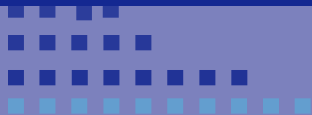# A Few Bad Apples Are Enough. An Agent-Based Peer Review Game.

Juan Bautista Cabotà, Francisco Grimaldo (U. València)
Lorena Cadavid (U. N. Colombia)
Giangiacomo Bravo (Linnaeus University)
Flaminio Squazzoni (GECS - U. Brescia)

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- The problem: The Peer Review (PR) process.

- Aim of this research.

- Proposed Peer Review Model

- Simulations

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- Future work

Peer review (PR) process

- PR is a cornerstone of science as it ultimately determines how the resources of the science system are allocated.

- Scrutinizes scientific contributions before they are made available to the community.

- Used in conferences, journals, granting agencies for project evaluations...

- As any social process, it can be evaluated with respect to a series of parameters:

• Quality, efficiency, effectiveness, fairness, fraud detection, innovation promotion...

PEERE COST ACTION: New Frontiers of Peer Review

- Improve efficiency, transparency and accountability of PR
- Working groups:
- Theory, analysis and models of PR.
- Data sharing and testing.
- Research and implementation agenda.

- http://www.cost.eu/domains_actions/TDP/Actions/TD1306

Aim of this research

- Several cases of misconduct and proofs of biased referee behaviour call for reconsideration of the process.

- Agent-based models allow us to simulate scientists' behaviour whereas we lack empirical data.

- The PR Process can be seen as a cooperation dilemma.

- Our goal is to explore the effect of …

  - Three different scientists' behaviours

  - A social norm

  - In random, scale-free and small-world networks

  - with a game-theory inspired model

The Peer Review Game

- Players (Agents):

- Take on two different roles: Author and Referee.

- Have a certain amount of **Resources (R_i)**.

- Invest an **effort (e_i)**, unique during simulation, in writing and reviewing.

    - Submission effort is random.

    - Review effort depends on the behaviour.

- That have a **Cost (c_i)** proportional to the effort.

- Submission & Review Quality $Q_i = e_i * R_i$

- The system:

- There is a finite amount of resources.

- Quality Threshold (T = 0,4).

Publication process

- In each time step, agents play twice, once as author and once as referee.

- The role order is random.

- Couples change with roles (the same two agents are unlikely to play together twice in the same time step).

- A reviewer does a fair review if $Q^r_j \geq T$

  - In this case, a submission is accepted if $Q^s_i \geq T$

- Otherwise, the reviewer does an unfair review:

  - The submission is accepted with probability 0.5

The Peer Review Game

- Payoff table:

- In each step, costs were subtracted and benefits were added to the authors' and referees' own resources.

		Referee	
		$Q^r_j \geq T$	$Q^r_j < T$
Author	$Q^s_i \geq T$	$b - c^s_i, - c^r_j$	$\frac{1}{2}b - c^s_i, - c^r_j$
	$Q^s_i < T$	$- c^s_i, - c^r_j$	$\frac{1}{2}b - c^s_i, - c^r_j$

Networks

- Random network

- A number of links were created between random scientists.

- Small-world network

Collaboration networks have the small world property: the average separation between the nodes is small.

Clustering coefficient is higher than expected for random networks. (Newman 2001).

- Scale-free network

Degree distributions of studied data indicate that scientific collaboration networks are scale-free. Node selection is governed by preferential attachment. (Barabási et. al. 2002).

