Reducing memory consumption of ProVerif with hash consing techniques

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Verification of protocols

(a) The Needham-Shroeder protocol

$$
\begin{aligned}
A \longrightarrow B &: \mathtt{enc}((A, n_A), \mathtt{pk}(B)) \\
B \longrightarrow A &: \mathtt{enc}((n_A, n_B), \mathtt{pk}(A)) \\
A \longrightarrow B &: \mathtt{enc}(n_B, \mathtt{pk}(B))
\end{aligned}
$$

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- Three main types of security properties handled: *secrecy*, *authenticity* and *equivalence*

Horn clauses

Example of Horn clause

$$(\texttt{enc}/\texttt{dec}\ \text{scheme}) \quad \texttt{att}(\texttt{enc}(x, k)) \wedge \texttt{att}(k) \Rightarrow \texttt{att}(x)$$

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Figure 4: Syntax of Horn clauses

$M, N ::=$	terms
x	variable
$f(M_1, \ldots, M_n)$	function application

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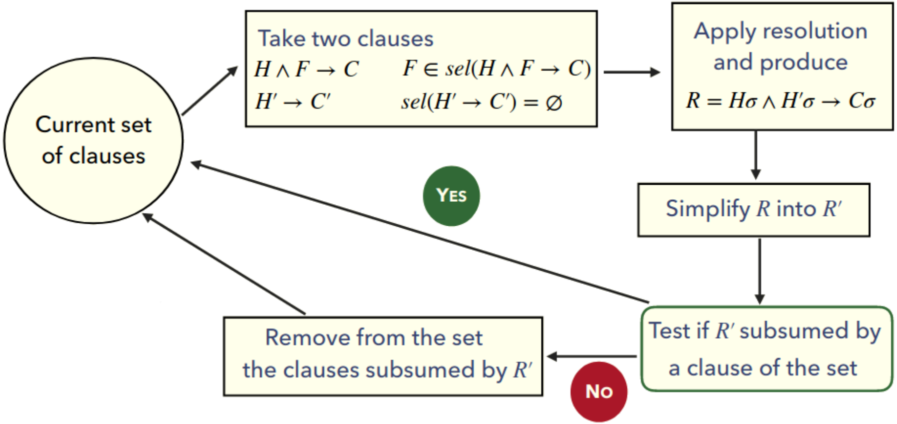
$M, N ::=$	terms
x	variable
$f(M_1, \ldots, M_n)$	function application
$F ::= p(M_1, \ldots, M_n)$	fact
$R ::= F_1 \wedge \ldots \wedge F_n \Rightarrow F$	Horn clause

Saturation process

Figure 5: Summary of the saturation procedure



New representation of terms

Let $t_1 = f(x, g(y, z))$ and $t_2 = f(g(y, z), g(a, a))$ be two terms.

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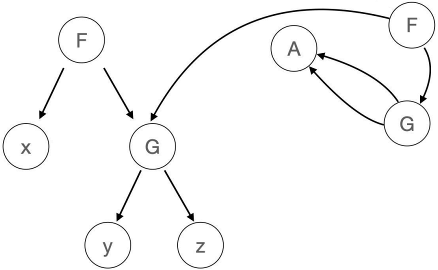
Figure 6: Example of term-graph representing t_1 and t_2



New representation of terms - OCaml

```
type hcterm = {

    hc_desc: hcterm_desc;
```

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type hcterm = {
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```
type hcterm = {
    hc_tag: int;
    hc_desc: hcterm_desc;
    mutable hc_link: hcterm_link
}

type hcterm_link =
    | HCNoLink
    | HCVisited of bool
    | HCTerm of hcterm
    | (* ... *)
```

Databases of Horn clauses

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- Several databases of Horn clauses:

  Solved clauses: $\texttt{sel}(H \Rightarrow C) = \varnothing$
  Unsolved clauses: $F \in \texttt{sel}(H \Rightarrow C)$

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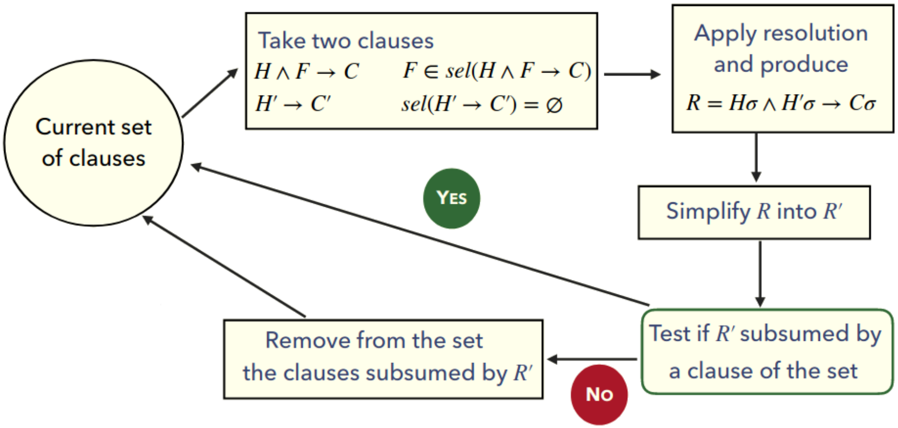
- Second step: cycle detection
- At most one function call on each node

Benchmarks

Type of query	**Version of** ProVerif				**Gain**	
	2.04		2.04_h1			
	Speed	Memory	Speed	Memory	Speed	Memory
Key secrecy & Uniqueness	2 h 48 min	162 GB	2 h 59 min	5.6 GB	0.9	29
Authentication	2 h 51 min	141 GB	3 h 16 min	22 GB	0.9	6.4
Secrecy & Authenticity	1 h 21 min	162 GB	1 h 12 min	2.4 GB	1.1	67.5

Conclusion and future work

Figure 7: Summary of the saturation procedure



Unsolved problem

Problem

Let $t_1, \ldots, t_n \in \mathcal{T}(\mathcal{X}, \mathcal{F})$ be n terms. Find the set of bijective renaming functions $\{\rho_i\}_{i=1}^{n}$ that minimises the quantity

$$\texttt{Card}\left(\bigcup_{i=1}^{n} \texttt{Subterms}(t_i \rho_i)\right).$$

Thank you for your attention!