ProofWeb : logic education through the web

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teaching logic with the computer

logic course for math/computer science students :

propositional logic
predicate logic
predicate logic with equality

practising natural deduction proofs

- **on paper**

  students does not learn to be precise

- **with the computer**

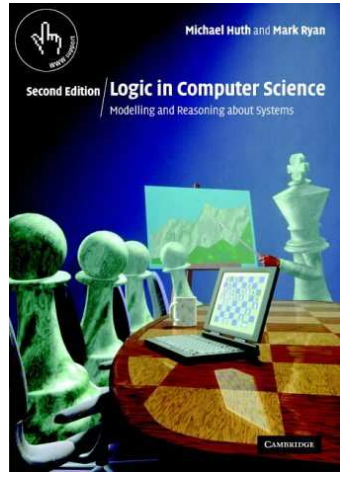
  student does not learn to do it all himself

both necessary: complement each other

features

- built on top of serious proof system: Coq
  - students work with an industrial strength system
  - proofs look exactly like in a traditional textbook

    compatible with: Huth & Ryan, Login in Computer Science



- web-based
  - students don't need to install anything
  - students can access their work from anywhere
  - teacher has at all times full info on student's work
- comes with a manual explaining the system
- comes with a set of graded exercises

Coq

proof assistant based on constructive logic

developed at INRIA, France
1984 until today

used for impressive proofs:

- four color theorem, Georges Gonthier
- verified C compiler, Xavier Leroy

power of Coq also makes ProofWeb attractive for education

natural deduction (Fitch style)

1	H1:	$\exists x,\ (P\ x \lor \neg Q\ a)$	assumption
2	H2:	$Q\ a$	assumption
	b		
3	H3:	$P\ b \lor \neg Q\ a$	assumption
4	H4:	$P\ b$	assumption
5		$\exists x,\ P\ x$	$\exists$i 4
6	H5:	$\neg Q\ a$	assumption
7		$\bot$	$\neg$e 6,2
8		$\exists x,\ P\ x$	$\bot$e 7
9		$\exists x,\ P\ x$	$\lor$e 3,4-5,6-8
10		$\exists x,\ P\ x$	$\exists$e 1,3-9
11		$Q\ a \to \exists x,\ P\ x$	$\to$i 2-10
12		$\exists x,\ (P\ x \lor \neg Q\ a) \to Q\ a \to \exists x,\ P\ x$	$\to$i 1-11

natural deduction (Gentzen style)

$$\dfrac{\dfrac{[\exists x,\ (P\ x \lor \neg Q\ a)]^{H1} \qquad \dfrac{\dfrac{[P\ b \lor \neg Q\ a]^{H3} \qquad \dfrac{\dfrac{[P\ b]^{H4}}{\exists x,\ P\ x}\,\exists i \qquad \dfrac{\dfrac{[\neg Q\ a]^{H5} \quad [Q\ a]^{H2}}{\bot}\,\neg e}{\exists x,\ P\ x}\,\bot e}{\exists x,\ P\ x}\,\lor e[H4,H5]}{\exists x,\ P\ x}\,\exists e[H3]}{Q\ a \longrightarrow \exists x,\ P\ x}\,\longrightarrow i[H2]}{\exists x,\ (P\ x \lor \neg Q\ a) \longrightarrow Q\ a \longrightarrow \exists x,\ P\ x}\,\longrightarrow i[H1]$$

user input

```
Require Import ProofWeb.

Variable P Q : D -> Prop.
Variable a : D.

Theorem example : exi x, (P(x) \/ ~Q(a)) -> Q(a) -> exi x, P(x).
Proof.
imp_i H1.
imp_i H2.
f_exi_e H1 b H3.
f_dis_e H3 H4 H5.
f_exi_i H4.
fls_e.
f_neg_e H5 H2.
Qed.
```

exercise colors

possibilities for an exercise :

- Not touched
- Incomplete
- Correct
- Solved

demo

http://proofweb.cs.ru.nl/

trying ProofWeb

three possibilities :

`http://proofweb.cs.ru.nl/`

1. **guest access** (no registration needed)
2. **host course in Nijmegen** (free)
3. download (open source) and **host course on your own system**

future plans

- **other proof display styles**
- **other logics**
  - modal logics
  - temporal logics
  - logic in Dijkstra style
- **MathWiki**