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Laboratory of Algorithms and Technologies for Network Analysis
National Research University
Higher School of Economics, Nizhny Novgorod

Laboratory of Advanced Combinatorics and Network Applications
National Research University
Moscow Institute of Physics and Technology

Conference onsite location: Nizhny Novgorod, HSE building on Rodionova street 136, room 401 (4-th floor).

Zoom reference to access the conference:
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Invited speakers

Roman Belavkin, Middlesex University, London, UK

Yury Kochetov, Sobolev Institute of Mathematics, Novosibirsk State University

Elena Konstantinova, China Three Gorges University, China & Sobolev Institute of Mathematics, Novosibirsk State University, Russia

Panos Pardalos, University of Florida, USA and HSE University, lab LATNA

Participants with talks

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Tkachev Daniil, HSE University, Centre of Decision Choice and Analysis

Trafalis Theodore, School of ISE, The University of Oklahoma, USA

Conference schedule

Monday, May 20. Room 401, Rodionova street 136

	Speaker	Title
10:00 - 10:45	Panos Pardalos	*Opening talk: Introduction to data analytics for networks – a historical perspective and major advances*
10:45 - 11:30	Yury Kochetov	*Invited talk: Grey Box Approach for Difficult Network Optimization Problems*
11:30 - 11:40	**Coffee break**	
Session: Complex Networks		
11:40 - 12:00	Brian Daniel Bernhardt, Chiara Marciano, Mario Guarracino	*Default probability of corporate enterprises: a network approach*
12:00 - 12:20	Sergey Sidorov	*Modelling the triadic closure mechanism in growth complex networks*
12:20 – 12:40	Alexey Grigoriev	*The distribution of the average friendship index for nearest neighbors in scale-free networks*
12:40 - 13:00	Timofei Emelianov	*Modelling the growth and contraction of complex networks using the triad closure*
13:00 - 15:00	**Lunch**	Cafeteria, floor [-1]
Session: Machine Learning		
15:00 - 15:20	Theodore Trafalis	*Federated Machine Learning and Weather Applications with Imbalanced Data*
15:20 - 15:40	Egor Churaev	*Personalized Engagement Detection in Facial Video*
15:40 - 16:00	Sanjar Dosov	*Automatic compression of Neural Networks*
16:00 - 16:10	**Coffee break**	
Session: Social Network Analysis		
16:10 - 16:30	Darya Maltseva	*Collaboration structures in Russian sociological community*
16:30 - 16:50	Natalia Matveeva	*How to analyze the structure of collaboration? The example of leading young universities*
16:50 - 17:10	Daniil Tkachev	*Network analysis of France and China Input-Output table*
17:10 - 17:30	Irina Pavlova	*Exploring International Dimension of Russian Economic Science*
17:30 - 17:50	Anna Kartasheva	*The Normative Dimension of Networks and Bias Resilience*
18:00	**Welcome reception**	Cafeteria, floor [-1]

