Statistical Machine Learning
Assignment 4

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The entire code listing is included in the zip-file. The listings shown here are merely code snippets.

1 Neural networks

1. Since all the weights have the same update function, if all the weights are 0, after the updates they will still remain the same as the other weights. This way you don't break the symmetry when backpropagating.

2. First, we take the weighted sum of the input x:

$$a_j = \sum_i w_{ji} x_i + b_3^{(1)} x_0$$
$$a_1 = w_{11} \cdot x_1 + b_{31} \cdot x_0 = 0.5 + 1 = 1.5$$
$$a_2 = w_{21} \cdot x_1 + b_{32} \cdot x_0 = 0.05 + 0 = 0.05$$
$$a_3 = w_{31} \cdot x_1 + b_{33} \cdot x_0 = -0.5 + 1 = 0.5$$

   Where the input x_i given in the assignment $\in \{x_1, t_1\} = \{0.5, 0.25\}$, and w_{ji} is also given $\in w^{(1)} = [1, 0.1, -1]$. Now we calculate the activation z_j of unit j:

$$z_j = h(a_j) = \tanh(a_j) = \frac{e^{a_j} - e^{-a_j}}{e^{a_j} + e^{-a_j}}$$
$$z_1 = \tanh(1.5) = 0.90515$$
$$z_2 = \tanh(0.05) = 0.04996$$
$$z_3 = \tanh(0.5) = 0.46212$$

   Then, we calculate the output using the linear activation function given in the assignment:

$$\begin{aligned} y &= \sum_j w_j^{(2)} z_j + b_1^{(2)} \\ &= w_1^{(2)} z_1 + w_2^{(2)} z_2 + w_3^{(2)} z_3 + b_1^{(2)} \\ &= -1 \cdot 0.90515 + 0.1 \cdot 0.04996 + -1 \cdot 0.46212 + 2 \\ &= -0.90515 + 0.004996 - 0.46212 + 2 \\ &= 0.63773 \end{aligned}$$

   Second, we backpropagate the error $\delta = (y - t)$

3.

4.

2 Neural network regression

1.

3 EM and doping

1.

4 Handwritten digit recognition

1.