

# Memory effect in news spreading networks

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## Abstract

We propose to analyze the influence of the memory in a news spreading dynamic. In the first part we aim to build a framework of agents connected in a network and to equip them with a set of basic functions (or methods) to let arise the dynamical process of diffusion. The goal is to expose a short presentation of the methodologies used in this agent based model and try to explain it with a simple tutorial.

## 1 Introduction

To analyze and model the interactions between users in the context of news spreading is useful to talk about groups of autonomous agents linked by friendly ties whose overall views constitute the network. The the population of the network consists of two breed of agents: sources and users. These two breeds will interact in autonomous approach during the execution of the program. The network is initially a random connections of the agents and modifies this topology following a set of microscopic agent's actions. Our belief is that the interactions, due to the natural news' diffusion in a social-like network, are guided by the ability of the news to capture each agent's attention, and by the social influence of the agents themselves. We hope to observe the spontaneous emergency of the scale-free regime following the dynamical micro-interactions. We also hope to reveal the natural segregation behaviour that subjugate a vastity of real social networks. In addition to these questions We wonder if there can be correlation between diffusion and the lenght of the agents' memory. To do it, we will build a framework of agents modelling based on a Swarm-like platform named SLAPP<sup>1</sup>.

## 2 Overview

We have build the model focusing on two coexisting points of view: its agent based nature and the network framework one. We have blended these two frames considering a network of agents.

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<sup>1</sup>For reference and download from: <https://github.com/terna/SLAPP>

## 2.1 Context

Let's focus on the dynamical spreading of rumor spreading on the social<sup>2</sup> network. Generally, the diffusion of news is studied in a stochastic context, governed by a set of stochastic differential equations. It arises from an apparent similarity with the epidemiological process. However, the diffusion of epidemics becomes a viral process when an epidemic threshold is exceeded, instead the rumor spreading process appears as a threshold-less process. The epidemic model of information diffusion is usually a compartmental model in which agents in different stages coexist in the world. The majority of initial users stay in the compartment of Ignorants whereas a minority of them are the Spreaders of the news. There is another compartment, the Stifler, the equivalent of recovery in the SIR model<sup>3</sup>.

This Spreader-Ignorant-stifler model (SIs) can be sketched by a set of simple interactions: one of these is spontaneous indeed the others are binary.

- $I \longrightarrow S$
- $S + I \longrightarrow S + S$
- $S + S \longrightarrow s + S$
- $s + S \longrightarrow s + s$

Where we indicate with  $S$  the Spreader status, with  $I$  the Ignorant and with  $s$  the Stifler user. The first process corresponds to the spontaneous transition from the ignorant compartment to the spreader compartment; the second one corresponds to the contamination of an ignorant by contact with a spreader user; the third and fourth interactions represent the transition by contact to the Stifler compartment.

The development of dynamics is governed by sequences of users' transitions from a compartment to another one, until all the users which were spreaders reached the stifler compartment and the remaining ignorant remains in their state. This approach is applicable to a network of users to predict the reproductive number<sup>4</sup> that enables to estimate the future qualitative behaviour of spreading: if this number is above some epidemic threshold then the virality of diffusion is guaranteed.

This description can be reliable with a single viral diffusion of news, but more difficult would result the analysis by a set of different differential equations when happens that a multiple news travel in the network. If the number of news increases, so that the number of equations increases.

An compartmental approach to study the phenomenon of information diffusion has been widely examined in the last years, furthermore with very different variants of the native models. In literature of spreading of news, only a few of models are built on an agent architecture and we report the references in the bibliography. There are a variety of papers

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<sup>2</sup>The word *social* is thought in a general context

<sup>3</sup>Acronym of Susceptible-Infected-Recovery, most famous model of epidemic spreading.

<sup>4</sup>The reproductive number  $R_0$  is defined by characteristic parameters that affect the diffusion like the average degree (in first approximation) and the rate of diffusion.

che evidenziano dei risultati molto interessanti e particolari riguardo l'influenza sociale, il contagio sociale o ad esempio su homophily and the diffusion across the communities-studi di influenza che affect the topology. alcuni studiano la diffusione di bufale o di meme o inseriscono utenti che possono fare factchecking o bot che diffondono o ancora inseriscono le sources d'informazione.

## 2.2 Why Agents?

The agents are a very useful paradigm to model social interactions. They can operate in their environment, make decisions and interact each other. There is no communication protocol between them. They want to maximize their own benefit which is communicate and share news with "friends".

The environment is not deterministic. Every action can produce different effects in a probabilistic way, but the single experiment must to be reproducible.

Also the actions between agents are non deterministic and do not have the complete control over another agent; the agents have limited senses and sensors.

The required characteristics of each agents are:

- Reactivity: The agents can control the clock and the news spreading around them during the evolution of the system.
- Proactiveness: Each agent knows what his goal is and how to reach it.
- Social Ability: They know how to send and receive news, to determine sympathy with neighbours.
- No mobility is required.

