Clausal Deletion Backdoors for QBF

Leif Eriksson - Independent researcher
Victor Lagerkvist - Linköping University
Sebastian Ordyniak - University of Leeds
George Osipov - Royal Holloway and Linköping University
Fahad Panolan - University of Leeds
Mateusz Rychlicki - Independent researcher

KR 2026

Theory vs Practice of SAT Solving

Theory

CNF-SAT is NP-complete.

Practice

SAT solvers can deal with instances with millions of variables.

Theory vs Practice of SAT Solving

Backdoors?

Theory

CNF-SAT is NP-complete.

Practice

SAT solvers can deal with instances with millions of variables.

Proposed explanation: backdoors

$$(x_1 \lor \overline{x_2} \lor x_3) \land (\overline{x_5} \lor \overline{x_4} \lor \overline{x_3}) \land (x_5 \lor \overline{x_6}) \land (\overline{x_7} \lor \overline{x_8} \lor \overline{x_3}) \land (x_8 \lor \overline{x_9} \lor x_3) \land (\overline{x_1} \lor \overline{x_8} \lor x_3)$$

Theory vs Practice of SAT Solving

Backdoors?

Theory

CNF-SAT is NP-complete.

Practice

SAT solvers can deal with instances with millions of variables.

Proposed explanation: backdoors

$$(x_1 \vee \overline{x_2} \vee x_3) \wedge (\overline{x_5} \vee \overline{x_4} \vee \overline{x_3}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_8} \vee \overline{x_3}) \wedge (x_8 \vee \overline{x_9} \vee x_3) \wedge (\overline{x_1} \vee \overline{x_8} \vee x_3)$$

Theory vs Practice of SAT Solving

Backdoors?

Theory

CNF-SAT is NP-complete.

Practice

SAT solvers can deal with instances with millions of variables.

Proposed explanation: backdoors

$$(x_1 \vee \overline{x_2} \vee x_3) \wedge (\overline{x_5} \vee \overline{x_4} \vee \overline{x_3}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_8} \vee \overline{x_3}) \wedge (x_8 \vee \overline{x_9} \vee x_3) \wedge (\overline{x_1} \vee \overline{x_8} \vee x_3)$$

$$x_3 = 1\colon (\overline{x_5} \vee \overline{x_4}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_8})$$

$$x_3 = 0\colon (x_1 \vee \overline{x_2}) \wedge (x_5 \vee \overline{x_6}) \wedge (x_8 \vee \overline{x_9}) \wedge (\overline{x_1} \vee \overline{x_8})$$

