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## Abstract

The dissertation presents an approach to questions and broader questioning phenomena inside the paradigm of dynamic epistemic logic. The main topics that emerge in the thesis are concerned with: defining a rich repertoire of questioning actions, developing a theoretical framework and logics to reason about interrogative actions, provide implementation tools for analyzing realistic scenarios of questioning in inquiry. In this way we provide a setting in which questions can be understood and analyzed in their intricate conceptual, logical and practical interdependence and strategic connection with knowledge and information dynamics.

Chapter 2 shows how dynamic logics of questions can analyze various aspects of private and public inquiry. We introduce a resolution modality based on the intersection between the two equivalence relations representing the information and questioning partitions. This provides a rich system of dynamic issue-management actions leading to complete dynamic logics for questioning in DEL style. These systems fit entirely within the methodology of dynamic-epistemic logic, and they seem to form a natural complement to what already exists in this area.

Chapter 3 complements the theoretical perspective with an implementation. This extends previous implementations for epistemic model checking with questioning specific functionality. The main new utilities are model checking utility for questioning, resolution, and epistemic formulae, and a general and extensible implementation for complex questioning and resolution dynamic actions that emerge in this framework. We also show how the implementation is useful by modeling and analyzing some paradigmatic examples of questioning scenarios.

Next we study the strategic aspects that emerge in DELQ both in games with questioning moves and in long term interactive inquiry.

Chapter 4 defines and investigates games with questioning moves. We first look at strategic games with two players. We then extend this basic approach to a more realistic setting with sequential moves, and oracles encoding interactions between imperfectly informed agents or limitations in external information sources or measurement instruments and experimental procedures. We give a

tripartite interpretation for questioning moves and use it to show first why questioning phenomena in multi-agent contexts are more complex than traditionally understood and second to distinguish games with questioning moves from games with informative actions. We analyze illustrative examples and present an inexistence result for Nash equilibrium with pure strategies in questioning games with oracles. We also identify the diffraction property and show why it is important for describing strategic abilities in extensive questioning games.

Chapter 5 provides an implementation for questioning games extending basic epistemic functionality to include strategic aspects specific for a game theoretic approach of questioning actions. The implementation provides ‘expressive harmony’ for questioning moves by linking the semantic level based on partitions of the domain with a corresponding syntactic level using disjunctions of nominals. In this way, we can compute complete game matrices for games with questioning moves and we give an algorithm for minimizing issue-epistemic models using a notion of behavioral equivalence that is adequate for the questioning language.

Next we investigate the connection between a questioning theory and the process of designing efficient querying strategies. In this way we provide a bridge between a theory of questions and known search heuristics using backtrack oracles.

Chapter 6 approaches the topic of designing questioning strategies in problem solving from a theoretical perspective. We take again solving games as our point of departure and a rich representative test case. In this context we investigate the problem of finding Nash equilibria in the location game played on a line. We also discuss the general relevance of this approach for designing querying strategies in problem solving by using oracles of operational properties to solve a principal problem using efficiently available sources of information. We give a characterization of NE by means of local properties in the game, We use an approach based on querying an oracle of local properties and matching of strategy profile fragments to design questioning strategies that solve the game in an efficient way. In the final section we provide a minimization algorithm for probabilistic issue models based on partition refinement solving the birelational coarsest partition problem and in accordance with the adequate notion of behavioral equivalence for probabilistic issue models and probabilistic questioning actions.

In Chapter 7 we present a *Haskell* implementation illustrating how queries of local properties in the game can search for equilibrium strategy profiles using list comprehension. This assumes the existence of oracles of local properties and uses this to search for Nash equilibria in pure strategies. Next, we give an *Alloy Analyzer* implementation for building countermodels for the location game and checking assertions about logical entailment within a predetermined scope between facts expressing local properties and NE.

Chapter 8 shows how our approach gives rise to a coherent research agenda with a broader scope, and points to some further directions for future research.