

# Beyond DRAT: Challenges in Certifying UNSAT<sup>1</sup>

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<sup>1</sup> Supported by FWF project P27528



## ARCADE

*“...bring together key people from various sub-communities of automated reasoning ...”*

## My research

- term rewriting
- automation
- certification
- CADE reviewing

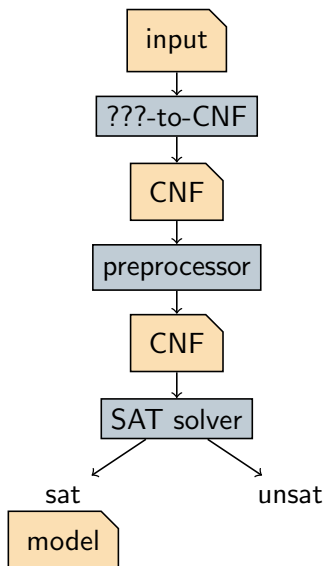
## Current state

- DRAT is de facto standard proof format for UNSAT
- covers DPLL+CDCL and many preprocessing techniques
- complete in theory
- some techniques are hard to express

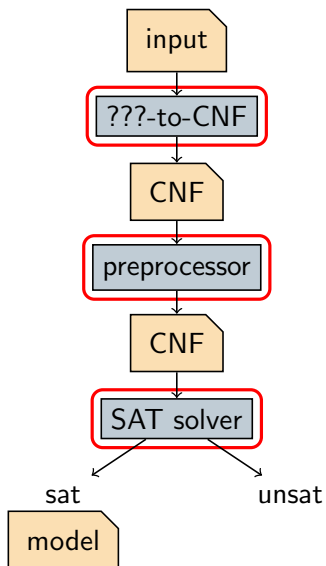
## Challenge

- certification for such techniques

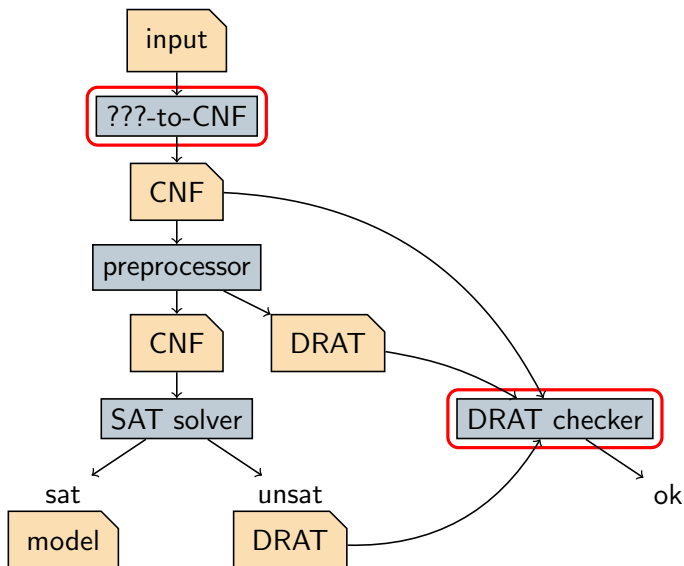
# SAT workflow



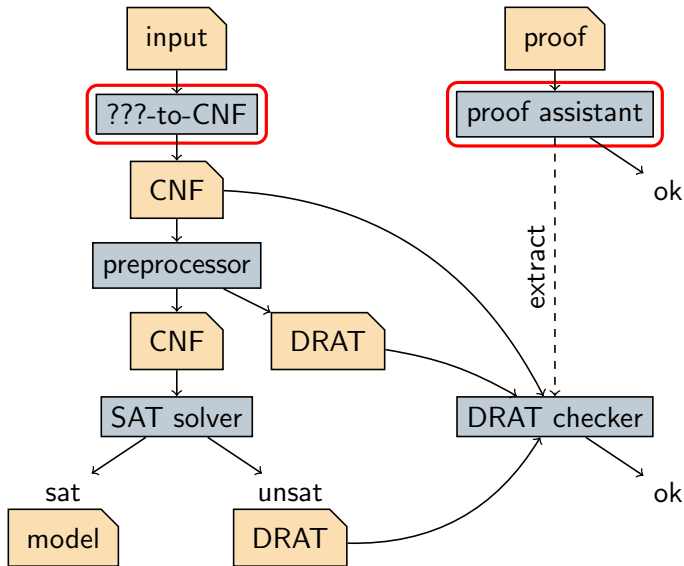
# SAT workflow



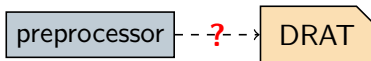
# SAT workflow



# SAT workflow



# DRAT in a nutshell

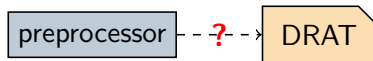


## DRAT

- sequence of clause additions and deletions
- steps preserve satisfiability
- **at most one variable changes in each clause addition**



# DRAT in a nutshell



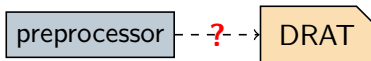
## DRAT

- sequence of clause additions and deletions
- steps preserve satisfiability
- at most one variable changes in each clause addition

## CADE-26 update: Propagation Redundancy

- some fixed variables may change to fixed values

# DRAT and Symmetry Breaking



## Symmetry breaking

- symmetries **permute** satisfying assignments
- add lex-leader constraints
- tedious in DRAT
  - define new variables for variables affected by permutation
  - copy clauses
  - derive lex-leader constraint
  - delete old clauses
  - repeat
- small witnesses exist
- BreakIDCOMiniSatPS won No-Limit track in SAT 2016 competition

## Proposal

- verified implementations allow more complex checkers
- ⇒ add dedicated checking for hard techniques like symmetry breaking

## Challenges

- common format
- extensibility
  - symmetry breaking
  - XOR constraints
  - pseudo-boolean constraints
  - ... (domain-specific?)
- partial checkability