



KNO.E.SIS

Ohio Centers of Excellence

WRIGHT STATE UNIVERSITY

FROM INFORMATION TO MEANING

# CS 499/699 – Logic for Computer Scientists

Winter Quarter 2012

Slides 1 – January 3, 2012

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Kno.e.sis Center

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<http://www.knoesis.org/pascal/>



**<http://www.pascal-hitzler.de/teaching/w12/>**

**Or go to <http://www.pascal-hitzler.de> and follow the link near the bottom of the page to the lecture.**

1. **Motivation (slides)**
2. **Organizational matters**
3. **Propositional Logic – Syntax (whiteboard)**

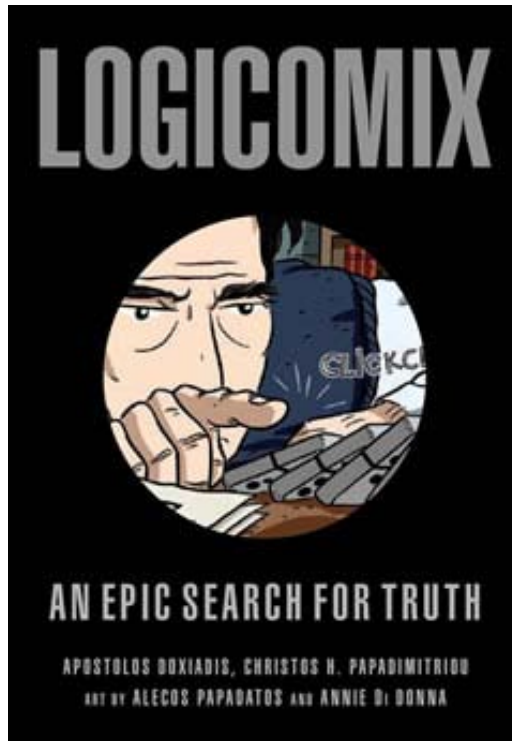
***Logic is a fundamental organizing principle in nearly all areas in Computer Science. It runs a multifaceted gamut from the foundational to the applied. At one extreme, it underlies computability and complexity theory and the formal semantics of programming languages. At the other extreme, it drives billions of gates every day in the digital circuits of processors of all kinds. Logic is in itself a powerful programming paradigm, but it is also the quintessential specification language for anything ranging from real-time critical systems to networked infrastructures. Logical techniques link implementation and specification through formal methods such as automated theorem proving and model checking. Logic is also the stuff of knowledge representation and artificial intelligence. Because of its ubiquity, logic has acquired a central role in Computer Science education.***

**[Cited from the LPAR-10 Call for Papers]**

**“Logic is the Calculus of Computer Science”**

- **Greek λογικός – possessed of reason, intellectual, dialectical, argumentative**
- **The study of reasoning.**
  
- **Dates back to Aristotle (384-322 BC)**
- **Has influenced western thinking and culture *decisively*.**
- **Some influences e.g. from Islamic philosophy (Avicennian logic)**
  
- **Aristotelian *sylogistic* logic dominated until mid-19<sup>th</sup> century.**
- **Then mathematical logic was developed [some big developments in mathematics at that time].**

**Boole, Frege, Whitehead, Russell, Wittgenstein**



- <http://www.logicomix.com/>
- Excellent comic about the groundbreaking developments in logic and mathematics end of the 19<sup>th</sup> century.
- It's actually very entertaining!

- The *Organon* – standard collection of Aristotle’s six works on logic.
- When is an argument valid?
- Syllogism: “a discourse in which, certain things having been supposed, something different from the things supposed results of necessity because these things are so”
- Syllogism: a form of valid (logical) argument.



*mode, that affirms by affirming*

(correct name: Modus ponendo ponens)

If P, then Q.

P.

Therefore, Q.

If today is Tuesday, then I will go to work.

Today is Tuesday.

Therefore, I will go to work.

*mode, that denies by denying*

(correct name: Modus tollendo tollens)

If P, then Q.

Not Q.

Therefore, not P.

If the watch-dog detects an intruder, the dog will bark.

