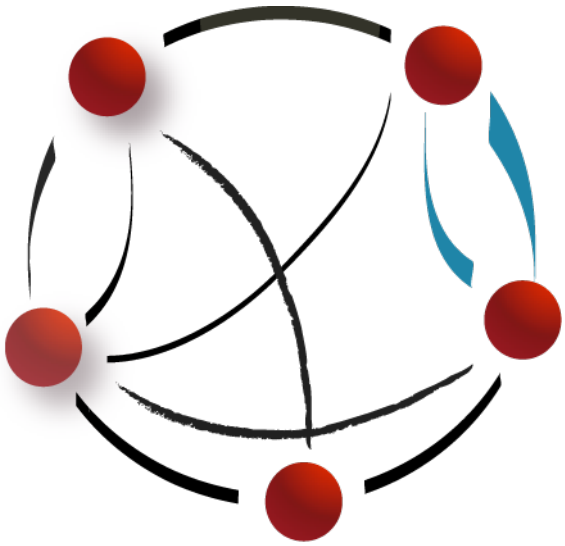
ALESSANDRO
VESPIGNANI

"Complex Systems, Networks and Epidemic Modeling"

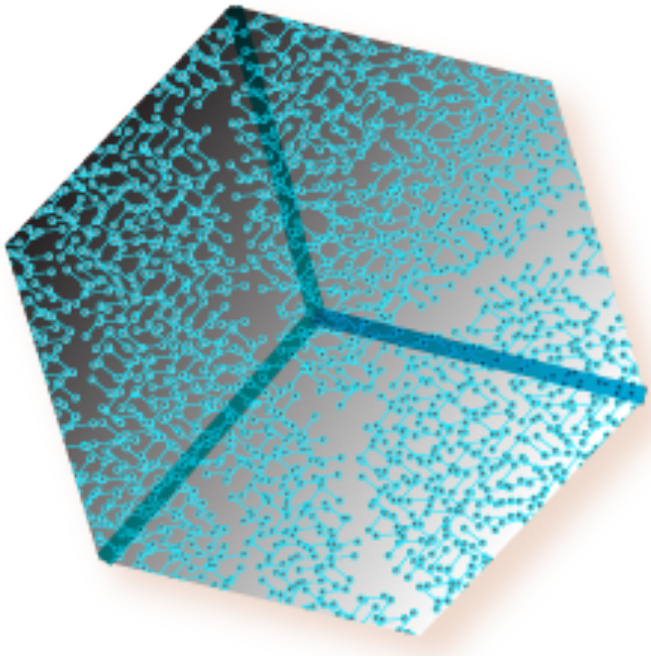
Analogous to meteorology, large-scale data-driven models of infectious diseases provide real- or near-real-time forecasts of the size of epidemics, their risk of spreading, and the dangers associated with uncontained disease outbreaks. These models are not only valuable because they predict where and how an epidemic might spread in the next few weeks, but also because they provide rationales and quantitative analysis to support public health decisions and intervention plans. Moreover, the advances in data-model integration have highlighted complex properties and heterogeneities that often elude the straightforward linear thinking we are used to, and surprise us with tipping points, emergent behaviors, and unexpected shifts in dynamical regime that characterize complex phenomena. I will present a review of recent results and challenges in the area, ranging from applied analysis for public health practice to foundational computational and theoretical challenges.



JAMES
GLEESON

"Cascade Dynamics on Networks"

Network models may be applied to describe many complex systems, and in the era of online social networks the study of dynamics on networks is an important branch of computational social science. Cascade dynamics can occur when the state of a node is affected by the states of its neighbours in the network, for example when a Twitter user is inspired to retweet a message that she received from a user she follows, with one event (the retweet) potentially causing further events (retweets by followers of followers) in a chain reaction. In this talk I will review some simple models that can help us understand how social contagion (the spread of cultural fads and the viral diffusion of information) depends upon the structure of the social network and on the dynamics of human behaviour. Although the models are simple enough to allow for mathematical analysis, I will show examples where they can also provide good matches to empirical observations of cascades on social networks.



TINA
ELIASSI-RAD

"Learning to Detect Fraud in Complex Systems"

We study companies that intentionally declare bankruptcy in order to avoid contributing their taxes -- i.e., they commit fraud. We link companies to each other through their shared resources, as some resources are the instigators of fraud. We introduce new approaches on (**1**) how to define and extract features from time-weighted networks, (**2**) how to integrate network-based and intrinsic features for fraud detection, and (**3**) how to diffuse fraud through a network, labeling the unknown and anticipating future fraud whilst simultaneously decaying the importance of past fraud. We find that domain-driven network variables have a significant impact on detecting fraud, and improve on baselines by detecting up to 55% additional fraudsters over time. This is joint work with Véronique Van Vlasselaer (SAS), Leman Akoglu (CMU), Bart Baesens (KU Leuven), and Monique Snoeck (KU Leuven).

