WoLLIC 2023 Invited Talks and Tutorials Titles and Abstracts

Thomas Bolander

Invited talk title: From Dynamic Epistemic Logic to Socially Intelligent Robots

Invited talk abstract: Dynamic Epistemic Logic (DEL) can be used as a formalism for agents to represent the mental states of other agents: their beliefs and knowledge, and potentially even their plans and goals. Hence, the logic can be used as a formalism to give agents a Theory of Mind allowing them to take the perspective of other agents. In my research, I have combined DEL with techniques from automated planning in order to describe a theory of what I call Epistemic Planning: planning where agents explicitly reason about the mental states of others. One of the recurring themes is implicit coordination: how to successfully achieve joint goals in decentralised multi-agent systems without prior negotiation or coordination. The talk will first motivate the importance of Theory of Mind reasoning to achieve efficient agent interaction and coordination, will then give a brief introduction to epistemic planning based on DEL, address its (computational) complexity, address issues of implicit coordination and, finally, demonstrate applications of epistemic planning in human-robot collaboration.

Makoto Kanazawa

Invited talk title: Learning Context-Free Grammars from Positive Data and Membership Queries

Invited talk abstract: A key difficulty in learning context-free, as opposed to regular, languages from positive data and membership queries lies in the relationship between the string sets corresponding to the nonterminals of a context-free grammar and the language generated by the grammar. In the case of a regular language, the states of a minimal DFA for the language correspond to the nonempty left quotients of the language. A left quotient of L is a language of the form $u \setminus L = \{ x \mid ux \in L \}$. Whether a string x belongs to $u \setminus L$ can be determined by the membership query "$ux \in L$?". In the case of a context-free language L generated by a context-free grammar G, there seems to be no general recipe for deciding membership in the string set associated with a nonterminal of G using the membership oracle for L.

In this talk, I present some results of recent work (with Ryo Yoshinaka) about learning a special class of context-free grammars whose nonterminals correspond to “relativized extended regular expressions”. These expressions translate into polynomial-time reductions of the membership

problem for nonterminals to the membership problem for the language generated by the grammar. There is a successful learner for this class that use these reductions to test postulated productions for adequacy.

It is an interesting problem to determine the scope of this class of context-free grammars. We have not yet found a context-free language that is not inherently ambiguous that has no grammar in this class. Another intriguing open question is whether extended regular expressions can be restricted to star-free expressions without altering the class of context-free languages that are covered.

Michael Moortgat

Tutorial title: Compositionality: categorial variations on a theme

Tutorial abstract: In the line of work initiated by Richard Montague, natural language syntax and semantics are related by a homomorphism, a structure-preserving map that sends the sorts and operations of a syntactic source algebra to their counterparts in an algebra for composing meanings. In categorial grammar, source and target take the form of deductive systems, logics of syntactic and semantic types respectively. Natural language syntax and semantics often pose conflicting demands on compositional interpretation and different strategies for resolving these conflicts have shaped the development of the field. The tutorial, aimed at researchers with a logic/computer science background, illustrates some of the main design choices: what is the nature of the syntactic calculus - modelling surface form (Lambek) or abstract syntax (Abstract Categorial Grammar); what is the target interpretation - truth-conditional/model-theoretic (formal semantics), or vector spaces/linear maps (distributional semantics); what is the division of labour between lexical and derivational semantics?

Invited talk title: Lambek Calculus and its modal extensions

Invited talk abstract: In this talk, I review the different uses of modalities in extensions of the Lambek calculus and the ensuing challenges for efficient Natural Language Processing.

The Syntactic Calculus, seen as a non-commutative [4] (or also non-associative [5]) precursor of Intuitionistic Linear Logic, is an early representative of substructural logic. With the revival of interest in the Syntactic Calculus came the realization that the original formulation lacked the expressivity required for realistic grammar development. The extended Lambek calculi introduced in the 1990ies enrich the type language with modalities for structural control. These categorial modalities have found two distinct uses. On the one hand, they can act as licenses granting modally marked formulas access to structural operations that by default would not be permitted. On the other hand, modalities can be used to block structural rules that otherwise would be available.

Examples of modalities as licensors relate to various aspects of grammatical resource management: multiplicity, order and structure. As for multiplicity, under the control of modalities limited forms of copying can be introduced in grammar logics that overall are resource-sensitive systems. As for order and structure, modalities may be used to license changes of word order and/or constituent structure that leave the form-meaning correspondence intact. The complementary use of modalities as blocking devices provides the means to seal off phrases as impenetrable locality domains.

Reviewing early results and current work on extensions of the Lambek calculus, one finds two contrasting views on the nature of modalities. One strand of research addresses the licensing type of control taking its inspiration from the '!' exponential of Linear Logic, but introduces sub-exponential refinements providing access to packages of structural rules, see [1] for a recent representative of this approach. Under the alternative view, advocated in [6] and subsequent work, modalities come in residuated pairs (adjoints), unary variants of the residuated triples (product, left and right implications) of the core Syntactic Calculus; the blocking and licensing type of control here share the same logical rules. A reconciliation of these views is suggested by the multi-type approach of [2] who argue on semantic and prooftheoretic grounds that the linear exponential, rather than being treated as a primitive connective, has to be decomposed into a composition of adjoint operations.

The fine-grained type theory of modally enhanced Lambek calculus increases the complexity of Natural Language Processing when it comes to supertagging (assigning words the contextually appropriate type in the light of high lexical type ambiguity) and parsing (associating a string of words with a structural representation that can serve as the scaffolding for semantic interpretation). In the final part of the talk I discuss proposals of [3] that aim to tackle these problems with an integrated neurosymbolic approach.

