What Happens in the Field Stays in the Field: Professionals Do Not Play Minimax in Laboratory Experiments

Steven D. Levitt, John A. List, and David H. Reiley
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HELLO!

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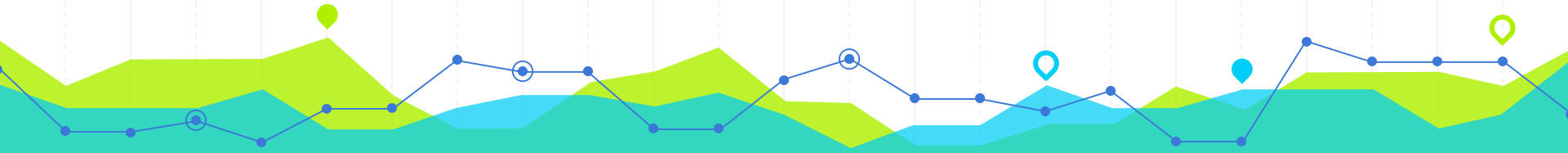


What is Minimax?

A maxminimizing mixed strategy for player i in a strategic game (with vNM payoffs) is a mixed strategy α_i^* that solves the problem

$$\max_{\alpha_i} \min_{\alpha_{-i}} U_i(\alpha_i, \alpha_{-i})$$

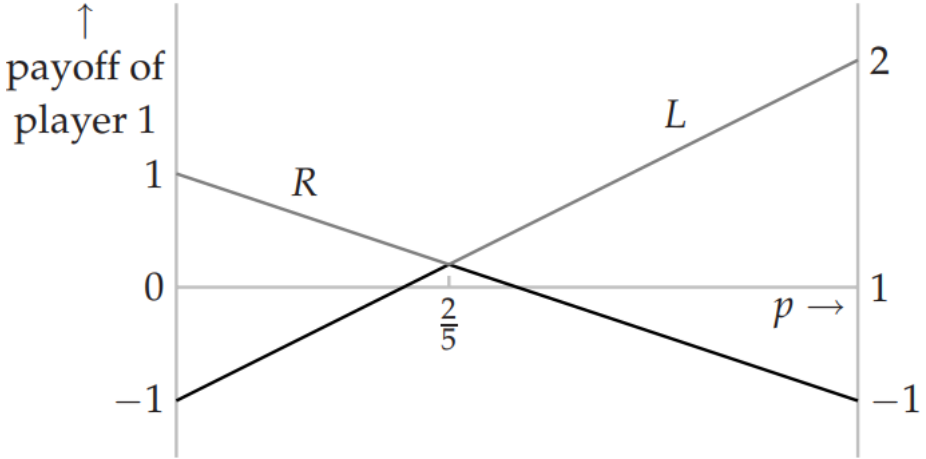
Consider The Following Game:

	A	B	C	D
UP	100,2	-100,1	0,0	-100,-100
Down	-100,-100	100,-49	1,0	100,2

Consider The Following Game:

	A	B
UP	2,-2	-1,1
Down	-1,1	1,-1

Finding Minimax Strategy



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In a strictly competitive game, If (α_1^*, α_2^*) *is a Nash equilibrium then* α_1^* *is a maxminimizer for player 1,* α_2^* *is a maxminimizer for player 2 , and vice versa*

Introduction

Why minimax?

- One needs to randomize strategies in order to prevent exploitation by one's opponent.
- In NE terms, no incentive for deviation.

Field Studies

Walker and Wooders (2001) analyze serve choices in Grand Slam tennis matches

Hsu et al. (2007) find that individual play is serially independent.

Chiappori et al. (2002) and Palacios-Huerta (2003) find similar results with penalti kicks

Field vs Lab

Fields

The Studies confirm minimax in professional competitions

Lab

subjects in laboratory studies typically do not play near the predictions
of minimax

The Question

why do controlled laboratory tests of minimax systematically provide data far from minimax predictions, whereas less controlled tests using field data appear to confirm theory?

Possible Explanations

- tests using field data lack statistical power to reject minimax play
- the laboratory has not provided the appropriate environment
- Palacios-Huerta and Volij (2007): subjects in laboratory experiments do not have uniformly high skill at playing games with mixed-strategy equilibria

Two additional pieces of evidence

- complementary experimental treatments that pit professionals against preprogrammed computers.
- post-experiment questionnaires.

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professional poker players play no closer to minimax than students and bridge professionals, and far from minimax predictions. This finding holds when the professionals compete against other players, as well as when they are informed that they are playing against a computer preprogrammed to exploit individual deviations from optimal play.

Game 1

Evader

Pursuer

	Black	Red
Black	Die roll 1or 2 (0,1)	0,1
Red	0,1	Die roll 1or 2 (1,0)

Game 2

Column

Row	Club	Heart	Spade	Diamond
Club	1,0	0,1	0,1	1,0
Heart	0,1	1,0	0,1	1,0
Spade	0,1	0,1	1,0	1,0
Diamond	1,0	1,0	1,0	0,1

Subject Pools

- college students ; 46 students from the University of Arizona
- bridge professionals
- world-class poker players; 130 participants
- American professional soccer players; 32 players, Game 2

we find little evidence that real-world experience transfers to the lab in these games

