12th International Conference on Network Analysis NET 2022

Nizhny Novgorod, May 23–25, 2022

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

Location: Zoom

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Plenary speakers

Vladimir Batagelj (IMFM, Ljubljana; IAM UP, Koper; HSE, Moscow)
On projections of two-mode networks

Adil Erzin (Novosibirsk State University and Sobolev Institute of Mathematics of Russian Academy of Science)
Packing 2-bar charts into a strip

Alexander Kononov (Sobolev Institute of Mathematics, Laboratory of Mathematical Models of Decision Making, Novosibirsk)
Multistage deterministic optimization problems: hardness and approximability compared to static analogues

Lina Mallozzi (University of Naples Federico II, Naples, Italy)
Optimal transport mass theory and bilevel optimization models

Giuseppe Nicosia (University of Catania, Italy)
Artificial Neural Networks as Complex Networks

Panos Pardalos (University of Florida, USA and HSE NN)
Cliques. Quasi Cliques, and Clique Partitions in Graphs

Jun Pei (Hefei University of Technology, China)
Creative Operation Management and Coordinated Efficient Scheduling based on the Platform

Martin Gomez Ravetti (Federal University of Minas Gerais, Brazil)
Network Diffusion Capacity

Dmitry Shabanov (Laboratory of Advanced Combinatorics and Network Applications, National Research University Moscow Institute of Physics and Technology (MIPT))
On the limit distribution of the chromatic number of a random graph

Conference schedule

Monday, May 23

	Speaker	Title
15:00-15:40	Opening lecture: Panos Pardalos	Cliques. Quasi Cliques, and Clique Partitions in Graphs
15:40:16:30	Plenary lecture Vladimir Batagelj	On projections of two-mode networks
16:30-16:40	Coffee break	
16:40-17:00	Fuad Aleskerov	Network Analysis of Publications on Studies of Parkinson Disease
17:00-17:20	Dmitry Egorov	Network analysis of food exports and imports
17:20-17:40	Ekaterina Vasilieva	Communities in world input-output network: robustness and rankings
17:40-18:00	Mario Guarracino	On fuzzy clustering of networks ensembles
18:00-18:20	Alexander Ponomarenko	Surface waves prediction based on long-range acoustic backscattering in a mid-frequency range
18:20-18:40	Pierre Miasnikof	Quadratic relaxations of two graph clustering formulations

The conference is organized in distant format, in Zoom

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Tuesday, May 24

Morning

	Speaker	Title
10:00-10:50	Plenary lecture Alexander Kononov	Multistage deterministic optimization problems: hardness and approximability compared to static analogues
10:50:11:40	Plenary lecture Lina Mallozzi	Optimal transport mass theory and bilevel optimization models
11:40-11:50	Coffee break	
11:50-12:10	Sergey Ketkov	On the multi-stage shortest path problem under distributional uncertainty
12:10-12:30	Dmitry Gribanov	Faster ILP Algorithms for Problems with Sparse Matrices
12:30-12:50	Nikita Severin	Dynamic Graph Representation Learning via Time-Interval Graph Neural Network
12:50-13:10	Alexander Tolmachev	On the partitions of a two-dimensional torus into parts of minimal diameter

Afternoon

	Speaker	Title
15:00-15:50	Plenary lecture Adil Erzin	Packing 2-bar charts into a strip
15:50:16:40	Plenary lecture Jun Pei	Creative Operation Management and Coordinated Efficient Scheduling based on the Platform
16:40-16:50	Coffee break	
16:50-17:20	Invited talk Martin Ravetti	Network Diffusion Capacity
17:20-17:40	Alexey Grigoriev	Trend Stationarity of the Average Degree for a Node's Neighbors in Growth Networks
17:40-18:00	Dmitry Semenov	Building a set of connected stocks with given confidence

Wednesday, May 25

	Speaker	Title
10:00-10:50	Plenary lecture Dmitry Schabanov	On the limit distribution of the chromatic number of a random graph
10:50:11:40	Plenary lecture Giuseppe Nicosia	Hypergraphs and Optimization for the Overproduction of Sustainable Chemicals
11:40-11:50	Coffee break	
11:50-12:10	Artem Sokolov	Towards speech emotion recognition in Russian domain
12:10-12:30	Xinze Li	Predicting Molecule Toxicity via Graph Neural Networks
12:30-12:50	Vsevolod Voronov	Continuous embeddings of unit distance graphs in a sphere
12:50-13:10	Dmitry Mokeev	Fixed size paths partitions of the threshold graphs

