The Misrepresentation Game: How to win at negotiation while seeming like a nice guy

Jonathan Gratch, Zahra Nazari and Emmanuel Johnson
University of Southern California, Institute for Creative Technologies
12015 Waterfront Dr., Playa Vista, CA 90094
gratch@ict.usc.edu

ABSTRACT
Recently, interest has grown in agents that negotiate with people: to teach negotiation, to negotiate on behalf of people, and as a challenge problem to advance artificial social intelligence. Humans negotiate differently from algorithmic approaches to negotiation: people are not purely self-interested but place considerable weight on norms like fairness; people exchange information about their mental state and use this to judge the fairness of a social exchange; and people lie. Here, we focus on lying. We present an analysis of how people (or agents interacting with people) might optimally lie (maximally benefit themselves) while maintaining the illusion of fairness towards the other party. In doing so, we build on concepts from game theory and the preference-elicitation literature, but apply these to human, not rational, behavior. Our findings demonstrate clear benefits to lying and provide empirical support for a heuristic – the "fixed-pie lie" – that substantially enhances the efficiency of such deceptive algorithms. We conclude with implications and potential defenses against such manipulative techniques.

General Terms and Keywords
Negotiation, Game Theory, Preference Elicitation

1. INTRODUCTION
Negotiation is an indispensable skill for any social creature. Within the multiagent systems community, negotiation between autonomous agents has been a central focus of research [28, 42, 45], both as a means for advancing electronic commerce [31] and as a challenge problem to enhance the capability of socially intelligent systems [24, 56]. More recently, there has been growing interest in agents that negotiate with people [27, 41]. There are many motivations for exploring human-agent negotiation. Agents could serve as virtual role players to help teach negotiation skills [7, 26]. Negotiation agents could allow companies more flexibility over setting fixed prices on the websites. More broadly, agents that understand human negotiation might serve as decision-support tools, for example, serving as negotiation mediators or providing automated analysis of human-human negotiations [10].

Negotiations between people differ considerably from the rational and structured frameworks favored in the multiagent community. Rational models, such as game-theory, treat negotiation as a joint decision between self-interested rational agents [35]. Communication, from this perspective is often considered superfluous "cheap talk" that cannot affect payoffs. Thus, negotiating agents typically interact via highly-constrained and structured mechanisms such as the alternating-offer protocol [44]. In contrast, human negotiators reach agreements through unstructured discussions that frequently violate axioms of rationality. For example, most people place considerable weight on social norms such as honesty and fairness [16, 20]. People don't view talk as cheap [18] and readily exchange honest information about their needs and goals [48, 50]. Indeed, withholding such information undermines trust [46]. These prosocial conventions can offer considerable advantages. People achieve higher joint outcomes than are predicted from rational models [21]. Unfortunately, prosocial tendencies also make people vulnerable to exploitation. This highlights another important difference between people and agents: people lie to gain strategic advantage [15].

This paper describes a rational analysis of lying in negotiation. Our analysis differs from classical game-theoretic analysis of communication between rational negotiators (such as [9, 14, 56]) and from behavioral game-theoretic analysis of how human negotiators behave towards each other (see [8]). Rather, we examine how a rational self-interested actor should act towards a typical human negotiator. Such an actor must reason about, and sometimes act in accordance with human social conventions, without being bound by them. Unfortunately, some human actors behave in this fashion. Indeed, this is the definition of the Machiavellian personality [22].

The literature on human negotiation has documented the myriad ways negotiators can lie. One approach is to feign a position of power. For example, when negotiating for a car, people often lie about their alternative offers ("I got a much better offer from the last dealer" or "this car is so popular we can't give discounts"). This can be an effective strategy, but often leaves the other party feeling abused and can undermine the possibility of getting deals from this party in the future [16].

A more effective approach would be to lie to one's opponent in such a way that they feel like they got a fair deal. O'Connor and Carnevale [38] present a simple but surprisingly effective technique for doing just that. They point out that negotiations often involve issues where both parties' interests align but they often believe they are in opposition. For example, consider a negotiation where both parties want to divide a basket of fruit (see Figure 1). Parties might assume that each side has the same interests, where in fact one side wants all fruit equally, but the other side only wants apples. The apples are referred to as a *common-value issue* because both parties' preferences are aligned. The presence of common-value issues creates the opportunity for an effective negotiation tactic. If one party realizes an issue is of common value before the other, they can feign opposed interest. This allows them to "claim value" over the undesired issue and trade this value off against something they want. For example, in the bottom half of Figure 1, the woman has misrepresented her interests in such a way that she wins the negotiation yet the man believes he received a fair deal.

Appears in: Proceedings of the 15th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2016), J. Thangarajah, K. Tuyls, C. Jonker, S. Marsella (eds.), May 9–13, 2016, Singapore.

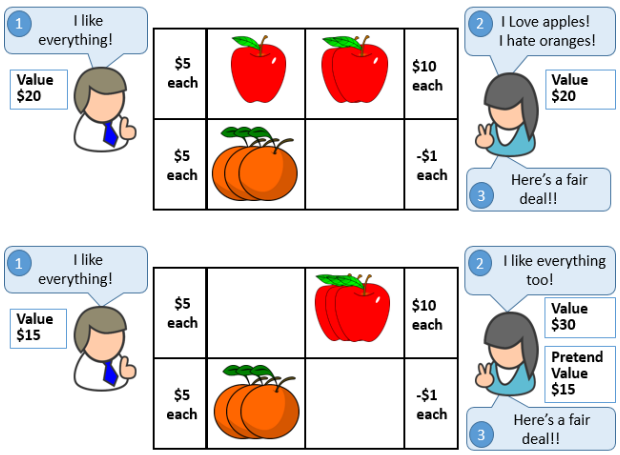


Figure 1: Bargaining without (top) and with (bottom) lying

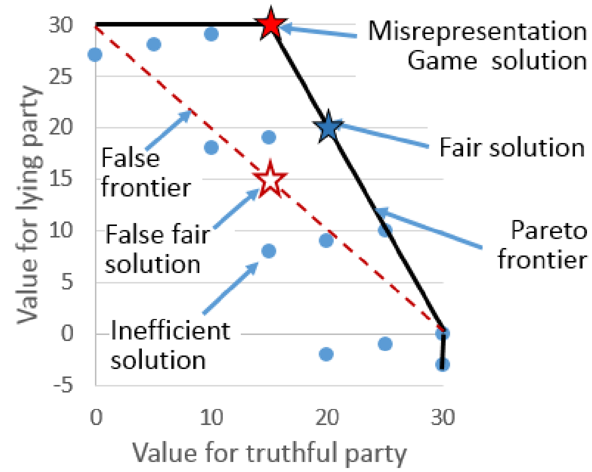


Figure 2: The space of bargaining solutions

In this article, we present an analysis of how people (or agents interacting with people) might optimally lie. By this, we consider how they might misrepresent their own interests in such a way to maximally benefit themselves while creating an illusion of fairness towards the other party. Our analysis builds on a game theoretic perspective and presents a simple game – *the misrepresentation game* – that formalizes this notion. We also build on techniques from the preference-elicitation literature to show how people (or agents interacting with people) can efficiently discover their opponent's interests without revealing much about themselves.

