Emergence of Risk Sensitivity in a First-principles Agent-based model

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Risk aversion and risk-seeking are acknowledged features of human and non-human behaviour. The risk sensitivity of different entities seems to be shaped by the same underlying principles. Thus, there could be a regularity concerning wherewith living entities originate risk-sensible behaviour. Previous works employed theoretical work and simulations to examine if risk preferences could arise from various adaptation styles (cultural and genetic).

The purpose of this work is to understand how risk preferences emerge in a complex system, identifying existing relationships between the emergence, the adaptation styles and the environmental variables. This abstract presents an agent-based model in which a single variety of agents can move on a toroidal surface. Agents survive by consuming energy. When an agent terminates energy, it dies. Hence, agents move to collect energy, and they have to ways to do it. First, an agent can head in the direction of a passive energy source and supply from it. Second, it can move towards a different agent and attack it with a given probability of success. One alternative is risky, and the other is safe. Agents choose between these two possibilities computing a payoff. The decision-making weighs the distance from an option and its preference, which can be genetic or learned from experience.

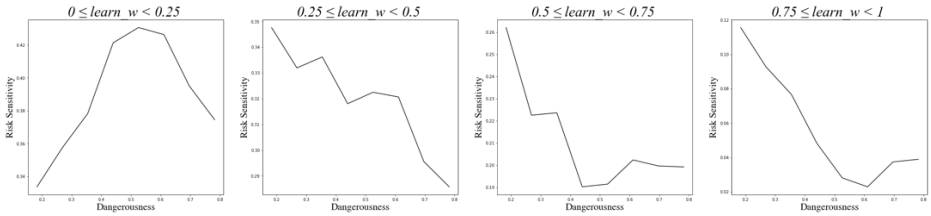

Figure 1: Risk sensitivity of population plotted on the dangerousness of the system with respect to the different style of adaptation, from evolution (left) to learning (right)

A sensitivity analysis was performed on the simulation model. It allowed identifying the influence of each parameter on the resulting risk preferences, such as the probability of success of aggression or the weight of adaptation styles on the decision-making. The analysis of the simulation results confirmed that both risk aversion and risk-seeking behaviours could emerge from the interaction of agents. Besides, we built a metric of environmental dangerousness to estimate the effect of every variable on the surviving rate of the population of agents. It seemed to exist a non-monotonic non-linear relationship between the dangerousness and the emergence of risk sensitivity, and that this relationship varies with the adaptation style (Figure 1). We propose the shape of the curve derives from the combination of two elements. One is the existence of incentives to develop risk preferences, which changes with the dangerousness of the surroundings. The second is a direct relationship between the harshness of the environment and the expected benefit of developing risk preferences. The simplicity of this model indicates that these findings could apply to different application fields. Future studies include the generalization of the results and the validation of the findings in real-world scenarios.