Neural networks - Problem solving sessions I

FER

November, 2022

Multilayer perceptron

- neuron models with nonlinear activation functions
- hidden layers
- training is based on **Error backpropagation learning algorithm**

Backpropagation algorithm summary

$$\Delta w_{ji}(n) = \eta \delta_j(n) y_i(n)$$

Neuron j is output neuron then:

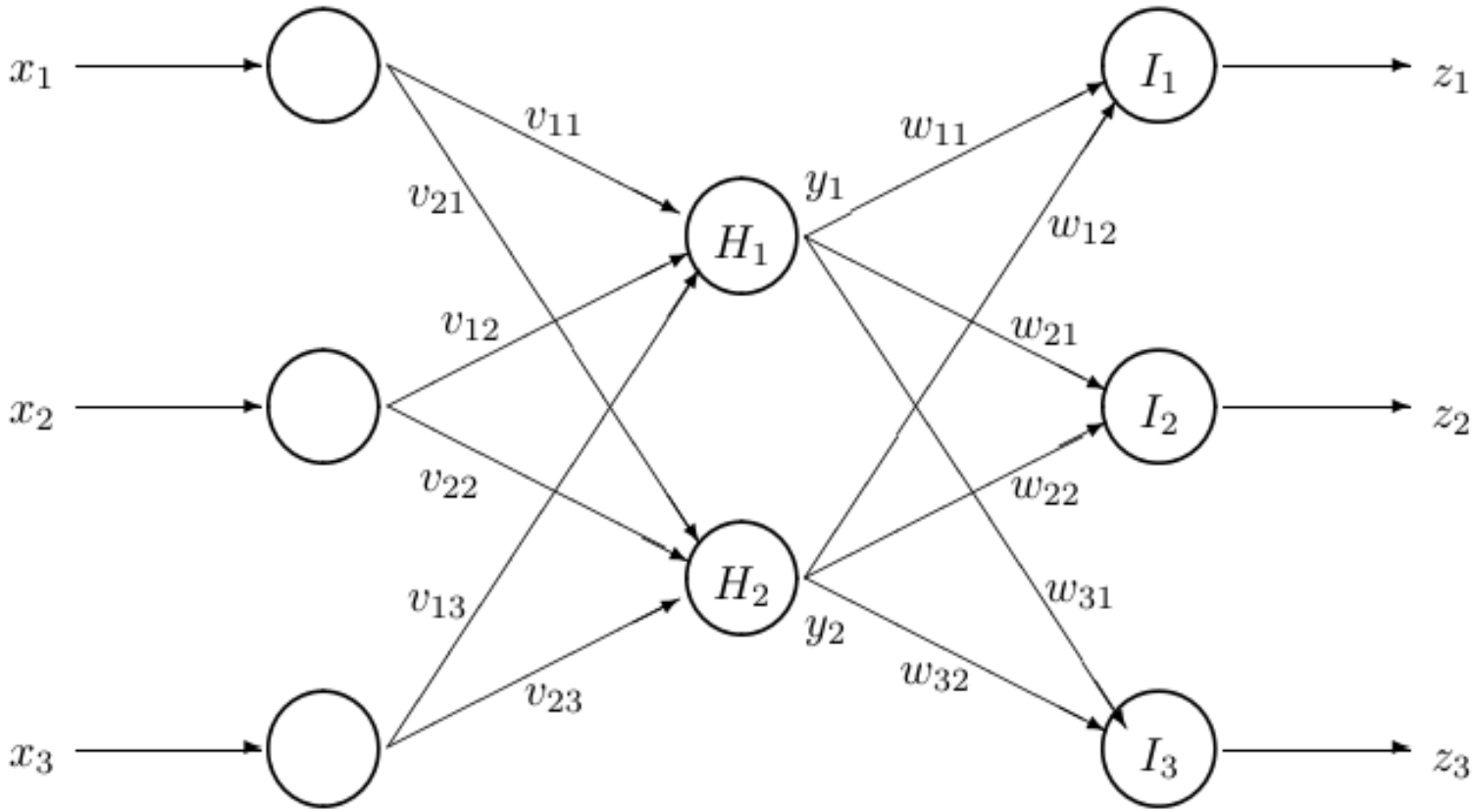
$$\delta_j(n) = \varphi_j'(v_j(n)) e_j(n)$$
$$e_j(n) = d_j(n) - y_j(n)$$

Neuron j is hidden neuron then:

$$\delta_j(n) = \varphi_j'(v_j(n)) \sum \delta_k(n) w_{kj}(n)$$

Example II: Forward pass

Our neural network:



