Agent Based Modelling of the Spread of COVID-19 in Austria

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Computational Modelling of Social Systems - Group 6

28. Juni 2023

Agenda

Basic Idea

Identify most-influential spreaders in an SIR-model

- SIR-model adapted to Covid Statistic in Austria

  (Source: Statistik Austria. (2022). Deutlich niedrigere Sterberaten bei gegen COVID-19 geimpften Personen im Vergleich zu Ungeimpften)

- Age distribution in Austria based on WIBIS-Inhabitants

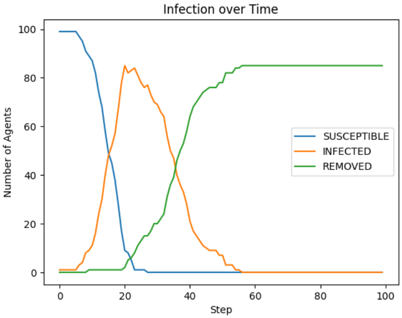
  https://wibis-steiermark.at/bevoelkerung/struktur/einwohner-nach-altersklassen/

- Identification of most-influential Spreaders
  - k-shell Decomposition

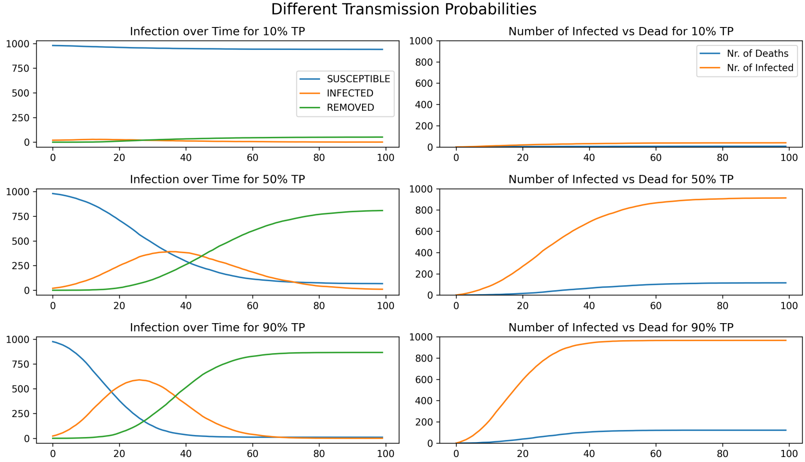
Compartment Model - SIR Model

- Individuals with a closed population
- Separated into mutually exclusive groups

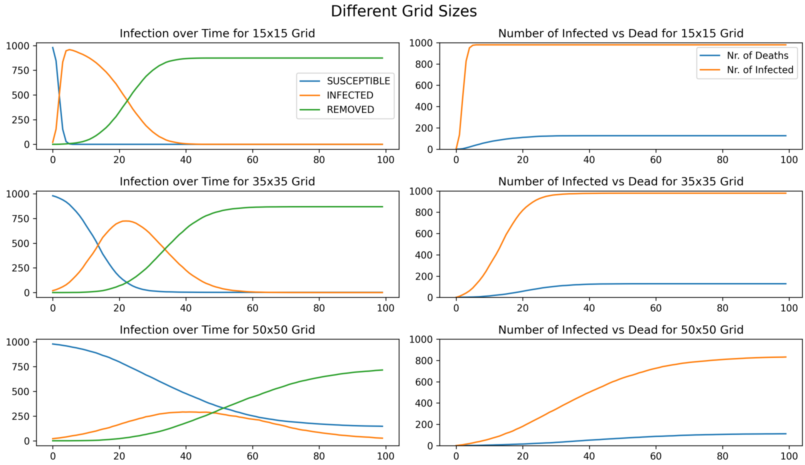
    1. susceptible
    2. infected
    3. recovered