Behavioural heterogeneity and social norm

- **Self-interested referees**
- Put less effort in reviewing ($e^r_j = 0.5$).
- Try to save resources for publishing.
- **Normative referees**
- Put a great effort in reviewing ($e^r_j = 0.75$).
- Intentionally contribute to the review process.
- **Conformists**
- Their review effort depends on a **<u>social norm</u>**:
  - Average of the review effort of the scientists with which they are connected.
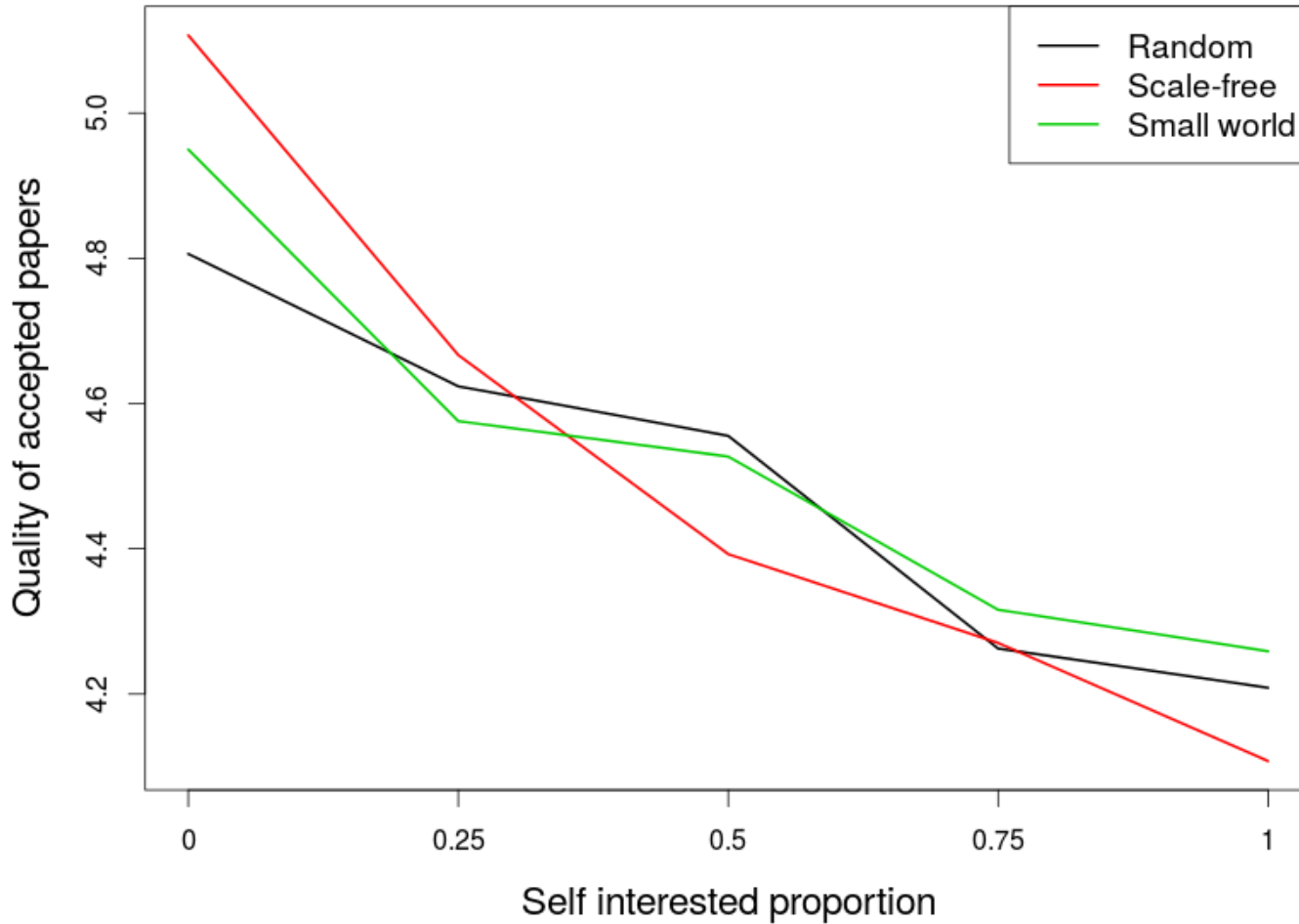
Running the Simulations

