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Game theory's role in role-playing

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Abstract

Green (*International Journal of Forecasting, 18*, 321–344) considers one method of testing the predictive value of game theory for conflict situations, and finds that role-playing does better. I discuss a second method, one that combines game theory and role-playing. This method has already been used with success to solve practical business problems. I argue game theory will have to play a critical part if role-playing is to be reliable for forecasting conflict outcomes. Existing research that combines game theory and experimental economics holds important lessons for the design of role-playing exercises.
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1. Introduction

If I needed advice on building a rocket, I wouldn't ask a physicist. I would ask an engineer. Physics is critical to a successful launch. But to build a rocket, you also need to know something about material science, chemistry, and so on. It is the engineer who synthesizes the necessary knowledge for practical use. In the same way, if I wanted to forecast a real-world conflict, I wouldn't ask the advice of a game theorist. Strategic behavior, the object of game theory, is surely important, but so too psychology, institutional factors, and so on.

But then, for conflict situations, who is the equivalent of the engineer? One answer would be domain experts; we might, for instance, forecast political conflicts using politicians. The Green (2002) study suggests an intriguing alternative, another way of combining the knowledge necessary to obtain a forecast: role-playing. Unlike myself (a game theorist and an experimental economist), Green conceives of role-playing and game theory as competing methods:

> Role-playing and game theory depend on contrasting assumptions about modeling conflict situations. Those who adopt a game theoretic approach must assume that the complexity of a conflict can be radically reduced without losing predictive validity. The role-play approach, on the other hand, incorporates complexity and emotion into a simulation (Table 1 and Fig. 1).

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Table 1
Solution to simulation experiment 9.3

Report 1:	The histogram of the sampling distribution of the median looks like a normal distribution.				
Report 2/3:	Statistic	Theoretical mean	Observed mean	Theoretical standard deviation	Observation standard deviation
	Mean	100	99.9017	8.3333[a]	8.2345
	Median	100	99.6683	10.4416[b]	10.1993
Report 4:	The experimental sampling distributions are reasonable approximations of the theoretical sampling distributions. Both sampling distributions are normal, but the median has a larger spread than the mean.				

[a] $25/\sqrt{9}$.
[b] $\sqrt{1.57}*25/\sqrt{9}$.

