Image Intro

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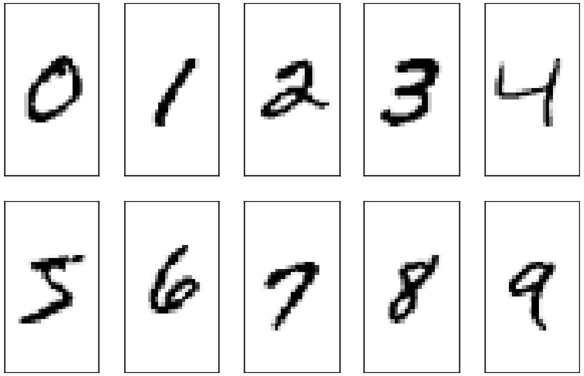
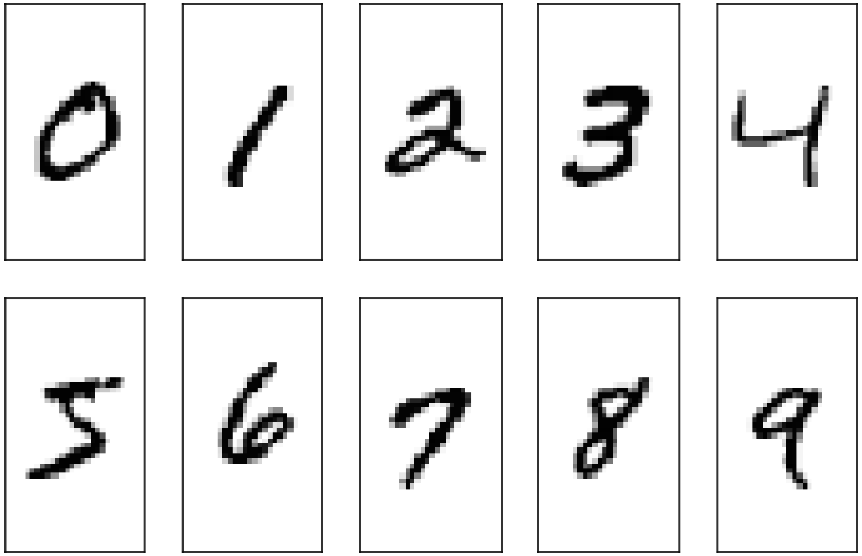
Patterns in Images

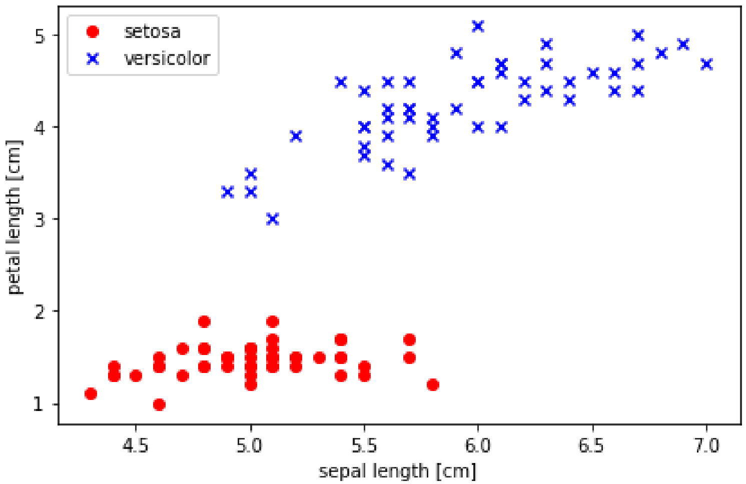
- Obtain
- Scrub
- Explore
- Model
- iNterpret

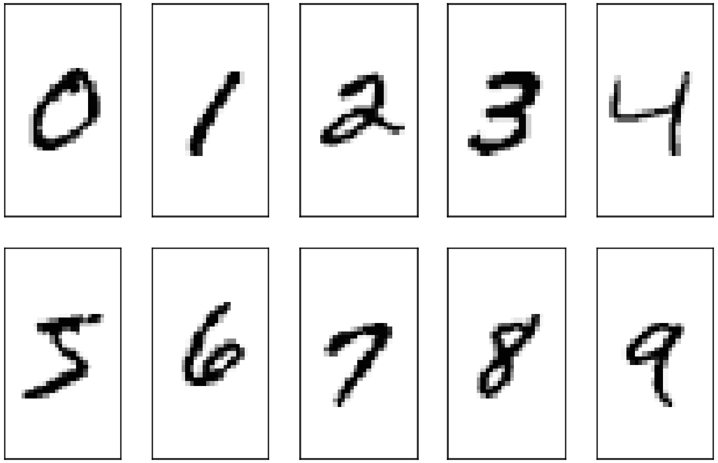


Our Challenge This Week?