References

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Magdalena Ortiz

Tutorial title: Description Logics and Other Decidable Logics for Graph-structured Data

Tutorial abstract: In this tutorial we will introduce a few expressive description logics that can be used to describe graph-shaped structures, and see how these logics relate to well-established modal logics such as graded and hybrid modal logics, and variants of propositional dynamic logic (PDL). We will also summarise some computational properties of these logics, particularly the boundaries of decidability and the complexity of basic reasoning services.

Invited talk title: A Short Introduction to SHACL for Logicians

Invited talk abstract: The SHACL Shapes Constraint Language was recommended in 2017 by the W3C for describing constraints on web data (specifically, on RDF graphs) and validating them. At first glance, it may not seem to be a topic for logicians, but as it turns out, SHACL can be approached as a formal logic, and actually quite an interesting one. In this talk, we give a brief introduction to SHACL tailored towards logicians. We discuss how SHACL relates to some well-known modal and description logics, and frame the common uses of SHACL as familiar logic reasoning tasks. This connection allows us to infer some interesting results about SHACL. Finally, we summarise some of our recent work in the SHACL world, aiming to shed light on how ideas, results, and techniques from well-established areas of logic can advance the state-of-the-art in this emerging field.

Aybüke Özgün

Tutorial title: Dempster-Shafer Theory and Topological Models for Evidence

Tutorial abstract: In the short tutorial preceding the invited talk, I will provide a brief introduction to Dempster-Shafer theory of belief functions and topological models for evidence, and motivate the proposed framework combining the two approaches.

Invited talk title: Beliefs based on Conflicting and Uncertain Evidence: Connecting Dempster-Shafer Theory and the Topology of Evidence

Invited talk abstract: One problem to solve in the context of information fusion, decision-making, and other artificial intelligence challenges is to compute justified beliefs based on evidence. In real-life examples, this evidence may be inconsistent, incomplete, or uncertain, making the problem of evidence fusion highly non-trivial. In this talk, I will present a new model for measuring degrees of beliefs based on possibly inconsistent, incomplete, and uncertain evidence, by combining tools from Dempster-Shafer Theory and Topological Models of Evidence. Our belief model is more general than the aforementioned approaches in two important ways: (1) it can reproduce them when appropriate constraints are imposed, and, more

notably, (2) it is flexible enough to compute beliefs according to various standards that represent agents' evidential demands. The latter novelty allows to compute an agent's (possibly) distinct degrees of belief, based on the same evidence, in situations when, e.g, the agent prioritizes avoiding false negatives and when it prioritizes avoiding false positives. Finally, I will discuss further research directions and, time permitting, report on the computational complexity of computing degrees of belief using the proposed belief model.
The main part of the talk is based on joint work with Daira Pinto Prieto and Ronald de Haan. The underlying topological formalism for evidence and belief has been developed in collaboration with Alexandru Baltag, Nick Bezhanishvili, and Sonja Smets.

Dusko Pavlovic

Tutorial title: Prerequisites for the talk on incompleteness of static theories and completeness of dynamic beliefs, in people and in bots

Tutorial abstract: The claim of the main talk is that combining the encodings and self-reference leading to the incompleteness results in static logics and the belief updates in dynamic logics leads to suitable completeness results. But the combined formalism needed to prove this claim may seem unfamiliar. I will use this tutorial to explain how this unfamiliar framework arises from familiar formalisms. (I will also do my best to make it possible to follow both the main talk and the tutorial independently, but the presented research is concerned with self-fulfilling and self-deceiving claims, so it is applicable to itself.)

Invited talk title: From incompleteness of static theories to completeness of dynamic beliefs, in people and in bots

Invited talk abstract: Self-referential statements, referring to their own truth values, have been studied in logic ever since Epimenides. Self-fulfilling prophecies and self-defeating claims, modifying their truth values as they go, have been studied in tragedies and comedies since Sophocles and Aristophanes. In modern times, the methods for steering truth values in marketing and political campaigns have evolved so rapidly that both the logical and the dramatic traditions have been left behind in the dust. In this talk, I will try to provide a logical reconstruction of some of the methods for constructing self-confirming and self-modifying statements.

The reconstruction requires broadening the logical perspective from static deductive theories to dynamic and inductive. While the main ideas are familiar from the theory of computation, the technical prerequisites will also be discussed in the introductory tutorial.

Richard Zach

Invited talk title: The epsilon calculus in non-classical logics: recent results and open questions

Invited talk abstract: The epsilon operator [1,3] is mainly studied in the context of classical logic. It is a term forming operator: if A(x) is a formula, then εxA(x) is a term— intuitively, a witness for A(x) if one exists, but arbitrary otherwise. Its dual τxA(x) is a counterexample to A(x) if one exists. Classically, it can be defined as εx ¬A(x). Epsilon and tau terms allow the classical quantifiers to be defined: ∃x A(x) as A(εx A(x)) and ∀x A(x) as A(τ x A(x)).

Epsilon operators are closely related to Skolem functions, and the fundamental so-called epsilon theorems to Herbrand's theorem. Recent work with Matthias Baaz [2] investigates the proof theory of ετ-calculi in superintuitionistic logics. In contrast to the classical ε-calculus, the addition of ε- and τ-operators to intuitionistic and intermediate logics is not conservative, and the epsilon theorems hold only in special cases. However, it is conservative as far as the propositional fragment is concerned.

Despite these results, the proof theory and semantics of ετ-systems on the basis of non-classical logics remains underexplored.

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