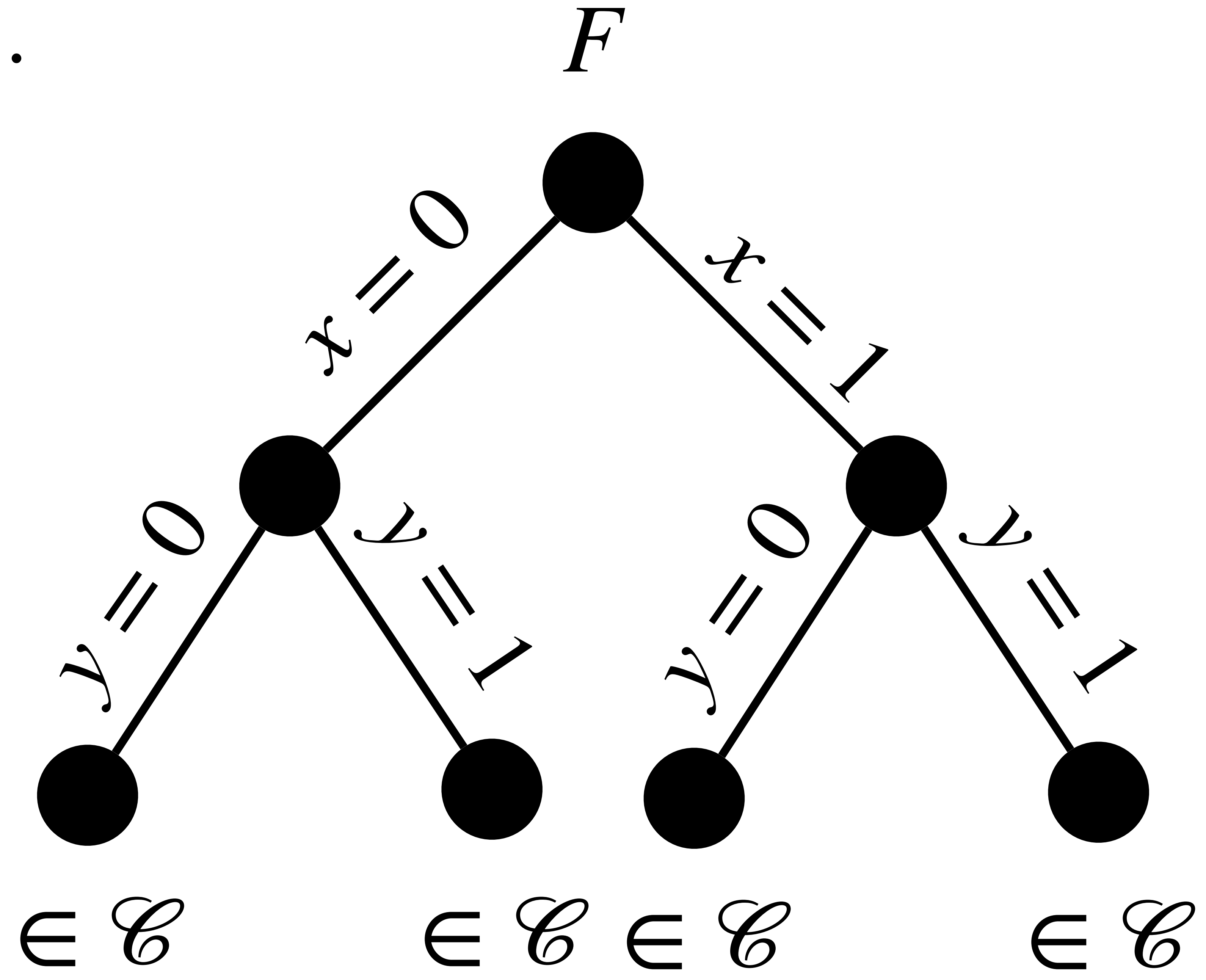
Theory vs Practice of SAT Solving

Backdoors

A backdoor to a class $\mathscr{C}$ for a formula F is a set of variables $B \subseteq V(F)$ such that

$F[\sigma]$ belongs to $\mathscr{C}$ for all assignments $\sigma : B \to \{0,1\}$.

Tractable classes $\mathscr{C}$ for SAT: 2-CNF, Horn, Affine, …



Theory vs Practice of SAT Solving

Backdoors

A backdoor to a class $\mathscr{C}$ for a formula F is a set of variables $B \subseteq V(F)$ such that

$F[\sigma]$ belongs to $\mathscr{C}$ for all partial assignments $\sigma : B \to \{0,1\}$.

Tractable classes $\mathscr{C}$ for SAT: 2-CNF, Horn, Affine, …

Problem 1: Finding a small backdoor to a class $\mathscr{C}$.

Problem 2: Evaluating F given a backdoor B. $2^{|B|} \cdot \text{poly}(n)$ time

Backdoors for QBF?

QBF: Does $\mathcal{Q}\,.\,F$ evaluate to 1?

$$\mathcal{Q} = \exists x_1 \forall x_2 \forall x_3 \exists x_4 \forall x_5 \exists x_6 \exists x_7 \exists x_8 \forall x_9$$

$$F = (x_1 \vee \overline{x_2} \vee x_3) \wedge (\overline{x_3} \vee \overline{x_4} \vee \overline{x_5}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_8} \vee \overline{x_3}) \wedge (x_8 \vee \overline{x_9} \vee x_3) \wedge (\overline{x_1} \vee \overline{x_8} \vee x_3)$$

Backdoors for QBF?

