UNIVERSITÀ DI TRENTO
Dipartimento di Matematica

DOTTORATO

CYCLE 34th
ORAL DEFENCE OF THE PHD THESIS

Monday 13 June 2022 – at 3:00 pm
Seminar Room “-1”

The event will take place online through the ZOOM platform.
To get the access codes please contact the secretary office

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PhD Student in Mathematics

Network models for large-scale human mobility

Abstract: Human mobility is a complex phenomenon emerging from the nexus between social, demographic, economic, political and environmental systems. In this thesis we develop novel mathematical models for the study of complex systems, to improve our understanding of mobility patterns and enhance our ability to predict local and global flows for real-world applications. After the introduction of the concept of human mobility from the point of view of complex systems science, we will illustrate the state-of-the-art models to describe human movements. The rest of the dissertation is divided into three parts: structure, causes and effects.

The first part is about the structure of a complex system: it represents our methodological contribution to Network Science, and in particular to the problem of network reconstruction and topological analysis. We propose a novel methodological framework for the definition of the topological descriptors of a complex network, when the underlying structure is uncertain. With this work we have provided a new approach to study the topological characteristics of complex networks from a probabilistic perspective.

The second part deals with the effects of human mobility: it represents our scientific contribution to the debate about the COVID-19 pandemic and its consequences. We unravel the causal relationships between 16 variables -- including different flavors of human mobility flows -- considered as the components of a complex socio-environmental system, and apply information theory, network science and Bayesian inference to map the backbone of the complex interplay between them. We introduce a novel information-theoretic method based on statistical divergence to identify abrupt changes in the system dynamics, caused by a sudden intervention. We found that despite a measurable improvement in the environmental conditions, locking down a region may be an insufficient remedy to reduce pollution.

The third part deals with the modelling of causes of human mobility: after a brief presentation of the phenomenon of human displacements caused by environmental disasters, we present the Feature-Enriched Radiation Model (FERM), our generalization of the Radiation Model which is a state-of-the-art mathematical model for human mobility. While the original Radiation Model considers only the population as a proxy for mobility drivers, the FERM can handle any type of exogenous information that is used to define the attractiveness of different geographical locations. The model exploits this information to divert the mobility flows towards the most attractive locations, balancing the role of the population distribution.

The mobility patterns at different scales can be reshaped, following the exogenous drivers encoded in the features, without neglecting the global configuration of the system.

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CONTATTI
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