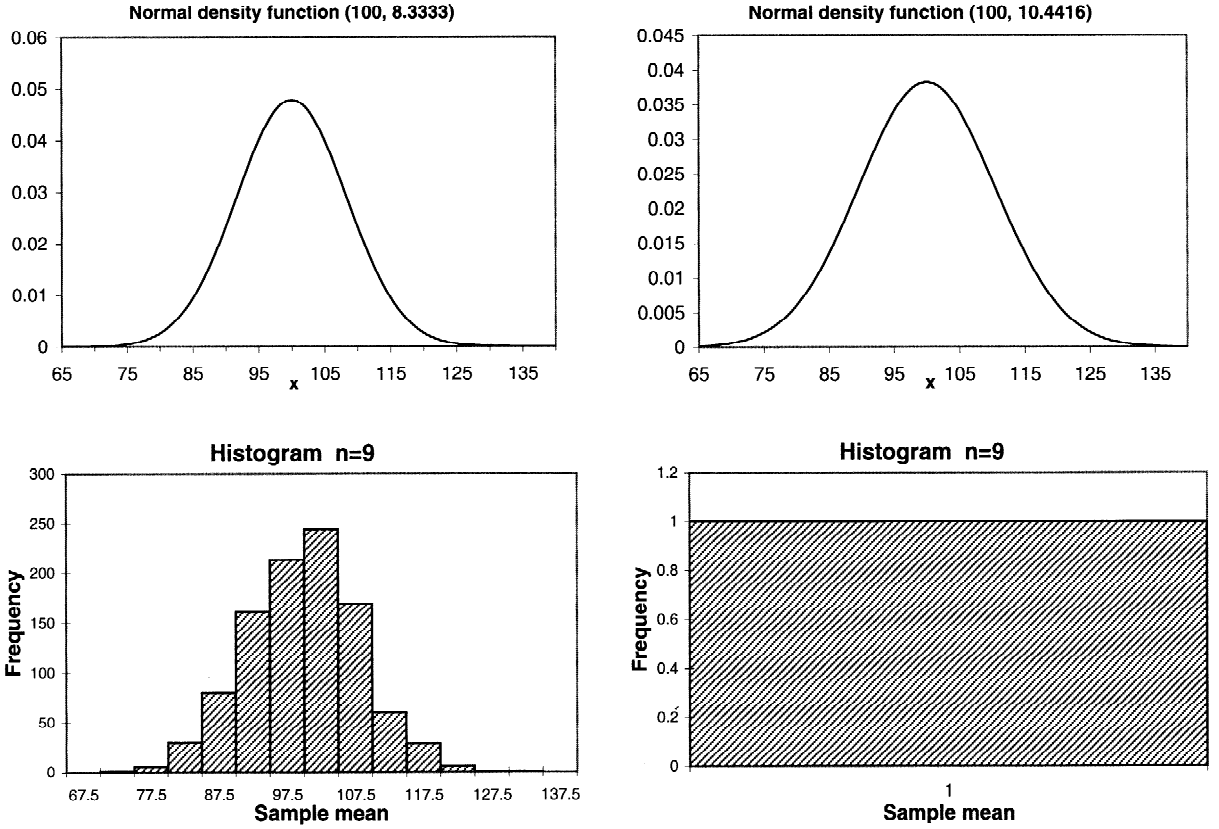

Fig. 1. Solution to Simulation Experiment 9.3.

In contrast, I will argue that role-playing will need game theory if it is to be successful at practical forecasting. Role-playing in the guise of experimental economics—and guided by game theory—is already being used to solve real world business problems. These problems are related to the kind of conflict situations Green studies, but also different. That said, research in experimental economics, guided by game theory, presently has some important lessons for role-playing design.

2. Game theory in practice and in learning

Green (2002) is right that most game theoretic models start by analyzing conflict situations that are 'radically reduced' versions of their real world counterparts. But this is standard to virtually all theorizing, in all sciences. The important practical question is whether these models produce usable insights. In fact, on this score, game theory can claim some considerable successes.

A recent issue of the journal *Interfaces*, devoted to experimental economics in practice (Bolton & Kwasnica, 2002), includes several studies with a strong game theoretic component. For example, Ledyard, Olson, Porter, Swanson, and Torma (2002) describe a combined value auction that they designed (game theory), laboratory tested, and implemented for Sears Logistic Services. Roth (2002) describes how game theory and experimental economics have been used in the design of labor clearing houses for American doctors, and in the design of US Federal Communications Commission auctions for the rights to radio spectrum. Also see Plott's (1987) classic experimental treatment, guided by game theoretic models, of problems such as the allocation of airplane slots and strategic agenda manipulation.

Experimental economists at IBM's T.J. Watson Research Center use game theory to guide their studies of bargaining, strategic learning and price formation (they describe their work and mission at http://www.research.ibm.com/iac/). Researchers at Hewlett-Packard Laboratories use game theory and experimental economics to study information dynamics in markets and other group interactions (see http://www.hpl.hp.com/shl/).

To date, most of this work has involved markets or other situations where the rules of interaction are largely formal. Conflict situations of the sort Green (2002) is interested are often less formal, and are arguably more complex, or at least more difficult to analyze. Even so, there is reason to believe that game theory will extend. Indirect evidence comes from business school classrooms where role-playing is a common, and successful pedagogical tool. Negotiation classes, for example, often have students role-play through bargaining scenarios, followed by a classroom analysis. The use of game theory (as well as experimental economics) in these analyzes is evident from popular textbooks (Raiffa, 1982; Bazerman & Neale, 1992; Thompson, 1992). Game theory is used to explain a variety of important concepts: the need to look forward and reason back (backwards induction), the strategic use of asymmetric information (winner's curse), and the structure of coalition negotiations (core stability).

3. Game theory lessons for constructing role-playing exercises

Of course classroom exercises are tools for conveying concepts and skills, not forecasting the future. So what lessons does game theory have for role-playing and the challenging job of forecasting conflict situations?

Before I address this question, let me address a more basic one implicit in Green's paper: Does constructing role-playing exercises require any conceptual guidance at all? I would say

'yes.' Role-playing involves simplification (otherwise it's the real thing). One of the critical tasks of the role-play designer is deciding what's critical and what's not (a referee tells me that four of the six exercises Green used were written with knowledge of the outcome). Motives, of course, are critical. What are the motives in the real-world situation, and what will evoke them in the role-players? Will the role-playing exercise permit the same opportunities for learning that are available to the real-world players? Does it matter that someone is monitoring the role-players when the real-world situation will go on behind closed doors? It is hard to see how role-playing could be a reliable forecasting tool unless we conceptually understand such issues.

The study of motives, learning, and the like are an important part of what modern game theory is about. Game theory is no longer (if it ever was) solely concerned with fully rational actors, although full rationality models have proven valuable in understanding actual behavior (e.g. Erev, Roth, Slonim, & Barron, 2002, description of labor market matching studies). As examples, I briefly summarize some lessons my own research has for role-playing design.

3.1. Determining motives

What features in the environment elicit concerns for fairness, or for reciprocity? What features induce hard-nosed competitive behavior? The answers to these questions are critical if the motives of role-player are to parallel that of the real world players.