Although we build on rational techniques like game theory, our goal is not to find a rational solution to the misrepresentation game in the classical sense, but rather to identify strategies that a purely self-interested actor could use against typical human opponents. This analysis is in service of several more fundamental goals. First, we seek better understanding of communication processes in human negotiation and how communication can be misused for malicious ends. Second, we aim to produce general models of negotiation that can guide behavior of agents that negotiate with people. In that people lie, it is important for agents to understand, detect and potentially defend against such malicious strategies. Finally, we seek to use these models to teach negotiation skills. For example, by practicing with malicious agents, human students can better prepare themselves to deal with malicious behavior that, unfortunately far too often, arises in the real world (e.g., see [24]).

In the sections that follow, we first define the misrepresentation game. We next present a simplified version of the game wherein the preferences of the opponent are assumed to be known in advance. We describe a surprisingly simple heuristic that appears optimal for a common class of negotiation tasks. We next extend the approach to situations where the opponent's preferences are unknown in advance and must be inferred through information exchange. Finally, we present user study that demonstrates that people are more satisfied with a deal from a lying agent than the same deal from an honest one. We conclude with a discussion of limitations and extensions to the current approach.

2. THE MISREPRESENTATION GAME

Before defining the misrepresentation game, we first introduce a formalization of negotiation and summarize some of the main behavioral findings on how people typically solve this task.

Multi-issue bargaining task: Negotiation can be formalized in many ways. In this article, we adopt a common formulation known as the multi-issue bargaining task [30] which has become a *de facto* standard for both teaching and research on negotiation in the social and computer sciences (e.g., see [1, 33, 52]). Multi-issue bargaining generalizes simpler games developed in game theory, such as the ultimatum game, and more closely approximates many of the challenges found in real-life negotiations.

In its basic form, multi-issue bargaining requires parties to reach agreement over a set of issues. Each issue consists of a set of levels and players must jointly decide on a level for each issue (levels might correspond to the amount apples in a basket of fruit, or different attributes of a single object, such as the price or warranty of a car). Each party receives some payoff for each possible agreement and each player's payoff is usually not known to the other party. The payoff is often, but not necessarily, assumed to be additive (e.g., a player's total payoff might be the sum of the value obtained for each issue, weighted by the importance of that issue). If parties fail to agree, they each receive a (usually much smaller) "disagreement payoff" (also known as a BATNA). For example, Figure 1 illustrates a two-issue (apples and oranges), four-level (zero-to-three fruit) bargaining task, where each party assigns different weights to the issues ($5 vs. $10 for apples, respectively). Henceforth, we assume the disagreement payoff is zero for each party.

Human negotiation behavior: Multi-issue bargaining has been studied extensively from the perspectives of game theory [35]), behavioral game theory (e.g., [43]) and psychology (e.g., [39]). This research has clarified important and systematic differences between rational predictions and actual human behavior. In particular, people rarely act out of pure self-interest. Rather, they exhibit "other-regarding" preferences (such as the desire for fairness and reciprocity). Further, they often feel bound by social and conversational conventions, such as honesty. Finally, people have limited cognitive abilities and have difficulty, in particular, with the recursive theory-of-mind reasoning required by game theoretic solutions. In solving the misrepresentation game, we assume human negotiators will exhibit the following empirically-supported characteristics (we consider ways to relax these assumptions in the conclusion):

Fairness: Following Rawls [40], we assume negotiators aim for an equitable solution. There have been many attempts to formalize principles of fairness [53]. Here, we adopt Kalai's principle of max-min fairness [29] (i.e., negotiators will strive to minimize the difference in payout between the parties in a negotiation). There is good empirical support that human negotiators tend towards equal distributions across a wide variety of contexts [20, 43].

Efficiency: Following Nash [35], we assume negotiators prefer deals that are *Pareto efficient.* This means that if a deal can be improved for one player without harming the other, the improvement will be preferred by both players. For example, Figure 2 shows the space of all possible deals for the negotiation illustrated in Figure 1. The x-axis represents the value of deals that the man could receive, whereas the y-axis represents the value of deals for the woman. The Pareto frontier represents the set of efficient solutions and any deal below this can be ignored. Note, however, that negotiators can only calculated the frontier if they share their preferences, but in most negotiations, this information is unknown to one or both negotiators. This leads to our next assumption.

The cooperative principle of language: Following Grice [25], we adopt the perspective that to communicate at all, negotiators must adhere to communicative conventions. Grice argues that speakers will exchange honest, relevant, clear and sufficient information to complete the task at hand. Clearly, some negotiators are tempted to violate these maxims. In particular, negotiators are reluctant to reveal their true preferences (violating Grice's maxim of quantity) as this makes negotiators vulnerable to exploitation. Yet to find efficient solutions, negotiators must exchange honest information. One solution to this dilemma is the principle of *reciprocal information exchange*: reveal information if and only if the other party reciprocates [55]. By engaging in such reciprocity, parties develop a mutual understanding of each other's preferences and can discover Pareto efficient solutions [50]. Thus, we assume that parties are honest, relevant and clear, but will only reveal preference information if comparable information is offered in exchange.

Fixed-pie bias: Finally, following Bazerman [4], we assume that cognitive limitations lead to departures from rational predictions. In particular, in what is known as the *fixed-pie bias,* negotiators often assume that the other party's interests are completely opposed to their own. In the absence of information exchange, this bias explains why negotiators often fail to discover efficient solutions [50]. It also implies they will be predisposed to believe lies that are consistent with this bias [38]. We assume human players hold this bias.

Definition: From the discussion above, most human negotiators will strive for fair and efficient solutions, and will discover these to the extent they engage in reciprocal information exchange. However, this creates the opportunity for malicious negotiators to misrepresent their preferences for strategic gain. For example, in the bottom of Figure 1, the woman is lying about her true preferences (by saying she likes all fruit equally when she truly prefers apples). Assuming the male negotiator takes this lie at face value, he would perceive a different (and incorrect) Pareto frontier (illustrated by the dashed diagonal line in Figure 2) wherein the deal giving away all three apples appears fair and efficient.

Given these preliminaries, we define the *misrepresentation game* as the problem of:

- gaining an information advantage by learning the opponent's preferences without revealing one's own preferences, and
- identifying a false set of preferences to communicate to one's opponent that (a) maximize one's own reward from a negotiation, (b) subject to the constraint that the other party believes the negotiated agreement to be fair and efficient.

For the remainder of this article we will formalize and analyze the properties of a special case of this game, subject to certain assumptions about the form of each player's preferences.

3. SOLVING THE GAME

We present an efficient solution to the misrepresentation game subject to an additional assumption about the form of players' utility functions. As we will discuss, this assumption simplifies both the problem of finding a false set of preferences and the problem of eliciting true preferences from the opponent. The cost of this assumption is it precludes certain utility functions and certain beneficial lies (which we will revisit at the conclusion). Our solution is presented in three stages. In Section 3.1, we present a solution when the opponent's preferences are known in advance. Section 3.2 extends this solution the case where the opponent's preferences are unknown. Finally, Section 3.3 presents a simulation study that assesses the solution's effectiveness.

