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Does one Bayesian make a difference?

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Abstract

This paper develops a model of repeated interaction in social networks among agents with differing degrees of sophistication. The focus of the model is observational learning; that is, each agent receives initial private information and makes inferences regarding the private information of others through the repeated interaction with his neighbors in the network. The main question is how well agents aggregate private information through their local interactions. I show that in finite networks consisting exclusively of non-Bayesian (boundedly rational) agents, who revise their choices by averaging over the previous period's observed choices, all agents fail to perfectly aggregate the privately held information. However, the presence of at least one Bayesian agent in a strongly connected network is shown to be generically sufficient for every agent, whether Bayesian or non-Bayesian, to perfectly aggregate the private information of all agents.

JEL classification: C70; D80; D83; D85

Keywords: Social networks; Information aggregation; Bayesian learning; Boundedly rational learning; Social learning; Consensus

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1. Introduction

A central question in economic theory is whether privately held information of a large number of individuals is aggregated. One particular aggregation device that has been especially prominent is the market price. There is a vast literature on the information value of prices and under which conditions they aggregate the dispersed private information. This discussion started with Keynes [25] and Hayek [22] and continues until the present day. In this paper, I focus on a different mechanism for aggregating private information, one which plays an important role in economic reality: social interaction.

The Internet-based social network revolution has greatly simplified social interaction and communication. As a consequence, social networks are becoming an increasingly important venue for the diffusion of information and opinions. The role of networks as an important conduit of information and opinions has long been documented empirically.[2] In this context, it is important to gain a deeper understanding of how social interaction affects the evolution of opinions and the spread of information.

This paper develops a model of repeated interaction in social networks among privately informed agents. The agents are embedded in a social structure and repeatedly interact with their social contacts. Over time, the repeated interaction allows agents to draw inferences on the private information of all other agents. However, Bayesian inferences on the private information of others require highly complex considerations, particularly in incomplete networks (see Gale and Kariv [15]).[3] The main goal of this paper is to gain a deeper understanding of how the interaction of agents with differing degrees of sophistication affects the quality of information the agents hold in the long run.

Two different types of agents are considered, Bayesian agents and non-Bayesian (boundedly rational) agents who are unable or unwilling to make complex inferences and instead revise their behavior based on simple learning heuristics. More precisely, the non-Bayesian agents are modeled according to the standard DeGroot [11] model. That is, they revise their choices by taking a weighted average of the previous period's observed choices. This paper mainly differs from the existing literature in considering network-based repeated interaction among agents of differing degrees of sophistication. The existing literature focuses either on networks consisting only of Bayesian agents, in the following denoted as Bayesian communication structures, or on networks consisting only of non-Bayesian agents, henceforth denoted as non-Bayesian communication structures.[4]

I focus on the information aggregation properties of mixed communication structures- networks that consist of Bayesian and non-Bayesian agents- and non-Bayesian communication structures. In particular, I am interested in perfect information aggregation where the choices of each agent converge to the choice that is optimal conditional on the pooled private information of all agents.[5] The main questions of the paper are the following. First, how well do

[2] The importance of interpersonal communication has been established for the adoption of consumer goods (see Feick and Price [14]), medical innovation (see Coleman, Katz and Menzel [9]), agricultural practices (see Munshi [29], Conley and Udry [10]), and microfinance (see Banerjee, Chandrasekhar, Duflo and Jackson [7]), among others.

[3] In a complete network, each agent is a neighbor of every other agent.

[4] See Gale and Kariv [15], Rosenberg, Solan and Vieille [34], and Mueller-Frank [27] for analyses of Bayesian communication structures; DeMarzo, Vayanos and Zwiebel [12], and Golub and Jackson [17] for non-Bayesian communication structures employing the DeGroot model [11]; and Mueller-Frank [28] for a more general analysis of non-Bayesian revision functions.

[5] For any realization of the private information.