“Evolutionary Dynamic for Inter-Group Cooperation”

AUTHORS: MIHAI SUCIU, NOEMI GASKO

PRESENTER: BRENDAN AVENT
Fast Version – Prisoner’s Dilemma

Rules:

- Each player independently chooses either Cooperate or Defect simultaneously.
- Payoffs to players are listed as (P1,P2) in each entry in the table.
- $T > R > P > S$, with $T + S < 2R$

Generalization: Public Goods game
Exremely Fast Version – Evolutionary Game Theory

Examines how cooperation emerges amongst selfish (self-interested) individuals

Prisoner’s Dilemma is of interest here

Via competition, EGT allows successful strategies to propagate through the players, while failing strategies die off
Hypergraph for inter-group cooperation

Proposed hypergraph model:
- Vertices represent the places
- Hyperedge represents a group of players

Simulations were run for with:
- Rule: $R_i, i \in \{1,2,3,4\}$ (next slide)
- Payoff values: $R = 2, P = 1, S = 0, T = b \geq 2$
- Percentage of defectors: $p_D$

No intra-group competition

Fig. 1. The hypergraph representation in the fourth round, $p_d = 0.01, b = 2.5$. Nodes in hyperedge are identified by different shades.
Rule list and scoring measure

$R_1$: For each player $i$ in a given hyperedge $E_a$, randomly choose another hyperedge $E_b$ and have $i$ compete against a randomly chosen number (determined at the beginning of the round) of opponents in that hyperedge.

$R_2$: For each player $i$, randomly choose a predefined number of opponents from another randomly chosen group.

$R_3$: Randomly choose a hyperedge $E_b$, and then for each player $i$ in $E_a$, $i$ competes against every player in $E_b$.

$R_4$: For each player $i$, randomly choose 1 opponent to compete against (standard situation, no hypergraph necessary).

Frequency of cooperation ($F$) is the scoring measure of cooperation:

$$F = \frac{\text{number of cooperators}}{\text{number of players}}$$
Quick Results

**Fig. 2.** Evolution of frequency of cooperation in the first hyperedge in two different simulations. Players play according to the rule $R_1$, $p_D = 0.01$, $b = 2.5$.

**Fig. 5.** Evolution of frequency of cooperation for a game played between ten groups, each group has ten players. Players play according to the rule $R_1$, $p_D = 0.01$, $b = 2.5$. Even if the number of defectors is greater than previous cases (one defector in each group) the groups cooperate for more rounds.
Quick Conclusions

Inter-group cooperation is hard.

When the number of defectors is relatively small, cooperation is not affected.

Cooperation is independent of the number of groups and the chosen $b$.

Once a defector strategy becomes adopted by cooperators, the strategy begins to spread exponentially.