Conversations and Incomplete Knowledge

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1 Introduction

Conversations often involve an element of planning and calculation of what to say to best achieve one's interests. We investigate scenarios of incomplete knowledge in strategic conversations, where the fundamental interests of the dialogue agents are opposed. For instance, a debate between two political candidates. Each candidate has a certain number of points she wants to convey to the audience, and each wants to promote her own position to the expense of the other's. To achieve these goals each participant needs to plan for anticipated responses from the other. Debates are thus games; an agent may win, lose or draw. Similar strategic reasoning about what one says is a staple of board room or faculty meetings, bargaining sessions, etc. We show the importance of a certain form of unawareness in strategic conversation.

We explore a linguistic consequence of the model of strategic conversation of (Asher and Paul, 2012; Asher and Paul, 2013) concerning a form of incomplete information, where one strategic player is unaware of moves that another player may perform. We show some interesting linguistic consequences of the model concerning this form of incomplete information and draw an abstract characterization of the structure of strategic conversations from the framework. This work complements more computational and empirical work like that of (Traum, 2008).

Background. For their model of strategic conversations, (Asher and Paul, 2012) use Banach Mazur or BM games, a kind of infinitary game (Kechris, 1995) used in mathematics and theoretical computer science. A BM game is a win-lose game $\langle X^\omega, Win \rangle$ involving two players; the 2 players each play a finite sequence of moves from a fixed set or vocabulary X, alternating indefinitely and building strings in X^ω; $Win \subseteq X^\omega$ is the winning condition for player 0 (for player 1

the winning condition is $X^\omega - Win$). The Cantor topology over X^ω of infinite strings allows us to characterize winning conditions in terms of basic open sets, unions of basic open sets (Σ_1^0), intersections of complements of basic open sets (Π_1^0), and so on. The *Borel hierarchy* consists of the Σ_1^0 sets, the Π_1^0 sets, and more generally includes $\Sigma_{\alpha+1}^0$ as the countable union of all Π_α^0 sets and $\Pi_{\alpha+1}^0$ as the complement of $\Sigma_{\alpha+1}^0$ sets. The hierarchy is strict and does not collapse (Kechris, 1995).

(Asher and Paul, 2012) characterize types of dialogues and their conversational goals using the BM framework. Message exchange games are BM games $\langle X^\omega, Win \rangle$ where X is a set of possible discourse moves, as described by, e.g., SDRT (Asher and Lascarides, 2003). BM games characterize in a precise way how some conversational strategies, and some winning conditions in strategic conversations, are much more complex than others. (Asher and Paul, 2012) also show how two conversationalists 0 and 1 may occupy a role in two different BM games such that 0 and 1 may both have winning strategies (1 in each game) and how this applies to cases of misdirection (Asher and Lascarides, 2013). Finally, BM games also can model why speakers do not "defect" when given the opportunity and it is in their interest. Consider a prosecutor who asks a defendant a question that may incriminate her and that she prefers not to answer. In a one shot linguistic exchange, it is not rational to answer such a question. However, if linguistic games are open ended allowing for further exchanges, then a defection strategy may carry heavy, known penalties.

Our contribution. BM games are determined (Martin, 1975); so if 0 and 1 are playing a game G in which each has complete common knowledge of the moves and strategies of the other, it is *not* rational for both 0 and 1 to play with a strict preference for winning. If they do play with such a preference, they must *not* have common and

complete knowledge of the game they are playing. We investigate two scenarios of incomplete and non-common knowledge: one is where the players are playing with different sets of moves and so the moves of one are not completely known to the other; the other is where players start out with the same repertoire of moves, but one forgets (or learns) certain moves and the other does not. In both scenarios the players are playing different games G and G' with sets of moves X and Y respectively such that $X \subsetneq Y$. In this case, one player will be unaware of some of the moves available to the other.

A question then is: if player 0 strategizes for $Win \, \phi$, what happens to ϕ in the game where player 1 has a set of moves available to him that is a strict superset of those 0 is aware of? (Asher and Paul, 2013) prove an abstract result showing that Win_X encoded in G' may have a higher Borel complexity. For our part we are just interested in the restriction of the theorem that states that a winning condition that has complexity Σ_1^0 in G will jump to Σ_2^0 in G'.

We illustrate the theorem's import with an excerpt from the Dan Quayle-Lloyd Bentsen Vice-Presidential debate of 1988. Quayle, as a very junior and politically inexperienced Vice-Presidential candidate, was repeatedly questioned about his experience and his qualifications to be President. Quayle's strategy to rebut doubts about his qualifications was to compare his experience to the young John Kennedy's. However, Bentsen made a discourse move that Quayle didn't anticipate.

(1)   Quayle: ... the question you're asking is, "What kind of qualifications does Dan Quayle have to be president," [...] I have as much experience in the Congress as Jack Kennedy did when he sought the presidency.

(2)   Bensten: Senator, I served with Jack Kennedy. I knew Jack Kennedy. Jack Kennedy was a friend of mine. Senator, you're no Jack Kennedy.

Quayle's strategy at that point fell apart, and he lost the debate handily. He was unprepared for Bentsen's move, which we model by having Quayle play a game with set of moves X and Bentsen a game with set of moves Y such that $X \subsetneq Y$.

The theorem implies that a winning strategy for Quayle's winning condition—implicating that he was comparable to a very distinguished President (a Σ_1 winning condition)—would have needed to take into account an intersection of open sets in Y defining the X winning condition in Y thus anticipating possible deviations from the conversational plays in X. Had he done so, he might have countered Bentsen's move and have kept the moves within X. A linguistic theory of discourse structure like SDRT tells us how:

Proposition 1

If a move α presupposes ϕ and ϕ is not locally accommodatable in α and a move β is such that $\beta \models \neg\phi$, then there is no link between α and β. I.e. α cannot be a response to β.

In this case, Bentsen's move presupposes that Quayle had implicated or said that he was comparable to John Kennedy, a presupposition that is not locally acommodatable (to Bentsen's move). Had Quayle explicitly added a rider to his response, like *though I would not presume to be the great statesman that Kennedy was, I have as much experience as he did when he sought the presidency*, Bentsen's move would have been incoherent and would have put him in a position to lose the debate.

BM games offer a simple and elegant way of describing a heretofore little studied form of unawareness, an unawareness of moves in the game instead of an unawareness of events (Haifetz et al., 2006). It is the former that is appropriate for the analysis of strategic conversation. Our observations provide a general characterization of the structure of strategic conversations, assuming that our dialogue agents are rational and are perfect reasoners, thus able to determine whether a winning strategy exists in the game they are playing.

Proposition 2 *Two rational players of a BM message exchange game assign a strict preference to their winning conditions only if they (i) are playing two games with compatible Win conditions, or (ii) assume they are playing a game where their opponent is unaware of some of their moves.*

Case (i) is the misdirection scenario; case (ii) includes both cases of forgetting and of assuming your opponent doesn't know all of your rhetorical repertoire. The result resembles exceptions due to unawareness of no speculative trade theorems in economics (Milgrom and Stokey, 1982).

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