

Aesop: White-Box Best-First Proof Search for Lean

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Aesop's Approach to Proof Search

Proof Search with Metavariables

Aesop's Approach to Proof Search

Proof Search with Metavariables

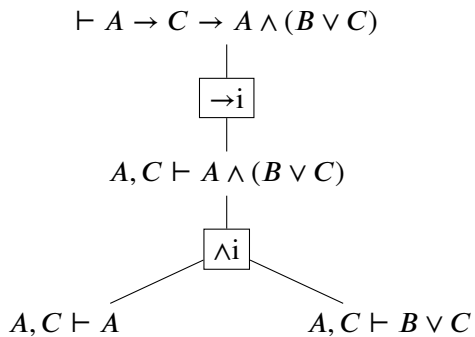
Basic Procedure

$$\vdash A \rightarrow C \rightarrow A \wedge (B \vee C)$$

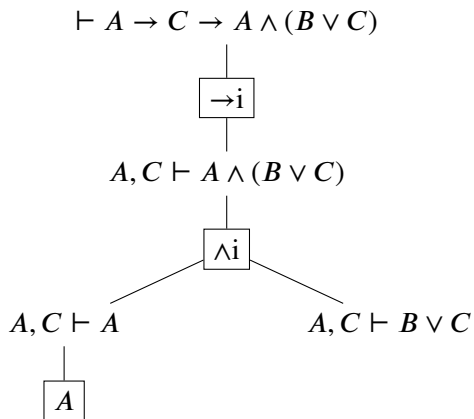
Basic Procedure

$$\vdash A \rightarrow C \rightarrow A \wedge (B \vee C)$$
$$\boxed{\rightarrow i}$$
$$A, C \vdash A \wedge (B \vee C)$$

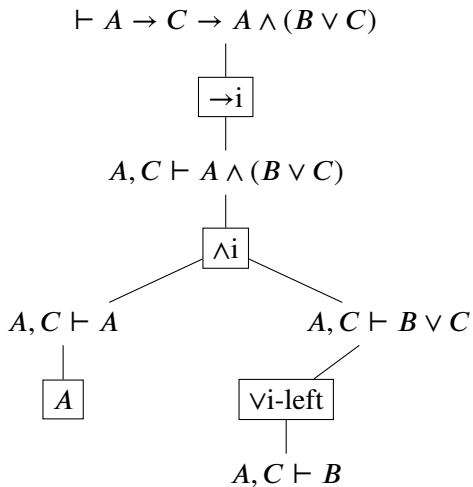
Basic Procedure



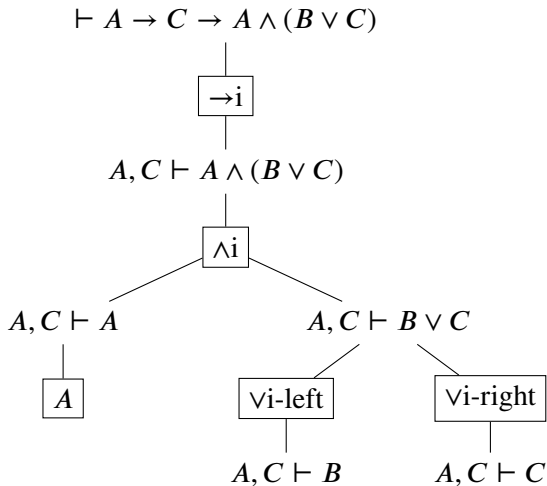
Basic Procedure



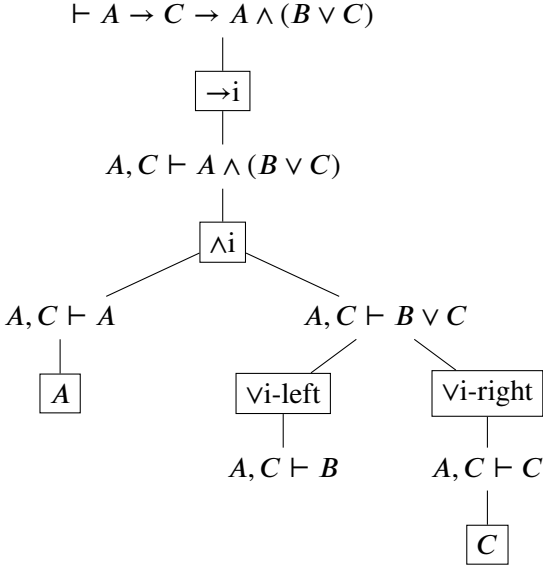
Basic Procedure



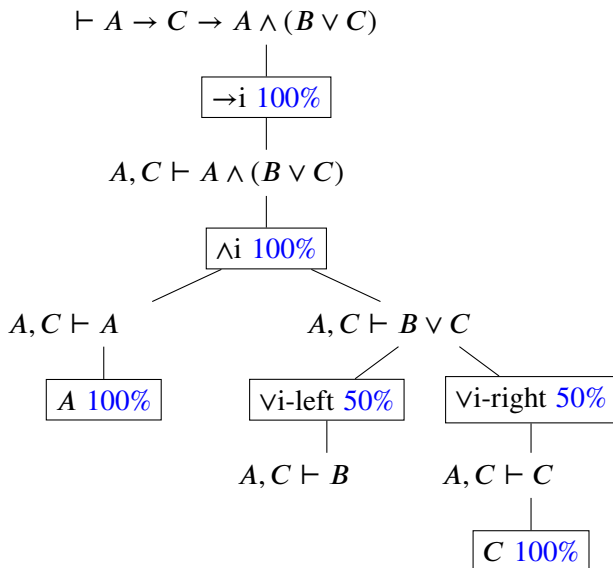
Basic Procedure



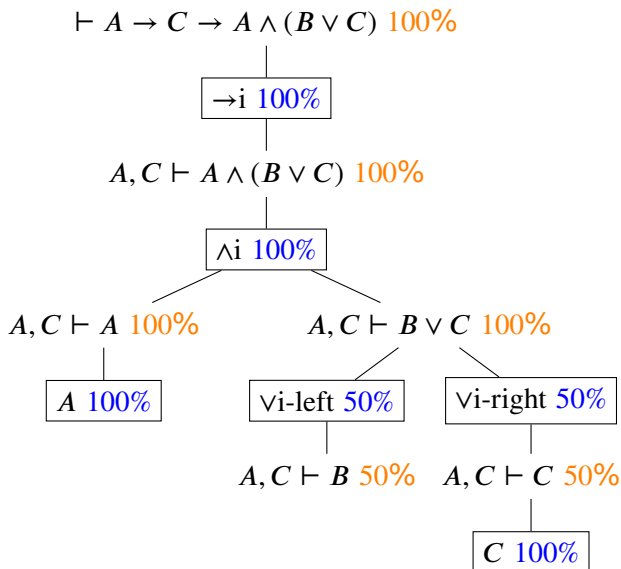
Basic Procedure



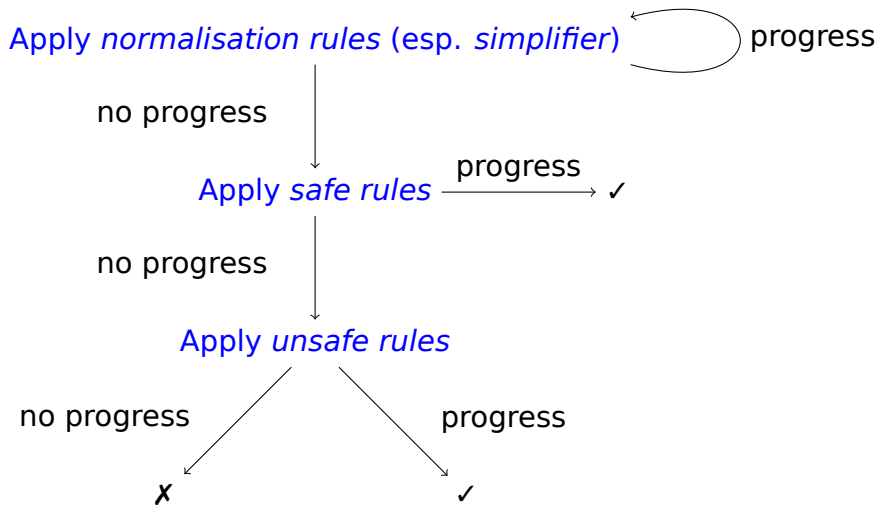
Best-First Search




Best-First Search

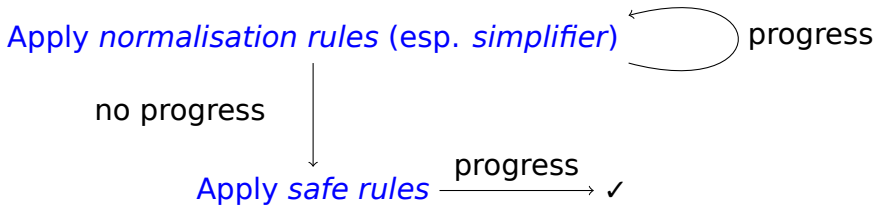


Extensions of the Basic Procedure

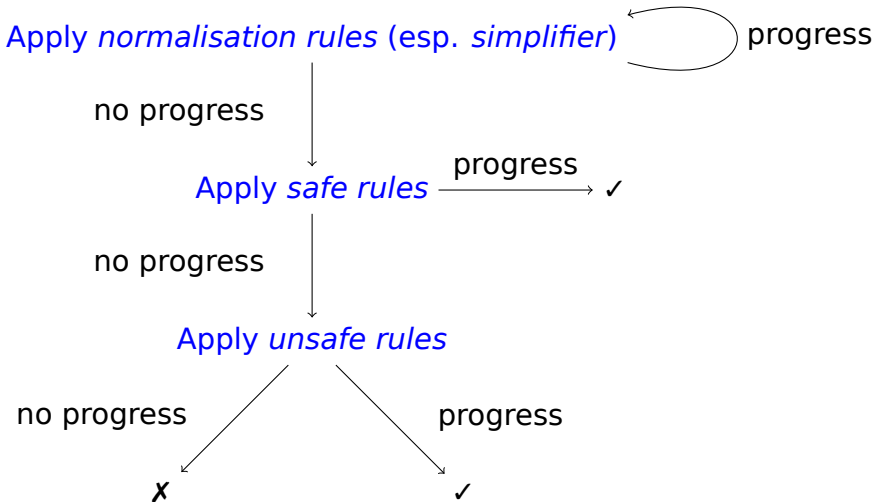


Apply *normalisation rules* (esp. *simplifier*)  progress

$$\frac{\Gamma, A, B \vdash T}{\Gamma, A \wedge B \vdash T} \wedge e$$



$$\frac{\Gamma \vdash A \quad \Gamma \vdash B}{\Gamma \vdash A \wedge B} \wedge i$$



Aesop's Approach to Proof Search

Proof Search with Metavariables

Proof Search with Metavariables

$$a < b, a < c, b < z \vdash a < z$$

Proof Search with Metavariables

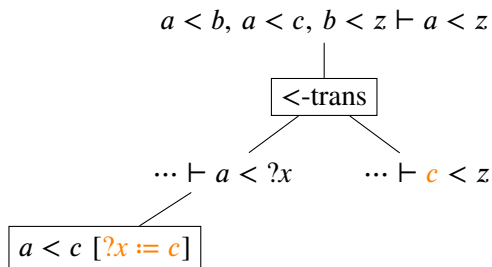
$a < b, a < c, b < z \vdash a < z$

$\langle\text{-trans}$

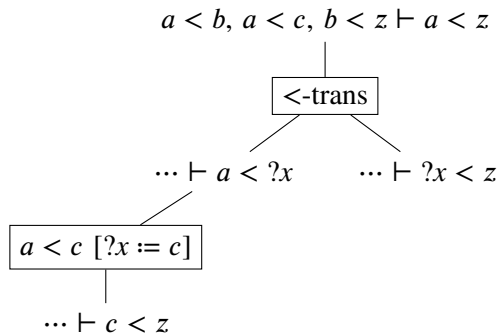
$\dots \vdash a < ?x$

$\dots \vdash ?x < z$

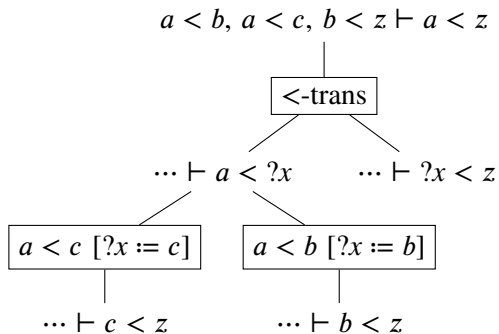
Proof Search with Metavariables



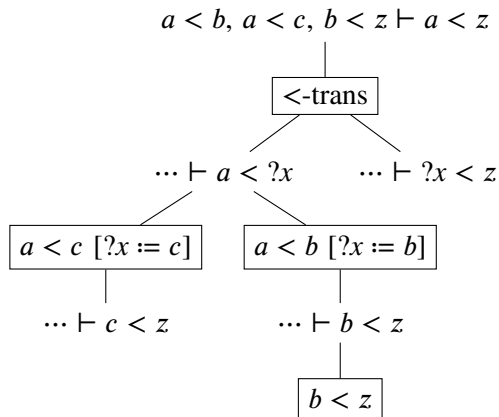
Proof Search with Metavariables



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Also in the Paper

- Built-in rules
- Rule indexing
- UI for adding common sorts of rules
- Case studies

Also in the Paper

- Built-in rules
- Rule indexing
- UI for adding common sorts of rules
- Case studies
 - 173 basic lemmas about lists (Aesop + induction proves 94%)
 - Sequent calculus prover

White-Box and Black-Box Proof Automation

Black-box

hammers

SMT solvers

ML-based provers

Coq sauto

Agsy

White-box

Coq eauto

Matita auto

Isabelle auto

Isabelle auto2

PVS grind

ACL2 waterfall

Aesop

White-Box and Black-Box Proof Automation

Black-box

fully automatic
powerful
the future

White-box

needs configuration
weak
boring old tech

White-Box and Black-Box Proof Automation

Black-box

fully automatic

powerful

the future

complex

unpredictable

opaque

fixed performance

proof export is hard

White-box

needs configuration

weak

boring old tech

simple

predictable

transparent

customisable performance

proof export is easy(ish)

White-Box and Black-Box Proof Automation

Black-box

hammers
SMT solvers
ML provers
Coq sauto
Agsy

Semi-white-box

Isabelle auto
Isabelle auto2
PVS grind
ACL2 waterfall

White-box

Coq auto
Matita auto?
Aesop