OB-PWS: Obfuscation-Based Private Web Search

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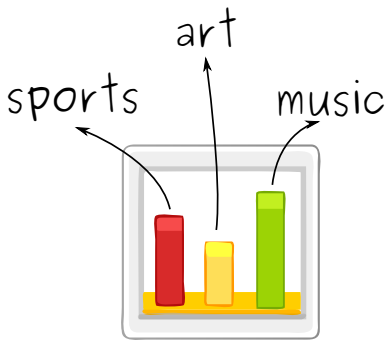
ESAT/COSIC, IBBT - KU Leuven

Wednesday, 23 May 2012

The Privacy Problem



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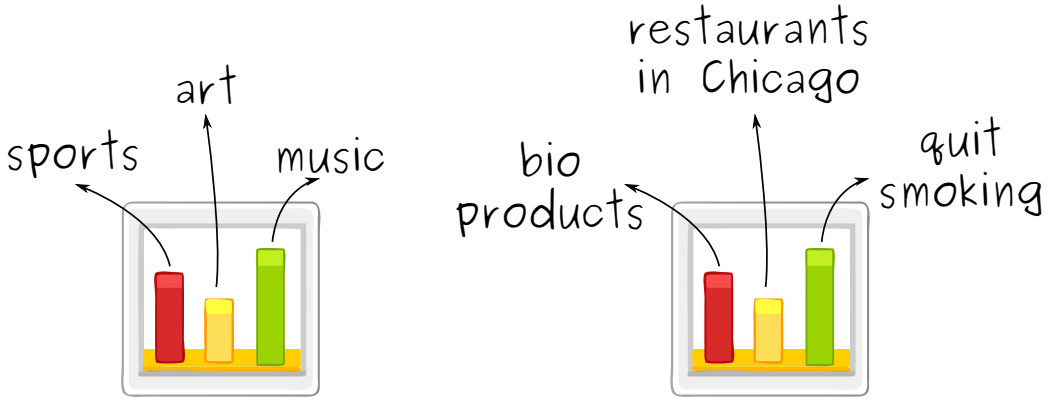

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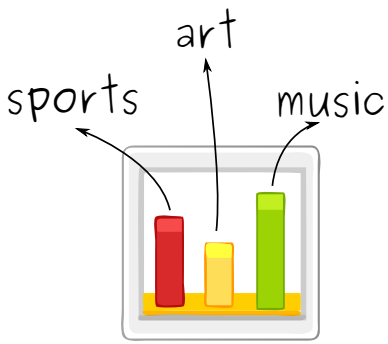

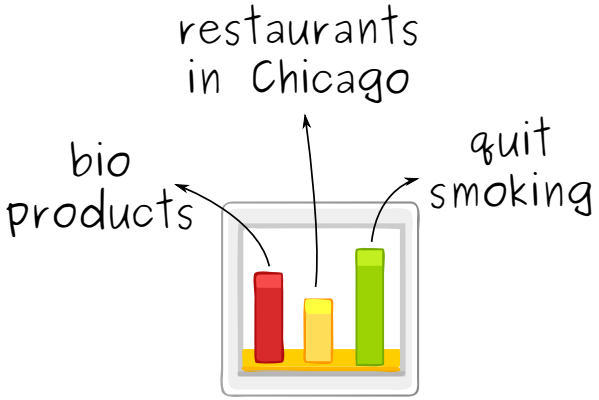

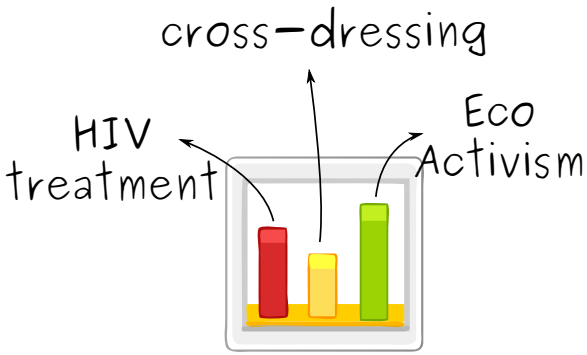

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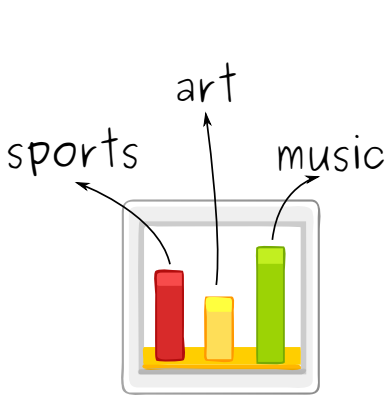

