NETWORK EPIDEMIC MODELLING of COVID 19 in HUNGARY

CHALLENGES: Network epidemic modelling

PRODUCTIVE SECTOR: Healthcare

PROBLEM DESCRIPTION

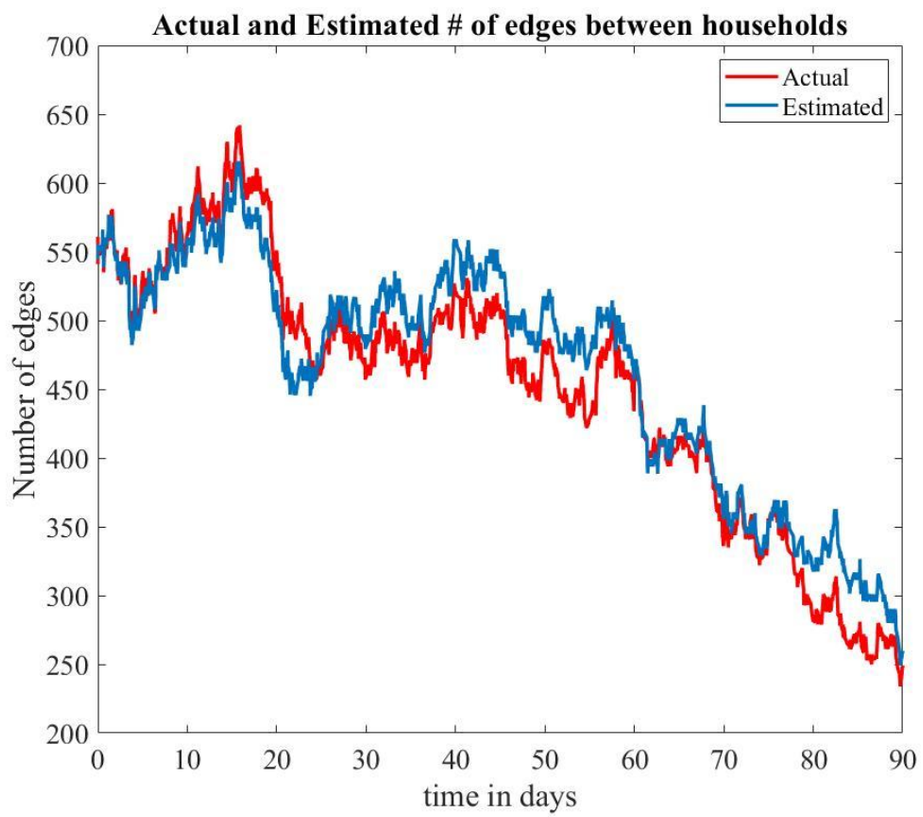
The goal is to help decision-makers by creating a good mathematical model and then tune its parameters, in order to recover available infection data and to predict the course of the covid-19 epidemic.

CHALLENGES AND GOALS

The main challenges are to choose a mathematical model which has sufficiently complex structure and can be fit to data, to develop mathematical methods to estimate parameters (infection and recovery rate), and to apply these to real, available epidemic data.

MATHEMATICAL AND COMPUTATIONAL METHODS

We studied an SIR model on a two-layer random graph, where small complete graphs represent the households and an Erdős-Rényi or preferential attachment graph is added. For parameter estimation, for the recovery rate we used the analogues of the methods in the deterministic, homogeneous case. We examined various possibilities and extensions for the estimations of the infection rate with or without knowing the number of SI edges. We implemented the algoritms in Matlab with Gillespie and fast SIR to check that the estimations work well.

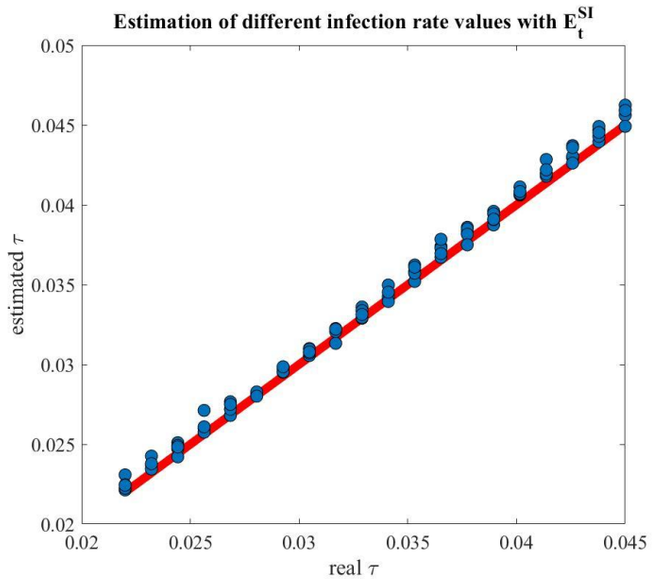


Comparison of the real and estimated number of SI edges in the two-layer random graph model

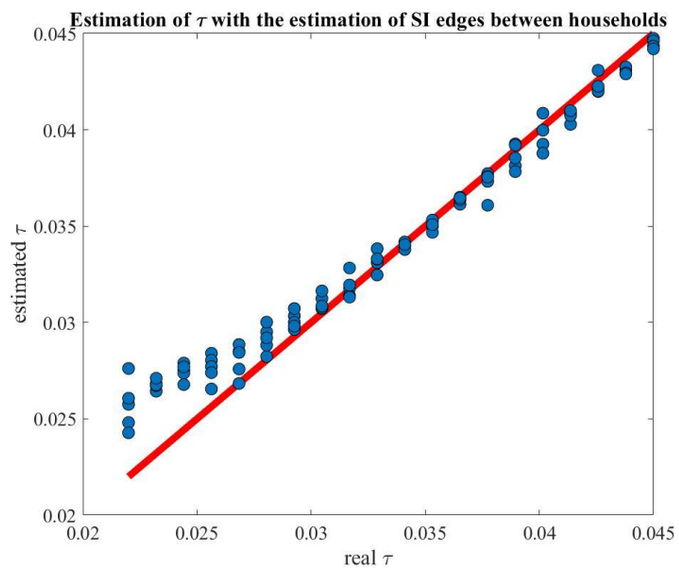
NETWORK EPIDEMIC MODELLING of COVID 19 in HUNGARY

Results and Benefits

We concluded that (1) **the number of S, I, R** (susceptible, infected, recovered) **individuals**; (2) **the number of households with a given S, I, R configuration** (e.g. one S, two I, one r); (3) estimation of **the proportion of people infected at home** together provide sufficient statistics for parameter estimation in the two-layer model.



Estimation of the infection rate if we know the number of SI edges



The same if we only estimate the numer of SI edges

Our study shows that it is worth making effort to keep track of the number of recovered people, and to perform tests for whole families, not only for individuals. Some randomly chosen samples could already be useful for estimation and forecasting.

HU-MATHS-IN
Hungarian Service Network for Mathematics in Industry and Innovations

MINISTRY OF INNOVATION AND TECHNOLOGY

Ministry of Innovation and Technology