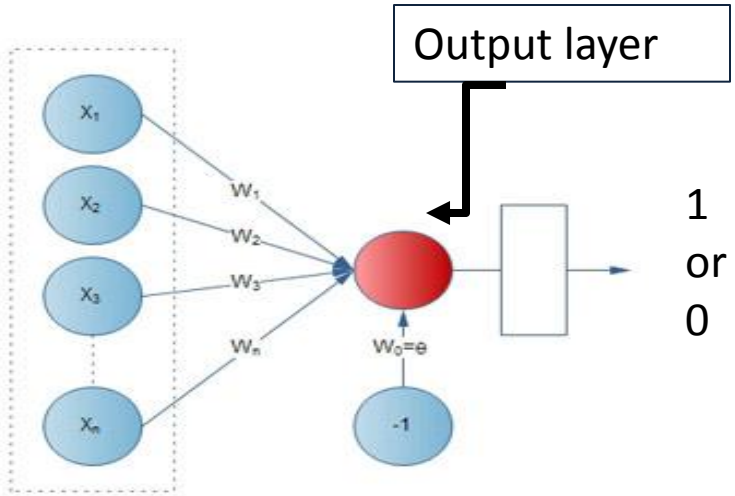
Project Goals

- Train a simple Perceptron program for classification using data with labels



It is a tree.

X(n) = Input layer
W(n) = weights



- Use the Perceptron to classify new data without labels

Method

- How Perceptron works for classification.

E.g.

Input (data with labels) for learning the weights in a Perceptron:

Data with 2 rows and 10 columns: $\begin{pmatrix} 1 & 2 & 4 & 8 & 7 & 1 & 2 & 5 & 1 \\ 2 & 2 & 1 & 3 & 4 & 1 & 2 & 1 & 0 \end{pmatrix}$

Data labels (classes):

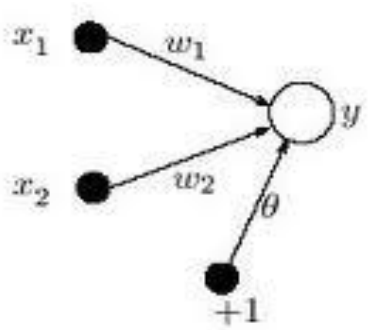
[0 1 1 1 1 0 1 0 0 0]

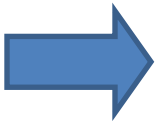
Program written using Matlab

Data 1: x1=1, x2=2, y=0

Data 2: x1=2, x2=2, y=1

……





Weights (w1, w2, ..) learnt

If a new data point comes, input it to the Perceptron, and get the output (label)

