

An Educational Proof Assistant for Language Theory

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The Challenge of Teaching Proofs

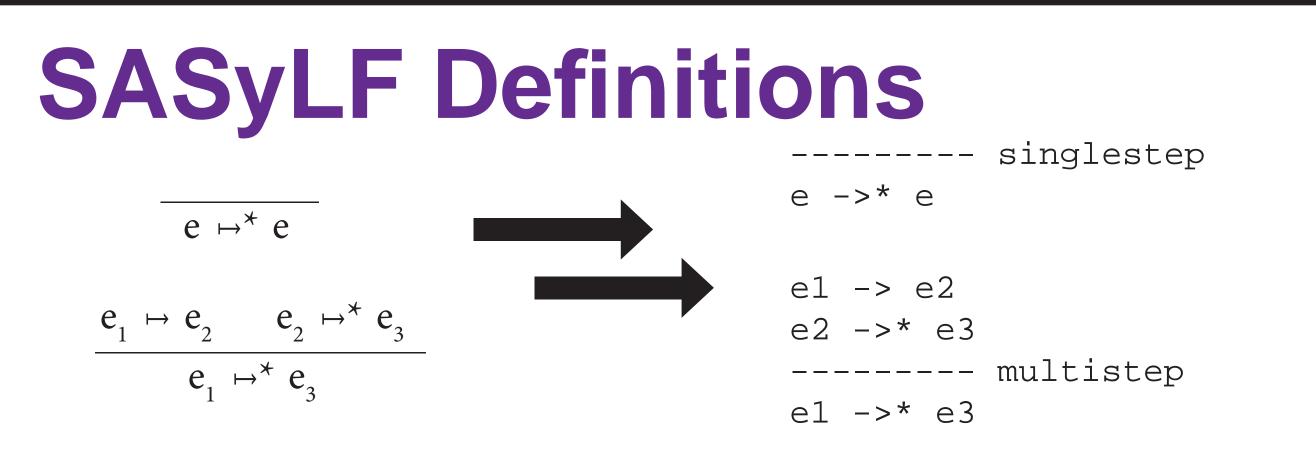
- Concepts like induction are inherently complex
- Easy to get details wrong, without realizing it
- Feedback in a typical course may take a week due to grading time

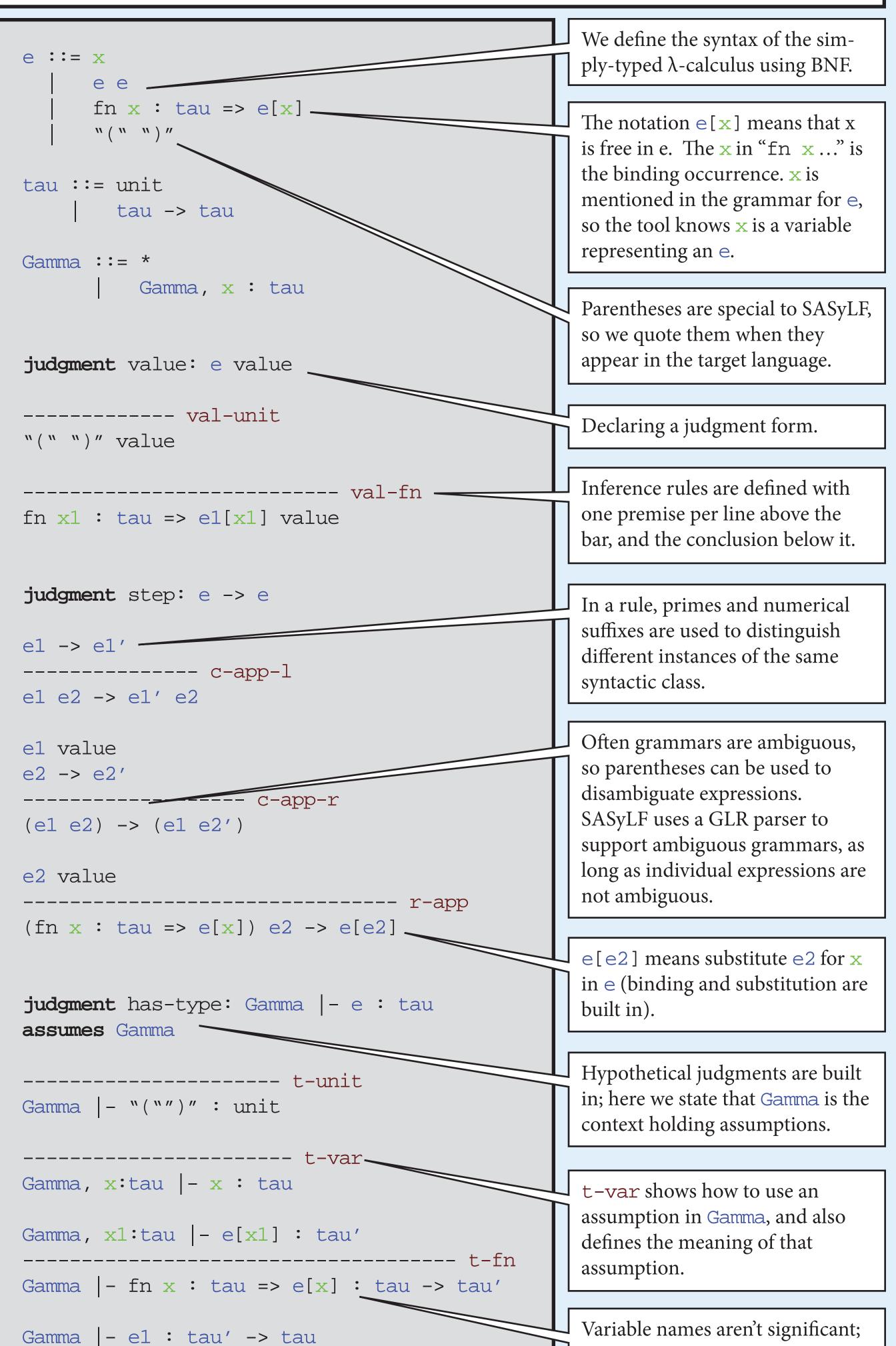
Wouldn't it be nice if there were an easy-to-use tool that provides students with immediate feedback on mistakes in their proofs?