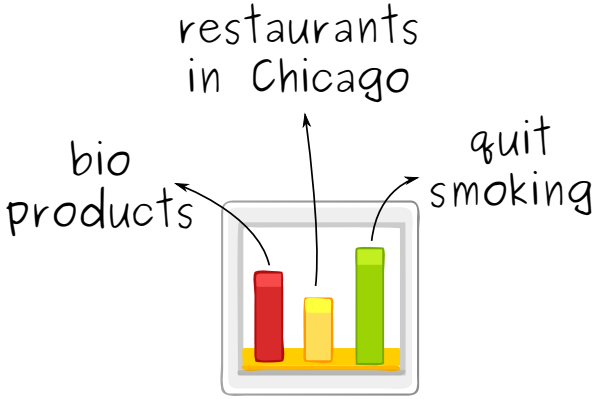

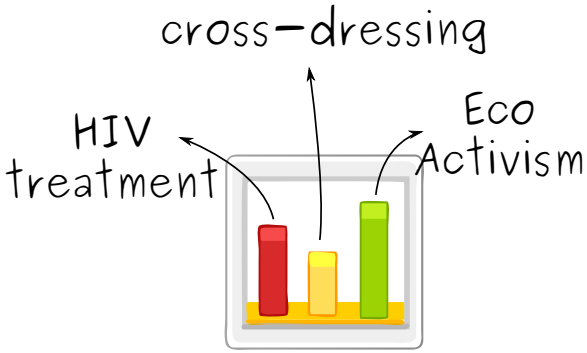

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  Individual search queries and/or profiling may reveal sensitive information.

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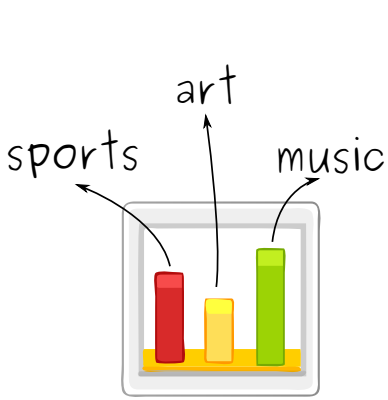

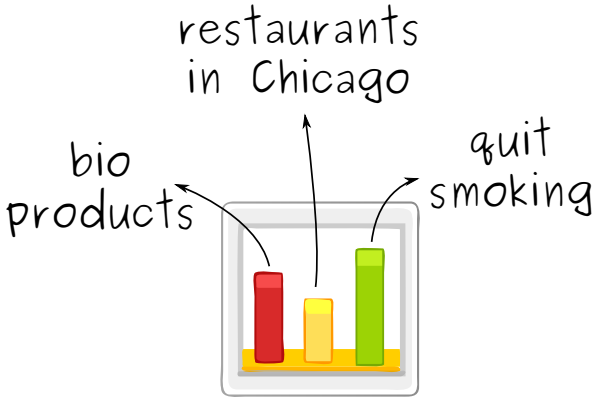

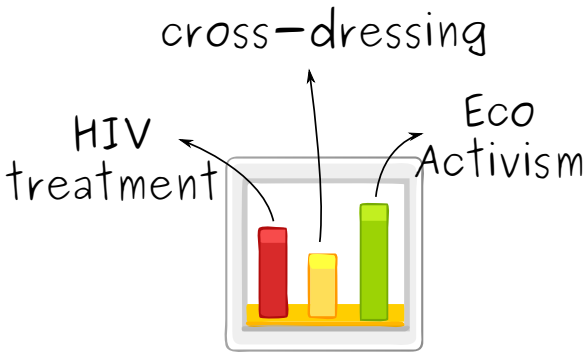

- PRIVACY PROBLEM:
  Individual search queries and/or profiling may reveal sensitive information.
- Some solutions:
  - Anonymous communications
  - PIR
  - **OB-PWS** $\Rightarrow$ Prevent **profiling** and provide query **deniability**.

Our contribution

- General model.
- Evaluation framework
  $\Rightarrow$ with relevant privacy properties (details in the paper).
- Analysis of 6 existing systems (4 in this talk).