Tuesday, May 21. Room 401, Rodionova street 136

	Speaker	Title
10:00 - 10:45	Elena Konstantinova	*Invited talk: Cubic Pancake Networks and Beyond*
10:45 - 11:30	Roman Belavkin	*Invited talk: Optimization of Large Networks with Information Constraints*
11:30 - 11:40	**Coffee break**	
Session: Optimization and Networks		
11:40 - 12:00	Dmitry Gribanov	*Faster ILP algorithms for delta-modular problems of small codimension*
12:00 - 12:20	Ilgam Latypov	*Balancing Efficiency and Interpretability: A New Approach to Multi-Objective Optimization with High Computation Costs in Lipschitz Functions*
12:20 – 12:40	Kirill Kaymakov, Dmitry Malyshev	*Efficient algorithm for finding k-th L_1- or L_∞ - distance in a system of plane points*
12:40 - 13:00	Evgeny Burashnikov	*Advanced Algorithmic Concepts for Knapsack Problem 0-1*
13:00-15:00	**Lunch**	*Cafeteria, floor [-1]*
Session: Optimization, Uncertainty and Networks		
15:00-15:20	Stravos Suravlas, Angelo Sifaleras	*On scheduling probabilistic block cyclic redistribution*
15:20-15:40	Dmitry Taletskii	*New upper bounds for the number of minimum dominating sets in trees*
15:40-16:00	Sergei Gladyshev	*Optimization models for an identical parallel machine scheduling problem with uncertain job durations to minimize lexicographically makespan and expected maximal overlap*
16:00-16:20	Sergey Ketkov	*A Study of Distributionally Robust Mixed-Integer Programming with Wasserstein Metric: on the Value of Incomplete Data*
16:20-16:40	Petr Koldanov	*Comparative analysis of conclusions uncertainty on connections between stocks of stock markets.*
16:40 – 17:00	Fuad Aleskerov, Anna Semenova	*Network Analysis of International Conflicts*

Invited talks

Belavkin Roman
Middlesex University, London, UK
Pardalos Panos
University of Florida, USA and HSE University, lab LATNA
Optimization of Large Networks with Information Constraints

The power-law degree sequence that characterizes many large networks can be obtained as solution to the maximum entropy problem, where logarithm of a degree is considered as a cost function to be minimized. We discuss the dual problem inspired by Shannon's rate distortion and Stratonovich's value of information theories, where networks are optimized to minimize the average path length subject to constraints on mutual information. We show that a solution to this problem corresponds to the preferential attachment algorithm known to generate the power-law graphs and characterized by the `small World' property. The information constraints define the exponent parameter β of the power-law graphs, which corresponds to the Lagrange multiplier called the inverse temperature. Its relation to free energy allows us to show that the famous disconnectedness result at $\beta=1$ due to Aiello, Chung, and Lu (2000) is a phase transition of the first kind. Thus, we demonstrate how information-theoretic concepts, such as entropy, information and free energy, facilitate the analysis of large random graphs and networks.

Konstantinova Elena
China Three Gorges University, China
Sobolev Institute of Mathematics, Novosibirsk State University, Russia
Cubic Pancake Networks and Beyond

Cubic Pancake Networks are presented by Cayley graphs over the symmetric group generated by three prefix-reversals. These graphs are important combinatorial objects not only in Cayley graph theory and in interconnection networks theory. In coding theory, these graphs allow to get generalized Gray codes. However, despite the importance of the class of Pancake graphs in distinct areas of mathematics and networks, even the connectedness of cubic Pancake graphs is still not completely solved. In this talk we discuss some old and new results on these graphs.

Pardalos Panos
University of Florida, USA and HSE University, lab LATNA
Introduction to data analytics for networks – a historical perspective and major advances

Data analytics for networks involves the use of advanced techniques and tools to extract insights and knowledge from large and complex datasets generated by network devices, applications, and services. This process involves collecting, storing, processing, and analyzing large amounts of data to identify patterns, trends, and anomalies that can provide valuable information for network operators. By leveraging data analytics, network researchers can make informed decisions about network planning, capacity management, service delivery, and customer experience. Additionally, data analytics can help network operators to detect and respond to security threats and attacks, by analyzing network traffic, identifying abnormal behavior, and detecting potential vulnerabilities. Overall, data analytics is a critical component of massive networks, enabling network researchers to extract valuable insights from massive datasets and improve network performance, efficiency, and security.

Kochetov Yury
Sobolev Institute of Mathematics, Novosibirsk State University
Grey Box Approach for Difficult Network Optimization Problems

In the grey-box optimization models, we know analytical forms for the constraints and the objectives in part only. Some terms are obtained from the business simulation models. As a result, we cannot apply the classical global optimization methods due to the lack of exact mathematical expressions and the computational cost is high due to the simulations. Important applications stem from various disciplines such as multi-echelon inventory systems, chemical and mechanical engineering, financial management, network topology design, and others. In this talk, we will discuss some promising directions in this area and theoretical bounds for global optimization methods. Successful cases for real-world applications will be presented.

