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From reasonable preferences, via argumentation, to logic

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ABSTRACT

This article demonstrates that typical restrictions which are imposed in dialogical logic in order to recover first-order logical consequence from a fragment of natural language argumentation are also forthcoming from preference profiles of boundedly rational players, provided that these players instantiate a specific player type and compute partial strategies. We present two structural rules, which are formulated similarly to closure rules for tableaux proofs that restrict players' strategies to a mapping between games in extensive forms (i.e., game trees) and proof trees. Both rules are motivated from players' preferences and limitations; they can therefore be viewed as being player-self-imposable. First-order logical consequence is thus shown to result from playing a specific type of argumentation game. The alignment of such games with the normative model of the Pragma-dialectical theory of argumentation is positively evaluated. But explicit rules to guarantee that the argumentation game instantiates first-order logical consequence have now become gratuitous, since their normative content arises directly from players' preferences and limitations. A similar naturalization for non-classical logics is discussed.

1. Introduction

An adequate theoretical framework to reconcile formal and informal argumentation should be rich enough to describe different practices of natural language argumentation, while allowing for normative evaluations of argumentative standards and outcomes. Most extant attempts, however, fall short of doing full justice to the strict requirements of formal languages and the complexity of natural language, on one hand, and to human reasoning in argumentative contexts, on the other. This includes the perhaps most promising approach by Wittgenstein [22], where logic is viewed as one among several language games that are played in a natural or a formal language. This had offered the well-known analogy between 'having a proof' and

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'winning a game', and thereby established an informal connection between the construction rules of a valid argument and being victorious over an opponent.

Logicians who have since studied the formal details of this connection have mostly sought to give an argumentative characterization of logic by viewing logical proofs as regimented argumentation procedures.[1] In particular game theory became a natural framework for modeling episodes of natural language argumentation that exactly or approximately characterize logical inference, giving rise to dialogical logic (DL) [12,13] and game-theoretical semantics (GTS) [10] as the two main approaches. Both entail an assumption which is often overlooked in proof theory, namely that game outcomes (read: conclusions) depend not only on the premises but also on the players' (read: arguers') strategies and preferences.[2]

By modeling the game-theoretical impact of argumentation on logic, DL and GTS both achieve a *partial* reduction of logic to argumentation procedures when they restrict players' strategies such that games realize the model-checking procedures and proof procedures that are typical of logical inference. In fact, DL claims to fully reduce logic to formal argumentation when analyzing what it means for natural language argumentation to be formal. But DL theorists simply assume that the relevant process is argumentative, without committing to a strong theoretical framework for characterizing argumentation. In particular, DL players lack explicit preferences or beliefs about the other players' strategies, thus DL seems to force *ad hoc* rules upon players in order to output the correct type of logical inference. Moreover, since DL is primarily concerned with formal argumentation, DL argumentation games can merely account for a fragment of natural language.[3]

Another attempt at describing and normatively governing the practice of argumentation is the pragma-dialectical (PD) theory of argumentation [21]. Particularly the PD code of conduct provides a set of norms for resolution-oriented natural language argumentation where arguers can have explicit preferences and beliefs about other arguers' strategies. But the PD norms have themselves remained informal, perhaps also because it is difficult to formalize them within classical logic.

As a common trait, notice that both DL and PD consider argumentation procedurally. Still, there remains a gap between both approaches insofar as DL uses a tight notion of formalism but a loose pre-theoretical notion of argumentation, while PD uses a tight theoretical notion of argumentation but a loose notion of formalism. The main goal of this paper is to show how to bridge this gap.

First, we provide a formal game-theoretical framework which makes explicit the preferences of players in an argumentative game, and makes understandable what it means for arguers to reach a consensus. Next, we show that this framework is consistent with the PD rules for a critical discussion. Intuitively, this amounts to tightening the loose notion of argumentation used in DL to make it commensurable with the tight notion used in PD.

More precisely, we demonstrate how typical DL restrictions that are imposed to recover first-order logical consequence from argumentation are forthcoming from preference profiles of boundedly rational players; these players compute partial strategies because they cannot optimize their strategies as they lack the ability to compute complete representations of a game, and must therefore satisfice [18]. These restrictions, or constraints, are formulated as rules in extensive forms (i.e., game trees) and as proof trees that resemble closure rules for tableaux proofs. Such constraints, we argue, are player-self-imposable through strategic reasoning that is provably equivalent to the elimination of dominated strategies. Thus coming to understand arguers as being engaged in a 'game for logical argumentation' shows how classical logic can be realized in contexts of a fragment of natural language argumentation, and also hints at how logic could genetically have "emerged" from argumentative procedures.

[1] Logic had thus returned to its origins in argumentation, if one views Aristotelian logic to emerge from the argumentative practices in the Academy and the Lyceum [16], being proceeded by the Socratic *elenchus*, among others. For a brief historical overview, see Dipert et al. [4], and Hintikka [9].

[2] A notable exception is Smullyan [19], who mentions the importance of proof strategies in tableaux proofs, the best ones being those that generate the shortest possible (correct) proof.

[3] This criticism extends to GTS under the conditions of the equivalence shown in Rahman and Tulenheimo [14].