Oliver: an OnLine Inference and VERification system

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Outline

- SUNY Stony Brook Curriculum presentation
- Discrete Structures I
- Propositional logic
- Pedagogical goals
- OLIVER
- WeBWorK for delivering Online homeworks for Discrete Structures
- Students Feedbacks
- Future directions

SUNY SB CS curriculum

- ACM standards for CS education and Discrete Structures

- Sequence of introductory courses of CS at SUNY Stony Brook

Discrete Structures I (around 1200 students each year until Spring 2002)

$\Downarrow$

Programming with JAVA

$\Downarrow$

Discrete Structures II

$\Updownarrow$

Data Structures with JAVA

Discrete Structures I

- **Propositional Logic**
- Number Theory
- Set Theory
- Functions
- Recursion
- Definition of functions in SML
- Induction
- Correctness of functions – illustrated through the use of SML and induction
- Automata
- Trees
- Graphs

Propositional Logic

- **Propositional Logic:**
  - **Formulas** are **Propositions**.
    - Propositional variables (p, q, r...), conjunctions ($\wedge$), disjunctions ($\vee$), conditionals ($\rightarrow$), biconditionals ($\leftrightarrow$) and negations ($\neg$) of propositions.
    - *Examples:* $p \wedge q$, $(p \vee q) \rightarrow q$
  - We consider **interactive direct proofs** based on an **inference system**.

- Cognitive psychologists estimate that only 1 to 4% of the population are able without explicit training to correctly apply the principles of formal logic.

- Visualization in assisting the reasoning process through the use of software and web-based tools can help students learn and enjoy logic [Barwise, Etchemendy, 1993, Bornat, Sufrin, 1999, Abraham and all, 2001].

Pedagogical goals

- Encourage mathematical thinking [Math-thinking, http://www.cs.geneseo.edu/~baldwin/math-thining].
- Convince students that logic is relevant to their career.
  - Students have no programming experience (60%.)
- Convince students that logic is accessible to them and can be enjoyable.
- Encourage experimentation on formal concepts.
- Encourage study groups.
- Instant feedback.
- Fast grading of proofs.

Oliver

OnLine Inference and VERification system

- Software composed of 2 pieces:
  - a propositional logic engine for checking inferences, and
  - a servlet-based interface allowing to access the system online.

- Oliver is **flexible**.

  Previous interactive systems (as Jape or Logic Tutor) use strict inference systems

  But Oliver accepts any valid direct proof.

- Oliver proofs are **"more natural"**.

- Oliver offers a way to **visualize** each step of the non-deterministic and discovery of the considered proof.

- Oliver provides **instant feedback**.

- Oliver encourages **experimentation**.

- Oliver generates **random problems** to reduce cheating and plagiarism.