Regular talks

Aleskerov Fuad (1), (2) and **Semenova Anna** (1)
(1) National Research University Higher School of Economics (HSE), Moscow,
(2) V.A. Trapeznikov Institute of Control Sciences of Russian Academy of Sciences (ICS RAS), Moscow, Russia
Network Analysis of International Conflicts

We study international conflicts based on the construction of a network among countries involved, and take into account the intensity of an international conflict as well as the intensity of internal conflicts in the country. In the construction of the network we consider the influence of third countries on the conflict.
We use classic centrality indices as well as new ones considering the parameters of the nodes and group influence of nodes on a single vertex.
Keywords: international conflicts; internal conflicts; intensity of conflicts; network centrality indices; group influence in conflicts networks

Bernhardt Brian Daniel, Marciano Chiara,
University of Cassino, Italy
Guarracino Mario
University of Cassino, Italy and lab LATNA HSE University
Default probability of corporate enterprises: a network approach

Nowadays, enterprises have to cooperate to survive in an increasingly competitive environment. The forms of cooperation an organization develops determine how a company is directed and controlled and how it governs itself. Different forms of cooperation exist depending on the relationships between the various interested parties, such as shareholders, management, the board of directors, and shareholdings. Comprehending the cooperation between enterprises through, for example, community detection can help assess the trend of one specific sector. Community detection is crucial in comprehending network structure and forecasting user actions. Using actual data from the subsidiary's construction sector enterprises, we extract a network from direct subsidiaries enterprises. Then, we leverage different detection algorithms to explore the interconnections within corporate enterprises and find out how the network topology influences the distribution of default probabilities, providing valuable insights into the dynamics of risk propagation within the industry. To this aim, we collected data from 13,430 construction companies in each of the 107 Italian provinces. For each company, we consider a first level of participation in which we identify the investee companies

and the related shareholdings (directly held). At a second level, we consider companies that are subsidiaries of subsidiaries (indirect subsidiaries). We build a network in which the nodes represent companies, weighted by default probabilities, and the edge is the participation of one company in another, weighted by the participation percentage. Results show it is possible to characterize the probability of default among the communities and gain insights into the relationship between company involvement and default risk.

Burashnikov Evegeniy
HSE University, Lab LATNA
Advanced Algorithmic Concepts for Knapsack Problem 0-1

The talk will present several advanced concepts for solving the popular NP-hard 0-1 Knapsack Problem. In particular, advanced upper and lower bounds for the branch-and-bound method will be discussed. The State of the art approach - Expknap, which uses the Core set concept to solve the problem, will also be discussed. A modification of this algorithm, which exploits the principle of item dominance, will be proposed.

Churaev Egor
HSE University, Lab LATNA and Deelvin Company
Personalized Engagement Detection in Facial Video

We suggest an innovative and precise method which adjusts a neural network binary classifier using a brief collection of videos from a specific user. Facial characteristics are captured through pre-trained, resource-efficient deep networks that can operate on a user's device without compromising privacy. Additionally, we present a freely accessible dataset for assessing the model's effectiveness. Through experimentation, we show that our approach, incorporating model adaptation, notably enhances (by 10-15%) the accuracy of predicting user engagement in videos.

Dosov Sanjar
HSE University, Lab LATNA
Automatic compression of Neural Networks.

Although Transformer models architecture have become popular for various NLP and Speech Processing tasks recently, it remains a challenging problem to reduce the storage cost of the parameters for resource-limited platforms. In the previous studies, tensor decomposition (TD) has achieved promising compression performance by embedding tensors sizes into a low-rank subspace. However, naive employment of TD leads to huge accuracy drop and it is unclear which tensors

should be compressed. Unlike the conventional approaches, this paper shows that list of tensors for decomposition can be chosen more effectively to obtain better compression with lower quality metric drop.

