

# Practice- Multilayer Perceptron with WEKA

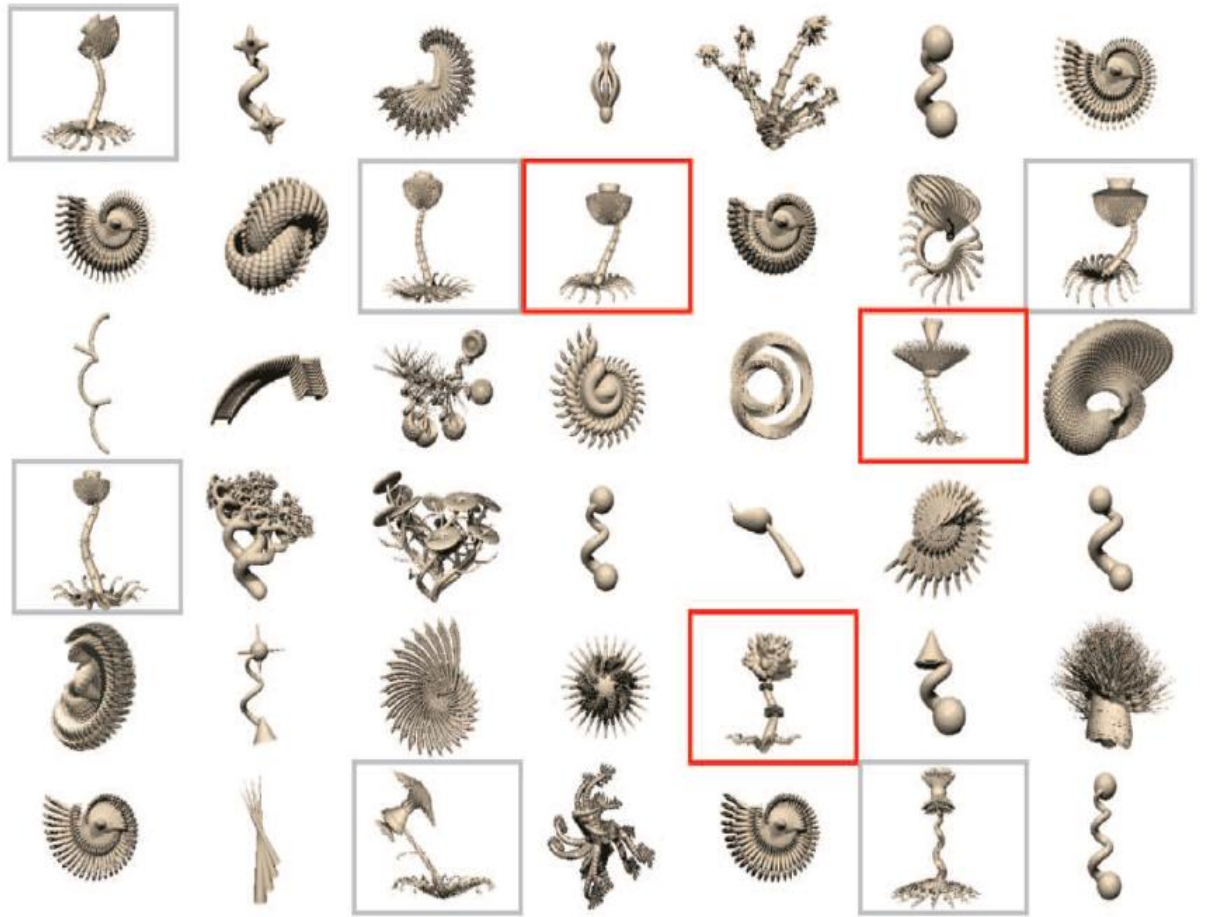
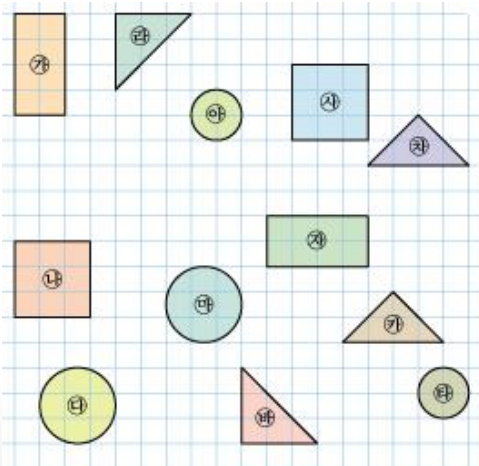
2012.04.18

Eun-Sol Kim

# Data & Classification

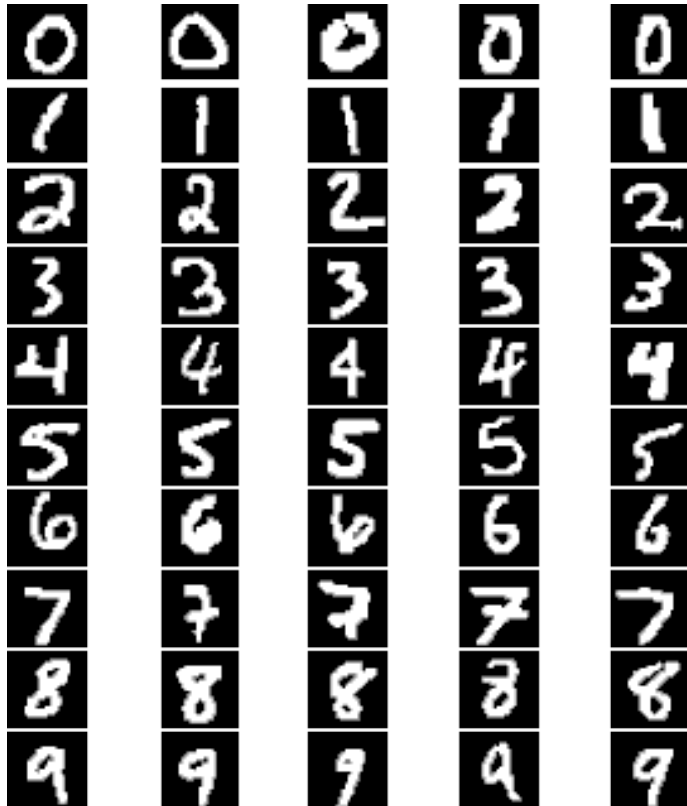
01가 3274

01가 3274



[Tenenbaum et al., Science 2012]

