Cambridge Networks Day 2019

an interdisciplinary meeting
on complex networks

http://www.cnn.group.cam.ac.uk

Thursday, 29 August 2019
Sainsbury Laboratory Cambridge

Danielle Bassett
Ginestra Bianconi
Charlotte Deane
Edoardo Gallo
Ronaldo Menezes
Roberta Sinatra

The Alan Turing Institute

UNIVERSITY OF CAMBRIDGE

Cambridge Networks Network

Cambridge Networks Network (CNN) was founded in September 2011, originally with the aim of bringing together academics from the University of Cambridge who share an interest in Complex Networks. We organise monthly seminars and send out regular newsletters listing relevant talks, conferences, news and job offers both in the UK and abroad. We have also established an online directory to help our members connect and we are working hard to develop our website (www.cnn.group.cam.ac.uk) into an ever more useful portal. CNN now comprises over 450 members, including many researchers from other universities around the UK and beyond.

Please email us (cnninfo@hermes.cam.ac.uk) with any news that you would like to share via our newsletter, or any resources that you would like us to include on our website. Are you developing a useful software package? Writing an interesting blog? Attending an exciting new conference? Aware of some relevant funding opportunities? Let us know! Please also feel free to get in touch if you would like to present your work at our seminars or if you have any further suggestions for how CNN could develop.

Sarah Morgan	(Brain Mapping Unit, University of Cambridge)
Sebastian Ahnert	(Cavendish Laboratory, University of Cambridge)
Goylette Chami	(Big data Institute, University of Oxford)
Petra Vertes	(Brain Mapping Unit, University of Cambridge)

Cambridge Networks Day 2019

Cambridge Networks Day 2019 is the sixth of our annual meetings on the topic of complex networks. It is an occasion for the research community to exchange ideas and expertise, intended to spark interdisciplinary collaborations. The day will include a diverse set of talks by invited speakers highlighting interesting new directions in the field of complex networks, as well as a poster session. We hope the day's events will strengthen the interdisciplinary links between researchers and promote communication within the community.

Supporters

CNDay2019 would not have been possible without the generous support of:

- The Alan Turing Institute
- The University of Cambridge
- King's College
- Cambridge Big Data
- The Sainsbury Laboratory

Programme

09:30	Coffee and Registration
09:50	**Welcome**
10:00	**Charlotte Deane** "Measuring rank robustness in scored protein interaction networks"
10:40	**Roberta Sinatra** "Physics, interdisciplinarity and the chaperone effect"
11:20	Coffee
11:40	**Edoardo Gallo** "Cooperation in networks"
12:20	**Poster orals** One-minute presentations
13:00	Buffet lunch and poster session
14:30	**Danielle Bassett** "Networks thinking themselves"
15:30	Coffee
15:50	**Ginestra Bianconi** "Multilayer networks: structure and function"
16:30	**Ronaldo Menezes** "On the scale, concentration and dynamics of crime"
17:10	**Poster prize + Closing remarks**

Measuring rank robustness in scored protein interaction networks

Charlotte Deane
Professor of Structural Bioinformatics, Head of Department of Statistics at Oxford University and Fellow at The Alan Turing Institute

Protein interaction databases often provide confidence scores for each recorded interaction based on the available experimental evidence. Protein interaction networks (PINs) are then built by thresholding on these scores, so that only interactions of sufficiently high quality are included. These networks are used to identify biologically relevant motifs or nodes using metrics such as degree or betweenness centrality. This type of analysis can be sensitive to the choice of threshold. If a node metric is to be useful for extracting biological signal, it should induce similar node rankings across PINs obtained at different reasonable confidence score thresholds. We propose three measures - rank continuity, identifiability, and instability - to evaluate how robust a node metric is to changes in the score threshold. We apply our measures to twenty-five metrics and identify four as the most robust: the number of edges in the step-1 ego network, as well as the leave-one-out differences in average redundancy, average number of edges in the step-1 ego network, and natural connectivity. Our measures show good agreement across PINs from different species and data sources. Analysis of synthetically generated scored networks shows that robustness results are context-specific, and depend both on network topology and on how scores are placed across network edges. Due to the uncertainty associated with protein interaction detection, and therefore network structure, for PIN analysis to be reproducible, it should yield similar results across different confidence score thresholds. We demonstrate that while certain node metrics are robust with respect to threshold choice, this is not always the case. Promisingly, our results suggest that there are some metrics that are robust across networks constructed from different databases, and different scoring procedures.

Notes:

Physics, interdisciplinarity and the chaperone effect

Roberta Sinatra
Assistant Professor in Computer Science at ITU Copenhagen

The unprecedented availability of large scale datasets about scholarly output has advanced quantitatively our understanding of how science progresses. In this talk, we present the quantitative investigation of three social phenomena in science by means of large-scale publication datasets. First, we take an intellectual census of physics by studying 135,877 physicist careers. We quantify their heterogeneous birth, growth and migration patterns among research areas and find that the majority of physicists began their careers in only three subfields, branching out to other areas at later career stages with different rates and transition times. Second, we explore the interdisciplinarity of Nobel Prize papers, using massive Web of Science citation data. We document disciplinary biases in the Nobel Prize and show the wide extent to which our public recognition for interdisciplinary research is out of date. Third, we develop a data-driven understanding of author order by quantifying the chaperone effect, capturing how scientists transition into senior status within a particular publication venue. Our findings shed light on the role played by experience in publishing within specific scientific journals, on the paths toward acquiring the necessary experience and expertise, and on the skills required to publish in prestigious venues.

