Summer School on Operational Research, Data and Decision Making

May, 21-23, 2019

National Research University Higher School of Economics,

Nizhny Novgorod

Faculty of Informatics, Mathematics and Computer Science

Laboratory of Algorithms and technologies for network analysis

НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ
НИЖНИЙ НОВГОРОД

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School Lecturers.

Alexander Dolgui, IMT Atlantique, Nantes, France,
https://www.mines-stetienne.fr/~dolgui/

- Combinatorial design of manufacturing systems: new approaches and real life applications
- Replenishment planning in assembly systems under lead time uncertainty

Mario Guarracino, ICAR-CNR, Naples, Italy,
http://www.na.icar.cnr.it/~mariog/
Supervised and unsupervised classification of networks

Petr Koldanov, HSE NN,
https://www.hse.ru/en/org/persons/14194055
Introduction to multiple hypotheses testing

Alexander Lazarev, Institute of Control Sciences of Russian Academy of Science, Moscow, http://www.orsot.ru/index.php/ru/blog/item/a-a-lazarev
Approximation of objective function of the scheduling problem

Nenad Mladenovic, Emirates College of Technologies, Abu Dhabi, UAE,
http://www.mi.sanu.ac.rs/~nenad/
- Variable neighborhood programming for symbolic Regression
- Review of Basic Local Searches for Solving the Minimum Sum-of-Squares Clustering Problem

Panos Pardalos, University of Florida USA and HSE,
https://www.ise.ufl.edu/pardalos/
Optimization and Data Sciences in Energy Networks

Oleg Prokopyev, University of Pittsburg, USA and HSE,
https://www.pitt.edu/~droleg/
Fractional 0–1 Programming: Applications, Complexity, Algorithms and Recent Advances

Yakov Zinder, University of Technology, Sydney, Australia,
https://www.uts.edu.au/staff/yakov.zinder
Scheduling with Limited Storage: computational complexity, exact and approximation algorithms, polynomial-time approximation schemes

Monday, May 20

Arrival of participants

Tuesday, May 21

Room 104 HSE, 136 Rodionova Str.

9:30-10:00 Registration of participants

10:00 -10:50 Panos Pardalos

Opening lecture: Optimization and Data Sciences in Energy Networks

10:50 -11:10 Coffee break

11:10 -12:00 Alexandre Dolgui

Lecture 1: Replenishment planning in assembly systems under lead time uncertainty

12:10 -13:00 Alexandre Dolgui

Lecture 2: Combinatorial design of manufacturing systems: new approaches and real life applications

13:00 -14:30 Lunch

14:30 -15:20 Alexander Lazarev

Lecture 1: Approximation of objective function of the scheduling problem

15:30 -16:20 Alexander Lazarev

Lecture 2: Approximation of objective function of the scheduling problem

16:20 -16:30 Coffee break

16:30 -17:20 Special session from participants of the ERASMUS PLUS cooperation project between HSE NN, Russia and University of Tuscia, Italy . Simone Minucci *Inverse Problems in Electromagnetism: Applications to Plasma Control in Nuclear Fusion Devices*

Wednesday, May 22

Room 104 HSE, 136 Rodionova Str.

10:00 -10:50 Yakov Zinder

Lecture 1: Scheduling with Limited Storage: computational complexity, exact and approximation algorithms, polynomial-time approximation schemes

11:00 -11:50 Yakov Zinder

Lecture 2: Scheduling with Limited Storage: computational complexity, exact and approximation algorithms, polynomial-time approximation schemes

11:50 -12:10 Coffee break

12:10 -13:00 Petr Koldanov

Lecture: Introduction to multiple hypotheses testing

13:00 -14:30 Lunch

14:30 -15:20 Nenad Mladenovic

Lecture 1: Variable neighborhood programming for symbolic Regression

15:30 -16:20 Nenad Mladenovic

Lecture 2: Review of Basic Local Searches for Solving the Minimum Sum-of-Squares Clustering Problem

16:20 -16:30 Coffee break

16:30 -17:20 Yakov Zinder

Seminar: Scheduling with Limited Storage: computational complexity, exact and approximation algorithms, polynomial-time approximation schemes

Thursday, May 23

Room 104 HSE, 136 Rodionova Str.