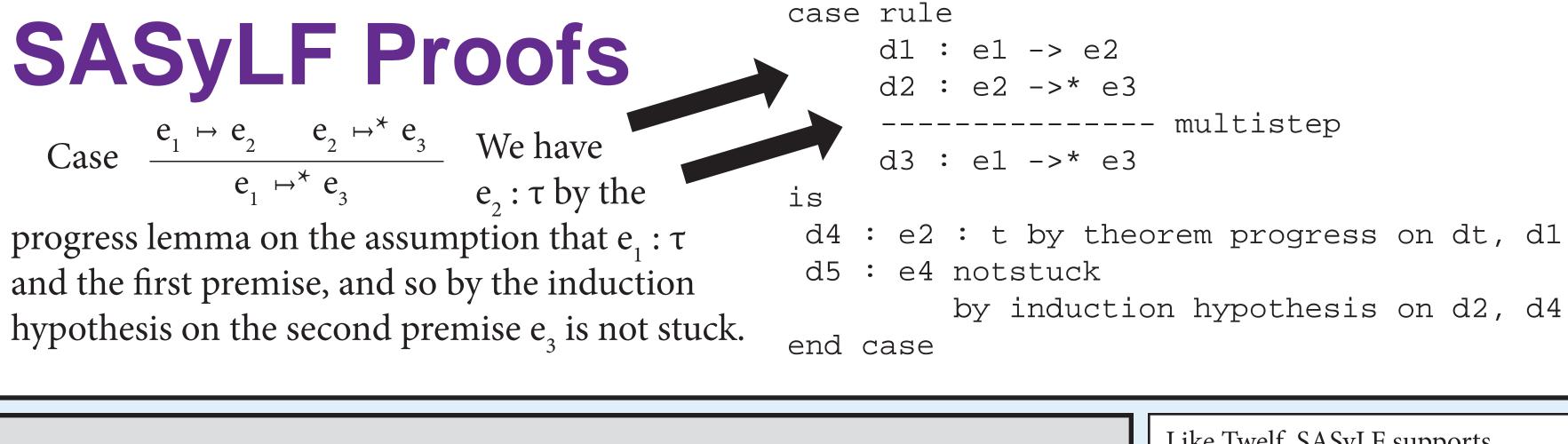
Introducing SASyLF: a Second-order Abstract Syntax Logical Framework ("Sassy Elf")