Emelianov Timofei
Saratov State University
Modelling the growth and contraction of complex networks using the triad closure

Many real systems exhibit the processes of growth and shrink. In this paper, we propose a network evolution model based on the simultaneous application of both node addition and deletion rules. To obtain a higher clustering that is present in real social networks, the model employs the triadic formation step at each iteration. The results show that the degree distribution in the networks generated based on this model follows a power law.

Gribanov Dmitry
HSE University, Lab LATNA
Faster ILP algorithms for delta-modular problems of small codimension

We consider ILP problems induced by systems in the standard form of small codimension k, and more general ILP problems on n-dimensional polyhedra with (n+k) facets. It is known that this class of problems admits FPT-algorithms parameterized by k and sub-determinants spectrum of a constraints matrix. In our work, we present refined FPT-algorithms parameterized by k and rank-order determinants. Additionally, we present better complexity bounds for feasibility problems, and consider different partial cases: expected ILP complexity with respect to varying r.h.s., ILP problems with generic constraint matrices, ILP problems on simplices.

Gladyshev Sergei
Moscow Institute of Physics and Technology
Optimization models for an identical parallel machine scheduling problem with uncertain job durations to minimize lexicographically makespan and expected maximal overlap.

This study examines the problem of scheduling on identical-parallel machines, where the duration of each job is fixed while minimizing the total processing time. However, during the execution of this initial schedule, unforeseen events may change the duration of jobs, consistent with predetermined probability distributions.

If these changes make the initial schedule infeasible, adjustments are made by moving jobs forward in time without changing the assignment to the machine or the execution sequence. After completing all the jobs, we can determine how much each job from the resulting schedule started executing later than was planned in the initial schedule. This is because the jobs in the resulting schedule overlap the jobs in the original schedule. It is necessary to minimize the expected maximum overlap. We propose a mathematical formulation for this problem and conduct computational experiments comparing the effectiveness of constraint, linear, and quadratic programming models heuristically approximating the optimal solution. The goal is to develop an initial schedule with minimal makespan while reducing the expected maximum overlap in the resulting schedule.

Grigoriev Alexey
Saratov State University
The distribution of the average friendship index for nearest neighbors in scale-free networks.

We study the behavior of the average value of the friendship index of the nearest neighbors for a node with a given degree. This value can be used to quantitatively characterize the asymmetry between the degrees of neighboring nodes in a network, as well as to examine the friendship paradox in social networks. Formally, we analyse the distribution of this quantity in undirected scale-free graphs when their sizes tend to infinity. Previously, it has been showed that the limit distribution of friendship index scales depending on the size of the graph. Therefore, we propose in this study a new alternative value - the average friendship rank for nearest neighbors of a node. It will be shown that new measure avoids the shortcomings of the average friendship index.

Kartasheva Anna
International laboratory for Applied Network Research, HSE University
The Normative Dimension of Networks and Bias Resilience

What kind of distortions can we encounter when building intelligent systems? To do this, let us turn to the concept of normativity. Normativity sets guidelines not only for human actions, but also for the settings of intelligent systems that allow us to evaluate reality from multidirectional positions. Some norms are translated formally, others are read by people intuitively. To build intelligent systems, knowledge of existing norms is not enough, since it is necessary to understand their contextual relevance. The ability of intelligent systems to propose, predict and independently

make decisions, in turn, can influence existing systems of normativity, abolishing some norms, transforming and generating others. The report examines both attempts to systematize studies of communication and communicative rationality, and attempts to typify norms: a norm can be understood as an invariant structure, as a generally valid concept, as consensus and as recognition.

