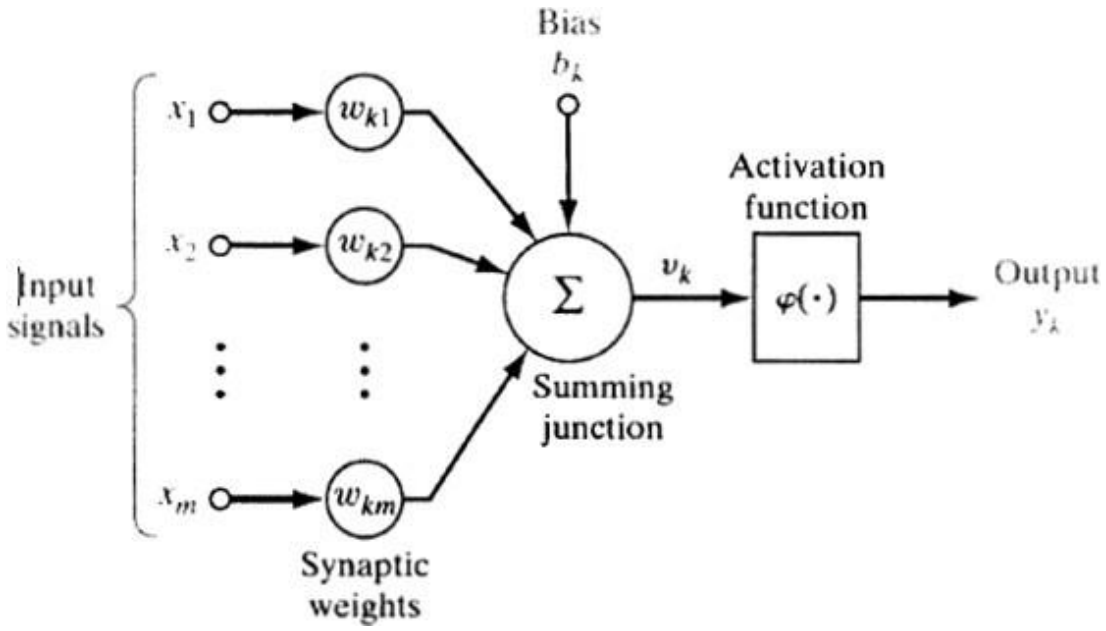
IT2011 - Artificial Intelligence and Machine Learning

Department of Information Technology, Faculty of Computing

Year 2 semester 1 (2025)

Tutorial 07

A perceptron is shown in the following Figure



1. What is the role of the synaptic weights ($w_{k1}, w_{k2}, \ldots, w_{km}$) in this model?
2. Why is the bias (b_k) included in the summing junction? What would happen if it were removed?
3. Explain the function of the activation function $\varphi(\cdot)$. Why do we need it instead of passing the summation directly as output? (If the activation function were removed, i.e., identity function, what kind of model would this neuron represent?)
4. What happens if all weights are set to zero?
5. Considering the 3-dimensional input signal (X_1), the initial weight vector (W_1), the activation function and the bias given below, calculate the output v_k of the single neuron shown above.

$$\text{inputs: } x_1 = 1, \quad x_2 = 2, \quad x_3 = -1$$
$$\text{weights: } w_{k1} = 0.3, \quad w_{k2} = -0.5, \quad w_{k3} = 0.8$$
$$\text{bias: } b_k = 0.2$$

Calculate the net input v_k

6. If the activation function is sigmoid, what is the output and compute it approximately for v_k=0.8

7. If the learning rate is 0. 01 and the expected output is 1, demonstrate how the weight update can be done. You must clearly show all the steps in your calculation.

8. If the activation function is a step function output = 1 if $v_k \geq 0$, *otherwise*0), *compute thefinaloutput*y_k for the above example.

9. Why is this structure considered the building block of Artificial Neural Networks (ANNs)?

10. Using a suitable illustration, explain how the training of a Multilayer Perceptron happens with the back-propagation algorithm.