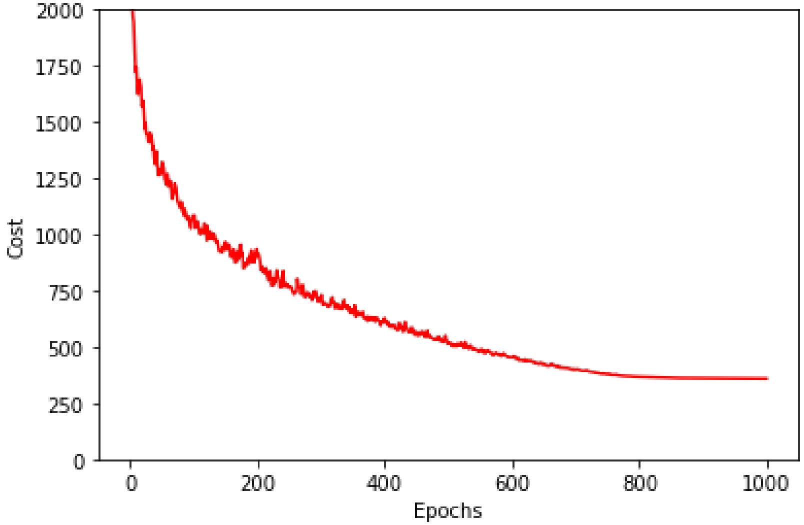


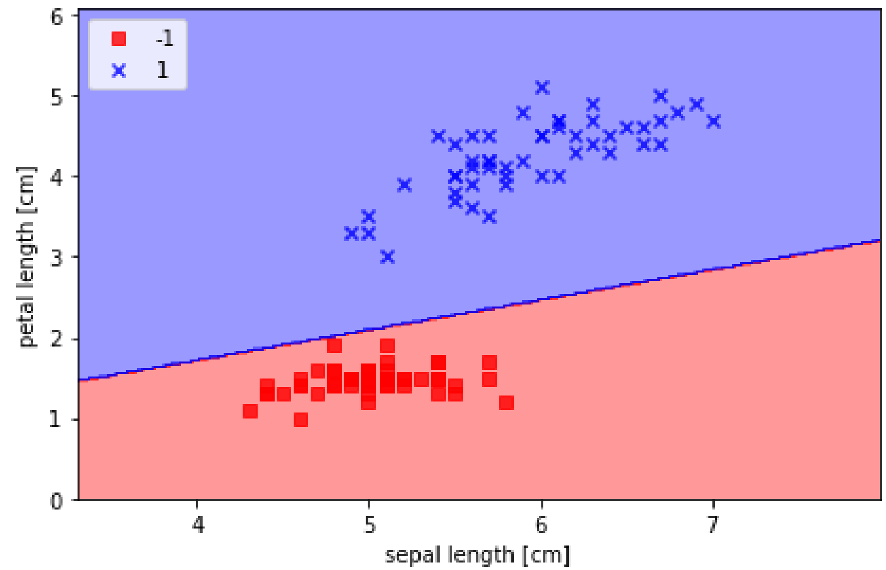
Using Machine Learning for Classification





But How?





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Data Review

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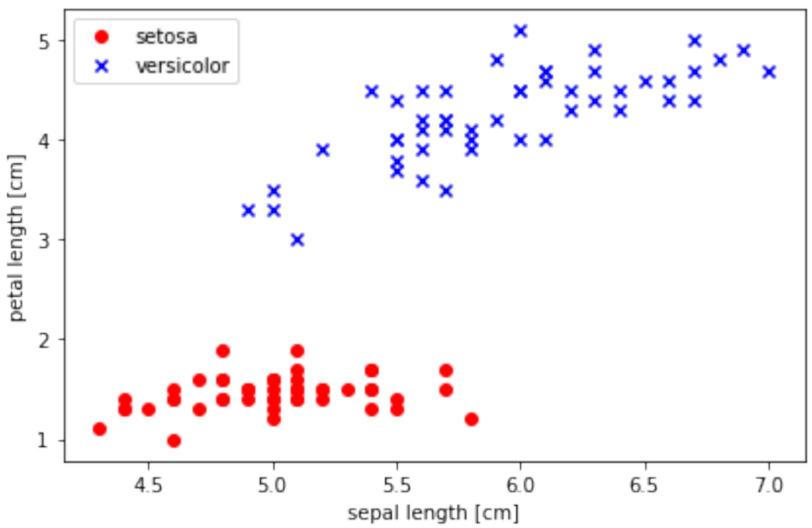
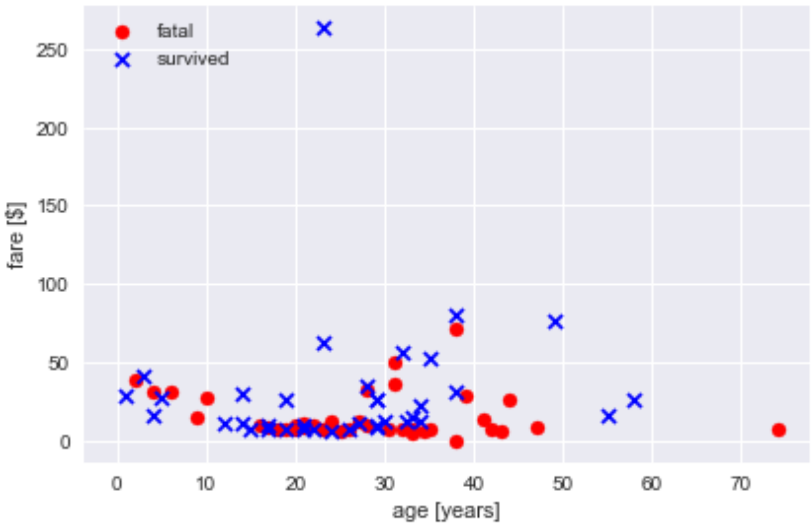
Basic Data

	0	1	2	3	4
0	5.1	3.5	1.4	0.2	Iris-setosa
1	4.9	3	1.4	0.2	Iris-setosa
2	4.7	3.2	1.3	0.2	Iris-setosa
3	4.6	3.1	1.5	0.2	Iris-setosa
4	5	3.6	1.4	0.2	Iris-setosa

