Advanced Topics in Logic

Hanoch Ben-Yami

2017–18 Winter Term

No. of Credits: 2. No. of ECTS credits: 4

Time-Period of the Course: one semester

Course Level: Elective

## Description

The course is divided into two parts: (i) the truth-valuational approach to logic; (ii) the quantified argument calculus.

(i) The standard semantics for Predicate Logic and other formal systems is model-theoretic, using domains and interpretation functions to explain when a sentence is true, and with this theory of truth define validity and prove various properties of the calculus, primarily soundness and completeness (“adequacy”). We shall criticise this semantics, claiming that its concepts of object and of reference are empty. We shall then replace it with a truth-valuational substitutional approach, which does away with models. Like the truth-table approach in propositional logic, the truth-valuational approach is a theory of truth-value relations between sentences and not a theory of truth. We shall prove the adequacy of the first order predicate calculus on the truth-valuational approach. We shall next apply this approach to modal logic and prove the adequacy of modal propositional logic without any recourse to possible worlds. We shall also see how the logical contingency of identity is justified on this approach. Our conclusions will be, among other things, that models (in the sense of Model Theory) and possible worlds can be eliminated from logic

(ii) Frege’s logic allots the role of logical subject term or argument only to singular terms, and in this way departs from Natural Language, in which quantified arguments also occupy that role. By contrast to Natural Language, Frege introduced quantification into his calculus as a sentential operator. We shall follow Natural Language in having the quantifier join a one-place predicate to form a quantified argument. This departure has far-reaching consequences, which we shall pursue. We shall develop a formal system which is closer in many respects to Aristotle’s logic than to Frege’s, the Quantified Argument Calculus (Quarc). It will incorporate elements analogous to Natural Language’s negative predication, converse relation terms, anaphora, and more. We shall also develop a deductive system which we shall prove to be adequate. We shall then apply the system to modal logic, show how it incorporates a *de dicto – de re* distinction, how it invalidates the Barcan formulas, and more. We shall also consider extensions of the system to three-valued logic, plural logic, incorporation of the ‘there is’ structure, and more; much of this is work-in-progress. A conclusion shall be that this system should replace the Predicate Calculus as a tool for representing and studying the logic of Natural Language.

## Breakdown into units

Weeks 1-5: Part (i)

Weeks 6-12: Part (ii)

## Course requirements

Attendance, readings and participation in discussion. A few written assignments – logic exercises – will be given during the course, with a Pass/Fail grade.

## Assessment

Term paper of approximately 2500 words (students should consult me about the paper’s subject)

## Course Goals

Thorough familiarity with the truth-valuational substitutional approach, which is an important alternative, logically and philosophically, to model-theoretic semantics. Familiarity with Quarc, an alternative to Predicate Logic which is closer to the logic of Natural Language and contributes to the clarification of several logic concepts.

## Learning outcomes

Apart from the course goals, the students will acquire improved competence in formal logic, knowledge of the history of logic, and a deeper understanding of some of the logic issues that have occupied contemporary philosophy.

## Readings

For Part (i):

Ben-Yami, H. Unpublished. Truth and Proof without Models.

Dunn, J. Michael and Belnap, Nuel D. 1968. The Substitution Interpretation of the Quantifiers. *Noûs* 2: 177-185.

Henkin, Leon. 1949. The Completeness of the First-Order Functional Calculus. *Journal of Symbolic Logic* 14: 159-166.

LeBlanc, Hugues. 1983. Alternatives to Standard First-order Semantics. In D. M. Gabbay and F. Guenthner (eds.). *Handbook of Philosophical Logic, Vol. I*. Reidel, Dordrecht: 189-274.

For Part (ii):

Ben-Yami, H. 2004. *Logic & Natural Language: On Plural Reference and Its Semantic and Logical Signifcance*. Ashgate, Aldershot.

Ben-Yami, H. 2014. The Quantified Argument Calculus. *Review of Symbolic Logic* 7(1): 120-146, doi: 10.1017/S1755020313000373.

Ben-Yami, H and Pavlovic, E. Unpublished. The Completeness of the Quantified Argument Calculus.

Francez, N. 2014. A Logic Inspired by Natural Language: Quantifiers as Subnectors. *Journal of Philosophical Logic*, doi: 10.1007/s10992-014-9312-z

Frege, G. 1879. *Begriffsschrift: Eine der Arithmetischen nachgebildete Formelsprache des reinen Denkens*. Verlag von Louis Nebert, Halle A/S.

Geach, P. T. 1962. *Reference and Generality: An Examination of Some Medieval and Modern Theories*, emended edition 1968, Cornell University Press.

Lanzet, R. 2017. A three-valued quantified argument calculus: Domain-free model-theory, completeness, and embedding of FOL. *The Review of Symbolic Logic* (2017), 1–34.

Linnebo, Ø. Plural Quantification. *Stanford Encyclopaedia of Philosophy*. <http://plato.stanford.edu/entries/plural-quant/>.

Pavlovic, E. *The Quantified Argument Calculus: An Inquiry into its Logical Properties and Applications*. PhD thesis, Central European University, Budapest, 2017.

Pavlovic, E., and Gratzl, N. Proof-theoretic analysis of the quantified argument calculus. Submitted for Review, 2016.

Raab, J. Aristotle, logic, and Quarc. Submitted for Review, 2017.