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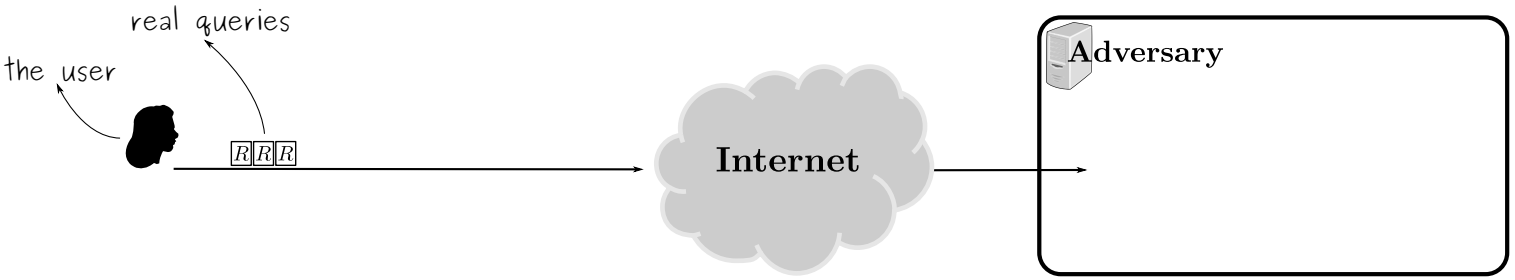

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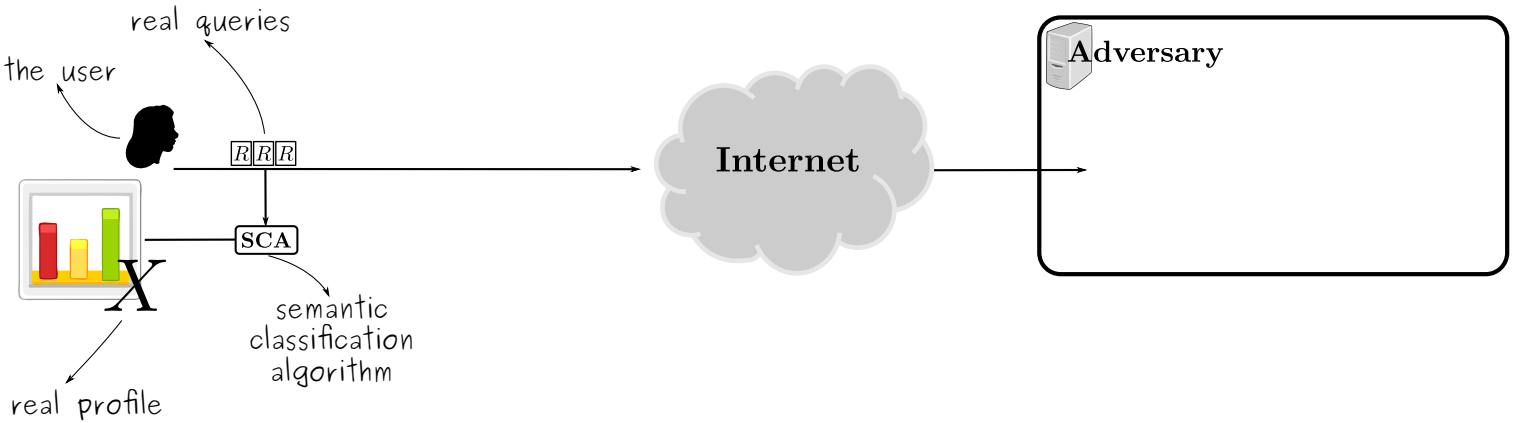