# Data & Features

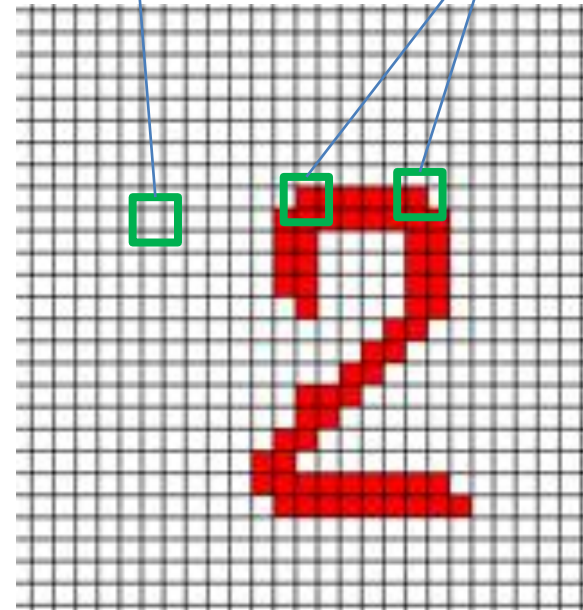


MNIST data set

Number of data(instances): 50

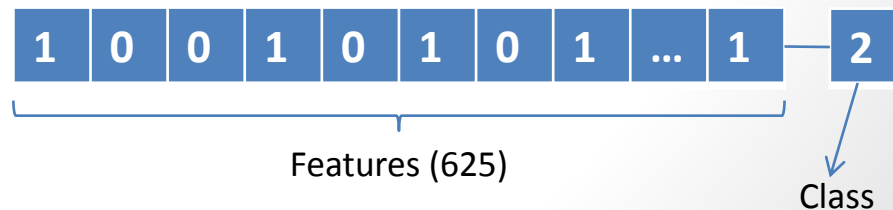
Number of class: 10

Feature value: 0    Feature value: 1

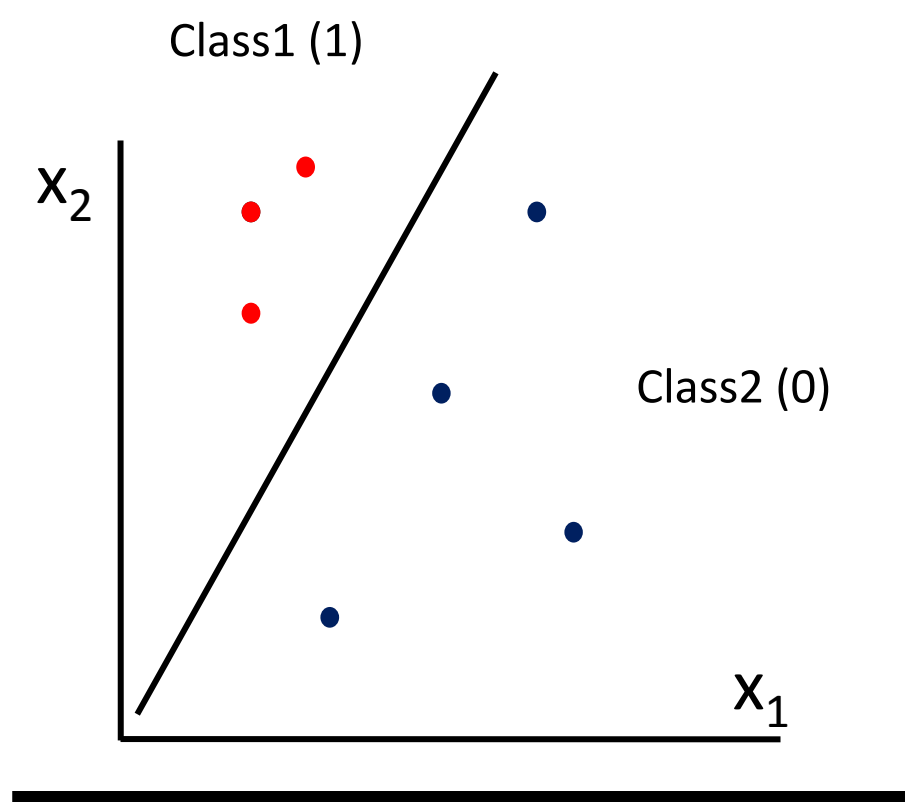


Data Label or Class: 2

Number of features:  $25 \times 25$  (625)  
(=attributes)

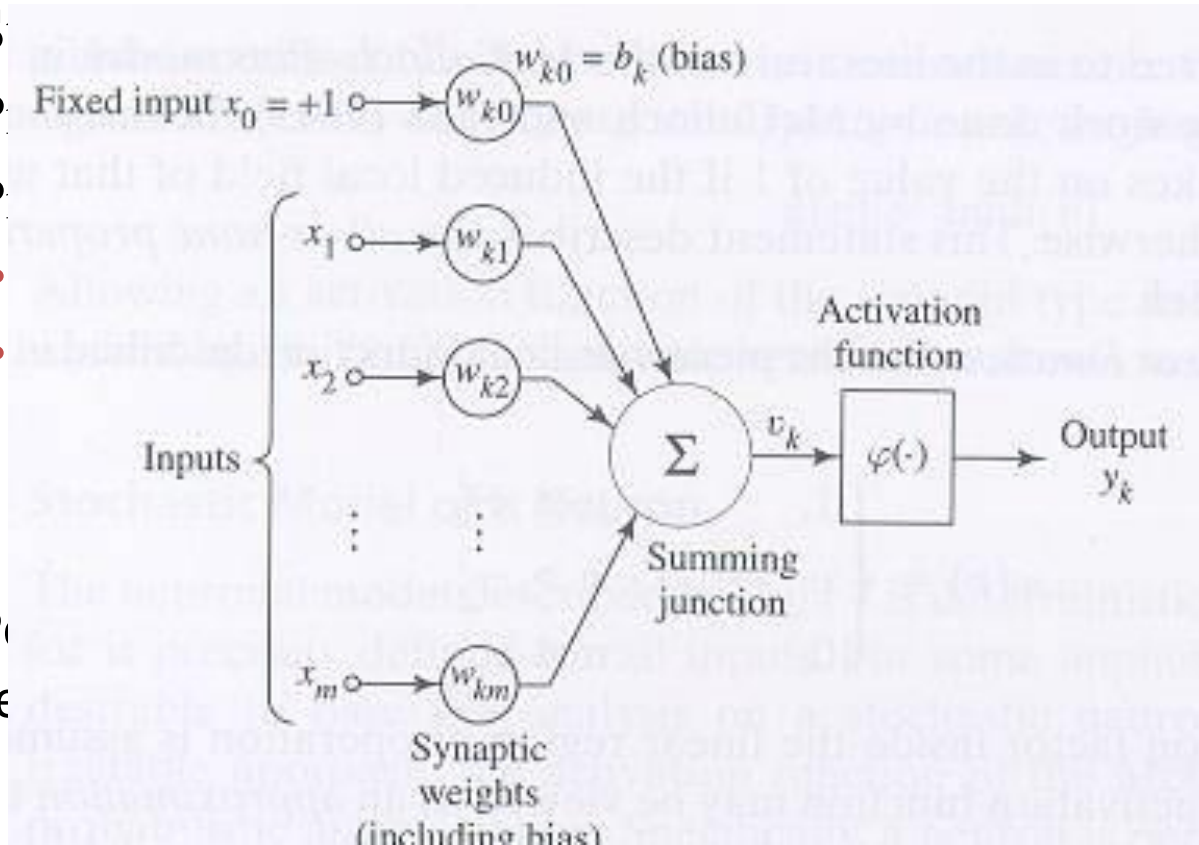


# Classification



# Perceptrons: How to learn

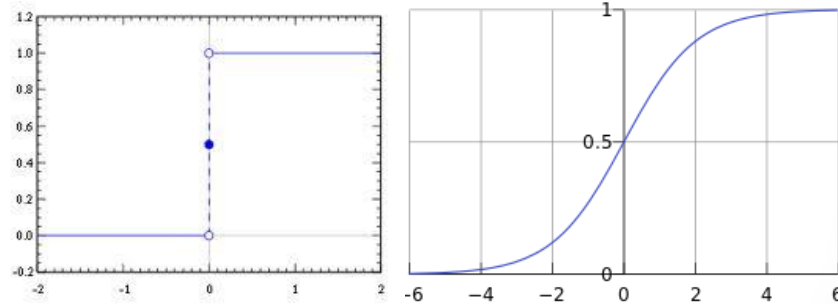
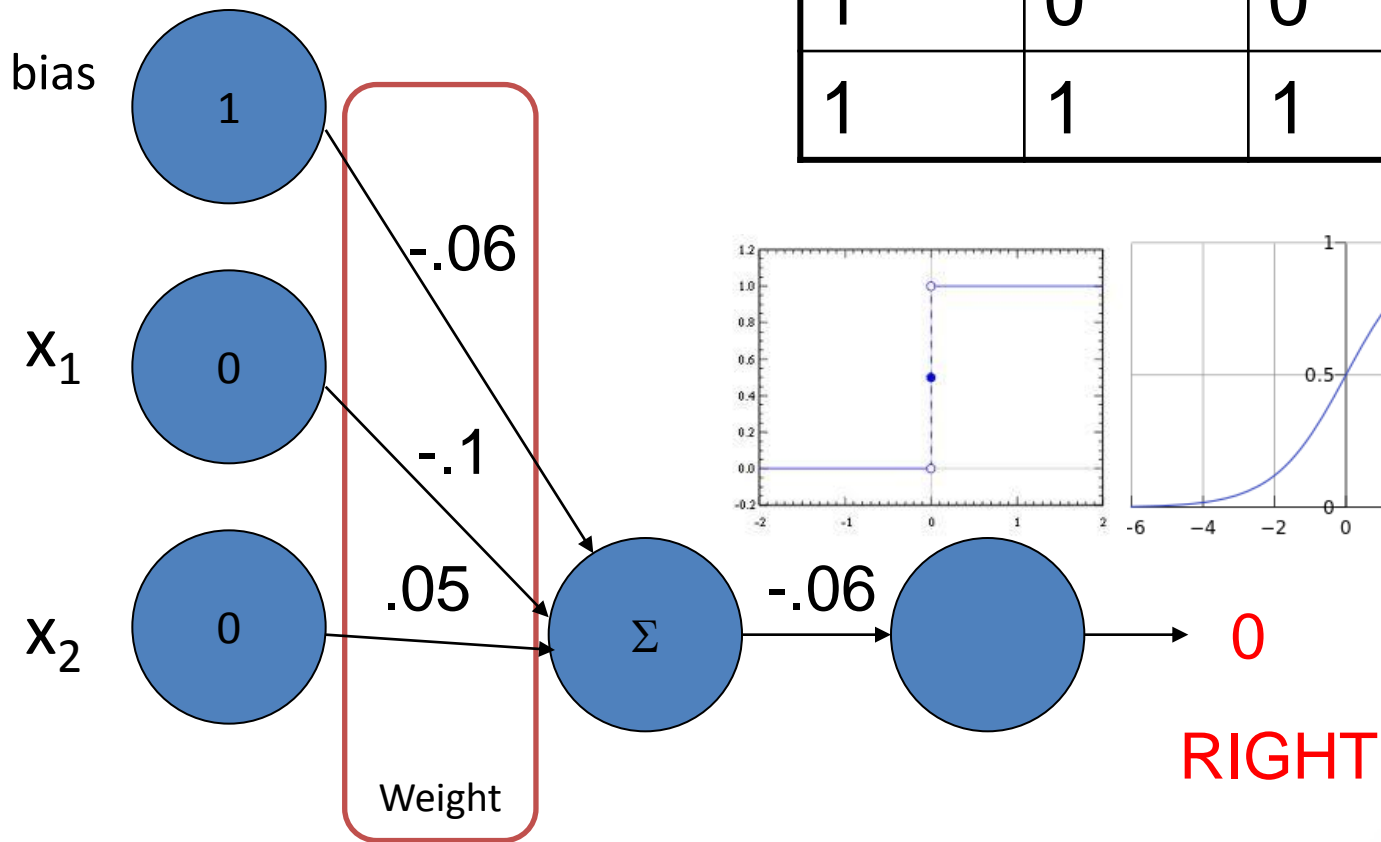
- S
- P
- P
- 
- 
- P
- re



