

The Lean Theorem Prover

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If you want to follow along:

- `https://leanprover.github.io/download`
- `https://github.com/gebner/avm2017_tutorial`

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Conclusion

The Lean Theorem Prover

- Interactive theorem prover
- Started in 2013, major rewrite in 2016
- Primarily developed by Leonardo de Moura (Microsoft)
- Big group at CMU around Jeremy Avigad
- <https://leanprover.github.io/>
- Open Source

Logical foundations

- Dependent type theory
 - Variant of the Calculus of Inductive Constructions
- Small kernel
 - Only basic inductive types and structural recursion
 - Well-founded recursion, etc., defined on top
- Proofs can be independently checked
 - 3 independent type-checkers
 - \sim 1500 lines of code

Dependent type theory is beautiful. Everything is a term:

- Formulas
- Proofs
- Terms
- Types
- Programs
- Tactics

Definitions, recursion/induction, etc. work *uniformly* on them.

- Dependent pattern-matching
- Type classes
- Coercions
- Inductive data types & structures (records)
- Do-notation (monads)
- Default arguments
- Call-by-name arguments
- Custom operators

Proof automation

- Type-class inference
 - General back-chaining solver
- Simplifier
 - (Conditional) term rewriting system
- Congruence closure (modulo AC)
- Unit propagation
- Heuristic instantiation (E-matching)
 - “SMT tactics”

Meta-programming features

- Fast virtual machine
- Profiler
- Debugger
- Efficient meta-programming
- Tactics implemented in Lean
- User-extensible syntax

Interactive features

- Plugins for Emacs and VS Code
 - and for Vim, and an online editor
- Immediate checking
- Go-to-definition, etc.
- Parallel and incremental compilation

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Coming soon

- Native compilation
- Automation for arithmetic
- Macros and refactoring
- Special-purpose automation
 - Bit-blasting
 - Presburger arithmetic

Further material

- Three online tutorials:
<https://leanprover.github.io/documentation/>
- Reference manual:
<https://leanprover.github.io/reference/>
- Gitter chat:
https://gitter.im/leanprover_public/Lobby
- Mailing list:
<https://groups.google.com/d/forum/lean-user>