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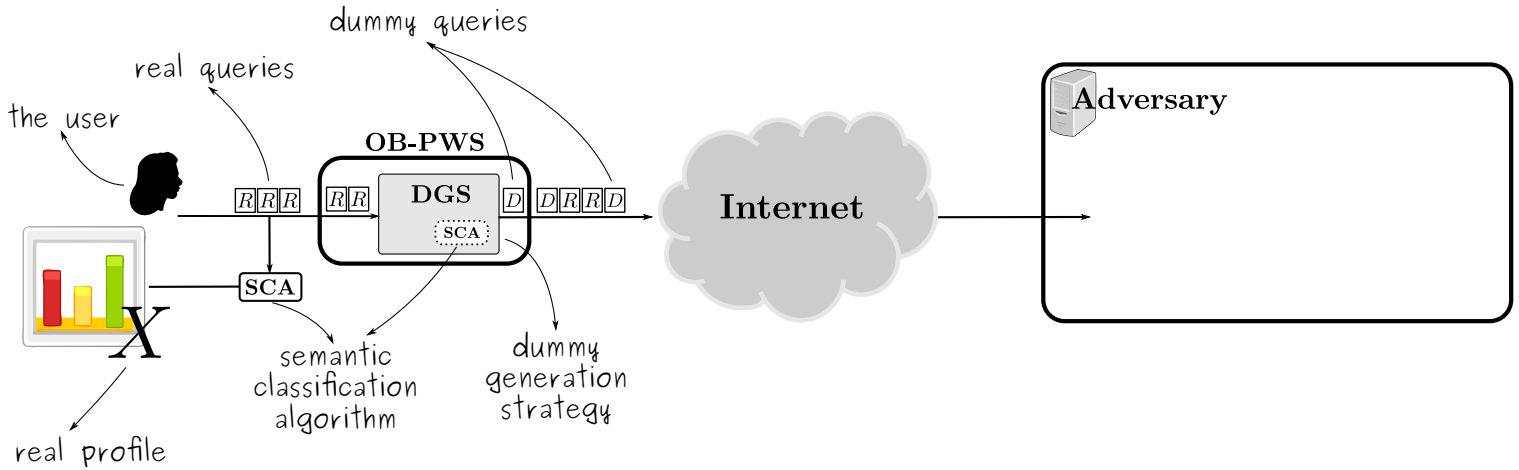

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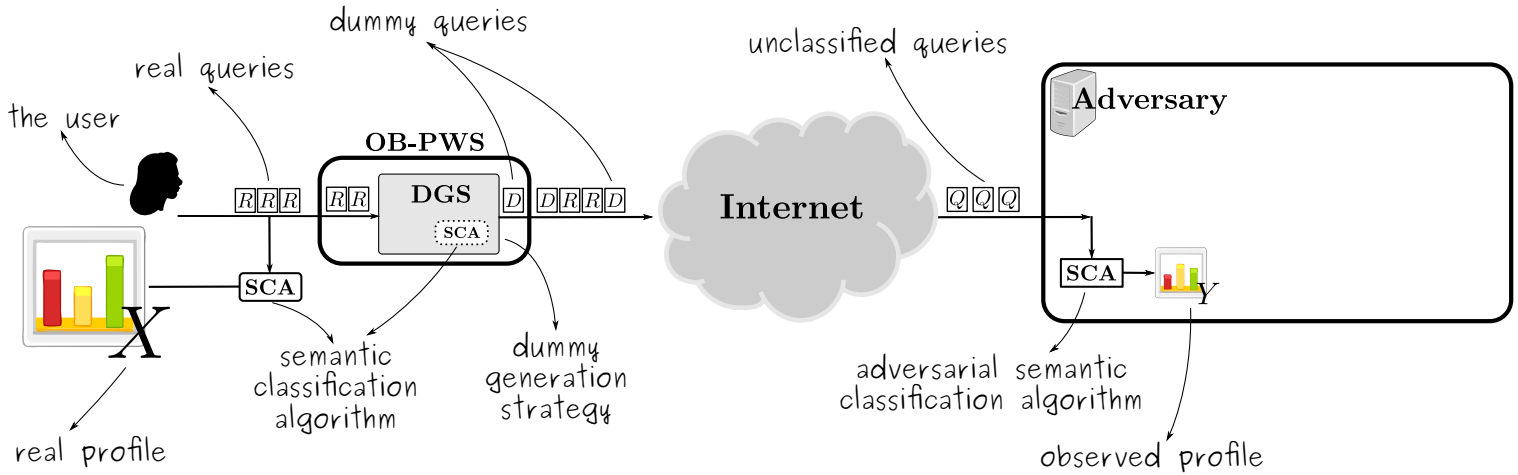