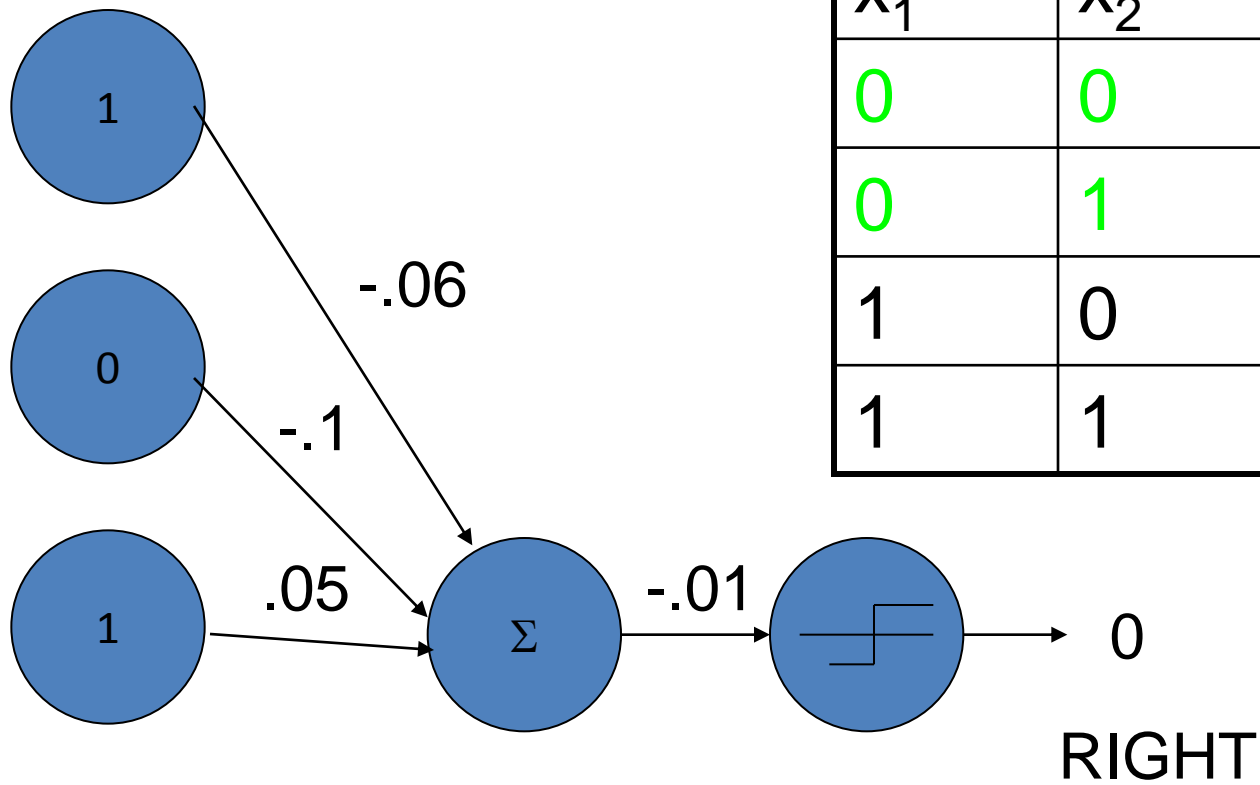
arious

# Perceptrons

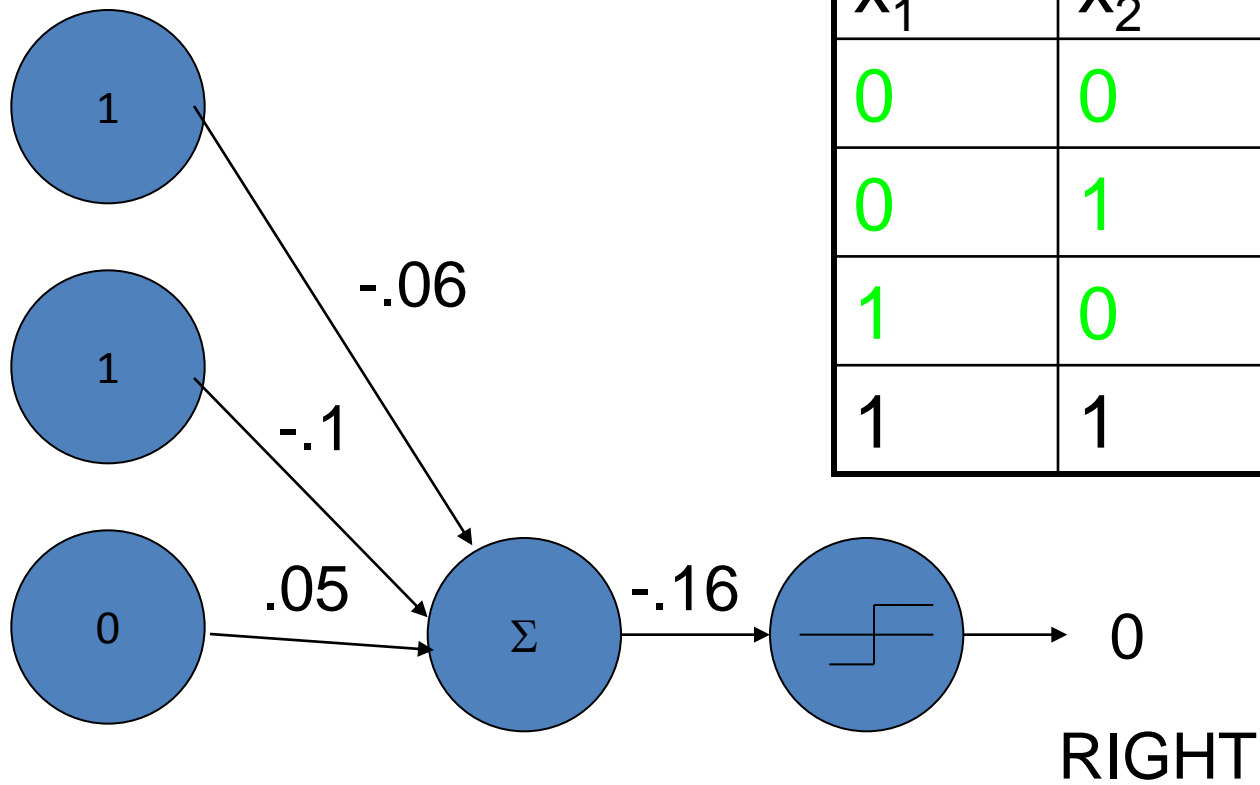
$x_1$	$x_2$	$0$
0	0	0
0	1	0
1	0	0
1	1	1



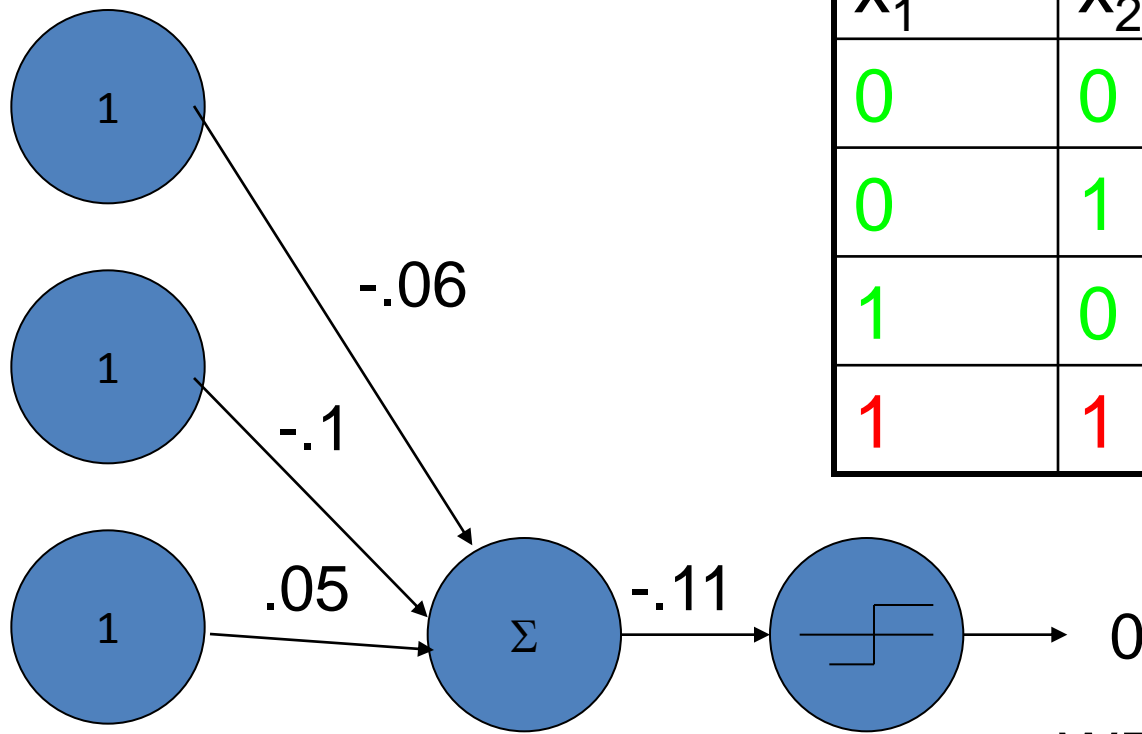
# Perceptrons



# Perceptrons



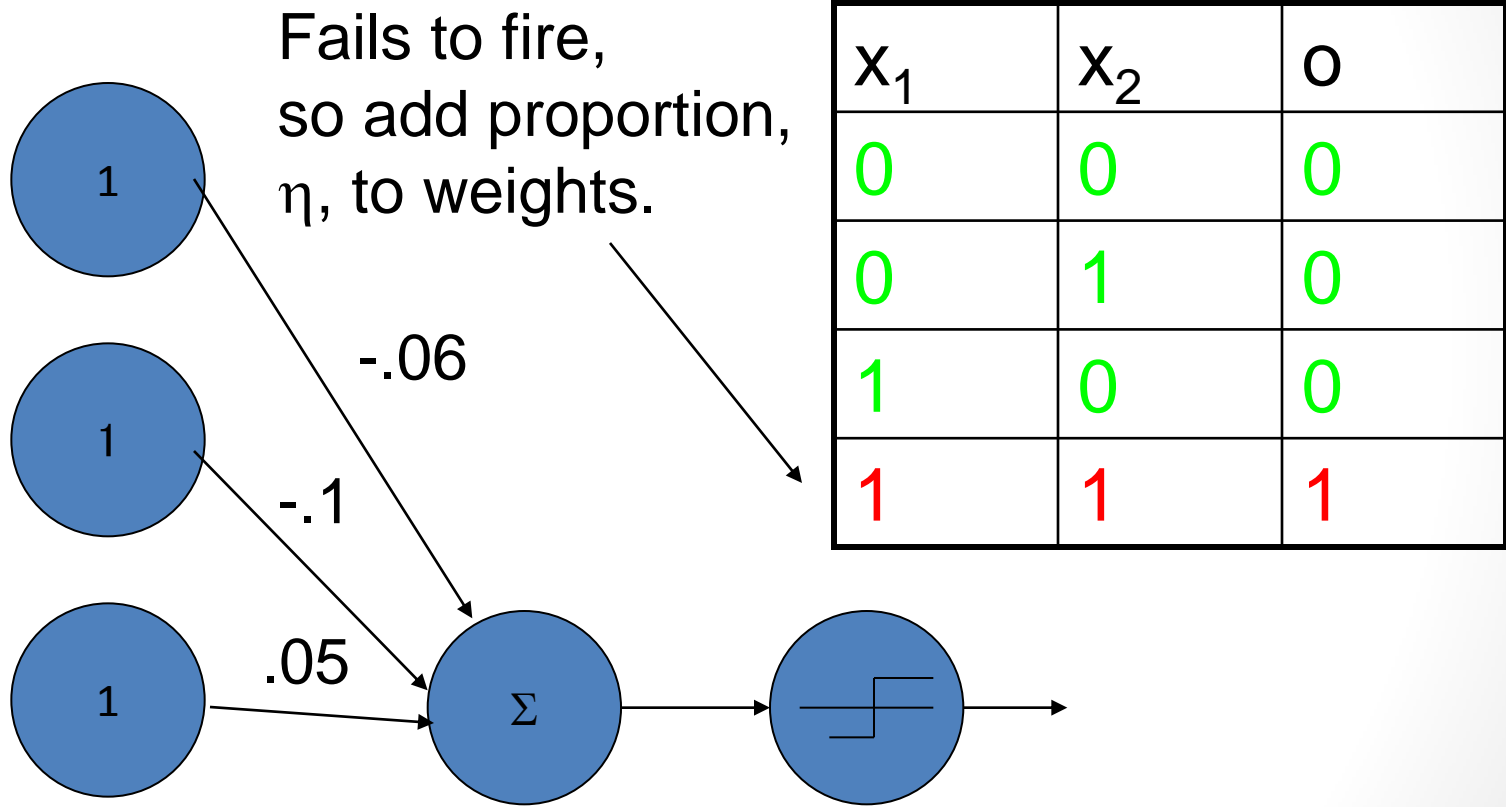
# Perceptrons



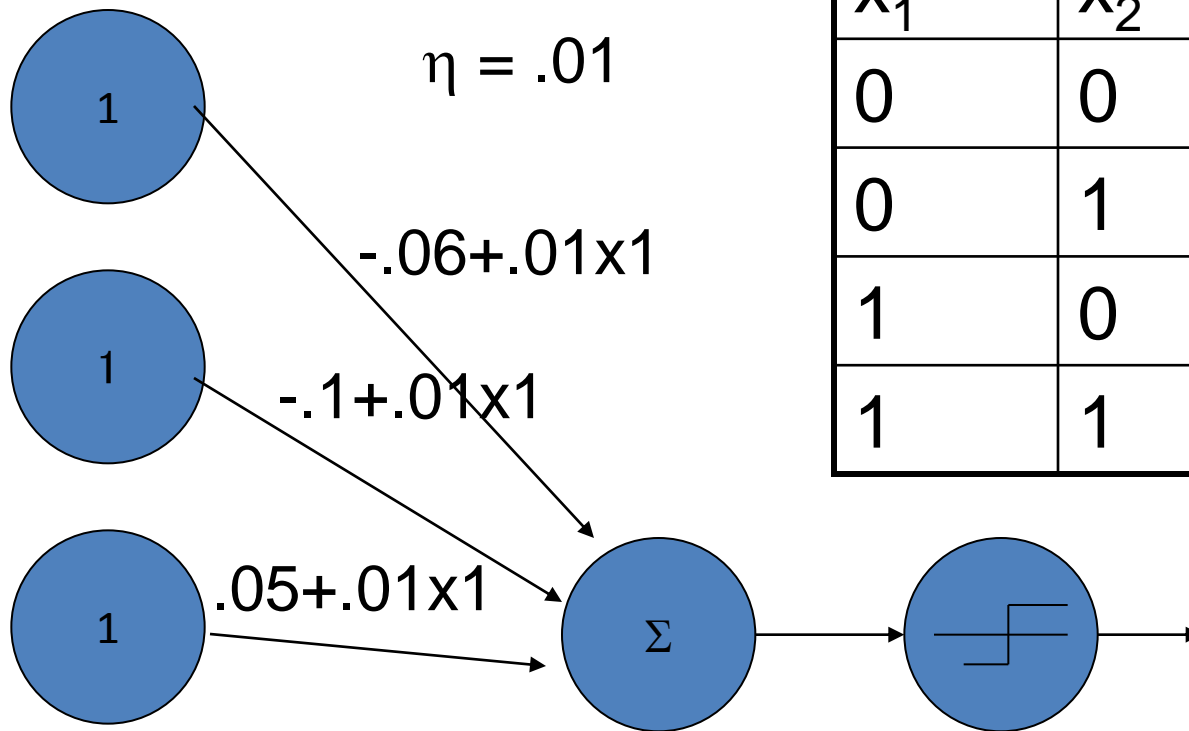
$X_1$	$X_2$	$0$
0	0	0
0	1	0
1	0	0
1	1	1

WRONG

# Perceptrons

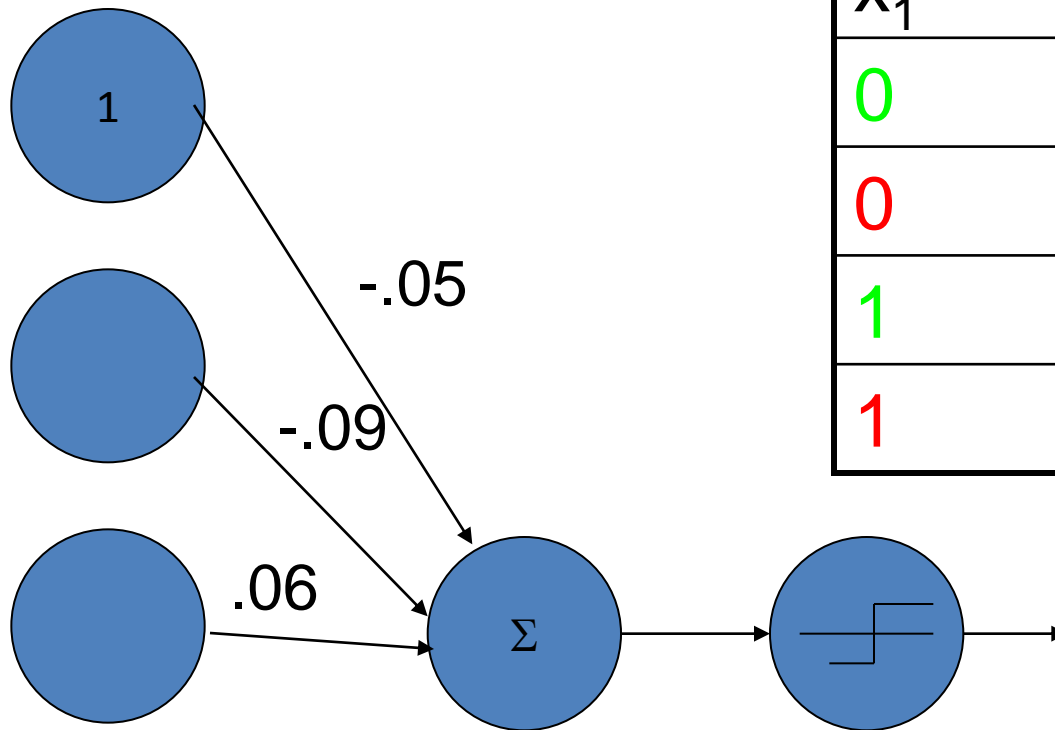


# Perceptrons



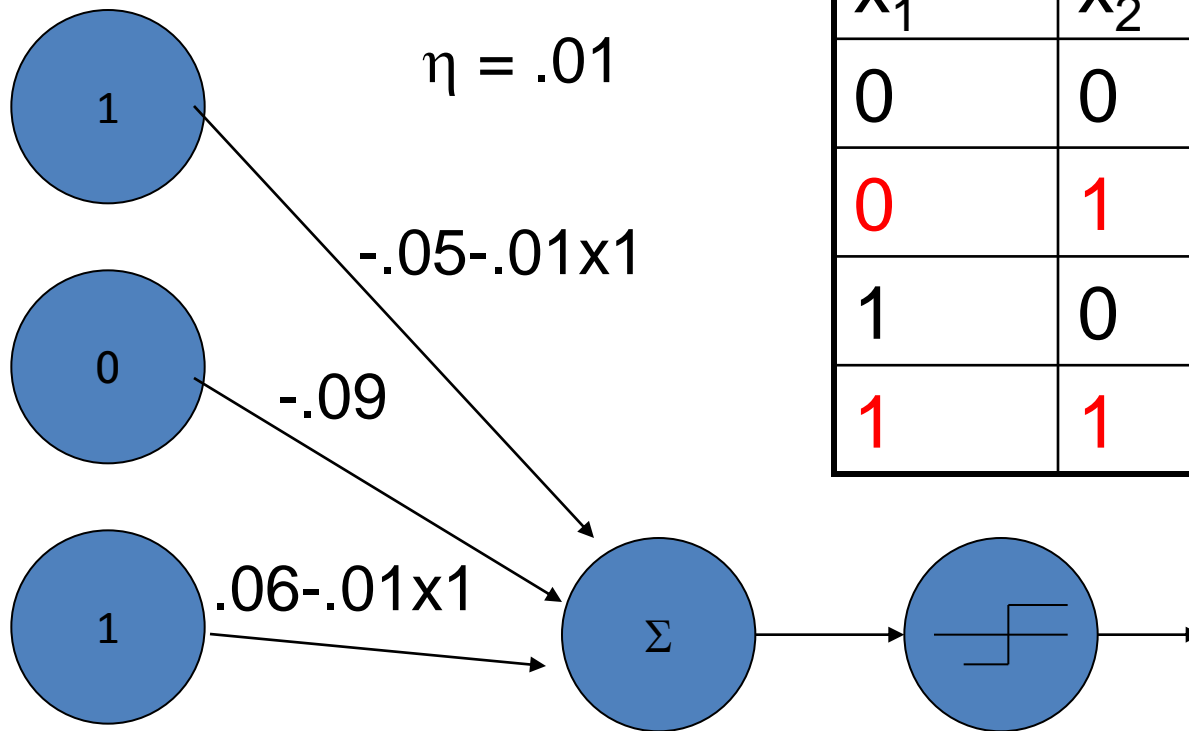
$x_1$	$x_2$	$0$
0	0	0
0	1	0
1	0	0
1	1	1

# Perceptrons



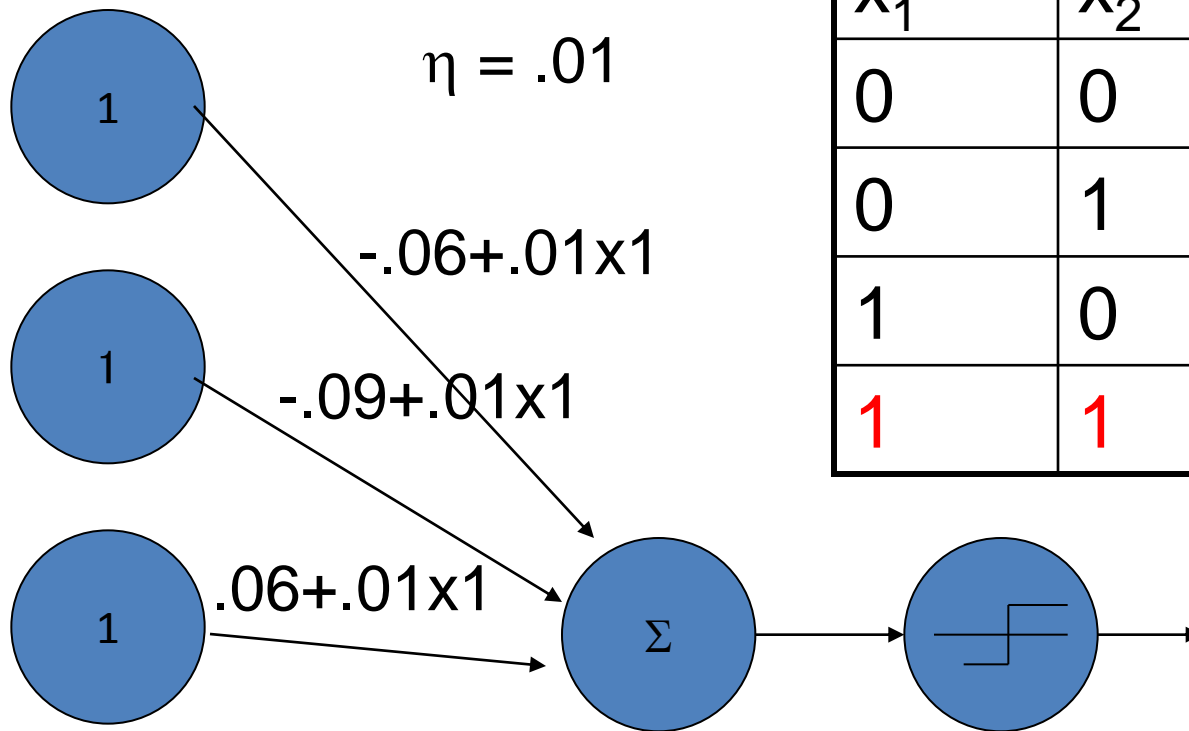
