Core Logic

1st Semester 2004/2005, period a & b

Dr Benedikt Löwe

Course Webpage.

`http://staff.science.uva.nl/~bloewe/`
`2004-I-CL.html`

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Goals of the course.

- Create a common ground for all Logic students (both academically and socially).

- Give an overview of where logic comes from and what it is, with a particular emphasis on ILLC-style logic.

Two main components of the course.

- *Core Logic Lectures.* (Wednesday 13-15)
  Provide a historical overview and surveys of particular research areas. Accompanied by homework exercises.

- *Core Logic Colloquium.* (Wednesday 15-17)
  Guest lectures connected to the material presented in the *Core Logic Lectures* give some deeper insight and/or a different viewpoint.

In weeks without a *Core Logic Colloquium*, the *Core Logic Lectures* will take over (part of) the time slot Wednesday 15-17.

Course syllabus.

September 8

Lecture   Introduction

September 15

Lecture   Origins of logic: Greek mathematics (Euclid) and Greek disputations. The Square of Oppositions. Aristotelian syllogistics.

Colloquium   *Jeroen Bons* (Utrecht), The History of Rhetoric

September 22

Lecture   More on syllogistics. Aristotelian Modal Logic. Stoic and Megarian Logic. Boëthius.

Course syllabus (2).

September 29

Lecture

The medieval university system. Trivium and Quadrivium. Peter Abelard. The recovery of ancient Greek texts.

Colloquium

Stephan Meier-Oeser (Berlin), The history of philosophy of language.

October 6

Lecture

Logic in the late middle ages (XIIIth and XIVth century). Some game-theoretic interpretations of logic: Dialogic logic.

Course syllabus (3).

October 13

Lecture   *Obligationes*.

Colloquium   *Jaap Maat* (Amsterdam), Logic from the XVIth to the XVIIIth century.

October 20

Lecture   Renaissance, Humanism, and Leibniz ("*calculemus*").   Boolean algebras as mathematizations of reasoning.

October 27   **No classes (EXAM WEEK).**

Course syllabus (4).

November 3

Lecture

Algebraic approaches to logic in the XIXth century. The birth of modern logic. First-order logic.

November 10

Lecture

Foundations of Mathematics. The *Grundlagenkrise der Mathematik*.

Colloquium

Yde Venema (Amsterdam), Algebraic Logic.

Course syllabus (5).

November 17

Lecture

Mathematical Logic in the XXth century: Gödel's completeness and incompleteness theorems. The classical division into the four large areas Model Theory, Proof Theory, Recursion Theory and Set Theory, important problems and their solutions.

Colloquium

Anne Troelstra (Amsterdam), Constructivism.

Course syllabus (6).

November 24

Lecture
Computability: Turing and the Halting Problem. Theoretical Computer Science and Complexity Theory.

Colloquium
Leen Torenvliet (Amsterdam), Mathematical Logic and its relation to the $\mathbf{P} = \mathbf{NP}$ problem.

December 1

Lecture
The modern view of modal logic: Kripke models and frames. Possible worlds.

Colloquium
Thomas Müller (Oxford), Temporal logic.

Course syllabus (7).

December 8

Lecture   Completeness. Representation Theorems. Cylindric Algebras.

Colloquium   *Johan van Benthem* (Amsterdam), Applications of Logic I.

December 15

Lecture   Applications of Logic in Computer Science and Computational Linguistics.

Colloquium   *N.N.*, Applications of Logic II.

December 22   **No classes (EXAM WEEK).**

Nine Guest Lectures.

Sep 15	*Jeroen Bons*	The History of Rhetoric.
Sep 29	*Stephan Meier-Oeser*	The history of philosophy of language.
Oct 13	*Jaap Maat*	Logic from the XVIth to the XVIIIth century.
Nov 10	*Yde Venema*	Algebraic Logic.
Nov 17	*Anne Troelstra*	Constructivism.
Nov 24	*Leen Torenvliet*	Mathematical Logic and its relation to the $\mathbf{P} = \mathbf{NP}$ problem.
Dec 1	*Thomas Müller*	Temporal logic.
Dec 8	*Johan van Benthem*	Applications of Logic I.
Dec 15	*N.N.*	Applications of Logic II.

Grading.

