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Title of the Manuscript
(Center, Bold, Times New Roman 14, maximum 15 words in english)

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Abstract

Abstract consists of objectives, methods, findings, and research contributions in 150 to 250 words which contains the main conclusions and provides important information and is accompanied by **5 keywords**. Furthermore, the determination of keywords needs to pay attention to important words contained in the title and abstract, separated by a semicolon. **The novelty** in this paper briefly explains why no one else has adequately researched the question. Then **the results** are made a list of the empirical findings and write the discussion in one or two sentences.

Keywords: *Keyword 1; keyword 2; keyword 3; keyword 4; keyword 5*

1. Introduction (10pt, bold)

One of Biologists' primary objectives since Darwin has been to explain the development of cooperation through natural selection. Cooperators aid others at their own expense, whilst defectors get rewarded for acting selfishly. A very common approach for simulations in this context is to use the prisoner's dilemma game. In a repeated game, it was notoriously shown that the optimal strategy is "tit for tat" [**?**], where cooperation is repaid with cooperation and defection with defection, and that given even a single element adopting this strategy in an otherwise always finite all-defective population, it is possible to specify circumstances under which cooperation might arise [**?**]. Also the case of indirect reciprocity has been object of many studies [**?**, **?**, **?**, **?**], and the main explanations rely on the concept of image scoring [**?**].

In this approach, it is unclear how the image score, which represents a person's willingness to cooperate, is universally accessible information, and in the case of using it as a proxy for many characteristics exhibited by a subset of a population, it would be more appropriate for it to be the property of the observer and not the observed.

In more recent approaches in explaining cooperation simulations took into account gossip and reputation ... However in most simulations the approach is discrete, an agent can either be a cooperator or a defector all the time or follow a predetermined strategy (such as "tit for tat"). In our simulation we explored a world where people's willingness to cooperate is represented by a percentage and we observed how cooperation can emerge from very simple gossiping rules.

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2. Model (10pt, bold)

In the model the agents play an iterated prisoner's dilemma game using a private list mechanism to record collaborators and increase their chances of choosing a previously met collaborator in successive games. However agents are not divided among cooperators and defectors, but their willingness to cooperate (or defect) is described by a number between 0 and 1, where 0 represent an always-defect and 1 an always-cooperate strategy. In practice this strategy value represent the probability of the agent to cooperate.

Agents are initialized with a strategy score of $0.5 \pm u$ where u is a random number picked from a uniform distribution between -0.3 and 0.3. At first each agent will pick randomly with whom to play, however, when an opponent cooperate the agent will record it on its own private cooperators list.

In successive games the agent will either pick randomly among the whole population or among its own list. An opponent that cooperated multiple times will have higher chances of being chosen to play with since the random choice from the list is weighted on a "cooperation score", which is simply a number representing how many times the agent met cooperated. If an agent present in the list defect, it will lose 1 point from its cooperation score. The score cannot be negative, as to say that defectors are not overly punished for their behaviour.

In addition to this mechanism, agents will also share their list with the top cooperators of it. The sharing mechanism simply makes it so that the agents receiving the shared lists will increase the cooperation scores of its own list by 1 point if the same agent is already present in its list, or add it to the list when is not present.

The payoff matrix for the game is as follows:

		Player 1	
		C	D
Player 2	C	$(3,3)$	$(5,0)$
	D	$(0,5)$	$(1,1)$

The agents have a certain probability to choose if pick an opponent randomly from the whole population or from the list. This is a fixed value for all the population.

Every few turns through a genetic algorithm the agents with the lowest payoff are substituted by the offspring of those with the highest payoff, which are basically clones with random mutation of the strategy score.

3. Result and Discussion (10pt, bold)

When the list mechanism is not present, as expected from game theory, the mean strategy score of the whole population decreases, meaning that the preferred strategy is to defect.

Instead when the list mechanism is present the average strategy score increases, leading to a more collaborative world. To be correct, we should also specify the list use percentage, when this score is higher than xxx then the environment is a collaborative one.