$X_1$	$X_2$	$0$
0	0	0
0	1	0
1	0	0
1	1	1

# Perceptrons



$x_1$	$x_2$	$0$
0	0	0
0	1	0
1	0	0
1	1	1

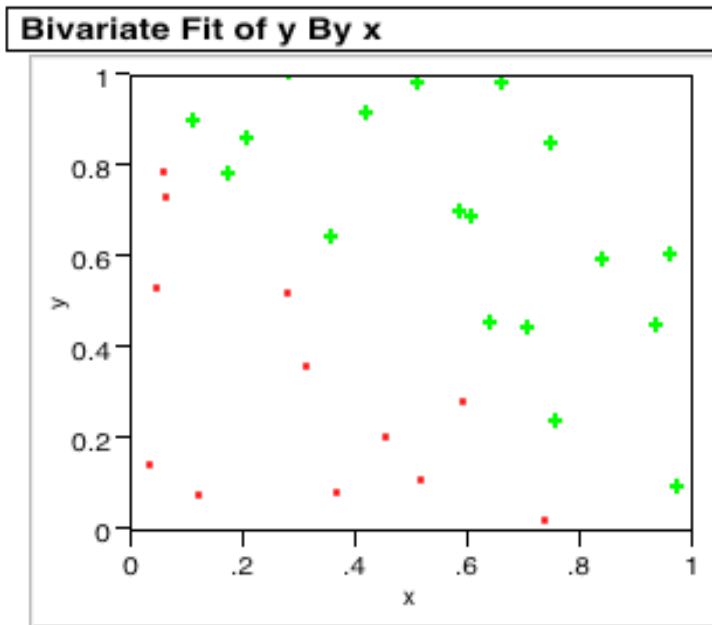
# Perceptrons



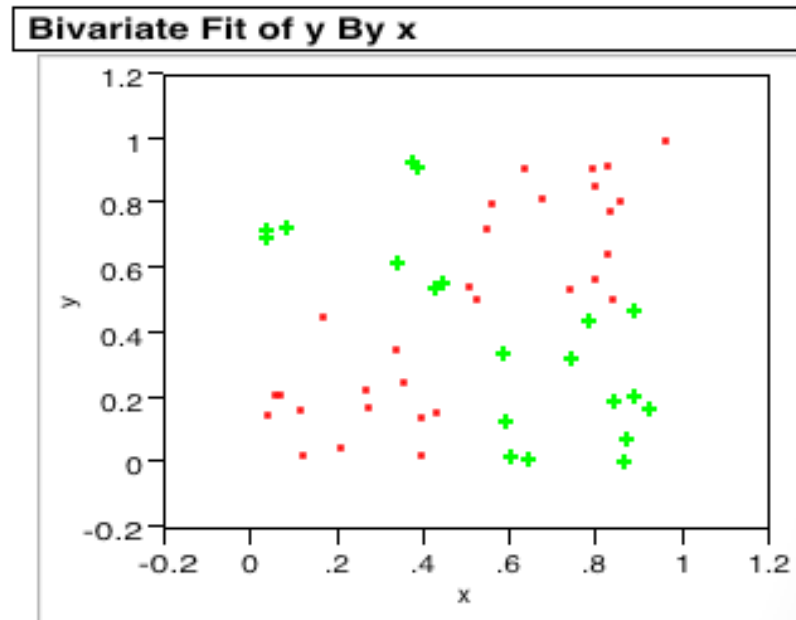
$x_1$	$x_2$	$0$
0	0	0
0	1	0
1	0	0
1	1	1

# Linearly & Nonlinearly separable

untitled: Fit Y by X

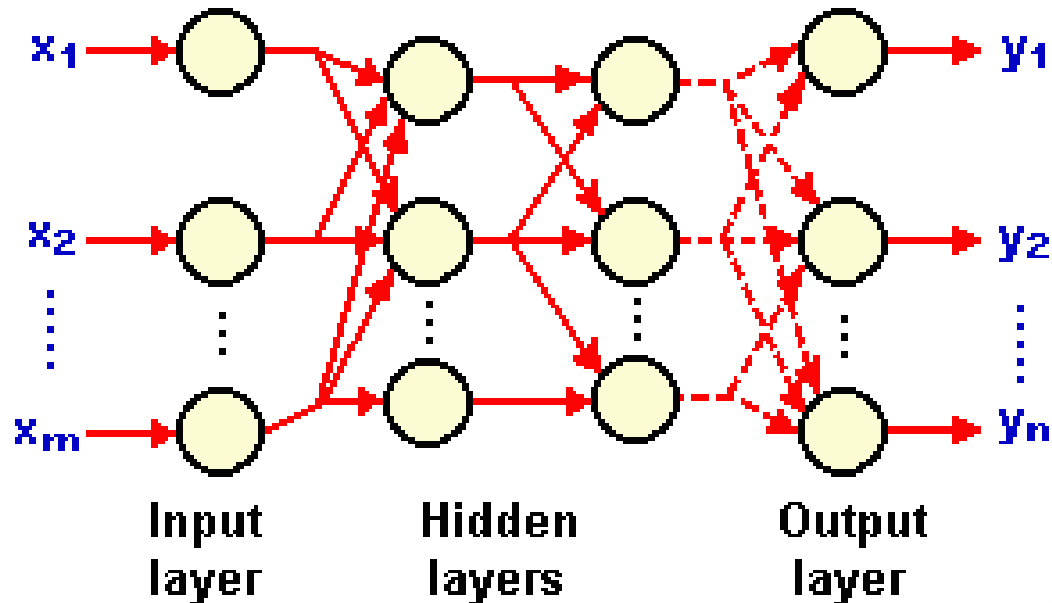


untitled: Fit Y by X





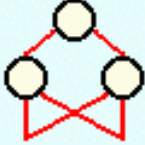
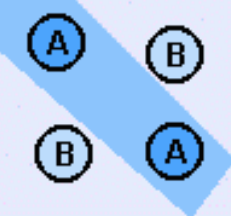


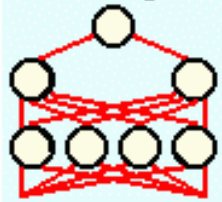





# Multi-layer Perceptron

- Can solve 'XOR' pattern learning
