Discovering Logic through Comics
It was a dark and stormy night ...

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

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

**Typical**

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

*ACM/IEEE CC 2001 - CS*
Logic in CS at CMU

2 hours in **DM**
- 1st year
- Next 3 years depend on it ...

Then **Theory 1**
- First intensive application of logic
- Struggle for many
  - High failure rate
Learning Objectives

Elements of Logic
- 10 hours of CCO1
- “Basic logic” topics
- Non-formalistic

Historical depth
- 1 hour in CCO1
- Establishment of ideas

Research, present, write, communicate
- Strong emphasis in CCO1
- Deep understanding of Logicomix
- Class presentations
- Essays
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
Homework 1
- Read *Logicomix*
- Write essay
  - Letter to friend
  - Review for amazon.com
- Ask 3 questions

Final paper
- Reread *Logicomix*
- Write new essay
  - Best from hw1

Homeworks 2–5
- Transcription exercises
- Small essays
- Logic exercises
- CS applications
How deep must we go in order to be satisfied with any argument? How much reasoning must be done in order to convince ourselves that we are absolutely right?

How is logic connected to weak logic?

How is logic connected to absolute logic?

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

How do we argue in order to overcome paradoxes?
Some homework Problems

Exercise 3: Truth tables for security (15 points)
Four machines, A, B, C, and D are connected by computer tools and inform you:
1. If D is infected, A is infected.
2. If C is infected, B is infected.
3. If C is infected, A is not infected.
Exercise 3: Language
At a trial, a defendant
"If my client is innocent, he did not do it, and
saw the knife
Furthermore, he was in the drawer.
But we all know the
Typical lawyer says: this argument? By
propositions in the
argument as an inference. Finally, we would table method in this case.
A list of the
Since, however, the government just gave quarter target!

Other exercises
- Conjunctive normal form
- Controlling Google search
- Boolean conditions in programs
- 3-valued logics
- Deduction theorem
- Ambiguity
- Program assertions
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
Did they get better logical skills?

- Followed freshmen cohort through 2\textsuperscript{nd} year
  
  \begin{itemize}
  \item A = those who took \textit{Discovering Logic}
  \item B = those who didn't
  \end{itemize}

- Performance in \textit{Theory 1}
  
  \begin{itemize}
  \item Compared with class average
  \item Normalized with prior CS and Math classes
  \end{itemize}

  \begin{itemize}
  \item A: 4\% better than predicted (69.82 vs. 65.55)
  \item B: as predicted (60.77 vs. 60.93)
  \end{itemize}

- But, sizes too small for conclusive results
... Spring 2012  (canceled in 2011)

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

Questions?