Modeling of Households in an Agent Based Population Model and Results for Epidemics

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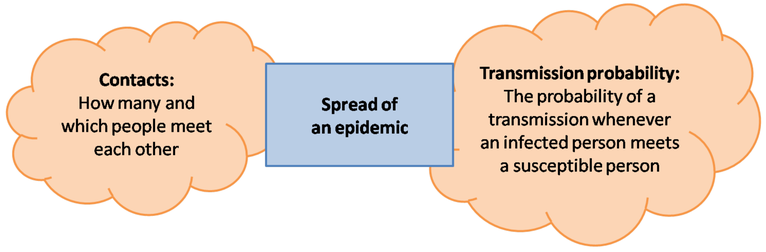
INTRODUCTION

Social contacts are a key element for the spread of epidemics. When it comes to agent based modeling it is possible to define some kind of social behavior for individual persons and analyze the impact of social contact structure.
Households are supposed to play important roles for the spread of some epidemics. Here we present a method to implement a household structure, adapt it to fit with real data and use it for scenarios.

Motivation:

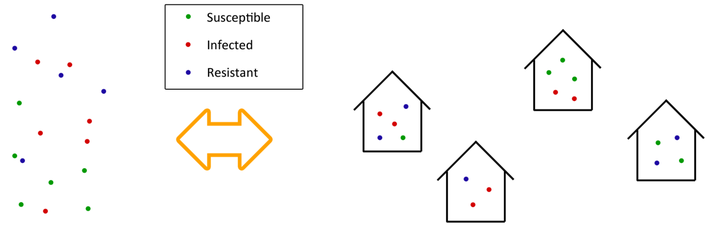
The behavior of an epidemic is generally based on two factors:



We are going to focus on the contacts and extend a model with only random contacts to a model with random contacts and contacts within households.

Model:

- Dynamic multi agent based model
- Agents: Single persons
- SIR model



GOALS

- Provide a strategy for implementing households in a multi agent based model.
- Validation: Compare a model using the household structure with the old model under the same assumptions.
- Use the new structure to simulate new scenarios.

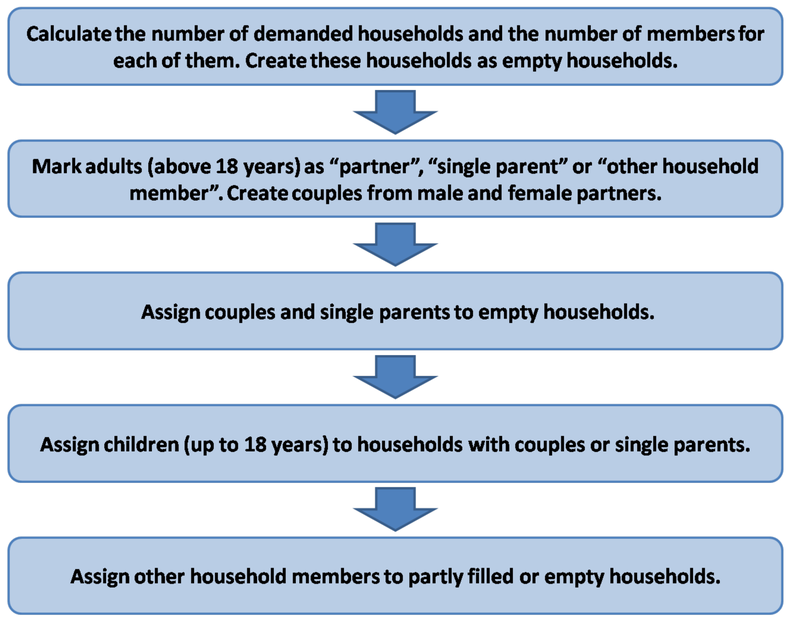
DATA

Household data for Austria is provided by “Statistics Austria”

- Distribution of size of households
- Fraction of men/women that live in a household ...
  - … with a partner
  - … as a single parent
  - … as another household member (for example as a child)
  - … alone

PROCEDURE

Start with a given population of single persons that shall be assigned to households. The procedure of creating households needs five steps:



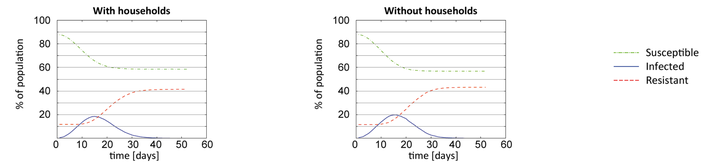
VALIDATION

We take an existing SIR model and implement the structure of households.
To remain comparable it is crucial to set the same assumptions. These assumptions are:

- The number of contacts per person must be the same in both models.
- The infection probability is the same for every contact, no matter whether it happens randomly or within a household.

Simulation for validation:

Population: 1000 persons Contacts: 15 per person per day
Infection probability: 4% 1 timestep = 1 day



Left: 435 households with an average size of 2.30 persons per household. The rest of the contacts are chosen randomly.
Right: All contacts are chosen randomly.

Results and interpretation:

The spread of a SIR-like-epidemic is almost the same for consideration of households compared to the original model without households.
That means that household structure itself does not affect the model but prevails the known and well examined behavior.

USAGE

Why do we need household structure if it does not affect the results?
With household structure we are able to simulate scenarios:

- Higher infection probability within households than for other contacts.
- Quarantine sick people by reducing their contacts to household members.
- Set up a curfew so that a part of the population has to stay at home.
- …

CONCLUSION

We have proposed an approach to implement households in an agent based model. The structure can easily be adapted to correspond with real life data. The changed structure itself does not affect the results significantly so it does not harm the validity of an existing model. But it allows simulating several scenarios that demand the existence of household structure.