The conference is organized in distant format, in Zoom

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Plenary and Invited talks

Vladimir Batagelj

IMFM, Ljubljana; IAM UP, Koper; HSE, Moscow

On projections of two-mode networks

In a *two-mode* (affiliation or bipartite) network $N = ((U, V), L, w)$ the set of nodes is split into two disjoint sets (*modes*) U and V. Each link $e \in L$ has one end-node in the set U and the other end-node in the set V. The function $w: L \to R$ assigns to each link its weight. The network is called *binary* iff $w(e) = 1$ for every $e \in L$. Examples of two-mode networks are attendance of persons to events, membership of persons in institutions, papers linked to their authors, votings of representatives on bills, purchasing of goods by customers, etc. The network N can be described by the corresponding matrix $\boldsymbol{UV}$. $UV[u, v] = w(u, v)$ for $(u, v) \in L$, and $UV[u, v] = 0$ otherwise.

An approach to the analysis of a two-mode network is its conversion or projection to an ordinary (one-mode, weighted) network on a selected set of nodes. This network can be analyzed further using standard network analysis methods. The standard projection to the second mode V is obtained by multiplying the transposed network matrix with the network matrix, $\boldsymbol{VV} = \boldsymbol{UV}^T \cdot \boldsymbol{UV}$. In a binary network, the entry $VV\ [v_1, v_2]$ of the projection matrix counts the number of ways we can move in the original network from the node v_1 through some first mode node to the node v_2. There are some problems with the standard projection (Batagelj, 2020). They can be resolved using network normalizations – the fractional approach. Especially we point to the role of the first mode nodes of degree 0 or 1.

Another type of projection is based on a (dis)similarity measure d on vectors over R, $VV[v_1, v_2] = d(UV[., v_1], UV[., v_2])$. In many cases, we can show how these measures are related to the standard projection (Batagelj, 2022). For illustrations, we present the results of applications of projections to some real-life networks.

1. Batagelj, V.: On fractional approach to analysis of linked networks. Scientometrics 123 (2020) 2: 621-633

2. Batagelj, V.: Analysis of the Southern women network using fractional approach. Social Networks 68(2022), 229-236

Adil Erzin

Novosibirsk State University and Sobolev Institute of Mathematics of Russian Academy of Science

Packing 2-bar charts into a strip

This is a new combinatorial optimization problem that generalizes the Bin Packing Problem and the 2D Vector Packing Problem. On the other hand, it is a special case of the Project Scheduling Problem with one limited renewable resource, when each project consists of two uninterrupted jobs of unit duration. The problem is to find a packing of bar charts consisting of two bars each into a unit-height strip of minimum length. We have proposed several polynomial approximation algorithms with non-trivial guaranteed accuracy estimates, both in general and in particular cases.

Alexander Kononov

Sobolev Institute of Mathematics, Laboratory of Mathematical Models of Decision Making, Novosibirsk.

Multistage deterministic optimization problems: hardness and approximability compared to static analogues

We review the recent results for the multi-stage deterministic problems introduced by Gupta et al. and Eisenstat et al., both in ICALP 2014. We are given a discrete time horizon and a set of instances of a combinatorial optimization problem, one for each time step. It is required to find a sequence of solutions, one solution per instance, optimizing the quality of the solution at each time step and stability (moving costs or profit) between solutions at successive time steps. For a sequence of solutions of a minimization multistage problem, the service cost is defined as the sum of the cost of the solutions of each individual instance over the time horizon, while the moving cost is defined as the sum of the costs induced by changing the solution at successive time steps of the time horizon. The goal is to find a sequence of solutions minimizing the sum of the service cost and the moving cost.

Lina Mallozzi

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

Optimal transport mass theory and bilevel optimization models

Optimal transport theory is widely used to solve problems in mathematics and different areas of the sciences. We present and discuss two-stage optimization models corresponding to economic equilibrium problems. A distribution of citizens in an urban area, where a given number of services must be located, is given. Citizens are partitioned in service regions such that each facility serves the customer demand in one of the service regions. At first, it is assumed that the demand is totally satisfied and in the spirit of a market survey, a social planner divides the market region into a set of service regions in order to minimize the total cost: the objective is to find the optimal location of the services in the urban area and the related costumers partition. Existence results are obtained by using optimal transport mass tools. Similar models where a given number of dimensional facilities must be located are also considered.

