Python - Backpropagation in neural networks

Course code: PYTHON_ML_BP

Backpropagation is a learning algorithm in neural networks that is used to adapt the weights in the network to minimize the prediction error at the output of the network.The backpropagation process consists of two main steps. The first step is forward propagation, which consists in the fact that the input data is sent through the network and the outputs are calculated for each neuron in the network. The second step is error backpropagation, which is used to adjust the network weights based on the calculated prediction error.In practice, backpropagation is used to calculate the gradient of the objective function with respect to each parameter in the network. This gradient is then used to update the network weights using an optimization method such as gradient descent. This gradually minimizes the network's error and improves its ability to predict.Backpropagation is used in various types of neural networks, including multilayer perceptrons, convolutional networks, and recurrent networks. It is one of the most important algorithms in machine learning and allows training neural networks that are able to perform complex tasks, such as image recognition or language translation. This training could be suitable for intermediate to advanced participants with previous experience in programming and fundamentals of machine learning. Greater emphasis should be placed on practical exercises and creation of own neural networks.

Participant requirements
- Knowledge of Python programming at the PYTHON_INTRO course level, but knowledge at the PYTHON_ADV course level is an advantage
- Knowledge of the basics of data analysis at the level of the PYTHON_DATAAN course
- Knowledge of the basics of machine learning at the level of the PYTHON_ML_INTRO course
- Knowledge of the basics of neural networks at the level of the PYTHON_ML_NN course
- Knowledge of the basics of Backpropagation in neural networks at the level of the PYTHON_ML_CNN course

Teaching methods
- Professional explanation with practical examples, exercises on computers.

Study materials
- Presentation of the subject matter in printed or online form.

Course outline
Day 1:
- Introduction to machine learning and neural networks
- Forward propagation in a neural network
- Activation function in a neural network
- Design of a simple neural network

Day 2:
- Backpropagation of the error in the neural network
- Gradient descent and its variants
- Calculation of gradients for each network parameter
- Practical exercises for backpropagation implementation

Day 3:
- Multilayer neural networks
- Network training using backpropagation
- Solving the problem of overtraining
- Practical exercises for training multilayer networks

Day 4:
- Convolutional neural networks and their foundations
- Pooling, convolution and strided convolution
- Design and training of a simple convolutional network
- Practical exercise on convolutional networks

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Day 5:
- Recurrent neural networks and their foundations
- LSTM and GRU networks
- Design and training of recurrent network
- Evaluation of results and possibilities for improvement
- Practical exercise on recurrent networks