3.1 When opponent's preferences known

The misrepresentation game can be greatly simplified if we know our other party's preferences in advance of the negotiation. This might occur if the other party first truthfully reveals their preferences, or the liar has done sufficient research to accurately estimate them. When the opponent's preferences are known, the game can be cast as an optimization problem: for all possible preference weights on each issue, identify the set of weights that maximizes the value to self while seeming fair.

Specifically, let *N* be the number of issues and let each issue have L_i levels (L_i could be an integer, e.g., corresponding to the number of apples and oranges in Figure 1; or it could be a real-valued resource that can be continuously partitioned, such as an employee's salary). Let $\{a_i\}$ be numeric weights representing the deceiver's true preference for each issue *i* and $\{b_i\}$ be the true preferences of their opponent. We assume $\{a_i\}$ and $\{b_i\}$ are permutations of $\{1,\ldots,N\}$. Let and x_i and y_i represent the portion of issue *i* claimed by the deceiver and the opponent, respectively and ($\{x_i\}$,$\{y_i\}$) denote a possible deal. Then, the objective of the deceiver is to find the optimal false preferences $\{\bar{a}_i\}$, also a permutations of $\{1,\ldots,N\}$, that maximizes the deceiver's true utility, given that the negotiated solution appears to be efficient and fair:

$$\max_{\bar{a}_i} \sum_{i=1}^{n} a_i \,.\, x_i \qquad (1)$$

where x_i is the optimal solution of

$$\max_{x_t, y_t} \bar{a}_i \,.\, x_i \qquad (2)$$

such that :

$$\sum_{i=1}^{n} \bar{a}_i \,.\, x_i \leq \sum_{i=1}^{n} b_i \,.\, y_i \qquad (3)$$

$$\forall i:\ x_i + y_i \leq L_i \qquad (4)$$

$$0 \leq x_i, y_i \leq L_i \qquad (5)$$

In general, (2-5) finds the optimal efficient solution, which satisfies Kalai's fairness condition which is imposed by constraint (3).

Ranking assumption: Note that our formulation does not allow arbitrary utility functions. Rather, treats each issue as a resource to be partitioned, and it restricts players to holding a qualitative ranking over the set of issues (i.e., $\{a_i\}$, $\{\bar{a}_i\}$, and $\{b_i\}$ are assumed to be permutations of $\{1,\ldots,N\}$). This restriction is not uncommon in multi-attribute problems as players often have difficulty articulating their preferences as a numeric utility function. Rather, people are more comfortable communicating qualitatively (e.g., they are good at saying they like A more than B but poor at quantifying how much they prefer A to B). Equations (1) and (3) also entail that issues are independent and that overall utility is a liner combination of issue-ranks. Together, these assumptions define a standard utility function known as the Borda Score [3] often used by AI preference-elicitation techniques (e.g., see [11]).

The ranking assumption simplifies the problem of finding the optimal lie. It also simplifies the problem, introduced in the next subsection, of eliciting preferences from the opponent (as many common preference elicitation techniques use the Borda Score). A consequence, however, is it precludes utility functions where preferences are non-linear or interdependent. It also limits the type of lies a negotiator can make. They can lie about the relative ranking of their preferences but not the absolute value of different issues. We return to these limitations in the conclusion.

The optimization problem could be generalized. Constraints (1) and (3) could be relaxed, but may preclude efficient solutions. Constraint (3) could be replaced with other fairness criteria, such as Nass's axiom of symmetry [35]. The ranking assumption could also be relaxed but will require additional constraints on lying to preclude trivial or degenerate solutions.

Solution: Our formulation consists of two-levels of optimization which is not straightforward to solve. Fortunately, Nguyen proves that it can be reformulated and solved as a mixed integer linear program (see [37] for details). Nguyen further proves that under the additional assumption that all levels are equal (i.e., for all i,j, $L_i = L_j$), the optimal solution to the misrepresentation problem is to pretend the same preferences as one's opponent (i.e., $\{\bar{a}_i\} = \{b_i\}$). This simple solution seems to apply more generally to a range of bargaining tasks, so from this we propose the following heuristic:

Definition: The *fixed-pie-lie heuristic* is to feign the identical preference structure as one's opponent.

One psychological advantage of the fixed-pie lie heuristic is that aligns nicely with the fixed-pie bias introduced in Section 2. According to this bias, people often come to a negotiation assuming their interests are opposed and that they will only be able to achieve half of their value (see [49]). In Figure 1, the total "pie" is appears to be worth $30 to the man on the left, thus it is plausible to believe that $15 is a fair deal. In fact, as parties have different preferences, the fair deal is $20. With the fixed-pie heuristic, a malicious opponent recognizes the pie can be grown but keeps this additional value for themselves.

Lying in this way can afford considerable benefit and comes at no cost (at lease when the opponent's preferences are known). This is illustrated in Figure 3. This figure contrasts the value obtained by lying with the value obtained by being honest for a large set of possible negotiation problems. Specifically, given N issues, each player could have one of $N!$ possible rankings (i.e., all permutations of the N issues). As each player could have a different ranking, this creates a space of $(N!)^2$ possible joint rankings. A negotiation problem must also specify the number of levels per issue. Figure 3 illustrates all 14,400 possible combinations of player preferences for two extreme cases: (1) continuous – where each issue can be continuously partitioned; and (2) 2-level discrete – wherein each issue consists of a single indivisible quantity that must be allocated to one party or the other. In each case, L_i equals one for all levels.

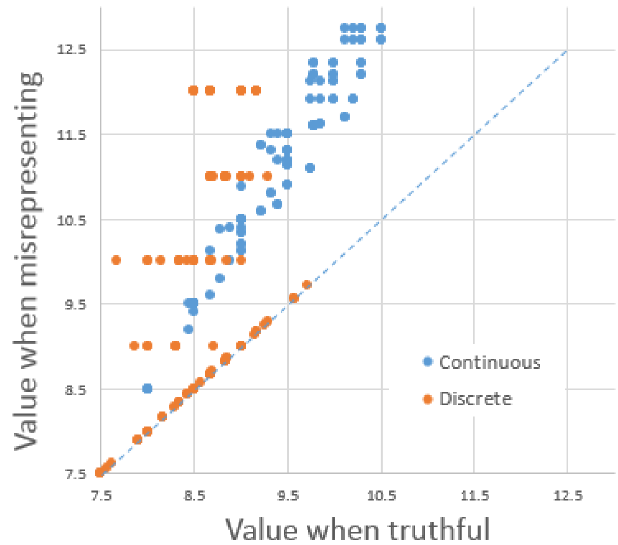


Figure 3: Shows relative advantage of lying for all possible 5-issue negotiations.

Figure 3 shows it never hurts to lie. In the continuous case (the blue circles), lying always offers improvement except when the negotiation truly has a fixed-pie structure (in this case, the solution is to tell the truth, which affords each party 7.5). In the discrete case (red circles), lying sometimes affords no benefit over truth, but also doesn't hurt. As the number of ways to partition each issue increases, these two sets of solutions will converge.

