2023 Dutch NetSci Summer Symposium

Keynote Speakers

Federica Eduati — Eindhoven University of Technology

Modelling biological networks in tumours and their microenvironment

Tumours are complex ecosystems composed of many interacting molecules and cells. Differences in networks wirings are behind the heterogeneity that patients present in tumour development and response to treatment. In this talk I will present how we can infer network structure in a specific tumour combining general prior knowledge on possible interactions and patient-specific data. This allows to understand mechanisms of resistance/response to treatment and potentially improve the way we personalise treatment based on patient's molecular characteristics (precision oncology). I will illustrate how we address the complex problem of understanding regulatory networks in tumours via multidisciplinary collaborations involving clinicians, engineers, biologists and mathematicians.

Ingo Scholtes — University of Würzburg — University of Zurich

Higher-order models of causal topologies in temporal networks – from modelling to deep learning

Graph Neural Networks (GNNs) have become a cornerstone for the application of deep learning to data on complex networks. However, we increasingly have access to time-resolved data that not only capture which nodes are connected to each other, but also when and in which temporal order those connections occur. A number of works have shown how the timing and ordering of links shapes the causal topology of networked systems, i.e. which nodes can influence each other over time. Moreover, higher-order models have been developed that allow us to model patterns in the resulting causal topology. While those works have shed light on the question how the time dimension of temporal graphs influences node centralities, community structures, or diffusion processes, we lack methods to incorporate those insights into state-of-the-art graph learning techniques.

Addressing this gap, we introduce De Bruijn Graph Neural Networks (DBGNNs), a time-aware graph neural network architecture for temporal network data. Our approach accounts for temporal-topological patterns that unfold via causal walks, i.e. temporally ordered sequences of links by which nodes can influence each other over time. We develop a graph neural network architecture that utilises De Bruijn graphs of multiple orders to implement a message passing scheme that follows a non-Markovian dynamics, which enables us to learn patterns in the causal topology of dynamic graphs.

Remco van der Hofstad — Eindhoven University of Technology
It's hard to kill fake news

Empirical findings have shown that many real-world networks are scale-free, in the sense that there is a high variability in the number of connections of the elements of the networks. Spurred by these empirical findings, models have been proposed for such networks. In this talk, we investigate the spread of fake news on them.

We assume that news starts spreading from a source using a first-passage percolation rumour spread dynamics. The source later realises that the news is in fact wrong. After this realisation, it starts spreading the correct news. We make the (optimistic) assumption that a vertex, once having heard the correct version of the news item, will only spread the correct information. As such, we are modelling misinformation rather than fake news, with fake news being able to sustain on a network even longer.

Our results show that in many settings, even when the correct news spreads faster, the incorrect news is likely to reach a large part of the network. We distinguish between the incorrect news weakly surviving, meaning that it reaching a growing number of vertices, and strong survival, where the incorrect news reaches a positive proportion of the vertices. We give explicit criteria for the incorrect news to weakly and strongly survive on the configuration model, which is one of the most popular networks models.

This lecture is based on joint work with Seva Shneer, and builds on earlier work with Gerard Hooghiemstra and Shankar Bhamidi.

Fernando P. Santos — University of Amsterdam

The impacts of link recommendation algorithms on opinion polarization

Online social networks are increasingly central in shaping our political opinions. These are also prime spaces where humans co-exist with AI: algorithms to personalise contents and provide recommendations are pervasive in online platforms. Link recommendation algorithms are implemented to recommend new connections to online platforms users, based on supposed familiarity, similar interests, or the potential to serve as a source of useful information. These algorithms impact the evolution of social networks' topology, yet their long-term impacts on human social dynamics remain unclear. In this talk, I will discuss a model to study such impacts and explore how algorithmic link recommendations interplay with opinion dynamics and the long-term impacts of such algorithms on polarisation.

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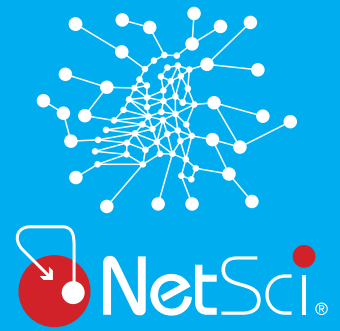
Oded Cats Delft University of Technology
Connecting the dots of network science applications in passenger transport systems

Networks play a crucial role not only in how we travel but also in how we conceptualise and solve planning and operations problems in the passenger transport systems domain. While maps and infrastructure layouts offer a natural point of departure, a variety of graph representations are needed in order to capture service characteristics and dynamics. Furthermore, networks are also used for representing and analysing demand patterns as well as demand-supply interactions. In this talk, I will introduce key relevant concepts in relation to network science in passenger transport and provide illustrations of selected applications.