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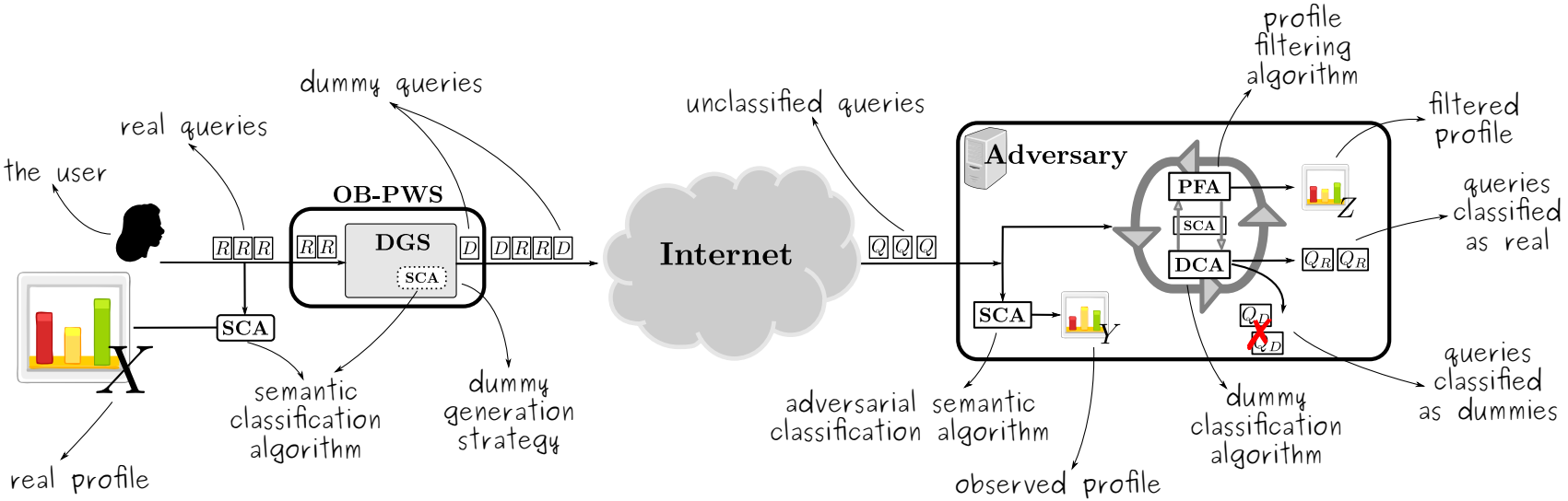

An Evaluation framework for DGS

A dual analysis is required:

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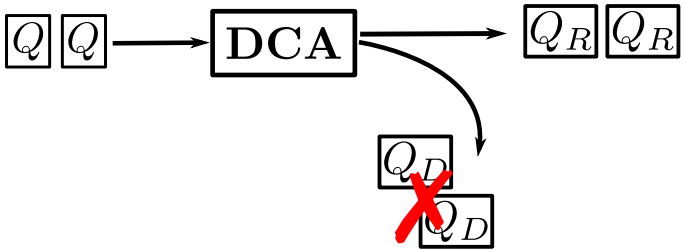
Query-Based Analysis



- Exploit vulnerabilities in the DGS to distinguish real from dummy queries.

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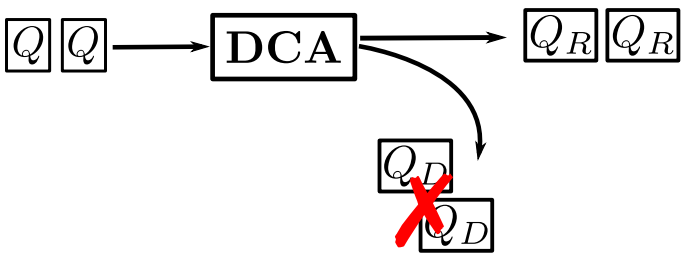
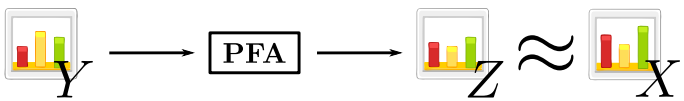


- Exploit vulnerabilities in the DGS to distinguish real from dummy queries.

Profile-Based Analysis



- Exploit vulnerabilities in the DGS to filter observed profile and recover the real profile.

GooPIR $h(k)$-Private Information Retrieval from Privacy-Uncooperative Queryable Databases [1]

