XIV Summer School on Operational Research, Data and Decision Making

May, 26-27, 2022

National Research University Higher School of Economics,

Nizhny Novgorod

Faculty of Informatics, Mathematics and Computer Science

Laboratory of Algorithms and technologies for network analysis

https://nnov.hse.ru/en/latna/conferences/ora2022

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School Lecturers

Lina Mallozzi, University of Naples Federico II, Naples, Italy

Lecture 1: Two-level optimization problems: existence results of solutions and approximate solutions.

Lecture 2: Two-level optimization problems: some results in probabilistic approach

Giuseppe Nicosia, University of Catania, Italy

Lecture 1. Introduction to Deep Learning

Lecture 2. Artificial Neural Networks as Complex Networks - A Primer

Jun Pei, Hefei University of Technology, China.

Lecture: When Platform Exploits the Advantage in Supply Chain: Change of Structure and Efficient Scheduling

Panos Pardalos, University of Florida, USA and HSE NN.

Lecture: Computational Approaches for Solving Systems of Nonlinear Equations

Mikhail Batsyn, LATNA HSE NN.

Lecture: Tabu search optimization algorithms.

The Summer School is organized in distant format, in Zoom

https://zoom.us/j/97807586194?pwd=UGxmeGpDc3BvK3JFK1NrRjlJQzVldz09

Conference ID: 978 0758 6194

Password: 465021

Day 1, Thursday, May 26.

	Lina Mallozzi, University of Naples Federico II, Naples, Italy
14:00 – 14:50	Lecture 1: Two-level optimization problems: existence results of solutions and approximate solutions.
15:00 – 15:50	Lecture 2: Two-level optimization problems: some results in probabilistic approach
	Giuseppe Nicosia, University of Catania, Italy
16:00 – 16:50	Lecture 1. Introduction to Deep Learning
17:00 – 17:50	Lecture 2. Artificial Neural Networks as Complex Networks - A Primer

Day 2, Friday, May 27.

09:00 - 09:50	**Jun Pei**, Hefei University of Technology, China. Lecture: When Platform Exploits the Advantage in Supply Chain: Change of Structure and Efficient Scheduling
10:00 – 10:50	**Mikhail Batsyn**, LATNA HSE NN. Lecture: Tabu search optimization algorithms.
11:00 – 12:20	**Student session.** Presentation of student projects. **Lev Evtodienko** - Audiovisual emotion recognition by using OpenVino **Kristina Egorova** - Network analysis in application to text summarisation problem. **Andrey Matveev, Vyacheslav Nazarov** - Knowledge mining with knowledge graph embeddings **Kirill Sozinov, Andrey Rogov** - Sentiment Analysis on Movie Reviews using Graph Convolutional Networks **Ilya Kozulin, Timofey Myakov** - Signal detection in the audio stream. **Andrey Bobrovskiy** - Pseudohyperbolic attractors of three-dimensional and four-dimensional systems and effective numerical methods for their research **Vladislav Koryakin** - On fast methods for constructing diagrams of homoclinic and heteroclinic bifurcations
12:20 – 13:10	**Panos Pardalos**, University of Florida, USA and HSE NN. Lecture: Computational Approaches for Solving Systems of Nonlinear Equations

Lina Mallozzi

Department of Mathematics and Applications "R. Caccioppoli" University of Naples "Federico II"

Lecture 1: Two-level optimization problems: existence results of solutions and approximate solutions.

A two-level optimization problem corresponding to a Stackelberg game in which one of the two players has the leadership in playing the game is considered. First, a review of results about existence of solutions and approximate solutions is presented in the case in which the solutions set to the lower level problem is a singleton.

In the case in which the response function of the follower is multi-valued different models are presented as weak and strong Stackelberg solutions, intermediate solutions, and in these cases existence and stability of solutions and approximate solutions are discussed as well. These models correspond to a precise behavior of the leader: he can act in an optimistic way (strong) or pessimistic one (weak), or he can gather information and estimate the follower response (intermediate).