Giuseppe Nicosia

University of Catania, Italy

Hypergraphs and Optimization for the Overproduction of Sustainable Chemicals

Panos Pardalos

University of Florida, USA;

Laboratory of Algorithm and Technologies for Network Analysis, HSE University, Nizhny Novgorod, Russia

Cliques. Quasi Cliques, and Clique Partitions in Graphs

The maximum clique problem and its variations is an NP-complete problem with many applications in diverse fields such as network analysis, drug design, and cryptography. In this lecture we will discuss different algorithms and applications, recent developments, and open problems.

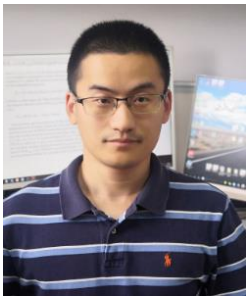
Jun Pei

Hefei University of Technology, China

Creative Operation Management and Coordinated Efficient Scheduling based on the Platform

The sharing economy has developed rapidly in recent years using both business-to-customer (B2C) and customer-to-customer (C2C) models. This has exerted a profound impact on incumbent firms that follow a traditional sales model. Although the effects of B2C or C2C sharing in certain scenarios have been studied by prior literature, the effect of external B2C sharing has not been considered. The possible distinction between the two sharing effects as well as incumbent firms' decisions on the sales and sharing models under the internal and external environments have not been addressed. In this talk, the effects of B2C and C2C sharing are compared in an internal sharing scenario where an incumbent firm can extend into the sharing business, and an external sharing scenario is considered where an independent entrant firm can provide B2C or C2C sharing and strategically set price. Furthermore, this talk will also introduce some novel scheduling problems based on the platform in these scenarios.

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.

Martin Gomez Ravetti

Federal University of Minas Gerais, Brazil

Network Diffusion Capacity

Improving the understanding of diffusive processes in networks is one of the main challenges of today's complexity science. Intrinsically, structures possess a diffusive potential that depends on their topological configuration. However, the diffusion of a process depends not only on this characteristic but also on the dynamical process itself.

In this work, we introduce a measure called Diffusion Capacity that quantifies the potential of an element or a system as a diffusive agent. Quantifying this potential will allow the design of more efficient systems in which it is necessary either to weaken or enhance diffusion. As a theoretical example, we present a heat diffusion model, and as examples, we study the heat diffusion of superficial air on Earth.

We show how Diffusion Capacity provides an efficient tool to study the dynamics of diffusive systems and how they can be used to identify structural modifications that could improve diffusion mechanisms.

Dmitry Shabanov

Laboratory of Advanced Combinatorics and Network Applications, National Research University Moscow Institute of Physics and Technology (MIPT)

On the limit distribution of the chromatic number of a random graph

A random graph in the binomial model $G(n,p)$ (a random graph in the Erdős-Renyi model) has been the main object of study in the probabilistic combinatorics since the end of the 50-s of the past century. One of first question posed by P. Erdős was a question concerning the asymptotic behavior of the chromatic number of the random graph $G(n,1/2)$, i.e. of the ``typical" chromatic number of a graph on n vertices. This problem attracted the attention of all the world's leading researchers in the probabilistic combinatorics, but the law of the large numbers for the chromatic number of $G(n,1/2)$ was established by B. Bollobás only in 1998. For not fast-growing product np, the chromatic number of $G(n,p)$ turns out to be concentrated in two consecutive numbers, which however were unknown. We will present our recent results where these values have been found for almost all functions $p = p(n)$ up to $o(n^{-3/4})$.

Regular talks

Fuad Aleskerov, Olga Khutorskaya, Vyacheslav Yakuba, Anna Stepochkina, Ksenia Zinovyeva

National Research University Higher School of Economics, Moscow

"Network Analysis of Publications on Studies of Parkinson Disease"

Thousands of scientific publications are made in each field of study every year. It is necessary to take into account major trends and previous experience in certain research areas and understand the contribution of different themes into it.

We analyze publications on Parkinson's Disease over the period from 2015 to 2021 in order to identify tendencies. Parkinson's Disease (PD) is a neurodegenerative disorder of the central nervous system. More than 10 million people worldwide are living with it. There have been more than 70 thousand publications from 4912 different journals over the selected period. After the data preprocessing 39811 publications and 3292 journals are left. 9626 publications are not cited at all, the rest have from 1 to 500 citations and only one paper is cited more than 1500 times.

Different methods can be applied to this problem. We have used centrality analysis as a part of network analysis. A citation networks for papers and journals have been built. The network is a weighted directed graph with papers or journals as vertices and citation between them as edges.

