Cooperation without Association
Christopher Ahern¹, Robin Clark¹, Steven Kimbrough²
¹Department of Linguistics, ²Operations and Information Management
University of Pennsylvania

Introduction

How does association factor into the evolution of cooperation?

The key to the evolution of cooperation, collective action, and social structure is association. [Association] of interactions allows the evolution of cooperative social structure that would otherwise be impossible. (Skyrms [2004] pp. xiii–xiv)

Association can be sustain without association

association

Win–Stay, Lose–Shift

The key to the evolution of cooperation, collective action, and social structure is association. [Association] of interactions allows the evolution of cooperative social structure that would otherwise be impossible. (Skyrms [2004] pp. xiii–xiv)

Question: Can cooperation be sustained without association?

Answer: Shadow of Society can loom as the Shadow of the Future.

Model

Prisoner’s Dilemma

• Two agents choose between cooperating and defecting.
• Cooperating provides a benefit to opponent, b, at a cost, c, where b > c > 0
• Cooperating is strictly dominated in one-shot game.

WIN–STAY, LOSE–SHIFT

• Strategy in an iterated PD (Nowak and Sigmund [1998])
• If agent WINS, continue with same action; if agent LOSES, shift to the other action.

<table>
<thead>
<tr>
<th>Cooperate</th>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>b − c, b − c</td>
<td>−c, b</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooperate</th>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>b, −c</td>
<td>0, 0</td>
</tr>
</tbody>
</table>

Social Information

• Agents have knowledge of others’ payoffs.
• Winning is doing better than the average payoff of some subset of population.

Results

• Randomly-paired interactions in population with proportion of cooperators p.
• Calculate the evolution and stability of p over time: p → p′ → p″...
• Closed circles represent stable equilibria, open circles represent unstable equilibria.

Insufficient Knowledge

Cooperation cannot be sustained.

<table>
<thead>
<tr>
<th>Cooperate</th>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stay, Stay, Shift, Stay</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooperate</th>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stay, Shift, Shift, Shift</td>
<td></td>
</tr>
</tbody>
</table>

Sufficient Knowledge

<table>
<thead>
<tr>
<th>Cooperate</th>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperate, Defect</td>
<td></td>
</tr>
</tbody>
</table>

Learning Analysis

Maximum rate of cooperation.

Figure 3: Proportion of cooperators with knowledge of population average

Conclusions

• Cooperation is possible without association by WIN–STAY, LOSE–SHIFT with social information.
• Very modest epistemic requirements for positive amount of cooperation.
• Maximum rate of cooperation is half (Palomino and Vega-Redondo [1999]).

Future Directions

• What does a little bit of association add?
• What effect of punishment or reward?
• What predictions for larger class of games?

References


Contact Information:
cahern@ling.upenn.edu
rclark@ling.upenn.edu
kimbrough@wharton.upenn.edu