Statistical Methods in Artificial Intelligence
CSE471 - Monsoon 2016 : Lecture 06

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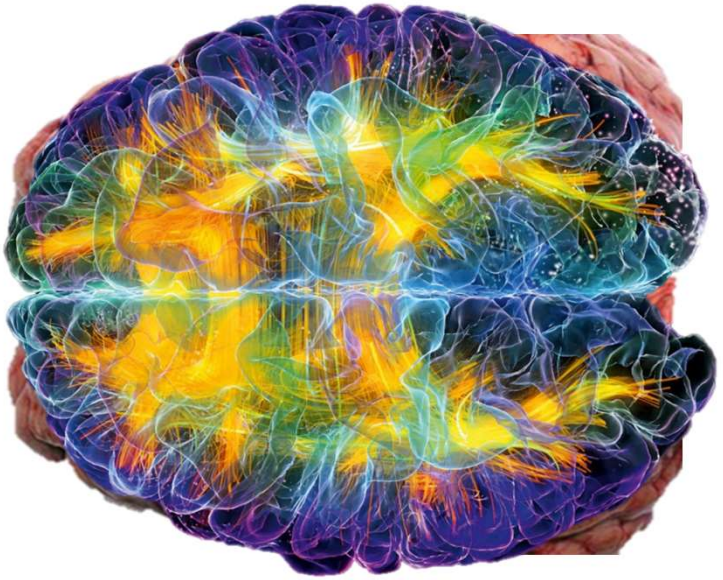
Lecture 06: Plan

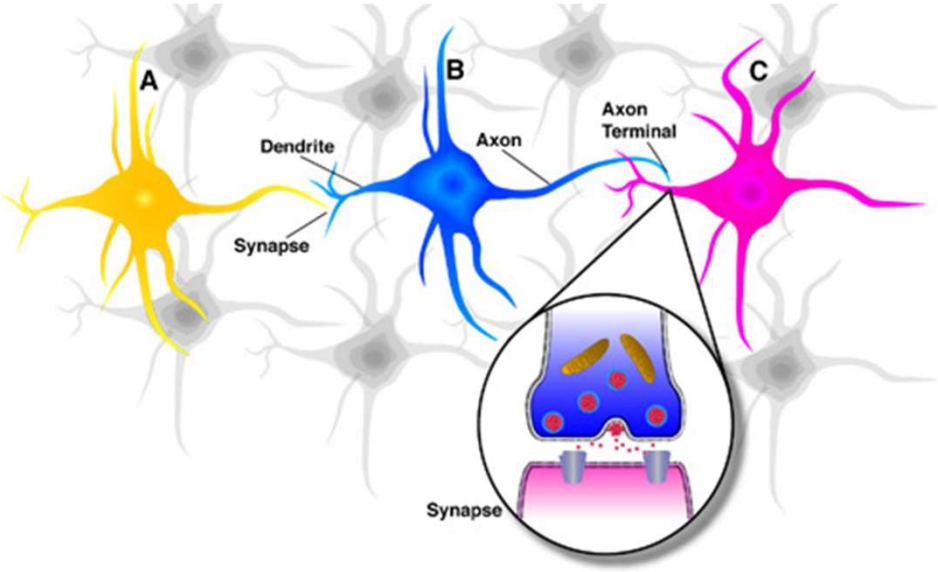
- Introduction to Neural Networks (NN)
- Construction of NN Classifier
- Feed Forward Operation in NN
- Modelling Non-Linearity with NN
- Understanding Backpropagation
- Backpropagation Derivation