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Cooperation in networks

Edoardo Gallo
University Lecturer in Economics at Cambridge University and Official Fellow at Queens' College

The maintenance of cooperative behaviour is fundamental for the prosperity of human societies. Recent experimental studies have shown that cooperation increases in dynamic networks in which subjects can choose their partners. In this talk I present evidence from 3 experimental studies that shed light on the features of the environment that enable dynamic networks to foster cooperation. In particular, I examine the role reputation, information about the network structure, the strength of connections, the graduality of the strengthening process, uncertainty and the rate of link formation play in enhancing cooperative behaviour and welfare. A common theme is that the features that foster cooperation reinforce the ability to punish defectors by cutting links. This punishment mechanism increases overall cooperation by enabling the formation of a close-knit community of highly cooperative individuals.

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Networks thinking themselves

Danielle Bassett
Professor of Bioengineering and Professor of Physics and Astronomy at the University of Pennsylvania

Human learners acquire not only disconnected bits of information, but complex interconnected networks of relational knowledge. The capacity for such learning naturally depends on the architecture of the knowledge network itself, and also on the architecture of the computational unit - the brain - that encodes and processes the information. Here, I will discuss emerging work assessing network constraints on the learnability of relational knowledge, and physical constraints on the development of interconnect patterns in neural systems. What do the correspondences between these domains tell us about the nature of modeling and computation in the brain, and mechanisms for knowledge acquisition?

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Multilayer networks: structure and function

Ginestra Bianconi
Reader in Applied Mathematics at Queen Mary University of London and Fellow at The Alan Turing Institute

In recent years multilayer networks are emerging as a novel and powerful way to describe complex systems. Multilayer networks are ubiquitous and include social networks, financial markets, infrastructures, molecular networks and the brain.Uncovering the interplay between multilayer network structure and function is a big theoretical challenge with a vast realm of applications. On the other side the urgency of understanding real-world multilayer network problems requires novel theoretical approaches. In this talk we will show how the fundamental statistical physics beyond multilayer networks reveals the information encoded in these structures and its effect on multilayer network dynamics.

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On the scale, concentration and dynamics of crime

Ronaldo Menezes
Professor of Data and Network Science and Head of Computer Science at the University of Exeter

Crime is a major risk to society's well-being, particularly in cities, and yet the scientific literature lacks a comprehensive statistical characterisation of crime that could uncover some of the mechanisms behind such pervasive social phenomenon. Evidence of nonlinear scaling of urban indicators in cities, such as wages and serious crime, has motivated the understanding of cities as complex systems - a perspective that offers insights into resources limits and sustainability, but usually without examining the details of indicators. Notably, since the nineteenth century, criminal activities have been known not to occur uniformly within a city. Crime concentrates in such way that most of the offenses take place in few regions of the city. However, though this concentration is confirmed by different studies, the absence of broad examinations of the characteristics of crime concentration hinders not only the comprehension of crime dynamics but also the proposal of sounding counter-measures. Here, we developed a framework to characterize crime concentration which splits cities into regions with the same population size. We used disaggregated criminal data from 25 locations in the U.S. and the U.K. which include offenses in places spanning from 2 to 15 years of data. Our results confirmed that crime concentrates regardless of city and revealed that the level of concentration does not scale with city size. We found that distribution of crime in a city can be approximated by a power-law distribution with exponent α that depends on the type of crime. In particular, our results showed that thefts tend to concentrate more than robberies, and robberies more than burglaries. Though criminal activities present regularities of concentration, we found that criminal ranks have the tendency to change continuously over time. Such features support the perspective of crime as a complex system which demands analyses and evolving urban policies covering the city as a whole.

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Poster Titles

- **Consciousness-specific interactions of neural complexity and integration - a spatial and temporal perspective.**
  Andrea Luppi

- **Measuring London metro network robustness from percolation and community modular analysis.**
  Yuerong Zhang

- **The model-assisted generative adversarial network.**
  Leigh Whitehead

- **Can fire sales risk be assessed based on partial information?**
  Raymond Pang

- **snkit: a spatial networks data cleaning toolkit.**
  Tom Russell

- **Complex Water Distribution Network: Topological approach for quality sensor placement.**
  Manuel Herrera

- **Achieving competitive advantage in academia through early career coauthorship with top scientists.**
  Weihua Li

- **Tree building in 3D neuron tracing for network analysis.**
  James Wilsenach

- **Functional module detection through integration of single-cell RNA sequencing data with protein interaction networks.**
  Florian Klimm

- **Analysing linear multivariate pattern transformations in neuroimaging data.**
  Olaf Hauk

- **Synaptic resolution connectomics reveals circuit and structural basis of memory extinction.**
  Markus W. Pleijzier

- **How does sub-cortical functional connectivity differ in schizophrenia?**
  Sam Ip

- **Detecting the community structure of neutral components in the genotype-phenotype map of RNA secondary structure.**
  Marcel Weiss

- **A novel model of network growth based on the logistic map.**
  Nikolas Drummond
- **Segregation and integration of functional brain networks of novel concept learning.**
  Isil Poyraz Bilgin
- **Finding dirty money: a case study in discovering suspicious company networks using machine learning.**
  Kathryn Poole
- **Using machine learning to predict protein-protein interaction networks.**
  Loïc Lannelongue

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