Binary Classification Using Perceptron

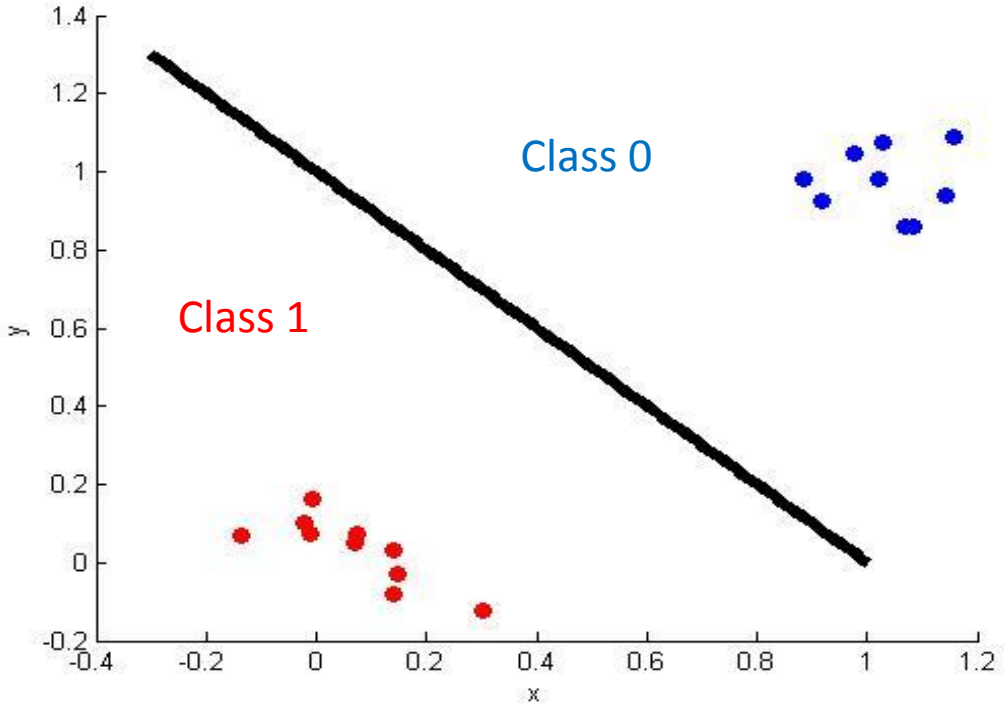
Simulation Data

Columns 1 through 10

-0.1350	0.3035	0.0725	-0.0063	0.0715	-0.0205	-0.0124	0.1490	0.1409	0.1417
0.0671	-0.1207	0.0717	0.1630	0.0489	0.1035	0.0727	-0.0303	0.0294	-0.0787

Columns 11 through 20

1.1419	1.0292	1.0198	1.1588	0.9196	1.0697	1.0835	0.9756	1.0216	0.8834
0.9384	1.0748	0.9808	1.0889	0.9235	0.8598	0.8578	1.0488	0.9823	0.9804



