Towards Reasoning About Strategic Moves and Reciprocity With i* and Game Trees

Vik Pant[1], and Eric Yu[1, 2]

[1]Faculty of Information, University of Toronto, Toronto, Canada
[2]Department of Computer Science, University of Toronto, Toronto, Canada
vik.pant@mail.utoronto.ca
eric.yu@utoronto.ca

Abstract. Reciprocity is an important motivator of human judgement and is frequently used to justify decisions. It is a common feature of social relationships wherein beneficial conduct is encouraged through rewards while deleterious behaviors are discouraged via punishment. However, despite its ubiquity and pervasiveness in intra- and inter-organizational relationships, there are circumstances when reciprocation can yield mutually injurious outcomes for impacted actors. Game theorists have proposed game trees for analyzing strategic decisions such as those pertaining to reciprocation. However, game trees are lacking in certain respects and only codify limited aspects of a focal decision as well as its problem and solution spaces. This paper discusses exploratory research into the modeling of strategic moves and reciprocity using i* and game trees. It discusses the main ideas that are relevant for developing a framework for analyzing strategic moves and reciprocity in a systematic and structured manner via a combination of these modeling techniques. Such a framework can help organizational decision-makers to exhaustively contemplate decisions concerning reciprocation by accommodating their predispositions and prerogatives.

Keywords: Coopetition. Reciprocity. Design. Modeling. Review.

1 Introduction

Reciprocity is an important consideration in many intra- and inter-organizational relationships [1][2]. It serves as a guideline for action whereby one actor is assured that its beneficial/deleterious actions towards other actors will be met by an equivalent response from those other actors. Reciprocity also impacts trust between actors because it incorporates mutuality into a relationship such that good behavior by an actor is rewarded with an increase in trust while bad behavior is punished with a decrease in trust [3]. Reciprocity is simple to justify in any relationship because it signifies the universal qualities of balance (symmetry) and fairness (equality). In this paper, we share our vision for a framework that supports the analysis of strategic moves and reciprocity in a systematic and structured manner using i* and game trees. Analysis of reciprocity is an important aspect of strategic dependency (SD) analysis because the balance of dependencies going in the two directions between two actors, sometimes mediated via other actors, can determine the viability of the relationships between those two actors. However, in current i*, the model is static (i.e., there is no provision for action over time), which makes it difficult to represent the notion of strategic moves and reciprocality in i*.

2 Strategic Moves and Reciprocity in Social Relationships

Reciprocity refers to "rewarding kindness with kindness and punishing unkindness with unkindness" [4]. It facilitates cooperative relationships among actors by serving as a guarantor of favorable treatment and a protector against injurious treatment. It "is a rather stable behavioral response by a nonnegligible fraction of the people" [5] and thus each social actor should "expect this behavior from others" [6]. Strategic reciprocity has been observed in many industrial settings [7]. However, despite its ubiquity and enduring nature as an influencer of social behavior, there are circumstances in which reciprocity can yield counter-productive decisions that lead to detrimental courses of action. Therefore, decision-makers within organizations can benefit by analyzing reciprocity using a systematic and structured approach.

Strategic relationships are characterized by long-term associations and diversified interactions between two or more actors. These are distinct from transactional contacts between two or more actors where the extent of the dealing is limited to a single exchange or deal. In transactional contacts, reciprocity may offer a useful guide for action because the short-term and non-recurring nature of such engagements may necessitate the threat of retaliation as a safeguard against exploitation and abuse. For example, in a spot (i.e. one-shot) transaction, an actor may cheat a cheater out of a desire for fairness and equity as well as to teach that cheater a lesson. By contrast, in strategic relationships, it may be necessary for an actor to eschew reciprocity if it is expected to further exacerbate and deteriorate that relationship. This might be unavoidable for sustaining the relationship and ameliorating it over time. Such countervailing longer-term considerations may compel a decision-maker to override the desire for short-term reciprocation.

The organizational scenario of knowledge expropriation within inter-partner learning arrangements offers an illustration of reciprocity in action within the industry. Knowledge sharing is identified as an important reason for the formation of business partnerships [8]. However, in such arrangements, it is possible for one or more actors to siphon off knowledge from their partners while hiding their knowledge from those partners [9]. If the opportunism of a cheater is detected by the actor that is cheated then that cheated actor might choose to retaliate immediately against the cheater. It might attempt to do so by cheating the cheater in return or shut it out of the learning alliance. This can lead to a series of reprisals that destabilize and undermine the relationship to the detriment of all affected actors. Conversely, the actor that is cheated may decide to forego the impulse for short-term reciprocation by comprehensively evaluating the long-term implications of tit-for-tat behaviors.