10:00 -10:50 Mario Guarracino

Supervised and unsupervised classification of networks

10:50 -11:10 Coffee break

11:10 -12:00 Oleg Prokopyev

Lecture 1: Fractional 0–1 Programming: Applications, Complexity, Algorithms and Recent Advances

12:10 -13:00 Oleg Prokopyev

Lecture 2: Fractional 0–1 Programming: Applications, Complexity, Algorithms and Recent Advances

13:00 Closing

13:15 -14:30 Lunch

Friday, May 24

Departure of participants

Alexander Dolgui,
IMT Atlantique, Nantes, France,
https://www.mines-stetienne.fr/~dolgui/

Lecture 1: Replenishment planning in assembly systems under lead time uncertainty

Abstract: In literature, most papers examine several stochastic demand processes where order lead times are constant. In reality, manufacturing firms use inventory management software, especially MRP, which ignored lead time uncertainty. It is true that in certain special cases, lead time uncertainty has essentially no effect and can be ignored. Nevertheless more often, lead time fluctuations strongly degrade tools performance and cause high production costs, just as demand uncertainty does. Seemingly, uncertainty has been neglected for a long time in favour of studying demand uncertainties. Industry agrees that it is overdue and there is a need to rectify this oversight. Nowadays, this gap in research activity begins to be filled in order to respond to companies having non-deterministic lead-times constraints. A new approach of replenishment planning under uncertainty of lead times is proposed and a survey of our results is given.

Lecture 2: Combinatorial design of manufacturing systems: new approaches and real life applications

Abstract: A complex machine or machining line consists of a sequence of work positions through which products move one way in order to be processed. Designing such a production system represents a long-term decision problem involving different crucial decision stages. Combinatorial design is one of them; it mostly deals with assigning the set of indivisible units of work (named tasks or operations) to work positions (or stations). In literature, the most attention was paid for combinatorial design of assembly lines (assembly line balancing problems). In our work, we develop approaches and formulations of combinatorial design for machining lines and complex machines. All types of machining lines are considered: mass production transfer lines, flexible lines based on machining centers and reconfigurable manufacturing systems.

Mario Guarracino,
ICAR-CNR, Naples, Italy,
http://www.na.icar.cnr.it/~mariog/

Lecture: Supervised and unsupervised classification of networks

Abstract—Networks represent a convenient model for many scientific and technological problems. From power grids to biological processes and functions, from financial networks to chemical compounds, the network representation of data makes it possible to highlight both topological and qualitative characteristics. In this talk, we report recent developments in supervised and unsupervised classification of network data. Given a dataset whose members are networks, we show how to cluster them. In case a class label is available, we show hot to build a mathematical model for their supervised classification.

We focus on networks with labeled nodes and weighted undirected edges, defining distances between networks. We provide empirical results on datasets of biological interest.

Petr Koldanov
NRU HSE NN, lab LATNA

Lecture: Introduction to multiple hypotheses testing

Abstract: The lecture discusses the problems of simultaneous testing of many hypotheses (multiple hypotheses testing), the procedures for testing many hypotheses with the control of the probability of at least one false rejection of the correct individual hypothesis, the method of union-intersection, one-step and multi-step procedures, optimal procedures that control the probability of at least one false rejection of the correct individual hypothesis

Alexander Lazarev
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Lectures 1-2: Approximation of objective function of the scheduling problem

Abstract: The problem of approximating the coefficients of the objective function of the scheduling problem for single machine is considered. It is necessary to minimize the sum of the weighted completion times when we are unknown coefficients, but a certain set of optimal schedules is known. It is shown that the approximation problem is reduced to finding a solution to the system of linear inequalities. For the case of equal release times of jobs method for solving the corresponding system of linear inequalities has been developed. Based on it, a polynomial algorithm is developed for searching for weighting coefficients that satisfy given optimal schedules, and estimating the approximation error. Different objective functions and measures of complexity will be discussed in details.