- Scenarios

- Combinations of different percentages of scientists' behaviour

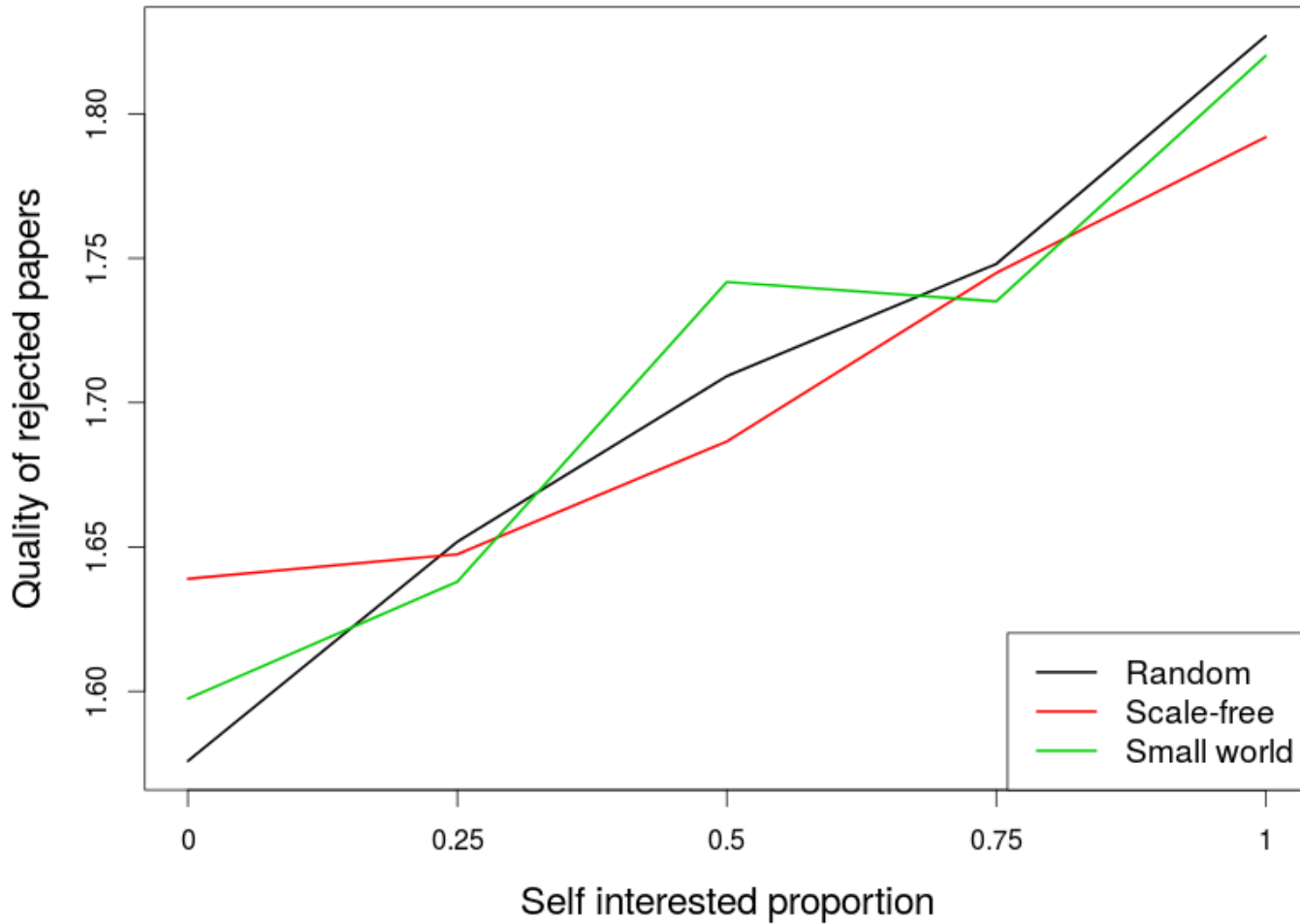- In different network topologies

- Indicators

- Quality of accepted papers.

- Quality of rejected papers.

