New Directions in Reasoning about Belief and Knowledge

Workshop at ILLC, University of Amsterdam

09:00-17:30, June 12, 2018

On the occasion of the two PhD defenses by Malvin Gattinger and Chenwei Shi we will have a workshop at ILLC at the University of Amsterdam.

Date and Time: Tuesday, June 12th 2018, 9:00-17:30

Location: ILLC Common Room F1.21, Science Park 107, Amsterdam

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Programme

09:00 - 09:30	Franz Berto (ILLC, Amsterdam and Department of Philosophy, St Andrews) The Theory of Topic-Sensitive Intentional Modals
09:30 - 10:00	Beishui Liao (Zhejiang University) Reasoning about values, norms and preferences in formal argumentation
10:00 - 10:30	Kaile Su (Jinan University Guangzhou and Griffith University Brisbane) Symbolic Model Checking Real-time Alternating-time Temporal Logic of Knowledge $RTATL^*K$
	(30 minutes coffee and tea break)
11:00 - 11:30	Aybüke Özgün and Ana Lucia Vargas Sandoval (ILLC, University of Amsterdam) APAL with Memory is Better
11:30 - 12:00	Chenwei Shi (ILLC, University of Amsterdam) Evidence-based belief: believing more or believing more consistently?
12:00 - 12:30	Malvin Gattinger (ILLC, University of Amsterdam) Symbolic Dynamic Gossip
	(1.5 hour lunch break)
14:00 - 14:30	Andreas Herzig (CNRS/IRIT, Université Paul Sabatier) Epistemic planning and the epistemic gossip problem
14:30 - 15:00	Davide Grossi (ALICE, Rijksuniversiteit Groningen) On the Graded Acceptability of Arguments
15:00 - 15:30	Yanjing Wang (Department of Philosophy, Peking University) Call Me by Your Name — Epistemic Logic with Assignments and Non-rigid Names
	(30 minutes coffee and tea break)
16:00 - 16:30	Paul Egré (Institut Jean-Nicod, CNRS-EHESS-ENS) Vagueness, Approximation, and the Maxim of Quality
16:30 - 17:00	Hans van Ditmarsch (CNRS/LORIA Nancy and ReLaX Chennai) Asynchronous announcements
17:00 - 17:30	Jan van Eijck (ILLC, University of Amsterdam and CWI, Amsterdam) Truth in Troubled Times

Titles and Abstracts

Franz Berto: The Theory of Topic-Sensitive Intentional Modals

A Topic-Sensitive Intentional Modal (TSIM) is a two-place, variably strict modal with an aboutness or topicality constraint, of the form '$X\phi\psi$' (read: 'Given ϕ, the agent X's that ψ', X being some mental state or act). TSIMs do nice things for mainstream and formal epistemology, belief revision theory, and mental simulation theory. I present a basic formal semantics for TSIMs and explore three readings of '$X\phi\psi$' one gets by imposing different constraints on their truth clauses: (1) as expressing knowability relative to information ('Given total information ϕ, one is in the position to know that ψ'), inspired by Dretske's insight that what one can know depends on the available (empirical) information; (2) as a mental simulation operator ('In mental simulation starting with input ϕ, one imagines that ψ') capturing features of mainstream mental simulation theories, like that of Nichols and Stich; (3) as a hyperintensional belief revision operator ('After (statically) revising by ϕ, one believes that ψ'), reducing the idealization of cognitive agents one finds in doxastic logics and standard AGM. I close by mentioning developments of TSIM theory currently in progress.

Beishui Liao: Reasoning about values, norms and preferences in formal argumentation

In ethical, legal and social artificial intelligence systems, agents are often associated with a set of values and norms. Different agents may have different preference orderings of the values, which in turn determine the orderings of the norms that promote or demote values. In this talk, I will review some formal argumentation-based approaches for reasoning about values, norms and preference, and discuss some further researcher problems.

Kaile Su: Symbolic Model Checking Real-time Alternating-time Temporal Logic of Knowledge $RTATL^*K$

By adding real-time temporal operators to ATL^*, we obtain a new temporal logic called $RTATL^*$, whose expressive power is stronger than any of the temporal logics above. In this talk, I introduce a BDD-based symbolic model checking method for multi-agent systems against $RTATL^*K$ ($RTATL^*$ plus knowledge logic).

Aybüke Özgün and Ana Lucia Vargas Sandoval: APAL with Memory is Better

Arbitrary Public Announcement Logic (APAL) and its relatives are natural extensions of Public Announcement Logic (PAL), involving the addition of operators $\Box\varphi$ and $\Diamond\varphi$, quantifying over public announcements $[\theta]\varphi$ of some given type. These logics are of great interest both philosophically and from the point of view of applications.