Introduction to Neural Networks

Motivation from Biology

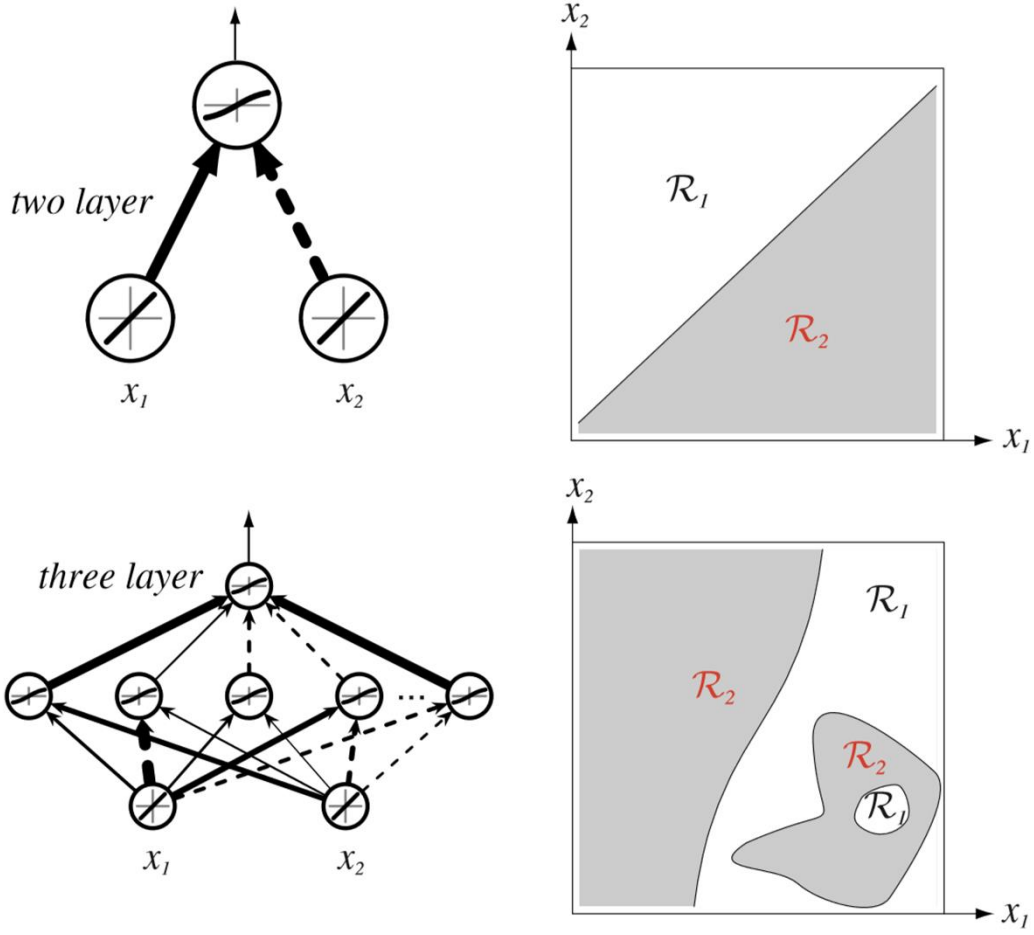


- Brain is the key component in our body as it enables learning.
- It has a collection of about 10 billion interconnected **neurons**.
- A neuron receives input from other neurons (generally thousands) from its **synapses**
- Inputs are approximately summed
- Once the this sum exceeds a threshold the neuron sends an electrical spike that travels through the axon to the next neuron(s)