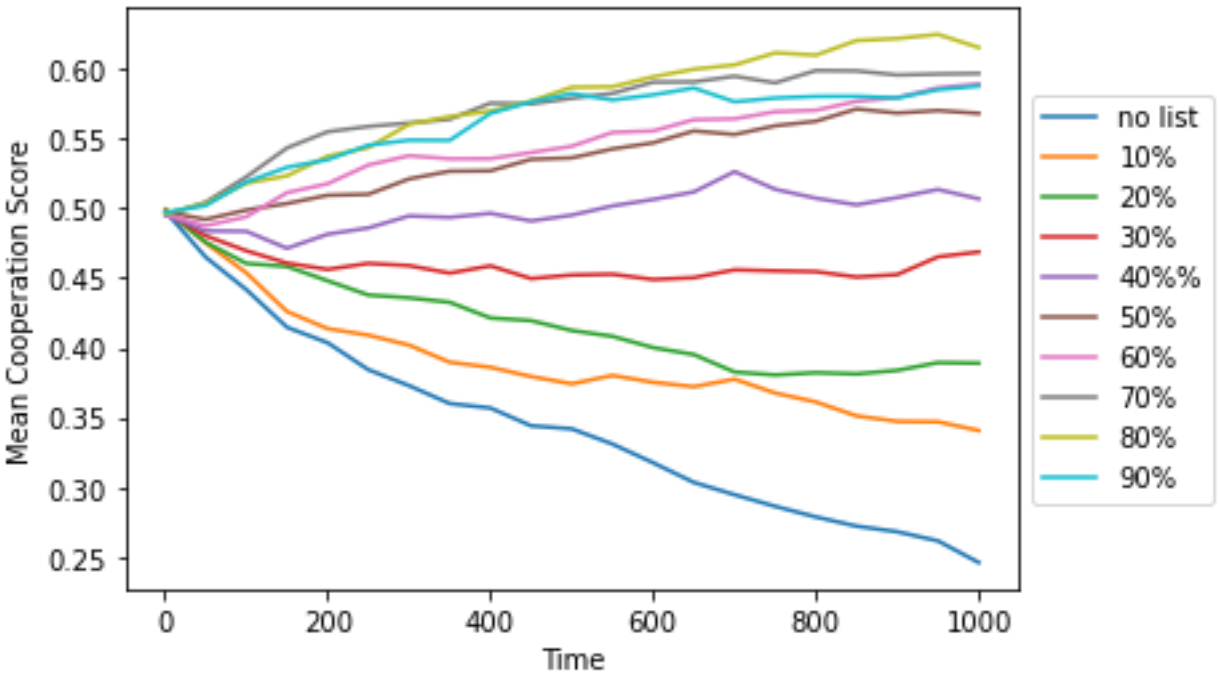

Figure 1. Cooperation Score Varying the List Usage

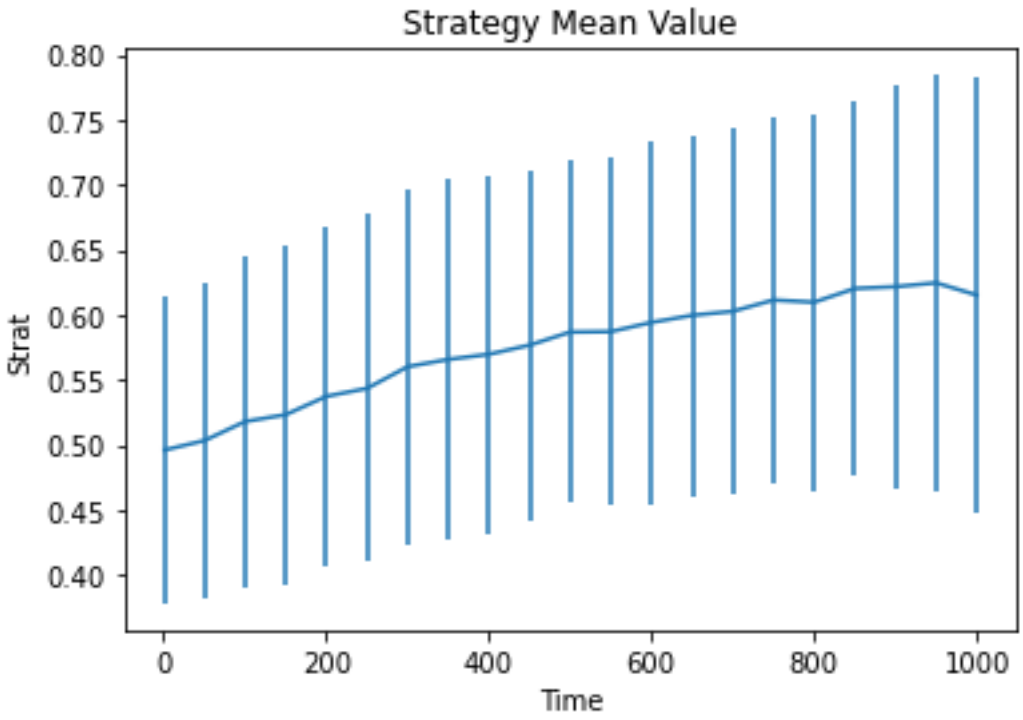