It should also be noted that the fixed-pie lie is especially nasty to the opponent. At least for the continuous case, the opponent always receives half of the diminished "fake pie." For the 5-issue problem, this corresponds to 7.5 (the opponent can sometimes do better than this in the discrete case, but always no-better than the liar).

3.2 When opponent's preferences unknown

The previous analysis suggests the fixed-pie-lie heuristic is optimal when the opponent's preferences are known. Unfortunately, negotiators do not have perfect access to their opponent's preferences but must infer them through an exchange of information. In agent-agent negotiations, opponent preferences (if they are considered at all) are typically inferred by the exchanging offers and counterproposals [2]. In human negotiations, preferences are most commonly inferred from explicit statements of preferences [36, 50]. We present a solution to this problem, subject to assumptions about how the opponent communicates. Unlike the perfect-information game, our solution is heuristic and we make no claims of optimality.

First, as discussed in Section 2, the cooperative principle of language suggests that human negotiators feel bound by social norms of honesty [25] and engage in reciprocal information exchange [5] (i.e., if preference information is provided by one party, the other party should reciprocate). This implies that a negotiator cannot elicit their opponent's preferences without giving up some information in return. Of course, an agent can give up fake information, but it is unclear how to lie without having perfect information about the opponent. Further, premature lies can limit the liar's options. For example, an agent might pretend they like apples best (when truthfully they like them least), but if they subsequently learn the opponent likes them least as well, they are trapped in their own lie: they can either agree to accept the undesired apples or admit to the

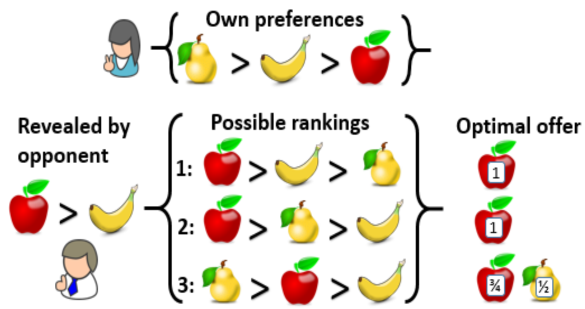


Figure 4: Example of preference elicitation

lie. Our solution relies on the assumption that people follow the cooperative principles of language and liars cannot admit to lies.

Second, as discussed in Section 3.1, people have difficulty expressing numeric preferences but they find it easy to make pairwise comparisons of the relative importance of different issues. Thus, we assume negotiators can only ask or assert relative pairwise comparison statements (e.g., "Do you like apples better than oranges?"). Obviously, more complex preference statements can be constructed from sequences of these primitives.

Finally, following [9], we analyze this problem as a "take it or leave it" bargaining game where parties first engage in several rounds of information exchange and then one party (the agent) makes a single offer which the other party (the human) must accept or reject. We assume the human opponent will accept this offer if and only if it appears fair under the possible models they have of the agent's preferences. Admittedly, this assumption imposes strong constraints on the liar's behavior: they are forced to make an initial offer and then stick to this offer at all costs. This may result in suboptimal solutions but greatly simplifies decision-making.

From these assumptions, it is clear that misrepresenting agents should (a) ask questions about their opponent's preferences that gain the maximal information while (b) reciprocating by offering information that allows the most freedom to misrepresent and then (c) make an offer when the costs of (b) exceed the benefits of (a).

Eliciting preferences: The first problem (a) is to determine which questions to ask, and in what sequence, to quickly and efficiently minimize uncertainty about the opponent's ranking. This problem has already been addressed in the preference-elicitation literature. Here we adopt the solution introduced by Lu and Boutilier [32].

We illustrate this algorithm with the aid of Figure 4. This example imagines a 3-issue negotiation over pears, bananas and apples. Each negotiator could hold one of 3! Possible rankings. The deceptive negotiator holds the ranking at the top (pears > bananas > apples). The other negotiator reveals that they prefer apples to bananas. This information rules out some possible rankings, but three are consistent with this statement. The figure also illustrates the optimal "fair" offer for each of these possible rankings. For example, if the opponent truly preferred apples>bananas>pears, then the liar should claim the same, offer one apple to their opponent, and keep the rest. Under the Borda-count utility function, this appears to afford each agent a utility of 3 (3 for apples vs. 2 for bananas plus 1 for pears) but, in truth, gains the liar 5 (3 for pears and 2 for bananas. Note that the same offer is optimal for the second ranking but a very different offer holds for the third ranking.

Lu and Boutilier use the principle of minimax regret to guide preference elicitation. With incomplete information, a lying negotiator must make their best guess concerning their opponent's preference. Regret is the loss (or regret) associated with guessing wrong. In Figure 4, the liar might propose offering a single apple as this yields the greatest expected return across all possible rankings. However, if the true ranking is ranking 3, this offer will be rejected (as it would appear unfair to the recipient). Lu and Boutilier propose a method of asking questions that minimizes the maximum possible regret. We refer the reader to their paper for details.

Under reciprocal information exchange, a misrepresenting agent faces a dilemma. The more information it asks, the more information it must provide (possibly constraining their freedom to misrepresent). Fortunately, the elicitation approach is incremental. At the start of a negotiation, an agent has no information about the opponent's preferences and all preference rankings are possible. This set reduces following each question. The algorithm repeatedly queries the opponent to determine their preference until regret falls below a certain threshold. In order to find the opponent's exact preference, this algorithm would have to be repeated until only one ranking is consistent. However, the algorithm can be terminated early. At this point, the opponent might have one of a number of preferences but the regret at picking one of these arbitrarily is guaranteed to fall below this threshold (assuming the opponent responded honestly).

If the elicitation algorithm is allowed to run to completion, the opponent's preferences are completely known and the agent can generate an offer as outlined in Section 3.1. If the preferences are incompletely determined, the agent can simply make an offer with the highest expected return over all possible consistent preferences.

Offering preferences: Assuming an agent must offer some information in return after each preference that it elicits, a misrepresenting should offer information that gives their opponent the least strategic advantage. In general, we should consider that the opponent might use sophisticated elicitation strategies as well, but in this article, we adopt a further simplification: the misrepresenting agent simply offers a preference statement of its own choosing after asking a preference question (e.g., Agent: "Do you like apples better than oranges?"; Human: "Yes?"; Agent: "I like apples better than oranges as well."). This minimally satisfies the principle of reciprocal information exchange while simplifying analysis (we return to this in the final section).