- No connection within a layer
- No direct connection input and output layers
- Fully connected between layers



# Pattern Separation and NN architecture

Structure	Type of Decision Regions	Exclusive-Or Problem	Classes with Meshed Regions	Most General Region Shapes
<b>Single-layer</b> 	Half plane bounded by hyperplane			
<b>Two-layer</b> 	Convex open or closed regions			
<b>Three-layer</b> 	Arbitrary (Complexity limited by number of nodes)			

# Artificial Neural Networks

Initialize all weights to small random numbers.

Until satisfied Do  $\rightarrow$  **The Number of iterations**

- For each training example, Do
  1. Input the training example to the network and compute the network outputs
  2. For each output unit  $k$

$$\delta_k \leftarrow o_k(1 - o_k)(t_k - o_k)$$

3. For each hidden unit  $h$

$$\delta_h \leftarrow o_h(1 - o_h) \sum_{k \in \text{outputs}} w_{h,k} \delta_k$$

4. Update each network weight  $w_{i,j}$

$$w_{i,j} \leftarrow w_{i,j} + \Delta w_{i,j}$$

where

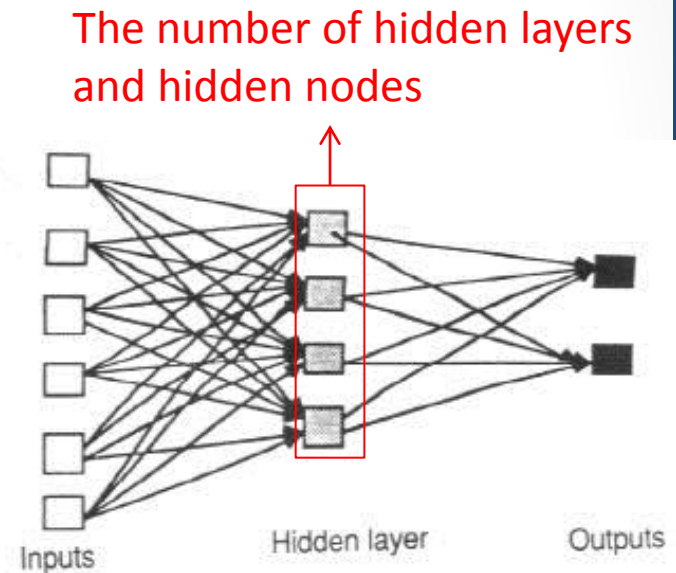
$$\Delta w_{i,j} = \boxed{\eta} \delta_j x_{i,j}$$