- Quality difference: quality difference between accepted and rejected papers.
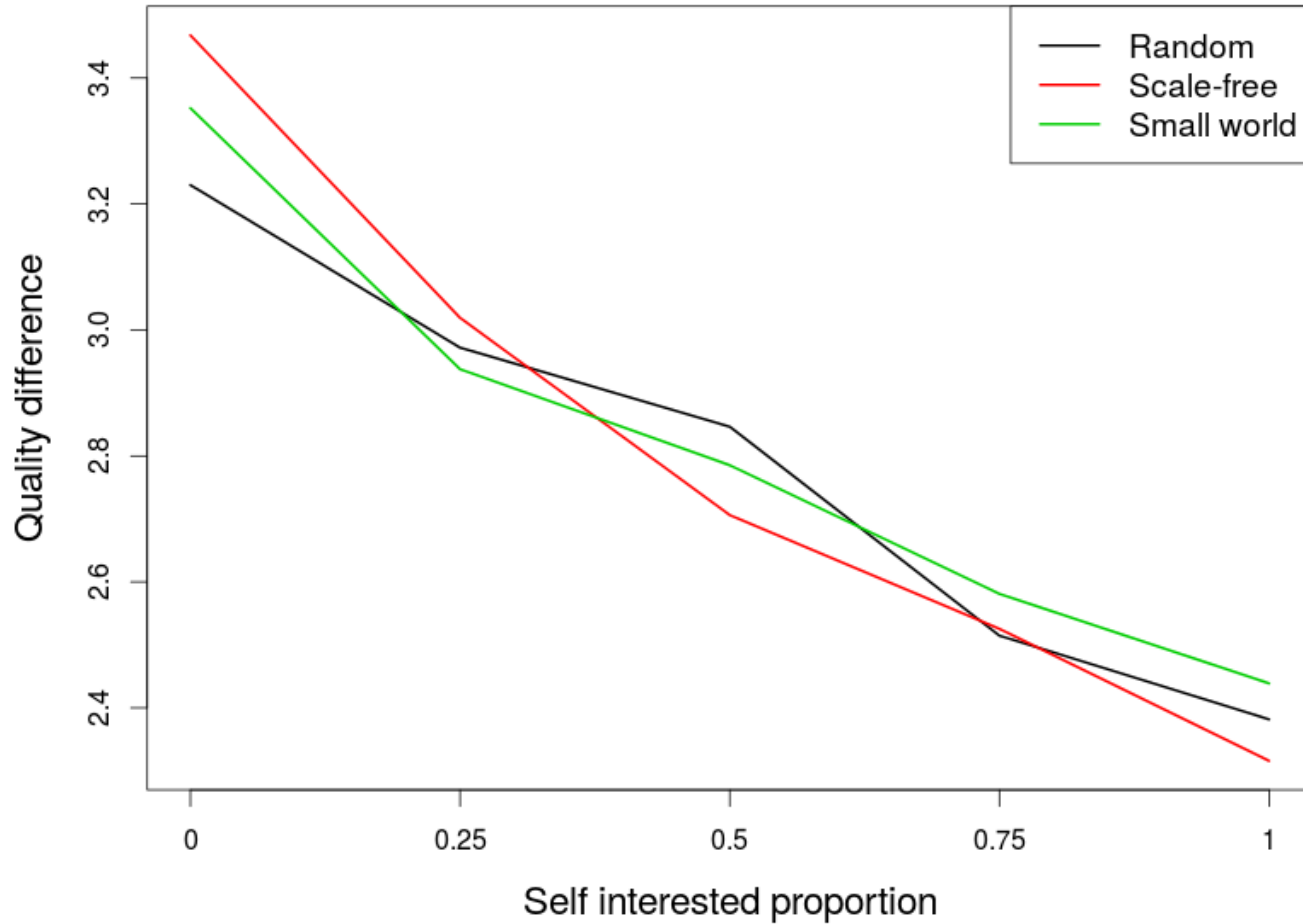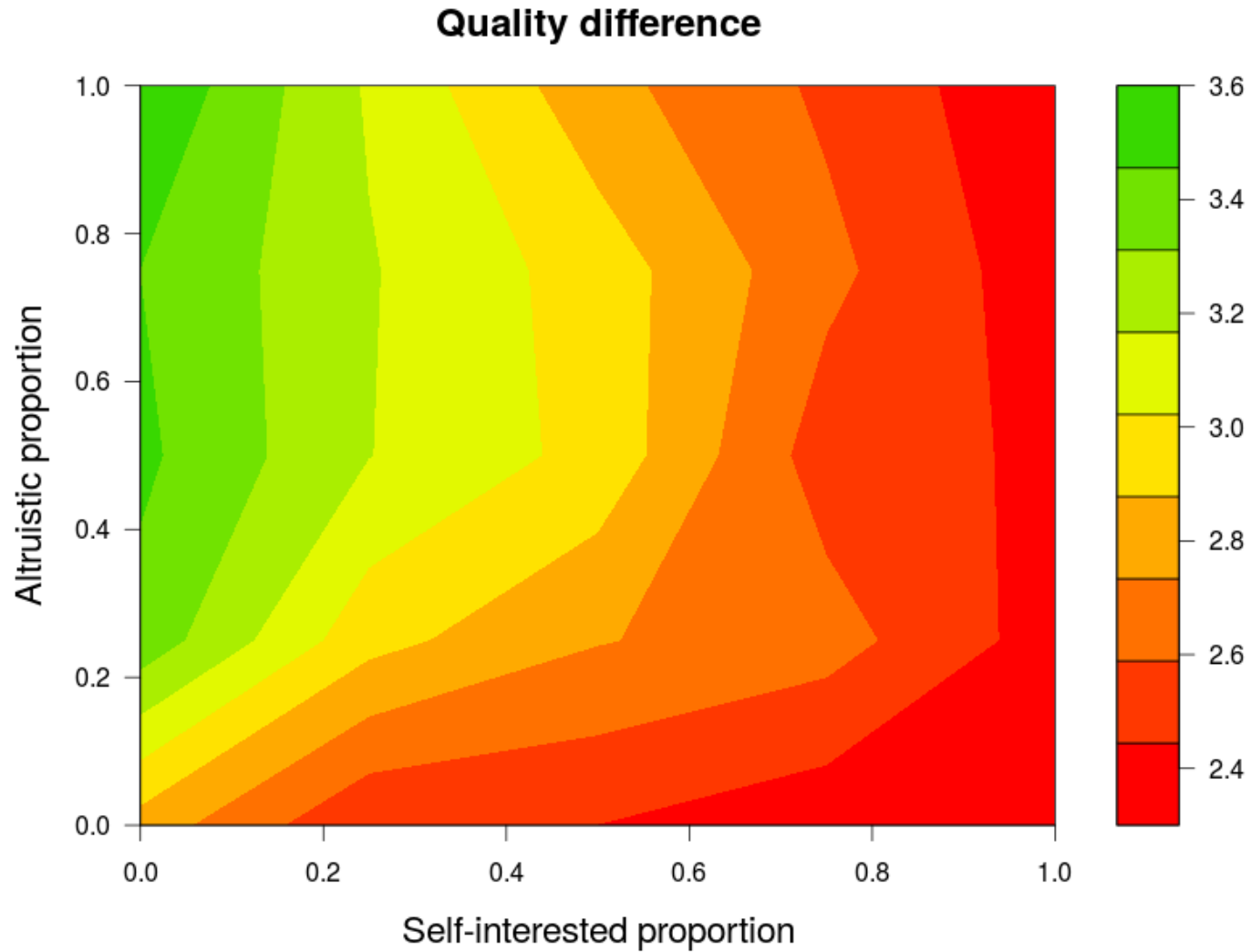
Quality of accepted papers

Quality of rejected papers

Quality difference

Quality difference

Conclusions

- Only a minimal percentage of self-interested scientists are needed to damage the quality of peer review.

- If referees' reliability is influenced by a social norm (people conform to others' behaviour) and the structure is similar to that of the scientific community, bias tends to increase.

- The review process should have some mechanisms aimed at counteracting the effects of self-interested referees.

Future work

- Further exploration of the parameter space.

- Addition of dynamism to the implemented networks.

- Inclusion of reputation mechanisms that reflect better the real scientific world in the long term.

- Calibration of the model with empirical data.

- Validation of the model against real-world data.

- Comparison of the model against other Game Theory models.

Thank you!

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