

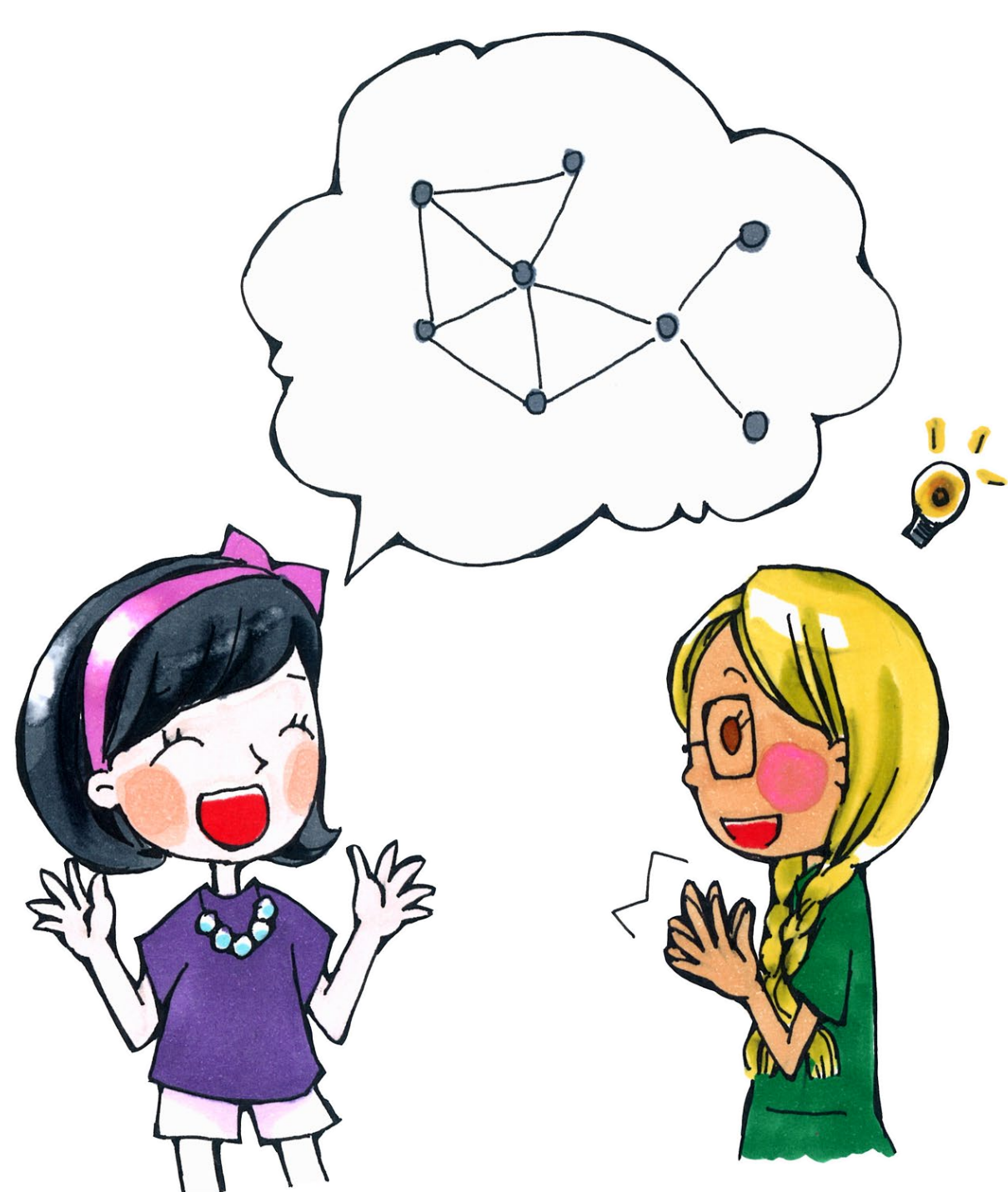


Network science and computational social science

World Research Hub Initiative

<http://petterhol.me>

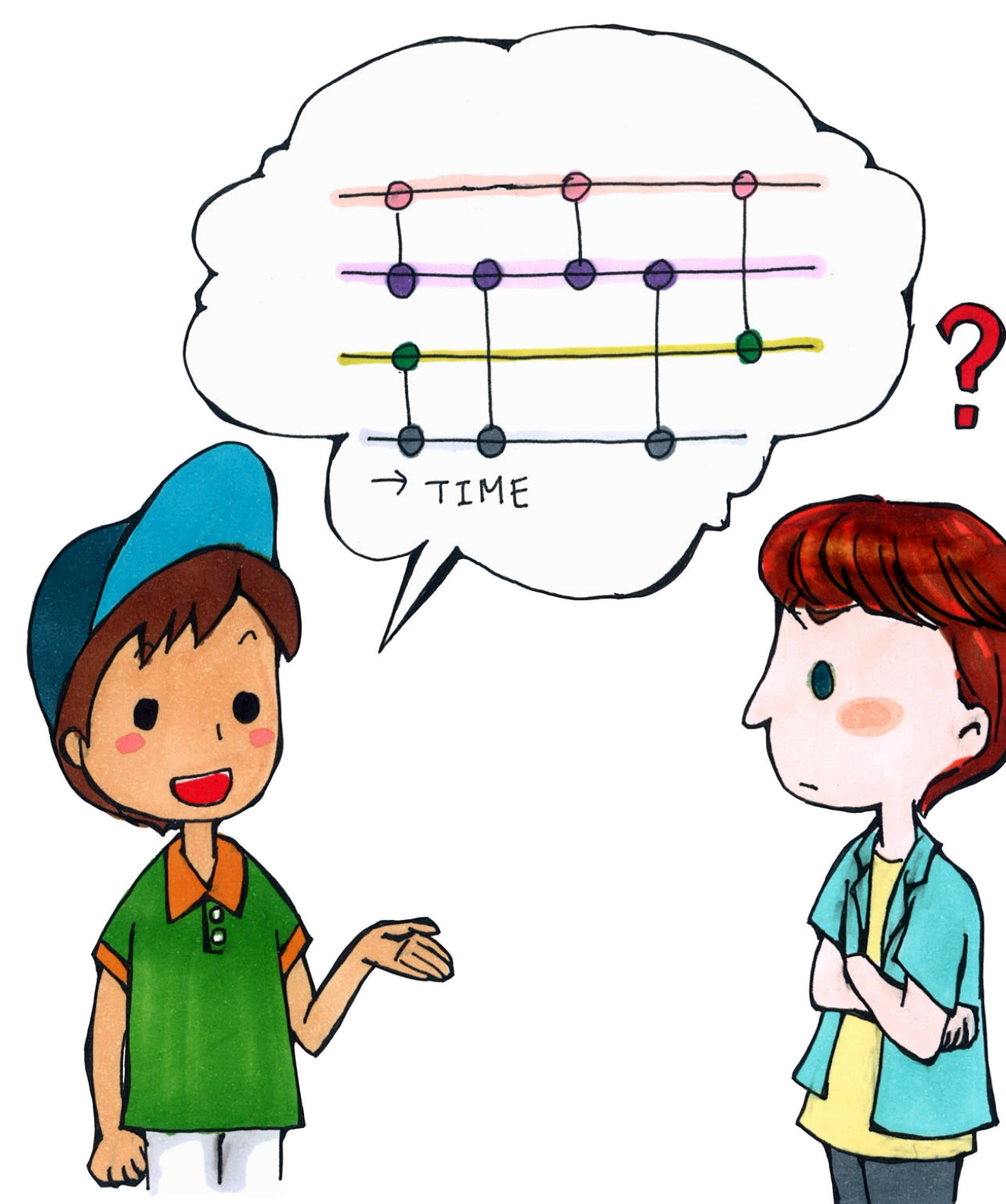
- Data science of large-scale networks
- Developing methods to integrate time in network modeling
- Studying cities as complex systems
- Understanding human cooperation via experimental game theory
- Studying the spreading of ideas, habits and diseases in society



Read more about network science in: Barabasi, *Network Science*, Cambridge UP, 2016.

