13:45 – 14:15

CONTAINMENT STRATEGIES FOR COVID-19 USING MOBILITY DATA

Prof. dr. N.V. (Nelly) Litvak

University of Twente | Eindhoven University of Technology

In their response to the COVID-19 outbreak, governments face the dilemma to balance public health and economy. Mobility plays a central role in this dilemma because the movement of people enables both economic activity and virus spread. We use mobility data in the form of counts of travelers between regions, to extend the often-used SEIR models to include mobility between regions. We quantify the trade-off between mobility and infection spread in terms of a single parameter, to be chosen by policy makers, and propose strategies for restricting mobility so that the restrictions are minimal while the infection spread is effectively limited. We consider restrictions where the country is divided into regions, and study scenarios where mobility is allowed within these regions, and disallowed between them. We propose heuristic methods to approximate optimal choices for these regions. We evaluate the obtained restrictions based on our trade-off. The results show that our methods are especially effective when the infections are highly concentrated, e.g., around a few municipalities, as resulting from superspreading events that play an important role in the spread of COVID-19. We demonstrate our method in the example of the Netherlands. The results apply more broadly when mobility data is available.
Joint work with: Martijn Gösgens, Teun Hendriks, Marko Boon, Stijn Keuning, Wim Steenbakkers, Hans Heesterbeek and Remco van der Hofstad.

Nelly Litvak is Professor of Algorithms for Complex Networks at the University of Twente and Eindhoven University of Technology in the Netherlands. She obtained her PhD in Stochastic Operations research from Eindhoven University of Technology in 2002. Her research interests include random graphs, randomized algorithms, and applications in large networks such as on-line social networks and the World Wide Web.

14:15 – 14:45

INCORPORATING TIME-USE AND HEALTH DATA INTO A DYNAMIC MICROSIMULATION EPIDEMIOLOGICAL MODEL FOR COVID-19

Prof. dr. G. (Gavin) Shaddick

University of Exeter

The need to inform policies and mitigation measures aimed at reducing the spread of the coronavirus highlights the need to understand the complex links between our daily activities and opportunities for the virus to spread. The national lockdowns, and more localised measures, have aimed to reduce the number of contacts between susceptible members of the population and those with the disease. Here, we develop a micro-simulation modelling framework and methods for its computational implementation that brings together epidemiological modelling, urban analytics, spatial analysis and data integration to provide the ability to assess the effects of past interventions and forecast the effects of future policy decisions. This information will be crucial in gaining a greater understanding of the effects of future policy decisions in different areas and within different populations. We demonstrate the use of the model in a case study based on the county of Devon where we compare the effects of different lockdown strategies and present a computationally efficient approach to running complex simulation models of this type.

Gavin Shaddick is Professor of Data Science and Statistics and Head of the Department of Mathematics at the University of Exeter. His focus in research is on the theory and application of Bayesian hierarchical models and spatio-temporal modelling in several fields including epidemiology, environmental modelling, and disease progression in rheumatology. Important applications are estimating the hazards of global air quality and research in the power industry. For this, computational techniques that allow the implementation of complex statistical and spatial models are used, with particular attention to the propagation of uncertainty throughout the modelling process.

15:15 – 15:45

FROM PREDICTIONS TO PRESCRIPTIONS: A DATA-DRIVEN RESPONSE TO COVID-19

Prof. dr. D.J. (Dimitris) Bertsimas

Sloan School of Management, MIT

The COVID-19 pandemic has created unprecedented challenges worldwide. Strained healthcare providers make difficult decisions on patient triage, treatment and care management on a daily basis. Policy makers have imposed social distancing measures to slow the disease, at a steep economic price. We design analytical tools to support these decisions and combat the pandemic. Specifically, we propose a comprehensive data-driven approach to understand the clinical characteristics of COVID-19, predict its mortality, forecast its evolution, and ultimately alleviate its impact. By leveraging cohort-level clinical data, patient-level hospital data, and census-level epidemiological data, we develop an integrated four-step approach, combining descriptive, predictive and prescriptive analytics. First, we aggregate hundreds of clinical studies into the most comprehensive database on COVID-19 to paint a new macroscopic picture of the disease. Second, we build personalized calculators to predict the risk of infection and mortality as a function of demographics, symptoms, comorbidities, and lab values. Third, we develop a novel epidemiological model to project the pandemic's spread and inform social distancing policies. Fourth, we propose an optimization model to re-allocate ventilators and alleviate shortages. Our results have been used at the clinical level by several hospitals to triage patients, guide care management, plan ICU capacity, and re-distribute ventilators. At the policy level, they are currently supporting safe back-to-work policies at a major institution and equitable vaccine distribution planning at a major pharmaceutical company, and have been integrated into the US Center for Disease Control's pandemic forecast.

Dimitris Bertsimas is currently the Boeing Professor of Operations Research, the Associate Dean of Business Analytics at the Sloan School of Management, MIT. He received his MSc and PhD in Applied Mathematics and Operations Research in 1987 and 1988 respectively. His research interests include optimization, machine learning and applied probability and their applications in health care, finance, operations management and transportation. He is the editor in chief of *INFORMS Journal of Optimization* and former editor of *Optimization for Management Science* and *Financial Engineering in Operations Research*.

16:30 – 17:00

CURBING THE SPREAD: OBSERVATIONS, INTERVENTIONS, MODELS, AND PREDICTIONS

Prof. dr. J. (Jacco) Wallinga

Leiden University | RIVM

The advent of the SARS-CoV-2 virus that causes COVID-19 has elicited an unprecedented research effort to understand the spread, to develop effective interventions, and to predict the possible impact of control measures on the course of the epidemic. Key observations include the number of reported cases over time, and essential interventions include physical distancing and vaccination. The models that are used to describe such observations and analyse the impact of such interventions typically invoke a basic representation of the infection cycle: persons can only be infected after exposure to others who have been infected earlier. Combining such a basic causal model structure with the available observations already allows for predicting the expected impact of control measures. The question is then how this ability to describe, analyse and predict observations can be used to curb the spread.

Jacco Wallinga holds the chair in Mathematical Modelling of Infectious Diseases at the department of Biomedical Data Sciences of the Leiden University Medical Center (LUMC). As an extraordinary Professor, he works on the estimation and prediction of control measures on the dynamics of infectious diseases. He became head of the RIVM department of Modelling of Infectious Diseases in 2005. He published over 150 articles in international peer-reviewed scientific journals and is a member of the editorial board of Epidemiology. He advises the Dutch government and international organizations on vaccination policies