This means that a reflexively reciprocal reaction can be possibly short-sighted in that it entails one actor retaliating to the most recent move by an opponent by taking the most self-interested immediate action, thus potentially foregoing longer-term strategic interests. The universality and timelessness of reciprocity, as a motivator of actions/reactions in strategic relationships, necessitate a framework for analyzing it in a detailed and deliberate manner. Such a framework can enable a decision-maker to take history into account and make tradeoffs between long and short-term interests. Without such a framework decision-makers are likely to follow their gut instincts, that are potent in all humans, of reciprocating under all circumstances. This may expose those actors to errors and mistakes due to omissions and confusions.

3 Towards Modeling Strategic Moves and Reciprocity Using i* and Game Trees

Reciprocity has been studied extensively by researchers of economics, sociology, and psychology to explain moves and countermoves of actors in many types of social relationships. In game theory, it is a basic assumption in many sequential move games, such as gift-exchange game and ultimatum game [10]. A game tree offers an approach for decision analysis when the decisions of one actor impact the decisions of other actors and vice versa. It is relevant for modeling reciprocity because such decisions can trigger tit-for-tat moves/countermoves among actors. Game trees are variations of decision trees in that, while decision trees depict the decisions of a single focal actor, game trees portray the decisions of multiple actors [11].

Zigler [12] notes that "a game tree is a graphical representation of the players' possible choices (also called their action sets) at each point in time, the sequence in which these choices are made, and the payoffs resulting from any combination of choices." It supports the depiction of decisions, their sequence in terms of precedence and subsequence, as well as the payoffs associated with each decision path from root to leaf nodes. Borovska and Lazarova [13] point out that game trees can be used to "find the optimal strategy as a sequence of best possible moves of a given player taking into account possible moves of the other player up to a given depth." Since the decisions, their sequence, and payoffs are included in game trees they can be used to solve optimization problems by searching the space of alternatives and outcomes.

Figure 1 presents a simple game tree with two actors and one decision for each actor. Let us assume that two rival firms, namely A and B, form a strategic alliance to achieve a shared objective. This is a common feature of coopetitive relationships whereby two or more firms cooperate and compete simultaneously. This game tree shows a dichotomous choice that is faced in multifaceted relationships where the actors share a partially convergent and partially divergent interest structure. The decision-makers in these firms are aware that they are in a partnership with their adversary and so the possibility for opportunism exists more so than in a relationship with a benefactor (e.g., a subsidiary or a parent firm).

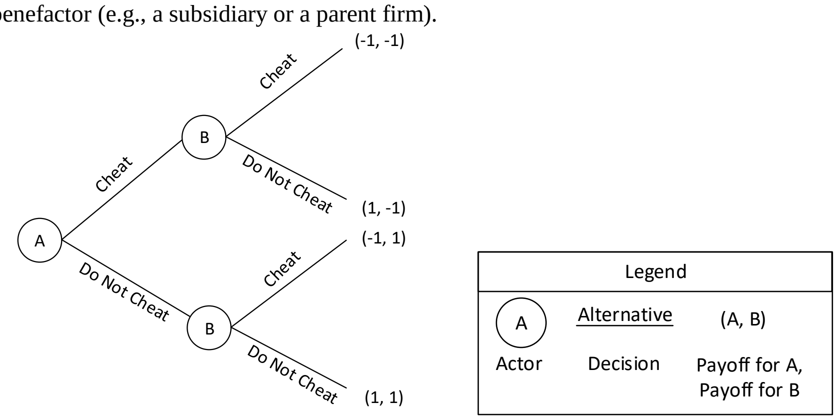

Figure 1. Simple game tree of two actors with one decision each and their resulting payoffs

In this configuration, two options that are available to each firm which are to cheat or not to cheat. The terms and conditions of the strategic alliance between firms A and B are enshrined within a partnership contract. However, due to information imperfection/asymmetry during contract negotiation it can be assumed that the contract is incomplete. Therefore, in spite of the presence of a formal legal document codifying the rules and regulations of the relationship between firms A and B there exists the opportunity for each of these actors to cheat the other actor. The numbers in the parenthesis represent the payoffs to firm A and firm B respectively as the outcome of each decision path. These numbers are presented purely for comparative purposes and their unit of measure is irrelevant.

In this example, we assume for the purposes of reasoning that an outcome of positive 1 is favorable to an outcome of negative 1 for each actor. Figure 1 shows that if each firm cheats then each firm earns a payoff of negative 1. Conversely, if neither firm cheats then both firms earn a payoff of positive 1. However, if one firm cheats while the other firm does not cheat then the cheater earns a payoff of positive 1 while the cheated earns a payoff of negative 1.