QBF: Does $\mathcal{Q} \,.\, F$ evaluate to 1?

$$\mathcal{Q} = \exists x_1 \forall x_2 \forall x_3 \exists x_4 \forall x_5 \exists x_6 \exists x_7 \exists x_8 \forall x_9$$

$$F = (x_1 \vee \overline{x_2} \vee x_3) \wedge (\overline{x_3} \vee \overline{x_4} \vee \overline{x_5}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_8} \vee \overline{x_3}) \wedge (x_8 \vee \overline{x_9} \vee x_3) \wedge (\overline{x_1} \vee \overline{x_8} \vee x_3)$$

QBF as a game: $\exists$-player and $\forall$-player take turns according to $\mathcal{Q}$.
Does $\exists$-player have a winning strategy (forcing F to be 1)?

Backdoors for QBF?

Quantifier prefix matters

QBF: Does $\mathcal{Q} . F$ evaluate to 1?

$\exists u \forall x. (\overline{u} \vee x) \wedge (u \vee \overline{x})$

$(\overline{u} \vee x) \wedge (u \vee \overline{x})$ is **satisfiable** // $(u \mapsto 1, x \mapsto 0)$

$\exists u \forall x. (\overline{u} \vee x) \wedge (u \vee \overline{x})$ is **false**

Backdoors for QBF?

Quantifier prefix matters for backdoors

QBF: Does $\mathcal{Q}\,.\,F$ evaluate to 1?

$\forall u \exists x.\ (\overline{u} \lor x) \land (u \lor \overline{x})$

$\forall u \exists x.\ (\overline{u} \lor x) \land (u \lor \overline{x})$ is **true**

Branch $x = 0$: $\forall u.\ (u)$ is **false**
Branch $x = 1$: $\forall u.\ (\overline{u})$ is **false**

Backdoors for QBF?

Tractable classes

QBF: Does $\mathcal{Q} . F$ evaluate to 1?

Schaefer: QBF is in P if F is in

1. 2-CNF
2. Affine
3. Horn
4. Dual Horn

Backdoors for QBF?

Attempt 1: out-of-class clauses

QBF: Does $\mathcal{Q} \,.\, F$ evaluate to 1?

Fix a tractable class $\mathscr{C}$ for QBF.

Backdoor to $\mathscr{C}$: clauses in F that are not in $\mathscr{C}$.

E.g. $(x_1 \vee \overline{x_2}) \wedge (\overline{x_3} \vee \overline{x_3}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_3}) \wedge (x_8 \vee \overline{x_9} \vee x_3) \wedge (\overline{x_1} \vee \overline{x_8} \vee x_3)$

Backdoors for QBF?

Attempt 1: out-of-class clauses

QBF: Does $\mathcal{Q}\,.\,F$ evaluate to 1?

Fix a tractable class $\mathscr{C}$ for QBF.

Backdoor to $\mathscr{C}$: clauses in F that are not in $\mathscr{C}$.

E.g. $\underbrace{(x_1 \vee \overline{x_2}) \wedge (\overline{x_3} \vee \overline{x_3}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_3})}_{\text{2-CNF}} \wedge \boxed{(x_8 \vee \overline{x_9} \vee x_3) \wedge (\overline{x_1} \vee \overline{x_8} \vee x_3)}$

Backdoors for QBF?

Attempt 1: out-of-class clauses

Bad news: solving CNF is equivalent to QBF(2-CNF) + 1 extra clause

$$F = \underbrace{(x_1 \vee \overline{x_2} \vee x_3)}^{C_1} \wedge \underbrace{(\overline{x_5} \vee \overline{x_4} \vee \overline{x_3})}^{C_2} \wedge \underbrace{(x_5 \vee \overline{x_6})}^{C_3} \wedge \underbrace{(\overline{x_7} \vee \overline{x_8} \vee \overline{x_3})}^{C_4} \wedge \underbrace{(x_8 \vee \overline{x_9} \vee x_3)}^{C_5} \wedge \underbrace{(\overline{x_1} \vee \overline{x_8} \vee x_3)}^{C_6}$$

Backdoors for QBF?