Convergence Limitations





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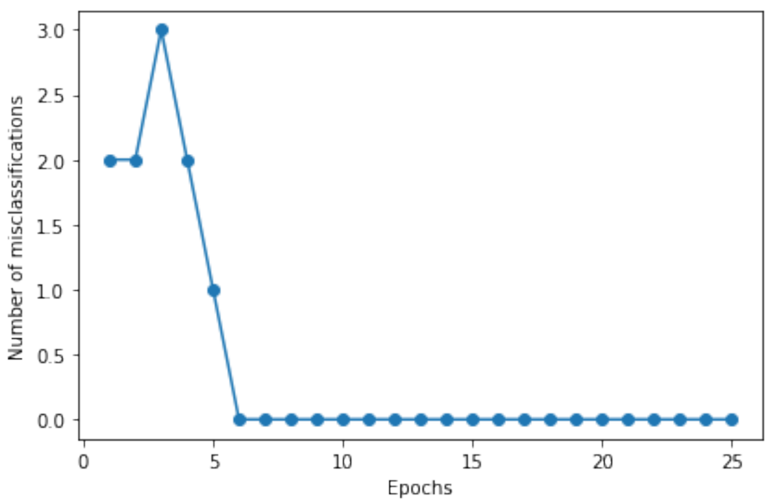
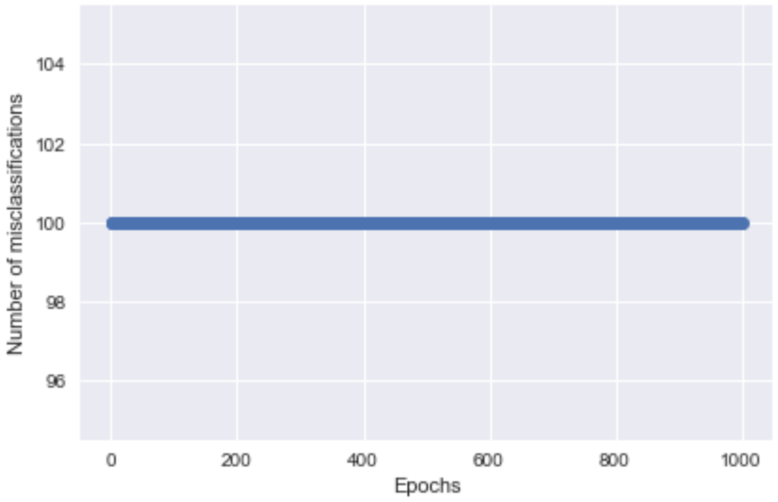
Convergence Limitations (cont.)





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Perceptron

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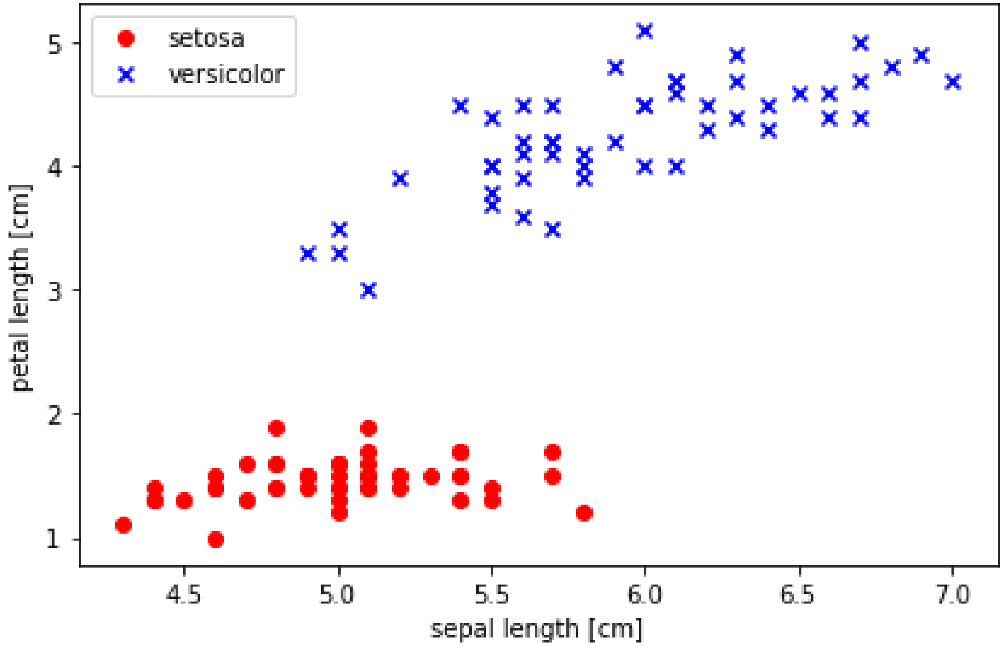
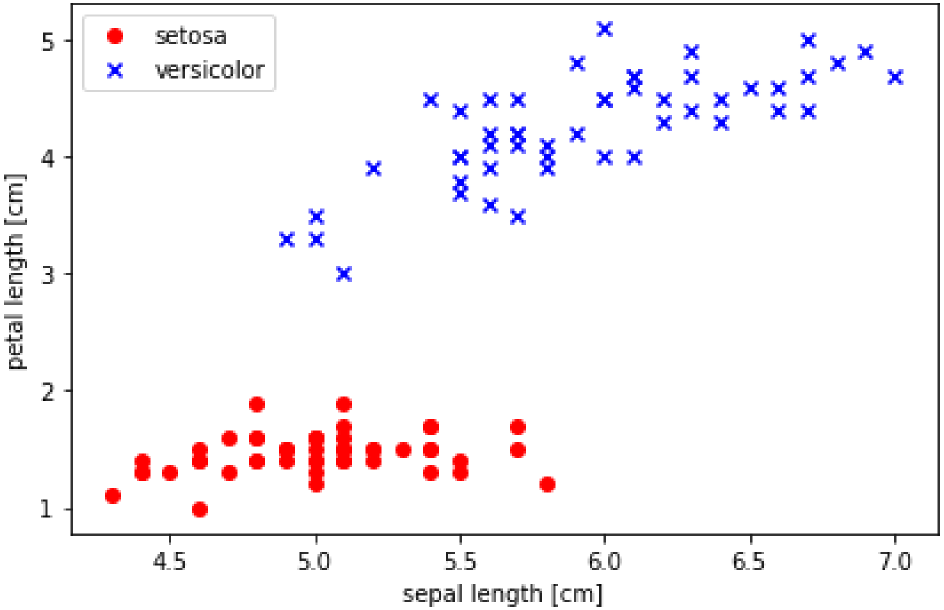
Perceptron Model