Network Science

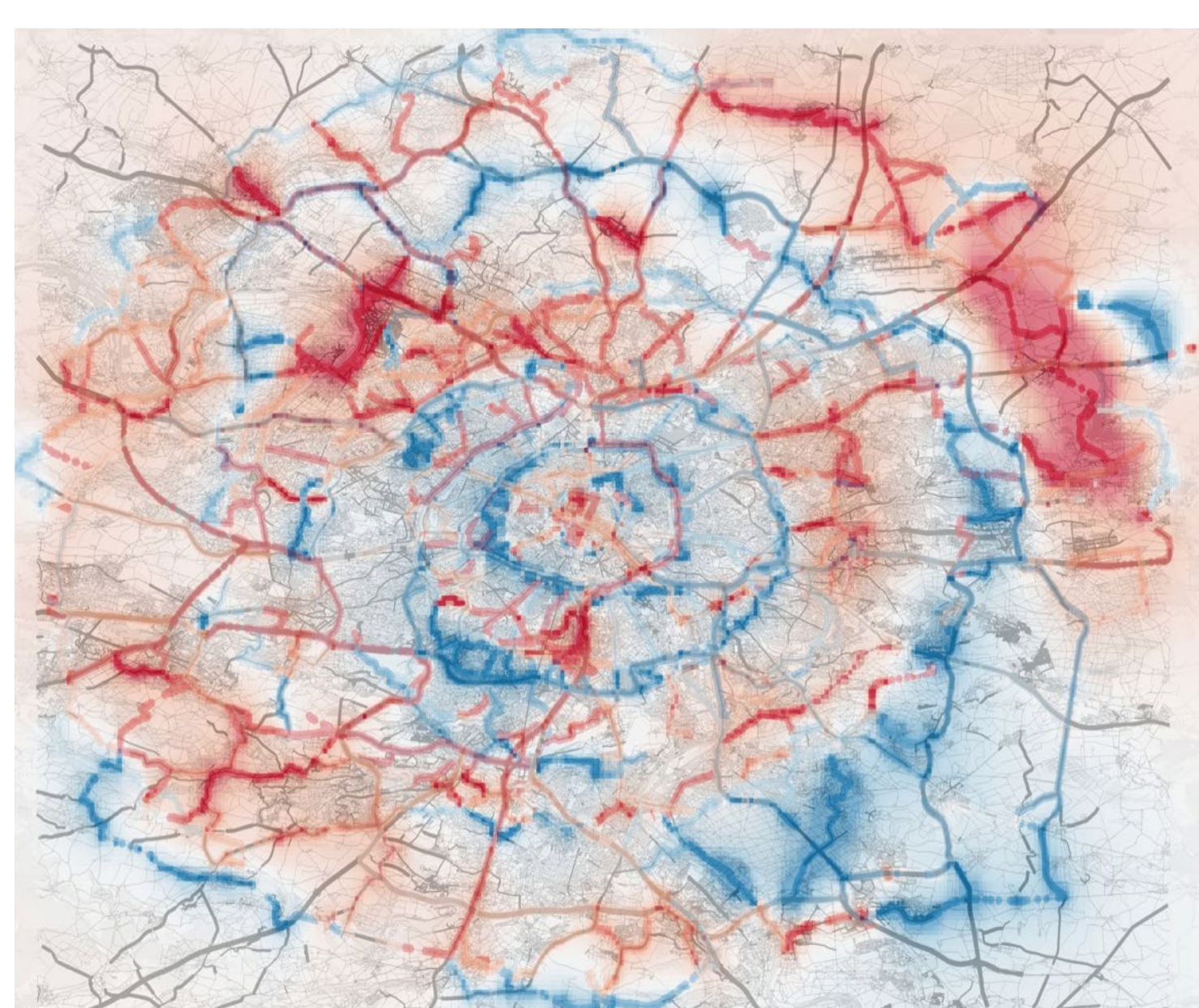
Networks are all around us: From friendship networks to power grids, from the nervous system to transportation infrastructures, from gene networks to food webs. These can all be studied by the same theoretical tools of network science. Network science is an interdisciplinary field using methods from mathematics, computer science, physics, and statistics, to study problems in sociology, neuroscience, engineering, political science, biology, political science, economics, urban planning, etc. To become a network scientist you need to be able to program and to be open to collaborate with people of diverse backgrounds.



