Beyond Cooperation-ism and Competition-ism (Exploring Social Phenomena with a Generalized Tit-For-Tat Model)

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Abstract

In an attempt to integrate social and non-social behavior when designing autonomous agents, we have been searching for a general model of social behavior that could be instantiated to account for a range of social phenomena. Residing in the bottom-up paradigm, such a cognitively economic model should be able to describe heterogeneous, adaptive agents and should scale well to complex social settings. The ordinary tit-for-tat model appears as a perfect candidate since it is "nice, forgiving and retaliatory" and it has proven evolutionarily stable. To allow for variation, heterogeneity and adaptivity without limiting ourselves to games, we generalized this model to include a *local, individualistic*, rather than externally imposed, criterion of cooperation/defection, and to depend on parameters and structures whose variability would show as heterogeneity at the population level: each generalized-tit-for-tat agent perceives the value of a "social" object and regards it as cooperative/ defective if it is above/below a certain threshold. Both the cooperative and defective action involve production of the *same* social object in a quantity given by a function which is different for cooperation and defection. The perception functions of the agents may include substantial filtering (or distortion of objective reality) that further enhances the model's genericity. The overall scheme implies that the social process is an auto-catalytic one, rather than one where an external agent manipulates the player-agents by rewarding them according to its own motivations. Instead, the agents are struggling to maximize their local satisfaction, i.e. the "social reward" they receive and to which they themselves participate.

We have used the generalized-tit-for-tat model to study phenomena in three exemplary cases. The first is an abstract "affection problem", where agents are trying to maximize the total affection they perceive. We demonstrate the necessity of generosity and the advantage of heterogeneous rather than homogeneous populations in terms of both average satisfaction and resistance to perturbations. We also investigate the relation between environmental or social perturbation and two variants of a blind adaptation mechanism, an "active" and a "passive" one.

The second case studied is an artificial economy where agents are making expenses according to an individual need, as well as a social participation mechanism. We distinguish between three types of agents according to social participation: rational, aggressive and scrooge consumers. The resistance of the artificial economy to perturbations is found satisfactory when rational agents are present in high proportions, while the aggressive and scrooge agents are shown to be the most manipulable and hence most unhappy ones.

The final example involves a set of producer agents living in a two-dimensional grid: each agent is satisfied when the social productivity standards in its position do not differ significantly from its own possibilities, otherwise it migrates to a neighboring place. We demonstrate that direct aggressivity is necessary in order to ensure high and uniform satisfaction and that phenomena such as insulationism do not owe their existence to any particular values of the agents' parameters but are a result of intricate interactions between heterogeneous agents, or equivalently of selection by a social environment.

The power of the approach may be partly attributed to the presence of genetic variations/diversity in the agents' parameters which gives rise to intricate dynamics, while in the same time enhancing *social autonomy* (in the sense of resistance to perturbations). The cognitive role of filtering/satisfaction functions is also briefly discussed. The same model has been successfully applied to autonomous agent control, both at the robot/animat and at the cellular level (Tzafestas, to appear).

Related publication

E. S. Tzafestas (to appear). Autonomy, diversity and cooperation: Explorations with a quantitative tit-for-tat model, *LAFORIA Research Report*.