Example II: Forward pass

a. After training the neural network, the following weight vectors are obtained:

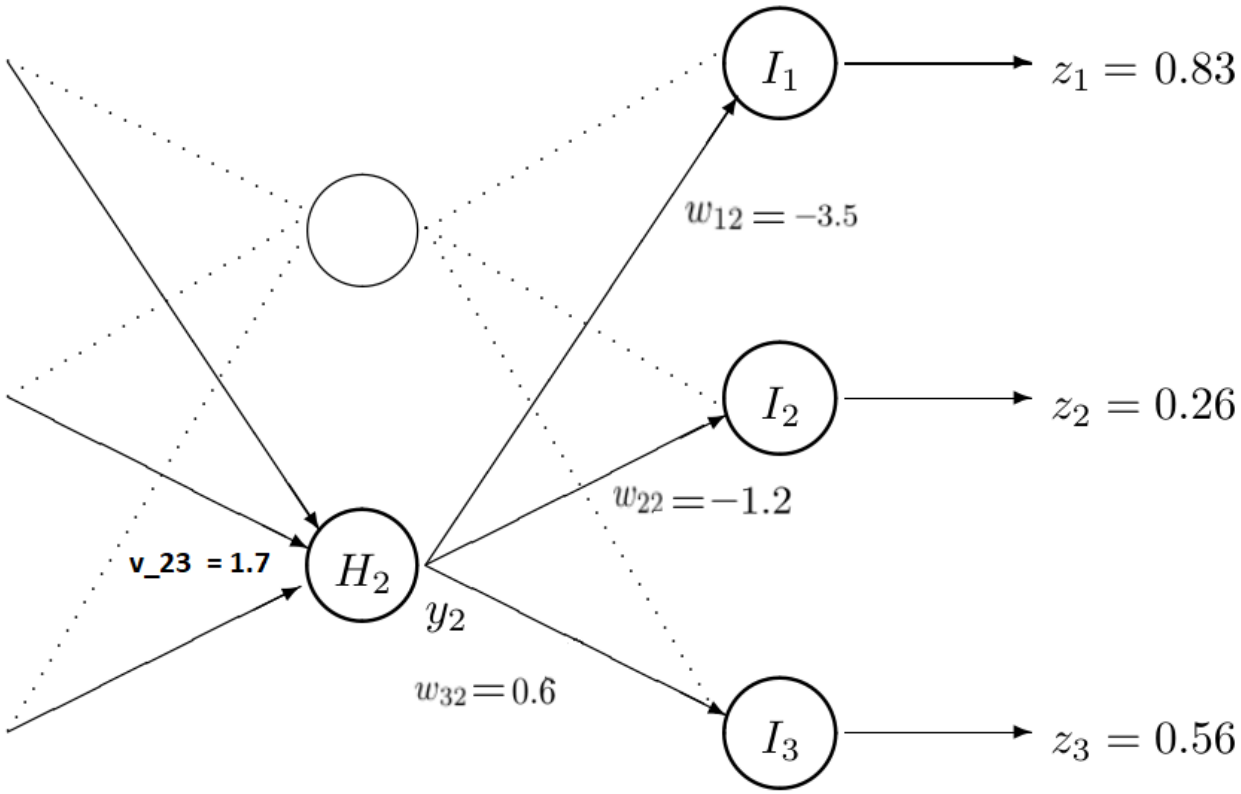
$$v_1 = \begin{bmatrix} -2.0 \\ 2.0 \\ -2.0 \end{bmatrix}; v_2 = \begin{bmatrix} 1.0 \\ 1.0 \\ -1.0 \end{bmatrix}$$

$$w_1 = \begin{bmatrix} -1.0 \\ -3.5 \end{bmatrix}; w_2 = \begin{bmatrix} 0.5 \\ -1.2 \end{bmatrix}; w_3 = \begin{bmatrix} -0.3 \\ 0.6 \end{bmatrix}$$

Assume that all neurons have sigmoid activation function and bias 0. Determine the vectors $y1$, $y2$, $z2$, if the input vector is given as: $\begin{bmatrix} 1 & 1 & 0 \end{bmatrix}^T$.

Example II: Backward pass

Let observe a part of the previous neural network.