Read more about temporal networks in: Holme, *Eur. Phys. J. B* 88, 234 (2015).

Temporal networks

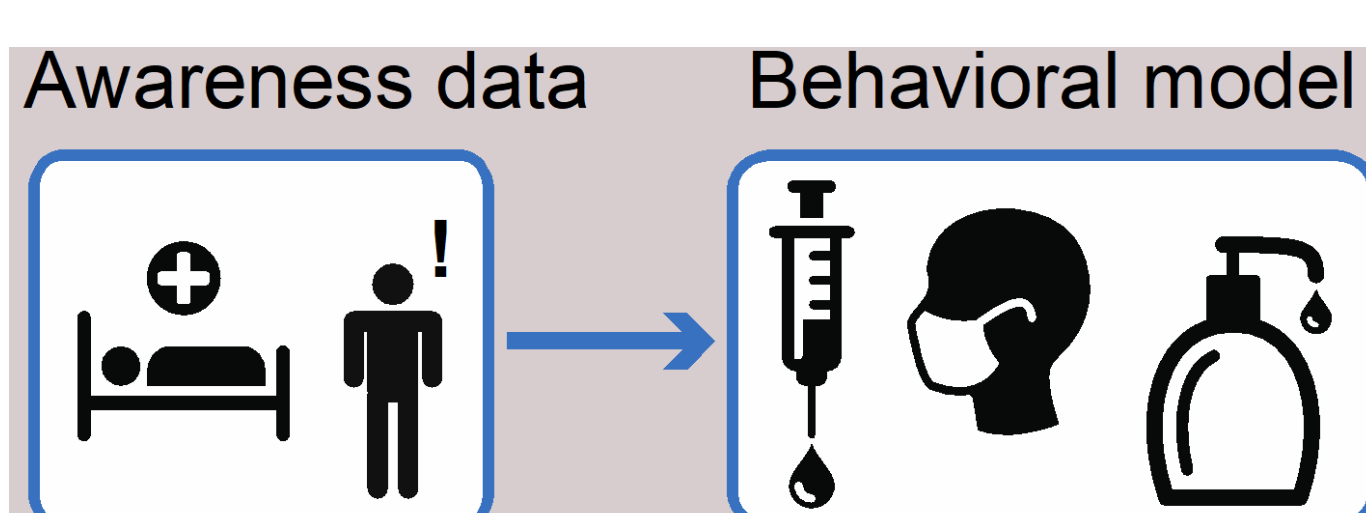
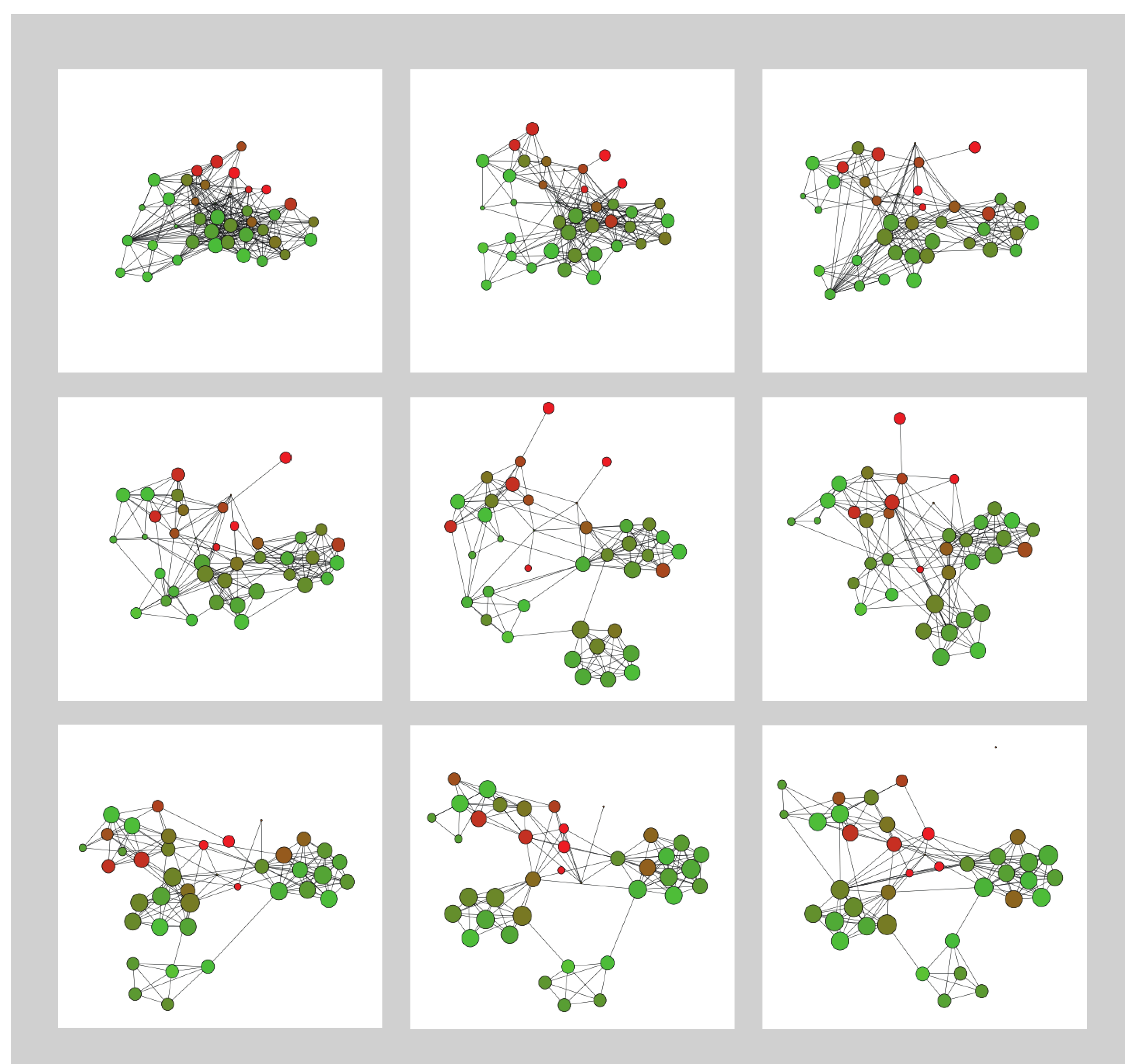
Many network data sets tell us not only which two entities that interact but also when the interaction happens. Maybe one can make network methods more efficient and accurate by including this information? That is the starting point of the field of temporal networks which is a very active area of research. We develop methods to simplify temporal networks and identify groups in them (corresponding to e.g. a meeting of people). We try to construct algorithms to identify important spreaders of information and infectious diseases. The study of temporal networks relies on good data sets (often *human proximity data*, saying who is close to whom at what time).



