UAU SIS mk model

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Abstract. Numerous real–world systems, for instance, the communication platforms and transportation systems, can be abstracted into complex networks.

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Contents

1. Introduction

The subject of containing spreading dynamics in networked systems has attracted substantial attention from multiple fronts, for instance, network science, statistical physics, and computer science.

2. Model description

In this study, we consider the UAU-SIOS model on a complex network G of N nodes and M edges.

$$\begin{cases} \theta_i(t) = & \prod_j \left[1 - a_{ji} P_j^{\mathrm{A}}(t) \lambda\right] \\ q_i^{\mathrm{U}}(t) = & \prod_j \left[1 - b_{ji} P_j^{\mathrm{I}}(t) \beta_{\mathrm{U}}\right] \\ q_i^{\mathrm{A}}(t) = & \prod_j \left[1 - b_{ji} P_j^{\mathrm{I}}(t) \beta_{\mathrm{A}}\right] \end{cases} \tag{1}$$

$$\begin{aligned} P_i^{UI}(t+1) = & P_i^{UI}(t)\theta_i(t)\left(1-\mu_1\right)\left(1-\sigma\right) \\ & + P_i^{AI}(t)\delta\left(1-\mu_1\right)\left(1-\sigma\right) \\ & + P_i^{US}(t)\theta_i(t)\left[1-q_i^U(t)\right]\left(1-\sigma\right) \\ & + P_i^{AS}(t)\delta\left[1-q_i^U(t)\right]\left(1-\sigma\right) \end{aligned} \tag{2}$$

Table 1. Basic statistics of the two synthetic networks and six real–world networks employed in this study: the number of nodes N, the number of edges M, the average degree $\langle k \rangle$, and the theoretical spreading threshold λ_c.

Name	N	M	$\langle k \rangle$	λ_c
SF2.3	200	1000	10	0.076
SF3.0	200	1000	10	0.083
Residence hall	217	1839	16.949	0.046
Hamsterster friendships	1788	12476	13.955	0.022
Jazz musicians	198	2742	27.697	0.025
Facebook (NIPS)	2888	2981	2.0644	0.036
Physicians	117	465	7.95	0.099
Air traffic control	1226	2408	3.928	0.109

3. Theoretical analysis

In this section, we first present the Discrete–Markovian–chain (DMC) approach [**?**, **?**] for the SIS model on the network G. Then, using a perturbation method for the DMC, we derive a formula that approximately provides the decremental outbreak size after deactivating an edge in the network G. Finally, using the formula, we study the problem of determining the optimal edge, which, if deactivated, can maximize the decremental outbreak size.

3.1. The Discrete–Markovian–chain approach for the SIS model

In this subsection, we adopt the discrete–Markovian–chain (DMC) approach to study the SIS model on the network G.

3.2. Determining the optimal edge for containing the spreading

For convenience, we denote the new network we get after deactivating the specific edge l in the original network by G_l'.

$$\dot{\rho}_l = c_{ij}\mathbf{1}^{\mathrm{T}}Xu + c_{ji}\mathbf{1}^{\mathrm{T}}Xv + \frac{\varepsilon_{ij}c_{ij}X_{ji}\mathbf{1}^{\mathrm{T}}Xu}{1-\varepsilon_{ij}X_{ji}} + \frac{\varepsilon_{ij}c_{ji}X_{jj}\mathbf{1}^{\mathrm{T}}Xu}{1-\varepsilon_{ij}X_{ji}}. \tag{3}$$

4. Simulation results

Figs. **??** (a) and (b). Tab. 1 (a) and (b).

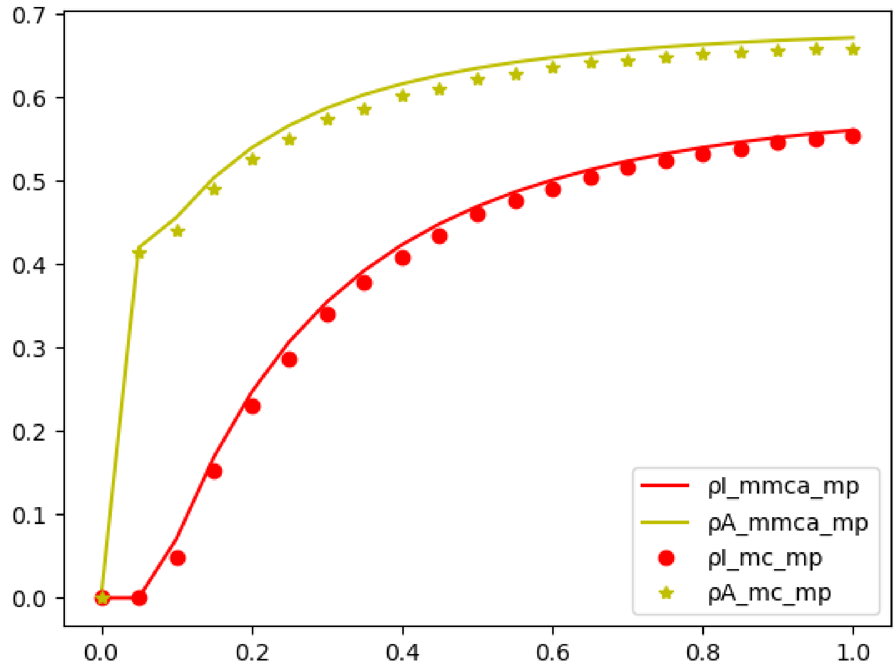

Figure 1. (Color online) check theory.

5. Conclusions

Containing spreading dynamics (e.g., epidemic transmission and misinformation propagation) in the networked systems (e.g., transportation systems and communication platforms) is of both theoretical and practical importance.

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Appendix A.

The iteration formula of $\dot{I}(t)$

This appendix shows the detailed steps of obtaining the iteration formula of $\dot{I}(t)$.

References