The models considered in this presentation will be framed in concrete applicative situations: Cournot duopoly, principal agent, IEA International Environment Agreement models.

Lecture 2: Two-level optimization problems: some results in probabilistic approach.

The mixed extension of a Stackelberg game, where players decide strategies randomizing and consider the average payoff, is presented, and the existence of such mixed (or approximated) solutions is discussed. Then, the hierarchical situation is extended to N-player ($N > 2$) case: here the concept of Stackelberg-Nash equilibrium is given and illustrated with examples.

The particular case of one leader and two followers is studied: by using the Shannon entropy, a regularization scheme for the two-stage game is introduced and some properties are presented, as the asymptotic subgame perfectness

# Giuseppe Nicosia

University of Catania, Italy

Lecture 1. Introduction to Deep Learning

Lecture 2. Artificial Neural Networks as Complex Networks - A Primer

Jun Pei

Hefei University of Technology, China

When Platform Exploits the Advantage in Supply Chain: Change of Structure and Efficient Scheduling

The development of digital technology, such as data mining and analysis techniques, has enabled e-commerce platforms to use the data generated in their ecosystems and forecast the online demand more accurately. By sharing the forecast information, platforms help their partners reduce the demand uncertainty. To examine the effects of the shared information, this talk discusses a two-echelon supply chain and investigates the relations between the forecast information and firms' channel strategies. Some managerial insights are provided for the OEM, brand store, and platform to capture the value of forecast information. Furthermore, some novel supply chain scheduling problems are introduced based on the changes.

BIO:
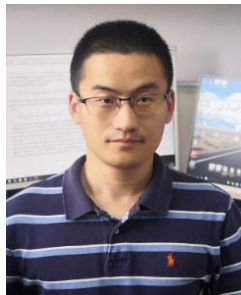
Jun Pei serves as Professor in School of Management, Hefei University of Technology, China. His research interests cover production scheduling, business analytics, industrial internet, and optimization in smart manufacturing. His research has appeared in premier academic journals, such as Production and Operations Management, INFORMS Journal on Computing, Omega and European Journal of Operational Research. He also serves as Co-Editor-in-Chief for Energy Systems, Associate Editor for Journal of Global Optimization, Journal of Combinatorial Optimization, Optimization Letters, Computational Social Networks, and SN Operations Research Forum, and Lead Guest Editor for Annals of Operations Research.

Panos M. Pardalos

University of Florida, USA and HSE NN

Computational Approaches for Solving Systems of Nonlinear Equations

Finding one or more solutions to a system of nonlinear equations (SNE) is a computationally hard problem with many applications in sciences and engineering.

First, we will briefly discuss classical approaches for addressing SNE.

Then, we will discuss the various ways that a SNE can be transformed into an optimization problem, and we will introduce techniques that can be utilized to search for solutions to the global optimization problem that arises when the most common reformulation is performed.

In addition, we will present computational results using different heuristics.

Mikhail Batsyn

LATNA, HSE, Nizhny Novgorod

Tabu Search optimization algorithms

In this lecture we will get acquainted with Tabu Search method, which allows local search to get out of local optima. We will consider several small examples demonstrating the advantages of this approach. Main features and parameters of Tabu Search will be discussed. Finally, we will explain in detail an efficient Tabu Search algorithm for the Maximum Clique Problem.

Student session

Lev Evtodienko
3d year student, HSE Nizhny Novgorod, Russia
Audiovisual emotion recognition by using OpenVino

The nature of emotions is multimodal itself. To fully handle emotion recognition, a specific class of neural networks should be considered. To research video emotions we used Acted Facial Expressions In The Wild database. To solve the problem we proposed a multimodal ensemble classifier based on neural networks. We have built a model, based on face emotion recognition and audio emotions, which were further ensembled. To make this model easily and universally deployable for different devices we used the OpenVino library. After conducting experiments, our best model achieves 60% accuracy and gains reasonable performance to be deployed on different workloads

This work is realized in the framework of the joint HSE-INTEL project "Audio-visual recognition of emotion with the use of OpenVino instruments"

Kristina Egorova
3d year student, HSE Nizhny Novgorod, Russia
Network analysis in application to text summarisation problem.

