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Referee Report:
"Resilient cooperators stabilize long-run cooperation in the finitely repeated Prisoner's Dilemma"
Authors: Andrew Mao, Lili Dworkin, Siddharth Suri & Duncan J. Watts

BREIF SUMMARY

This paper furthers the understanding of cooperation in repeated iterations of Prisoner's Dilemma. The authors leverage the prior understanding and methodology of playing a series of Prisoners Dilemma with a select group of people but have expanded the learning by conducting the experiment in a virtual lab and using a simulation model. By using the online platform, Amazon Mechanical Turk, the researchers have been able to chart the cooperation dynamics over a longer timescale revealing interesting patterns in cooperation.

COMMENTS

Research question and results

The researchers do a good job of identifying and stating the research question. The research statement is explicitly stated in the first paragraph of the paper as follows, "What happens to cooperation in finitely repeated games when individuals within the same population repeatedly play these games over long intervals of time? Do they begin to exploit one another leading to the eventual erosion of cooperation? Or do they instead remain resilient in the face of occasional exploitation and continue to cooperate even when it is costly to them?" (Mao, Dworkin, Suri & Watts) The idea of what the research is pursuing is clear, but the research question spans three questions while it is possible to consolidate into a concise question. A suggestion to improve is provided in the grammar check section of this report.

The authors answer the question methodically by outlining the methods used, clarifying any assumptions and describing and graphically illustrating the results. Through this paper, the authors quantified that even on the long run, about 60% of people fall into pattern of known "rational behavior" that is they acted in their self-interest but 40% remained cooperative no matter what. They additionally answered what was the long run impact of this resilient cooperation on the overall behavior of the sample population.

Methods

There are two broad categories of methods employed in this study – the virtual lab experiment constructed with participants from Amazon Mechanical Turk and a simulation model. The methods used are not only sufficient but an improvement to existing practice of conducting cooperation research on the participants in a laboratory setting. Using the virtual lab extended the time interval over which experiment was conducted testing the typical inference of prisoner's dilemma studies, that within a given population over time it would unravel into no cooperation. The researchers show thought in participant recruiting and analysis of why participants dropped out to prove viability of using the virtual environment. One thing to consider and verify is whether the participants' perceptions of the cost incurred in virtual and real life is the same. If people have a tendency to underplay the cost in a virtual environment, the results of 40% resilient cooperation might be inflated in real life.

To show the effect of minority resilient cooperators on the population, the authors simulate using agent-based modeling and simplify agents into consistent cooperators and updating rationalizers. The strategy employed by the rational agent is divided into three categories and well explained by the authors and appropriate.

Finally, making the data and code openly available is a good example for open source research method that invites collaboration, review as well as potential participation from a broader audience.

Literature Review and Citation

Overall the authors have done a good job in incorporating a broad range of literature on prisoner's dilemma spanning topics in from economics to evolutionary biology. This helped establish what concepts are known and leveraged and how the results from this study adds to the knowledge. For many key known ideas in this field, multiple references are reviewed and cited. For example, the known range of 40 and 60% of participant cooperation in one shot dilemma refers to five citations from different areas (Mao et.al 2). While I would not consider multiple citations per idea unnecessary, some of them could be reduced to broadened literature review to incorporate ideas on simulation enhancement. Very few citations are included in simulation methods section. Additional review of literature in computational model and simulation of Prisoner's Dilemma would be advisable. For instance, the researchers cite the notable political scientist, Robert Axelrod's highly cited works like "The Evolution of Cooperation" but do not refer to his work "The Complexity of Cooperation" that specifically

focuses on agent-based models of competition and collaboration. Consider reviewing that work and related citations.

The inclusion of papers that share insights on use of Amazon Mechanical Turk such as citation number 40, 48 and 49 is the right idea to construct meaningful virtual lab experiments. Additional review of literature on behavior of individuals in virtual environment would be advisable to conclusively prove that these results can be generalized to larger population in real life.

Grammar, Spelling and Style Check

This paper is a well written and meets requirements for correct spelling and readable, concise style. The paper consistently follows the spelling norms of British English and no errors were detected. One minor point to consider is the use of commas. There were a number of lines in the paper that could have been made clearer and easier to read by appropriate use of commas. Here are some select examples with the corrections highlighted in red:

> "In other respects, Fig. 1 shows that early behavior…" (Mao et.al 2)
>
> Moreover, between games, cooperation levels exhibited…" (Mao et.al 4)

Another look through with this grammar check in mind would be advisable. Additional review of lengthy, verbose sentences should be done. An improvement to research question is suggested below:

> "What happens to cooperation when individuals play finitely repeated games over long intervals of time – do they begin to exploit each other to eventual erosion of cooperation or do they remain resilient at all costs?" (Mao et. al 2)

I did not follow if there was any reason to use a font size that is 2 points lesser than the font for the rest of the paper for the methods section. It should be updated to 9.5 like the rest of the paper.

EXTENSION PROPOSED

The most striking part of the results was that 40% of the people chose to remain cooperative at the cost of their own success and the researchers show that this minority group contributes to the long run cooperation threshold. Based on the results as well as further investigation suggested by the authors, I would propose a further exploration of this phenomenon. The research would answer questions such as: the internal and external factors that encourage cooperative behavior, benefits of stabilizing unravelling dynamics in various settings and what is the effect of having a resilient majority. A good research question to pursue would be: what is the impact of varying resilient cooperators in competitive

environments versus collaborative organization? As the authors note that having a certain number of resilient cooperators stabilized the entire population to a more cooperative threshold not unravel into completely uncooperative actions. Is there a threshold after which an organization that is built on competitive, “self-interested” culture, for instance commission-based sales team, suffer from negative consequences of cooperation? On the flip side, organizations that need cooperation to exist, such a new product design team, what is the consequence of not having minimum number of resilient cooperators? This can be conducted using agent-based simulation as described in the paper but the strategy selection of “rational thinkers” could be simulated to match real life scenarios and incentives. With additional literature review, a more clarity on motivations for resilient cooperators should be gained and used to model a strategy for those agent types as well. In this method though, an additional factor must be considered – the effect of quantified cooperation threshold on results. To corroborate hypothetical scenarios to real life, collaboration with a large company with varied operations will be conducted. A good set of data would be financial reports for one or more quarters for a sales team and design team in a corporation to gauge results. To understand the team dynamics, we would need human resources data about the employees and if possible, chats from collaborative tools such as slack or webex and information about meetings schedules. Like the study by Mao and coauthors, open ended surveys should be conducted to gain insight into strategy of work of employees within teams and consequently categorized into strategies for cooperation and rationalization. Using this data and simulation model, the consequences of the stabilizing effect of resilient cooperators on different organization types can be analyzed.

REFERENCES

Axelrod, Robert. The Complexity of Cooperation: Agent-Based Models of Competition and Collaboration. Princeton University Press, 2008.

Mao, Andrew, Lili Dworkin, Siddharth Suri, and Duncan J. Watts, Resilient Cooperators Stabilize Long-run Cooperation in the Finitely Repeated Prisoners Dilemma," Nature Communications, January 2017, p. p. 13800.