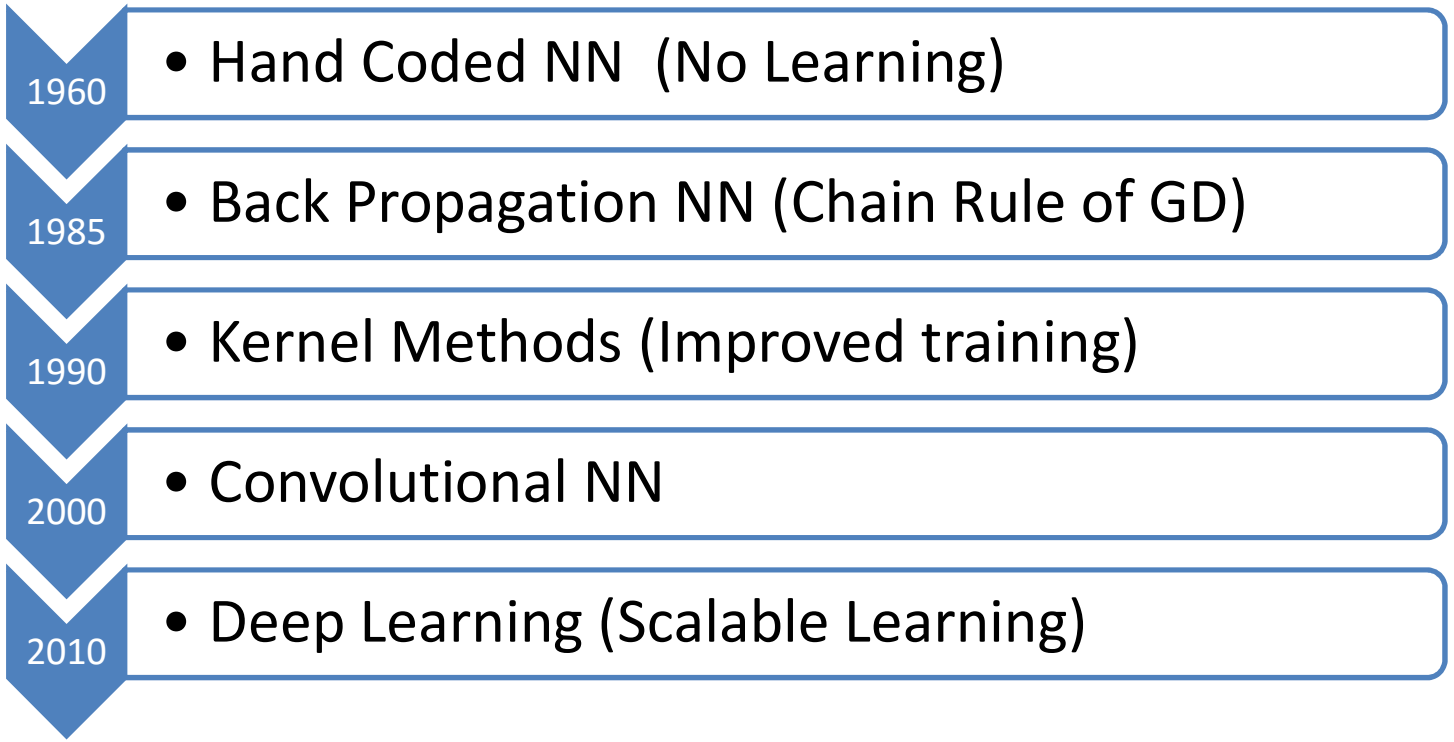
Introduction to Neural Networks

- Natural Extension of LDF (Perceptron) for Non-linear classification



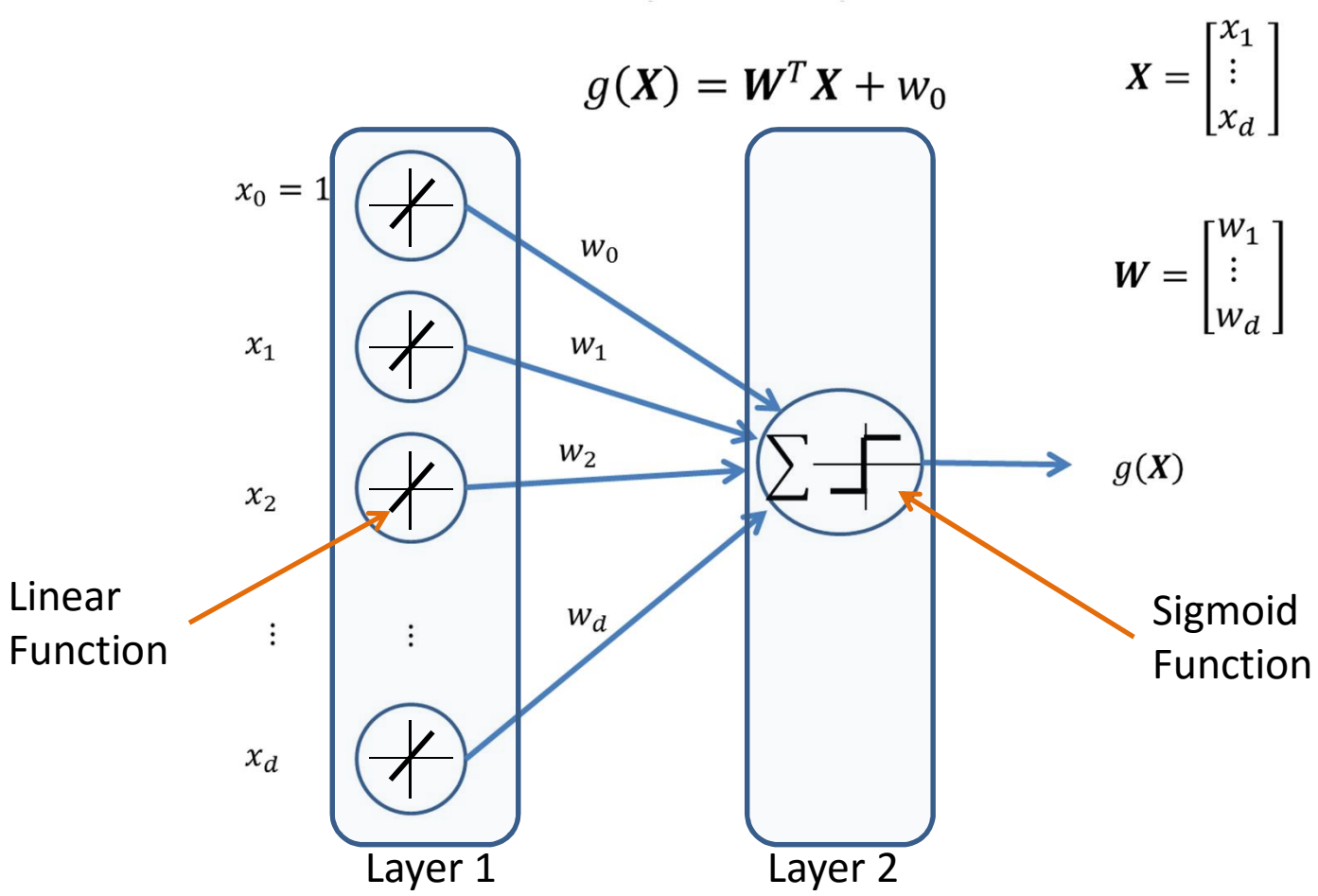
Introduction to Neural Networks