Acknowledgements:
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Nenad Mladenovic
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Lecture 1: Variable neighborhood programming for symbolic Regression
(jointly with Souhir Elleuch, Bassem Jarboui, Jun Pei)

Abstract: In the field of Automatic Programming (AP), the solution of a problem is a program, which is usually represented by an AP tree. A tree is built using functional and terminal nodes. For solving AP problems, we propose a new local search procedure that adapts the 'elementary tree transformation' (ETT) into this specific tree. The elementary tree transformation is the process of removing an edge and adding another one to obtain a new feasible tree. Our results indicate that the neighborhood of an AP tree, that have two types of nodes, is smaller than the neighborhood size of a spanning tree with a single type of nodes. As our new ETT local search can be part of many AP metaheuristics, it can be used to solve various AP problems. In this paper, we incorporate it into the Basic Variable Neighborhood Programming (BVNP) scheme to solve the Symbolic regression problem. BVNP is the basic method of the recently proposed Variable Neighborhood Programming (VNP) algorithm. It is AP meta-heuristic which combines stochastic and deterministic changes of neighborhoods. Experimental comparison with Variable Neighborhood Programming without ETT, Genetic Programming, and Artificial Bee Colony Programming shows clearly better speed of convergence and computational stability of the proposed method.

Lecture 2: Review of Basic Local Searches for Solving the Minimum Sum-of-Squares Clustering Problem
(jointly with Thiago Pereira, Daniel Aloise, Jack Brimberg)

This paper presents a review of the well-known K-means, H-means, and J-means heuristics, and their variants, that are used to solve the minimum sum-of-squares clustering problem. We then develop two new local searches that combine these heuristics in a nested and sequential structure, also referred to as variable neighborhood descent. In order to show how these local searches can be implemented within a metaheuristic framework, we apply the new heuristics in the local improvement step of two variable neighborhood search (VNS) procedures. Computational experiments are carried out which suggest that this new and simple application of VNS is comparable to the state of the art.

Oleg Prokopyev,
University of Pittsburg, USA and HSE NN
https://www.pitt.edu/~droleg/

Lectures 1-2: Fractional 0–1 Programming: Applications, Complexity, Algorithms and Recent Advances

Abstract: We overview a class of nonlinear integer optimization problems commonly known as fractional 0–1 programming problems (also, often referred to as hyperbolic 0–1 programming problems), where the objective is to optimize the sum of ratios of affine functions subject to a set of linear constraints. Such problems arise in diverse applications across different fields, and have been the subject of study in a number of papers during the past few decades. We overview the literature on fractional 0–1 programs including their applications, related computational complexity issues and solution methods including exact, approximation and heuristic algorithms.

Yakov Zinder
University of Technology, Sydney, Australia,
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Lectures 1-2, Seminar: Scheduling with Limited Storage: computational complexity, exact and approximation algorithms, polynomial-time approximation schemes

Abstract: Limited storage space is a crucial restriction in many practical scheduling problems. For example, memory of the base station limits the data gathering in the star networks where datasets from the worker nodes are to be transferred to the base station for processing. Data transfer can commence only if the available memory of the base station is not less than the size of the corresponding dataset. Only one node can transfer data to the base station at a time, although during this process the base station can process one of the previously transferred datasets. The memory, consumed by a dataset, is released only at the completion of its processing by the base station. Similar situation arises in the systems for auto-assembled multimedia presentations for devices such as cell phones, including query-based presentations from multimedia databases, automatically composed programs based on the user's profile, etc.The above situation can be modelled as the two-machine flow shop with storage. This scheduling model is also adequate to various situations arising in manufacturing and supply chains. The purpose of the lectures is two-fold: to present a survey of the recent results, obtained for the above scheduling model, and to present several aspects of combinatorial optimisation, including design of exact polynomial-time algorithms, analysis of computational complexity, approximation algorithms such as Lagrangian relaxation, and polynomial approximation schemes, using variations of the same mathematical model. Some other practical scheduling problems with limited storage space will be briefly outlined.