Attempt 1: out-of-class clauses

Bad news: solving CNF is equivalent to QBF(2-CNF) + 1 extra clause

$$F = \underbrace{(x_1 \vee \overline{x_2} \vee x_3)}^{C_1} \wedge \overbrace{(\overline{x_5} \vee \overline{x_4} \vee \overline{x_3})}^{C_2} \wedge \overbrace{(x_5 \vee \overline{x_6})}^{C_3} \wedge \overbrace{(\overline{x_7} \vee \overline{x_8} \vee \overline{x_3})}^{C_4} \wedge \overbrace{(x_8 \vee \overline{x_9} \vee x_3)}^{C_5} \wedge \overbrace{(\overline{x_1} \vee \overline{x_8} \vee x_3)}^{C_6}$$

$$F' = (\overline{C_1} \vee \overline{C_2} \vee \overline{C_3} \vee \overline{C_4} \vee \overline{C_5} \vee \overline{C_6}) \wedge \dots$$

Backdoors for QBF?

Attempt 1: out-of-class clauses

Bad news: solving CNF is equivalent to QBF(2-CNF) + 1 extra clause

$$F = \underbrace{(x_1 \lor \overline{x_2} \lor x_3)}^{C_1} \land \overbrace{(\overline{x_5} \lor \overline{x_4} \lor \overline{x_3})}^{C_2} \land \overbrace{(x_5 \lor \overline{x_6})}^{C_3} \land \overbrace{(\overline{x_7} \lor \overline{x_8} \lor \overline{x_3})}^{C_4} \land \overbrace{(x_8 \lor \overline{x_9} \lor x_3)}^{C_5} \land \overbrace{(\overline{x_1} \lor \overline{x_8} \lor x_3)}^{C_6}$$

$$F' = (\overline{C_1} \lor \overline{C_2} \lor \overline{C_3} \lor \overline{C_4} \lor \overline{C_5} \lor \overline{C_6}) \land (x_1 \rightarrow C_1) \land (\overline{x_2} \rightarrow C_1) \land (x_3 \rightarrow C_1) \land \dots$$

Backdoors for QBF?

Attempt 1: out-of-class clauses

Bad news: solving CNF is equivalent to QBF(2-CNF) + 1 extra clause

$$F = \underbrace{(x_1 \vee \overline{x_2} \vee x_3)}^{C_1} \wedge \overbrace{(\overline{x_5} \vee \overline{x_4} \vee \overline{x_3})}^{C_2} \wedge \overbrace{(x_5 \vee \overline{x_6})}^{C_3} \wedge \overbrace{(\overline{x_7} \vee \overline{x_8} \vee \overline{x_3})}^{C_4} \wedge \overbrace{(x_8 \vee \overline{x_9} \vee x_3)}^{C_5} \wedge \overbrace{(\overline{x_1} \vee \overline{x_8} \vee x_3)}^{C_6}$$

$$F' = (\overline{C_1} \vee \overline{C_2} \vee \overline{C_3} \vee \overline{C_4} \vee \overline{C_5} \vee \overline{C_6}) \wedge \bigwedge_{C_i \in F} \bigwedge_{\ell \in C_i} (\ell \rightarrow C_i)$$

F is satisfiable $\Longleftrightarrow$ $\forall$-player wins on $\forall x_1, \ldots, x_9 \exists C_1, \ldots, C_6 \,.\, F'$

Backdoors for QBF?

Attempt 1: out-of-class clauses

Bad news: solving CNF is equivalent to QBF(2-CNF) + 1 extra clause

$$F = \overset{C_1}{(x_1 \vee \overline{x_2} \vee x_3)} \wedge \overset{C_2}{(\overline{x_5} \vee \overline{x_4} \vee \overline{x_3})} \wedge \overset{C_3}{(x_5 \vee \overline{x_6})} \wedge \overset{C_4}{(\overline{x_7} \vee \overline{x_8} \vee \overline{x_3})} \wedge \overset{C_5}{(x_8 \vee \overline{x_9} \vee x_3)} \wedge \overset{C_6}{(\overline{x_1} \vee \overline{x_8} \vee x_3)}$$

$$F' = \underbrace{(\overline{C_1} \vee \overline{C_2} \vee \overline{C_3} \vee \overline{C_4} \vee \overline{C_5} \vee \overline{C_6})}_{\text{huge clause}} \wedge \bigwedge_{C_i \in F} \bigwedge_{\ell \in C_i} (\ell \rightarrow C_i)$$

F is satisfiable $\iff$ $\forall$-player wins on $\forall x_1, \ldots, x_9 \exists C_1, \ldots, C_6 \,.\, F'$

Backdoors for QBF

Attempt 2: CC-backdoors

QBF: Does $\mathcal{Q} . F$ evaluate to 1?

