COMP2111 Week 5
Term 1, 2019
Predicate Logic: Tools
Logic, computationally

- Easy problems: verifying a proof, checking a satisfying model
- Hard problems: finding a proof, finding a satisfying model
Summary

- Theorem provers
- SMT solvers
- Knowledge Based Systems
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Theorem provers

Proof assistants:

- Interactive/directed theorem proving
- Some have automated theorem proving
- Minimal default behaviour
  - Can implement a wide range of logical systems
  - Can prove correctness from foundations
- Some can extract code from specifications (e.g. Coq)
Theorem provers: Examples

- Coq (used to prove 4-colour theorem)
- Isabelle (proved functional correctness of seL4 microkernel)
- HOL (proved Kepler conjecture)
- Natural deduction prover
Summary

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Satisfaction Modulo Theories

- SAT solvers for (fragments of) Predicate Logic
- Theories force certain interpretations (e.g. arithmetic)
- Two main approaches:
  - Convert everything into SAT
  - Combination of SAT solver and Theory-specific solvers

Advantages
- Tend to be very fast
- Good at handling domain-specific logic (e.g. arithmetic)

Disadvantages
- Restricted to quantifier-free fragments
- Unwieldy statements
SMT solvers: Examples

- **Z3**
  - Wide range of built-in theories
  - Backend for verification tools such as Dafny (see SENG2011)
- **OpenSMT**
- **CVC4**
Example usage

Logic puzzles (e.g. Zebra puzzle)

Example

- The Spaniard lives to the right of the red house
- The Norwegian lives in the blue house
- The Italian lives in house #2

Question: Who lives in the white house?
Summary

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Knowledge Based Systems

Build up “knowledge” from base facts and inference rules

Advantages
- Works with unrestricted Predicate logic
- Simpler statements

Disadvantages
- More fine-tuning of constraints required
- Can be quite slow
KBS: Example

IDP: Knowledge Based System for Predicate Logic
Example usage

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