November 17, 2025

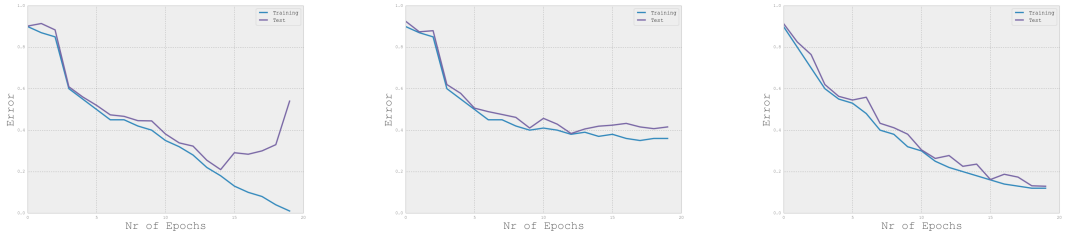
Faculty of Computer Science, Heinrich-Heine-University Düsseldorf

Deep Learning

Winter term 25/26 – Exercise Sheet 5

Submission Deadline: Monday, November 24, 2025, 2:00 PM

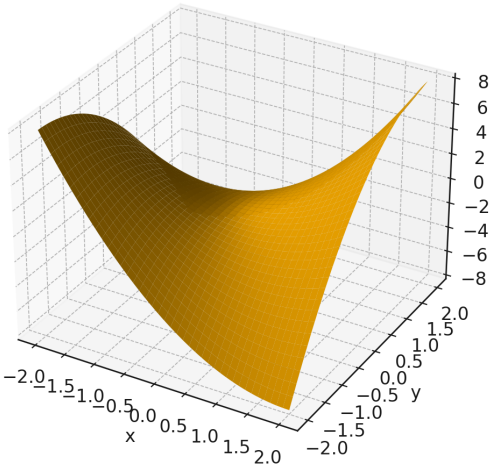
1. **Underfitting and Overfitting** (6P)
   a) What are underfitting and overfitting? (2P)
   b) What is bias-variance tradeoff? (2P)
   c) You are training three classifiers on a training set. The plots in Figure 1 show the evolution of their classification error on training and test set during training. Do the models underfit, overfit or model the data well? (2P)



(a) Model 1 (b) Model 2 (c) Model 3

Figure 1: Training and test error over the course of training.

2. **Saddle point** (4P)
   Given the function $f(x_1, x_2) = x_1^2 + 2x_1x_2 - x_2^2$ calculate the critical point, the Hessian matrix H in it, the eigenvectors and eigenvalues of H, and interpret the results in terms of the curvature of the graph shown in the following figure.


8
6
4
2
0
−2
−4
−6
−8
−2.0
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0
x
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
−2.0
y