

## SHORT TERM SCIENTIFIC MISSION (STSM) – SCIENTIFIC REPORT

The STSM applicant submits this report for approval to the STSM coordinator

**Action number: CA-16228 (European Network of Game Theory)**

**STSM title: Social Learning Dynamics with Multiple Mentors**

**STSM start and end date: 23/07/2018 to 30/07/2018**

**Grantee name:**

### PURPOSE OF THE STSM/

(max.500 words)

Social learning processes are commonly modelled by payoff-monotone dynamics, according to which, strategies that induce higher payoff to their followers gradually become more frequent. A leading example of such dynamics is the replicator dynamics (Taylor and Jonker, 1978), which can be interpreted in terms of biological asexual reproduction or as social learning by imitation. According to the latter interpretation, a new agent who joins the population randomly chooses a member of the population as a “mentor,” and imitates the mentor’s strategy; the probability that an agent is chosen as a mentor is proportional to that agent’s fitness.

In many situations it seem plausible that a new agent may choose more than one mentor, and imitates some strategic aspects from each mentor. In biological heredity processes this represents the fact that each offspring inherits genes from both of his parents. These kinds of processes have infrequently analysed in the Biological literature (Eshel and Feldman, 1984; Liberman, 1988; Matessi and Di Pasquale, 1996) and in the Economic Literature (Waldman, 1994).

In this project we plan to formalize the non-payoff-monotone dynamics induced by these processes (which we call, hybrid-replicator dynamics), study its rest points, introduce and analyse various notions of dynamic stability (which also take into account various stochastic perturbations), and apply it to learn various situations of learning processes with economic significance.

### **DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS**

(max.500 words)

During the STSM we have done the following work:

- 1) We constructed a formal model of the dynamics, and reformulated it in terms of related vector fields.
- 2) We analysed the induced dynamics, using various mathematical techniques.
- 3) We tested the predictions of the dynamics in a numeric simulation.
- 4) We planned how we will continue work on the project in the following months.

### **DESCRIPTION OF THE MAIN RESULTS OBTAINED**

During the STSM we have achieved the following results:

- 1) We characterized rest points for the case in which each new agent combines traits from two different mentors.
- 2) We characterized necessary and sufficient conditions for asymptotic stability of asymptotically stable pure population states.
- 3) We applied the model to a few interesting family of games, and demonstrated induced stable states.
- 4) We reformulated the dynamics in terms of fitness-weighted frequencies, and obtained a seemingly different (yet, equivalent) formula of the dynamic, which is closely related to dynamics in the existing biological literature (see, e.g., Feldman, 1971; Rutschman, 1994). The key novelty of our model, relative to the existing literature, is combining this dynamics with payoffs that depend on the population state.

### **FUTURE COLLABORATIONS (if applicable)**

(max.500 words)

*We plan to continue working on the project in the next several months (which might be extended to a couple of years).*