Logical
Inference 1
introduction
Chapter 9

Some material adopted from notes by Andreas Geyer-Schulz,, Chuck Dyer, and Mary Getoor

# Overview

- Model checking for propositional logic
- Rule based reasoning in first-order logic
  - Inference rules and generalized modes ponens
  - -Forward chaining
  - -Backward chaining
- Resolution-based reasoning in first-order logic
  - Clausal form
  - -Unification
  - -Resolution as search
- Inference wrap up

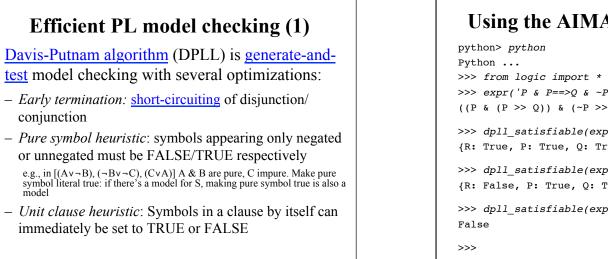
## PL Model checking

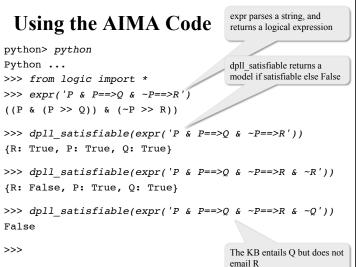
- Given KB, does sentence S hold?
- Basically generate and test:
  - -Generate all the possible models
  - -Consider the models M in which KB is TRUE
  - $-\operatorname{If} \forall M \ S$  , then S is provably true
  - -If  $\forall M \neg S$ , then S is **provably false**
  - -Otherwise ( $\exists M1 \ S \land \exists M2 \neg S$ ): S is satisfiable but neither provably true or provably false

### From Satisfiability to Proof (1)

- To see if a satisfiable KB entails sentence S, see if  $\underline{KB} \land \neg \underline{S}$  is satisfiable
  - -If it is not, then the KB entails S
  - -If it is, then the KB does not email S
  - -This is a refutation proof
- Consider the KB with (P, P=>Q, ~P=>R) -Does the KB it entail Q? R?

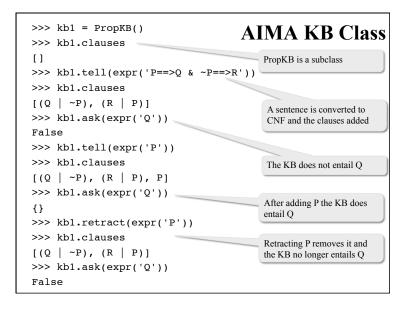
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#### Efficient PL model checking (2)

- <u>WalkSAT</u> is a local search for satisfiability: Pick a symbol to flip (toggle TRUE/FALSE), either using min-conflicts *or* choosing randomly
- ... or you can use *any* local or global search algorithm!
- There are many model checking algorithms and systems
  - -See for example, MiniSat
  - -International SAT Competition (2003, ... 2012)



#### **Reminder: Inference rules for FOL**

- Inference rules for propositional logic apply to FOL as well
  - Modus Ponens, And-Introduction, And-Elimination, ...
- New (sound) inference rules for use with quantifiers:
  - -Universal elimination
  - -Existential introduction
  - -Existential elimination
  - -Generalized Modus Ponens (GMP)