Behavioral Game Theory

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1. Introduction

"Game theory is a study of mathematical models of conflict and cooperation between intelligent and rational decision makers" -wikipedia

Behavioral Game theory is about what players actually do, driven by empirical observation (mostly experiment).

- Start with a game experiment
- Think of plausible explanations for the differences
- Extend formal game theory

2. Ultimatum Game

This is a very simple game.

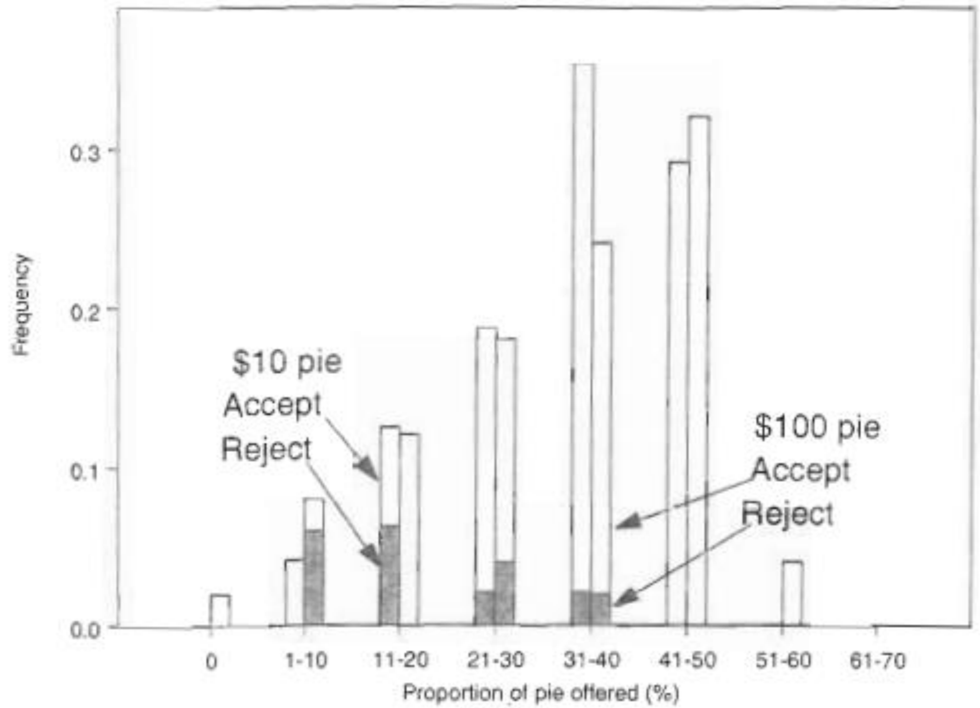
- Two players, a Proposer and a Responder
- Bargain over some amount, e.g. $10
- The Proposer offers *x* to the Responder
- If the Responder take the offer, the Responder gets *x* and the Proposer gets $10-*x*
- If the Responder can reject it, they both get nothing.

Fun game!

The formal game theory's analysis is like this:

- Players are self-interested
- The Proposer has all the bargaining power

Experiment



- Half of offers of $2 or less are rejected
- When bargaining over $100, similar pattern of results occur

Why do Responders reject substantial sums?

- Players have a preference for being treated fairly!
- “Negative reciprocity”

Where does this fairness preference come from?

- Methodology, demography, culture, structure…

- Rejections in ultimatum games do not necessarily reject the strategic principles.

Can we model the social preference?

- Maintain the assumptions that players maximize their utilities
- Allow the utility to reflect a social preference

Find new utility functions!

- Inequality-Aversion Theories
- Fairness Equilibrium

Fairness Equilibrium-two player games

- Strategies: a_i
- i's beliefs about the strategy of the other player: b_{3-i}
- i's beliefs about what player j believes about player i's strategy: c_i

How to describe kindness and utilities?

- Suppose player 1 has the belief b_2 about what player 2 will do.
- Call the highest, lowest and fair payoffs for player 2, $\pi_2^{max}(b_2)$ $\pi_2^{min}(b_2)$ $\pi_2^{fair}(b_2)$
- Player 1's kindness toward 2, which depends on her actual choice a_1, is

$$f_1(a_1, b_2) = \frac{\pi_2(b_2, a_1) - \pi_2^{fair}(b_2)}{\pi_2^{max}(b_2) - \pi_2^{min}(b_2)}$$

Similarly, player 1 also forms a perceived kindness number:

$$\tilde{f}_2(b_2, c_1) = \frac{(\pi_1(c_1, b_2) - \pi_1^{fair}(c_1))}{(\pi_1^{max}(c_1) - \pi_1^{min}(c_1))}$$

➢ Player 1's utility function including social preferences:

$$U_1(a_1, b_2, c_1) = \pi_1(a_1, b_2) + \alpha\tilde{f}_2(b_2, c_1) + \alpha\tilde{f}_2(b_2, c_1)\cdot f_1(a_1, b_2)$$

Fairness Equilibrium-two player games

- Fairness Equilibrium

- Choose strategy with highest utility
- Beliefs about strategies are correct— $a_i = b_i = c_i$

- Example: Prisoners' dilemma with social preferences

		Cooperate	Defect
Cooperate	C	$4 + 0.75\alpha, 4 + 0.75\alpha$	$0 - 0.5\alpha, 6$
Defect	D	$6, 0 - 0.5\alpha$	$0, 0$

- When α is large enough, both cooperation is a fairness equilibrium!