Intuitively, it may appear that neither firm should cheat as that would lead to each firm earning a payoff of positive 1. This rationale would be reinforced by examining the decision path where both firms cheat because in that case each of these firms would earn a payoff of negative 1. However, this simplistic line of reasoning relies on certain assumptions that may not be realistic. For example, since partners in coopetitive relationships are also rivals, a firm may be tempted to cheat the other firm in order to harm it regardless of its own payoff. It may also reason that if its opportunism goes undetected (i.e., by hiding, shielding, masking, or spinning) then it will benefit while the other firm will be harmed.

Conversely, if its deception is detected then the other firm will retaliate by attempting to cheat it and in which case both firms will earn a payoff of negative 1. In both cases, the first mover can guarantee a payoff of negative 1 for the second mover by cheating it. If the possibility of earning a payoff of negative 1 is an outcome that the first mover is willing to tolerate, while ensuring that the second mover definitely earns a payoff of negative 1, then the first mover is better off cheating. Likewise, the second mover may be tempted to retaliate by cheating the first mover upon the detection of cheating by the first mover. However, the second mover may forego the urge for reciprocation due to its priorities. For example, the second mover may be more conscious about its reputation in the industry than the first mover. Thus, it might be willing to overlook cheating by the first mover by deciding not to cheat and maintain its goodwill.

The reasoning presented above highlight different ways of analyzing decision paths and in doing so points to a key limitation of game trees. Game trees can be used to depict the interrelated decisions of different actors, their sequences, and payoffs related to various decision paths. However, game trees cannot be used to represent the intentions and motivations of the focal decision-makers. Each decision maker can have unique priorities and preferences. Therefore, each decision-maker may analyze its space of alternatives (represented as decision paths) differently with respect to its particular goals, and objectives (represented as payoffs).

Analysts can solve optimization problems using search algorithms on game trees but search algorithms apply many domain assumptions such as those about the subject and measurement of optimization (i.e., what must be optimized and what is meant by optimization – e.g., minimization, maximization, etc.). These assumptions are absent from the game trees and the inability of representing the assumptions that are critical for solving a particular optimization problem on a specific game tree means that either assumptions are excluded from the record or they are denoted as accompanying text. Neither option is optimal as the former implies the preservation of an incomplete record that is not conducive to auditing while the latter implies the storage of unstructured and free-form documentation that does not readily allow automated evaluation.

We posit that i* is fit for the purpose of depicting the decision rationale that is used to solve an optimization problem on a game tree. i* is well suited for this because it supports the analysis of tradeoffs between alternatives in terms of quality objectives. i* supports the depiction of softgoals that can be used to compare and contrast the impact of each alternative. It also supports the representation of dependencies between actors that serve as sources of opportunities/vulnerabilities thereby supporting/constraining different courses of action. i* permits allocentric analysis through its support for the presentation of multiple viewpoints (e.g., for each actor). This characteristic of i* is crucial for performing qualitative analysis of goal satisfaction that reflects the perspective of each decision-maker. Furthermore, typical search algorithms on game trees assume that the problem space is fully known, and that the solution space is given and fixed. i* provides representation for exploring and elaborating on the problem understanding as well as the solution space.

Figure 2 presents a simple i* strategic rationale diagram of the goal models of abovementioned firms A and B. We use alternatives from figure 1 in figure 2 to simplify the correlation between these diagrams. A more sophisticated i* strategic rationale (SR) diagram would elaborate and expand these alternatives beyond those that are included in figure 1. This diagram shows that each actor has a distinct worldview that will impact its perception of the desirability of a particular course of action (i.e. decision path). Firm B is risk averse, values the goodwill that it enjoys in the market, and prefers to engage in fair dealings. It does not like to gamble or take bets, as it relates to its contractual relationships, and thus it avoids cheating its partners. Conversely, Firm A prefers to take risks, harm its adversaries, and force renegotiations of its agreements to continually obtain favorable terms and conditions. It is unconcerned with its reputation in the market and is comfortable with cheating.

