ACL2 Support for Interactive Proof

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OUTLINE

Introduction

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Demos (I)

Rewriting in ACL2

Demos (II)

Very Brief Survey of ACL2 Features

Conclusion
Quoting the ACL2 home page:

ACL2 is a logic and programming language in which you can model computer systems, together with a tool to help you prove properties of those models. "ACL2" denotes "A Computational Logic for Applicative Common Lisp".

Goal for this talk:
Give a sense of the ACL2 system, especially how it supports user interaction.

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But I may skip some material. I hope to leave lots of time for discussion.
Please ask questions during the talk!
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- Boyer-Moore Theorem Provers go back to the start of their collaboration in 1971.

Industrial usage:
- As far as I know, ACL2 is the only interactive theorem prover (ITP) used with some regularity at several companies: AMD, Centaur, IBM, Intel, Oracle, Rockwell Collins.
- There are also users in the U.S. Government and universities, including —
  - UT Austin: x86 interpreter defined in ACL2, validation by co-simulation, proofs about x86 machine code.
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The ACL2 logic is a first-order logic with induction up to \( \varepsilon_0 \). But all ACL2 theories extend a given ground-zero theory, which axiomizes data types for:

▶ numbers (complex rationals), characters, strings, symbols;
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  and the Eclipse-based **ACL2 Sedan**.

A potential weakness: first-order logic with only basic quantifier support (but recursion helps).
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That talk mentions this link to several demos and their logs:

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Not included above is a larger example (a SASL unification program).
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  ▶ ACL2 provides automation for induction, linear arithmetic, Boolean reasoning, rule application, . . .
  ▶ . . . but lemmas are usually needed (sometimes from libraries).
ACL2 supports formally verified extensions. In particular, GL is a verified clause processor defined and verified by an ACL2 user, Sol Swords. GL does proofs about finite domains by bit-blasting. The next demo illustrates GL. It also shows the use of LOCAL, for "private" events (using conservativity).

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The basic idea: the ACL2 rewriter automatically applies the rule

\[ H \rightarrow L = R \]

by replacing an instance \( L/s \) of \( L \) by \( R/s \), when the rewriter can verify \( H/s \).
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The documentation topic for rewrite shows many ways to control the rewriter (needed only occasionally). I’ll mention only a few:
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ACL2 >:pe fold-consts-in-+

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-158 (DEFTHM FOLD-CONSTS-IN+
  (IMPLIES (AND (SYNTAXP (QUOTEP X))
                 (SYNTAXP (QUOTEP Y)))
             (EQUAL (+ X (+ Y Z)) (+ (+ X Y) Z))))
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ACL2 >
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▶ ACL2 heuristically chooses and applies a destructor-style induction scheme.
▶ ACL2 simplifies the base and induction steps.
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— **DEMO** (excerpted from my TPHOLs 2008 talk) —
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VERY BRIEF SURVEY OF ACL2 FEATURES
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▶ . . . by exploring briefly the **ACL2 documentation**.

**NOTE:**
I would be very happy to elaborate on any of these topics!
Very Brief Survey of ACL2 Features (2)

In particular, we might explore a few debugging features, as time and interest permit.

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- cgen
- cw-gstack
- disassemble$
- dmr
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- failure
- find-lemmas
- forward-chaining-reports
- guard-debug
- measure-debug
- nil-goal
- print-gv
- profile-acl2
- profile-all
- proof-checker
- proof-tree
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ACL2 provides automation but scales to large problems... with libraries and by supporting user interaction.

For more information, see the ACL2 home page.

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