THEORETICAL-GNOSEOLOGICAL AND PRACTICAL ANALYSIS OF DIALOGICAL AND INTERACTIVE LOGIC SYSTEMS

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Abstract

This article explores the theoretical-gnoseological and practical aspects of dialogical and interactive logic systems within the framework of modern cognitive science and artificial intelligence. The study aims to understand how dialogical logic facilitates dynamic knowledge formation, mutual understanding, and reasoning, while interactive logic systems bridge human-machine communication. The research draws from classical gnoseology, constructivist epistemology, and computational logic paradigms to propose an integrated model for dialogical reasoning in modern interactive environments.

Keywords: Dialogical logic, interactive systems, gnoseology, epistemology, cognitive modeling, artificial intelligence, reasoning, communication theory, pragmatics, human-machine interaction.

Introduction

The rapid evolution of communication technologies and artificial intelligence has intensified interest in dialogical and interactive forms of reasoning. Dialogical logic, rooted in the works of Paul Lorenzen and Kuno Lorenz, emphasizes reasoning as an interaction between participants in a dialogue. It opposes monological logic, which treats reasoning as isolated deduction. The gnoseological (epistemological) dimension of this topic concerns how knowledge is produced, shared, and justified through dialogical processes.

Interactive logic, on the other hand, expands dialogical reasoning into computational and cognitive domains, enabling systems that "reason" interactively with human agents. Such systems are not only reactive but capable of contextual adaptation and learning. Therefore, a theoretical-gnoseological and

practical analysis of these systems is crucial for understanding how reasoning, knowledge acquisition, and interaction intersect in both human cognition and artificial intelligence.

Dialogical logic and interactive logic systems represent innovative approaches to understanding reasoning, argumentation, and knowledge through dynamic, participatory frameworks rather than static, monological structures. Dialogical logic, primarily developed by Paul Lorenzen and Kuno Lorenz in the mid-20th century, models logic as a dialogue game between a Proponent (who defends a thesis) and an Opponent (who challenges it), where validity is established if the Proponent has a winning strategy against all possible challenges. This framework draws on game theory and constructivist philosophy, emphasizing the pragmatic use of language in interactions. Interactive logic systems, while overlapping with dialogical logic, encompass a broader spectrum, including game semantics, interactive theorem proving in computer science (e.g., systems like Coq or Isabelle where users interact with machines to construct proofs), and logics for analyzing multi-agent interactions or strategic games. The key distinction, where articulated, lies in dialogical logic's focus on normative, argumentation-based dialogues rooted in philosophical traditions (e.g., Greek dialectics), whereas interactive logic often extends to computational or empirical contexts, such as medieval disputation games (obligationes) or modern game-theoretical semantics that incorporate model theory for atomic statements. Both challenge traditional truth-functional semantics by prioritizing interaction as the basis for meaning and validity.

Theoretical Analysis

Theoretically, dialogical logic redefines logical constants (e.g., connectives like "and," "or," and quantifiers) through "particle rules" that specify how they are challenged and defended in a dialogue. For instance, in a conjunction ($A \land B$), the Opponent can challenge either A or B, and the Proponent must defend the chosen part. Structural rules govern the overall game, such as alternation of moves, finiteness (via repetition ranks to prevent infinite loops), and the "Formal Rule" (Proponent can only assert atomic statements conceded by the Opponent, ensuring analyticity). Dialogues operate at two levels: the "play level" (individual sequences of moves) and the "strategy level" (a tree of all possible plays where the Proponent wins every branch). This setup captures differences between

classical and intuitionistic logic; classical logic allows more flexible defenses (e.g., multiple responses to the same challenge), enabling principles like the law of excluded middle, while intuitionistic logic enforces a "Last Duty First" rule for stricter constructivism.

Interactive logic systems build on similar foundations but often incorporate broader mechanisms. In game semantics, for example, truth is determined through interactive plays over models, differing from dialogical logic's avoidance of external semantics by making meaning "immanent" to the dialogue itself. Historical roots trace back to ancient dialectics for dialogical logic and medieval interactive logics like obligationes, where disputants engaged in rule-bound debates to test consistency. In contemporary terms, interactive logics include systems for analyzing games, such as strategy logics or epistemic game theory, where agents' interactions model reasoning under uncertainty. Theoretically, both emphasize finitary, decidable processes, but interactive systems may allow infinite strategies in quantified logics, managed through restrictions like term copying.

