Tárgytematika / Course Description
Neural networks

GKNM_MSTA049

Tárgyfelelős neve / Teacher's name: dr. Takács Gábor
Félév / Semester: 2023/24/1
Beszámolási forma / Assesment: Vizsga
Tárgy heti óraszáma / Teaching hours(week): 2/2/0
Tárgy féléves óraszáma / Teaching hours(sem.): 0/0/0

OKTATÁS CÉLJA / AIM OF THE COURSE

The goal of the course is to introduce the most important types of artificial neural networks, moreover, to teach modern methods for training these networks.

TANTÁRGY TARTALMA / DESCRIPTION

- Historical overview. Motivating examples, applications of neural networks in image recognition, object detection and localization, speech detection, etc.
- Technical details, overview of the necessary python modules and their installation, computational considerations: numpy, pandas, scikit-learn, keras, tensorflow / tensorflow-gpu / tensorboard.
- Simple implementation of a shallow neural network from scratch. Loss functions. Gradient-based optimization: batch, mini batch and stochastic gradient descent methods. Regularization techniques: L1, L2, elastic net, dropout. Basic examples in scikit-learn.
- Review of the logistic regression and the multilayer perceptron (shallow neural networks). Experiments on a simple multi-class classification problem: handwritten digit classification on the MNIST dataset.
- The importance of the choice of hyperparameters, such as: learning rate, number of hidden layers, number of neurons in the layers, activation function, optimization method.
- Convolutional neural networks (CNNs). Convolutional layers. Pooling layers. Fully connected layers. Experiments with different CNN architectures in Keras using the Sequential API, best practices.
- Avoiding overfitting with regularizations, dropout layers. Speeding up the learning with batch normalization layers. Keras callbacks, checkpoints. Model saving, loading in Keras, visualizing models (using Graphviz).
- GoogLeNet (winner of ImageNet Large Scale Visual Recognition Challenge in 2014) with the inception module and current versions. VGG (2nd of ILSVRC in 2014). ResNet (winner of ILSVRC in 2015) with residual networks.
- Creating more complex architectures using the Keras Functional API. Transfer learning, fine-tuning existing pre-trained models for new problems.
- Visualization of the "black box" using t-SNE embeddings. Visualization of the activations, filters.
- Recurrent/Recursive neural networks (RNNs). Examples for sequential data, time series. Gated recurrent units (GRUs). Long short-term memory (LSTM) networks.
- Generative Adversarial Networks (GANs). Basic implementation of a GAN in Keras.
- Fine-tuning pretrained Transformer-based language models.

SZÁMONKÉRÉSI ÉS ÉRTÉKELÉSI RENDSZERE / ASSESMENT'S METHOD

The colloquium consists of a written and an oral part, so that their weights in the evaluation are 60% and 40%. The written part is problem solving at the computer, retated to the course content. The role of the oral part is to verify that the students have the necessary theoretical knowledge about the field.

KÖTELEZŐ IRODALOM / OBLIGATORY MATERIAL

F. Chollet: Deep Learning with Python, Manning Publications, ISBN: 1617294438, 9781617294433.

AJÁNLOTT IRODALOM / RECOMMENDED MATERIAL

M. Nielsen: Neural Networks and Deep Learning, http://neuralnetworksanddeeplearning.com/.