Classical and new centrality indices have been calculated for papers and journals over the whole period and over the years. The new indices take into account different parameters of vertices, as well as group and indirect influence. Moreover, with changing the parameters we can identify groups of specialized journals, which intensively cite each other, and unique scientific fields that are not directly related to Parkinson's Disease but have a strong influence on this branch of science.

Ilaria Bombelli (1) , Ichcha Manipur (2) , **Mario Rosario Guarracino (**2, 3), and Maria Brigida Ferraro (1)

(1) Department of Statistical Sciences, Sapienza University of Rome, Rome, 00185, Italy, (2) Institute for High-Performance Computing and Networking, National Research Council, Naples, 80131, Italy, (3) Department of Economics and Law, University of Cassino and Southern Lazio, Cassino, 03043, Italy.

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"On fuzzy clustering of networks ensembles"

As the statistical analysis of networks finds application in an increasing number of disciplines, novel methodologies are needed to handle such complexity. In particular, cluster analysis is among the most successful and ubiquitous data exploration and characterisation techniques. In this work, we focus on the fuzzy clustering of ensembles of networks. Networks are represented using probability distributions of topological properties or vector representations derived from whole-graph embedding methods. We compare two fuzzy computational procedures for clustering multiple networks on synthetic data, where each network represents an observation . Finally, we apply this approach to a real-world case study.

Dmitry Gribanov

Laboratory of Algorithm and Technologies for Network Analysis, HSE University, Nizhny Novgorod, Russia

Faster ILP Algorithms for Problems with Sparse Matrices

We give an ILP algorithm for problems with sparse constraint matrices, whose theoretical complexity bound is better than the currently known state of the art complexity bound. We apply the last result for multipacking and multicover problems on graphs and hypergraphs, where we need to choose a minimal/maximal multiset of vertices to cover/pack the edges by a prescribed number of times. For example, we show that the stable multiset and vertex multicover problems on simple graphs admit single-exponential FPT-algorithms parameterized by the number of vertices.

Alexey Grigoriev, Sergei Sidorov, Sergei Mironov

Saratov State University

“Trend Stationarity of the Average Degree for a Node's Neighbors in Growth Networks”

We consider a process describing the dynamics of the average degree of a node's neighbors in growing networks. For each individual node in networks generated by preferential attachment models, this process is a non-stationary Markov process. Using the mean field approach, we find the unconditional expectation of this process at an arbitrary point in time. In addition, we find the dynamics of the expected value for the variation of this process over time. The results show that variation of the average degree of neighbors of a fixed vertex in networks generated using the Barabasi-Albert model (as well as the triadic closure model) tends to zero. The main research question addressed in the talk is whether this phenomenon is carried out in real networks. To answer this question, we study the behavior of the average degree of a node’s neighbors in six real dynamic networks.

Fuad Aleskerov[1,2], **Dmitry Egorov[1]**, Vyacheslav Yakuba[2,1]

1. *National Research University Higher School of Economics, Moscow, Russia;*
2. *V.A.Trapeznikov Institute of Control Sciences of Russian Academy of Sciences, Moscow, Russia*

“Network analysis of food exports and imports"

We discuss the role of individual economies in the global food network. An analysis of the structure and dynamics of commodity flows reveals changes in the global food market over 2016 – 2020. The problem is related to the global problem of food insecurity, which remains acute on the international level. The use of classical centrality indices and centrality indices that take into account short-range (SRIC) and long-range (LRIC) interactions in the networks makes it possible to assess the direct and indirect influence of the economies on the food supply chains.

Special attention is given to the comparison of the networks built for different categories of food products, for instance, meat, dairy products, fish and cereals.

Alexey Ermoshkin[1], Dmitry Kosteev[1], **Alexander Ponomarenko**[2], Dmitry Razumov[1], Mikhail Salin[1]

1. *Center for hydroacoustics and Geophysical research division, Institute of Applied Physics of the Russian Academy of Sciences, Nizhny Novgorod, Russia*
2. *Laboratory of Algorithm and Technologies for Network Analysis, HSE University, Nizhny Novgorod, Russia*

Surface waves prediction based on long-range acoustic backscattering in a mid-frequency range

New data was obtained for a frequency band that had not been so well-studied for sea surface probing applications before. During the described 2-weeks sea experiment 1-3 kHz tonal pulses were emitted from a platform, located on the northern Black Sea shelf, and Doppler spectrum of reverberation was studied. We believe that this band is worth further studying due the sound propagation range is large enough to meet practical needs in coastal zone while the angle-distance resolution is quite moderate. However, it is quite difficult to interpret the obtained data since backscattering spectrum shape is influenced by a series of effects and has a complicated link to wind waves and currents parameters. Backscattering of acoustical signals was received for distances around 2 nautical miles. Significant wave height, dominant wave frequency were estimated as the result of such signals processing with the use of machine learning tools. A decision-tree-based mathematical regression model was trained to solve the inverse problem. Wind waves prediction is in a good agreement with direct measurements, made on the platform, and machine learning results allow physical interpretation.

