Aybüke Özgün
Yulia Zinova (Eds.)

Language, Logic, and Computation

**13th International Tbilisi Symposium, TbiLLC 2019
Batumi, Georgia, September 16–20, 2019
Revised Selected Papers**

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Preface

The Thirteenth International Tbilisi Symposium on Language, Logic and Computation (TbiLLC 2019) was held during September 16–20, 2019, in Kobuleti, Georgia. The symposium was organized by the Centre for Language, Logic and Speech at the Tbilisi State University, the Georgian Academy of Sciences, the Institute for Logic, Language and Computation (ILLC) of the University of Amsterdam, and the Collaborative Research Center 991 of Heinrich Heine University Düsseldorf. This biennial conference series and the proceedings are representative of the aims of the organizing institutes: to promote the integrated study of logic, information, and language. While the conference is open to contributions from any of the three fields, it aims to foster interaction among them by achieving stronger awareness of developments in the other fields, and of work that embraces more than one field or belongs to the interface between fields.

The scientific program of TbiLLC 2019 consisted of tutorials, invited lectures, contributed talks, and two workshops. The symposium offered two tutorials in language and logic and aimed at students as well as researchers working in the other areas: "Sign language linguistics. State of the art" by Fabian Bross (University of Stuttgart, Germany) and "Axiomatic Semantics" by Graham E. Leigh (University of Gothenburg, Sweden).

Seven invited lectures were delivered at the symposium: four on logic, by Gianluca Grilletti (Munich Center for Mathematical Philosophy, Germany), Philippe Balbiani (CNRS, University of Toulouse, France), Adam Bjorndahl (Carnegie Mellon University, USA), and Alexandru Baltag (University of Amsterdam, the Netherlands), two on language, by Thomas Ede Zimmermann (Goethe University Frankfurt, Germany) and Berit Gehrke (Humboldt University of Berlin, Germany), and one on computation by Libor Barto (Charles University in Prague, Czech Republic).

The workshop on Syntax, Semantics, and Pragmatics of Aspect Across Modalities (SSPAM), organized by Berit Gehrke and Fabian Bross, featured six contributed talks. The workshop on Topology and Modal Logic, organized by Adam Bjorndahl, featured five invited talks.

The contributed talks at the symposium were selected based on peer-reviewed extended abstract submissions. After the symposium, contributed talks, invited lecturers, and tutorial speakers were invited to submit full papers of their presented work for the post-proceedings. This volume contains a selection of papers that went through a rigorous two-stage, single-blind refereeing process during which each paper was reviewed by one to three anonymous referees. The post-symposium paper submissions and reviewing process were entirely organized by the editors of this volume. The papers are listed in alphabetical authorship order and divided into two main groups: Language and Logic, and Logic and Computation. Here we give a brief overview of their contribution.

Nino Amiridze investigates a relatively new development in modern spoken Georgian (Kartvelian) – the truncation of the final vowel in vocative forms of disyllabic nouns. The author considers a similar rule, operating both in some of the Georgian dialects and also in the former contact language Russian and argues between the language-family-internal vs. external contact scenarios, to find out the origin of the new pattern.

Fabian Bross offers a brief overview of linguistic research into sign languages. The target audiences are people with some background in linguistics of spoken languages. Bross briefly introduces sign languages, discusses some basics of phonological structure of these types of languages (including the use of space) as well as some new findings on the syntax of sign languages, and, finally, addresses some methodological issues. The majority of data comes from German Sign Language, although data from other sign languages is also included.

Stergios Chatzikyriakidis and Zhaohui Luo look at the issue of gradability within MTT-semantics. Specifically, they look at both gradable adjectives and nouns and show that the rich typing mechanisms afforded by MTT-semantics can provide us a natural account of gradability. Gradable adjectives take indexed nouns as their arguments, while gradable nouns are Σ-types where their first projection is a degree parameter. Chatzikyriakidis and Luo also look at multidimensional adjectives and use enumerated types to capture the multiple dimensions. They formalize their account in the Coq Proof Assistant and check its formal correctness. They also describe a recent proposal to model gradability by means of subtype universes in MTTs.