Game theoretic models, many developed recently, provide insight into how motives and environment interact. One such model is ERC (Bolton & Ockenfels, 2000). ERC posits that, along with the pecuniary payoff, the relative payoff, a measure of how a person's pecuniary payoff compares to that of others, motivates people. Somewhat more specifically, player A maximizes the expected value of her motivation function,

$$v_A = v_A(y_A, \sigma_A)$$

own absolute payoff own relative payoff

where

$$\sigma_A = \sigma_A(y_A, c) = \begin{cases} y_A/c, \text{ if } c > 0 \\ 1/2, \text{ if } c = 0 \end{cases}$$

and $c = y_A + y_B$ is the total payoff distributed. The motivation function increases in the absolute payoff, y_A, and decreases as the relative payoff, σ_A, moves away from the equal shares payoff of $1/2$.

Combining the motivation function with a standard game theoretic equilibrium concept (subgame perfection) provides a simple but unified explanation for implies impasses in bargaining can happen over concerns for relative payoff (a failed negotiation leaves all bargainers equally bad off). On the other hand, the model implies that nearly everyone plays competitively in market situations (those who don't suffer both in relative and absolute terms). For dilemma games, the reciprocity motive is most likely be triggered in the face of efficiency gains. In sum, the model suggests that the fairness and reciprocity will loom largest in bargaining games and situations where cooperation might increase efficiency, and that these motives will be less important where people compete over fixed resources. These implications are broadly consistent with experiment. Unifying models of strategic learning are also emerging from these studies (see Erev et al., 2002).

3.2. Issue: experimenter observation

Will the investigator watching the role-playing have an influence on the outcome, perhaps

because the role-players believe the investigator has certain expectations? Answering this question is tricky because it calls for a design in which the experimenter can gather data without watching what individual subjects are doing.

Bolton and Zwick (1995) demonstrates how formal game theoretic models can be used to obtain a sharp design of an otherwise difficult to get at hypothesis. The experiment involved a simple bargaining game in which a proposer offers a split of a monetary pie to a responder, who then either accepts or rejects. Because the permissible actions are so well-defined, we were able to design an experiment in which players made their moves known by sending boxes to one another. When a proposal was accepted, the appropriate box was opened and the payoff distributed. The experimenter could not tell which boxes had been opened, but had enough information to be sure the rules were being followed. The data indicated that, if there was any experimenter observation effect, it was small. There is no systematic evidence for an experimenter observation effect in other games of this sort. Hoffman, McCabe, Shachat, and Smith (1994) find a sizable effect in a dictator game, but Bolton et al. (1998) and Johannesson and Persson (2000) both find no effect. Laury, Walker, and Williams (1995) report no systematic effect on the level of contributions in a public goods game.

Experimenters have used game theoretic models to look for other kinds of 'lab effects.' Cooper, Kagel, Lo, and Gu (2001) compare behavior of students and government bureaucrats in a ratchet game. Brandts and Charness (2000) look at frames that might invoke an emotional (hot) response versus those geared to evoke a cool response. Brosig, Ockenfels, and Weimann (2001) study how different communication media influence behavior in a public goods game. All these results speak to the issue of designing role-playing games that are free of undesired contamination.

3.3. Issue: statistical analysis

What statistical techniques will be needed to evaluate role-playing? My experience with experimental economics suggests that new techniques, or at least techniques that are novel to social scientists, may be necessary.

The design features that made the Bolton–Zwick experiment a sharp test of the experimenter observation hypothesis also made it difficult to evaluate by standard statistical techniques. Fong and Bolton (1997) constructed a Bayesian statistical model that exploited the fact that the experiment has a 'bioassay' design, common to experiments in the life sciences and engineering. In a bioassay test, one estimates the probability of a response (e.g. death or product failure) as a function of some stress (e.g. dose or pressure). In the context of the Bolton–Zwick experiment, the response curve relates the probability of observing equilibrium play to the extent of inequality in the equilibrium allocation. We found statistical evidence for an experimenter observation effect, although these estimates indicated the effect would be small in magnitude. Subsequent analysis by Fong, Pammer, Arnold, and Bolton (2002) loosened the shape constraints on the original model and found this weakened the evidence for a statistical effect even further.

El-Gamal, McKelvey, and Palfrey (1993) apply Bayesian methods to determine optimal statistical design and to determine the optimal time to stop sampling in the context of selecting a model that best describes learning behavior in the centipede game, a type of dilemma game.

4. Final remarks

To date, most work combining role-playing experiments and game theory, and dealing with conflict situations, focuses on substantial simplifications of real world conflict situations. But

contrary to Green (2002), I would say that this is the strength of the work, not its weakness: Some of the key principles in launching a rocket were gleaned from studying the free fall of an apple. Simplification allows us a clearer view of the fundamental mechanisms at work.

That said, it's important to keep our eyes on what practical import we can expect from the work. Clearly, the insights from game theory will need to be combined with knowledge from other fields (e.g. domain specific knowledge such as law) if role-playing is to be used to forecast real world outcomes. Green's results suggest that role-playing may be an appropriate vehicle for doing the combining. Game theory and role-playing could prove a valuable partnership.

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