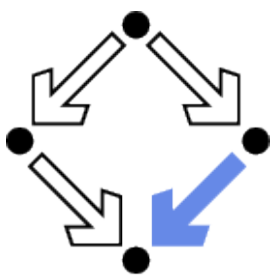
Computational Logic in the First Semester of Computer Science: An Experience Report

David M. Cerna, Martina Seidl, Wolfgang Schreiner, Wolfgang Windsteiger, and Armin Biere

May 4^{th} 2020

JOHANNES KEPLER UNIVERSITY LINZ

FMV



Introduction

- Together, the authors form the core team of the LOGTECHEDU project.

  http://fmv.jku.at/logtechedu/

- The goals of this project are:
  - Pursuing the development and use of logic-based software tools for educational purposes.
  - Development and expansion of logic education within undergraduate university curricula.
- Our introductory logic course exemplifies these points.
- In this talk we will give an outline of the **course**, our **experience** and discuss an end of the semester **questionnaire** we designed.

Logic and Computer Science

- Quoting [Makowsky and Zamansky, 2017], the presence of logic courses in undergraduate university curricula is in decline.
- This trend has nothing to do with the relevance of logic to modern computer science.
- Verification technology relies on automated reasoners that evaluate logical formulas [Calcagno et al. , 2015; Cook, 2018]
- Logical formalisms form the basis of the symbolic branch of artificial intelligence [Russell and Norvig, 2010]
- If anything, logic is as important to computer science today as it was at the foundation of the field.

Logic and Computer Science: Educational Side

- A classical course in formal logic approaches the subject for an abstract point of view.
- While this is sensible because
  - Part of the beauty of logic is its abstraction, and
  - it allows one to formally cover important results,
- it leaves a disconnect between the presented material and the practical use.
- Even when practical applications are presented, experience has shown that
- **"what is this all for?"** still lingers on students minds.

Logic: A First Semester Course

- We made logic one of the first things CS students see when they enter university.
- As one may expect students will not be provided a detailed exposition of the **incompleteness theorems**.
- What they will see is
  - Encoding of problems as SAT and SMT formulas.
  - An introduction to formal language.
  - Syntax and semantics separation.
  - Construction of formal proofs.
- Throughout the semester examples are provided connecting the material to other parts of the curriculum.
- Some of the course material may be found here:

http://fmv.jku.at/logic/index.html

Logic Course: Structure

- The course concise of three modules, namely
  - Propositional Logic or SAT (4 weeks)
  - First-order logic or FOL (6 weeks)
  - SMT (2 weeks)
- Every week there is a **mini-test** examining students on the previous weeks material.
- Additionally there are **weekly challenges** which can be used for bonus points on the upcoming mini-test.
- Each of the shorter modules has a single **lab assignment** while FOL has two.
- Lab assignments may be used to replace a single mini-test from the same module.
- Both weekly challenges and lab assignments are **optional**.

Logic Course: Details

- The course does have exercise sessions.
- They concise of the lecturer presenting exercises and providing a few exercises as **homework**.
- This homework is recommended, **not graded**.
- Feedback concerning the **students performance** is provided through the mini-test and the optional assignments.
- Each of the optional assignments requires either the use of an existing solver or one of our educational tools **educational software tools**.

Software: AXolotl

Software: RISCAL

Software: Theorema