3. Beauty Contest

Review:

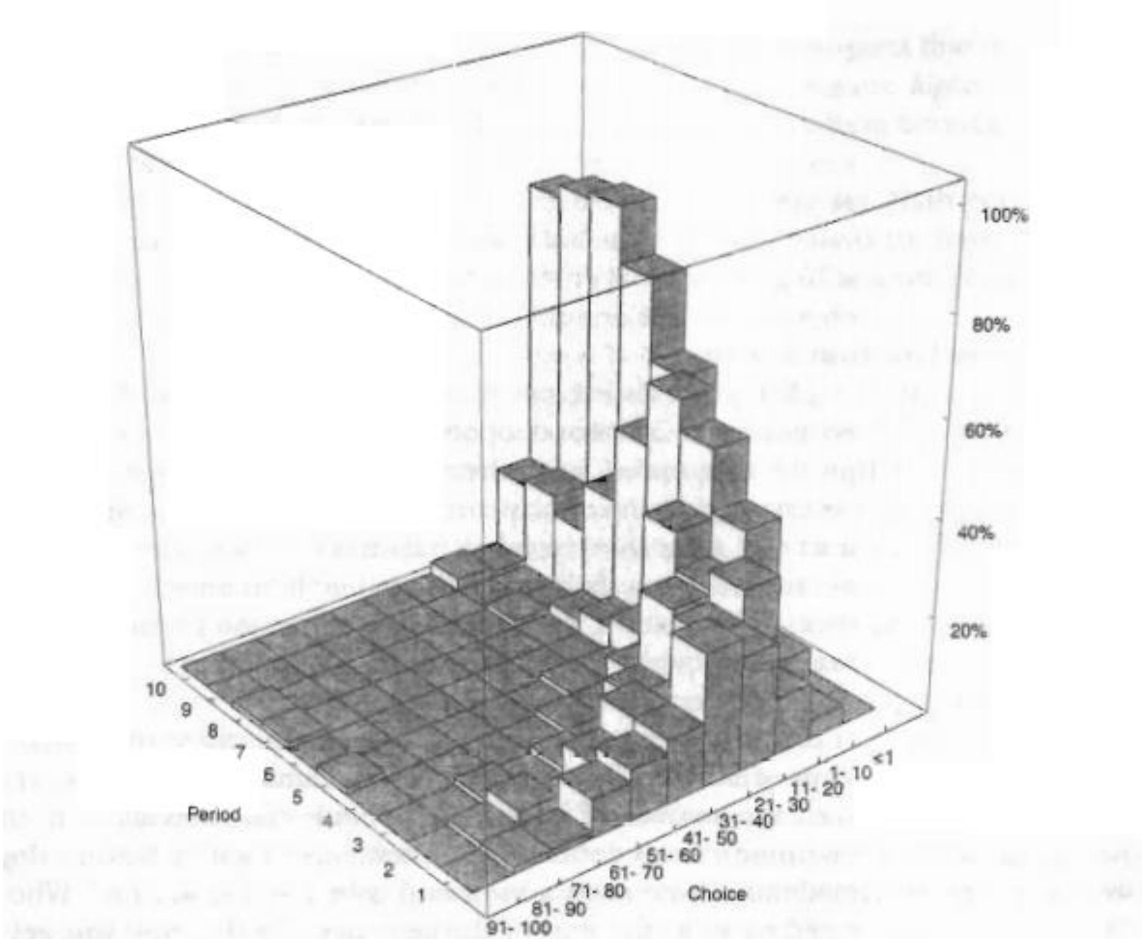
- N players simultaneously choose a number in the interval [0,100]
- Take an average of the numbers and multiplied by p<1 (e.g. 0.7)
- The player whose number is closest of this target wins a fixed prize.

The formal game theory's analysis

- All players choose a same number 0!

This game is a "dominance solvable game"

Experiment



First round choices are around 21~40!

How can we explain this phenomenon ?

- An interesting story…

- Why it's difficult to achieve Nash Equilibrium?

  - Iterated reasoning
  - Consider other players' reasoning and beliefs

- Limited iterated reasoning to understand the initial choices!

- A theory of learning to explain players' movement

How can we explain this phenomenon?

- Iterated reasoning is limited to a couple of steps

- Limited iterated reasoning could be modeled formally

- Quantal Response Equilibrium
- Cognitive Hierarchy
- Level-k
- …

4. Conclusion

- Behavioral Game theory studies what players actually do in a game.
- It's based on experimental facts.
- It extends formal game theory by including feeling, thinking and learning

- Feeling: players express social preferences
- Thinking: limited strategic thinking- bounded rationality
- Learning: players change behaviors in the process of a game

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Thank You !