



Iliano Cervesato
Carnegie Mellon University
Qatar



Discovering Logic through Comics

The Story

It was a dark and stormy night ...

A new course ...
... on logic ...
... for CS freshmen ...
... based on a comic book

The origins of *Discovering Logic*

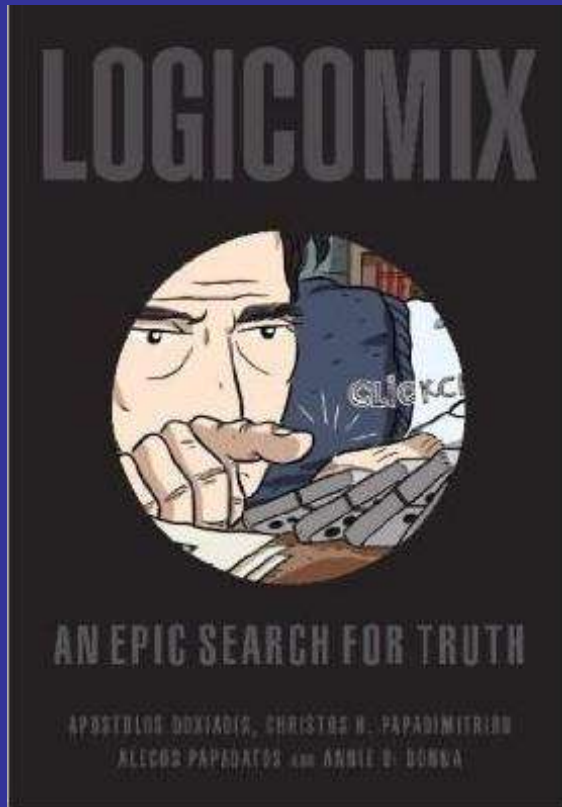
Problem

- Difficulties with formal statement in sophomore classes - *Theory 1*
 - Going from English to logical meaning
 - to solve problems
 - to gain deep understanding
 - No difficulty *applying* rules

Opportunity

- Publication of *Logicomix*

Logicomix



A comic book!

- Not a textbook
- A story about
 - Bertrand Russell
 - Development of modern logic
 - The making of *Logicomix*



Logic in the CS Curriculum

Recommended

- Minimum of 10 hours of *basic logic*
+ 12 hours on proof techniques
- Logic as needed in advanced classes
- Logic elective

ACM/IEEE CC 2001 - CS

Typical

- Brief exposure in *Discrete Math*
- Logic as needed in advanced classes
- Logic elective

INSUFFICIENT

Logic in CS at CMU

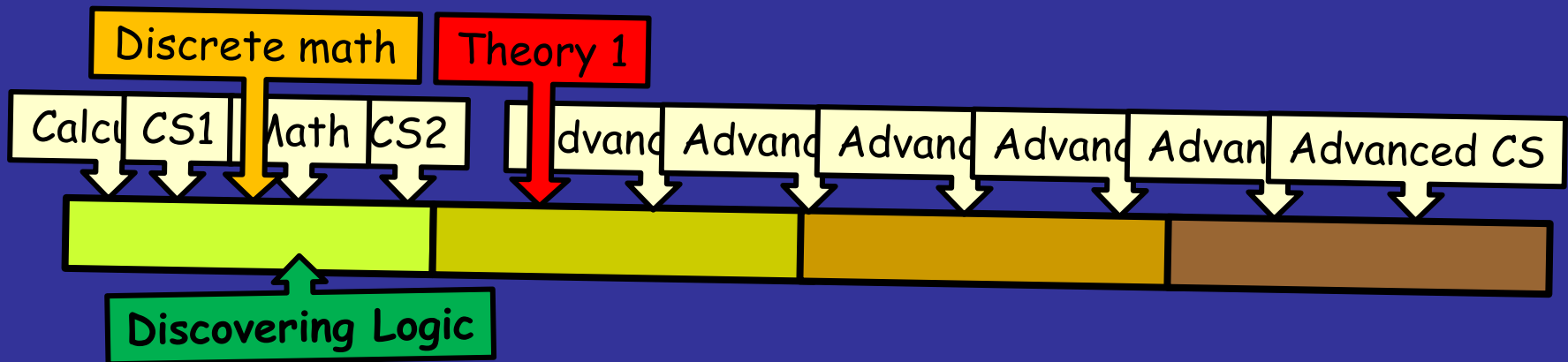
2 hours in *DM*

- 1st year
- Next 3 years depend on it ...