Figure 2. Cooperation Score with Error Bars (list usage 80%)

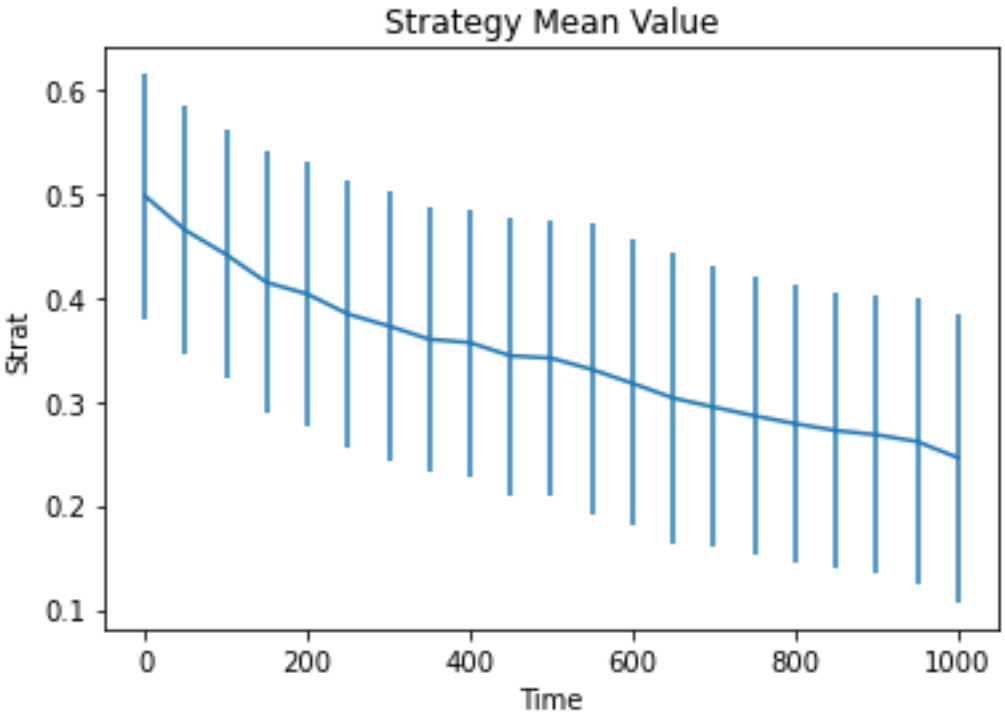

Figure 3. Cooperation Score with Error Bars (no list)