International Conference NET 2023. Confirmed invited speakers. Abstracts of talks

Fuad Aleskerov,

Bibliometric analysis of publications on Parkinson's Disease

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Parkinson's Disease is the second most common neurodegenerative disorder in the world. Thousands of scientific works are published every year. Therefore, it is essential to apply modern research methods and computational techniques for the analysis of the large amount of bibliometric data. We have collected and preprocessed information about more than 70 thousand publications, almost 40 thousand authors, more than 3 thousand affiliations and 3 thousand journals on various aspects of Parkinson's Disease in the period from 2015 to 2021. We have constructed and analyzed citation networks for publications, journals, authors and organizations published their scientific works on Parkinson's Disease.

In this work 4 classical centrality indices (In-degree, Eigenvector, Pagerank and Betweenness) and 2 new centrality indices have been evaluated for the citation networks. The new indices allow to take into account a group influence, and identify pivotal nodes. Using these methods, we have identified the most influential publications, journals, authors and organizations in the scientific area of Parkinson's Disease

Roberto Battiti,

Università degli Studi di Trento, Italy, LION lab

Machine Learning and Intelligent Optimization: two married topics

Learning and Intelligent Optimization (LION) is the combination of Machine Learning from data and Optimization to solve complex and dynamic problems. The LION way is about increasing the automation level and connecting data directly to decisions and actions. This context is related to prescriptive analytics, the third and final phase beyond descriptive (old-style business intelligence) and predictive analytics. LION's adoption will create a prairie fire of innovation that will reach most businesses in the next decades. Optimization is surely used for Machine Learning but the contrary direction is also of interest: to use learning from data to create more efficient heuristic optimization algorithms.

Mario Guarracino,

University of Cassino and ICAR-CNR, Italy and lab LATNA HSE University

Biological networks provide benchmarks for graph algorithms

In this talk, we describe TumorMet, a repository of networks extracted from context-specific genome-scale metabolic models of different tumor types. These networks provide benchmarks for graph algorithms and statistical network analyses. Researchers and practitioners can use this repository in graph and whole-graph classification, clustering, and community detection studies. Along with the data, we developed and provided Met2Graph, a software package for creating different graphs, and easy generation of datasets for downstream analysis.

This work is in collaboration with Ilaria Granata, Ichcha Manipur, Maurizio Giordano, and Lucia Maddalena

Ilaria Granata,
ICAR-CNR, Italy
Biological networks to predict context-specific essential genes

Essential genes are critical for the growth and survival of cells. Their prediction in a context-specific manner is of great value in exploring the mechanism of complex diseases, the study of the minimal required genome for living cells and the development of new drug targets. From PPI to disease networks, from healthcare systems to scientific knowledge, biomedical networks are general descriptions of systems of interacting entities. In the last decade, we have seen a quick expansion of representation learning approaches for modelling, analysing, and learning such networks, thanks to their extraordinary effectiveness in giving significant predictions and insights. In this scenario, the description and representation of biological systems through network structures allow extracting additional knowledge other than the biological and genetic attributes characterising the gene essentiality. To this extent, here we present the usage of tissue-specific PPI and metabolic networks enriched with topological, biological and embedding-derived features to develop a deep learning-based model for predicting essential genes.

Dmitry Ignatov,
HSE University, Laboratory for Models and Methods of Computational Pragmatics
Multimodal clustering for community detection: searching for relevant approximations

Multimodal clustering is an unsupervised technique for mining interesting patterns in *n*-ary relations or *n*-mode networks. Among different types of such generalised patterns one can find biclusters and formal concepts (maximal bicliques) for two-mode case, triclusters and triconcepts for three-mode case, closed *n*-sets for *n*-mode case, etc. Object-attribute biclustering (OA-biclustering) for mining large binary datatables (formal contexts or two-mode networks) arose by the end of the previous decade due to the intractability of computation problems related to formal concepts; this pattern type was proposed as a meaningful and scalable approximation of formal concepts. In this talk, we present recent advances in OA-biclustering and its extensions to mining multi-mode communities in the SNA setting. We also discuss the connection between clustering coefficients known in the SNA community for one-mode and two-mode networks and OA-bicluster density, the main quality measure of an OA-bicluster. We also mention how concentration inequalities can reduce complexity in the bicluster's density estimation within a guaranteed error. Our experiments with two-, three-, and four-mode large real-world networks show that this pattern type is suitable for community detection in multi-mode cases within a reasonable time even though the number of corresponding *n*-cliques is still unknown due to computation difficulties. An interpretation of OA-biclusters for one-mode networks is provided as well.

Maksim Zhukovskii,
University of Sheffield, Department of Computer Science, UK and MIPT
Saturation in random graphs.

The F-saturation number of a graph G is the minimum number of edges in F-free inclusion-maximum subgraph of G. New general bounds of F-saturation numbers of random graphs will be presented in the talk

Andrey Leonidov,
Lebedev Physical Institute of the Russian Academy of Sciences and MIPT
Noisy discrete choice games on graphs

Static equilibria and dynamical evolution of noisy binary and ternary choice games on random graphs are discussed. The effect of farsightedness of agents resulting in the phenomenon of strategic cooling for the noisy binary choice game on complete graph is described.

