Overall Goal
Obtain a verified symmetry breaking tool for SAT by formalizing Crawford's idea for symmetry breaking [2].

Motivation
• Unlike other tools in the SAT ecosystem, this requires a mix of graphs and Boolean formulas.
• Practically relevant to compare to Shatter [3], BreakID [4], etc.
• Used beyond SAT (e.g., ASP).

Typical SAT Workflow
Original Problem
Boolean Formula
CNF Transformation
CNF Formula
Symmetry Breaker
Formula w/o Symmetries
SAT Solver [1]
Solution
Model

Preliminary Results:
PVS Formalization
We have formalized Theorem 1 using PVS. This work is available at the URL below. Some of the challenges we faced:
• Explicit type coercions, bloating the notation.
• Heavy case analysis over the edge datatype.

The Road Ahead
• Formalizing Theorem 2.
• Obtaining executable code from the formalizations.
• Adapt the formalizations to the approach in Shatter [3], BreakID [4].
• Carry out performance analysis.

Theorem 1: Given a formula \( F \) and a color-preserving automorphism \( \phi \) of its incidence graph, an assignment \( a \) satisfies \( F \) if and only if the assignment \( a \circ \phi \) satisfies \( F \).

\[ p_1(x) = i_1 \leq \pi(i_1) \]
\[ p_i(x) = \left( \bigwedge_{j=1}^{i-1} i_j = \pi(i_j) \right) \rightarrow i_i \leq \pi(i_i) \text{ for } 1 < i \leq n \]
\[ p_n(x) = \bigwedge_{i=1}^{n} p_i(x) \]

Appendix symmetry breaking clauses as per Theorem 2 for every color-preserving automorphism breaks the syntactic symmetries of the formula.

References

Crawford's Symmetry Breaking [2]

Theorem 2: Given a CNF formula \( F \) and a color-preserving automorphism \( \phi \) of its incidence graph, \( F \) is satisfiable if and only if \( F \land P(\phi) \) is satisfiable, where

\[ p_1(x) = i_1 \leq \pi(i_1) \]
\[ p_i(x) = \left( \bigwedge_{j=1}^{i-1} i_j = \pi(i_j) \right) \rightarrow i_i \leq \pi(i_i) \text{ for } 1 < i \leq n \]
\[ p_n(x) = \bigwedge_{i=1}^{n} p_i(x) \]

Appending symmetry breaking clauses as per Theorem 2 for every color-preserving automorphism breaks the syntactic symmetries of the formula.

Example graph for \((x, \lor x) \land (x, \lor \neg x)\)