Some considerations about proof assistants for education

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June 2007
PhoX is used for teaching with

- master students in logic at Paris VII
- 2nd and 3rd year math students in Savoy
- 3rd year computer science students in Savoy

Evolution

Before 2005: using extensible tactics
Since 2005: using “proof by contextual menu”

Results

\[ \frac{3.5}{5} : \text{mark given by students!} \]
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Plan

1. How PhoX works
2. Demos
3. Doing Mathematics
4. Doing Computer sciences
5. Problems and remarks
6. Possible directions of improvement
PhoX’s Extensible commands

(green = extensible)
PhoX’s contextual menu

- Clic + Selections
  - Set of Tactics
    - Set of Goals
      - Menu
        - Final Tactic
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Demos

- A demo for math students with tactics
- The same demo with “contextual menu”
- A demo for computer sciences students
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Two phases

Understanding and finding the proof
Very little learning time needed for “proof by contextual menu”

Writing the proof
Surprisingly difficult

Conclusion
The second phase and the splitting in two phases are really necessary
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Nqthm and Sylvain Baro’s Phd

ML programs as term

- PhoX is extended with ML programs as terms
- Arbitrary recursion is allowed
- bool = prop
- Phox is inconsistent! (as LEGO)
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Proofs are trivial
They follow the code ...

Only two problems:
- Finding the lemmas
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Proof are useless

Many students did not see the interest of proving code

- In their algorithmic courses: almost no proof (except for complexity).
- A lot of trivial steps... but one can get lost.
- Technical difficulties for induction, hard to teach.
Benefit of contextual menus

**Good**
- Learning time reduced a lot.
- Readability of proof script slightly improved (not much).

**Bad**
- The script does not show the proof structure.
- The menus are too far from natural language.
- Menu are long to read
- and students read them entirely!
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Possible directions of improvement

Contextual menu - V2 : Use Mizar mode !

Before

(* let E, F, f, A and B assume (E ⇒ F) f
  [H], A ⊂ F [H0] and B ⊂ F [H1]
prove
  image f (A ∩ B) ⊂ image f A ∩ image f B *)
intros [ -lim 1].

After

let E,F let f in (E ⇒ F) let A,B ⊂ F
show image f (A ∩ B) ⊂ image f A ∩ image f B.
An entirely new prover based on a very small but very powerful ML.

- Only one kind of Cartesian product and disjoint union
- Exceptions, functors, modules, objects, polymorphic variants, ...
- Subtyping (explicit cast not needed)
- Deduction system inside the language
- Consistency (we hope so ;-)