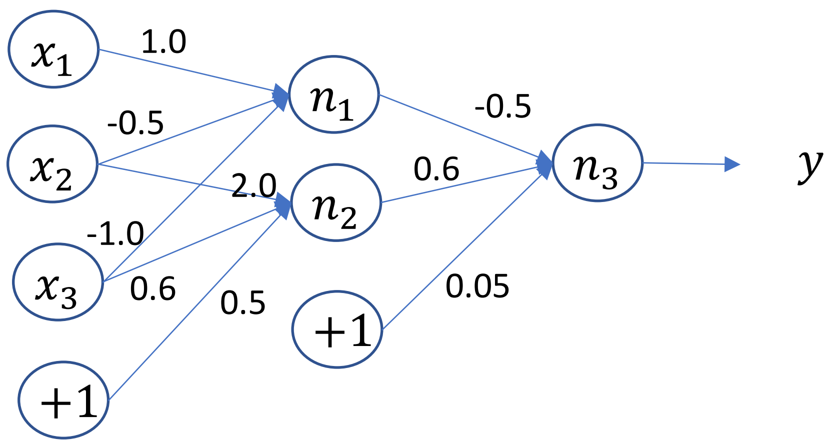

Figure 1

1. Figure 1 shows a two-layer feedforward neural network receiving 3-dimensional inputs $(x_1, x_2, x_3) \in \boldsymbol{R}^3$. The connection weights and biases of the neurons $n_1, n_2,$ and n_3 are as indicated in the figure. The hidden-layer neurons have activation functions given by $g(u) = \frac{1.0}{1+e^{-0.5u}}$ where u denotes the synaptic input to the neuron. The activation function $f(u)$ of the output neuron is a ReLU function: $f(u) = \max\{0, u\}$.

   a. Write weight vectors and biases connected to individual neurons, and the weight matrix and bias vector connected to the hidden layer.

   b. Find the synaptic inputs and activations of the neurons for the following input signals:

   (i) (1.0, –0.5, 1.0) (ii) (-1.0, 0.0, –2.0) (iii) (2.0, 0.5, –1.0).

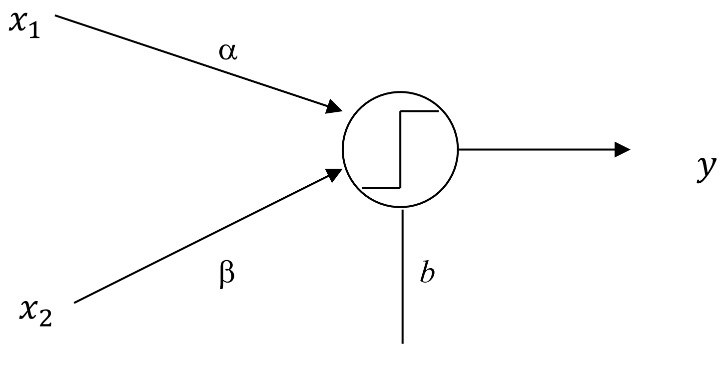

Figure 2

2. Two input binary neuron shown in figure 2 has a unit step activation function with a bias $b = 0.5$ and receives two-dimensional input $(x_1, x_2) \in \boldsymbol{R}^2$.

   (a) Find the space of possible values of weights (α, β) if the neuron is
   (i) ON for input (1.0, 1.0)
   (ii) ON for input (0.5, -1.0)
   (iii) OFF for input (2.0, -0.5).

   (b) Indicate the weight space in 2-D α-β plot and show that (-0.2, 0.2) is in this space.

$\geq 0 \Rightarrow 1$
$\leq 0 \Rightarrow 0$

3. The network shown in figure 3 consists of neurons having threshold activation functions and receives three-bit binary patterns $(x_1, x_2, x_3) \in \{0,1\}^3$. By analyzing the outputs for all possible three-bit input patterns, determine the logic function that the network implements. All unlabeled weights shown in figure 3 are of unity weight.

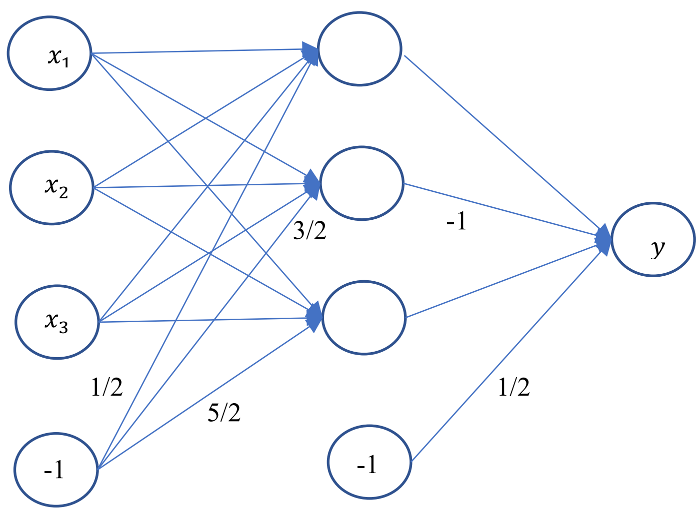

Figure 3