Sergey Ketkov

National Research University Higher School of Economics, Nizhny Novgorod

“On the multi-stage shortest path problem under distributional uncertainty"

In this study we consider an ambiguity-averse multi-stage network game between a user and an attacker. The arc costs are assumed to be random variables that satisfy prescribed first-order moment constraints for some subsets of arcs and individual probability constraints for some particular arcs. The user aims at minimizing its cumulative expected loss by traversing between two fixed nodes in the network, while the attacker maximizes the user’s objective function by selecting a distribution of arc costs from the family of admissible distributions. In contrast to most of the previous studies in the related literature, both the user and the attacker can dynamically adjust their decisions at each node of the user’s path. By observing the user’s decisions, the attacker needs to reveal some additional distributional

information associated with the arcs emanated from the current user's position. It is shown that the resulting multi-stage distributional robust shortest path problem admits a linear mixed-integer programming reformulation (MIP).

In particular, we distinguish between acyclic and general graphs by introducing different forms of non-anticipativity constraints. Finally, we perform a numerical study, where the quality of adaptive decisions and computational tractability of the proposed MIP reformulation are explored with respect to several classes of synthetic network instances.

Xinze Li, Ilya Makarov, Dmitrii Kiselev

Laboratory of Algorithm and Technologies for Network Analysis, HSE University, Nizhny Novgorod

Predicting Molecule Toxicity via Graph Neural Networks

Predicting molecular properties with Graph Neural Networks (GNNs) has drawn lots of attention recently. In cases where labeled molecules are insufficient, an effective approach is to pre-train GNNs on large-scale unlabeled molecular data, and then finetune them on downstream tasks. However, pre-training on graph for molecular property prediction remains challenges: (1) node-level auxiliary tasks do not preserve useful domain knowledge; (2) fusion of motif-based methods and node-level tasks are computationally extensive. To address them both, we propose Descriptor-based Graph Self-supervised Learning (DGSSL), which is a method utilizing domain knowledge to assist graph representation learning. Specifically, it detects active or descriptor centers in molecules and encodes the motif-like information as special atomic numbers in pre-training task, which enables node-level self-supervised pre-training frameworks for GNNs can also capture the rich information in local subgraphs. Experiments show that our method achieves state-of-the-art performance on three toxicity-related benchmarks

Ilya Makarov, **Nikita Severin**

Laboratory of Algorithm and Technologies for Network Analysis, HSE University, Nizhny Novgorod, Russia

Dynamic Graph Representation Learning via Time-Interval Graph Neural Network

Graph representation learning is a family of techniques which project nodes, edges or subgraphs into vector spaces that can be used for solving downstream tasks. Since

there are a lot of real-world networks evolving over time, research efforts on dynamic network embedding have been increasing in recent years. Many existing methods represent graph evolution as a sequence of node-wise events. To update node embeddings, they consider all events independently, processing one after another or several events in parallel, which leads to the following problems. On the one hand, such models take into account only evolution of local substructures, ignoring graph-level structural changes. On the other hand, they are limited to work only with small sets of events at a time, which leads to high computational complexity. To overcome aforementioned challenges, we present a novel approach based on encoding temporal information into a sequence of time-interval patches. The proposed model can be implemented as an additional block for the existing ones or used independently in downstream graph machine learning models.

Pierre Miasnikof

University of Toronto, Canada

Quadratic relaxations of two graph clustering formulations

We begin with an introduction to the graph clustering (network community detection) problem. We describe two binary quadratic formulations from the literature, which we have tailored to the graph clustering problem. We then relax these formulations and convert them into constrained quadratic optimization problems. Performance, clustering quality is assessed by comparing the intra-cluster densities of the clusters identified by our optimization routine to the known densities of our test cases. These test cases are generated using the stochastic block model. We end this talk with a presentation of preliminary results. Future work will include performance comparisons against two meta-heuristic techniques, simulated annealing and particle swarm optimization.