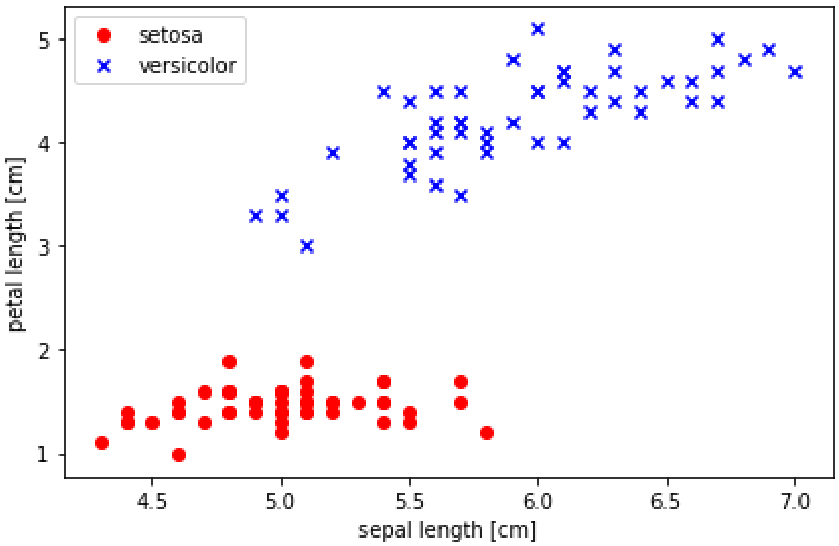
Rosenblatt's Model

- Initialize the weights
- For each sample:
  - Compute the output
  - Update the weights



Rosenblatt's Model (cont.)

- $\boldsymbol{w} = \begin{bmatrix} w_1 \\ \vdots \\ w_m \end{bmatrix}, \ \boldsymbol{x} = \begin{bmatrix} x_1 \\ \vdots \\ x_m \end{bmatrix}$
- $\varphi(z) = \begin{cases} 1, \text{if } z \geq \theta \\ -1 \text{ otherwise} \end{cases}$



Perceptron Learning Rule

- $\boldsymbol{w} = \begin{bmatrix} w_1 \\ \vdots \\ w_m \end{bmatrix}, \ \boldsymbol{x} = \begin{bmatrix} x_1 \\ \vdots \\ x_m \end{bmatrix}$

$$z = \boldsymbol{w}^T \boldsymbol{x}$$

$$\Delta w_j = \eta\left(y^i - \hat{y}^i\right)x_j^{(i)}$$

- $\varphi(z) = \begin{cases} 1, \text{if } z \geq \theta \\ -1 \text{ otherwise} \end{cases}$

Perceptron Learning Rule (cont.)

$$z = \boldsymbol{w}^T \boldsymbol{x}$$

$$\Delta w_j = \eta\left(y^i - \hat{y}^i\right)x_j^{(i)}$$

Adaline

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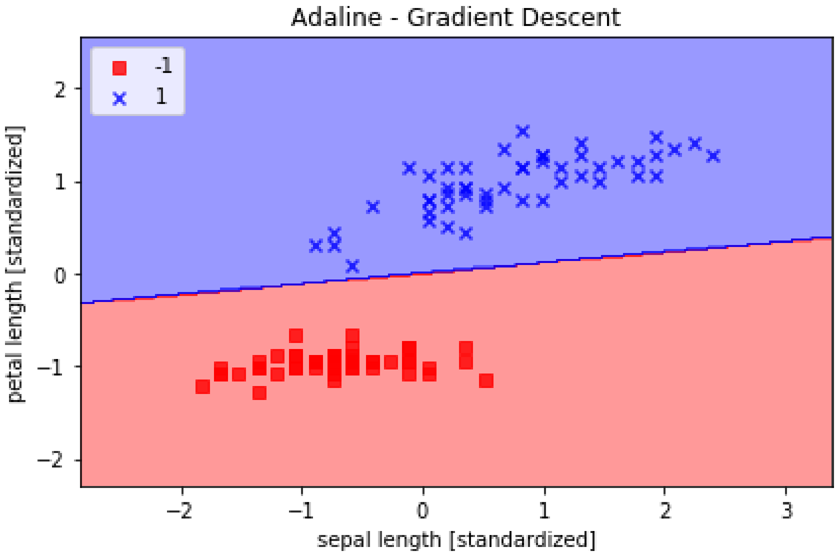
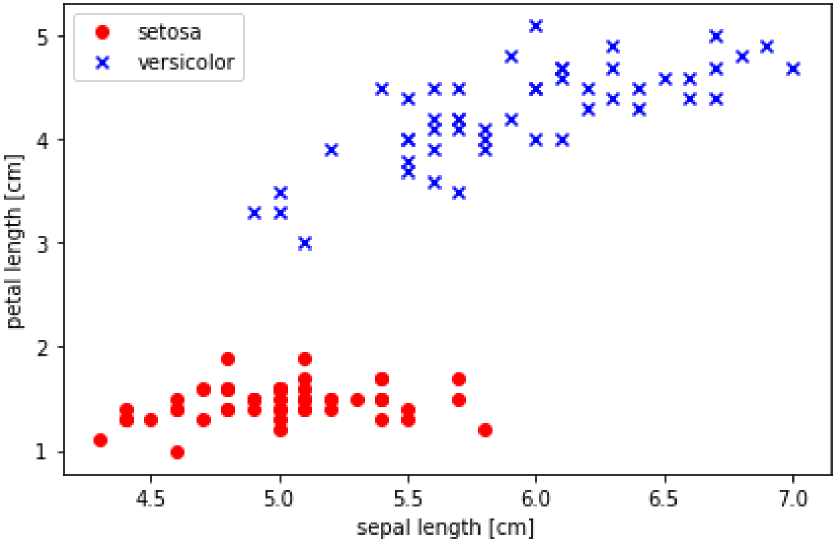
Adaptive Linear Neurons