Gnoseological (Epistemological) Analysis

From an epistemological standpoint, dialogical and interactive logic systems portray knowledge as inherently dialogic and emergent from interaction, rather than as a fixed correspondence to reality. In dialogical logic, meaning and truth are constituted through the "game of giving and asking for reasons," aligning with inferentialism (e.g., Robert Brandom's ideas) where assertions carry commitments and entitlements justified intersubjectively. This constructivist epistemology views knowledge as "dialogue-definite"—finite plays yield decidable outcomes—but not always proof-definite, emphasizing strategic reasoning over absolute truth. The "Immanent Reasoning" extension integrates local reasons (evidence-based justifications) with strategic ones, linking to Constructive Type Theory where judgments like "a : A" (evidence a for proposition A) make epistemic content explicit. Epistemologically, this counters dogmatism by requiring defenses against skepticism, fostering a dynamic view of knowledge as a social practice influenced by Wittgenstein's language-games. Interactive logic systems extend this to computational and multi-agent epistemologies. In interactive theorem proving, knowledge is co-constructed between human and machine, ensuring proof correctness through iterative

refinement. In game logics, epistemological implications involve modeling belief, knowledge, and strategic reasoning among agents, addressing issues like common knowledge in interactive scenarios. Both approaches challenge monological epistemologies by highlighting normativity in interaction: knowledge arises from accountability (e.g., defending claims) and pluralism (e.g., varying rules reflect different epistemic norms). Critiques include potential over-formalization, but extensions like material dialogues incorporate empirical content, such as evidence in legal or scientific reasoning.

Practical Analysis

Practically, dialogical logic finds applications in argumentation theory, where it models real-world debates (e.g., pragma-dialectics) and legal reasoning, enabling frameworks for defeasible inferences and hypothetical judgments. In AI and computer science, it informs dialogue systems, belief revision, and non-monotonic reasoning, with extensions to modal and linear logics for handling uncertainty or resources. Educational uses include teaching critical thinking through adversarial games, while historical reconstructions apply it to ancient logics (e.g., Aristotle's syllogistics or Jain logic).

Interactive logic systems are applied in software verification via interactive provers, ensuring robust proofs for complex systems. In game theory and economics, they analyze strategic interactions, such as in epistemic game models for decision-making under incomplete information. Practical benefits include adaptability to pluralism (e.g., switching between classical and intuitionistic modes) and integration with applied linguistics for natural language processing. Challenges involve computational complexity in strategy computation, but tools like semantic tableaux mitigate this. Overall, these systems enhance practical reasoning in fields requiring collaboration, from AI ethics to policy debates, by formalizing interaction without reducing it to static rules.

The integration of dialogical and interactive logic has profound philosophical and practical implications. Theoretically, it challenges the Cartesian notion of isolated cognition and reinforces a communicative model of rationality. From a gnoseological perspective, it situates knowledge within dialogue — meaning emerges not from solitary reflection but through communicative exchange.

In practical contexts, this framework underpins the development of adaptive learning environments, intelligent tutoring systems, and ethical AI dialogue

models. For instance, the dialogical nature of reasoning ensures transparency and explainability in AI systems, supporting responsible decision-making. Furthermore, understanding the logical structure of dialogue informs the design of more human-like AI capable of maintaining coherent multi-turn interactions. However, dialogical and interactive logics face challenges, particularly in balancing logical consistency with pragmatic flexibility. While traditional logic demands strict formalism, dialogical systems must accommodate ambiguity, irony, and contextual shifts — features typical of natural human dialogue.

Conclusions

The study concludes that dialogical and interactive logic systems represent a synthesis between classical epistemology and modern computational cognition. The dialogical approach redefines logic as a process of mutual reasoning, while interactive systems embody this process technologically.

Dialogical logic offers a powerful gnoseological framework for understanding reasoning as an interactive, cooperative process.

Interactive logic systems operationalize dialogical principles, creating practical tools for communication and learning.

Both systems contribute to the development of transparent, adaptive, and epistemically grounded AI models.

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