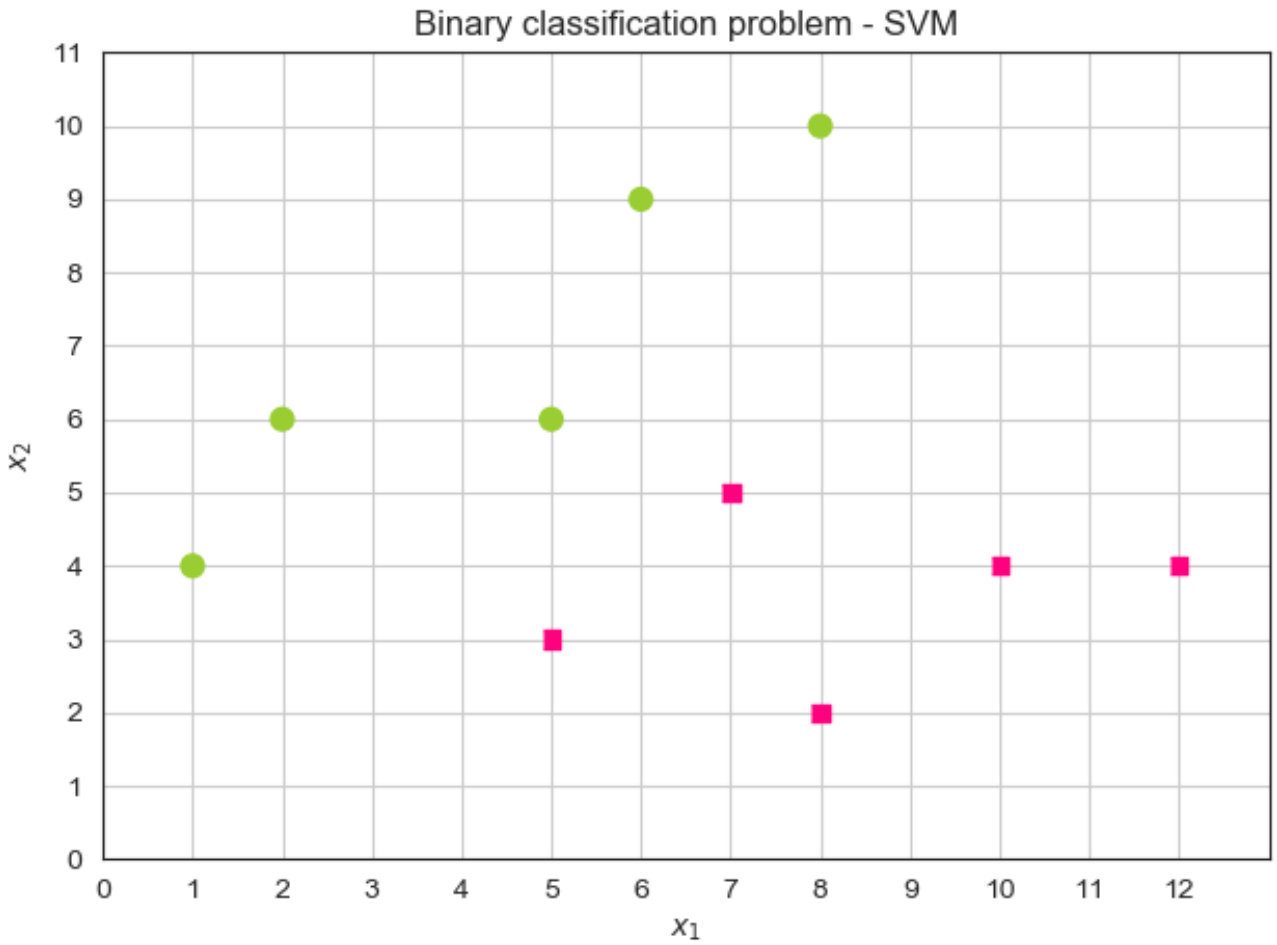
Example II: Backward pass

The vectors z_1, z_2, z_3 denote the outputs of the neural network. a Determine updated weights w_{12}, w_{22}, w_{32} after one step of applying delta rule learning if the desired outputs are $t = \left[0.58, 0.26, 0.56\right]^T$, the input is $y_2 = 0.5$ and the learning rate is 0.05.

Support vector machines

- support vector
- separation margin
- dual problem
- Lagrange multiplicators
- Mercer's theorem
- Kernel functions and the kernel trick

Example IV: Support vector machine



Example IV: Support vector machine

a. Find the separation plane equation as found by the SVM algorithm.
b. Calculate the separation margin.
c. Will the separation plane equation change if we remove the point (5, 6) from the dataset? Why?