Fix a tractable class $\mathscr{C}$ for QBF.

CC-backdoor to $\mathscr{C}$: variables in F covering all clauses outside $\mathscr{C}$.

E.g. $(x_1 \vee \overline{x_2}) \wedge (\overline{x_3} \vee \overline{x_3}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_3}) \wedge \boxed{(x_8 \vee \overline{x_9} \vee x_3) \wedge (\overline{x_1} \vee \overline{x_8} \vee x_3)}$

$B = \{x_1, x_3, x_8, x_9\}$ is a clause-covering backdoor to 2-CNF.

Backdoors for QBF

CC-Backdoors: Alternative view

Fix a tractable class $\mathscr{C}$ for QBF.

How fast can we solve QBF on formulas $\mathcal{Q}\,.\,F_{in} \wedge F_{out}$ where

- F_{in} belongs to $\mathscr{C}$, and
- F_{out} is an arbitrary formula on k variables (k is small)

E.g. $\boxed{(x_1 \vee \overline{x_2}) \wedge (\overline{x_3} \vee \overline{x_3}) \wedge (x_5 \vee \overline{x_6}) \wedge (\overline{x_7} \vee \overline{x_3})} \wedge \boxed{(x_8 \vee \overline{x_9} \vee x_3) \wedge (\overline{x_1} \vee \overline{x_8} \vee x_3)}$

Note: F_{in} and F_{out} may share variables!

Backdoors for QBF

Our Results

CC-backdoor to $\mathscr{C}$: # variables in F covering all clauses outside $\mathscr{C}$.

Let k be the CC-backdoor size.

1. $2^k \cdot \text{poly}(n)$ algorithms for QBF with CC-backdoor to 2-CNF
2. $2^k \cdot \text{poly}(n)$ algorithms for QBF with CC-backdoor to Affine
3. W[1]-hard with CC-backdoor to 3-Horn

Algorithm for 2-CNF

One-variable Lookahead

$\mathcal{Q} = \exists x \forall y \exists a \exists b \exists c \exists d$

$F = (x \lor a) \land (\overline{x} \lor b) \land (y \lor b) \land (\overline{a} \lor \overline{b} \lor \overline{c} \lor \overline{d})$

CC-Backdoor $B = \{a, b, c, d\}$

Algorithm for 2-CNF

One-variable Lookahead

$\mathcal{Q} = \exists x \forall y \exists a \exists b \exists c \exists d$

$F = (x \lor a) \land (\overline{x} \lor b) \land (y \lor b) \land (\overline{a} \lor \overline{b} \lor \overline{c} \lor \overline{d})$

CC-Backdoor $B = \{a, b, c, d\}$

What happens if $x \mapsto 0$? $\quad x = 0 \land F_{2CNF} \implies a = 1$

What happens if $x \mapsto 1$? $\quad x = 1 \land F_{2CNF} \implies b = 1$

Algorithm for 2-CNF

One-variable Lookahead

$\mathcal{Q} = \exists x \forall y \exists a \exists b \exists c \exists d$

$F = (x \vee a) \wedge (\bar{x} \vee b) \wedge (y \vee b) \wedge (\bar{a} \vee \bar{b} \vee \bar{c} \vee \bar{d})$

CC-Backdoor $B = \{a, b, c, d\}$

What happens if $x \mapsto 0$? $\quad x = 0 \wedge F_{2CNF} \implies a = 1$

What happens if $x \mapsto 1$? $\quad x = 1 \wedge F_{2CNF} \implies b = 1$

Both choices reduce backdoor size.

Since x is $\exists$, try both and accept if either branch accepts.