**Learning rate**

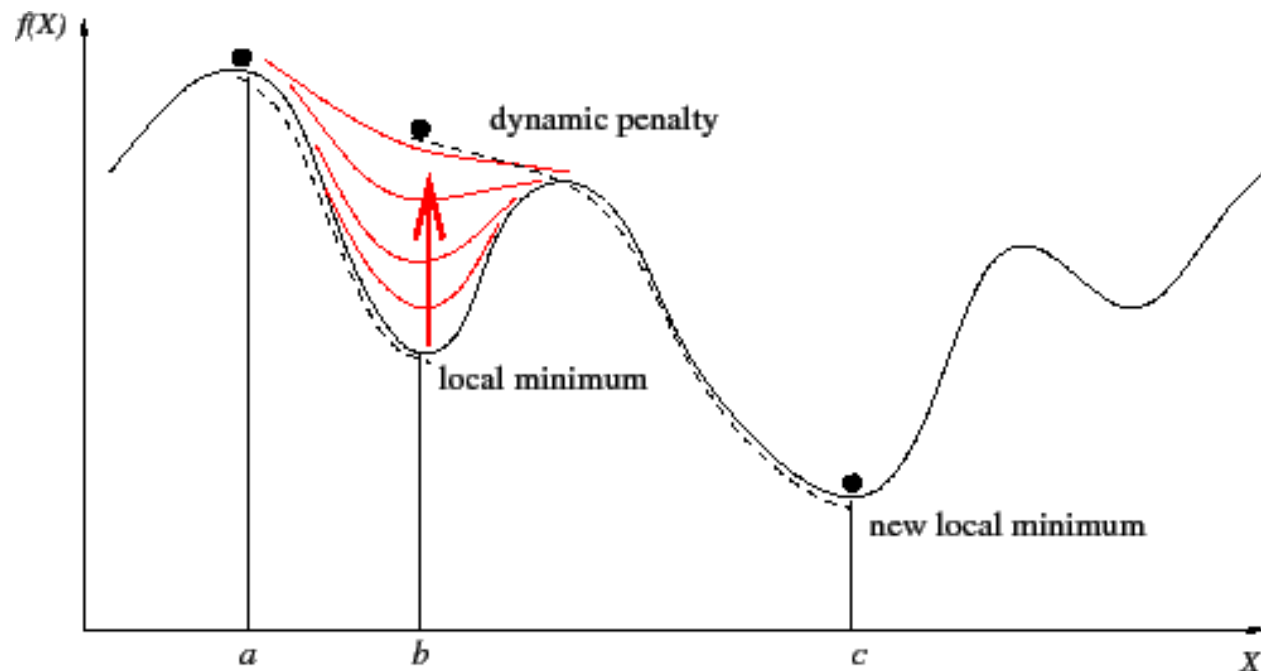
$$\Delta w_{i,j}(n) = \eta \delta_j x_{i,j} + \boxed{\alpha} \Delta w_{i,j}(n - 1)$$

**Momentum**

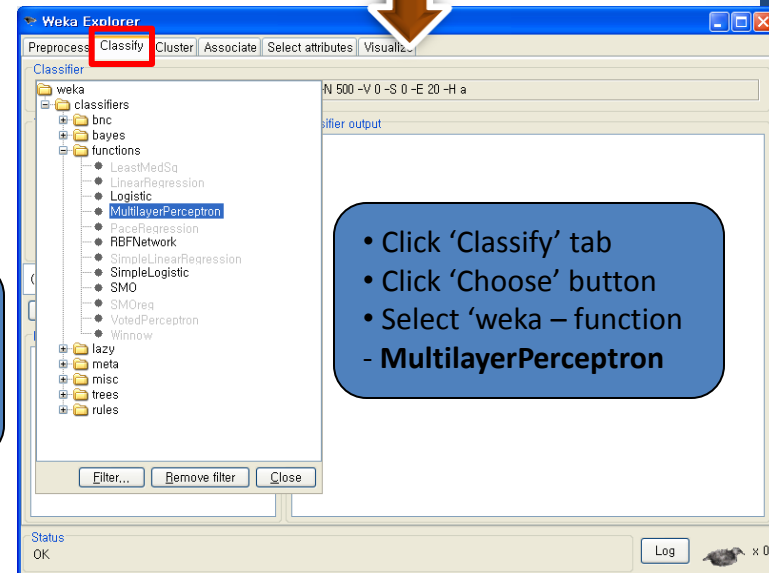
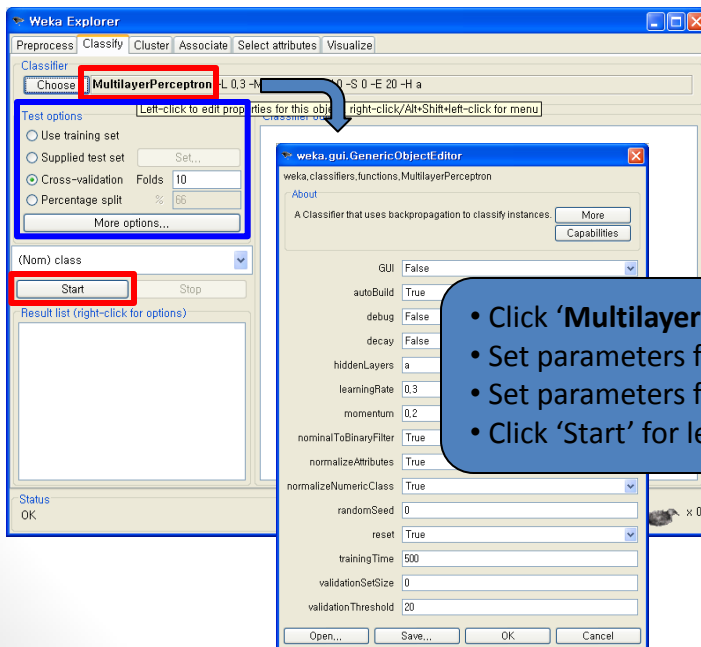
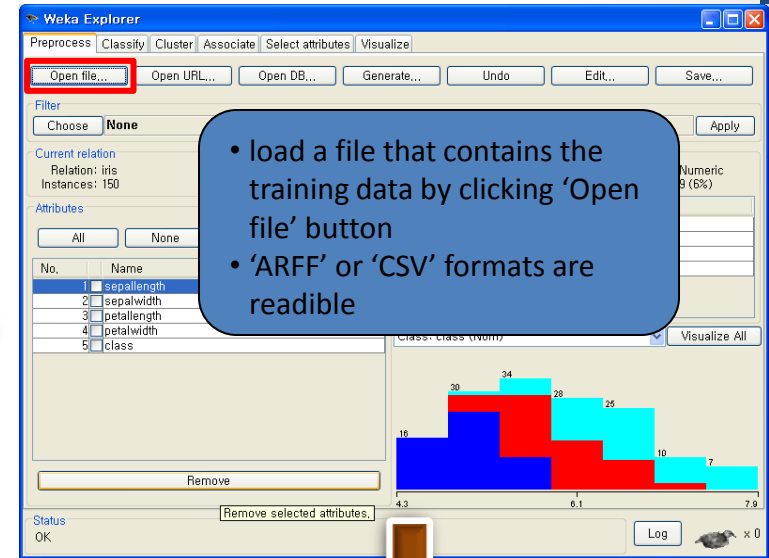
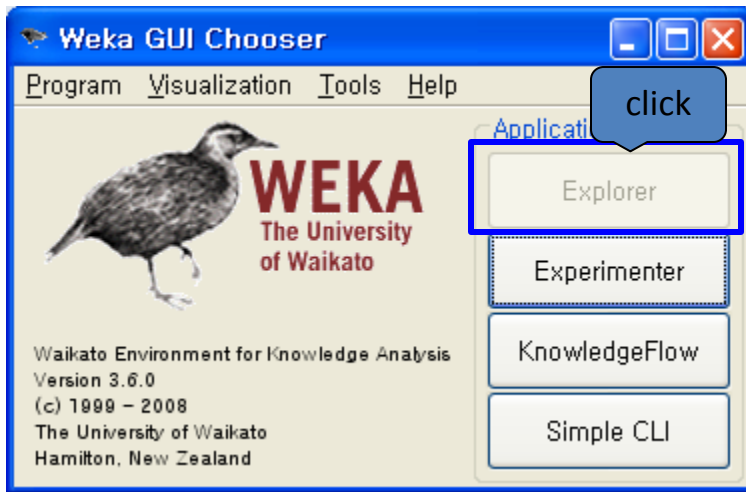
$\square$ : Four main parameters for learning MLPs



# Local minimum & Momentum



# Neural Networks in Weka



# Test Options and Classifier Output

The screenshot shows the Weka Explorer interface. The 'Classifier' tab is active, and 'MultilayerPerceptron' is selected. The 'Test options' section is highlighted with a green box, showing 'Cross-validation' selected with 5 folds and 66% split. The 'Classifier output' window is highlighted with a red box, displaying the following summary and detailed accuracy metrics:

```
Time taken to build model: 0.63 seconds

Stratified cross validation on

=== Summary ===

Correctly Classified Instances      144          96  %
Incorrectly Classified Instances     6           4  %
Kappa statistic                     0.94
Mean absolute error                  0.0376
Root mean squared error              0.1448
Relative absolute error              8.4538 %
Root relative squared error          30.7184 %
Total Number of Instances           150

=== Detailed Accuracy By Class ===

          TP Rate  FP Rate  Precision  Recall  F-Measure  ROC
          1         0         1           1         1           1
          0.9       0.01      0.978      0.9       0.938      0
          0.98      0.05      0.907      0.98      0.942      0
Weighted Avg.  0.96      0.02      0.962      0.96      0.96       0

=== Confusion Matrix ===

 a b c <-- classified as
50 0 0 | a = Iris-setosa
 0 45 5 | b = Iris-versicolor
 0 1 49 | c = Iris-virginica
```