Ketkov Sergey
University of Zurich, HSE University lab LATNA

A Study of Distributionally Robust Mixed-Integer Programming with Wasserstein Metric: on the Value of Incomplete Data

This study addresses a class of linear mixed-integer programming (MILP) problems that involve uncertainty in the objective function parameters. The parameters are assumed to form a random vector, whose probability distribution can only be observed through a finite training data set. Unlike most of the related studies in the literature, we also consider uncertainty in the underlying data set. The data uncertainty is described by a set of linear constraints for each random sample, and the uncertainty in the distribution (for a fixed realization of data) is defined using a type-1 Wasserstein ball centered at the empirical distribution of the data. The overall problem is formulated as a three-level distributionally robust optimization (DRO) problem. First, we prove that the three-level problem admits a single-level MILP reformulation, if the class of loss functions is restricted to biaffine functions. Secondly, it turns out that for several particular forms of data uncertainty, the outlined problem can be solved reasonably fast by leveraging the nominal MILP problem. Finally, we conduct a computational study, where the out-of-sample performance of our model and computational complexity of the proposed MILP reformulation are explored numerically for several application domains.

Kaymakov Kirill
HSE University, Coleman Tech LLC
Malyshev Dmitry
NN Branch of HSE University, Moscow Institute of Physics and Technology

Efficient algorithm for finding k-th L_1- or L_∞-distance in a system of plane points.

For a given tuple P=(p_1,…,p_n) of points of the unit square and a number 1≤k≤(n¦2), this talk considers the problem of finding the k-th ordinal distance between elements of P in the l_s-norm, where s∈\{1,∞\}. In other words, it is considered the problem of finding the minimum d_k such that ∑_(i<j)▒I (\|p_i,p_j \|_s≤d_k)≥k is satisfied, where I is the indicator function and s∈\{1,∞\}. In this

talk, for any $\epsilon>0$, we propose an ϵ -approximate algorithm with the computational complexity $O(n \log(n) \log(1/\epsilon))$ to calculate d_k.

Koldanov Petr
HSE University, Lab LATNA

Comparative analysis of conclusions uncertainty on connections between stocks of stock markets.

The problem of analyzing the relationships between stock market returns is considered. The correlation is measured both by the traditional Pearson correlation coefficient and the rank-based Kendall correlation coefficient. Various measures of uncertainty in drawing conclusions about the relationships in stock markets are proposed, based on the method of separating conclusions into significant and admissible. A comparison of the uncertainty in drawing conclusions about relationships in stock markets in Russia, the USA and France is conducted. It is shown that these markets differ insignificantly in terms of the share of uncertain conclusions, regardless of the correlation coefficient used. However, in terms of the ratio of admissible to significant conclusions about relationships, the stock market in Russia is significantly more uncertain.

Latypov Ilgam
Moscow Institute of Physics and Technology,
Institute of Artificial Intelligence Moscow State University

Balancing Efficiency and Interpretability: A New Approach to Multi-Objective Optimization with High Computation Costs in Lipschitz Functions.

In practical engineering and optimization scenarios, tackling multi-objective optimization (MOO) problems often involves employing scalarization methods. Traditional approaches, while being effective, often entail significant computational overhead due to iterative computations. In this paper, we propose a novel method specifically tailored for Lipschitz objective functions aimed at computing function values only once, thus substantially reducing computational costs. This approach is advantageous in scenarios where function computation is expensive or where function values are computed once and then computation become unavailable. Our algorithm uses the Gembchiki\cite{gembicki1975approach} scalarization method, is formulated as a convex optimization problem and offers efficient and practical solution to MOO problems. Additionally, we propose interpretable parameters selection for the scalarization method, enhancing the interpretability and practical applicability of the optimization results. Empirical evaluations, conducted on graph-

based supply network problems, demonstrate the effectiveness and scalability of our approach, highlighting its potential to address computational challenges in MOO across various domains.

