

# CS 499/699 – Logic for Computer Scientists

Spring Quarter 2010

Slides 1 – March 29, 2010

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

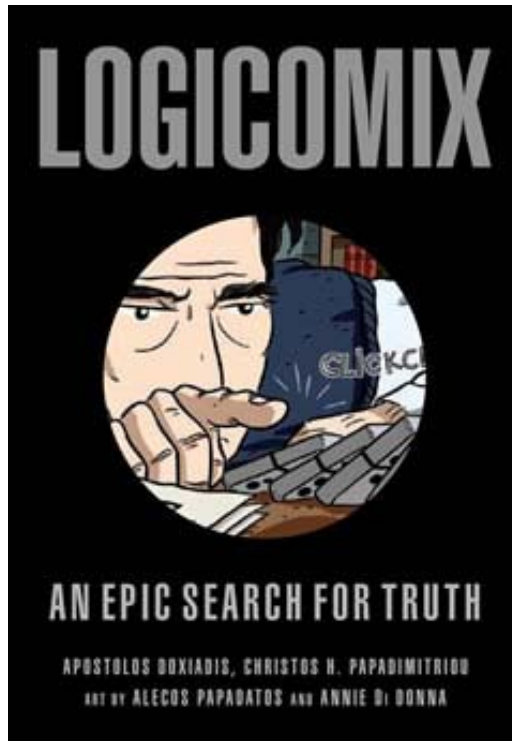
***Logic is a fundamental organizing principle in nearly all areas in Computer Science. It runs a multifaceted gamut from the foundational to the applied. At one extreme, it underlies computability and complexity theory and the formal semantics of programming languages. At the other extreme, it drives 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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- **Office Hours: Wed 3-4, Joshi 389.**  
**Email contact preferred.**
- **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 (**modified and accepted**):**  
**Midterm exam: 30%**  
**Final exam: 50%**  
**Graded Homework Assignments: 20%**



- I will be absent May 3<sup>rd</sup> and 5<sup>th</sup>.
  - How do we make up for this?
    - Have 7.5 sessions 20 minutes longer (we'll do this).
    - Find alternative dates for meeting.
    - Give you extra hand-in homework.
- 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 usually counts 4 points [exceptions are marked].  
Exercises are due *one week after I pose them*.
- Webpage/slides.  
I prefer to use a public website:  
<http://knoesis.wright.edu/faculty/pascal/teaching/s10/>

## 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**

- **March 29/31: Introduction. Propositional Logic part 1.**
- **April 5/7: Propositional Logic part 2.**
- **April 12/14:**
- **April 19/21:**
- **April 26/28: mid-term exam**
- **May 3/5: no classes**
- **May 10/12:**
- **May 17/19:**
- **May 24/26:**
- **June 2:**