Oleg Kapanadze, Gideon Kotzé, and Thomas Hanneforth describe past and present work surrounding the development of treebank-related NLP resources for Georgian. In particular, they provide an overview of efforts made in the development of a morphologically and syntactically annotated treebank, as well as its application in the development of a syntactic parser. Building on this, the authors also report ongoing work in utilizing manual and automatic alignment solutions for the creation of a Georgian/German parallel treebank. The end goal is the development of resources and tools for improved computational processing and linguistic analysis of the Georgian language.

Ralf Naumann and Wiebke Petersen outline a formal framework that combines results from neurolinguistic research on two ERP components, the N400 and the LPP, with formal semantics. At the semantic level they combine de Groote's continuation-based version of Montague semantics with van Eijck's Incremental Dynamics enriched with frames. Naumann and Petersen provide an analysis in terms of complex properties that apply both to the semantic and the discourse level and which combine world knowledge with syntagmatic and paradigmatic relationships.

Sebastian Padó and Daniel Hole are concerned with the phenomenon of function word polysemy. They adopt the framework of distributional semantics, which characterizes word meaning by observing occurrence contexts in large corpora and which is in principle well situated to model polysemy. Although function words were traditionally considered as impossible to model reliably, due to their highly flexible use, Padó and Hole establish that contextualized word embeddings, the most recent generation of distributional methods, offer hope in this regard. Using the German reflexive pronoun *sich* as an example, they find that contextualized word embeddings capture

theoretically motivated word senses for *sich* to the extent to which these senses are mirrored systematically in linguistic usage.

Swantje Tönnis takes a new perspective on *es*-clefts in German, focusing on how an *es*-cleft contributes to the discourse structure and how it does this differently than its canonical counterpart. The provided analysis combines an adapted version of Roberts' (2012) QUD stack and Velleman et al.'s (2012) approach to clefts. In particular, Tönnis presents a model that includes implicit and potential questions into the QUD stack and introduces the concept of expectedness, that she argues is crucial for the acceptability of clefts. Tönnis proposes that the cleft addresses a question that came up in the preceding context but that is not as urgent for the addressee to be answered at that point in the discourse compared to other questions. Those questions that are more urgent are answered with a canonical sentence. This approach is compatible with other functions that have been proposed for clefts, such as marking exhaustivity, maximality, or correction. However, it can also account for examples where the cleft serves to establish discourse coherence.

Thomas Ede Zimmermann scrutinizes the very notion of extension, which is central to many contemporary approaches to natural language semantics. The starting point is a puzzle about the connection between learnability and extensional compositionality, which is frequently made in semantics textbooks: given that extensions are not part of linguistic knowledge, how can their interaction serve as a basis for explaining it? Before the puzzle is resolved by recourse to the set-theoretic nature of intensions, a few clarifying observations on extensions are made, starting from their relation to (and the relation between) reference and truth. Extensions are then characterized as the result of applying a certain heuristic method for deriving contributions to referents and truth-values, which also gives rise to the familiar hierarchy of functional types.

Malte Zimmermann, Lea Fricke, and Edgar Onea present two novel diagnostics for gauging the exhaustivity level of German *wh*-interrogatives embedded under the predicates *wissen* 'know' and *überraschen* 'surprise'. The readings available in combination with the concessive particle combination *SCHON…aber* 'alright…but' and the Q-adverb *teilweise* 'partially' provide evidence that embedded *wh*-interrogatives under veridical and distributive *wissen* 'know' have a weakly exhaustive (WE) reading as their basic semantic interpretation. The logically stronger strongly exhaustive (SE) reading is a pragmatic enrichment that can be cancelled by *SCHON…aber*. Zimmermann, Fricke, and Onea provide an event-based analysis of *know+wh* as expressing the maximal plurality of sub-events of knowing the individual answers to the question. Under the cognitive-emotive attitude verb *überraschen* 'surprise', which is not obligatorily distributive, *wh*-interrogatives allow for two types of WE-interpretations, distributive and non-distributive. The *SCHON…aber*-diagnostic shows the logically stronger distributive WE-reading to be a pragmatic enrichment. In view of experimental evidence that *surprise+wh* allows for SE-interpretations, Zimmermann, Fricke, and Onea provide a tentative analysis of *surprise+wh* as expressing a psychological state caused by a complex situation, or subparts or missing parts thereof.