Márton Karsai Central European University
Static representations of temporal networks

Temporal networks are commonly used to represent systems where connections between elements are active only for restricted periods of time, such as telecommunication, biochemical reactions or social networks. The time-varying nature of such interactions determine several network properties, like valid temporal paths, that in turn influence the emergence of any macroscopic phenomena on the temporal network. Nevertheless, the actual representations of temporal networks hardly allow the effective computation of these dynamical network properties. In this talk we will take an overview about various static representations of temporal networks that allow to describe a sequence of time-varying interactions as static structures that can be further analysed effectively by the armada of characterisation methods developed for static networks. The proposed representations open an avenue to the lossless description and computationally efficient characterisation of very large temporal networks and ongoing dynamics processes.

Johanna H. Meijer Leiden University Medical Centre
The biological clock; from cell to network and beyond

The presence of 24-hour rhythms is deeply rooted in biology and is explained by the presence of "oscillators" or "biological clocks" in the nervous system of all organisms. At the base of our brain, a small structure consisting of about 10,000 neurons is autonomously able to produce rhythms of about 24 hours, referred to as circadian rhythms (circa: about; dies: day). The principle of this ability is a negative feedback loop between translation and transcription, within individual cells of the clock. Understanding the 24-hour rhythms in our body (the circadian system) is often understood as an attempt to identify the components of the cellular negative feedback loop. A slightly different question is "how can we explain the properties of the circadian system". Explaining -or even finding- properties is a different exercise from identifying components. In my talk I will show 1. how the properties of individual cells can be opposite to the properties of the ensemble; 2. that scale invariance requires an extended neuronal network, and 3. That neuronal clock activity and behaviour are mutually dependent as shown by parallel time series obtained from clock cells and behaviour.

Tom van der Zanden Maastricht University
Efficiently computing the Shapley value of connectivity games in low-treewidth graphs

Game-theoretic centrality measures are a powerful tool to identify key players in covert networks (that model, e.g., the interactions between suspected terrorists or criminals). Unfortunately, such measures are often NP-hard to compute and thus intractable, even for small graphs. We show that, for three connectivity games, their Shapely value can be efficiently computed if the underlying graph has low treewidth. Using this method, we are able to compute the Shapley Value for several graphs for which this was previously infeasible (including, notably, the 69-vertex graph of the terrorists involved in the 9-11 attacks studied in previous work on Shapley value-based centrality).

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Contributed Talks

Network Theory

Day 1 14:30 to 15:30

Francesca Giuffrida, "Effects of ensemble non-equivalence on network model selection".

Jiaze Li, "Hierarchical community structure in networks".

Nandan Malhotra, "Spectrum of sparse inhomogeneous random graphs".

Pierfrancesco Dionigi, "Spectral breaking of ensemble equivalence".

Network Applications

Day 1 16:00 to 17:00

Jie Li, "Multilayer disease networks via multipartite projections: linking risk factors to CVD-depression multi-morbidities via molecular mediators".

Fernando Nobrega Santos, "Emergence of high-order functional hubs in the human brain".

Bas Chatel, "Alone in the crowd: a computational social network model on clustering mechanisms of loneliness".

Frederike Oetker, "Tie strength in criminal cocaine networks in the Netherlands".

Network Dynamics

Day 2 11:10 to 12:10

Sergey Shvydun, "Modelling the dynamics of complex networks: a system identification approach".

Federico Capannoli, "Meeting, coalescence and consensus on random directed graphs".

Shilun Zhang, "Predicting nodal spreading influences in complex networks via iterative metrics".

Robin Persoons, "Transition from time-variant to static networks: timescale separation in NIMFA SIS".

Mekelweg 4
2628 CD, Delft
Building 36, Boole auditorium

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Poster Session

List of Posters

Abadi, Noam	Maximum information entropy production for network dynamics modelling
Budel, Gaby	Complementarity vs. similarity in semantic networks
Catanzaro, Alessio	Pizza model for graphs and beyond: scale-invariant model for real-world networks
Evmenova, Elizaveta	Analysis of directed signed networks
Gösgens, Martijn	The hyperspherical geometry of community detection: modularity as a distance
Gündlach, Rowel	Invasion percolation on power-law branching processes
Gündlach, Rowel	On the local structure of the minimum spanning tree on the configuration model
Hasselman, Fred	The geometry of synchronisation: quantifying the coupling direction of physiological signals between individuals using inter-system recurrence networks
Hilman, Rafiazka	Multiscale spatial distribution of economic diversity in New York
Hourican, Cillian	Removing echoes of synergistic interactions in hypernetworks
Jokić, Ivan	Linear clustering process on networks
Parvaneh, Azadeh	Friendship paradox for random graphs
Qiu, Zhihao	The inverse all shortest path problem
Rydin, Arja	A longitudinal network analysis of the comorbidity of major depressive disorder and cardiometabolic diseases
Sabbaqi, Mohammad	Graph-time convolutional neural networks: architecture and theoretical analysis
Wang, Fenghua	Controller placement with respect to controller reachability
Yang, Maosheng	Data processing and learning on simplicial complexes
Zou, Li	Temporal network prediction and interpretation

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