Discovering Logic

Then *Theory 1*

- First intensive application of logic
- Struggle for many
 - High failure rate



Learning Objectives

Elements of Logic

- 10 hours of CC01 ✓
- "Basic logic" topics
- Non-formalistic

Historical depth

- 1 hour in CC01 ✓✓✓
- Establishment of ideas

Research, present, write, communicate

- Strong emphasis in CC01 ✓✓
- Deep understanding of *Logicomix*
- Class presentations
- Essays

Course Structure

First offered in Spring 2010

➤ 7-week elective

- One 80-minute lecture per week
 - Starting week 3
 - 40 minute presentations + 40-minute lecture
- 3 units (= 6 hours work per week)

➤ Enrollment

- 9 students (out of 27)
 - 1 dropped
- More on lecture 1

Grading

- 15% class discussion
- 30% presentations
- 40% homeworks
- 15% final paper

Course Contents

Core Material

- Motivations
- Propositional logic
 - Reading logic
 - Truth tables
 - Natural deduction
- First-order logic
 - (same)
- Paradoxes
- Logic programming

Student Presentations

- People
 - Papadimitriou
 - George Boole
- Context
 - Math in 19th century
 - Dadaism
- Logic
 - Non-Euclidean geometry
 - Fuzzy logic
 - Theorem proving

Didactic Approach

Core Lectures

- Highly interactive
 - Discussions
 - Humor
- Guided discussions
 - from defining *valid inference*
 - to nailing down rules for disjunction
- Inductive approach

Student Presentations

- 15 minutes + debriefing
- Research topic, organize findings, present them
- Critiqued by other students
- Empower students



How *Logicomix* was used

1. Attract students
 2. Discuss history of logic
 3. Starting point for
 - Discussions
 - Presentation topics
- Not to teach logic



Homeworks

Homework 1

- Read *Logicomix*
- Write essay
 - Letter to friend
 - Review for amazon.com
- Ask 3 questions

Final paper

- Reread *Logicomix*
- Write new essay
- Answer questions
 - Best from hw1

Homeworks 2-5

- Transcription exercises
- Small essays
- Logic exercises
- CS applications

Student Questions

How is logic connected to

How is logic connected to

Are people coming up with new logics today?
For what purpose?

How do
paradoxes?

must be done in order to con-
our-
ves that we are absolutely right?

Some homework Problems

Exercise 3: Truth tables for security (15 points)

Four machines, A, B, C, and D, are connected to a computer virus may infect them. A security tool informs you about the infection status of the machines.

1. If D is infected, then A is infected.
2. If C is infected, then B is infected.

Exercise 3: Logic

At a trial, a defense lawyer says:

"If my client is not in the area at the time of the crime, then he saw the knife in the drawer. Furthermore, if he saw the knife in the drawer, then he is a gentleman. But we all know that gentlemen do not commit crimes."

Typical lawyer question: Is this argument valid?

Propositions in the argument as an inference. Is the argument valid. Also, say why it is much more convenient to use derivations than truth table method in this case.

Other exercises

- Conjunctive normal form
- Controlling Google search
- Boolean conditions in programs
- 3-valued logics
- Deduction theorem
- Ambiguity
- Program assertions

...the sentences will be that "和" means "then", that "只"

...he was in the barn. ...er 10. ...fe was ...es and

...ed by atomic overall reference the truth

...t have to tell ...ust write the ...e the Chinese

...we would ...however, the government just gave ...So it is my pleasure to announce that we will meet our 3rd quarter target!"

Student Feedback

- Numerous feedback channels
 - Survey:
 - What worked?
 - What can be done better?
 - Other suggestions?
- Highlights
 - Presentations, homeworks, course contents
- Complaints
 - *80 minutes a week is not enough*

Assessment

Did they get better logical skills?

- Followed freshmen cohort through 2nd year
 - A = those who took *Discovering Logic*
 - B = those who didn't
- Performance in *Theory 1*
 - Compared with class average
 - Normalized with prior CS and Math classes
 - A: 4% better than predicted (69.82 vs. 65.55)
 - B: as predicted (60.77 vs. 60.93)
- *But, sizes too small for conclusive results*

The Sequel ...

... Spring 2012 (canceled in 2011)

- 2 classes a week
 - 80 min. lecture
 - 50 min. recitation
- Expanded syllabus
 - More CS applications of logic
- Handouts



<http://www.qatar.cmu.edu/iliano/courses/10S-CMU-CS199>



**Thank
you!**

Questions?