Setting the data set used for evaluation

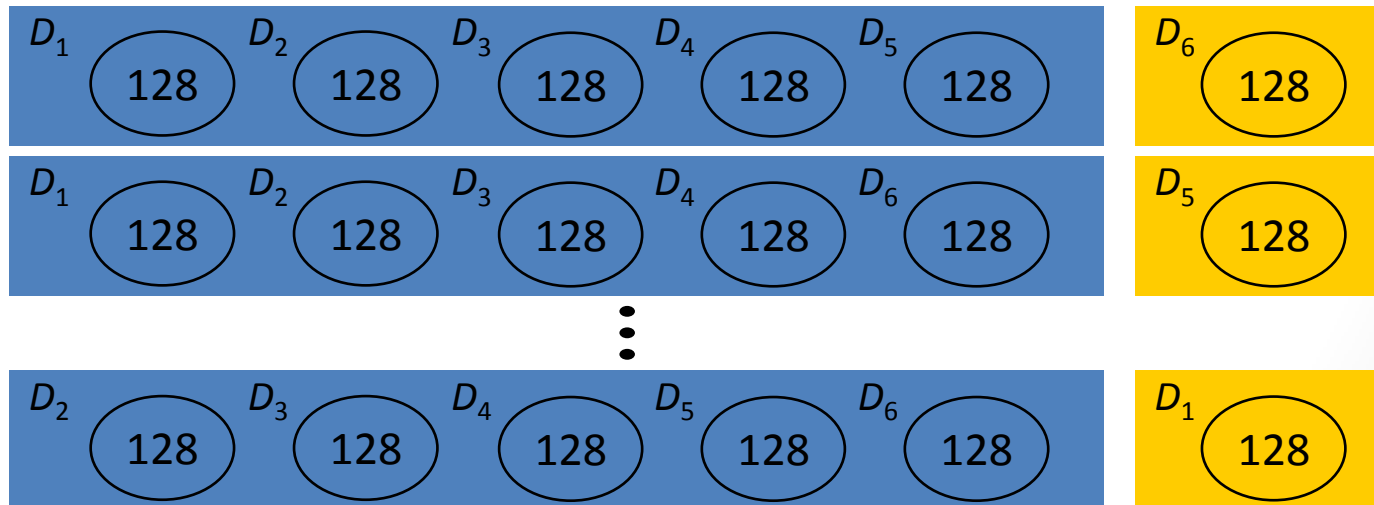
There are various metrics for evaluation

# Evaluation Method - Cross Validation

- K-fold Cross Validation
  - The data set is randomly divided into  $k$  subsets.
  - One of the  $k$  subsets is used as the 'test set' and the other  $k-1$  subsets are put together to form a 'training set'.


6-fold cross validation

$$Error = \frac{1}{k} \sum_{i=1}^k Error_i$$



# Using Experimenter in Weka

- Tool for 'Batch' experiments



Weka GUI Chooser

Program Visualization Tools Help

WEKA  
The University of Waikato

Application

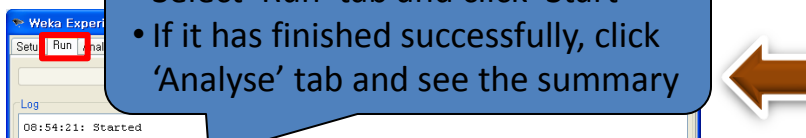

Experimenter

KnowledgeFlow

Simple CLI

Waikato Environment for Knowledge Analysis  
Version 3.6.0  
(c) 1999 - 2008  
The University of Waikato  
Hamilton, New Zealand

click



Weka Experiment Environment

Setup Run Analyse

Experiment Configuration Mode: Simple

Open... Save... New

Results Destination

ARFF file Filename: Browse...

Experiment Type

Cross-validation

Number of folds: 10

Classification Regression

Datasets

Add new... Edit select... Delete select...

Use relative pat...

Iteration Control

Number of repetitions: 10

Data sets first Algorithms first

Algorithms

Add new... Edit selected... Delete selected

Use relative pat...

E:\WPProgram Files\Weka-3-6\data\Wiris.arff

Up Down Load options... Save options... Up Down

Notes

08:54:21: Started

Log

Weka Experiment Environment

Setup Run Analyse

Source

No source

File... Database... Experiment

Configure test

Testing with Paired T-Tester (co...)

Row Select

Column Select

Comparison field

Significance 0.05

Sorting (asc.) by

Test base

Displayed Columns

Show std. deviations

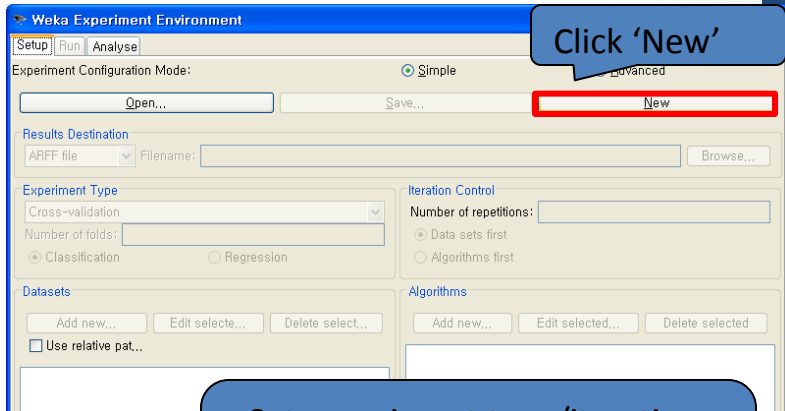
Output Format

Perform test Save output

Result list

Select 'Run' tab and click 'Start'

If it has finished successfully, click 'Analyse' tab and see the summary



Weka Experiment Environment

Setup Run Analyse

Experiment Configuration Mode: Simple

Open... Save... New

Results Destination

ARFF file Filename: Browse...

Experiment Type

Cross-validation

Number of folds: 10

Classification Regression

Datasets

Add new... Edit select... Delete select...

Use relative pat...

Iteration Control

Number of repetitions: 10

Data sets first Algorithms first

Algorithms

Add new... Edit selected... Delete selected

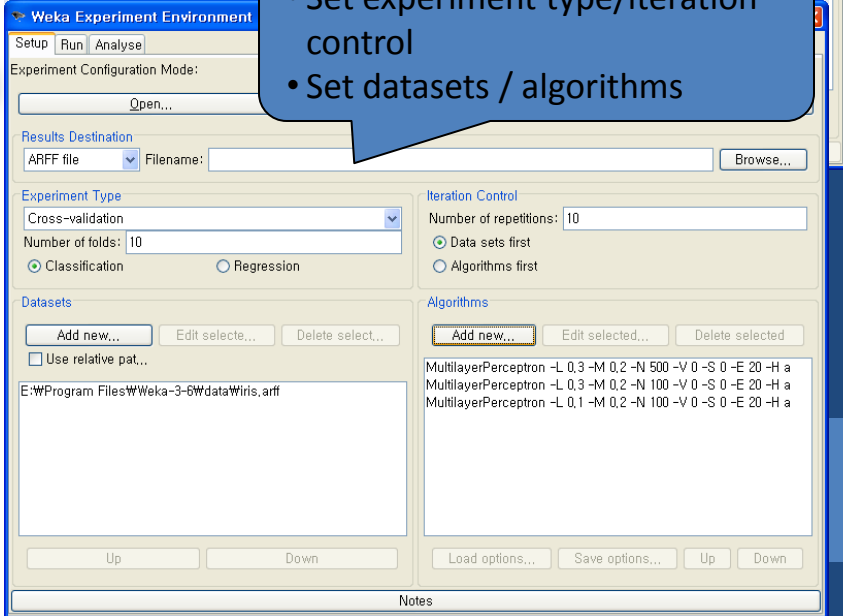

Use relative pat...

E:\WPProgram Files\Weka-3-6\data\Wiris.arff

Up Down Load options... Save options... Up Down

Notes

Click 'New'



Weka Experiment Environment

Setup Run Analyse

Experiment Configuration Mode: Simple

Open... Save... New

Results Destination

ARFF file Filename: Browse...

Experiment Type

Cross-validation

Number of folds: 10

Classification Regression

Datasets

Add new... Edit select... Delete select...

Use relative pat...

Iteration Control

Number of repetitions: 10

Data sets first Algorithms first

Algorithms

Add new... Edit selected... Delete selected

Use relative pat...

E:\WPProgram Files\Weka-3-6\data\Wiris.arff

Up Down Load options... Save options... Up Down

Notes

Set experiment type/iteration control

Set datasets / algorithms