Adaline Rule

- Linear activation function
- Quantizer for predicting the class



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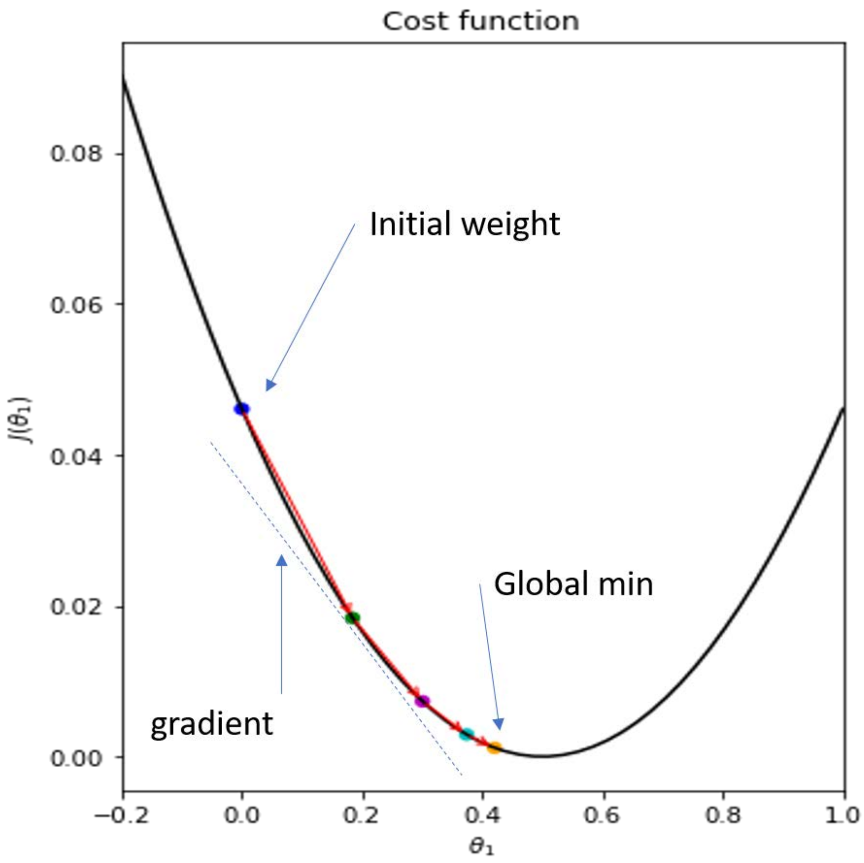
Adaline Rule (cont.)

- $\boldsymbol{w} = \begin{bmatrix} w_1 \\ \vdots \\ w_m \end{bmatrix}, \ \boldsymbol{x} = \begin{bmatrix} x_1 \\ \vdots \\ x_m \end{bmatrix}$
- $\varphi(z) = \boldsymbol{w}^T \boldsymbol{x}$

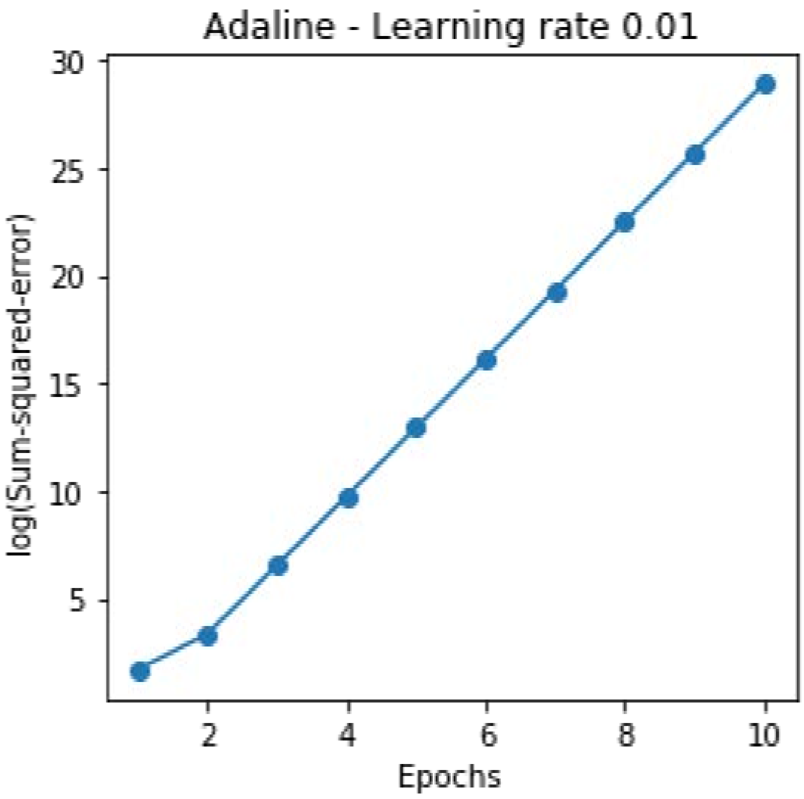
$$\varphi(\boldsymbol{w}^T \boldsymbol{x}\ ) = \boldsymbol{w}^T \boldsymbol{x}$$

