



Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Lecture with Computer Exercises:
Modelling and Simulating Social Systems with MATLAB

Project Report

**Simulation of Information Spreading
in a Facebook Network**

Urs Lustenberger , Nino Wili , Patrick Zöchbauer

Zurich
December 2013

Agreement for free-download

We hereby agree to make our source code for this project freely available for download from the web pages of the SOMS chair. Furthermore, we assure that all source code is written by ourselves and is not violating any copyright restrictions.

Urs Lustenberger

Nino Wili

Patric Zöchbauer

Contents

1	Abstract	4
2	Individual contributions	4
3	Introduction and Motivations	4
4	Description of the Model	4
4.1	Homogeneous SIR model	5
4.2	Agent-based model	5
5	Implementation	5
5.1	The Network	5
6	Simulation Results and Discussion	5
7	Summary and Outlook	6
8	Appendix	6

1 Abstract

2 Individual contributions

3 Introduction and Motivations

Everyone is on facebook

Commercials are personalized, the flow of info is interesting for companies

Are there "more important" persons in typical facebook network?

important questions (does the inhomogeneity of the real network influence the "total" evolution? are there "influentials"?)

4 Description of the Model

The process of information spreading has many similarities with epidemiology, so the well known SIR-model was adapted[1]. The "susceptibles", are not aware of the information and are called "ignorants" within this work. "Infected" individuals know about the information and are willing to share it with other people, in other words they spread it and are therefore called "spreaders". The adaptation of the epidemiological term "recovered" is not that straightforward because it is not entirely clear, what that means in this context but they can be looked at persons that are aware of the information but don't want to tell it others. They are called "stiflers".

In the SIR-model as well as in the Agent-based model, the following set of "reaction equations" was used(I: Ignorant, S: Spreader, R: Stifler):

$$\begin{cases} I + S \xrightarrow{\lambda} 2S & (1) \\ S + R \xrightarrow{\alpha} 2R & (2) \\ S + S \xrightarrow{\alpha} S + R & (3) \end{cases}$$

The main difference to the standard SIR-model is that spreaders don't become stiflers spontaneously but this change is only induced by meeting an other spreader or stifler. Also it can be shown that for $\frac{\lambda}{\alpha} > 0$, i.e. for any positive rate, the number of stiflers is non-zero for large times. That means that there is no epidemic threshold as in the standard SIR-model.

4.1 Homogeneous SIR model

In the mathematical treatment of the model in a homogeneous system, the set of differential equations is expressed in terms of the densities $i(t) = I(t)/N$, $s(t) = S(t)/N$ and $r(t) = R(t)/N$.

$$\begin{cases} \frac{di(t)}{dt} = -\lambda \cdot s(t)i(t) \end{cases} \quad (4)$$

$$\begin{cases} \frac{ds(t)}{dt} = \lambda \cdot s(t)i(t) - \alpha \cdot s(t)[s(t) + r(t)] \end{cases} \quad (5)$$

$$\begin{cases} \frac{dr(t)}{dt} = \alpha \cdot s(t)[s(t) + r(t)] \end{cases} \quad (6)$$

4.2 Agent-based model

In the inhomogeneous, agent-based model, the individuals are connected in a certain manner (facebook friends in this particular work). Only connected agents are able to meet. If a meeting occurs, transitions are induced at a certain probability depending on the relation between the agents (details are discussed later). Additional to the different degree of the agents, they also have a different activity, i.e. different probability to meet somebody. In total, the number of meetings in a certain time is proportional to the product of the degree (number of friends) and the activity.

To convert the reaction equations into an agent-based model, time was discretized and in each time step a series of steps is done as in !!!flow diagramm!!!

5 Implementation

5.1 The Network

how did we get the network?

how did we get the coordinates with gephi?

how was the code implemented? (how detailed does this have to be? references to matlab files?)

6 Simulation Results and Discussion

most important question!

7 Summary and Outlook

blub

8 Appendix

Code

```
                                ../../code/parameters.m
1  %pmeet=0.8; %probability, that a person wants to meet another person
2  %used in "talkstep" to determine meeting-vector
3
4  %pinform=0.9; %probability that a spreader meeting a ignorant tells him
5  %as "lambda" in (Alain Barrat)
6
7  pforget=0.2; %p, that if a spreader meets a spreader, one of them becomes a
8  %stifler. or if a stifler meets a spreader, both become
9  %stiflers
```

References

- [1] A. Barrat, M. Barthlemy, A. Vespignani. Dynamical Processes on Complex Networks. Chapter 10.