

DAIS2022: Assignment #4

Deep Learning

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Introduction

In this assignment, we want to get familiar with deep learning and its pitfalls. We will have a look at how we can train neural networks, possible problems and how we can evaluate trained classifiers.

The assignment has 100 points in total, distributed over the tasks. You need to get at least 50 points to pass this assignment.

1 Autodiff: 10 points

The computation of gradients is one of the core principles of deep learning. One of the more efficient algorithms for that purpose is reverse-mode autodiff, which is employed by all major deep learning frameworks like TensorFlow or PyTorch. In this task, we will try to follow along the steps of the algorithm and solve an example.

The task is modeled as a quiz and can be found on the moodle course of page or by clicking the following link: <https://lernen.min.uni-hamburg.de/mod/quiz/view.php?id=87099>

2 Activation Functions and Vanishing Gradients: 20 points

The gradient flow through neural networks is modulated by activation functions. Different activation functions can lead to differences in model performance and learning capabilities. Sometimes, the use of specific activation functions in combination with certain architectural choices can lead to problems. One such problem, that will be explored, is the vanishing gradient problem. Please do all the tasks specified in the attached Jupyter notebook *ActivationFunctions.ipynb*.

3 Classifier Evaluation: 20 points

This task presents you with the first steps in PyTorch, a deep learning framework popular in research and industry. We already implemented a model to predict different types of wines. It is up to you to properly evaluate the model's performance in order to judge its actual prediction performance. Please do all the tasks specified in the attached Jupyter notebook *Evaluation.ipynb*.

4 CIFAR10REC: 50 points

This task presents you the Cifar10 dataset. The provided notebook contains code that is almost complete for creating and training a deep neural network that performs a complex visual recognition task

(recognising different objects!). Please do all the tasks specified in the attached Jupyter notebook *CIFAR10REC.ipynb*. The main challenge here is to build and train a performant Multi-Layer Perceptron (MLP). A model with at least 50% test accuracy is suggested.

5 CNNs (Task 4.6): 30 points (Bonus)

This task presents you a more sophisticated architecture to recognize objects. The main challenge here is again to build and train a performant Convolutional Neural Network (CNN) and compare it against your old MLP. Please do all the tasks specified in the attached Jupyter notebook *CIFAR10REC.ipynb*.

6 Next Assignment

Now that you have gained some insights into supervised learning, we will proceed with another learning strategy: ensemble and reinforcement learning. Therefore, refresh yourself with following topics:

- Bagging and Boosting in ensemble Learning
- Markov Decision Process (MDP), Estimation of Return (maximum accumulated future reward), Action Selection, TD-learning and SARSA Algorithm in reinforcement