Given these further restrictions, we propose two possible misrepresentation approaches and, in the next section, contrast their effectiveness with an honest control condition:

- One misrepresentation approach (max-max regret) is essentially the dual of min-max regret. The idea is to offer information, at each round, that maximizes the possible regret of the opponent. For example, if the opponent asks a very informative question ("Do you like A>B?") the agent could respond with a different, less informative response ("Well, I like C > D").
- A second misrepresentation approach is motivated by the fix-pie-lie heuristic. Namely, at each round, if the opponent acknowledges that A>B, the agent should simply respond in kind ("A>B for me too")
- Finally, an honest agent would offer preference statements that are maximally helpful to the opponent (i.e., that minimize the opponent's max regret)

3.3 Simulation Study

The previous subsection identified two possible heuristics for solving the misrepresentation problem while satisfying the constraint of

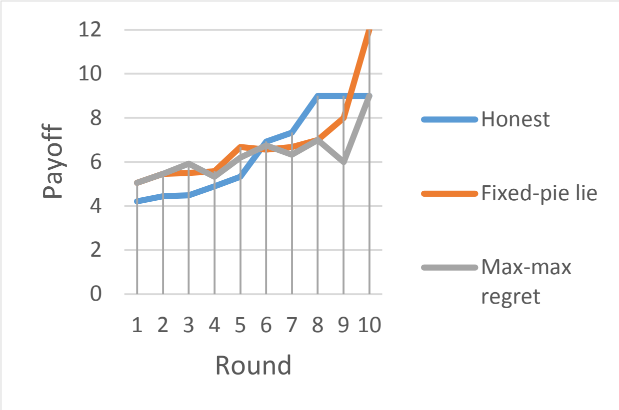


Figure 5: Illustrates the benefit of lying when the opponent's preferences are unknown. Results contrast the returns from two misrepresentation heuristics with being honest.

reciprocal information exchange. Both approaches use min-max regret to elicit questions from the opponent but differ in how they offer information in return (max-max regret vs. fixed-pie lie). Here we run a simulation experiment to contrast these approaches.

In that there is a potential tradeoff between the cost and benefits of exchanging information, we empirically explore this tradeoff. A misrepresenting agent could simply keep asking questions until the opponent's preferences are fully known. This yields more information about the opponent but forces the agent to reveal its own information in return (possibly limiting opportunities to misrepresent). Alternatively, an agent could terminate questions early and make its best guess at a good offer.

We compared max-max regret and fixed-pie-lie against an agent that was honest and maximally helpful. We compared these heuristics on a 5-issue negotiation task where there is a good opportunity to misrepresent: parties' preferences are complementary (A>B>C>D>E vs. A<B<C<D<E). For each approach (max-max regret, fixed-pie-lie and honest), we ran a simulated negotiation of these strategies against a truthful opponent. This opponent only accepted offers that appeared fair given what the agent revealed about its preferences. We varied how many rounds the agent could ask questions before making an offer from 1 to 10 (10 rounds of questions are sufficiently to completely determine the opponents preferences for a 5-issue negotiation).

The results are shown in Figure 5. They illustrate the complex relationship between the costs and benefits of asking questions. Both max-max regret and fixed-pie lie led to greater returns for small numbers of questions. Fixed-pie lie performed best when the opponent's preferences were fully revealed. At some points, honesty appears to be the best policy.

One might expect max-max regret to out-perform fixed-pie-lie because it is doing a more systematic exploration of the space of possible preference models and picking the one that maximizes maximum expected value. The problem is that, at early points in the elicitation phase there is insufficient information to determine the value of different lies, so the method can commit itself to statements that constrain its options to lie in later rounds. Overall, the fixed-pie-lie heuristic is simple and works surprisingly well.

4. USER EVALUATION

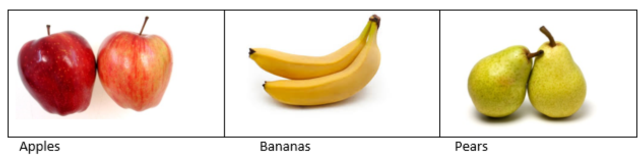
Up to this point, we have made theoretical arguments and evaluated methods against simulated human opponents. But would actual human negotiators be fooled by such simple techniques? Here we report the results of a study that answers this question. Specifically, we test two hypotheses:

H1 (perceived fairness of outcome): We hypothesize that people would be more willing to accept an offer (H1a), find it more fair (H1b) and satisfying (H1c), and place greater trust in their opponent (H1d) if the opponent misrepresents their preferences as a fixed pie, compared with an offer of equal value where the true preferences were honestly conveyed.

H2 (perceived fairness of communication): We hypothesize that people need their preference statements to be reciprocated and would be more willing to accept an offer (H2a), find it more fair (H2a) and satisfying (H2c), and place greater trust in their opponent (H2d) if the opponent provides reciprocal but false preference statements, compared with an offer of equal value without reciprocal information provided.

Together, these hypotheses imply a corollary: opponent models matter. In other words, people base their decisions, not based on their absolute benefit, but their perceptions of the other party's interests and how this relates to norms of distributional and communicative fairness.

To test these hypotheses, we conducted an online experiment using seventy-five participants recruited over Amazon Mechanical Turk. Participants were randomly assigned to one of three conditions. In all conditions, participants were asked to imagine they were in a



Imagine you are negotiating over the six items shown above (2 apples, 2 bananas and 2 pears) with another person. Apples are worth $3 each, bananas $2 each and pears are $1 each. Thus, your preference is Apples > Bananas > Pears and you don't know your partner's preference. Below is a dialog between a partner and yourself. Based on your preference and the dialog provided, please decide if you would accept the partner's offer:

Condition 2:	
Partner:	Do you like apples more than bananas?
You:	Yes
Partner:	I like bananas more than apples
Partner:	Do you like bananas more than pears?
You:	Yes
Partner:	I like pears more than bananas
Partner:	How about this, I give you both apples and I get the rest?

Figure 6: An illustration of the "truthful" condition

	% Accept	Satisfied	Trust in partner	Fairness of offer
Fixed-pie Lie	**0.88***	**3.73⁺**	3.15	**3.73***
Honest	0.58	3.12	3.04	2.81
No information	0.56	3.26	3.19	3.04

Table 1: Experimental Results (* $p \leq 0.05$; $^{+}$ $p \leq 0.10$)

negotiation. They were presented a dialog between them and a hypothetical opponent concerning how to partition a basket of fruit (see Figure 6). They were asked if they would accept they offer made by their opponent (yes/no), and to rate its fairness, their satisfaction with the offer, and whether they felt the other party seemed honest (all items using 5-point Likert scale).

The only difference between conditions was the preference statements made by the opponent. In the misrepresentation condition, the opponent produces preference statements according to the fixed-pie-lie heuristic and the participant was offered half the apparent value. In the honest condition (illustrated in Figure 6), the opponent produces honest preference statements (clearly indicating that the pie could be grown), but the participant received the same offer as in the misrepresentation condition. Finally, in the non-reciprocal condition, the opponent asks questions but does not provide any information in return. Again, the identical offer was proposed across conditions. Table 1 summarizes the results.

Our first hypotheses shows good support. People were more willing to accept an offer (H1a) and found it more fair (H1b) if their opponent misrepresented their preferences as a fixed pie and claimed half the pie. People accepted more offers from the fixed-pie-lie condition (M=88%) compared to the honest condition (M=58%); χ^2(1, N=52)=6.26, p=0.027. They rated the offer from the lying opponent as more fair (M=3.73, SD=0.33) than the truthful opponent (M=2.81, SD=0.51); t(25)=3.00, p=0.006. There was a near-significant trend (p=0.065) in perceived satisfaction (H1c) and no difference in trust (H1d) in the partner.