Maltseva Daria
International laboratory for Applied Network Research, HSE University
Collaboration structures in Russian sociological community

Modern scientific research is based on the importance of studying social interaction between scientists to determine the effectiveness of scientific teams and consider the structural changes necessary to increase their competitiveness. The community of sociologists in Russia is characterized by weak integration into foreign sociological science and selective representation of researchers in the world scientific discourse due to the peculiarities of its formation, as well as disintegration at the local level due to the high level of centralization and inequality between capitals and regions in modern Russia.

This study is aimed at studying collaboration networks in the local scientific community of Russian sociologists in the period from 2010 to 2021. The main method of data analysis is bibliometric network analysis of publications, which is a special case of using the methodology of social network analysis (SNA). The source of data is the scientific electronic library eLibrary, Using the API service of eLibrary, the authors of the study collected the dataset for analysis – more than 75 bibliographic descriptions of scientific articles in Russian and foreign scientific journals published by Russian sociologists over the specified period of time.

The report will present the methodological approach developed by the authors for collecting, preprocessing, and analyzing bibliographic data in Russian language from eLibrary using a special computer program “Bib-eLib”. The data analysis methodology involves the use of statistical and network analysis of networks of co-authorship and collaboration.

The network analysis strategy used allowed authors to record the main trends in the formation of scientific cooperation practices at the macro level, to identify stable groups of social scientists at the meso level, as well as to extract the most active and productive researchers at the micro level.

In addition to the substantive interest, the scientific novelty and practical significance of the project lies in the development of an integrated methodological approach for the analysis of bibliographic data in Russian, which can be used to study the interactions of Russian researchers from various scientific disciplines.

Keywords: sociology, collaboration, scientific community, social structure, bibliometric analysis

Matveeva Natalia
International laboratory for Applied Network Research, HSE University

How to analyze the structure of collaboration?
The example of leading young universities.

There is a crucial question about the ways of young universities' evolution and the role of collaboration in this development. Co-authorship networks reveal university collaboration structure and it's specific. In our work we analyze co-authorship networks of 8 young universities. These universities have leading positions in World universities rankings. Analyzed universities are from East and Southeast Asia and Europe, and have technical or general profiles. We use publication data from Scopus for 2017-2019 attributed to universities' profiles. Based on this data co-authorship networks of each university were constructed. First, we analyze two-mode authorship networks WA (works ^{x} authors). These networks represent the connection between authors and their works. We analyzed the number of rows (works) and columns (authors), the average number of works per author, the average number of authors per work, max and min authors of a work, the size and proportion of the largest component, the proportion of isolated nodes, size of the main core, number of links in the main core and other. We observe that 7 out of 8 universities have comparable collaboration characteristics and one university differs a lot. This university (HKUST) actively participates in mega-science projects with several thousands of authors. European universities (UM and UPF) have two times more average numbers of authors per work than other universities. We also observe that co-authorship networks of analyzed universities have different sizes. The number of authors and their links differ a lot. For this reason, we normalized the analyzed network to make the publication output of authors comparable. We use both Standard (Newman) and Strict normalization. From normalized co-authorship networks were extracted subsets of the most productive authors (ps-core) and analyzed them. For each university, we try to choose a t-level to make the size of the core comparable (about 100 authors). We observe that in NTU and PolyU universities the level of authors' connectives is the highest and in HKUST is the lowest. Almost all universities have about 40 connected components, only POSTECH University has 32. With that, the size of these components is different. The cores of analyzed universities have different structures. In some universities the core consists of many numbers of isolated small groups (NTU, HKUST, UPF) in others there are big clusters with many numbers of authors (POSTECH for example). In the last stage, we analyze the affiliation and region of authors from the main core. We observe that according to collaboration orientation analyzed universities can be

divided into three groups: 1. Oriented on wide international collaboration: NTU and UTS; 2. Oriented on domestic collaboration: POSTECH, KAIST, UPF. 3. Oriented on region collaboration (with neighboring countries): HKUST, PolyU, UM. So we observe that all analyzed universities actively collaborate with other organizations, and the collaboration strategies are different.

