



ELSEVIER

Available online at www.sciencedirect.com

SCIENCE @ DIRECT®

Physica A 324 (2003) 402–407

PHYSICA A

www.elsevier.com/locate/physa

Applications of small-world networks to some socio-economic systems

A.S. Elgazzar

Mathematics Department, Faculty of Education, El-Arish 45111, Egypt

Abstract

Small-world networks (SWN) are found to be closer to the real social systems than both regular and random lattices. Then, a model for the evolution of economic systems is generalized to SWN. The Sznajd model for the two-state opinion formation problem is applied to SWN. Then a simple definition of leaders is included. These models explain some socio-economic aspects. © 2003 Elsevier Science B.V. All rights reserved.

Keywords: Small-world networks; Evolutionary economic models; Opinion formation models

1. Introduction

The diffusion of a new concept (a technology, an opinion, an information, a disease, ...) through social and economic systems is a complex process that typically forms waves or avalanches. Also, it usually displays rich dynamics that is attracting the interest of many mathematicians and theoretical physicists [1].

A social network has two main properties: clustering and small-world effect. Clustering means every one has a group of collaborators, some of them will often be a collaborator by another person. Small-world effect means the average shortest person to person (vertex to vertex) distance is very short compared with the whole size of the system (number of vertices).

Regular lattices display the clustering property only. On the other hand, random lattices display the small-world effect without clustering [2]. The concept of SWN introduced in Refs. [2,3] has shown to combine both features. A SWN is a connected ring with some shortcuts joining between some randomly chosen vertices are added with small probability ϕ . Also, this structure combines between both local and nonlocal

E-mail address: elgazzar@mans.edu.eg (A.S. Elgazzar).

interactions. This combination is observed in many real systems. Then it is a useful concept in modeling the real systems. We used this concept in modeling different systems [4–8]. Here our interest is restricted to apply the concept of SWN to a model for the evolution in economic systems [8] and to a sociophysics model [7].

2. A model for the evolution of economic systems in SWN

A real economic system is a population of agents each of them has a technological level (a_i). Every agent is assumed to interact with a group of collaborators (neighbors) obtaining payoffs (profits). The base payoff is assumed to be higher for the higher technological levels, and the payoffs have to be bounded. Also, if an agent is too advance or too backwards relative to his/her neighbors, he/she always has incompatibility costs.

Every agent has to update his/her technological level to obtain the best payoff. Then the population reaches a state at which each agent is satisfied with his/her payoff. Then the technological level of a randomly chosen agent is raised by a quantity $\Delta \in (0, 1)$. Usually the new technology has a cost. The neighbors of this agent updates their technological levels according to the new conditions. They have the possibility to accept or refuse the new technology. The new technology may diffuse through the whole population making a uniform front for cheap updating cost. On the other hand, if the cost is very high, only few agents can modify their levels. For intermediate cost values, the updating process continues through the population making an avalanche until another stable state is reached, and so on. The avalanche's size, s is the number of agents that updated their levels in a step. It has been shown that [9] the avalanches size and several aspects of social and economic systems can be described in terms of power law distribution as,

$$P(s) \propto s^{-\gamma}, \quad \gamma \geq 1. \quad (1)$$

There are two updating optimalities: Nash and Pareto defined as follows:

Definition 1 (Nash optimality). An agent selects the technological level that maximize his own payoff without regards to his/her collaborators.

Definition 2 (Pareto optimality). An agent selects the technological level that maximize the average payoff of his/her group (he/she and the collaborators).

Towards a theoretical approach to this phenomena, Arenas et al. [10] introduced the following payoff function:

$$\pi(a_i, a_j) = \begin{cases} a_i - k_1(1 - \exp(-(a_i - a_j))) & \text{if } a_i \geq a_j, \\ a_i - k_2(1 - \exp(-(a_j - a_i))) & \text{if } a_i < a_j, \end{cases} \quad j = i \pm 1, \quad (2)$$

where k_1 and k_2 represent the incompatibility costs resulting from being too advance or too backwards, respectively. The payoff of the agent i , π_i is $\pi_i = \pi(a_i, a_{i-1}) + \pi(a_i, a_{i+1})$.

متن کامل مقاله

دریافت فوری ←

ISIArticles

مرجع مقالات تخصصی ایران

- ✓ امکان دانلود نسخه تمام متن مقالات انگلیسی
- ✓ امکان دانلود نسخه ترجمه شده مقالات
- ✓ پذیرش سفارش ترجمه تخصصی
- ✓ امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
- ✓ امکان دانلود رایگان ۲ صفحه اول هر مقاله
- ✓ امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
- ✓ دانلود فوری مقاله پس از پرداخت آنلاین
- ✓ پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات