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A Comprehensible Automated Theorem Prover for the Sequent Calculus Verifier

What?

- A prover that produces readable proofs in the SeCaV system for first-order logic
- A formal proof of soundness/completeness for the prover in Isabelle/HOL
- A prover where students can understand every part of both the prover itself and the proofs it generates

Algorithm

- Phases: $\alpha\beta\delta$-rules followed by γ-rules for every term in the sequent
- Phases control the rule applications to make the algorithm complete
- Two structural rules: Rotate for moving formulas and Duplicate for copying γ-formulas
- Only one rule is ever applicable (enabled)
- The prover constructs a coinductive proof tree by applying the rules
- Provable formulas result in finite proof trees
- Unprovable formulas result in trees containing infinite "escape paths" (i.e. the prover runs forever, since validity is only semi-decidable)

An analytic completeness proof (work ongoing)

- The prover either terminates with a finite proof tree or produces a tree containing a saturated escape path
- The formulas on a saturated escape path form a Hintikka set
- We can construct a countermodel from this Hintikka set (!)
- This means the prover must produce finite trees for valid formulas