From our work Lee et al. *Nature Communications* 8, 2229 (2017). It shows the *inness* structure of Paris. Inness measure the tendency to drive towards the city center. For the red regions, the city center is like an attractive force pulling car travelers towards it.

Urban Data Science

Humanity has recently passed the point where more than half of everyone lives in a city. Living in cities has many benefits: It can be more energy efficient than living in the countryside; it facilitates human interaction, and it's positive side effects such as innovation. There are also problems: Disease spread faster, it is hard to scale up the infrastructures of a growing city, etc. Understanding the constraints and opportunities that comes with urban living is thus very important. Recently many new data sources have become available available for studying cities. We try to use these in combination with theoretical modeling to understand cities and develop methods to aid urban planning.



Goal: Modeling how awareness of epidemics affect health behavioral change.

Illustration of modeling how the awareness of a disease affects peoples' behavior, and subsequently the disease spreading.

Network Epidemiology

Infectious diseases are a big burden to urban health, and one area where theoretical science can help. We use modeling and data to identify hot spot for disease spreading and intervention methods to contain epidemic outbreaks. In this work we collaborate with both medical and social scientists

Experimental Game Theory

How do cooperate in a society when there are many short term reasons not to do that? This is the main question of this field where we contribute, both with theoretical modeling and experiments where people play games to mimic situations in reality. This field is important in the context of climate change—how can we make people to refrain from convenient routines for long term benefits of a sustainable living. The figure above comes from an experiment of social network formation with cooperative interaction (green individuals as more cooperative, larger nodes have higher profit). From ongoing work with Holme and Marko Jusup.