- Natural Extension of LDF (Perceptron) for Non-linear classification
- Temporal History



Construction of NN Classifier

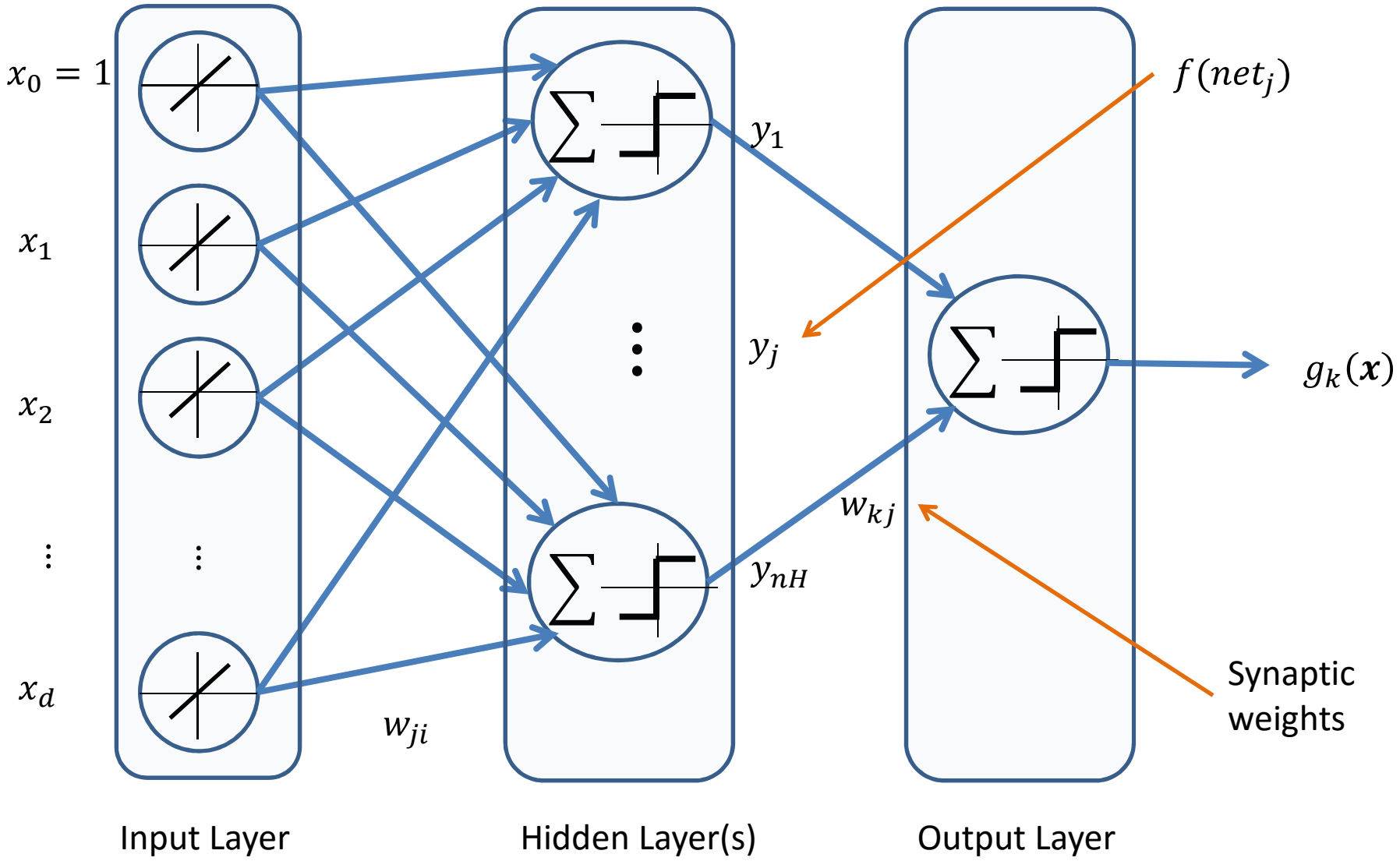
- Construction of a Two Layer Neural Network