Dmitry Mokeev

NRU Lobachevsky State University of Nizhny Novgorod, NRU Higher School of Economics in Nizhny Novgorod

Fixed size paths partitions of the threshold graphs

Abstract: The problem of partitioning a graph into k-paths is as follows. Given a graph G with the number of vertices $|G|$ multiple of k. It is required in the graph G to find $|G|/k$ paths of size k that do not contain pairwise common vertices or show that such a partition does not exist.

Partitioning problems arise in the design of electronic boards using a computer and are studied from the point of view of parameterized complexity. It is known that the

problem is NP-complete for $k \geq 3$ for general graphs, for subcubic bipartite graphs, and for planar bipartite graphs.

A graph is called threshold if it can be built from a single-vertex graph by sequentially adding one isolated vertex or a dominant vertex (i.e. a single vertex connected to all other vertices) to the graph.

We study the computational complexity of the problem in the class of threshold graphs and prove its polynomial solvability for arbitrary k in this class.

Dmitry Protasov, **Alexander Tolmachev**, Vsevolod Voronov

Moscow Institute of Physics and Technology,
Caucasus Mathematical Center of Adyghe State University

"On the partitions of a two-dimensional torus into parts of minimal diameter"

We consider the problem of calculating the minimal value of d_k at which a two-dimensional torus R^2/Z^2 can be split into k parts whose diameter does not exceed d_k. Some estimates are proved for small values of k. Using a global search algorithm based on generating an initial partition and applying a stochastic gradient descent algorithm, upper estimates of d_k are obtained for $k \leq 20$.

Dmitry Semenov, Petr Koldanov

Laboratory of Algorithm and Technologies for Network Analysis, HSE University, Nizhny Novgorod

Building a set of connected stocks with given confidence.

The paper considers the task of analyzing the relationships between stocks based on the results of observations of their returns.

To reliably identify pairs of strongly connected stocks, procedures for constructing confidence sets of a given level are proposed. To construct such sets, multiple hypothesis testing procedures are used. One-step statistical procedures are investigated, constructed using three types of individual tests: Pearson, Kendall, Fechner. The dependence of the confidence probability, the size of the constructed confidence set and the average number of links that did not fall into the confidence set, on the model of joint behavior of stock returns, such as individual tests and the volume of observations, is studied. The results of statistical modeling show the stability of procedures based on a combination of individual Kendall and Fechner tests, and the instability of procedures based on a combination of individual Pearson tests.

Artem Sokolov

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

“Towards speech emotion recognition in Russian domain.”

The talk covers speech emotion recognition (SER) task, provides the overview of popular approaches and datasets. Described new corpus with Russian speech that collected internally by Sber called Dusha. Finally, I describe several experiments with the MobileNetV2-based neural network architecture and a self-attention layer described in SAGAN.

Ekaterina Vasilyeva

P.N. Lebedev Physical Institute of the Russian Academy of Sciences

“Communities in world input-output network: robustness and rankings"

The study is made by A. Kireyev (IMF), A. Leonidov (LPI, MIPT), S. Radionov (LPI, HSE, FRC CSC RAS, FRIMF) and E. Vasilyeva (LPI, MIPT)

We introduce a method for assessing the robustness of community detection and apply it to a world input-output network (WION) to obtain economically plausible results. This method enabled us to rank communities in the WION in terms of their robustness and stability. The algorithmic assignment variability index proposed in this study is shown to have predictive power in terms of forthcoming community rearrangement. We also provide several new approaches for identifying key economic communities. These approaches are based on the application of several centrality measures to a synthetic network in which nodes represent WION communities. Using these methods, we show that in 2000–2014, United States and Japan-centered communities demonstrated decreasing trends, while the importance of the China-centered community predominantly increased. A notable feature of the Germany-centered community rank evolution is that its influence grew only as a result of the inclusion of the Netherlands and Belgium in 2013.

The talk will be based on the results presented in
https://doi.org/10.1371/journal.pone.0264623

Vsevolod Voronov

Caucasus Mathematical Center of Adyghe State University

“Continuous embeddings of unit distance graphs in a sphere”

We consider the problem of finding a realization of some graph G as a graph of unit distances on a two-dimensional sphere of radius r. A realization that is continuously dependent on r provides a constructive lower bound for the chromatic number of the sphere on some interval of radius values. An optimization algorithm is proposed to find such realizations. Based on L. Lovasz's construction, a number of new estimates were obtained.