Codes:	BBN-FIL-401.77, BMA-FILD-401.77, BMA-LOTD-311.03, BMI-LOTD-311E.03
Course:	The many faces of modal logic
Teacher:	Attila Molnár
Location and time:	I/221, Wed, 13:30 – 15:00
Consultation:	Wed, 12:00 – 13:30, molnar.h.attila@gmail.com, phil.elte.hu/attila
First occasion:	10/02/2016, 13:30 – 15:00

Courses required:	Logic seminar and lecture
Asessments:	Homeworks

Description:

This introductory course on modal logic focuses on the applications of modalities in various fields of philosophical logic. This course can also be viewed as an introduction to non-classical logics where all the discussed logics share two common features: the contamination of classical logic and the usage of some intensional sentence operator called modality. The semantics of our logics will be given by possible worlds: A modal model is a collection of classical models with an additional element that forms a structure from the isolated classical models; an accessibility relation, a topological neighbourhood function, a probability measure, etc.

In general, the three most important properties of a logic are the expressive power, completeness/axiomatizability and decidability. These are usually works against each other: second-order logic is extremely expressive but lacks axiomatizability, first-order (predicate) logic is expressive and axiomatizable but not decidable, and zero-order (propositional) logic has a very limited expressive power but it is decidable. Modal logic can be viewed as an attempt to strengthen the expressive power of zero-order logic by introducing predicate variables (tools of second order logic) but keeping the axiomatization or decidability properties via some philosophically appealing limitations (e.g. the internal perspective of modal logic, the ability to change the state in the object language, etc.).

In this course, our first goal is to give a general introduction into the expressive power and the 'mechanics' of the discussed logics. Our second goal is to give a practical (or mathematical) introduction to the students on how to axiomatize different logics or how to prove that no axiomatization can be done.

Schedule:

(the first four introductory occasions are detailed to help those who have some previous experiences in the topics.)

- Basics
  - 1–2: zero-, first- and second-order classical logics. Generalized/Henkin-style second-order models. Second-order models as (non-axiomatizable) subclasses of first-order models, axiomatizability of zero-and first-order logic.
  - 2–4: Introduction into modal logics: Language, Kripke style semantics. Standard translation. Definable first- and second-order properties. Undefinable properties, validity-preserving model-transformations. Standard alethic systems (K, K4, S4, T, B, S5). Completeness theorems, canonical formulas. Decidability.
- More tools for relational semantics:
  - 5–6: Logic of time: Deterministic and indeterministic temporal logics.
  - 7: Referring to the states: Hybrid logics.
  - 8: Logic of programs and change: Dynamic logics.
  - 9: Knowledge representation: Description and epistemic logics.
- Beyond relational semantics:
  - 10: Logic of Probability: Probabilistic logic.
  - 11: Logic of Space: Topological (neighbourhood-) semantics.
  - 12: Generalizing relational semantics: Scott-Montague (neighbourhood-) semantics.
  - 13: The big one: First-order modal logics.

The numbers approximate the occasion on which we will discuss the topic, for more details contact the lecturer.

References

P. Blackburn, M. de Rijke, and Y. Venema. *Modal Logic*. Cambridge University Press, New York, NY, USA, 2001. ISBN 0-521-80200-8.

P. Blackburn, J. F. A. K. v. Benthem, and F. Wolter. *Handbook of Modal Logic, Volume 3 (Studies in Logic and Practical Reasoning)*. Elsevier Science Inc., New York, NY, USA, 2006. ISBN 0444516905.

B. Chellas. *Modal Logic: An Introduction*. Cambridge University Press, 1980. ISBN 9780521295154.

D. Gabbay, I. Hodkinson, and M. Reynolds. *Temporal Logic (Vol. 1): Mathematical Foundations and Computational Aspects*. Oxford University Press, Inc., New York, NY, USA, 1994. ISBN 0-19-853769-7.

R. Goldblatt. *Quantifiers, Propositions and Identity*. Cambridge University Press, 2011.

R. Goldblatt. The countable henkin principle. In M. Manzano, I. Sain, and E. Alonso, editors, *The Life and Work of Leon Henkin*, Studies in Universal Logic, pages 179–201. Springer International Publishing, 2014. ISBN 978-3-319-09718-3. doi: 10.1007/978-3-319-09719-0_13.

J. van Benthem. *Logical Dynamics of Information and Interaction*. Cambridge University Press, New York, NY, USA, 2014. ISBN 1107417171, 9781107417175.