Construction of NN Classifier

- Hidden Layer
- Bias Unit
- Neuron
- Net Activation
- Synapses/ Synaptic Weights
- Activation Function

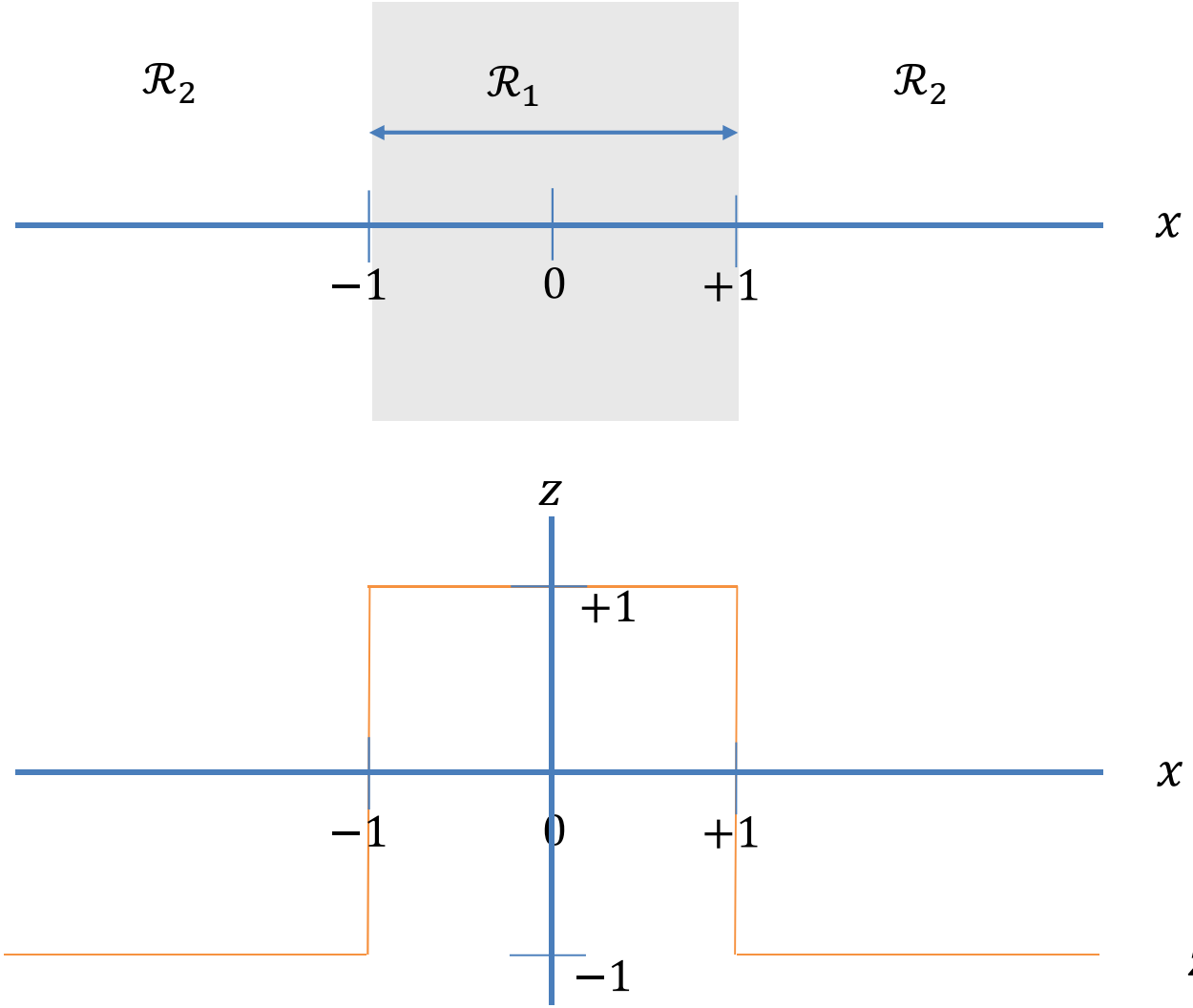
Construction of NN Classifier



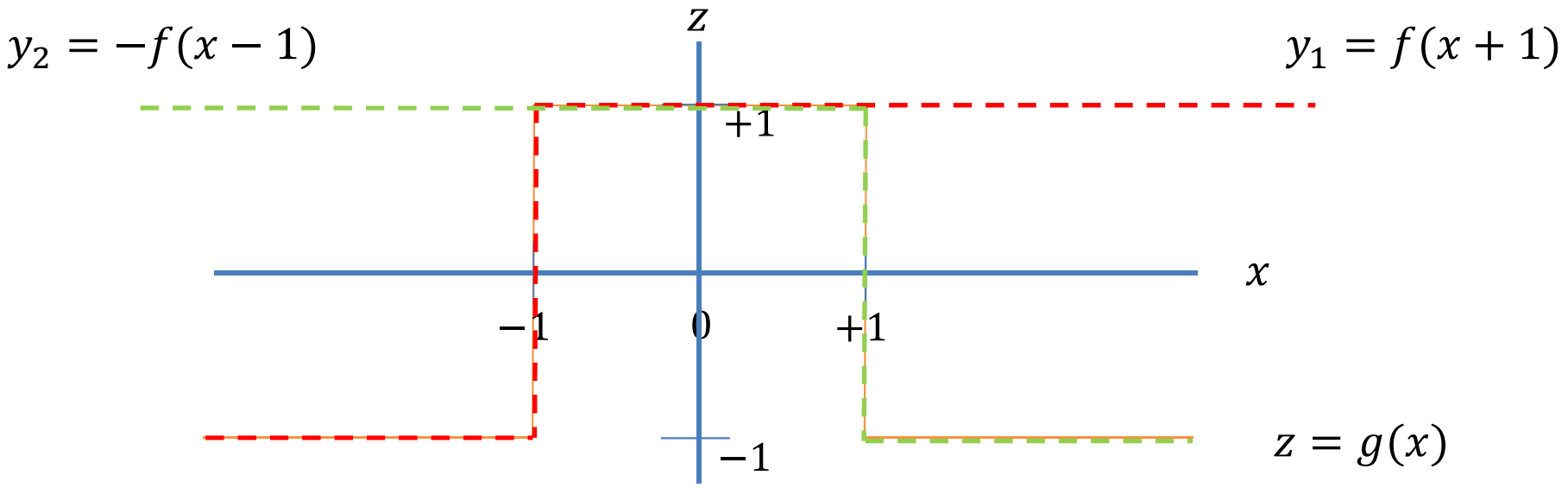
Feed Forward Operation in NN

- $net_j = \sum_{i=1}^{d} x_i w_{ji} + w_{j0} = \sum_{i=0}^{d} x_i w_{ji} = \mathbf{w}^T{}_j \mathbf{x}$
- $y_j = f(net_j)$
- $y_j = sgn(net_j)$
- $net_k = \sum_{j=1}^{nH} y_j w_{kj} + w_{k0} = \sum_{j=0}^{nH} y_j w_{kj} = \mathbf{w}^T{}_k y$
- $z_k = f(net_k) = sgn(net_k)$
- $g_k(\mathbf{x}) = z_k = \sum_{j=1}^{nH} w_{kj} f(\sum_{i=1}^{d} x_i w_{ji} + w_{j0}) + w_{k0}$

