Some considerations about proof assistants for education

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History

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

$\frac{3.5}{5}$: mark given by students !

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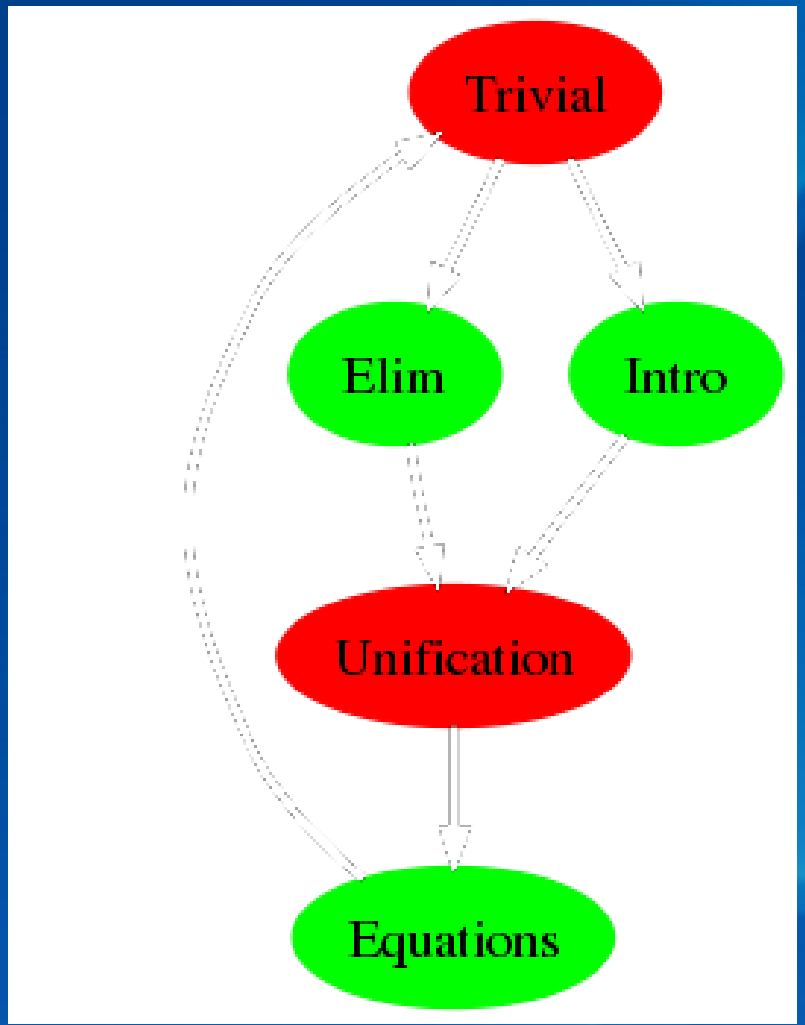
Plan

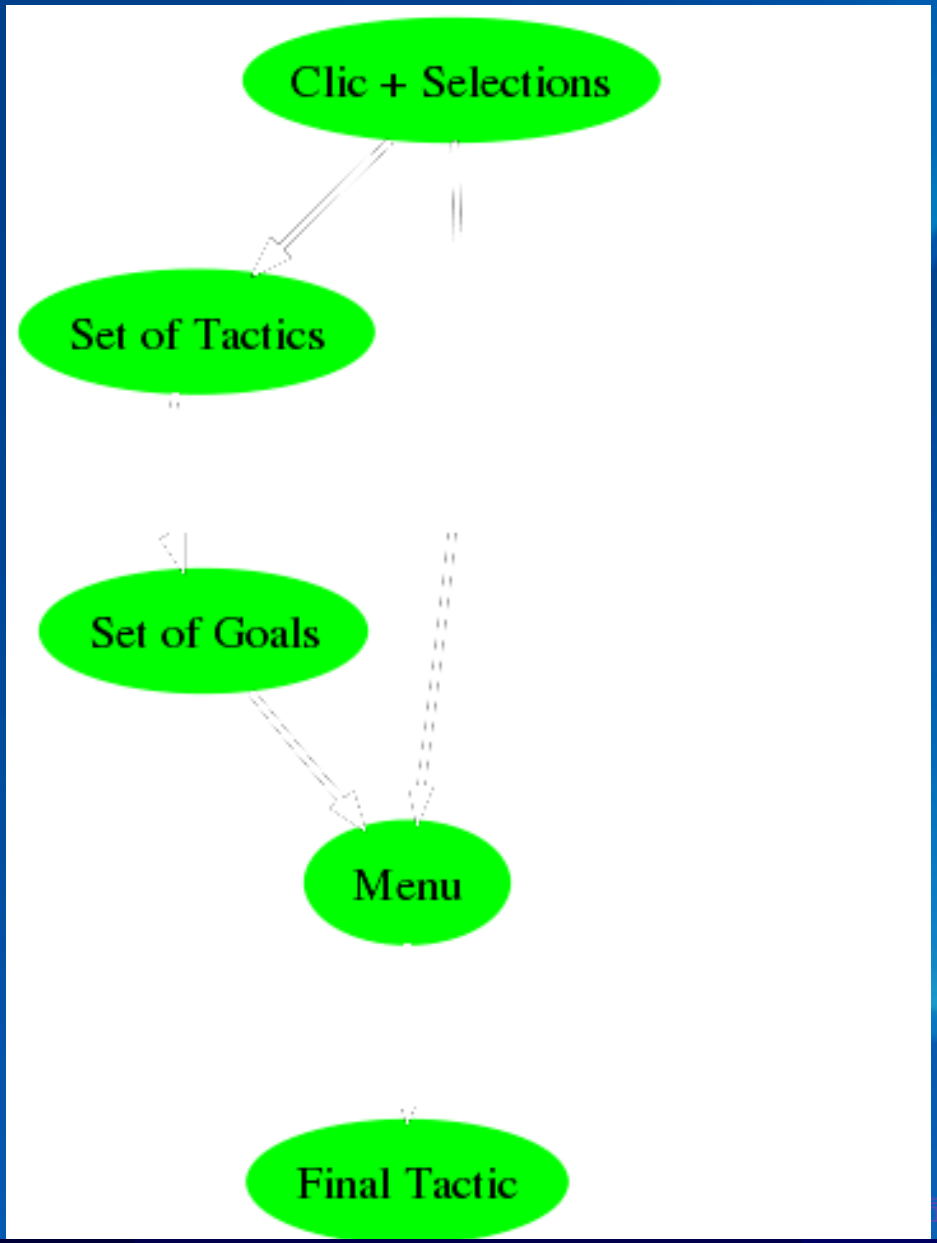
1. How PhoX works
2. Demos
3. Doing Mathematics
4. Doing Computer sciences
5. Problems and remarks
6. Possible directions of improvement

PhoX's Extensible commands

(green = extensible)



PhoX's contextual menu



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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 :

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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 step ... but one can get lost.
- Technical difficulties for induction, hard to teach.

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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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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.
```

PML

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 ;-)

`http ://www.lama.univ-savoie.fr/~raffalli/pml`