13 homework sheets (25 each):   325 points

Three *Colloquium* summaries (50 each):   150 points

TOTAL: 475 points

You can submit as many *Colloquium* summaries as you want – the best three will count. A summary has between 100 and 200 words.

The deadline for the homework sheets and the summaries is **Wednesday 13:00**, one week after the homework was handed out or one week after the guest lecture.

What is logic?

Classification of Sciences

- Historical background

- Some philosophical problems

- Six approaches to classify sciences (where can we subsume logic according to them?)

A linguistic/cultural *caveat.*

- **Science** is neither ***wetenschap*** nor ***Wissenschaft***.

- Similarly, **humanities** are sometimes neither ***geesteswetenschappen*** nor ***Geisteswissenschaften***.

- Some people think that ***Sozialwissenschaften*** is a much broader term than **Social Sciences**.

A point on terminology. In the Dutch language, the term '*wetenschappen*' covers both the sciences and the humanities, and the term 'science' is used in this broad sense in this essay. Do not just think of physicists tending to large machines, or sociologists waving questionnaires, but also of that philosopher pondering the notion of rational discourse, or that lonely scholar of early Coptic manuscripts!

Johan van Benthem

A history of classification (1).

- Plato, Aristotle, the medieval university system.

- Hugh of St.Victor (d. 1142)
  omnia disce, videbis postea nihil esse superfluum

- Renaissance encyclopedias, *e.g.*, Giorgio Valla (1447-1500), *De expetendis et fugiendis rebus* or Francis Bacon (1561-1626), *De dignitate et augmentis scientiarum*.

- Modern classification systems started to be investigated in the times of the great modern encyclopedias: Denis Diderot (1713-1784) and Jean Le Rond d'Alembert (1717-1783), *Encyclopédie ou Dictionnaire Raisonné des sciences, des artes et des métiers*.

A history of classification (2).

- Georg Wilhelm Friedrich Hegel (1770-1831)

- André Marie Ampère (1775-1836)

- Jacques-Charles Brunet (1780-1867)

- Arthur Schopenhauer (1788-1860)

- Auguste Comte (1798-1857)

- Antoine Augustin Cournot (1801-1877)

- Herbert Spencer (1820-1903)

- Hermann Ludwig Ferdinand von Helmholtz (1821-1894)

- Wilhelm Wundt (1832-1920)

- Wilhelm Dilthey (1833-1911)

- Charles S. Peirce (1839-1914)

- Wilhelm Ostwald (1853-1932)

- Paul Tillich (1886-1965)

Historical types of classification.

- **Hierarchical**
  - from the simple to the complex (Comte)
  - from the pure to the applied (Peirce)
  - from the abstract to the concrete (Spencer)
- **Historical** (Brunet)
- **Structural**
  - objective / subjective (Whittaker, 1926)
  - cosmological / of the mind (Ampère, 1834)
  - empirical *a posteriori* / pure *a priori* (German idealism)
  - real / formal (Wundt)
  - ideal / real / normative (Tillich)
  - Discovery / Review / Practical (Peirce)
  - laws / facts / rules (Naville, 1920)
- **Interdependence** (Piaget; Bruner's *spiral curriculum*).

A serious philosophical problem.

Realism vs Idealism.

- *Realism.* *There is a reality outside of the human mind.*

- *Idealism.* *The only real things are perceptions.*
  Esse est percipi. (Bishop Berkeley, 1685-1753)

Advantages/Disadvantages.

- Ockham's razor: *Entia non sunt multiplicanda sine necessitate.*

- The coat in the cupboard.

Classifications (1).

- *Classification I.* **According to subject matter: ontological.**

  - "real" vs "in the mind"

  - physical objects, beings, subjects, institutions, abstract objects, etc.

- *Classification II.* **According to subject matter: status of theoretical statements.**

  - objective vs subjective

- *Classification III.* **Epistemology of theoretical statements.**

  - *a priori* vs *a posteriori*

Classification (2).

- *Classification IV.* **Pragmatical.**

  - Research organization
  - Funding
    - personnel costs / material costs
    - funding sources

- *Classification V.* **Sociological.**

  - community feeling

  - institutional organization / embedding

- *Classification VI.* **Historical.**

  - Brunet 1865