Motivations range from supporting an analysis of Fitch's paradox [4] by modeling notions of 'knowability' (expressible as $\Diamond K\phi$), to determining the existence of communication protocols that achieve certain goals (cf. the famous Russian Card problem, given at a mathematical Olympiad [5]), and more generally to epistemic planning [3], and to inductive learnability in empirical science [1]. One problem with the APAL formalism and many of its variants is that they use *infinitary* axiomatizations. It is therefore not guaranteed that the validities of these logics are recursively enumerable.

In this talk, we introduce Arbitrary Public Announcement Logic with Memory (APALM), obtained

by adding to the models a 'memory' of the initial states, representing the information before any communication took place ("the prior"), and adding to the syntax operators that can access this memory. We show that APALM is recursively axiomatizable (in contrast to the original Arbitrary Public Announcement Logic, for which the corresponding question is still open). We present a complete recursive axiomatization, that uses a natural finitary rule. If time permits, we also discuss this logic's expressivity and the appropriate notion of bisimulation.

This is joint work with Alexandru Baltag, presented in [2].

[1] Baltag, A., Gierasimczuk, N., Özgün, A., Vargas-Sandoval, A. L., and Smets, S. (2017) A dynamic logic for learning theory. Dynamic Logic. New Trends and Appl., pp. 35–54, Springer.
[2] Baltag, A., Özgün, A., and Vargas-Sandoval, A. L. (2018) Apal with memory is better. Proc. of the 25th Wollic, to appear.
[3] Bolander, T. and Andersen, M. B. (2011) Epistemic planning for single-and multi-agent systems. Journal of Applied Non-Classical Logics, 21, 9–34.
[4] van Benthem, J. (2004) What one may come to know. Analysis, 64, 95–105.
[5] van Ditmarsch, H. (2003) The russian cards problem. Studia logica, 75, 31–62.

Chenwei Shi: Evidence-based belief: believing more or believing more consistently?

In this talk, I will introduce three notions of evidence-based belief and show some interesting results about the relationship between them. The first notion — justified belief — is firstly proposed in [1] and then topologized by [2]. The second — grounded belief — is proposed in [3]. The difference between these two notions reveals the tension between believing more and believing more consistently. To resolve this tension, we propose the third notion of evidence-based belief — full-support belief [4], which strikes a balance between justified belief (believing more consistently) and grounded belief (believing more).

[1] van Benthem, Johan and Eric Pacuit. 2011. "Dynamic logics of evidence-based beliefs." *Studia Logica: An International Journal for Symbolic Logic* 99(1/3):61– 92.
[2] Baltag, Alexandru, Nick Bezhanishvili, Aybüke Özgün and Sonja Smets. 2016a. Justified belief and the topology of evidence. In *WOLLIC 2016: Logic, Language, Information, and Computation*, ed. Jouko Väänänen, Åsa Hirvonen and Ruy de Queiroz. Springer, Berlin, Heidelberg pp. 83–103.
[3] Shi, Chenwei, Sonja Smets and Fernando R. Velázquez-Quesada. 2017a. "Argument-based belief in topological structures." *Electronic Proceedings in Theoretical Computer Science* 251:489–503. In Proceedings TARK 2017, arXiv: 1707.08762.
[4] Shi, Chenwei, Sonja Smets and Fernando R. Velázquez-Quesada. 2018. Beliefs Based on Evidence and Argumentation. To appear in Proceedings of WOLLIC 2018.

Malvin Gattinger: Symbolic Dynamic Gossip

In the *gossip problem* a group of n agents each initially have one secret. They communicate via one-to-one telephone calls and exchange all secrets they know in each call. We can then ask questions about how long it will take until everyone knows all the secrets, how the agents should decide whom to call, etc. The problem was generalized to *dynamic gossip* in which not everyone can call everyone else, but there is a changing reachability graph. Intuitively, this graph describes who has the phone number of whom and agents also exchange phone numbers in each call.

Explicit model checking of gossip protocols leads to the common state explosion problem: The number of states or possible worlds is exponential in the number of agents and secrets. Moreover, formalizing the effect of telephone calls leads to action models of exponential size as well, see [1].

In this talk based on Section 6.6 of my PhD thesis I will present a *symbolic* description of gossip calls as *transformers* that can encode the exponential action models more succinctly. I will also show how these transformers can be implemented in Haskell and used with SMCDEL.

[1] Maduka Attamah, Hans van Ditmarsch, Davide Grossi, and Wiebe van der Hoek: *Knowledge and Gossip.* In: Proceedings of ECAI 2014. https://doi.org/10.3233/978-1-61499-419-0-21

Andreas Herzig: Epistemic planning and the epistemic gossip problem

The gossip problem, in which information ('secrets') must be shared among a certain number of agents using the minimum number of calls, is not only of interest in the design of communication networks and protocols, but also as a paradigmatic multiagent planning problem. We extend the gossip problem to arbitrary epistemic depths. For example, we may require not only that all agents know all secrets but also that all agents know that all agents know all secrets. We model and study the gossip problem and several of its variants in a simple dynamic epistemic logic that is based on the observation of propositional variables by agents.

This is joint work with Martin Cooper, Faustine Maffre, Frederic Maris and Pierre Regnier.