Elena Konstantinova
University of Novosibirsk and Sobolev Institute of Mathematics
Integral networks

Since 1986 (SIAM International Conference on Parallel Processing), Cayley graphs are used as a "tool to construct vertex-symmetric interconnection networks." In 2009, O. Ahmadi, N. Alon, I.F. Blake, and I.E. Shparlinski studied graphs with integral spectrum, i.e.whose eigenvalues are integers. It was shown that the most graphs have nonintegral eigenvalues. On the other hand, it was noted that integral graphs play an important role in quantum networks supporting the so-called perfect state transfer. In this talk we discuss recent results on integral networks presented by Cayley graphs over the symmetric group.

Darya Maltseva,
HSE University, International laboratory for Applied Network Research
Structures of collaboration in the Russian sociological community

Modern science research proceeds from the importance of studying the social interaction between scientists and their teams to determine their effectiveness, and successfully uses the tools of bibliometric analysis to study networks of co-authorship and collaboration. The community of Russian sociologists 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.
Our study is aimed at studying collaboration networks in the scientific community of Russian sociologists in the period from 2010 to 2019. The main method of data analysis is the bibliometric network analysis of publications, which is a special case of applying the social network analysis methodology. To build networks of collaborations between Russian sociologists, the methodology of bibliometric network analysis is used. 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.

Pierre Miasnikof,
University of Toronto, Canada
Clusterability in a directed graph

I will begin with a review of our statistical technique to assess clusterability of a graph. Graph clustering (netwoerk community detection) is a pivotal topic in network science. Clustering algorithms will always identify clusters, regardless of the underlying network structure. Clustering a graph that does not have a clustered structure is not only a waste of time, it inevitably leads to misleading conclusions. Our statistical procedure aims to determine if a graph meets the prerequisite structure for clustering to be worthwhile. I will end with a presentation of our recent work which extends this test procedure to directed graphs.
NB. This talk will offer a synopsis of three different papers, two published & one in progress.

Joint work with Demni, Guaraccino, Prokhorenkova, Raigorodskii, Shestopaloff (in alphabetical order)

Panos Pardalos,
University of Florida, USA and HSE University, lab LATNA
Diffusion capacity of single and interconnected networks

This lecture addresses the significant challenge of comprehending diffusive processes in networks in the context of complexity. Networks possess a diffusive potential that depends on their topological configuration, but diffusion also relies on the process and initial conditions. The lecture introduces the concept of Diffusion Capacity, a measure of a node's potential to diffuse information that incorporates a distance distribution considering both geodesic and weighted shortest paths and the dynamic features of the diffusion process. This concept provides a comprehensive depiction of individual nodes' roles during the diffusion process and can identify structural modifications that may improve diffusion mechanisms. The lecture also defines Diffusion Capacity for interconnected networks and introduces Relative Gain, a tool that compares a node's performance in a single structure versus an interconnected one. To demonstrate the concept's utility, we apply the methodology to a global climate network formed from surface air temperature data, revealing a significant shift in diffusion capacity around the year 2000. This suggests a decline in the planet's diffusion capacity, which may contribute to the emergence of more frequent climatic events. Our goal is to gain a deeper understanding of the complexities of diffusive processes in networks and the potential applications of the Diffusion Capacity concept.

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Marcello Pelillo,
Ca' Foscari University of Venice, Italy
From Optima to Equilibria: Game-Theoretic Models of Pattern Analysis and Recognition.

Abstract: The development of game theory in the early 1940's by John von Neumann was a reaction against the then dominant view that problems in economic theory should be formulated using standard optimization theory. Indeed, most real-world economic problems typically involve conflicting interactions among decision-making agents that cannot be adequately captured by a single (global) objective function, thereby requiring a more sophisticated treatment. Accordingly, the main point made by game theorists is to shift the emphasis from optimality criteria to equilibrium conditions. Because it provides
an abstract, theoretically grounded framework to elegantly model complex scenarios, game theory has found a variety of applications not only in economics and, more generally, social sciences but also in different fields of engineering and information technologies. In this talk, after a short introduction to the basic concepts of game theory, I'll provide an overview of the work I've done in the past few years aimed at reformulating a number of pattern recognition problems in terms of game-theoretic problems. These include, e.g., clustering, semi-supervised learning, graph matching, and contextual classification. Applications of these ideas to computer vision will be discussed. [I shall assume no pre-existing knowledge of game theory by the audience, thereby making the talk self-contained and understandable by a non-expert.]

