

MLISP: Machine Learning in Signal Processing

Problem set 5

Prof. V. I. Morgenshtern

Problem 1:

Lecture notes to Lecture 20, problem 1-1

Problem 2:

Lecture notes to Lecture 20, problem 1-2

Problem 3:

Lecture notes to Lecture 20, problem 1-3

Problem 4:

Lecture notes to Lecture 20, problem 1-4

Problem 5:

Lecture notes to Lecture 21, problem 2-1

Problem 6:

Lecture notes to Lecture 21, problem 3-2

Problem 7:

Lecture notes to Lecture 21, problem 3-3

Problem 8:

Lecture notes to Lecture 21, problem 3-6

Problem 9: (optional)

Lecture notes to Lecture 22, problem 4-1

Problem 10: The back-propagation algorithm (exam practice)

Consider a fully connected neural network. Let a_j^l denote the output of the neuron j in layer l . Then the propagation of information in the network from layer $l - 1$ to layer l is described by the equation:

$$a_j^l = \sigma \left(\sum_k w_{jk}^l a_k^{l-1} + b_j^l \right)$$

where b_j^l is the bias of the neuron j in layer l , w_{jk}^l is the weight from neuron k in layer $l - 1$ to neuron j at layer l , and $\sigma(z)$ is the activation function.

1. What difficulty is caused by step activation functions such as

$$\sigma(z) = \begin{cases} 1, & z > 0 \\ 0, & z \leq 0 \end{cases}$$

for the back-propagation algorithm? Explain your answer.

2. What is the main difficulty in training deep neural networks using the back-propagation algorithm. Explain your answer.