Our second hypothesis also shows good support. People accepted more offers (H2a) and found them more fair (H2b) when provided reciprocal but deceptive feedback about their opponent's preferences than no feedback at all. They accepted more from the fixed-pie-lie condition (M=88%) than the no-information condition (56%); χ^2(1, N=53)=7.07, p=0.014. People rated the lying opponent as more fair (M=3.73, SD=0.33) than the no-information condition (M=3.04, SD=1.18); t(25)=2.18, p=0.039. There was a nonsignificant trend (p=0.091) in perceived satisfaction (H2c) and no significance difference in trust (H1d) in the partner.

For completeness, we compared differences in acceptance rate and subjective impressions between the honest and no-information conditions but found no significant differences.

In summary, people were much more willing to accept an offer when the opponent misrepresents their preferences then when truthful. This is because the truthful offer was seen as considerably less fair (people recognized the pie had grown but the opponent was keeping a disproportionate amount). People were also less willing to accept offers when the agent failed to reveal its own preferences, giving support for the principle of reciprocal information exchange. Again, such offers were considered less fair. From this we can conclude that malicious agents must attend to two concerns: relative fairness of the offer and relative fairness of information exchange.

5. LIMITATIONS AND CONCLUSION

We presented a method that allows negotiators to reap unequal rewards over opponents while maintaining the illusion of fairness. Our analysis and results demonstrate there can be considerable strategic benefits from this form of lying. The simulation results in Section 3.2 illustrate that many negotiations can yield strategic gain and sometimes these rewards can be considerable (Figure 3). Section 3.4 illustrates that these rewards can be achieved even when an opponent's preferences are unknown (via deceptive reciprocal information exchange). Finally, the experimental results in Section 4 illustrate that people find these deceptive strategies to be credible and even preferred to honesty (or no information at all). Apparently in negotiation, honesty is not always the best policy.

There are several ways to extend the current analysis.

Improving the analysis: We have proven the validity of the fixed-pie lie when the opponent's preferences are known in advance [37] but rely on simulation and empirical data for the more typical situation where this information is unknown. We suspect it should be straightforward to prove the validity of the fixed-pie-lie heuristic under fairly general assumptions.

Relaxing assumptions about the structure of the negotiation: Our assumptions about the structure of players' utilities greatly simplifies our analysis but limits the generality of the approach. Much of the innovative work in negotiation agents explores less restrictive assumptions such as non-linear utilities [19], incomplete information about levels and even non-convexity of the utility space [12]. More work is needed in generalizing our solution to these contexts.

More importantly for the goals of this paper, these assumptions preclude some opportunities for misrepresentation that have been observed in the human negotiation literature. For example, negotiations typically include a "disagreement payoff" (the utility received by each player if a negotiation fails). One common tactic is for a negotiator to feign a higher disagreement payoff than they actually hold. This could be explored by adding this payoff to the game.

Our assumption of an additive preference function also precludes certain misrepresentation tactics. For example, a negotiator might claim a nonlinear relationship over the levels of an issue (i.e., "I get a bonus if I get all three apples"). Including a broader space of preference functions would enrich our analysis.

More generally, the concept of fairness itself might be open to negotiation and misrepresentation. In this article, we adopt the *equality principle* which states that everyone in a group should share benefits equally. However, Welsh [53] argues that different people use different fairness criteria, and even the same person might use different criteria in different circumstances. For example, the *need principle* states that those who are in more desperate need of a resource deserve a greater share, whereas the *equity principle* argues the opposite (arguing that gains should be partitioned relative to each parties' power/resources). Our ranking assumption obscures the differences between these principles because players discuss their ranking but not their need. Without this assumption, liars could be free to claim the receive less for each issue and thus "need" a greater share (e.g., see Roth's findings of focal points [43]).

Relaxing assumptions about the nature of the opponent: Our results illustrate the potential benefits of lying, but opponents might adopt a variety of countermeasures that could undermine this potential. In the current analysis, we assumed the opponent was truthful, and in indeed in many laboratory studies of negotiation participants tell the truth much more than would be predicted by rational models, but this tendency is hardly universal.

One straightforward way to approach mutual deception is to extend the analysis in Section 3.1 to consider a Stackelberg formulation of the misrepresentation game. In Stackelberg games, one player (the defender) moves first, and the second player responds. In a Stackelberg formulation of the misrepresentation game, one negotiator might publicize a false set of information about their preferences (e.g., the MSRP of different automobile packages) in order to minimize the risk of exploitation or maximize their own gain.

Our current analysis also assumed the human opponent passively accepted reciprocal preference statements, however we should relax this assumption to allow opponents to ask arbitrary preference questions, and perhaps to refuse to directly answer. If the human is free to ask arbitrary preference questions, the misrepresenting-agent is left the dilemma of whether to address these questions directly or to defect them in some way. For example, if the human asks "do you like apples more than oranges," the agent might deflect the response by answering a different question ("Well, I like bananas better than pears") or to hedge the response ("I might like apples better"). If the agent is allowed to deflect, we must assume the human opponent can as well, and such contingencies must be incorporated into the analysis. One approach is to assume deflections come at some cost and model these in the analysis of what questions to ask and answer.

Finally, we only considered a negotiation protocol where parties exchange information about preferences before making a take-it-or-leave it offer. Human negotiations typically involve a mixture of information and offer exchanges and this sort of flexibility needs to be incorporated into our models. Indeed, discrepancies between what one's opponent says and what they offer can be a good indicator of deception [36].

Countermeasures: The previous discussion has focused on how to increase the generality and robustness of strategic misrepresentation but our ultimate aim is to use such models to help people (and agents) to avoid being deceived. Understanding and modeling a malicious technique is often a necessary the first step to proposing countermeasures (e.g., [34]).

In our own work, we are developing these techniques to inform the design of a negotiation tutoring system [24]. Specifically, students would be able to practice negotiation tactics, including how to detect and avoid deceptive behavior, with computer generate opponents. One such tactic is to offer one's opponent a counteroffer that would, assuming they are truthful, have equivalent value. For example, in the situation at the bottom of Figure 1, the man could counter by offering the reverse ("How about I take all apples and you take all oranges?"). Taking her false statements at face value, she should be indifferent to these two deals. In reality, this reverse deal has negative value to her.

The opportunity to make counteroffers highlights the potential riskiness of misrepresentation. For example, if the man insisted on offering oranges, the woman would be caught in her lie. She would either be forced to accept a disadvantageous offer or backtrack on her preference statements (see [47]. The former approach would harm her gains within the negotiation but the latter would harm her reputation for honesty and possibly undermine long term rewards. The idea of repeated interactions presents other complications. For example, if a company uses deception in their negotiations but lies in different ways to different customers, customers could compare notes and uncover the deception.

