19D033 Computational Machine Learning II

Winter Term - 3 ECTS
Mandatory Course
Prof. Omiros Papaspiliopoulos

Prerequisites to Enroll

Knowledge analogous to an introductory course in Machine Learning (Computational Machine Learning I or Foundations of Data Science) and one in computing and data analysis with Python (e.g. DS Brush up course or Foundations of Data Science)

Overview and Objectives

The course centers around neural and deep neural networks, starting from basic concepts and building all the way to current research. It is divided into three main parts. Part A covers fundamental concepts and architectures, such as feed-forward networks, autoencoders and variational autoencoders, disentangled representations, back propagation and regularization in networks (including Bayesian networks). Part B introduces recent advances in Deep Learning including Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) and their application in Computer Vision and Natural Language Processing. Popular deep learning frameworks such as Tensorflow (Keras) and PyTorch will be reviewed, along with code implementing network architectures learn in the course. Part C will touch upon current research themes, such as deep recommender systems.

Course Outline

- Part A: feed-forward networks, autoencoders and variational autoencoders, disentangled representations, back propagation and regularization in networks (including Bayesian networks)
- Part B: Convolutional Neural Networks, Recurrent Neural Networks, advanced network architectures, Tensorflow and PyTorch frameworks, practical session
- Part C: Current research topics

Required Activities

Weekly small group projects, a final group project.

Evaluation

70% final group project, 30% weekly group projects

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Competences

☒ Modeling and predicting high-dimensional data with advanced statistical methods in the field of data science in order to improve strategic decision making.

☒ Apply the knowledge of programming languages, computer programs and advanced services in the Cloud to solve the problems that are presented to the data scientist.

☒ Solve the real problems that arise in the fields of study through the accurate analysis of the data.

☒ Visualize and interact with high-dimensional data in order to contextualize the information and facilitate subsequent decision-making.

☒ Work in a heterogeneous team of researchers in the field of the economic analyst using specific group techniques.

☒ That students know how to apply the acquired knowledge and their ability to solve problems in new or unfamiliar environments within broader (or multidisciplinary) contexts related to their area of study.

☒ That the students be able to integrate knowledge and face the complexity of making judgments based on information that, being incomplete or limited, include reflections on the social and ethical responsibilities linked to the application of their knowledge and judgments.

☒ That the students know to communicate their conclusions and the knowledge and last reasons that sustain them to specialized and non-specialized publics in a clear and unambiguous way.

☒ That students have the learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

Learning Outcomes

☒ Elaborate and estimate probabilistic prediction models based on certain data.

☒ Predict random processes.

☒ Apply supervised and semi-supervised learning algorithms.

☒ Apply search algorithms and estimation methodologies in networks through observation of data.

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Materials

The course builds upon the authority and research of the main instructors and the guest lecturers. The course will refer to various research articles. In terms of book references the following books-chapters are relevant:

Pattern Recognition and Machine Learning, Bishop (Chapter 5)

Pattern Recognition and Neural Networks, Ripley (Chapter 5)

Deep Learning, Goodfellow,Bengio, Courville (various chapters)