ACL2 Support for Automated and Interactive Proof

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The University of Texas at Austin
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KeY Workshop, July 27, 2015
OUTLINE

Introduction

Background

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 a combination of automated proof and user interaction.

BUT HOW CAN I ACHIEVE THIS GOAL?
My answer ....
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- Please ask questions during the talk!
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- **Workshop series**: #13 is at UT, Oct. 1-2, 2015.
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Development history:
- 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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ACL2 extensions are conservative (a demo will discuss this).

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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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All demos today, with logs, are in the gzipped tar file demos.tgz in this directory.

ACL2 programming and evaluation

[DEMO]: file demo-1.lsp (log demo-1-log.txt)

ACL2 as an automatic theorem prover

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ACL2 provides automation for induction, linear arithmetic, Boolean reasoning, rule application, ...

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DEMOS (I) (CONTINUED)

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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             (EQUAL (+ X (+ Y Z)) (+ (+ X Y) Z))))
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ACL2 !>
REWITING IN ACL2 (3)

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- Our final demo illustrates “the method” recommended for dealing with proof failures.
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- cw-gstack
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