

SOIA
Semantics and Ontology of InterAction
Joint project ISTC - IRIT (CNRS-UPS, Toulouse, France)

Modeling interaction

Modeling interaction between agents has become more and more important for a variety of areas of computer science recently. Obviously enough, human-computer communication and dialogue systems are areas that have received attention for quite a long while. More recently however, the expanding use of the web has pointed out the need to model as well interaction between artificial agents. This agent paradigm has fostered a growing scientific activity on *formal models of interaction* based on a cooperation of several research domains, in particular, logic, linguistics and computational linguistics.

Three different approaches can be identified, all of them using logic as a general framework, and all of them exploiting the philosophical concept of speech act introduced by Austin and Searle, but in different ways.

NLP and logic-based AI joined in the 90's on the study of formal models of interaction in multi-agent and/or dialogue systems, exploiting two families of formal tools: epistemic and doxastic logics —among which the so-called BDI (beliefs, desires and intentions) logics; and dynamic logics of action theory.

In parallel, the formal semantics trend in philosophy of language and linguistics has significantly evolved from the advent of dynamic semantics (with, e.g., DRT or Discourse Representation Theory) so as to take into account more and more pragmatic phenomena. The resulting theories of the semantics-pragmatics interface tackle now explicitly dialogue phenomena and can be legitimately considered as formal theories of interaction. One such theory is SDRT (Segmented DRT), whose main focus is on the structure of discourse in terms of rhetorical relations.

Lastly, formal dialectics, which has a long tradition in the study of a special kind of interaction, argumentation, together with (dialogue) Game Theory, have also become a hot topic in AI. In this approach, dialogue is viewed as the product of a set of rules based on public and normative notions (commitments, obligations...).

The missing ontological link

These three formal approaches to interaction all involve some crucial ingredients such as events, states, actions, speech acts, rhetorical relations, mental states (among which beliefs, intentions, goals), plans, propositions, arguments, facts, commitments and conventions.

The first objective of this project is to compare the ontological status of these ingredients in the various theories, identify and characterize formally the basic entities and primitive concepts they rely on, analyze their relationships, and eventually challenge these choices by proposing theoretical refinements and extensions motivated on psychological, linguistic, philosophical and, especially, ontological grounds. Indeed, in these theories ontological aspects are either partially addressed, taken for granted or left unspecified, and the comparison of the theories from an ontological point of view has not been made.

If we want to be able to connect the form of the interaction with the contents of the exchange, it is essential that this work be done in relation with more general ontological considerations. The notions specific to interaction must then be integrated within a general ontological picture, that is, be placed in a top-level ontology. Actually, applied formal ontology aiming at producing top-level ontologies has up to now mainly focused on the sub-domain of concrete entities, and, for instance, their relationships with space, time and matter. Research is now

turning to the integration of the large amount of philosophical work on other domains like that of abstract entities (e.g., propositions, facts, arguments, universals), of agents (physical or social, individual or collective, human or artificial), of subjective entities (emotions, mental states, propositional attitudes) and of social entities (laws, commitments, conventions). This project thus aims at contributing to this task.

A Semantic focus

A particular attention will be given to linguistic interaction, with the perspective of the semantics-pragmatics interface which explains the links between the contents of what is said and the structure of the interaction. The second approach to modeling interaction described above, and more precisely, SDRT, will thus be focused on. This theory is now well developed as regards discourse in general but has just started to address dialogue specifically. Only a few relevant rhetorical relations have been identified, and their semantics needs to be reconsidered and extended in the light of the ontological studies above. New linguistic investigations will also be carried out in cooperation with linguists, both to yield new insights and to test hypotheses. In particular, several lexical categories will be studied: connectives as evidence of rhetorical relations, attitudinal verbs and adverbs as referring to mental states, as well as the class of verbs explicitly denoting speech acts.

Sub-topics of research and expected results

Corpus linguistics and AI: Corpus-based extraction of terminologies and domain-specific ontologies related to the ways and forms of interaction, social cooperation and organization.

Formal ontology, applied linguistics and AI: Ontology of abstract entities such as propositions, arguments and facts; ontology of mental entities such as mental states and propositional attitudes; ontology of social entities such as commitments and obligations; ontology of occurrents, especially actions (linguistic, epistemic and physical); their position and interaction with more general frameworks such as top-level ontologies and lexical resources.

Formal linguistics and philosophy of language: identification and semantics of dialogue relations in SDRT; lexical semantics of rhetoric markers, attitudinal verbs and adverbs, and verbs describing illocutionary acts; revision and extension of ontological basis of SDRT.

Logic of Action and Knowledge Representation: Semantics of action languages, especially causal or dependency relations between propositions, direct / indirect and primary / secondary effects of actions; semantics of literal or non-literal speech acts (felicity and satisfaction conditions); belief and intention dynamics, especially abandoning or obsolescence of intentions or goals.

Applications

Beyond the intrinsic interest of these theoretical objectives, this research topic is potentially important for many areas of computer science through a variety of applications:

- Multi-agent interaction systems: efficient communication between heterogeneous agents through the use of theoretically compatible interaction systems and general and domain ontologies guaranteeing common understandability of the contents of the messages;
- NLP and HC Interaction: new developments will stem from improved theories of human dialogue
- Semantic web and electronic business: enriching models with ontologies of services, transactions and other communicative or physical actions;
- Information retrieval: extending the range of document annotation with intentions and goals.