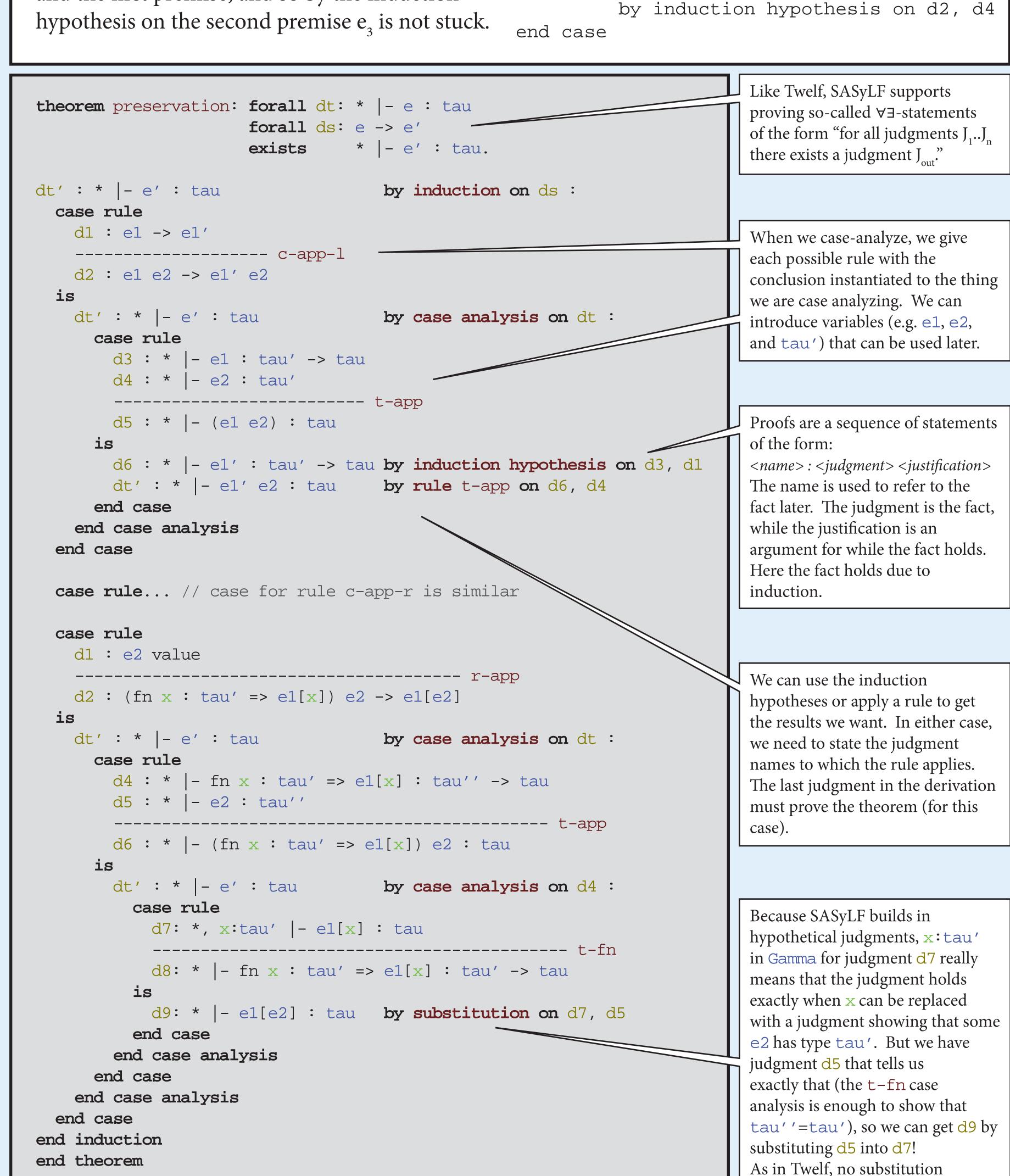
SASyLF Design Goals

- Gentle learning curve. Professors don't have time to spend teaching tools!
- Familiar syntax. The surface syntax of SASyLF mirrors paper proofs.
- Explicit notation. Making clear what is going on aids the learning process.
- Minimal math context. SASyLF is based exclusively on rule induction set theory, etc. is omitted.
- Support for variable binding. Encoding variables is difficult and distracting.
- Incremental proof development. Can write "unproved" for any statement and the assistant will assume it is true (but will yield a warning).
- Local checking and localized errors. Understanding what went wrong is critical to learning, so all checks are local and errors point to the specific low-level step that failed.









Teaching with SASyLF

we can use x1 for x as long as

we're consistent within the

premise.

We used SASyLF for an assignment on reasoning about the dynamic semantics of programs in a Spring 2008 graduate course at CMU. Our findings in a controlled experiment were generally promising:

- 11 of 13 students who used the SASyLF tool found that it helped them find errors in their proofs
- 12 of 13 said the tool increased their confidence that their proofs were correct.

Gamma | - e2 : tau'

Gamma - e1 e2 : tau

----- t-app

- In contrast, 14 of 16 members of the control (no tool) group wished they had earlier feedback on their mistakes.
- Some students dropped out due to usability issues with the tool, many of which we have since addressed. Still, 7 of 11 surveyed students who completed the study with the tool would use the tool again, and another three would use it if the usability issues were addressed.

Comparing the tool to handwritten proofs, one student said, "I actually did the entire assignment on paper first and then moved over to using the tool. I found the paper approach really easy. But once I started using the tool I started understanding the concepts better."

www.sasylf.org

- Open source release of SASyLF
- Paper(s) describing the tool and our
- teaching experience
- Documentation and examples
- A solution to part 2A of the POPLmark challenge for mechanized metatheory

lemma is required, although we

could prove one for pedagogical

purposes if we want.

Related Work

Proof Assistants used for PL Metatheory

- **Educational Tools** for Logic
 - Tutch
- Tarski's World
- **Educational Tools** for PL Theory
- DrScheme

Twelf

• Isabelle/HOL

Abella

• Coq