Pavlova Irina
International laboratory for Applied Network Research, HSE University
Exploring International Dimension of Russian Economic Science.

This study is devoted to the analysis of the international dimension of Russian science in the field of economics as a scientific field through the construction of bibliometric maps. The initial data set includes all publications from the Web of Science (WoS) with the criterion of the country data field "CU=(Russia)" of 1,383,996 bibliographic records in WoS (Core Collection) with full record format.

The subset in Business & Economics (SC category, WoS research category) includes 22,839 records. Bibliometric network analysis implemented in VOSviewer was supplemented by the analysis in Biblioshiny web module as well as in R with Bibliometrix library.
The analysis of co-authorship showed that the economic community is quite heterogeneous, but is visualized quite compactly on the bibliometric map. There are a total of 36,078 authors in the preliminary data set for Business & Economics. With setting a limit on the number of publications (the author has at least several publications), only 3534 meet this threshold of at least 3 publications and only 1236 authors meet the threshold of at least 5 publications. In general, the core of the economic community is represented by a number of interconnected clusters of collaborating authors. However, it is worth noting that the economic community tends to work on publications in collaborations rather than on an individual basis.

An analysis of co-authorship collaborations by country showed that a total of 112 countries are represented on the collaboration map with 86 countries meet the threshold of at least 5 publications in the dataset. The top 5 countries include the USA, Great Britain, France, Germany, Italy. Foreign countries form 3 clusters of cooperating countries: (1) European countries, USA, Canada; (2) countries of Southeast Asia, Africa, the Middle East; (3) CIS countries and countries of Central and Eastern Europe. Temporal analysis shows that it is cooperation with the countries of the second cluster that is the youngest in a chronological context.
An analysis of the co-authorship of organizations demonstrates that the core-

periphery cooperation model is not typical for economic research. Leadership among academic institutions remains with the Russian Academy of Sciences and the National Research University Higher School of Economics. Also, on the map of organizations of Russian economic science are traditionally known largest academic structures due to their history, reputation, International Centre of Decision Choice and Analysis and geography (mainly Moscow and St. Petersburg).

Despite the fact that the international dimension of Russian economic research is mainly represented by Russian authors, it was possible to identify patterns of cooperation both within domestic and international research teams (co-authorship, co-occurrence, co-citation). As a general conclusion, it is worth noting that the patterns of collaboration in the Russian economic community in the context of international cooperation are fundamentally different from the same sociological community, the analysis of which was previously carried out by the author of this study. Further research will be devoted to the analysis of other scientific disciplines in Russian science using the WoS database to identify diverse cooperation patterns typical for different scientific disciplines or groups of disciplines.
The study was completed within the framework of the HSE University Basic Research Program.

Sidorov Sergei
Saratov State University
Modelling the triadic closure mechanism in growth complex networks.

The structure and properties of many real networks cannot be meticulously captured by random graph models that cannot generate networks with complex cluster and community patterns. In social graphs, a simple yet realistic mechanism known as triadic closure is considered to be an important factor in producing high clustering and complex community structures. Triadic closure refers to the phenomenon where new links are formed between nodes that have a common neighbor, resulting in the closing of triads. In this talk we examine different types of triadic closure mechanism in growth complex networks.

Souravlas Stravos, Sifaleras Angelo
University of Macedonia, Greece
On scheduling probabilistic block cyclic redistribution.