Bio Sketch: Marcello Pelillo is a Professor of Computer Science at Ca' Foscari University, Venice, where he leads the Computer Vision and Machine Learning Group. He has been the Director of the European Centre for Living Technology (ECLT) and has held visiting research positions at Yale University (USA), University College London (UK), McGill University (Canada), University of Vienna (Austria), York University (UK), NICTA (Australia), Wuhan University (China), Huazhong University of Science and Technology (Wuhan, China), South China University of Technology (Guangzhou, China). He is an external affiliate of the Computer Science Department at Drexel University (USA) and of the Italian Institute of Technology. His research interests are in the areas of computer vision, machine learning and pattern recognition where he has published more than 200 technical papers in refereed journals, handbooks, and conference proceedings. He has been General Chair for ICCV 2017, Program Chair for ICPR 2020, and he is regularly an Area Chair for the major conferences in his field. He is the Chief Editor of Frontiers in Computer Science – Computer Vision, and serves (or has served) on the Editorial Boards of several journals, including IEEE Transactions on Pattern Analysis and Machine Intelligence, Pattern Recognition, IET Computer Vision, Visual Intelligence, etc. He is also on the Advisory Board of Springer's International Journal of Machine Learning and Cybernetics. Prof. Pelillo is Fellow of the IEEE, the IAPR, and the AAIA, and is an IEEE SMC Distinguished Lecturer.

Sergey Sidorov,
Saratov State University
Stochastic Processes in Complex Networks

We examine the dynamics of local node characteristics, such as node degree, the average degree of a node's neighbours, the friendship index of a node, in complex networks. They are Markov stochastic processes, and at each moment of time these quantities take on its values in accordance with some probability distributions. We are interested in some characteristics of the distributions: their expectations, their variances as well as their coefficient of variations. First, we look at several real communities to understand how these values change over time in real networks. The empirical analysis of the behavior of these quantities for real networks shows that the coefficient of variation remains at high level as the network grows. Then we examine the evolution of these quantities over time for synthetic networks obtained as simulations of the Barab\'{a}si--Albert model and its modifications. We compare the behavior of these local indicators in Barab\'{a}si--Albert networks with their behaviour in real networks.

Angelo Sifaleras,
University of Macedonia, Thessaloniki, Greece
Recent applications of Variable Neighborhood Search simheuristic approaches

Stochastic optimization problems have a wide range of applications in several research fields such as engineering, biology, and economics. Thus, a large number of stochastic optimization algorithms have been proposed in the literature for the efficient solution of such problems. In this lecture, we present two recent real-world examples of successful combination of the Variable Neighborhood Search (VNS) metaheuristic and simulation methods, in different fields. The first example is an application of smart grid optimization. Together with Creos Luxembourg S.A. (https://www.creos-net.lu), the leading grid operator in Luxembourg, we show how to suggest optimal countermeasures to operators facing potential overloading incidents. The second example is an application of slot machine return-to-player optimization. This problem occurs in the gaming industry in order to develop modern virtual casino gambling machines. Together with Zeusplay (https://zeusplay.com), we show how to control the distribution of the symbols in the reels in order to achieve the desired return-to-player. In both of these cases, the VNS-based simheuristic approach proved to be very successful with good computational results.

Mahmud Siamizade and Theodore B. Trafalis
Carnegie Mellon alumni association, University of Oklahoma USA
A deterministic global optimization algorithm for an integrated oil refinery network optimization,

The petroleum refinery is a complex network of echelons spanning from unloading crude oil at the refinery’s front end, generating utilities for refinery operations, blending different crudes, and procuring crude blends to intermediate products, blending intermediates into final products and distributing refined products from refinery to distribution centers by means like pipelines. These refinery processes are tightly interconnected and optimal solutions to this problem are achieved by horizontal and vertical integration of the refinery processes through an enterprise-wide approach. Nevertheless, there are challenges associated with this integrated approach which arise

from the difficulty of modeling this entire complex network and obtaining a solution with reasonable quality and solution time.

Despite these complexities, this study presents a novel integrated optimization approach with a multi-period mixed-integer nonlinear programming (MINLP) model for the supply chain of a refinery network integrating decisions pertaining to crude unloading, oil procurement while accounting for the highly nonlinear nature of the processing units, final product pooling and blending, inventory management, distribution by pipeline and the utility system. The main contribution of the paper is the development of a hybrid methodology based on a bi-level optimization algorithm and obtaining ε- global optimal solutions.

The refinery network's integrated model was solved by both purposed methodology and commercial solver. The results from the proposed method introduced far more improvements in both economic and operational objectives than commercial solver while obtaining ε-global optimal solutions in very competitive solution time.

Oleg Khamisov,
Melentiev Energy Systems Institute of Siberian Branch of the Russian Academy of Sciences, Irkutsk,

Network equilibrium in developing power energy systems.

We consider a mathematical model of power energy system consisting of power network, power energy producers and consumers distribuletd over nodes of the network. Different types of plants with different costs functions are considered. According to the developing feature of the model we have to decide how existing node power capacities and network arcs transmission capacities can be expanded in order to cover the growing power energy demand of the consumers. Behavior of consumers is given by inverse demand functions. behavior of producers is determined by profits. The expansion of the network transmission capacity is limited. The problem consists in answering the question whether an equilibrium situation exists and if exists find it. In our talk we describe how bilevel programming methodology in combination with implicit global optimization techniques can be applied to solving the problem under consideration.