Characterizing the disadvantages of deception: Here we focus on potential benefits of deception but it can also have obvious costs, especially if both parties are being deceptive. In negotiation research, several studies have illustrated that honest information exchange can lead to better outcomes than deceptive communication or no communication, and achieve greater gains that might seem possible from a purely rational analysis (e.g., [50, 51]). In fact, it might turn out that, under more relaxed assumptions, that honest is the best policy after all. Indeed, Figure 5 illustrates that honesty pays at least under certain circumstances (where intermediate-levels of information are exchanged).

There may also be more intelligent strategies that switch between lying and honesty depending on the situation (see [47]). For example, although the fixed-pie lie exceeded the performance of the max-max regret heuristic in our simulation study (Figure 5), a disadvantage of the fixed-pie lie is that it commits a player to lying from the point of the very first question. Max-max regret strives to be honest but minimally informative. An advantage of this latter approach is that it doesn't committed a player to deception. Rather, the max-max regret heuristic allows a player to revert to honesty if this turns out to afford the greatest reward.

Contrasting human and rational behavior: The immediate next steps in our research, beyond relaxing the assumptions listed above, is to use these models to analyze the behavior of human negotiators. The present analysis suggests that people will tend to win at negotiations if they ask a lot of questions about what their opponents want, are vague about their own interests, and then invent a set of lies that makes self-advantageous deals seem fair. In other work, we have collected a large corpus of human-human negotiations where people clearly lie (see [17]) but we have yet to characterize the tactics they use and the success or failure of these lies. The rational analysis we present here can provide a valuable yardstick with which to measure and give insight into human negotiation processes and ultimately aid in the design that can cope with humans behaving badly. One next step is to use the analysis in this paper to examine if human liars are following our proposed solution.

The ethics of misrepresentation: Our analysis suggests that people, and (potentially) autonomous agents acting on behalf of people, can perform better in negotiations by misrepresenting their preferences. But should such agents ever be constructed. One source of guidance to this question is the rich literature on business and legal ethics, wherein negotiation is a central topic. Interestingly, misrepresentation is often argued to be legal and even ethical. For example, the American Bar Association's code of ethical conduct prohibits lawyers from knowingly misrepresenting facts, but then goes on to say that statements concerning price or value in a negotiation are not considered facts (e.g., see [13]). The rational is that a certain amount of "puffing" is to be expected. In contrast, others point out that such lies cause harm to the opponent and therefore are unethical, even if not illegal [54]. Others claim that it may be unethical to misrepresent through verbal statements but that misrepresenting the same information via emotional expressions is acceptable [23]. The ethics of such emotional manipulation has been considered within the field of affective computing (e.g., see [6]).

In conclusion, we presented an analysis of how people, or agents interacting with people, can win at negotiations while seeming fair. Our findings demonstrate clear benefits a type of lying (misrepresenting the relative importance of different issues) and suggest that negotiators should adopt a "fixed-pie lie" (i.e., pretend that their preferences are identical to their opponent). Future research should extend this analysis to more ecologically-valid situations and a broader class of misrepresentation techniques.

6. ACKNOWLEDGMENTS

This work benefited from some suggestions by Zinovi Rabinovich and Svetlana Obraztsova. We are also thankful for the feedback from the anonymous reviewers. This work was supported by the National Science Foundation under grant BCS-1419621 and the U.S. Army. Any opinion, content or information presented does not necessarily reflect the position or the policy of the United States Government, and no official endorsement should be inferred.

7. REFERENCES

[1] Baarslag, T., Fujita, K., Gerding, E. H., Hindriks, K., Ito, T., Jennings, N. R., Jonker, C., Kraus, S., Lin, R., and Robu, V., “Evaluating practical negotiating agents: Results and analysis of the 2011 international competition,” *Artificial Intelligence,* vol. 198, pp. 73-103, 2013.

[2] Baarslag, T., Hendrikx, M., Hindriks, K., and Jonker, C., "Measuring the performance of online opponent models in automated bilateral negotiation," *AI 2012: Advances in Artificial Intelligence*, pp. 1-14: Springer, 2012.

[3] Baharad, E., and Nitzan, S., “The Borda rule, Condorcet consistency and Condorcet stability,” *Economic Theory,* vol. 22, no. 3, pp. 685-688, 2003.

[4] Bazerman, M. H., and Carroll, J. S., “Negotiator cognition,” *Research in Organizational Behavior,* vol. 9, pp. 247-288, 1987.

[5] Brett, J. M., and Gelfand, M., "At your service - teaching notes," *Negotiation,teamwork and decision-making exercises*, Evenston, IL: Dispute Resolution Research Center, 2009.

[6] Bringsjord, S., and Clark, M. H., “Red-pill robots only, please,” *Affective Computing, IEEE Transactions on,* vol. 3, no. 4, pp. 394-397, 2012.

[7] Broekens, J., Harbers, M., Brinkman, W.-P., Jonker, C. M., Van den Bosch, K., and Meyer, J.-J., "Virtual reality negotiation training increases negotiation knowledge and skill." pp. 218-230.

[8] Camerer, C., *Behavioral game theory: Experiments in strategic interaction*: Princeton University Press, 2003.

[9] Chakraborty, A., and Harbaugh, R., “Cheap talk comparisons in multi-issue bargaining,” *Economics Letters,* vol. 78, no. 3, pp. 357-363, 3//, 2003.

[10] Chalamish, M., and Kraus, S., “AutoMed: an automated mediator for multi-issue bilateral negotiations,” *Autonomous Agents and Multi-Agent Systems,* vol. 24, no. 3, pp. 536-564, 2012/05/01, 2012.

[11] Chen, L., and Pu, P., *Survey of preference elicitation methods*, 2004.

[12] Conley, J. P., and Wilkie, S., “An extension of the Nash bargaining solution to nonconvex problems,” *Games and Economic behavior,* vol. 13, no. 1, pp. 26-38, 1996.

[13] Craver, C. B., “Negotiation Ethics: How to Be Deceptive Without Being Dishonest/How to Be Assertive Without Being Offensive,” *S. Tex. L. Rev.,* vol. 38, pp. 713, 1997.

[14] Crawford, V. P., and Sobel, J., “Strategic Information Transmission,” *Econometrica,* vol. 50, no. 6, pp. 1431-1451, 1982.

[15] Croson, R., Boles, T., and Murnighan, J. K., “Cheap talk in bargaining experiments: lying and threats in ultimatum games,” *Journal of Economic Behavior & Organization,* vol. 51, no. 2, pp. 143-159, 2003.

[16] Curhan, J. R., and Elfenbein, H. A., “What do people value when they negotiate? Mapping the domain of subjective value in negotiation,” *Journal of Personality & Social Psychology,* vol. 91, no. 3, pp. 493-512, 2006.

[17] DeVault, D., Mell, J., and Gratch, J., “Toward Natural Turn-Taking in a Virtual Human Negotiation Agent,” in AAAI Spring Symposium on Turn-taking and Coordination in Human-Machine Interaction, Stanford, CA, 2015.

[18] Farrell, J., and Gibbons, R., “Cheap talk can matter in bargaining,” *Journal of Economic Theory,* vol. 48, no. 1, pp. 221-237, 1989.

