

Logic in AI

Teachers: Dag Westerståhl, Fenrong Liu, and Jeremy Seligman

Course description

This is a seminar style course. We aim to present recent research in logic that interacts with philosophy, linguistics, social sciences, computer science and AI. Our first topic is the currently much debated issue of the normativity of logic. We will look at a few papers around this topic. Next we consider how generalizations, and in particular generalizations with exceptions, are expressed in natural languages, using tools from generalized quantifier theory. We go on to investigate a few logics and formal models that have been used to study some intriguing phenomena in social networks. Simulations will be presented to illustrate the properties of social networks.

We will invite some guests whose research is relevant to the seminar topics to present their latest ideas.

Students are required to read relevant papers and present part of papers in class, at the end they need to hand in a final paper in English 10-15 pages.

Schedule and topics:

1. 3/02 Logics, logical constants, logical consequence by Dag Westerståhl
2. 3/09 Pre on Steinberger's SEP entry by GUI Haibin (Tsinghua)
3. 3/16: Guest lecture "Logics for visual-epistemic reasoning in multi-agent systems" by Valentin Goranko (Stockholm University)
4. 3/23 Guest lecture: Jin Yuelin's Thesis Backs Tarski's Thesis Up by LIU Xinwen (CASS)
Student Pre on McFralane's paper by YAN Jialiang (CASS)
Student Pre on Russell's paper by CHENG Cheng (Renmin Uni.)
5. 3/30 Generalizations with exceptions by Dag Westerståhl
6. 4/06 Holiday
7. 4/13 Guest lecture "Event types, Mandarin semelfactives and the noun-verb parallel"
by DENG Dun (Tsinghua University)
Guest Lecture "Interpreting generics: how to tolerate with exceptions?" by ZHANG Liying (Central University of Finance and Economics)
8. 4/20 Generalizations with exceptions
9. 4/27 Guest lecture by Johan van Benthem (Stanford and Amsterdam)
10. 5/04 Holiday
11. 5/11 Special Session on Logic and Games:
1:30-3:00 Olivier Roy (University of Bayreuth)
3:10-4:40 Adam Brandenburger (New York University)
12. 5/18 Intro to Hybrid logic by Jeremy Seligman
13. 5/25 Hybrid logic student pre
14. 6/01 Hybrid logic by Jeremy Seligman
15. 6/08 Hybrid logic student pre
16. 6/15 Hybrid logic by Jeremy Seligman

Appendix:

Guest Lecture: Deontic Logic and Game Theory

by Olivier Roy (Professor, University of Bayreuth)

Abstract: What is the logical structure of rational recommendations in strategic interaction? After clarifying and motivating that question, I will provide a critical survey of the existing literature on the topic, and argue for one specific approach that defines obligation and permissions, respectively, in terms of necessary and sufficient conditions for rationality.

Guest Lecture: Epistemic Game Theory

By Adam Brandenburger (J.P. Valles Professor, NYU Stern School of Business)

Abstract: For John von Neumann, who founded game theory in 1928, the fundamental question in a game was how a player should choose a strategy without knowing what strategies other players choose. His answer was his maximin ("protective") decision criterion, which gives a player the highest possible payoff independent of other players' choices. In his famous 1951 work, John Nash took a very different approach. His concept of equilibrium effectively assumes that each player in a game actually does know the strategies adopted by the other players, and each player chooses an optimal strategy in light of this information. Epistemic game theory restores von Neumann's starting point, but then proceeds differently. In this new approach, players make predictions rather than choose protectively. A game model now includes a structure that talks about what each player thinks the other players' strategies are, what each player thinks other players think the strategies are, and so on to higher-order thinking about thinking. This richer language of interaction offers the promise that findings from the cognitive sciences (psychology and neuroscience, in particular) can now be injected into game theory, to help the field advance from principle-based to fact-based analysis of games. In this talk, I will go through this story, using some material from my book *The Language of Game Theory: Putting Epistemics into the Mathematics of Games* (World Scientific, 2014).