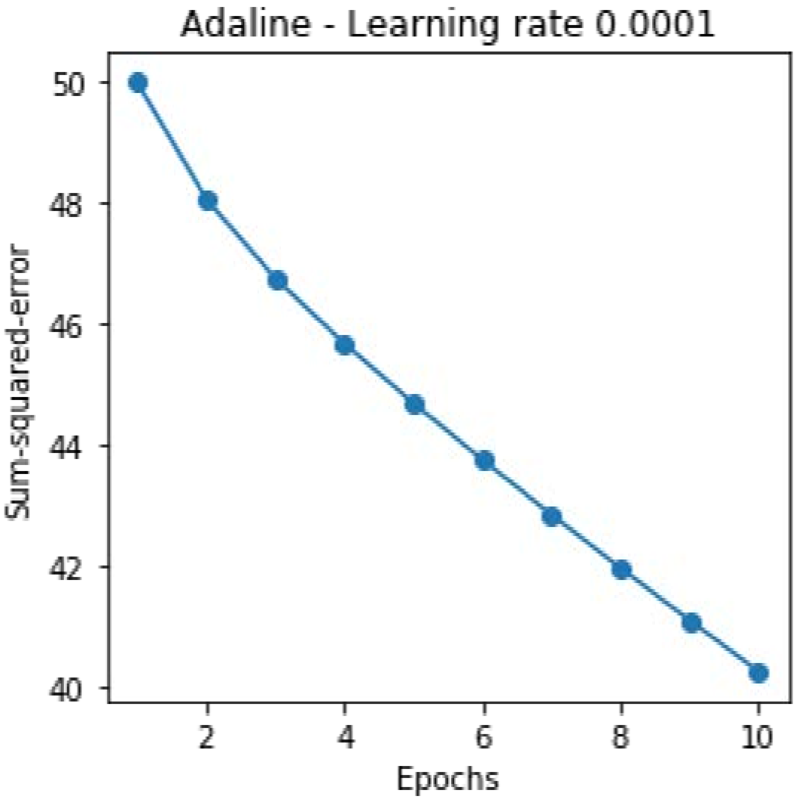
$$\Delta \boldsymbol{w} = -\eta \nabla J(\boldsymbol{w})$$

Gradient Descent



Learning Rate





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Neural Networks

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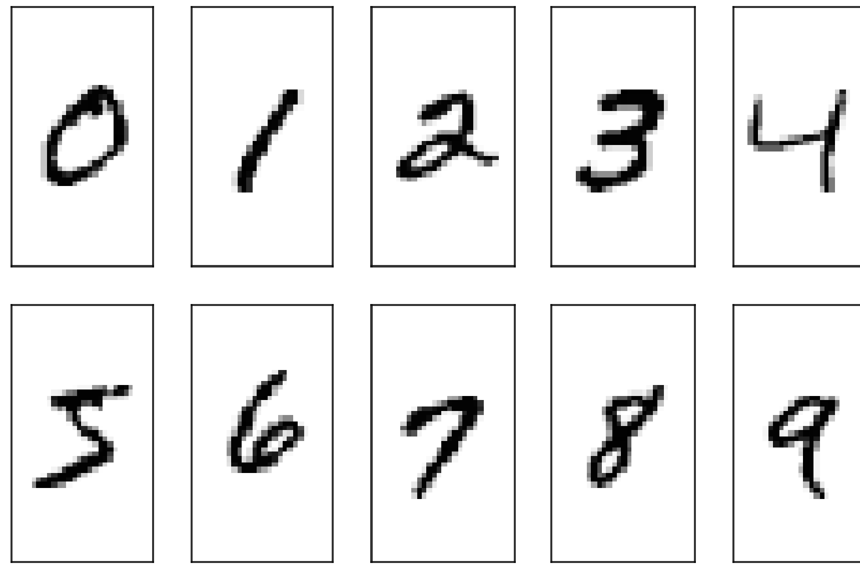
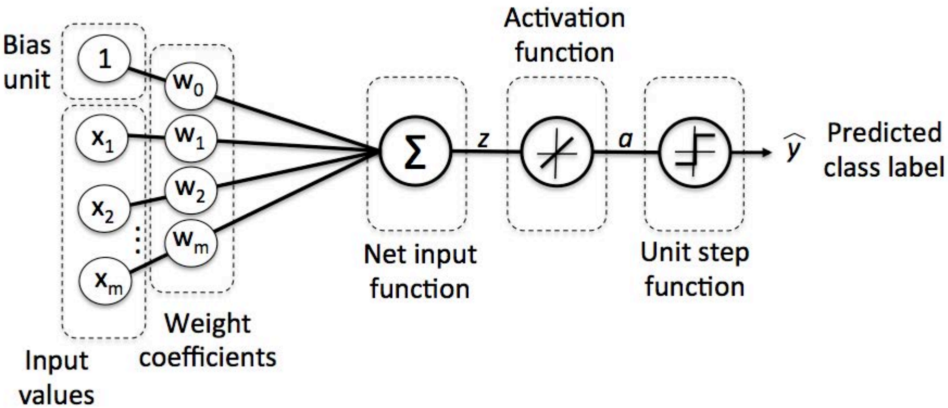
Neural Networks



Single Layer Recap

- Perceptron model
  - Unit step function
- Adaptive linear neuron
  - Activation function
- Input layer – output layer



Source: Raschka (2015).

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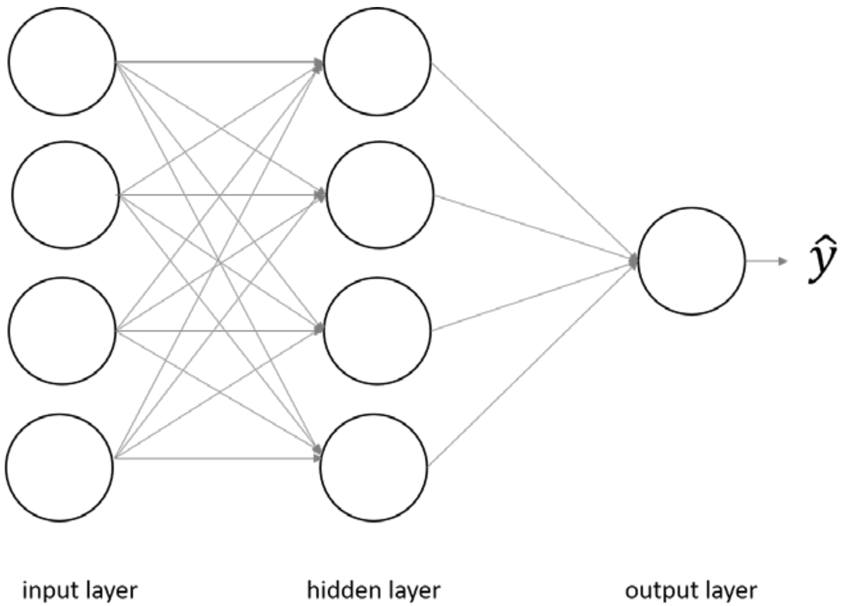
Multilayer Introduction

