Solution

- Starting point: $w = [0 \ 0 \ 0]$, $b = 0$

- Training:
  
  iteration 1:
  applying ex.1: $p_1 = [1 \ 0 \ 0]^T$, $t_1 = 1$
  $a = \text{hardlim}([0 \ 0 \ 0][1 \ 0 \ 0]^T + 0) = \text{hardlim}(0) = 1$
  $e = t_1 - a = 1 - 1 = 0$
  $w_{\text{new}} = [0 \ 0 \ 0] + 0[1 \ 0 \ 0]^T = [0 \ 0 \ 0]$
  $b_{\text{new}} = 0 + 0 = 0$,
  i.e. no change in $w$ and $b$ as $e = 0$

  iteration 2:
  applying ex.2: $p_2 = [0 \ 1 \ 1]^T$, $t_2 = 0$
  $a = \text{hardlim}([0 \ 0 \ 0][0 \ 1 \ 1]^T + 0) = \text{hardlim}(0) = 1$
  $e = t_2 - a = 0 - 1 = -1$
  $w_{\text{new}} = [0 \ 0 \ 0] + (-1)[0 \ 1 \ 1]^T = [0 \ -1 \ -1]$
  $b_{\text{new}} = 0 + (-1) = -1$
  i.e. $w$ an $b$ have been updated

Solution – cont.

- Similarly:
  
  end of iteration 3: $w_{\text{new}} = [1 \ 0 \ -1]$, $b_{\text{new}} = 0$
  end of iteration 4: $w_{\text{new}} = [0 \ -1 \ -2]$, $b_{\text{new}} = -1$
  end of iteration 5: no change
  end of iteration 6: $w_{\text{new}} = [1 \ -1 \ -1]$, $b_{\text{new}} = 0$
  end of epoch 1

- Check if the stopping criteria is satisfied - each training example is applied to check if it is correctly classified:
  
  applying ex.1: $p_1 = [1 \ 0 \ 0]^T$, $t_1 = 1$
  $a = \text{hardlim}([1 \ -1 \ -1][1 \ 0 \ 0]^T + 0) = \text{hardlim}(0) = 1$ – correct
  applying ex.2: $p_2 = [0 \ 1 \ 1]^T$, $t_2 = 0$
  $a = \text{hardlim}([1 \ -1 \ -1][0 \ 1 \ 1]^T + 0) = \text{hardlim}(-2) = 0$ – correct
  Similarly for ex.3, 4, 5 and 6 – all are correctly classified => end of training

- 1 epoch was needed to train the perceptron. The training set is linearly separable as the perceptron was able to learn to separate it.