Binary Classification Using Perceptron

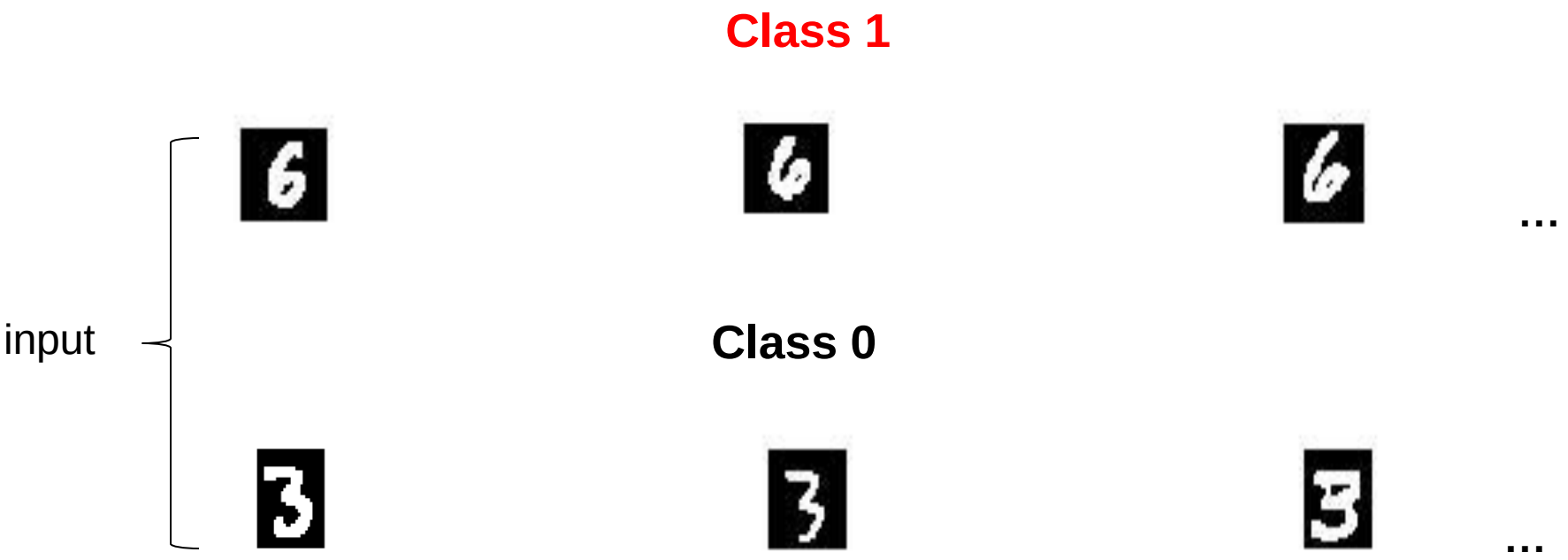
Real Image Data

Class 0

Class 1

- There are two classes of images (digit 3 or 6)
- Each image represented by784x1 vector (784 rows and 1 column) composed of pixel values
- One column = 1 image
- One row = 1 pixel

Training Real Image



- Each represented by 784x1 vector (784 rows and 1 column)
- One column = 1 image
- One row = 1 pixel

Testing Results

Outputs after testing perceptron

Unknown images

???
???
???
???
???
???
???
???
???
???

Class 0

Class 1

$$f(x) = \begin{cases} 1 & \text{if } w \cdot x + b > 0 \\ 0 & \text{otherwise} \end{cases}$$

W(n) = weights
X(n) = Inputs
b = a constant (between -1 and 1)

-1.7687
-2.2404
3.5064
3.2895
3.1984
-4.9908
-4.5961
2.7174
3.2576
4.8277

Class labels

0
0
1
1
1
0
0
1
1
1

Summary

- Perceptron is a binary classifier

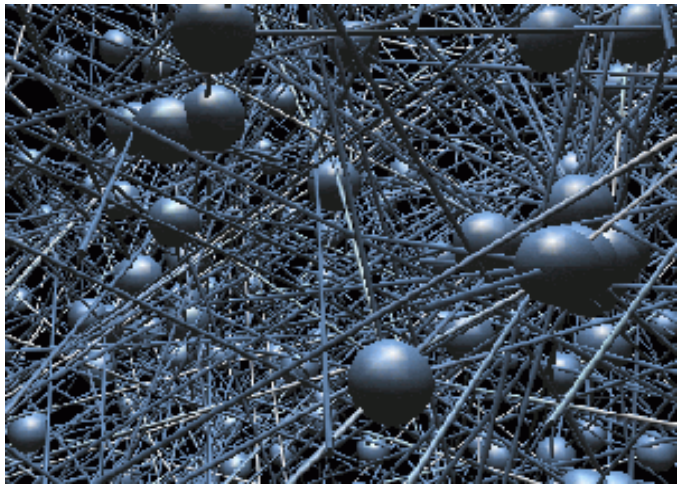
- Binary classification problems

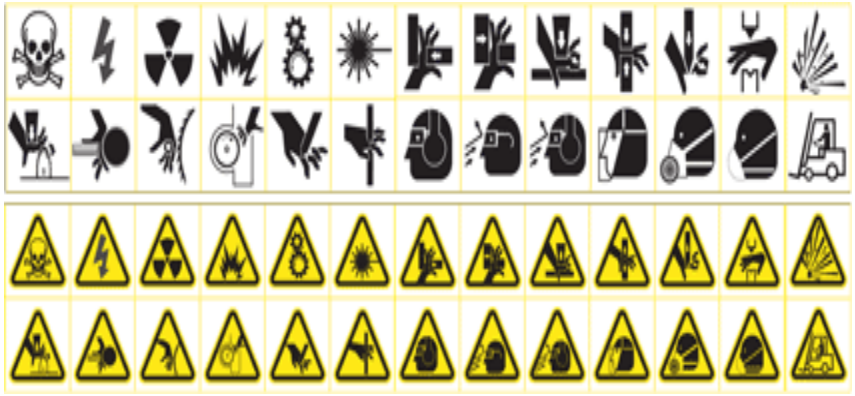
--tested on image classification (2-digit recognition)

Future Plans

- advanced classification methods

- Dealing with complicated classification problems.





Acknowledgements

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Thank you for your attention!