Don’t Be a Tattle-Tale: Preventing Leakages through Data Dependencies on Access Control Protected Data

Primal Pappachan†‡, Shufan Zhang*, Xi He*, Sharad Mehrotra†
† University of California Irvine ‡ Pennslyvania State University * University of Waterloo

1. Inference Problem

<table>
<thead>
<tr>
<th>Eld</th>
<th>EName</th>
<th>Zip</th>
<th>State</th>
<th>Role</th>
<th>World</th>
<th>s</th>
<th>Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>t₁</td>
<td>34</td>
<td>Tina</td>
<td>45678</td>
<td>WA</td>
<td>Student</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td>t₂</td>
<td>56</td>
<td>Bobby</td>
<td>54321</td>
<td>CA</td>
<td>Faculty</td>
<td>40</td>
<td>200</td>
</tr>
<tr>
<td>t₃</td>
<td>78</td>
<td>Dale</td>
<td>53567</td>
<td>CA</td>
<td>Faculty</td>
<td>40</td>
<td>134</td>
</tr>
<tr>
<td>t₄</td>
<td>12</td>
<td>Khan</td>
<td>54321</td>
<td>CA</td>
<td>Staff</td>
<td>30</td>
<td>7200</td>
</tr>
</tbody>
</table>

2. Background

Design time prevention
Function
Denial Constraints (DCs)
For
Access Control Policies: V(O)
Access View as a collection of cells
Design time prevention
Query views: Ṽ(O)

3. Security Model

Inference channel:
- Denial Constraints (DCs)
- Function-based Constraints

4. Tattle-Tale Condition

\[ \text{TTC}(\delta, V, c_i) = \begin{cases} \text{True, when all the other predicates (except Pred(c_i)) evaluate as True} \\ \text{False, otherwise} \end{cases} \]

5. System Overview

Data Utility:
- With increasing number of sensitive cells, the number of hidden cells increases linearly
- Our approach always hides less cells than the baselines

6. Evaluation

Performance:
- The overhead of our approach is small, compared to the baselines
- When increasing the number of sensitive cells, the performance overhead scales linearly for our approach

7. Takeaways

- Strong security model
- Tattle-Tale Condition
- Full Deniability
- Relaxing assumptions in the model

Check out the project repo!