Interactive Course Material by TP-based Programming

A Case Study

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What is Isabelle?

- Interactive Theorem Prover (Interactice TP)
- Large body of mechanized math knowledge
- Developed in Cambridge, Munich and Paris

What is ISAC?

- ISAbelle for Calculations
- Interactive Course Material
- Learning Coach
- Developed at Austrian Universities

ISAC for Interactive Course Material

- Stepwise solving of engineering problems
  → One Framework for all phases of problem solving
- Explaining underlying knowledge
  → Transparent Content, Access to Multimedia Content
- Checking steps input by the student
  → Proof Situation
- Assessing stepwise problem solving
  → One system for tutoring and assessment

Course Material Creation Iterations

1. Problem Analysis

   Variants of problem solving steps

2. **Analysis of mechanized knowledge**

   Existing and missing knowledge

3. **Programming in a TP based language (TP-PL)**

4. Additional Content

   Multimedia explanations for underlying knowledge

Issues to Accomplish Information Collection

- What knowledge is mechanized in Isabelle?

  Theorems, Definitions, Numbers,...

- What knowledge is mechanized in $\mathcal{ISAC}$?

  Problem specifications, Programs,...

- What additional explanations are required?

  Figures, Examples,...

Representation Problems

- Can meaning of symbols be varied?

  $u[n]$ is a specific function in Signal Processing

- Simplification, tricks and beauty

$$X \cdot (a + b) + Y \cdot (c + d) = aX + bX + cY + dY$$

$$\frac{1}{j\omega} \cdot \left(e^{-j\omega} - e^{j3\omega}\right) = \frac{1}{j\omega} \cdot e^{-j2\omega} \cdot \left(e^{j\omega} - e^{-j\omega}\right) =$$

$$= \frac{1}{\omega} e^{-j2\omega} \cdot \frac{1}{j} \left(e^{j\omega} - e^{-j\omega}\right) = \frac{1}{\omega} e^{-j2\omega} \cdot 2\,sin(\omega)$$

Demonstration

- Backend
  - Equation solving
  - Notation problems, Working with Rulesets
  - Framework expansion
  - My Work

Conclusion

- Proof of concept for TP-PL succesfull
- Usability of TP-PL not sufficient
- Requirements for improved usability clarified

- Unacceptable to spend 200h on 1 program
- *ISAC* pointed at my own error

Contact

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