Davide Grossi: On the Graded Acceptability of Arguments

I will introduce a theory of the degree of justification of arguments, which relies solely on the structure of a Dung argumentation graph. The theory is based on the graded generalization of the two key notions underpinning Dung's solutions for attack graphs: self-defense and conflict-freeness. This leads to a natural generalization of Dung's theory, whereby standard solutions are weakened or strengthened depending on the level of self-defense and conflict-freeness they meet. I will sketch the fixpoint theory of these graded solutions, establishing existence results for them. I will conclude by pointing at interfaces between graded solutions for attack graphs and modal logic.

This is joint work with Sanjay Modgil (King's College London).

Yanjing Wang: Call Me by Your Name: Epistemic Logic with Assignments and Non-rigid Names

In standard epistemic logic, agent names are usually assumed to be common knowledge. This is unreasonable for various applications, in particular in social networks. Inspired by term modal logic and assignment operators in dynamic logic, we introduce a lightweight modal predicate logic whose names are not rigid. The language can handle various *de dicto / de re* distinctions in a natural way. We show the decidability of the logic over arbitrary and reflexive models and give a complete axiomatization over S5 models.

This is joint work with Jeremy Seligman.

Paul Egré: Vagueness, Approximation, and the Maxim of Quality

This talk discusses the ways in which a vague language with approximator expressions might be more optimal than a language with only precise expressions, in situations in which the speaker is facing uncertainty (Williamson 1994, Channel 1994, van Deemter 2009, Frazee & Beaver 2010). The main idea is that vagueness often acts as mechanism of error-reduction, and the main thesis is that it is a way of securing Grice's Maxim of Quality in cooperative exchanges. The talk is based on joint work with S. Verheyen.

Hans van Ditmarsch: Asynchronous Announcements

We propose a multi-agent epistemic logic of asynchronous announcements, where truthful announcements are publicly sent but individually received by agents uncertain about atomic propositions describing the state of the world, and about each other's uncertainty. Additional to epistemic modalities, the logic therefore contains two types of dynamic modalities, namely for sending messages and for receiving messages. The semantics defines truth relative to the current state of reception of messages for all agents, where we assume that messages are received in the order in which they are being sent. What an agent knows is a function of her initial uncertainty and of the messages she has received so far. More precisely: after an announcement an agent knows that a proposition is true, if and only if on condition of the truth of that announcement, the agent knows that after that announcement and after any number of other agents also receiving it, the proposition is true. Knowledge need not be truthful, because some messages that were already sent may not yet have been received by the knowing agent, so that her knowledge may be outdated. Interestingly, messages that are announcements may result in partial synchronization, namely when an agent learns from receiving an announcement that prior announcements must already have been received by other agents.

We show that on multi-agent epistemic models (with arbitrary accessibility relations), each formula in asynchronous announcement logic is equivalent to a formula in basic multi-agent modal logic, and we provide a complete axiomatization, and also on the class of S5 models (for initial uncertainty of agents). We then determine the complexity of model checking and of satisfiability. As is maybe to be expected, your uncertainty about other agents having received messages increases the complexity of the logic in comparison to standard public announcement logic.

This is joint work with Philippe Balbiani. Hans van Ditmarsch is a long-term visitor at ReLaX from January until June 2018. ReLaX is an international joint research unit of CNRS, Université de Bordeaux, École Normale Supérieure Paris-Saclay, Chennai Mathematical Institute and the Institute of Mathematical Sciences. As a CNRS unit, ReLaX is CNRS UMI 2000. It is attached to the INS2I (Institute for Information Sciences). ReLaX was created on January 1, 2017. Its director is Madhavan Mukund. Its deputy director is Pascal Weil.

Jan van Eijck: Truth in Troubled Times

Imagine you are in Las Vegas, and you are in the position to bet on proposition X (say some scandal about Trump). After you have placed your bet on X or on not-X, an oracle is going to reveal, infallibly, whether X is true. If you guessed correctly you receive one million dollars. If your guess was incorrect you get nothing.

This imaginary game will reveal your true belief about X. The thought experiment allows you to find out what is your truth, and it also reveals something important about the connection between truth and action that is commonly overlooked in formal accounts of truth, belief and knowledge. To be truthful, it is not enough to keep to the known facts in what we communicate. Truthfulness is a concept that extends far beyond our words. Truthfulness is about revealing our inner core in our actions.

If there is time, I will also talk about some real life experiences around finding common ground for discussing what is true and what is not. I have had some shocking encounters with believers in conspiracy theories, and I would like to share what I have learned from that. I hope to shed light on what makes some people believe in conspiracies, and on what makes these people suspicious about sources of information that are commonly thought to be reliable (Wikipedia, for instance).

Harry G. Frankfurt, On Truth, Alfred A. Knopf, New York, 2017
Jonathan Haidt, The Righteous Mind, Random House, New York, 2012
Vaclav Havel, Living in Truth, 1986