Modelling the Non-linearity



Modelling the Non-linearity

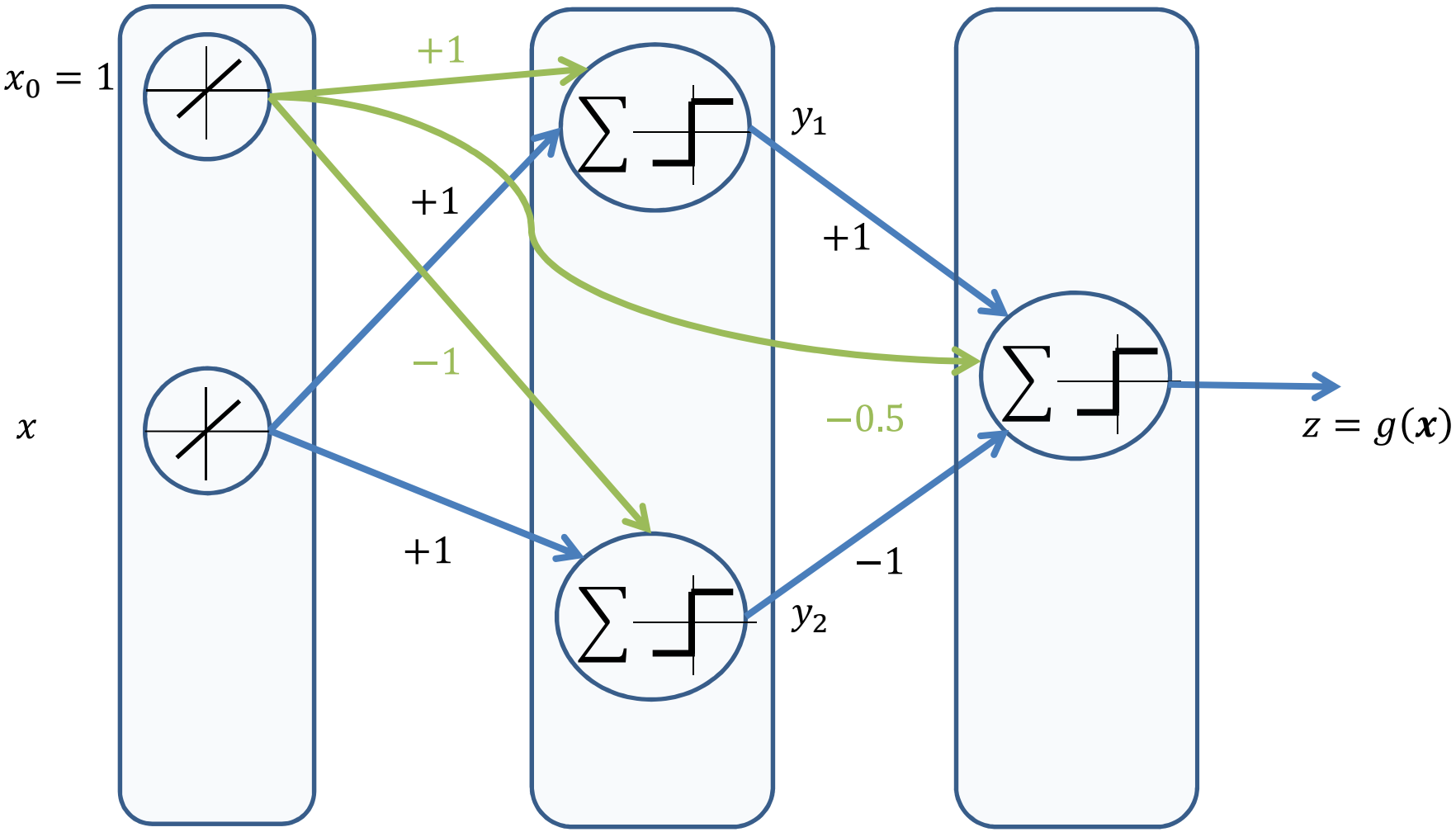


$$y_1 = sgn(w * x + b) \qquad w = 1, b = +1$$

$$y_2 = sgn(w * x + b) \qquad w = 1, b = -1$$

$$z = g(x) = sgn(w_1 y_1 + w_2 y_2 + b) \qquad w_1 = +1, w_2 = -1, b = -0.5$$

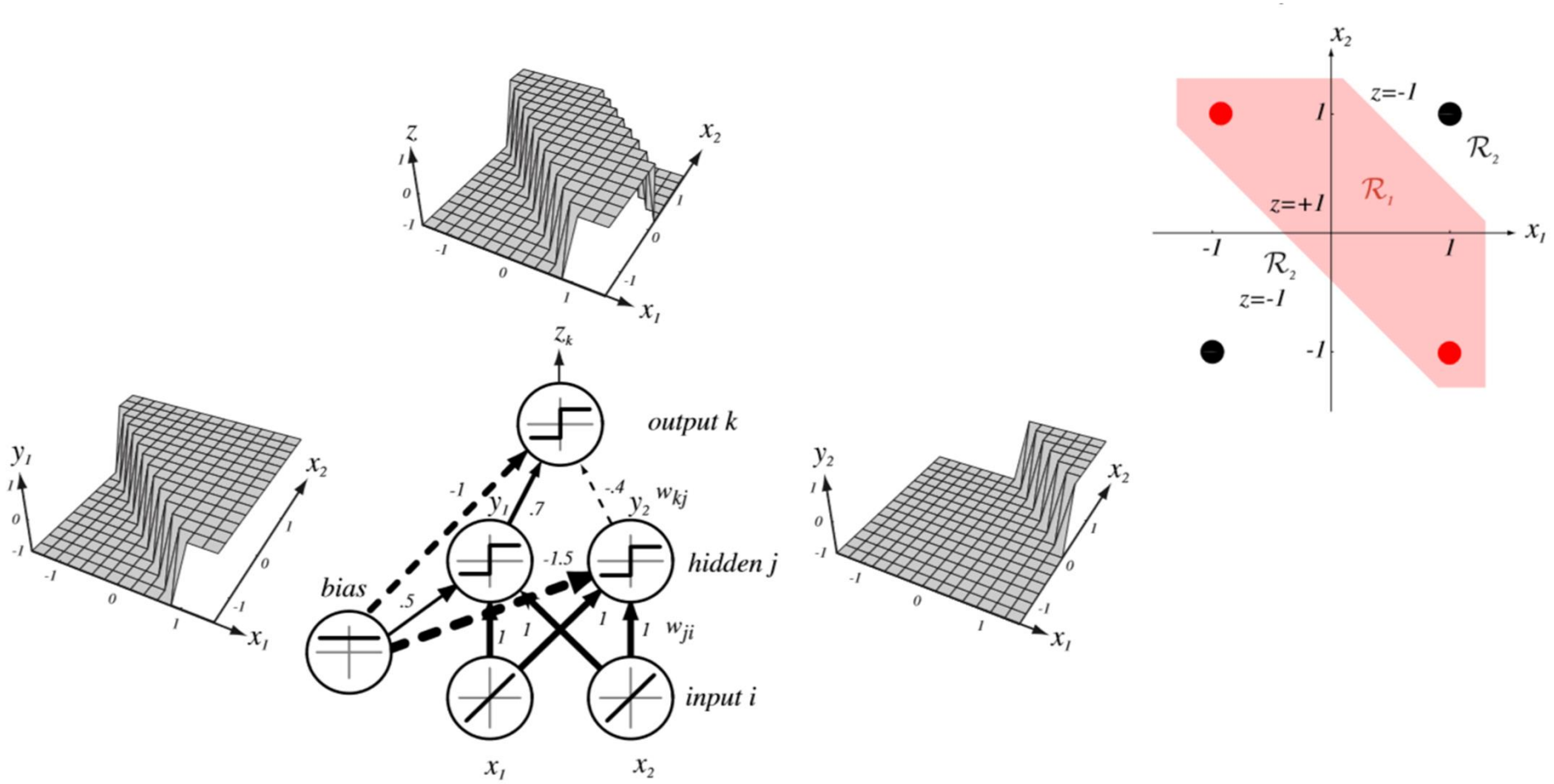
Modelling the Non-linearity



Modelling the Non-linearity

x	$net_{j=1}$	$net_{j=2}$	y_1	y_2	$net_{k=1}$	z
+2	+3.0	+1.0	+1	+1	-0.5	-1
+1.2	+2.2	+0.2	+1	+1	-0.5	-1
+0.5	+1.5	-0.5	+1	-1	+1.5	+1
0	+1.0	-1.0	+1	-1	+1.5	+1
-0.5	+0.5	-1.5	+1	-1	+1.5	+1
-1.2	-0.2	-2.2	-1	-1	-0.5	-1
-2	-1.0	-3.0	-1	-1	-0.5	-1

Modelling the Non-linearity



Understanding Backpropagation