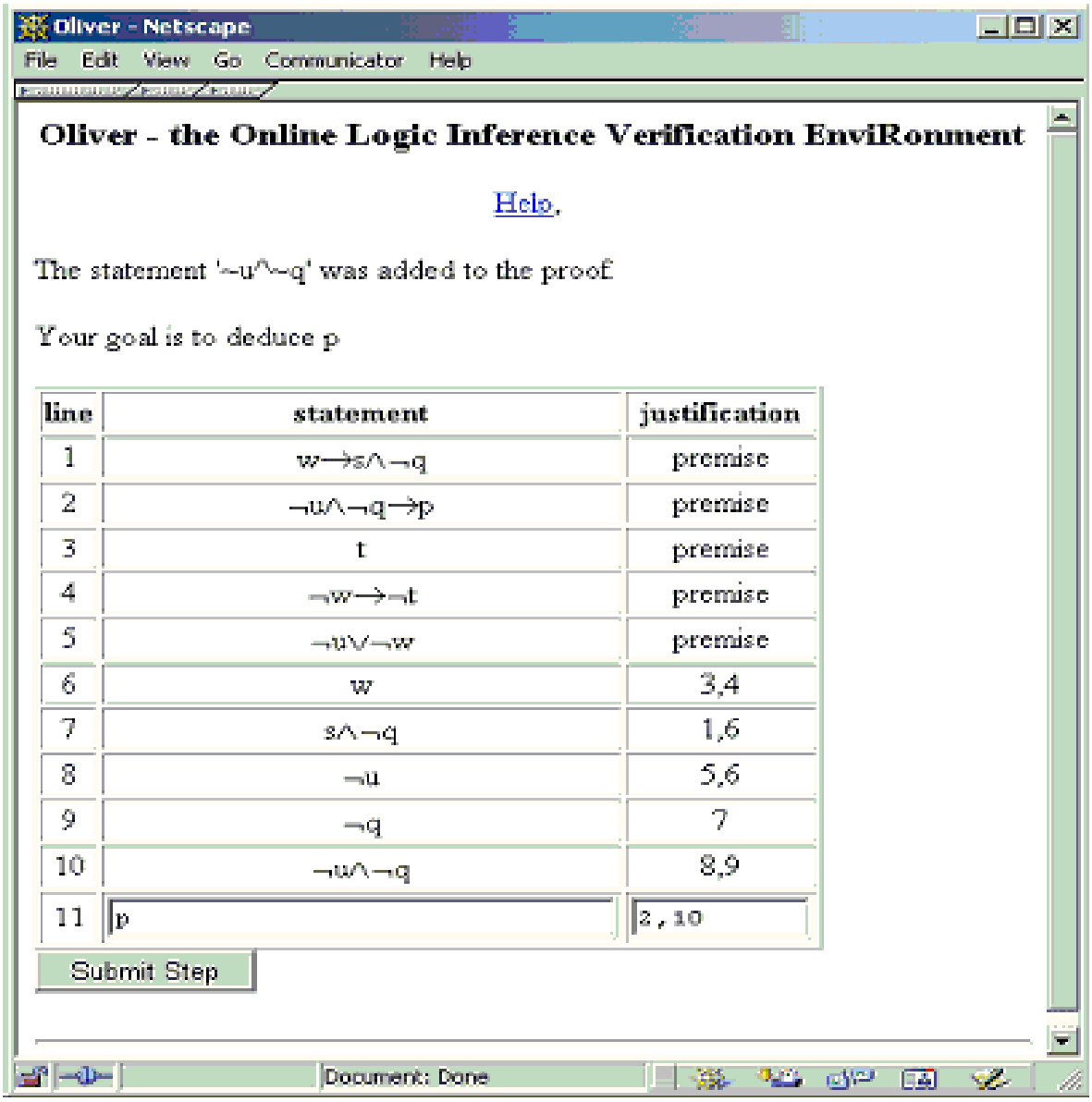
- Oliver **grades** the proofs (success or failure.)

- Oliver records all proofs in a **database** for further analysis.

- Oliver has been integrated **WeBWorK** [Pizer, Gage].

- Try Oliver:
  http://www.csis.pace.edu/~scharff/SOFTWARE/OLIVER/oliver.html

Oliver in action



Oliver and WeBWorK

- WeBWorK
  - Developed at the University of Rochester [Pizer, Gage]
  - Web-based system for delivering and evaluating homework problems
  - Features: user authentication, encourage experimentation, instant feedback, instant grading, individualized problem sets, evaluation of free-form symbolic answers, distribution of solutions, development of problems using the PG language...

- Advantages of the integration of Oliver in WeBWorK:
  - Experimentation
  - Grading
  - Distribution of solutions
  - Control of plagiarism and cheating.

User feedback and analysis

- More than 2000 students used Oliver.
- 71% said that Oliver was the most useful web-based homework and 52% said logic was their favorite topic.
- Students have a different attitude toward Oliver homework w.r.t standard paper homeworks.
  - Students are driven to get every proof right.
- Proof quality and test scores have improved dramatically with the use of Oliver.
- WeBWorK is very popular among students (22% of students prefereed paper-based homeworks.)

Conclusion and future directions

- Use of Oliver in Discrete Structures I.
- Develop new Oliver problems and let students develop their own problems.
- Study of our database of proofs.
- Oliver with inference rule names.
- Better integration of Oliver in WeBWorK:
  - One window.
  - Record incomplete proofs to make it more concordant with WeBWorK.
- Oliver for indirect proofs.
- Use of WeBWorK: an active project.