Text summarisation is an actively developing area. Many techniques have been applied including neural networks and sophisticated nlp algorithms. In this talk I will present a study of network analysis applications to this problem. Russian news collection has been used as a dataset for benchmarking.

This work is realized in the framework of the joint HSE-INTEL project "Insights generation using graph analytic algorithms with a Python application"

Andrey Matveev, Vyacheslav Nazarov
3d year students, HSE Nizhny Novgorod, Russia
Knowledge mining with knowledge graph embeddings

Interpretable is an important requirement for many applications such as medical assistant software, autonomous cars, and virtual assistants. The knowledge graph approach is a way to build interpretable AI systems. Automatic knowledge graph extraction from natural language text is a hot research topic, as well as link prediction. In the present study we consider both tasks. With the help of pykeen graph library we have implemented a pipeline that includes 3 stages: knowledge graph extraction from text, knowledge graph embeddings, and link prediction.

This work is realized in the framework of the joint HSE-INTEL project "Insights generation using graph analytic algorithms with a Python application"

Kirill Sozinov, Andrey Rogov
3d year students, HSE Nizhny Novgorod, Russia
Sentiment Analysis on Movie Reviews using Graph Convolutional Networks
Graph neural networks algorithm is a hot topic that successfully has been applied to drug discovery, fraud detection, clustering, and social media analysis. In the talk I will present an attempt to apply graph convolutional neural networks to the sentiment analysis problem.

The movie reviews collection has been used as the dataset.

This work is realized in the framework of the joint HSE-INTEL project "Insights generation using graph analytic algorithms with a Python application"

Ilya Kozulin, Timofey Myakov
2d year students, HSE Nizhny Novgorod, Russia
Signal detection in the audio stream.
This short report will be devoted to signal detection in the audio stream. As a target signal we considered the call of North Wales. We have studied a combination of the features from the music acoustic field with various machine learning classification algorithms.

This work is realized in the framework of the joint HSE-INTEL project "Detecting the signal in audio stream"

Andrey Bobrovskiy
3d year student, HSE Nizhny Novgorod, Russia
Pseudohyperbolic attractors of three-dimensional and four-dimensional systems and effective numerical methods for their research
Now there are known several numerical methods for checking pseudohyperbolicity of strange attractors. However, all these methods are very time-consuming even in the case of checking pseudohyperbolicity of an attractor at fixed parameter values. At the same time, the problem of finding pseudohyperbolic attractor in two-parameter families (on the plane of two parameters) is very relevant. In this work, we apply parallel programming technologies for solving this problem. With help of these methods, it is possible to speed up calculations by orders of magnitude. The effectiveness of the developed methods will be demonstrated on the following systems: the three-dimensional and four-dimensional Shimizu-Morioka system, the three-dimensional and four-dimensional Lorenz system, the Lyubimov-Zaks system.

This work is realized in the framework of the joint HSE-INTEL project "Porting numerical methods of bi-parameter scanning of chaotic dynamical systems to one API/XPU".

Vladislav Koryakin

3rd year student, HSE Nizhny Novgorod, Russia

On fast methods for constructing diagrams of homoclinic and heteroclinic bifurcations

In this work, we develop fast numerical methods for homoclinic and heteroclinc bifurcation analysis in flow systems with chaotic behavior. These methods are based on the symbolic approach proposed by Prof. A. Shilnikov and his students. The effectiveness of the developed parallel methiods is demostrated on examples of well-known three-dimansional systems.

This work is realized in the framework of the joint HSE-INTEL project "Porting numerical methods of bi-parameter scanning of chaotic dynamical systems to one API/XPU".