Algorithm for 2-CNF

One-variable Lookahead (case $x = 0$)

$\mathcal{Q} = \forall y \exists b \exists c \exists d$

$F = (y \vee b) \wedge (\overline{b} \vee \overline{c} \vee \overline{d})$

CC-Backdoor $B = \{b, c, d\}$

Algorithm for 2-CNF

One-variable Lookahead (case $x = 0$)

$\mathcal{Q} = \forall y \exists b \exists c \exists d$

$F = (y \vee b) \wedge (\overline{b} \vee \overline{c} \vee \overline{d})$

CC-Backdoor $B = \{b, c, d\}$

What happens if $y \mapsto 0$? $y = 0 \wedge F_{2CNF} \implies b = 1$

What happens if $y \mapsto 1$? $y = 1 \wedge F_{2CNF}$ has no effect on B

Algorithm for 2-CNF

One-variable Lookahead (case $x = 0$)

$\mathcal{Q} = \forall y \exists b \exists c \exists d$

$F = (y \vee b) \wedge (\bar{b} \vee \bar{c} \vee \bar{d})$

CC-Backdoor $B = \{b, c, d\}$

What happens if $y \mapsto 0$? $\quad y = 0 \wedge F_{2CNF} \implies b = 1$

What happens if $y \mapsto 1$? $\quad y = 1 \wedge F_{2CNF}$ has no effect on B

Branch $y \mapsto 0$ is "harder" than $y \mapsto 1$.

Since y is $\forall$, proceed with the harder branch.

Algorithm for 2-CNF

One-variable Lookahead (formalized)

QBF formula $\mathcal{Q}\,.\,F$ where $F = F_{2CNF} \wedge F_{out}$

Backdoor: $B = V(F_{out})$

1. Pick the first variable x in $\mathcal{Q}$.
2. Compute U_0 and U_1 : unit propagations from $x = 0$ and $x = 1$.
3. Check if $\mathcal{Q}\,.\,F_{2CNF}\,[U_b]$ is true for $b \in \{0,1\}$.
4. If both true and some $U_b \cap B = \emptyset$:

   $\exists x$: keep U_b $\qquad$ $\forall x$: keep $U_{\neg b}$
5. Otherwise, both branches hit B.

Algorithm for 2-CNF

One-variable Lookahead (formalized)

QBF formula $\mathcal{Q} . F$ where $F = F_{2CNF} \wedge F_{out}$

Backdoor: $B = V(F_{out})$

1. Pick the first variable x in $\mathcal{Q}$.
2. Compute U_0 and U_1 : unit propagations from $x = 0$ and $x = 1$.
3. Check if $\mathcal{Q} . F_{2CNF} [U_b]$ is true for $b \in \{0,1\}$.
4. If both true and some $U_b \cap B = \emptyset$:

   $\exists x$: keep U_b $\forall x$: keep $U_{\neg b}$
5. Otherwise, both branches hit B.

Key Lemma: In case 5,

$$\mathcal{Q} . F[x = \neg b] \Longrightarrow \mathcal{Q} . F[x = b]$$

Algorithm for Affine

$\mathcal{Q} = \forall x_1 \exists x_2 \exists x_3 \exists x_4 \exists x_5$ $B = \{x_1, x_3, x_4\}$

$F = (x_1 + x_2 + x_5 = 0) \wedge (x_4 + x_5 = 1) \wedge (x_1 + x_3 = 0) \wedge (x_2 + x_3 = 1) \wedge (x_1 \vee x_3 \vee x_4)$

Observations:

1. In every equation the innermost variable is $\exists$, otherwise reject.

Algorithm for Affine

$\mathcal{Q} = \forall x_1 \, \exists x_2 \, \exists x_3 \, \exists x_4 \, \exists x_5$

$B = \{x_1, x_3, x_4\}$

$F = (x_1 + x_2 + x_5 = 0) \wedge (x_4 + x_5 = 1) \wedge (x_1 + x_3 = 0) \wedge (x_2 + x_3 = 1) \wedge (x_1 \vee x_3 \vee x_4)$

$x_5 = x_4 + 1$

Observations:

1. In every equation the innermost variable is ∃, otherwise reject.
2. Eliminate any innermost variable that is not in the backdoor.

Algorithm for Affine

$\mathcal{Q} = \forall x_1 \exists x_2 \exists x_3 \exists x_4$ $B = \{x_1, x_3, x_4\}$

$F = (x_1 + x_2 + x_4 = 1) \wedge (x_1 + x_3 = 0) \wedge (x_2 + x_3 = 1) \wedge (x_1 \vee x_3 \vee x_4)$

Observations:

1. In every equation the innermost variable is ∃, otherwise reject.
2. Eliminate any innermost variable that is not in the backdoor.