- Hidden layer fully connected to input layer

- Output layer fully connected to hidden layer

- Multiple hidden layers

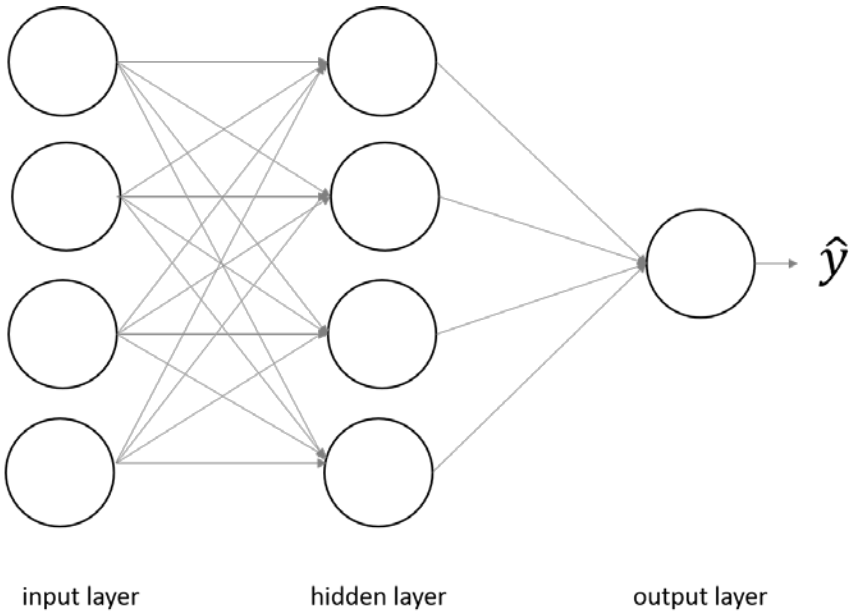


Source: Adapted from Raschka (2015).

Multilayer Perceptrons

- Feedforward

- Hidden layers
  - Linear units
  - Rectified linear units
  - Logistic sigmoid
  - Softmax



Source: Adapted from Raschka (2015).

Propagation

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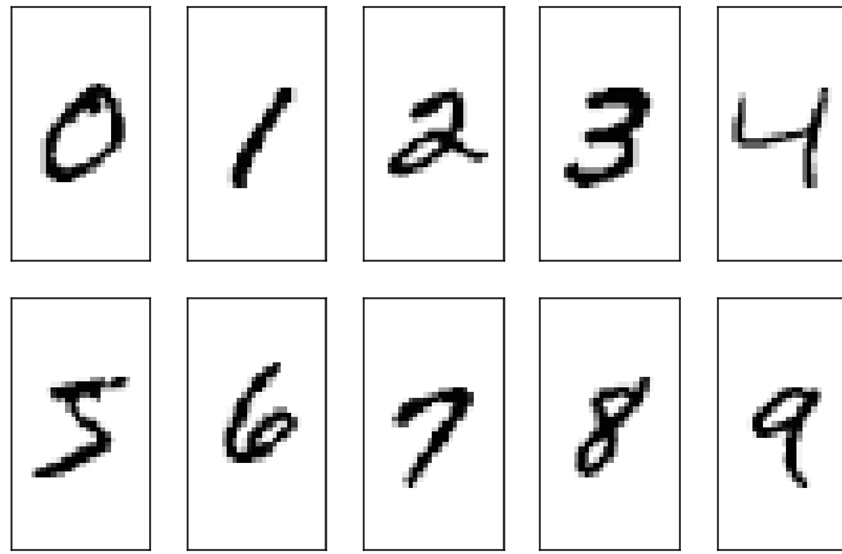
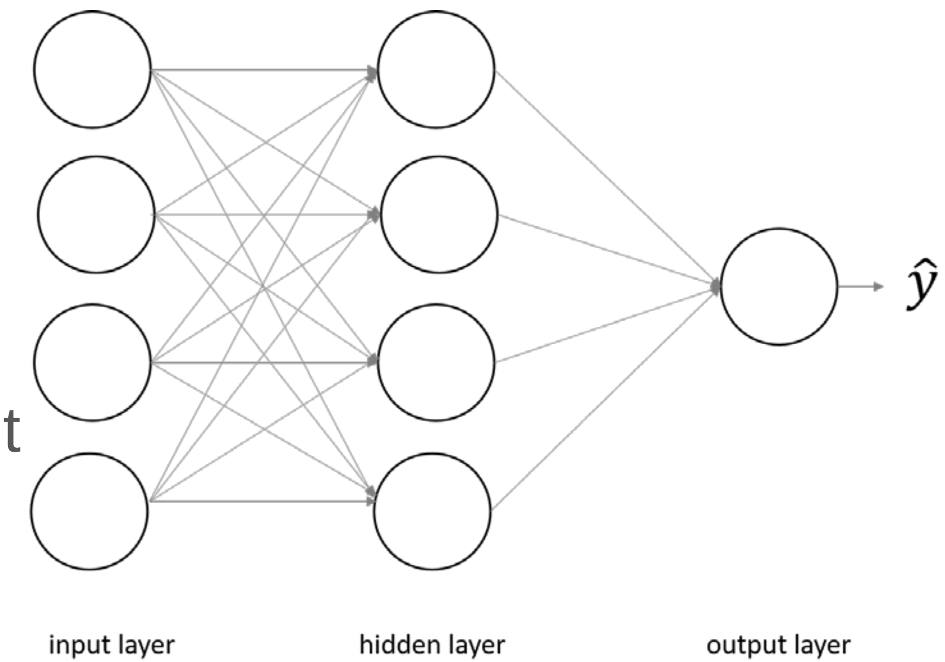
Neural Networks