Human vs The Machine

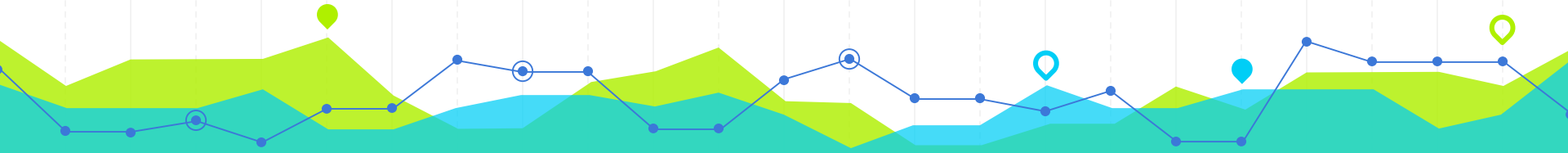
Two Programs:

- An optimal one with learning
- An exploitable program which chooses actions with identical probability

Predictions

Conditional on minimax, we must have:

- he aggregate marginal and joint distributions of actions should correspond to that predicted by equilibrium play
- for each particular pair of players, the marginal and joint distribution of actions should correspond to that predicted by equilibrium play
- actions should be serially uncorrelated



Results

Table 1: Summary of Results across Subject Pools in the 2 x 2 Game

Source:	Levitt, List & Reiley		Palacios-Huerta & Volij	
Test:	College Students	Poker Players	Soccer Pros	Soccer College
# of Players	11	22	40	40
#Pairs of Roles	22	44	40	40
I. Minimax play at aggregate level				
Chi-square test for minimax play:				
Pursuer (or Row Player)	<0.001	<0.001	<0.001	<0.001
Evader (or Column Player)	<0.001	<0.001	0.374	<0.001
Joint play	<0.001	<0.001	0.001	N/A
II. Minimax play at individual level				
Rejections at 5 percent:				
Pursuer	59%	68%	5%	5%
Evader	55%	52%	5%	10%
Joint Play	91%	75%	0%	5%
Neither Player	27%	41%	0%	N/A
III. Runs Tests				
Rejections at 5 percent:	23%	18%	5%	8%
for too few runs:	10%	14%	0%	N/A
for too many runs:	14%	5%	5%	N/A

Table 2: Summary of Results across Subject Pools in the 4 x 4 Game

Source:	Levitt, List & Reiley			Palacios-Huerta & Volij	
Test	College Students	Poker Players	Soccer Pros	Soccer Pros	Soccer College
# of Players	12	26	16	40	40
# Pairs of Roles	24	52	32	40	40
I. Minimax play at aggregate level					
Chi-square test for minimax play:					
Row Player	0.320	0.253	0.001	0.956	0.956
Column Player	0.008	<0.001	<0.001	0.932	0.932
Joint play	0.105	0.008	<0.001	0.910	N/A
II. Minimax Play at individual level					
Rejections at 5 percent:					
Row Player	33%	27%	28%	5%	10%
Column Player	46%	35%	16%	5%	10%
Joint Play	38%	31%	28%	10%	5%
III. Runs Tests					
Rejections at 5 percent:	38%	35%	16%	5%	8%
for too few runs:	4%	12%	6%	0%	N/A
for too many runs:	38%	23%	9%	5%	18%

Table 3: Summary of Results for Subjects Playing against Computers

Source:	Computer Programmed for Optimal Play		Computer Programmed for Naïve Play	
Test:	**2 x 2**	**4 x 4**	**2 x 2**	**4 x 4**
Type of Player:	**All Players**	**All Players**	**All Players**	**All Players**
# of Players	21	21	13	13
# Player-Roles	42	42	26	26
I. Minimax Play at Aggregate Level				
Chi-square test for minimax play:				
Evader/Row Player	<0.001	0.132	1.000	<0.001
Pursuer/Column Player	<0.001	<0.001	<0.001	<0.001
II. Minimax Play at Individual Level				
Rejections at 5 percent:				
Evader/Row Player	52%	48%	77%	92%
Pursuer/Column Player	57%	33%	85%	100%
IV. Runs Tests				
Rejections at 5 percent:	38%	31%	62%	27%
for too few runs:	24%	24%	54%	19%
for too many runs:	14%	7%	8%	8%
V. Mean Player Payoff as a Fraction of Total Payoff				
Overall	50%	49%	51%	58%
Rounds 1-25	51%	53%	51%	57%
Rounds 26-50	50%	47%	50%	60%
Rounds 51-75	48%	46%	51%	55%
Proportion of players who beat the computer:	57%	43%	62%	92%

Further Results

- Students played red 61 percent of the time; poker players only 56 percent
- Most of the deviations take the form of playing red too infrequently
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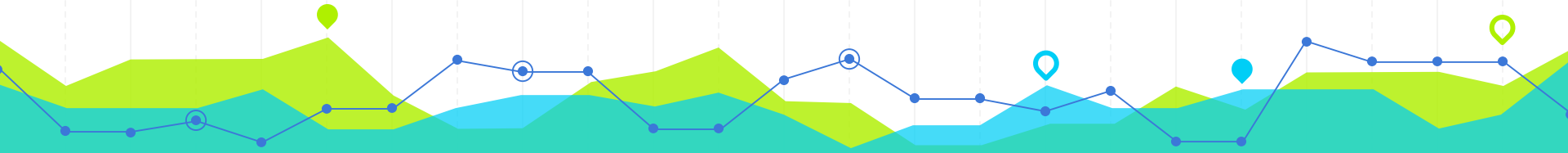

Conclusion

Among our professionals what happens in the field stays in the field.

Possible Explanations

- Players would like to play minimax, but they are unable to do so because they cannot solve for the equilibrium.
- They do not believe that their opponents will play minimax .
- the nature and contextof the constructed situation did not induce the professionals to retrieve the relevant cognitive tool kit to play optimally.

THANKS!

Any questions?

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