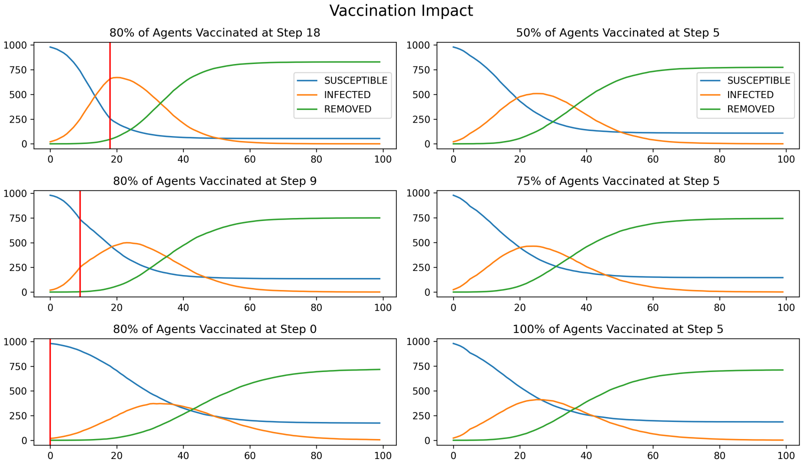
Transmission Probabilities



Different Grid Sizes



Vaccination Impact



Influential Spreaders in Complex Networks: Key Takeaway

- most influential spreader nodes not always most connected nodes
- method to identify most influential spreaders: k-shell decomposition

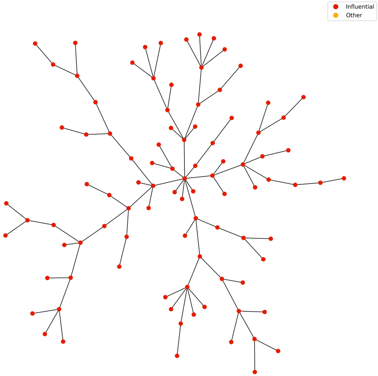
k-shell Decomposition

k index is denoted by k_S, initially k_1

- recursively eliminate nodes (agents) with degree S.
- no nodes with degree S left to eliminate? $k_S \rightarrow k_{S+1}$
- continued until no nodes left in network
- Result: each node is associated with one k_S index.

Highest k_S index nodes $\rightarrow$ most influential spreaders

SIR-Model & k-shell Decomposition Problem



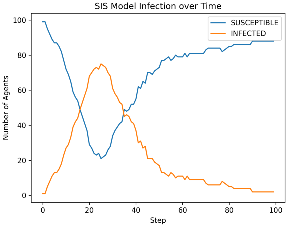
SIR network $\rightarrow$ tree structure

- no cycles in network
- each node (agent) has k_1 index
- Solution: Switch to an SIS-Model

SIS-Model

Implementation

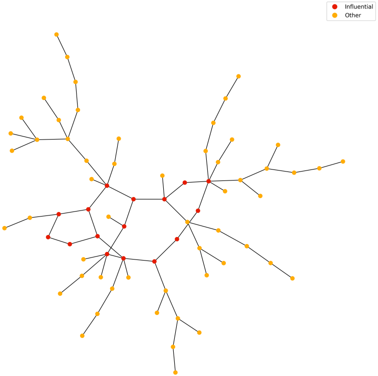
- Agents become susceptible again instead of being removed
- Agents have a 10% probability to get infected again
- We do not consider that immunity decreases with time



SIS-Model & k-shell Decomposition

Cycles in Network

- Nodes with k_S, where $S > 1$, can exist
- Nodes with $k_S = \max k_S$ are the most influential spreaders.
- 81.25% of influential spreaders are not vaccinated



Conclusion

- Higher transmission probabilities and smaller environments increase the number of infections
- Early vaccination and greater number of vaccinated agents flatten infection curve
- k-shell decomposition can capture the topolgy of the network better than counting degrees
- Contrary to what is stated in the paper, we do not find the k-shell decomposition useful for SIR models
- We are also implementing differentiation according to preconditions, type of vaccination and their efficacy.