ARNE
TRAULSEN

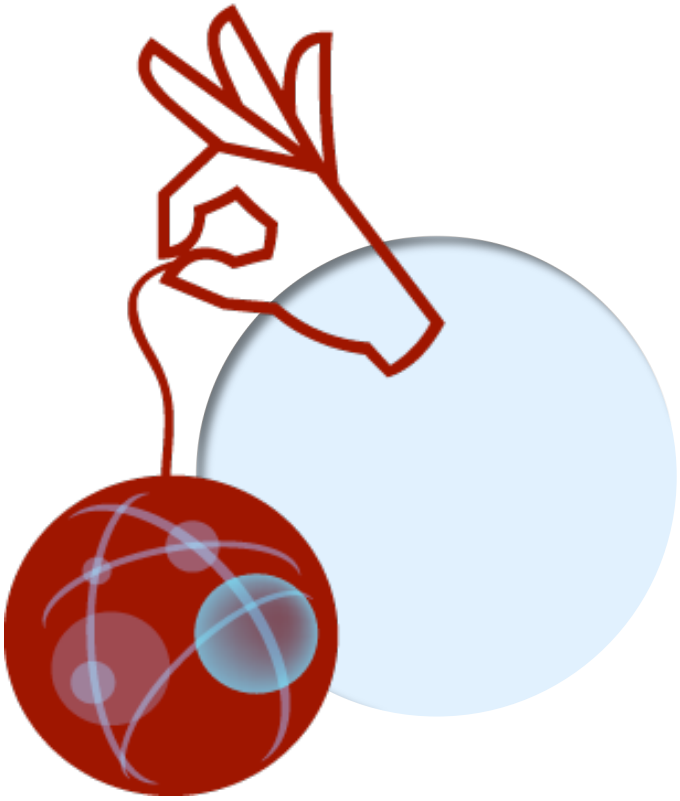
“Evolution in Network Structured Populations - from social networks to cancer”

Evolution can be strongly affected by population structure, but theoretical work shows that it is difficult to identify what exactly drives evolutionary dynamics. One possibility is to infer whether structures increase or decrease the evolutionary chances of novel mutants and even this is a challenging task. Using methods from population genetics and evolutionary demography can help to understand the underlying dynamics better, potentially paving the way for concrete applications, ranging from the evolutionary dynamics in river systems to cancer evolution.

SUSANNA
MANRUBIA

"On the Architecture of Genotype Spaces and the Dynamics of Molecular Adaptation"

Evolutionary dynamics is often viewed as a subtle process of change accumulation that causes a divergence among organisms and their genomes. However, this interpretation is an inheritance of a gradualistic view that has been challenged at the macro-evolutionary, ecological, and molecular level. Actually, the evolutionary dynamics of molecular populations shares deep qualitative and quantitative similarities with slowly driven physical systems, remarkably non-linear responses analogous to critical transitions, sudden state changes and hysteresis. Furthermore, the functional promiscuity inherent to genotypes transforms classical fitness landscapes into multiscapes where adaptation may be instantaneous in response to an environmental change. The quantitative nature of adaptive molecular processes is deeply dependent on a multilayered network-of-networks structure of genotype spaces that we begin to unveil.



SANJEEV
GOYAL

"The Rise and Fall of Empires"

In the study of war, a recurring observation is that conflict between two opponents is shaped by third parties. The actions of these parties are in turn influenced by other proximate players. These considerations lead us to propose a model with multiple inter-connected opponents. We study the influence of resources, technology, and the network of connections, on the dynamics of empires.

CIRO
CATTUTO

“High-resolution Social Networks: experiences and perspectives”

Digital technologies afford the quantification of specific human behaviors with unprecedented levels of detail and scale. Personal electronic devices and wearable sensors, in particular, can be used to map the network structure of human and animal close-range interactions in many settings relevant for complex systems research. In this talk, I will review the state of the art of sociometric measurements and discuss the experience of the *SocioPatterns* collaboration, an effort aimed at measuring and modeling high-resolution social networks using wearable proximity sensors. I will illustrate statistical regularities, network structures and heterogeneities of empirical data collected in environments that span schools, hospitals, households and low-resource rural settings. I will reflect on challenges such as generalization, sampling and data incompleteness, and illustrate modeling approaches based on ideas from machine learning. I will close with an overview of future research directions and applications.