

Core Logic

1st Semester 2005/2006, period a & b

Dr Benedikt Löwe

Course Webpage.

`http://staff.science.uva.nl/~bloewe/
2005-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.* (Tuesday 14-16)
Provide a historical overview and surveys of particular research areas. Accompanied by homework exercises.
- *Core Logic Colloquium.* (Tuesday 16-17)
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* may take over (part of) the time slot Tuesday 16-17.

Course syllabus (1).

September 6

Lecture Introduction

September 13

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

Colloquium TBA

September 20

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

Colloquium TBA

Course syllabus (2).

September 27

Lecture

The medieval university system. Trivium and Quadrivium. Peter Abelard.

Colloquium

Marian Counihan (Amsterdam), Logic meets psychology.

October 4

Lecture

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

Colloquium

Wolfram Hinzen (Amsterdam), Philosophy of Language and Mind.

Course syllabus (3).

October 11

Lecture Termistic Logic. Insolubles. *Obligationes*.

Colloquium

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

October 18

Lecture

The great changes between 1450 and 1550. Leibniz (“*calculus*”). De Morgan. Boole. Boolean algebras as mathematizations of reasoning.

Colloquium

TBA

October 25

No classes (EXAM WEEK).

Course syllabus (4).

November 1

Lecture

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

Colloquium

Eric Pacuit (Amsterdam), Games, Puzzles, Logic.

November 8

Lecture

Foundations of Mathematics. The *Grundlagenkrise der Mathematik*.

Colloquium

TBA

November 17

Lecture

Axiomatization of Set Theory. Polish Mathematics. Computability: Turing and the Halting Problem. The Church-Turing Thesis.

Colloquium

TBA

Course syllabus (5).

November 22

Lecture

Recursion Theory. Independence Results in Set Theory. Proof Theory. Tarski. Model Theory.

Colloquium

TBA

November 29

Lecture

The modern view of modal logic: Kripke models and frames. Application of Modal Logic.

Colloquium

TBA

Course syllabus (6).

December 6 **Class cancelled.**

December 13

Lecture

An overview of recent developments in mathematical logic. Theories and formalisms for truth.

Colloquium

TBA

December 20 **No classes (EXAM WEEK).**

Grading.

12 homework sheets (22 each):	264 points
Three <i>Colloquium</i> summaries (30 each):	90 points
TOTAL:	354 points

You can submit as many *Colloquium* summaries as you want – the best three will count. A summary has between 100 and 200 words. Check the course webpage for guidelines of how to write summaries.

The deadline for the homework sheets and the summaries is **Tuesday 14:00**, one week after the homework was handed out or one week after the guest lecture. You hand in by e-mail to `sbold@science.uva.nl`, before the lecture or to the mailbox **S. Bold** in Euclides.

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)
- **Structural**
 - objective / subjective (Whittaker, 1926)
 - empirical *a posteriori* / pure *a priori* (German idealism)
 - real / formal (Wundt)
 - ideal / real / normative (Tillich)
 - Discovery / Review / Practical (Peirce)
 - laws / facts / rules (Neville, 1920)
- **Historical** (Brunet)
- **Interdependence** (Piaget; Bruner's *spiral curriculum*).

An example (Peirce; 1889/1903).

Peirce's classification system (due to Tommi Vehkavaara)

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

The ILLC (1).

Institute for Logic, Language and Computation.

- Early beginnings: *Instituut voor Taal, Logica en Informatie* (ITLI), 1986.
- Established in 1991.

The ILLC (2).

Mission Statement. Many broad flows of information drive the modern technological world. It is a challenge for contemporary science to provide a deeper understanding, and where possible, enhance existing practice. Indeed, in the course of this century, information has become a crucial theme for scientific studies across many disciplines. Encoding, transmission and comprehension of information are the central topics of research at the ILLC. The broader context in which ILLC sees itself is that of an upcoming information science or 'informatics', which is concerned with information flow in natural and formal languages, as well as many other means of communication, including music and images of various kinds.

Research at ILLC aims at developing logical systems that can handle this rich variety of information, making use of insights across such disciplines as linguistics, computer science, cognitive science, and artificial intelligence. Additional methods are actively pursued as well, whenever relevant, ranging from statistics to argumentation theory. The ILLC aims at overcoming traditional borderlines between faculties and disciplines, and serves as a rallying point for information scientists across computer science, linguistics, philosophy, or social sciences. Moreover, the institute propagates exact logical standards of semantic clarity, algorithmic perspicuity, and increasingly also efficient computability.

The resulting view of information science transcends the boundaries of the university. ILLC is also committed to dissemination of its results into the broader world of general education, vocational training, and industrial research.

The ILLC (3).

Research Groups (“Projects”).

- *Theory of Interpretation.*
- *Cognitive Systems and Information Processing.*
- *Constructive and Intensional Logic.*
- *Algorithmics and Complexity Theory.*

ILLC Groups.

- *Theory of Interpretation.*

Paul Dekker, Jeroen Groenendijk, Theo Janssen, Jaap Maat, Robert van Rooij, Martin Stokhof

- *Cognitive Systems and Information Processing.*

Reinhard Blutner, Rens Bod, Wolfram Hinzen, Henkjan Honing, Michiel van Lambalgen, Remko Scha, Khalil Sima'an, Frank Veltman, Henk Zeevat

- *Constructive and Intensional Logic.*

Johan van Benthem, Dick de Jongh, Benedikt Löwe, Eric Pacuit, Anne Troelstra, Yde Venema

- *Algorithmics and Complexity Theory.*

Krzysztof Apt, Harry Buhrman, Peter van Emde Boas, Leen Torenvliet, Paul Vitanyi