



# **Essential Thinking. The Art of Creative Thinking for Problem Solving.**

Lecture Notes  
and  
Support Stuff  
Faculty EAIIB-IEiT AGH



**Antoni Ligęza**

Other support material:

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

<https://ai.ia.agh.edu.pl>

## Agenda for Today

---

A warm welcome!

Many thanks for choosing this course and for your trust!

Thank you registration in Moodle; or please do it.

Hope for mutually profitable cooperation.

1. **Decision** about selection of the language: Polish or English (with comments in Polish).
2. A word of presentation: (i) who am I? (ii) what I am doing here?
3. Essential Thinking: About the idea of the course/workshop.
4. **Syllabus**: <https://syllabus.phd.agh.edu.pl/pl/wizard/token/step-1/ae645122-5aa8-4b56-992c-e32e1ccc61d8?apiKey=5f16b9e34be5c> - only in Polish.
5. Brutal reality. I am flexible. Your ideas and contribution are welcome!
6. **Decision** about the form: on-line vs. full contact?
7. Consequences of the decision... computers, software, more work, less efficiency,...
8. Hard reality. **Workshop** - interactive work and your work/contribution expected.
9. Contents of the course. Theory, examples, synthesis, tools; projects/presentations.
10. First example of work: <https://www.youtube.com/watch?v=Sx-5YJbszuI>
11. Second example of presentation: <https://www.youtube.com/watch?v=YokKp3pwVFc>

12. Some example methodologies:

- Forward Reasoning – Deduction,
- Backtracking Search (M&K),
- Constraint Processing (+ BS) (SMM),
- Problem Decomposition (Hanoi),
- Heuristic Search,
- Problem Relaxation,
- Consistency-Based Reasoning; Exploring Inconsistency,
- Abduction,
- Induction,
- Model Discovery,
- ...

13. Tools: Prolog, clp(fd), MiniZinc

14. Applications – presentations by participants!

---

## Essential Thinking: 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.

fake – 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...

trick – 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/wizard/token/step-1/26b82c67-338a-4321-b075-fe1edb3a1e80?apiKey=5de78a88decf9>
3. **Formal frames:** Regulamin Studiów w AGH<sup>1</sup>, 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**,
  - discussion, questions and possible answers,

---

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

- 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#logika\\_dla\\_informatykow2020\\_2021](https://ai.ia.agh.edu.pl/pl:dydaktyka:logic:start#logika_dla_informatykow2020_2021)
  17. **Only 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](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](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](http://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/>