flea

bit(e)s and pieces

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Hofstadter's Law: It always takes longer than you expect, even when you take into account Hofstadter's Law.

— Douglas Hofstadter, Gödel, Escher, Bach: An Eternal Golden Braid

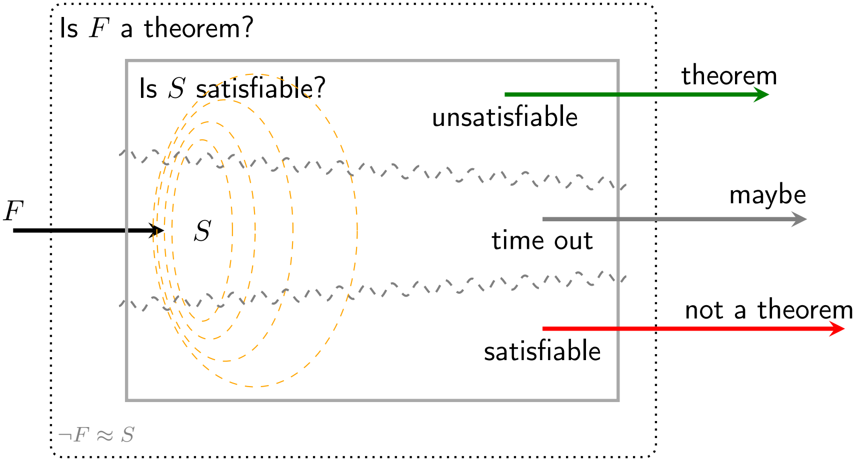
1. Previously
2. Procedure
3. Equality
4. work to do

References

Clark Barrett, Pascal Fontaine, and Cesare Tinelli, *The Satisfiability Modulo Theories Library (SMT-LIB)*, `www.SMT-LIB.org`, 2016.

Bruno Dutertre, *Yices 2.2*, Computer-Aided Verification (CAV'2014) (Armin Biere and Roderick Bloem, eds.), Lecture Notes in Computer Science, vol. 8559, Springer, July 2014, pp. 737–744.

Goal


Is F a theorem?
Is S satisfiable?
unsatisfiable
theorem
F
S
maybe
time out
not a theorem
satisfiable
$\neg F \approx S$

Definition (Ordered Resolution)

$$\frac{L \vee C \quad \neg L' \vee D}{(C \vee D)\sigma}$$

where

$L\sigma$ strictly maximal in $C\sigma$, $\neg L'\sigma$ maximal in $D\sigma$, $\sigma = \mathrm{mgu}(L, L')$.

Definition (Inst-Gen)

$$\frac{L \vee C \quad \neg L' \vee D}{(L \vee C)\sigma \quad (\neg L' \vee D)\sigma}$$

where

$$\mathrm{sel}(L \vee C) = L \qquad \mathrm{sel}(\neg L' \vee D) = \neg L' \qquad \sigma = \mathrm{mgu}(L, L')$$

Example (Resolution)

$$\dfrac{\dfrac{\mathsf{P}(x) \vee \neg\mathsf{P}(y) \quad \neg\mathsf{P}(\mathsf{a})}{\neg\mathsf{P}(y) \quad \mathsf{P}(\mathsf{b})}\ x \mapsto \mathsf{a}}{\square}\ y \mapsto \mathsf{b}$$

Example (Inst-Gen)

$$S_0\bot = \{\mathsf{P}(\bot) \vee \neg\mathsf{P}(\bot), \neg\mathsf{P}(\mathsf{a}), \mathsf{P}(\mathsf{b})\}$$ satisfiable

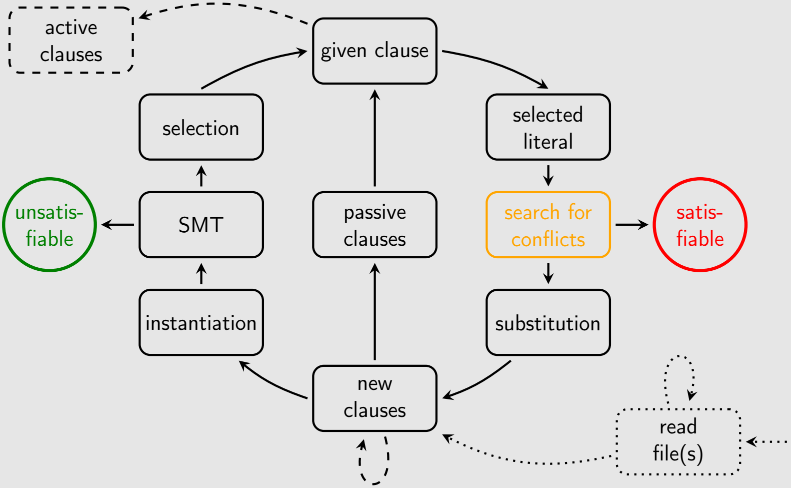
$$\dfrac{\mathsf{P}(x) \vee \neg\mathsf{P}(y)) \quad \neg\mathsf{P}(\mathsf{a})}{\mathsf{P}(\mathsf{a}) \vee \neg\mathsf{P}(y)}\ x \mapsto \mathsf{a}$$

$$S_1\bot \supsetneq \{\neg\mathsf{P}(\mathsf{a}), \mathsf{P}(\mathsf{b}), \mathsf{P}(\mathsf{a}) \vee \neg\mathsf{P}(\bot)\}$$ satisfiable

$$\dfrac{\mathsf{P}(\mathsf{b}) \quad \mathsf{P}(\mathsf{a}) \vee \neg\mathsf{P}(y)}{\mathsf{P}(\mathsf{a}) \vee \mathsf{P}(\mathsf{b})}\ y \mapsto \mathsf{b}$$

$$S_2\bot \supsetneq \{\neg\mathsf{P}(\mathsf{a}), \mathsf{P}(\mathsf{b}), \mathsf{P}(\mathsf{a}) \vee \neg\mathsf{P}(\mathsf{b})\}$$ unsatisfiable

