Practical Work 03 – 07/03/2024
Model Selection

Objectives

The main objectives of this Practical Work for Week 3 are the following :

a) Play through an example of overfitting and determine the optimal model complexity.

b) Use an MLP model for classifiying Fashion MNIST images. Build the model in pytorch with one hidden layer with 200 units. Verify that you can transition from the overfitting regime (starting training with just a single batch of 64 samples) to a regime with better generalisation by increasing the number batches used for training.

c) Evaluate MLPs with different number of layers and units per layer for FashionMNIST image classification. Identify an MLP for which you obtain optimal validation performance (accuracy), on the full training dataset, without using regularisation.

d) Evaluate whether you can gain performance (accuracy) by tuning the complexity and regularisation (dropout, L2).

Submission

— **Deadline** : Wednesday 20 March, noon

— **Format** : Jupyter notebooks including comments and results. For the solution of Exercises 2-4, you will use one single notebook.

— Please **only one submission per group** - with a clear indication of the group id, the names of the participants.

Exercise 1   Optional : Bias-Variance Tradeoff

Evaluate the bias and variance error for the polynomial models as presented in the lecture. Follow the instruction in the notebook `overfitting_polynomial_stud.ipynb`

Exercise 2   Evaluation of an MLP for Fashion MNIST with Increasing Training Set

In this exercise (as in the two subsequent exercises), you will build an MLP for Fashion MNIST classification. As a first step, you will train an MLP with a single hidden layer with only one single batch (batchsize 32). This is a good test indicating whether you have properly implemented the model. Then, gradually increase the training set and see whether you will arrive in a situation where there is no longer overfitting. Use the notebook `mlps_for_fashion_MNIST_stud.ipynb` (Exercise 2.) that provides the skeleton for the exercise and some additional details.

Exercise 3   Evaluation of an MLP for Fashion MNIST with Different Model Complexities

Continue from the previous exercise - but now playing with different model complexities while using the full training data. Again use the notebook `mlps_for_fashion_MNIST_stud.ipynb` (here, Exercise 3.) that provides the skeleton for the exercise and some additional details.

Exercise 4   Evaluation of an MLP for Fashion MNIST with Different Model Complexities and with Regularisation

Continue from the previous exercise - but now adding regularisation. Interesting are particularly the cases of the previous exercise where you could observe overfitting. Try to tune the complexity of the model and regularisation parameters to obtain a best MLP model. Again use the notebook `mlps_for_fashion_MNIST_stud.ipynb` (here, Exercise 4.) that provides the skeleton for the exercise and some additional details.

Exercise 5   Optional : Review Questions

a) Explain the terms bias and variance. What are the factors that make the bias larger or how can it be made smaller ? What factors lead to a large variance or how can it be reduced ?

b) Why is the training error an increasing function of the split ratio (fraction of samples used for training) ? Why is the validation error a decreasing function of the split ratio ?

c) What is understood under the phenomenon of "deep double decent" ?

d) What is the goal of regularisation in deep learning ?

e) Mention 4 regularisation method.