

## Exercise 2 – Determining the spreading of epidemics

**Deadline:** April 23/2019. **Upload in the moodle:** 1. A presentation of the project in .pdf (no more than 6 pages). 2. The source code through which you generated the presented results

The files name should be surname\_name\_ex2.pdf and surname\_name\_code2.XX If the project has been developed by a group (max 3 persons), please indicate the name of the other authors in the presentation of the project (.pdf)

### The Dataset:

A) Files net1.txt and net2.txt contain two undirected networks representing two different mobility (i.e. contact) networks among individuals.

B) File cases\_100locations\_first77days.txt describes the early stages of an outbreak of Chicken Pox in 100 different locations (see file's header for a description of the fields).

### Tasks

1. Using the two networks provided in (A), calculate the epidemic threshold in the SIS dynamics for the homogenous, heterogenous and quenched mean-field approximations for  $\mu=0.5$ .
2. Implement the (stochastic) SIS model in the two networks and simulate the entire phase diagram for  $\mu=0.5$ . Compare the three theoretical thresholds with the numerical results. *Suggestion:* you need to simulate many (e.g. 100) simulations for each network and compare mean and std with the different analytical approximations.
3. Characterize the two networks in terms of their connectivity, degree distribution, page-rank distribution, clustering coefficient. Comment the results at the light of point 2 (e.g. how structural properties of the networks and results of the epidemic dynamics are related?)

4. (Optional). If you can segregate 1% of the individuals (i.e. remove 1% of the networks nodes), which node would you remove and why? What happen if you run again the SIS in network 1 and 2 with the nodes that you removed? Briefly discuss your results.
5. Plot the the early stages of infected for the 100 locations. Assuming that the disease spreading can be approximated by a SIR dynamics, use the method described in <https://towardsdatascience.com/infection-modeling-part-1-87e74645568a> to estimate the parameters of the SIR model. Will the chicken pox outbreak become viral?