Block-cyclic data distribution is commonly used to organize array elements on the processors of a coarse-grained distributed memory parallel computer. In many scientific applications, the data layout must be reorganized at run-time in order to

enhance locality and reduce remote memory access overheads. In this paper, we present a general framework for developing array redistribution algorithms by employing probabilistic strategies. Probabilistic strategies are required in order to check and control the probability of certain processors being overloaded in the near future. In such a scenario, changes in the current data distribution are required. The state of the network is controlled via a Markovian network. Using our proposed framework, we have developed efficient algorithms that redistribute an array from one block-cyclic layout to another. Some of the contributions of this work are the following: The proposed probabilistic model can be used independently with any other existing block-cyclic redistribution strategy, not only the one developed in this work. Also, it is simple and does not add any overhead. Finally, it can work proactively in order to avoid possible overloading of certain processors, and thus it is particularly suitable for dynamic distribution problems, that is, during runtime.

Taletskii Dmitrii
HSE University, lab LATNA

New upper bounds for the number of minimum dominating sets in trees

A dominating set in a graph is a subset D of its vertices such that any vertex not belonging to D is adjacent to at least one vertex in D. A dominating set is said to be minimum if it is of minimum cardinality. To date, relatively few estimates of the maximum possible number of minimum dominating sets (MDS) in trees are known. We show that every n-vertex tree with maximum vertex degree at most 4 has at most (√2)^n MDS. Moreover, for all n > 1 we construct an n-vertex tree with maximum vertex degree 5 containing more than (1/3)*(1.415)^n MDS. Finally, we show that every n-vertex tree has fewer than (1.4205)^n MDS.

Tkachev Daniil
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Network analysis of France and China Input-Output table

We consider a network of exchange of goods between sectors of France and China in 2020. Centrality indices are used to identify most important sectors in the network of exchange of goods between economic sectors. We apply classic centrality indices as well as new centrality indices to identify sectors, which might be under risk in case of economic shock. This network can be considered as a directed weighted graph. Each sector and transaction between sectors considered as a node and an edge in this graph respectively. The arrow direction and weight of each edge show direction and the value of considered transaction. The network is based on the official data of exchange of goods between sectors of France and China in 2020 from OECD. OECD provides Inter-Country Input-Output (ICIO) tables for a period 1995-

2020. We refer to them as OECD-ICIO tables and work with the 2023 edition (OECD 2023). It covers 76 countries (including all OECD, European Union, ASEAN and G20 countries) plus rest of the world and 45 industries. 3 Industry classification follows International Standard Industrial Classification (ISIC) of all economic activities revision 4 and covers 17 manufacturing sectors and 28 non-manufacturing sectors. We choose input- output tables for our network analysis as they present transactions in intermediate inputs between sectors which are reported in million USD in the OECD-ICIO tables. New centrality indices take into account properties of vertices and group influence. In this work we use new centrality indices with different values of vertices parameters and compare results with classic centrality indices. The most vulnerable sectors in France and China economy in 2020 by PageRank, Eigenvector, In-degree are Wholesale and retail trade, repair of motor vehicles for France and Construction for China. By Betweenness – Mining support service activities for France, Fishing, and aquaculture for China. By Closeness – IT and other information services for France and Computer, electronic and optical equipment for China. At the same time, the most vulnerable sectors in France economy by new centrality indices with different parameters are Air transport; Arts, entertainment and recreation; Financial and insurance activities; Warehousing and support activities for transportation; Rubber and plastic products; Professional, scientific and technical activities. The most vulnerable sectors in China economy according to new centrality indices with different parameters are Professional, scientific and technical activities; Financial and insurance activities; Fishing and aquaculture; Agriculture, hunting, forestry. The detailed results will be presented in conference.

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Federated Machine Learning and Weather Applications with Imbalanced Data

Federated learning is a distributed machine learning (ML) paradigm that allows for the collaborative training of models across various agents without directly sharing sensitive data, ensuring privacy and robustness. In this talk I discuss federated ML, investigating the algorithmic and data-driven challenges of deep learning models in the presence of additive noise in this framework. I also discuss a real-world application of federated ML in weather prediction applications that suffer from the issue of imbalanced datasets. Using data from multiple sources combined with advanced data augmentation techniques show that the accuracy and generalization of weather prediction models is improved.