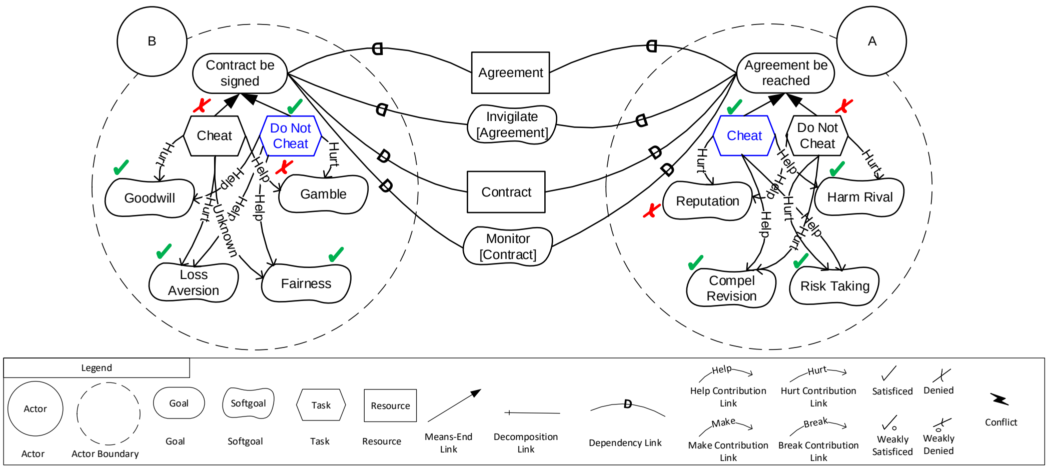

Figure 2. Simple i* Strategic Rationale diagram of two actors, their alternatives and goals

4 Conclusion

Section 3 used an example to show that, even though Firm A, the first mover in figure 1, will cheat Firm B, the second mover, it is preferable for Firm B to eschew its impulse for hasty retaliation due to its long-range proclivities and propensities. This suggests that there are circumstances when certain intentions override the urge of an actor to get even with another actor by reciprocating immediately. Thus, modeling reciprocity necessitates the means of representing extended temporal sequence of strategic moves, and how the decision by one actor at any point in time should consider past moves by each actor, and possible future moves. i* can be used in combination with game trees to expose and highlight such situations to help decision-makers arrive at defensible decisions about reciprocation.

This example illustrated that two firms in a business partnership can evaluate the same game tree in completely different ways. The idiosyncratic goals and objectives of each firm, which are underpinned by their motivations and intentions, determine the attractiveness of each option for them. Analysis of payoffs in game trees can be supplemented by analysis of softgoals in i*. Our technique of using i* models and game trees in a complementary manner can help each decision-maker to evaluate its space of alternatives in line with its particular intentionality.

Gans et al. [14] propose a TCD (Trust–Confidence–Distrust) approach for continuous requirements management in inter-organisational networks. Our work is synergistic to this approach which "combines the structural analysis of strategic dependencies and rationales, with the interaction between planning, tracing, and communicative action." [14] Both of these approaches consider path dependency, history, and strategic dependency between actors during analysis.

5 References

1. Hu, Y., & Korneliussen, T. (1997). The effects of personal ties and reciprocity on the performance of small firms in horizontal strategic alliances. *Scandinavian Journal of Management*, 13(2), 159-173.
2. Buunk, B. P., & Schaufeli, W. B. (1999). Reciprocity in interpersonal relationships: An evolutionary perspective on its importance for health and well-being. *European Review Of Social Psychology*, 10(1), 259-291.
3. Altmann, S., Dohmen, T., & Wibral, M. (2008). Do the reciprocal trust less?. *Economics Letters*, 99(3), 454-457.
4. Ashraf, N., Bohnet, I., & Piankov, N. (2006). Decomposing trust and trustworthiness. *Experimental Economics*, *9*(3), 193-208.
5. Fehr, E., & Gächter, S. (2000). Fairness and retaliation: The economics of reciprocity. *The Journal Of Economic Perspectives*, *14*(3), 159-181.
6. Sobel, J. (2005). Interdependent preferences and reciprocity. *Journal Of Economic Literature*, *43*(2), 392-436.
7. Krämer, A., Jung, M., & Burgartz, T. (2016). A small step from price competition to price war: Understanding causes, effects and possible countermeasures. *International Business Research*, 9(3), 1.
8. Jiang, X., & Li, Y. (2009). An empirical investigation of knowledge management and innovative performance: The case of alliances. *Research Policy*, 38(2), 358-368.
9. Trkman, P., & Desouza, K. C. (2012). Knowledge risks in organizational networks: an exploratory framework. *The Journal of Strategic Information Systems*, 21(1), 1-17.
10. Falk, A., & Fischbacher, U. (2006). A theory of reciprocity. *Games And Economic Behavior*, 54(2), 293-315.
11. Dixit, A. K., & Nalebuff, B. (2008). *The Art Of Strategy: A Game Theorist's Guide To Success In Business & Life*. WW Norton & Company.
12. Ziegler, A., 2004. *A Game Theory Analysis Of Options: Corporate Finance And Financial Intermediation In Continuous Time*. Springer.
13. Borovska, P., & Lazarova, M. (2007, June). Efficiency of parallel minimax algorithm for game tree search. In: *Proceedings of the 2007 Intl Conf on Comp Sys and Tech*. ACM.
14. Gans, G., Jarke, M., Kethers, S., & Lakemeyer, G. (2003). Continuous requirements management for organisation networks: a (dis) trust-based approach. *Requirements Engineering*, 8(1), 4-22.