

# Selected Topics in Automated Reasoning

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## 1. Propositional logic

- Syntax; semantics; models, validity, satisfiability, entailment, equivalence;
- Translation to CNF/DNF;
- Resolution: soundness; completeness (multiset orderings; ordering on clauses; the model construction; idea of completeness proof)
- The DPLL method

## 2. First-order logic

- Syntax, semantics: models and assignments; validity, satisfiability; Entailment and equivalence;
- Validity vs. unsatisfiability.
- The theory of a structure; Logical theories (syntactic/semantics view).
- Normal forms and Skolemization
- Herbrand interpretations (definition)
- General resolution (resolution for ground clauses, Robinson's idea; unification, lifting lemma, saturation of sets of general clauses, refutational completeness of resolution, ordered resolution with selection, redundancy)
- Herbrand's theorem, the theorem of Lwenheim-Skolem (only statement)

## 3. Decidable fragments of first-order logic

- Variable-free formulae; variable-free Horn formulae
- The Bernays-Schoenfinkel class (definition, main idea in decidability proof)

## 4. Satisfiability w.r.t. a theory

- Convex theories, T-validity vs. T-satisfiability.

5. Theory of uninterpreted function symbols  
(validity of univ. formulae; satisfiability of ground formulae)
  - Ackermann's reduction
  - optimized satisfiability check using confluence closure on DAGs
6. Difference logic (method for checking satisfiability; idea of proof)
7. Combinations of theories (definition: syntactical vs. semantical view; examples)
8. The Nelson/Oppen procedure for reasoning in combinations of theories over disjoint signatures.
9. DPLL(T)
10. Locality: main ideas