[19] Fatima, S., Wooldridge, M., and Jennings, N. R., "An analysis of feasible solutions for multi-issue negotiation involving nonlinear utility functions." pp. 1041-1048.

[20] Fehr, E., and Schmidt, K. M., “A Theory of Fairness, Competition, and Cooperation,” *The Quarterly Journal of Economics,* vol. 114, no. 3, pp. 817-868, August 1, 1999, 1999.

[21] Frank, R., *Passions with reason: the strategic role of the emotions*, New York, NY: W. W. Norton, 1988.

[22] Fry, W. R., “The effect of dyad Machiavellianism and visual access on integrative bargaining outcomes,” *Personality and Social Psychology Bulletin,* vol. 11, no. 1, pp. 51-62, 1985.

[23] Fulmer, I. S., Barry, B., and Long, D. A., “Lying and Smiling: Informational and Emotional Deception in Negotiation,” *Journal of Business Ethics,* vol. 88, no. 4, pp. 691-709, 2008.

[24] Gratch, J., Devault, D., Lucas, G., and Marsella, S., “Negotiation as a Challenge Problem for Virtual Humans,” in 15th International Conference on Intelligent Virtual Agents, Delft, The Netherlands, 2015.

[25] Grice, H. P., "Logic and Conversation," *Syntax and Semantics*, P. Cole and J. Morgan, eds.: Academic Press, 1975.

[26] Hill, R. W., Lane, H. C., Core, M., Forbell, E., Kim, J., Belanich, J., Dixon, M., and Hart, J., "Pedagogically Structured Game-based Training: Development of the ELECT BiLAT Simulation."

[27] Hindriks, K. V., and Jonker, C. M., "Creating human-machine synergy in negotiation support systems: Towards the pocket negotiator." pp. 47-54.

[28] Jennings, N. R., Faratin, P., Lomuscio, A. R., Parsons, S., Sierra, C., and Wooldridge, M., “Automated Negotiation: Prospects, Methods and Challenges,” *International Journal of Group Decision and Negotiation,* vol. 10, no. 2, 2001.

[29] Kalai, E., “Proportional Solutions to Bargaining Situations: Interpersonal Utility Comparisons,” *Econometrica,* vol. 45, no. 7, pp. 1623-1630, 1977.

[30] Kelley, H. H., and Schenitzki, D. P., “Bargaining,” *Experimental Social Psychology. New York: Holt, Rinehart, and Winston*, pp. 298-337, 1972.

[31] Lopes, F., Novais, A. Q., and Coelho, H., "Bilateral Negotiation in a Multi-Agent Energy Market," *Emerging Intelligent Computing Technology and Applications*, Lecture Notes in Computer Science D.-S. Huang, K.-H. Jo, H.-H. Lee, H.-J. Kang and V. Bevilacqua, eds., pp. 655-664: Springer Berlin Heidelberg, 2009.

[32] Lu, T., and Boutilier, C., "Robust approximation and incremental elicitation in voting protocols." p. 287.

[33] Movius, H., “The Effectiveness of Negotiation Training,” *Negotiation Journal,* vol. 24, no. 4, pp. 509-531, 2008.

[34] Naamani-Dery, L., Obraztsova, S., Rabinovich, Z., and Kalech, M., "Lie on the fly: iterative voting center with manipulative voters." pp. 2033-2039.

[35] Nash Jr, J. F., “The bargaining problem,” *Econometrica: Journal of the Econometric Society*, pp. 155-162, 1950.

[36] Nazari, Z., Lucas, G., and Gratch, J., “Opponent Modeling for Virtual Human Negotiators,” in 15th International Conference on Intelligent Virtual Agents, Delft, the Netherlands, 2015.

[37] Nguyen, T., and Gratch, J., *Misrepresentation Negotiation Games,* ICT-TR-01.2016, University of Southern California Instutite for Creative Technologies, Playa Vista, CA, 2016.

[38] O'Connor, K. M., and Carnevale, P. J., “A Nasty but Effective Negotiation Strategy: Misrepresentation of a Common-Value Issue,” *Personality and Social Psychology Bulletin,* vol. 23, no. 5, pp. 504-515, May 1, 1997, 1997.

[39] Pruitt, D. G., *Negotiation behavior*: Academic Press New York, 1981.

[40] Rawls, J., *A theory of justice*: Harvard university press, 2009.

[41] Rosenfeld, A., Zuckerman, I., Segal-Halevi, E., Drein, O., and Kraus, S., "NegoChat: a chat-based negotiation agent." pp. 525-532.
[42] Rosenschein, J. S., and Zlotkin, G., *Rules of encounter: designing conventions for automated negotiation among computers*: MIT press, 1994.
[43] Roth, A. E., “Bargaining experiments,” 1995.
[44] Rubinstein, A., “Perfect equilibrium in a bargaining model,” *Econometrica: Journal of the Econometric Society*, pp. 97-109, 1982.
[45] Sandholm, T., and Lesser, V. R., "Issues in automated negotiation and electronic commerce: Extending the contract net framework." pp. 66-73.
[46] Schug, J., Matsumoto, D., Horitaa, Y., Yamagishi, T., and Bonnet, K., “Emotional expressivity as a signal of cooperation,” *Evolution and Human Behavior,* vol. 31, pp. 87-94, 2010.
[47] Schweitzer, M. E., Brodt, S. E., and Croson, R. T. A., “Seeing and believing: visual access and the strategic use of deception,” *International Journal of Conflict Management,* vol. 13, no. 3, pp. 258-375, 2002/03/01, 2002.
[48] Sierra, C., and Debenham, J., "The LOGIC negotiation model." p. 243.
[49] Thompson, L., and Hastie, R., “Social perception in negotiation,” *Organizational Behavior and Human Decision Processes,* vol. 47, no. 1, pp. 98-123, 1990/10/01, 1990.
[50] Thompson, L. L., “Information exchange in negotiation,” *Journal of Experimental Social Psychology,* vol. 27, no. 2, pp. 161-179, 3//, 1991.
[51] Valley, K., Thompson, L., Gibbons, R., and Bazerman, M. H., “How Communication Improves Efficiency in Bargaining Games,” *Games and Economic Behavior,* vol. 38, no. 1, pp. 127-155, 1//, 2002.
[52] Van Kleef, G. A., De Dreu, C. K. W., and Manstead, A. S. R., “The interpersonal effects of anger and happiness in negotiations,” *Journal of Personality and Social Psychology,* vol. 86, no. 1, pp. 57-76, 2004.
[53] Welsh, N. A., “Perceptions of fairness in negotiation,” *Marq. L. Rev.,* vol. 87, pp. 753, 2003.
[54] Wetlaufer, G. B., “Ethics of Lying in Negotiations, The,” *Iowa L. Rev.,* vol. 75, pp. 1219, 1989.
[55] Wilson, S. R., and Putnam, L. L., *Interaction goals in negotiation*, 1990.
[56] Zlotkin, G., and Rosenschein, J. S., "Incomplete Information and Deception in Multi-Agent Negotiation." pp. 225-231.