



Logic for Computer Science. Knowledge Representation and Reasoning.

Lecture Notes
for
Computer Science Students
Faculty EAIIB-IEiT AGH



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Other support material:

<http://home.agh.edu.pl/~ligeza>

<https://ai.ia.agh.edu.pl/pl:dydaktyka:logic:start>

Podstawowe zasady

Serdecznie witam!

Dziękuję za wybór Informatyki na AGH! I gratuluję!

Dziękuję za rejestrację na kurs i udział w wykładach oraz ćwiczeniach!

1. Zapraszam na wykłady – obecność nie jest obowiązkowa – ale **wskazana – usilnie pożądana**,
2. Zapraszam do aktywnego udziału w wykładzie,
3. Pytania – tak!
4. Generalnie nie wyrażam zgody na nagrywanie (wyjaśnienie na wykładzie),
5. Materiały .pdf są udostępniane (przed lub po wykładzie).
6. Wykłady są dokumentowane na stronie
<https://ai.ia.agh.edu.pl/pl:dydaktyka:logic:start>
7. Problemy – proszę zgłaszać na bieżąco, najlepiej z wyprzedzeniem, postaram się pomóc...

Logic: Let us start thinking...

Where are we/you?

<https://www.youtube.com/watch?v=eBLJ7oixbOI>

Logic: Direct correct proof:

<https://www.youtube.com/watch?v=YFZzLQN5qOU>

Logic: Proof by contradiction

<https://www.youtube.com/watch?v=sRDwsfNDXak>

Let us prove that $2+2=5$

<https://www.youtube.com/watch?v=Cpug-FCZjhU>

Let us prove that $3=0$

<https://www.youtube.com/watch?v=SGUZ-8u10xM>

Basic Ideas behind this Course

Goals of the course:


- to teach selected methods of Logical Knowledge Representation,
- to teach selected methods of Logical Inference,
- with the focus on Propositional Logic Calculus, and also
- First Order Predicate Logic,
- with the ultimate sub-goals:
 - building logical models (KR),
 - performing logical reasoning (AR),
 - automated problem solving (APS),
 - analysis of logical properties (LPA).


$$\text{KR} + \text{AR} \longrightarrow \text{APS} + \text{LPA}$$

- to keep the course at understandable basic level and practical applications rather than just theory:
 - necessary background knowledge — but also in an informal way,
 - modern tools — if available,
 - examples + applications,
 - further references; internet sources.
- a reference point: CS157: <http://logic.stanford.edu/classes/cs157/current/>

General Principles

Warning: This presented course support material is not error-free. Everybody using these texts must do it with full comprehension and on his/her own responsibility.

!!!  !!! – identifies (some) pages where **fake info** is presented **on purpose**. Further explanation – during the lecture. If you are not present on the lecture – try to identify the fake info – and further think, why it was put there...

!?!  !?! – identifies (some) pages where a trick is hidden or a tricky problem is asked to be solved; be aware that you should locate the problem and know how to solve it! Again, if not present on the lecture – do it by yourself...

1. **Goal:** to learn some knowledge and practical skills in **logic**.
2. Syllabus: see <https://syllabusy.agh.edu.pl/pl>
3. Formal frames: Regulamin Studiów w AGH¹, but also **logic** and **reasonable, common sense approach**.
4. Example of particular practical rules GEIST: <http://geist.agh.edu.pl/pub:teaching:gris>
5. Forms of work and **knowledge acquisition**:
 - lecture,
 - blackboard exercises,
 - *e-learning* (Wikipedia, Coursera,...),
 - **personal, independent study**,

¹<http://http://www.agh.edu.pl/pracownicy/dokumenty/regulaminy/>

- discussion, questions and possible answers,
 - consultations.
6. Participation in practical classes is obligatory.
 7. Personal attendance and *mindfulness* (*uwaga*) at/during the lectures is **strongly recommended**.
 8. A large dose of Enthusiasm, additional activity – supported by personal skills are welcome.
 9. **It is strongly recommended** to take personal notes.
 10. Everybody builds her/his own **Logical Knowledge Base!**
 11. **Full understanding of the material** is of principal importance!
 12. You can ask questions – any time and *almost* on any topics.
 13. Tests, exams, practical exercises, etc. — it is obligatory that you present **original work on your own**.
 14. The general principles — according to **Regulamin Studiów**.
 15. **We have only 10 regular lectures...**
 16. A schedule/report of lectures: <https://ai.ia.agh.edu.pl/pl:dydaktyka:logic:start>
 17. **Only 14 (28) hours...No final exam???**

Bibliography

1. **Mordechai Ben-Ari: Mathematical Logic for Computer Science (Logika matematyczna w informatyce). Springer-Verlag, London, 2012 (WN-T, Warszawa, 2005, 2006).**
2. Kenneth A. Ross i Charles R. B. Wright: Discrete Mathematics (Matematyka dyskretna). WN PWN, 2013.
3. Antoni Ligęza: Logical Foundations for Rule-Based Systems. Springer-Verlag, Berlin, 2006. Wydawnictwo AGH, Kraków, 2005.
4. Michael R. Genesereth, Nils J. Nilsson: Logical Foundations of Artificial Intelligence. Morgan Kaufmann Publishers, Inc., Los Altos, California, 1987.
5. Zbigniew Huzar: Elementy logiki dla informatyków. Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław, 2007.
6. Stuart Russell, Peter Norvig: Artificial Intelligence. A Modern Approach. Pearson, 2010.
7. Marek Wójcik: Zasada rezolucji. Metoda automatycznego wnioskowania. PWN, Warszawa, 1991.
8. C. L. Chang and R. C. T. Lee: Symbolic Logic and Mechanical Theorem Proving. Academic Press, 1973.
9. Ronald J. Brachman and Hector J. Levesque: Knowledge Representation and Reasoning. Morgan Kaufmann, 2004.
10. Frank van Harmelen, Vladimir Lifschitz, Bruce Porter (Eds.): *Handbook of Knowledge Representation*. Elsevier B.V., Amsterdam, 2008.
<http://ii.fmph.uniba.sk/~sefranek/kri/handbook/>

Support Material: On the Net

Mathematical Logic for Computer Science:

<https://www.weizmann.ac.il/sci-tea/benari/research-activities/mathematical-logic-computer-science-third>

Stanford on-line Course:

<https://www.coursera.org/learn/logic-introduction>

Lectures - On-Line Documentation and Archives:

<https://ai.ia.agh.edu.pl/pl:dydaktyka:logic:start>

1. Wikipedia-pl: http://pl.wikipedia.org/wiki/Logika_matematyczna
2. Wikipedia-en: <http://en.wikipedia.org/wiki/Logic>
3. AI-Lab-Prolog: http://ai.ia.agh.edu.pl/wiki/pl:prolog:prolog_lab
4. EIS-KRR: <http://ai.ia.agh.edu.pl/wiki/pl:dydaktyka:krr:start>
5. ALI-home: home.agh.edu.pl/~ligeza
6. David Poole and Allen Mackworth: Artificial Intelligence. Foundations of Computational Agents. <http://artint.info/>
7. Ulf Nilsson and Jan Maluszynski: Logic, Programming and Prolog. <http://www.ida.liu.se/~ulfni/lpp/>