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Evolving traders and the business school with genetic programming: A new architecture of the agent-based artificial stock market[☆]

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Abstract

In this paper, we propose a new architecture to study artificial stock markets. This architecture rests on a *mechanism* called 'school' which is a *procedure* to map the phenotype to the genotype or, in plain English, to uncover the secret of success. We propose an *agent-based model of 'school'*, and consider school as an evolving population driven by single-population GP (SGP). The architecture also takes into consideration traders' search behavior. By *simulated annealing*, traders' search density can be connected to *psychological factors*, such as *peer pressure* or economic factors such as the *standard of living*. This market architecture was then implemented in a standard artificial stock market. Our econometric study of the resultant artificial time series evidences that the return series is independently and identically distributed (iid), and hence supports the efficient market hypothesis (EMH). What is interesting though is that this iid series was generated by traders, who do not believe in the *EMH* at all. In fact, our study indicates

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that many of our traders were able to find *useful signals* quite often from business school, even though these signals were short-lived.

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1. Background and motivation

Over the past few years, genetic algorithms (GAs) as well as genetic programming have gradually become a major tool in *agent-based computational economics* (ABCE). According to Holland and Miller (1991), there are two styles of GAs or GP in ABCE, namely, *single-population GAs/GP* (SGA/SGP) and *multi-population GAs* (*GP*) (MGA/MGP). SGA/SGP represents each agent as a *chromosome* or a *tree*, and the whole population of chromosomes and trees are treated as a society of market participants or game players. The evolution of this society can then be implemented by running canonical GAs/GP. Arifovic (1995, 1996), Miller (1996), Vila (1997), Arifovic et al. (1997), Bullard and Duffy (1998a,b, 1999), Staudinger (1998) are examples of SGA, while Andrews and Prager (1994), Chen and Yeh (1996, 1997, 1998), and Chen et al. (1996) are examples of SGP. MGA/MGP, in contrast, represents each agent as *a society of minds* (Minsky, 1986). Therefore, GAs or GP is actually run inside each agent. Since, in most applications, direct conversations (imitations) among agents do not exist, this version of applications should not be mistaken as the applications of *parallel and distributed GAs/GP*, where communications among '*islands*' do exist. Examples of MGA can be found in Palmer et al. (1994), Tayler (1995), Arthur et al. (1997), Price (1997), Heymann et al. (1998).

While these two styles of GAs/GP may not be much different in engineering applications, they do answer differently for the fundamental issue: '*who learns what from whom?*' (Herreiner, 1998). First, agents in the SGA/SGP architecture usually learn from other agents' experiences, whereas agents in the MGA/MGP architecture only learn from their own experience. Second, agents' interactions in the SGA/SGP architecture are direct and through *imitation*, while agents' interactions in the MGA/MGP architecture are indirect and are mainly through *meditation*. It is due to this difference that SGA/SGP is also called *social learning* and MGA/MGP *individual learning* (Vriend, 1998). At the current state, the SGA/SGP architecture is much more popular than the MGA/MGP architecture in ABCE.

In addition to its easy implementation, the reason for the dominance of SGA/SGP in ABCE is that economists would like to see their genetic operators