Guest lecture: Event types, Mandarin semelfactives and the noun-verb parallel

by 邓盾 DENG Dun (Tsinghua University)

Abstract: Vendler (1967) proposes a quadripartite classification of eventualities, namely states, activities, accomplishments and achievements, using three parameters: whether the eventuality is dynamic (states are not), telic (activities are not) and instantaneous (accomplishments are not). Given its linguistic relevance, linguists have been investigating morphological, syntactic, semantic as well as pragmatic issues regarding the "Vendler classes". In this talk, I rely on data from Mandarin to discuss two closely related and controversial issues. I will show that a special type of functional words, namely so called "verbal classifiers" (cf. Zhu 1982), can help to pick out a class of verbs whose denotation is different from all the four Vendlerian types. I argue that this class of Mandarin verbs corresponds to what Smith (1991) calls "semelfactives", which have overt morphological marking in Slavic languages like Russian. Drawing on evidence from Mandarin semelfactives and also facts about verb reduplication, I defend and revise Bach's (1981) classic proposal that the mass-count distinction in the nominal domain is parallel to the atelic-telic distinction in the verbal domain, contra Rothstein's (2008) claim.

Guest lecture: Interpreting generics: how to tolerate with exceptions?

By 张立英 ZHANG Liying (Central University of Finance and Economics)

Abstract: Generic sentences, such as 'birds fly', 'ducks lay eggs', express rules or laws. Unlike universal sentences, generic sentences tolerate exceptions. Even when there is no positive example in the real world (for example, 'unicorns have one horn'), we sometimes accept a generic sentence, which makes generic sentences intensional. This talk will introduce some classic theories on generics such as stereotype theory, rule-based theories (default logic, autoepistemic reasoning), relevant quantification, circumscription, prototype theory, modal conditional approaches, double normal

semantics, sense semantics and probability approach. After that, we will discuss the way we tolerate with exceptions.

Guest lecture: Jin Yuelin's Thesis Backs Tarski's Thesis Up

by 刘新文LIU Xinwen (CASS)

Abstract: Jin's Thesis about the essence of logic in 1927 would back up Tarski's Thesis about logical notions in 1986 which lacks a metaphysical defense before.

Guest lecture "Logics for visual-epistemic reasoning in multi-agent systems"

by Valentin Goranko (Stockholm University)

Abstract: In this talk I will discuss logic-based reasoning evolving from the interaction between knowledge and visual information that agents receive and process. In particular, I will present a formal logical framework for multi-agent visual-epistemic reasoning, where each agent receives visual information from the environment via mobile camera with a given angle of vision in the plane. The agents can thus observe their surroundings and each other and can reason about each other's observation abilities and knowledge derived from these observations. I will introduce suitable logical languages for formalising such reasoning, involving atomic formulae stating what agents can see, multi-agent epistemic operators, as well as dynamic operators reflecting the ability of agents (or, their cameras) to move and turn around. I will then introduce several different types of models for these languages and will discuss their expressiveness and axiomatisation problems, and how they interact with the underlying geometric constraints and assumptions. At the end I will state some technical results and open problems.

This talk is based on a joint work with Olivier Gasquet (Univ. Paul Sabatier, IRIT, Toulouse) and Francois Schwarzentruher (ENS Rennes).

Reading materials for the topic "normativity of logics"

- (1) Florian Steinberger, The normative status of logic, Stanford Encyclopedia of Philosophy, 2016.
- (2) John McFarlane, In which sense (if any) is logic normative?, 2004.
- (3) Gillian Russell, Logic isn't normative, Inquiry, 2017

Reading materials for the topic "generalization with exceptions"

- (1) Dag Westerstahl, entry on GQs in the Stanford Encyclopedia <https://plato.stanford.edu/entries/generalized-quantifiers/>
- (2) Stanley Peters and Dag Westerstahl, Making exceptions (DRAFT paper)