Forward Propagation

- Start at input layer
- Forward propagate patterns
- Calculate error
- Calculate network output
- Threshold function

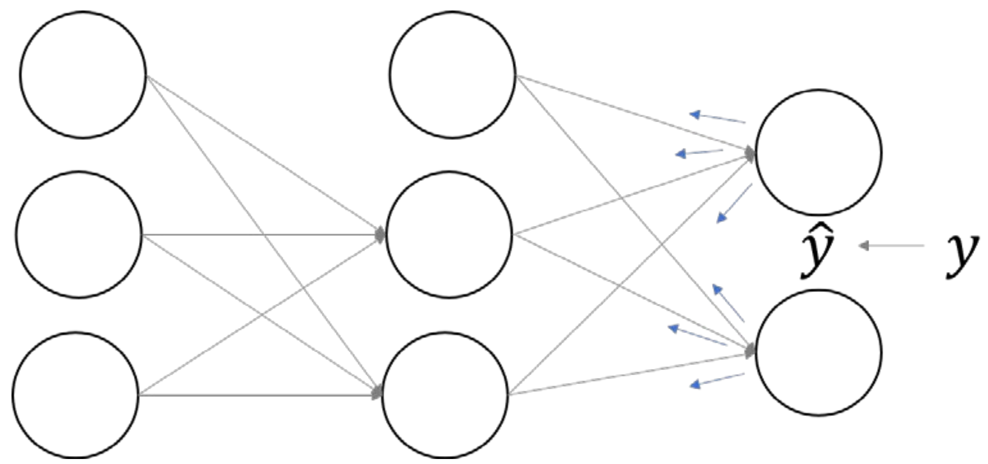


Source: Adapted from Raschka (2015).

Back Propagation

- Computationally efficient

- Matrix – vector computation



Source: Adapted from Raschka (2015).

Templating

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Neural Networks

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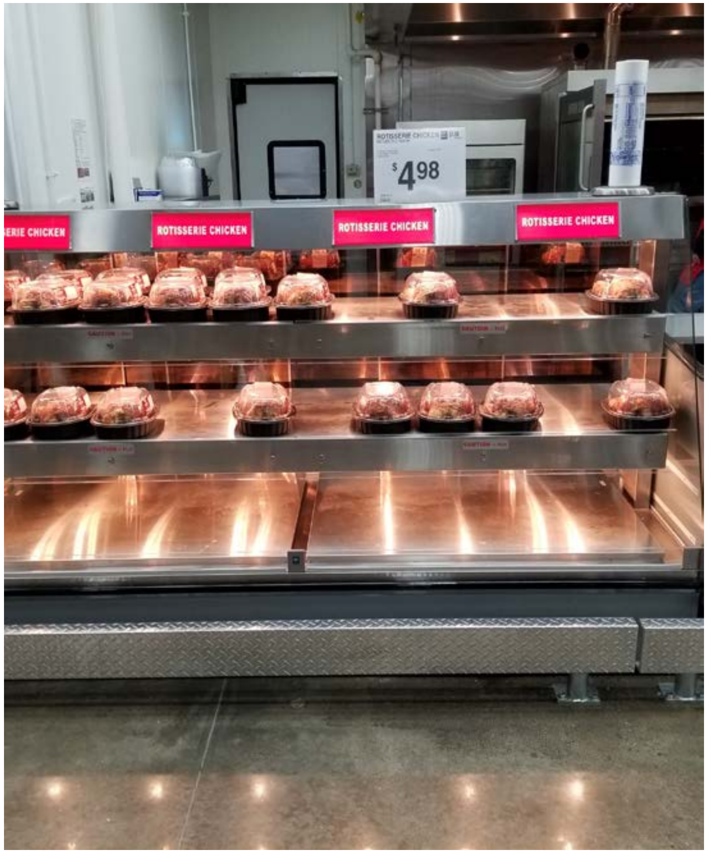
Template Matching

- Given a template image
- Match within larger image
- OpenCV based



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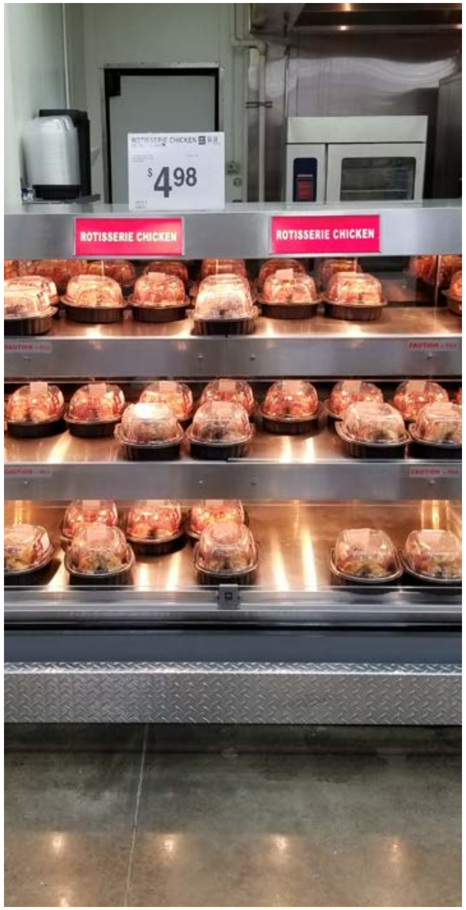
Methods

- CCOEFF
- CCOEFF Normed
- CCORR
- CCORR Normed
- SQDIFF
- SQDIFF Normed



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Limitations

- Requires similar scale
- Requires similar rotation
- Finds area with “most” correlation
- Not optimal for counting ☺