Run-Loop


active clauses
given clause
selection
selected literal
unsatis- fiable
SMT
passive clauses
search for conflicts
satis- fiable
instantiation
substitution
new clauses
read file(s)

Subsumption

$S = \{C, D, \ldots\}$ $\quad \exists\theta\ C\theta \subseteq D$ $\quad$ C subsumes D

$$S \text{ satisfiable } \overset{\checkmark}{\Longleftrightarrow} (S \setminus D) \text{ satisfiable}$$

$$\theta \text{ is proper, } S\bot \text{ satisfiable } \overset{\text{✗}}{\Longleftrightarrow} (S \setminus D)\bot \text{ satisfiable}$$

$$\theta \text{ is renaming, } S\bot \text{ satisfiable } \overset{\checkmark}{\Longleftrightarrow} (S \setminus D)\bot \text{ satisfiable}$$

Example

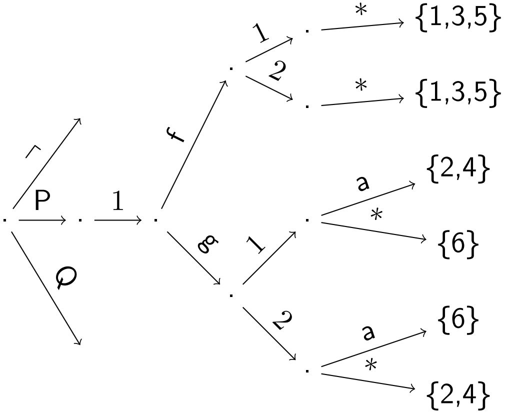
$\{\mathsf{P}(x, y), \neg\mathsf{P}(\mathsf{a}, z)\}$ $\quad$ $\{\mathsf{P}(x, y), \neg\mathsf{P}(\mathsf{a}, z), \mathsf{P}(\mathsf{a}, z)\}$

$\{\mathsf{P}(\bot, \bot), \neg\mathsf{P}(\mathsf{a}, \bot)\}$ $\quad$ $\{\mathsf{P}(\bot, \bot), \neg\mathsf{P}(\mathsf{a}, \bot), \mathsf{P}(\mathsf{a}, \bot)\}$

needed data structures

1. representation of clauses, literals and terms
2. fast retrieval of clauses with a selected literal that is unifiable with the negation selected literal of a given clause
3. fast retrieval of clauses with a set of literals that is a renamed subset of a given clause

$$\{{}^{1:}\mathsf{P}(\mathsf{f}(x,x)), {}^{2:}\mathsf{P}(\mathsf{g}(\mathsf{a},x)), {}^{3:}\mathsf{P}(\mathsf{f}(y,z)), {}^{4:}\mathsf{P}(\mathsf{g}(\mathsf{a},y)), {}^{5:}\mathsf{P}(\mathsf{f}(y,x)), {}^{6:}\mathsf{P}(\mathsf{g}(y,a))\}$$



$$\neg\mathsf{P}(\mathsf{g}(\mathsf{b},z)) \mapsto \{\mathsf{P}.1.\mathsf{g}.1.\mathsf{b}, \mathsf{P}.1.\mathsf{g}.2.*\} \mapsto \{6\} \cap \{2,4,6\}$$

Example

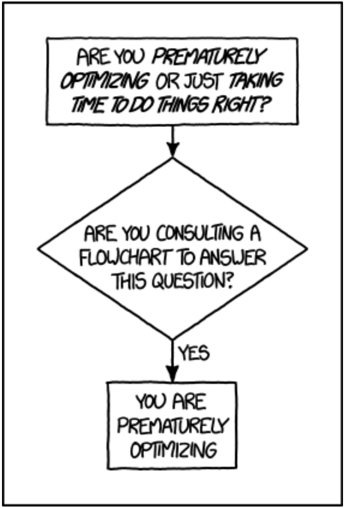
$$S = \{\mathsf{P}(\mathsf{a}), \neg\mathsf{P}(\mathsf{f}(\mathsf{a},\mathsf{b})), \mathsf{f}(x,\mathsf{b}) = x\} \qquad \text{unsatisfiable}$$

$$\mathsf{a} \neq y \lor \neg\mathsf{P}(\mathsf{a}) \lor \mathsf{P}(y) \qquad \mathsf{P}(\mathsf{a}),\ \text{congruence}$$

Schemata

$$
\begin{array}{rl}
x = x & s \neq s \\
x \neq y \lor y = x & s \neq t \\
x \neq y \lor y \neq z \lor x = z & s \neq t \\
x_1 \neq y_1 \lor x_2 \neq y_2 \lor \mathsf{f}(x_1, x_2) = \mathsf{f}(y_1, y_2) & \mathsf{f}(s_1, s_2) \neq \mathsf{f}(t_1, t_2) \\
x \neq y \lor \neg\mathsf{P}(x) \lor \mathsf{P}(y) & \mathsf{P}(s) \\
x \neq y \lor \neg\mathsf{P}(x) \lor \mathsf{P}(y) & \neg\mathsf{P}(s)
\end{array}
$$

- migrate to Linux / Swift 3
- integrate unit superposition
- integrate ordered maximal completion
- experiments
- optimizations


ARE YOU PREMATURELY OPTIMIZING OR JUST TAKING TIME TO DO THINGS RIGHT?
ARE YOU CONSULTING A FLOWCHART TO ANSWER THIS QUESTION?
YES
YOU ARE PREMATURELY OPTIMIZING