Bahareh Afshari and Graham E. Leigh prove Lyndon interpolation for the modal μ-calculus, a strengthening of Craig interpolation which is not implied by uniform interpolation. The proof utilises 'cyclic' sequent calculus and provides an algorithmic construction of interpolants from valid implications. This direct approach enables

Afshari and Leigh to derive a correspondence between the shape of interpolants and existence of sequent calculus proofs.

The core of the paper by Philippe Balbiani and Tinko Tinchev is constituted by Chagrova's Theorems about first-order definability of given modal formulas and modal definability of given elementary conditions. Balbiani and Tinchev consider classes of frames for which modal definability is decidable as well as classes of frames for which first-order definability is trivial, and provide a new proof of Chagrova's Theorem about modal definability as well as the sketches of the proofs of new variants of Chagrova's Theorem about modal definability.

Alexandru Baltag, Nick Bezhanishvili, and Saúl Fernández González introduce a multi-agent topological semantics for evidence-based belief and knowledge, which extends the dense interior semantics developed in Baltag, Bezhanishvili, Özgün, and Smets (2016). The authors provide the complete logic of this multi-agent framework together with generic models for a fragment of the language. They also define a new notion of group knowledge which differs conceptually from previous approaches.

In this paper, Dragan Doder, Zoran Ognjanović, Nenad Savić, and Thomas Studer present a logic for reasoning about higher-order upper and lower probabilities of justification formulas. They provide sound and strongly complete axiomatization for the logic and show that the introduced logic generalizes the existing probabilistic justification logic PPJ.

Besik Dundua, Temur Kutsia, and Mikheil Rukhaia define an unranked nominal language, an extension of the nominal language with sequence variables and term tuples. They define the unification problem for unranked nominal terms and present an algorithm solving the unranked nominal unification problem.

Gianluca Grilletti and Davide Emilio Quadrellaro focus on univariate formulae χ, that is, formulae containing at most one atomic proposition. For every such formula, they introduce a lattice of intermediate theories: the lattice of χ-logics. The key idea to define χ-logics is to interpret atomic propositions as fixpoints of the formula χ^2, which can be characterised syntactically using Ruitenburg's Theorem. Grilletti and Quadrellaro show that χ-logics form a lattice, dually isomorphic to a special class of varieties of Heyting algebras. This approach allows the authors to build five distinct lattices—corresponding to the possible fixpoints of univariate formulas—among which the lattice of negative variants of intermediate logics.

Temur Kutsia and Cleo Pau focus on proximity relations: fuzzy binary relations satisfying fuzzy reflexivity and symmetry properties. Tolerance, which is a reflexive and symmetric (and not necessarily transitive) relation, can be also seen as a crisp version of proximity. Kutsia and Pau discuss two fundamental symbolic computation problems for proximity and tolerance relations: matching and anti-unification, present algorithms for solving them, and study properties of those algorithms.

Graham E. Leigh presents a short introduction to the logical analysis of truth and related concepts. He examines which assumptions are implicit in the paradoxes of truth and self-reference, and presents some of the important formal theories of truth that have arisen out of these considerations.

We would like to thank all the authors for their contributions, and the anonymous reviewers for their high-quality reports. We would also like to express our gratitude to

the organizers of the symposium, who made the event an unforgettable experience for all of its participants. The Tbilisi symposia are renowned not only for their high scientific standards, but also for their friendly atmosphere and heartwarming Georgian hospitality, and the 13th symposium was no exception. Finally, we thank the ILLC (University of Amsterdam) and the Department of Computational Linguistics at Heinrich Heine University Düsseldorf for their generous financial support for the symposium.

December 2021   Aybüke Özgün
                                                                         Yulia Zinova

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