The dog did nothing in the night-time.

Therefore, no intruder was detected.

*mode, that affirms by denying*

**P or Q.**

**Not P.**

**Therefore, Q.**

**Either Monique is in the library, or she's in the pub.**

**But she's not in the library.**

**So she must be in the pub.**

*mode, that denies by affirming*

**Not both A and B.**

**A.**

**Therefore, not B.**

**Ann and Bill cannot both win the race.**

**Ann will win the race.**

**Therefore, Bill cannot win the race.**

- **We could go on for quite a bit.**
- **Can we do this in a more structured way?**
- **Yes, we'll do that: Propositional Logic.**

***“What is the secret of your long life?” a centenarian was asked. “I strictly follow my diet: If I don’t drink beer for dinner, then I always have fish. Any time I have both beer and fish for dinner, then I do without ice cream. If I have ice cream or don’t have beer, then I never eat fish.”***

**Claim:**

**He has three options:**

- 1. He has fish and beer, but no ice cream.**
- 2. He has beer, but neither fish nor ice cream.**
- 3. He has beer and ice cream, but no fish.**

**Why?**

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- This class has a distance learning option.
- I.e. there will be quite a bit of communication via email. If something slips my attention (e.g., concerning difficulties with the online material) please let me know. I'm also learning as we go.
- It is okay to send me solutions to homework assignments by email (scans or typeset [LaTeX recommended]). However, it is your responsibility that everything is clearly readable after printout. I will deposit the graded homework with the department secretary for pick-up [let me know if this is a problem].
- **I assume everybody will be physically present for the exams.** Let me know ASAP if you cannot do this.



- Physical class meetings are Tuesdays and Thursdays **4:15pm** to 5:30pm (note this is **5 minutes later than usual**).
- Room: 124 Allyn

- **Office Hours: Thursdays 1pm-2pm, Joshi 389.**  
**Email contact preferred. Phone will only work by appointment.**
- **Textbook (required):**  
**Uwe Schöning, Logic for Computer Scientists, Birkhäuser, 2008.**
- **Textbook (recommended):**  
**Mordechai Ben-Ari, Mathematical Logic for Computer Science, Springer, 1993**  
**I will only take the Tableaux Algorithms from this one.**
- **Grading:**  
**Midterm exam: 30%**  
**Final exam: 50%**  
**Graded Homework Assignments: 20%**

- **We will frequently make exercise sessions. You will get exercises, to be done at home and graded by me, and discussed afterwards in class.**
- **Each exercise is labeled “hand-in” or “no hand-in”. Only the “hand-in” exercises count towards your grade, but you can also hand in the others to get my feedback/corrections.**
- **Each “hand-in” exercise counts 5 points. An average of 4 points is 100%.  
Exercises are due *one week after I pose them – before class.***
- **The exercises are the tough part of the class. If you stay on top of them, you’ll find the exams relatively easy.**

- I *strongly* recommend that you work in teams (e.g., two people) to discuss the more difficult exercises. However, I expect that, after discussion, each person writes the solution entirely by him/herself.
- If I get two identical or near-identical write-ups, or otherwise two versions which look like one is a copy of the other, both parties will receive zero points.
- And yes, it's easy to spot this. In fact, if you manage to do a *clever* copying – one where it's clear it's not a copy – then I don't have a problem with this (because this requires insight into the exercise).

- **I prefer to use a public website:  
<http://www.pascal-hitzler.de/teaching/w12/>**
- **The manuscript also contains future material, taken from last year and subject to change [you can ignore this, but you may find it instructive to take a look].**
- **The new manuscript will be an updated/corrected version of last year's and will be posted shortly before class (usually, the evening before) in a near-final version. The final version will be posted, usually, on the evening of the class session.**
- **The manuscript bears a date (first page) and margin notes indicate the dates when which part was covered (important e.g. for due dates of exercises).**

## Tentative

**We cover Schönig 1.1, 1.2, 1.4, then Ben-Ari 2.6**

**We cover Schönig 2.1, 2.2, 2.3, then Ben-Ari 5.5**

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