Automated Theorem Proving and Discovery

Prof. Marek Rychlik
email: rychlik@math.arizona.edu
http://alamos.math.arizona.edu

October 4, 2004

Course Description

Automatic theorem proving connects rigorous mathematics with current advances in computation. It is a field devoted to creating systems capable of proving and discovering new theorems via computation. The field has matured over the years and a number of interesting texts and software systems have become available.

This course is devoted to the major developments in the area of automated theorem proving to-date. It will present techniques, software and sample applications. As a basis for the class discussion we will use the following textbook:

Melvin Fitting: *First-Order Logic and Automated Theorem Proving*
1996, 2nd ed, Springer-Verlag, ISBN:0387945938

The course will begin with a mathematically rigorous exposition of propositional first-order logic. This is the framework independent of any particular proof mechanization technique. Subsequently, we will study well-known proof procedures: tableau, resolution, natural deduction, Gentzen sequents and axiom systems.

We will see how the subject ties with deep mathematical issues of completeness of deduction systems. Some theorems and topics covered in the class will include: **a Model Existence Theorem, Models and Interpretations, Compactness and Interpolation, Beth Definability Theorem.** The subject matter will be illustrated with demonstrations of theorem provers written in the *Prolog* programming language and *ACL2*, which is well-known for being able to prove quite famous theorems by transfinite induction.

Prerequisites

A course in one or more of the following subject:

1. Foundations of Mathematics.
2. Real Analysis
3. Discrete Mathematics
4. Theory of Computation
5. Good general mathematical background and a dose of enthusiasm.

The following are a plus: A working knowledge of a programming language, experience with a CAS like Mathematica, Maxima (formerly MACSYMA) or Maple, general experience in the use of computers.