The agents are rationals meaning that they try to reach their goal sympathizing with their "neighbours" Each agent can receive information from the world or from another agent; it can also interact with the world or with an agent, in order to meet own character or objective. Their ability to modify the environment is the motion of a link in the social network. The only accessible variable for each agent is the clock number; they can also access something "near" them.

Each agent makes local fair decisions: global behaviours may emerge. When active each agent can control the environment and react to the changes. It is possible that during his inactive state the environment has changed and the goal of the agent is unreachable. For this reason the agent can act in an unpredictable way and somehow irrational.

## 2.3 The network of Agents

The network is composed by Agents eventually connected by a weighted and undirected links. At the first time, the network is composed by the sum of a fixed number of sources

and users.

The users is linked between them with fixed probability calculated from the average degree desidered and insert by external input. In this way we obtain a random network of users, with exponential trend for the degree distribution in the thermodynamic limit. The links are the only possibility to establish a relation between the agent; a random value of weight of the link can to rapresent the previous bias in friendship.<sup>5</sup> The result of this mechanism of generation of graph not return a real network, because social real network has the property of scale-free<sup>6</sup>, instead random graph have a majority of node-degrees peaked around the average-degree. Also, the variance is very large in scale free network and expected the existence of hubs in the network. Though it would be better, we start with a random network with the hope to observe a naturally evolution in this direction.

The sources are thinkable like a news pool from which the users can to draw news and eventually to spread it. The source are more strongly connected with users that the inner links between the themeselves users, because we assume that the newspapers have more links that a common user. The sources contain a fixed number of news (usually three), generate at fixed instant of time and dote of different impact. Each single news is modeling like a vector of topics, which components carry the amount of each topics inside the single news. The news is also equipped with an identified code of the source and with the clock in which appear it in the world. Another features of the sources is the innate diversity between them based on the amount of there specific topics in the "character" of the source, this "prevalence of topic" affect the news at the time of generation. In other words, each news coming from the same source are focused, on average, on the same topics.

We try to reproduce the intrinsec diversity of the taste of the users with a vector correspond to a *state-of-mind* with dimensionality equal to the number of topics. The state-of-mind of the users is inzialized at random, although in possible further development to be innest a process to changing the state-of-mind during the dynamic flow of time. This State-of-mind rapresent the personality of the user, his interest, and may affect his own choices.

The users could diffuse the news in relation to their intention: they have a storage memory and they remember a number of news read and spread in the past. The users has a some kind of knowledge of his neighbourhood, with whome can to interact, to spread a news, to influence themselves and to do change the state-of-mind (campo visivo limitato). The sources not receive the news from the network: for easier computation also the links between sources and users is indirect even if the news are only in outcome.

The time is scan by the Observer

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<sup>5</sup>La tipologia di link scelta evidenzia la bilateralità e l'intensità della comunicazione tra gli agenti. ....prendendo come esempio uno scambio di informazione tra due persone oppure tra una persona e un giornale, il peso rappresenta il feeling, l'affiatamento pregresso; un segno posto davanti ad esso ne potrebbe specificare l'entità (buono, indifferente, cattivo)..

<sup>6</sup>The scale free property is described principally by power law degree distribution, sicchè l'andamento per gradi alti tende a zero ma non si annulla.

Eh

L'utente avrà inoltre un tempo di attivazione che sarà regolato attraverso un suo orologio interno tenendo conto del tempo che scorre nel mondo: solo mentre è attivo sarà possibile per lui interagire con il sistema. Ogni fonte genererà nuove notizie tenendo conto lei stessa del tempo che passa.

### 3 Our Model

We use the SLAPP platform for agent simulation, SLAPP3 provides agent based protocol in Python 3; specifically: 1observer tempo del mondo - Classi agenti e sui breed(classi derivate) - Usiamo superAgent ch disegna i grafici e crea gli agenti. - azioni generiche già implementate da specificare a seconda della modellizzazione :DO1.. Draw net...

Schedule: modo per programmare le varie azioni, in ordine temporale esplicitamente dato d noi. Le azioni possono essere performati con una certa probabilità... removelinks... Si interfaccia alle azioni generich sopramenzionate.

Le varie Funzioni base (1.2.3.4.5.... 9che concatenate costituiscono le azioni vere e proprie degli agenti: Funzioni e metodi delle classi::: SPECCHIETTO User/Sources La dinamica del sistema sarà determinata dalle azioni degli utenti; i parametri sopra descritti influenzeranno le loro decisioni.

- Agent.py (user/source)
- SkyAgent (Message scheduler and ConnectionManager ) write the log files...
- Graph (Create the Graph/ edges and display the graph)
- Souces
- Users
- msglog

Funzioni: Una apposita funzione “distanza” permette di confrontare una notizia con lo stato mentale del singolo utente; in esso è contenuto un vettore avente come dimensione il numero di topics. Lo stato contiene inoltre altri parametri che caratterizzano con maggiore specificità il singolo utente, ad esempio la sua propensione a leggere e diffondere notizie.

### 4 Tutorial

The basic tutorial

Set of environment states

Set of agent actions