Algorithm for Affine

$\mathcal{Q} = \forall x_1 \exists x_2 \exists x_3 \exists x_4$ $\qquad B = \{x_1, x_3, x_4\}$

$F = (\cancel{x_1} + x_2 + \cancel{x_4} = 1) \wedge (x_1 + \cancel{x_3} = 0) \wedge (x_2 + \cancel{x_3} = 1) \wedge (x_1 \vee x_3 \vee x_4)$

Observations:

1. In every equation the innermost variable is ∃, otherwise reject.
2. Eliminate any innermost variable that is not in the backdoor.
3. Pivot on any innermost non-backdoor variable that is not private.

Algorithm for Affine

$\mathcal{Q} = \forall x_1 \exists x_2 \exists x_3 \exists x_4$ $\quad B = \{x_1, x_3, x_4\}$

$F = (x_1 + x_2 + x_4 = 1) \wedge (x_1 + x_3 = 0) \wedge (x_2 + x_3 = 1) \wedge (x_1 \vee x_3 \vee x_4)$

$x_2 = x_3 + 1$

Observations:

1. In every equation the innermost variable is ∃, otherwise reject.
2. Eliminate any innermost variable that is not in the backdoor.
3. Pivot on any innermost non-backdoor variable that is not private.

Algorithm for Affine

$\mathcal{Q} = \forall x_1 \, \exists x_2 \, \exists x_3 \, \exists x_4$ $\qquad B = \{x_1, x_3, x_4\}$

$F = (x_1 + x_3 + x_4 = 0) \wedge (x_1 + x_3 = 0) \wedge (x_2 + x_3 = 1) \wedge (x_1 \vee x_3 \vee x_4)$

Observations:

1. In every equation the innermost variable is $\exists$, otherwise reject.
2. Eliminate any innermost variable that is not in the backdoor.
3. Pivot on any innermost non-backdoor variable that is not private.
4. Reduce every equation to contain at most one non-backdoor variable.

Algorithm for Affine

$\mathcal{Q} = \forall x_1 \exists x_2 \exists x_3 \exists x_4$ $B = \{x_1, x_3, x_4\}$

$F = (x_1 + x_3 + x_4 = 0) \wedge (x_1 + x_3 = 0) \wedge (x_2 + x_3 = 1) \wedge (x_1 \vee x_3 \vee x_4)$

Reduce every equation to contain at most one non-backdoor variable.

Total number of variables: at most $2k$ **Kernel!**

Algorithm for Affine

$\mathcal{Q} = \forall x_1 \exists x_2 \exists x_3 \exists x_4$

$B = \{x_1, x_3, x_4\}$

$F = (x_1 + x_3 + x_4 = 0) \wedge (x_1 + x_3 = 0) \wedge (x_2 + x_3 = 1) \wedge (x_1 \vee x_3 \vee x_4)$

Reduce every equation to contain at most one non-backdoor variable.

Total number of variables: at most $2k$ **Kernel!**

Furthermore: at most k equations $\Longrightarrow$ at most k variables require branching. Time 2^k

Summary

Towards Full Classification

Schaefer's theorem: QBF is in P if the formula is:

1. 2-CNF
2. Affine
3. Horn
4. Dual Horn

Summary

Towards Full Classification

Our theorem: QBF with a CC-backdoor to

1. 2-CNF is in FPT.
2. Affine is in FPT.
3. Horn is W[1]-hard.
4. Dual Horn is W[1]-hard.

Is the classification complete?

Summary

Towards Full Classification

Our theorem: QBF with a CC-backdoor to

1. 2-CNF is in FPT.
2. Affine is in FPT.
3. Horn is W[1]-hard.
4. Dual Horn is W[1]-hard.

Is the classification complete?

Open case: clauses of the form (x), $(\bar{x})$, $(x \rightarrow y)$ and $(\overline{x_1} \vee \ldots \vee \overline{x_d})$ for $d \geq 3$.