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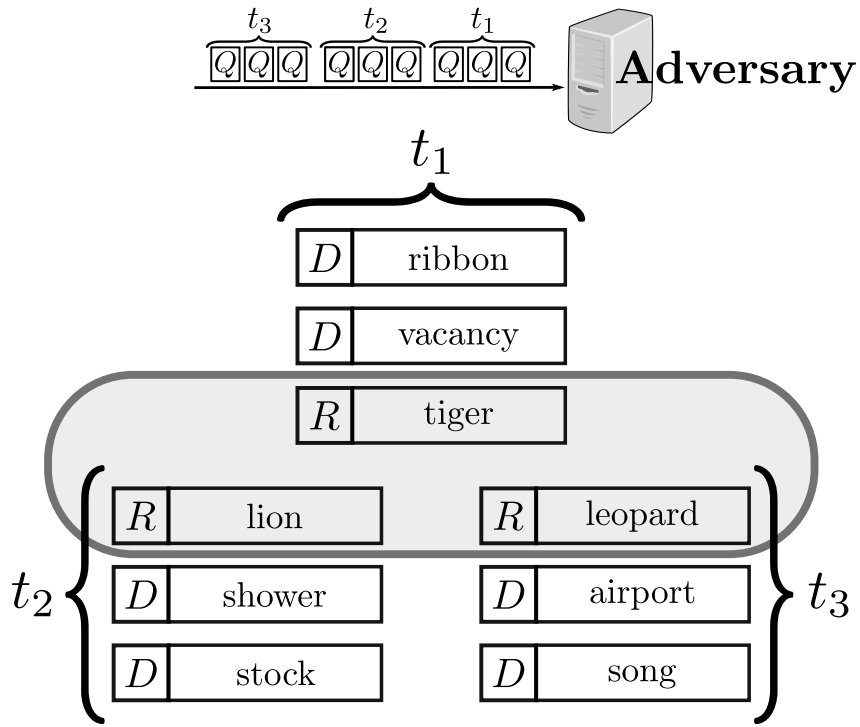
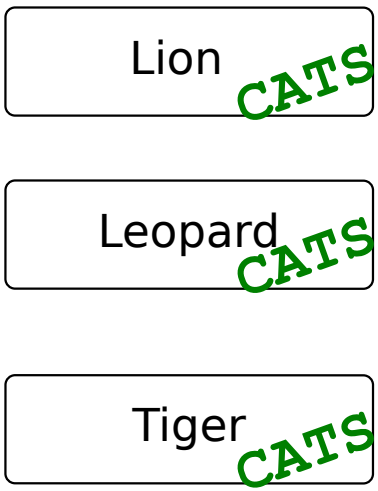
- A k-anonymity inspired approach.
- Prevents attacks based on:
  - Timing/metadata.
  - Popularity of queries.
  - Statistical disclosure.
- However does not consider the *topic* of the queries.



$\Rightarrow$ No dummy indistinguishability.

PDS Plausibly Deniable Search [2]



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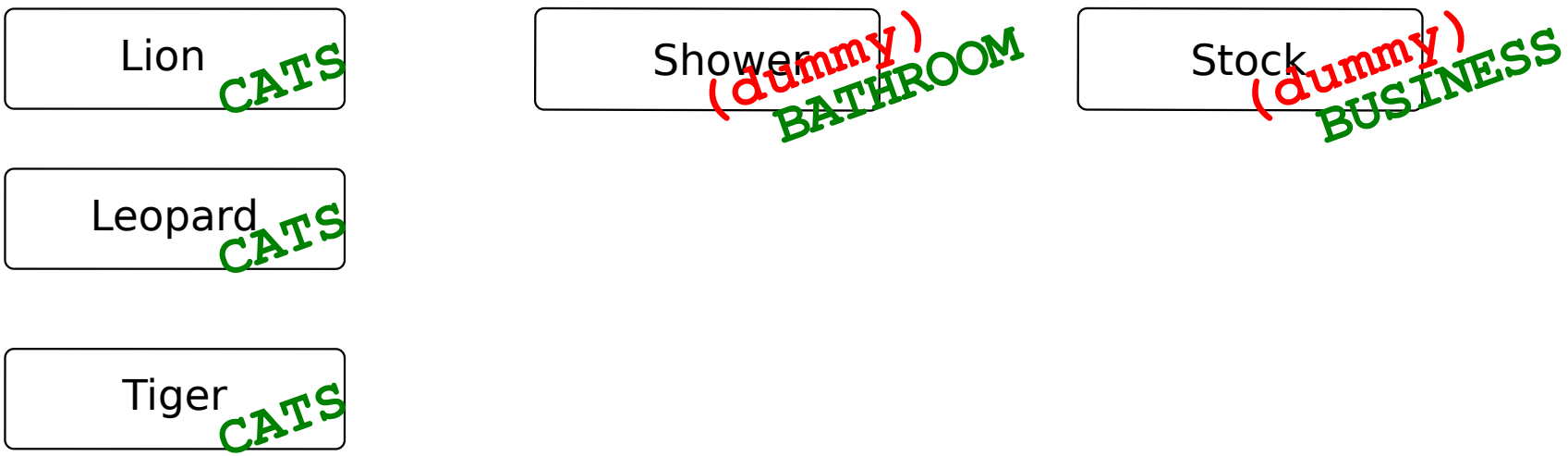

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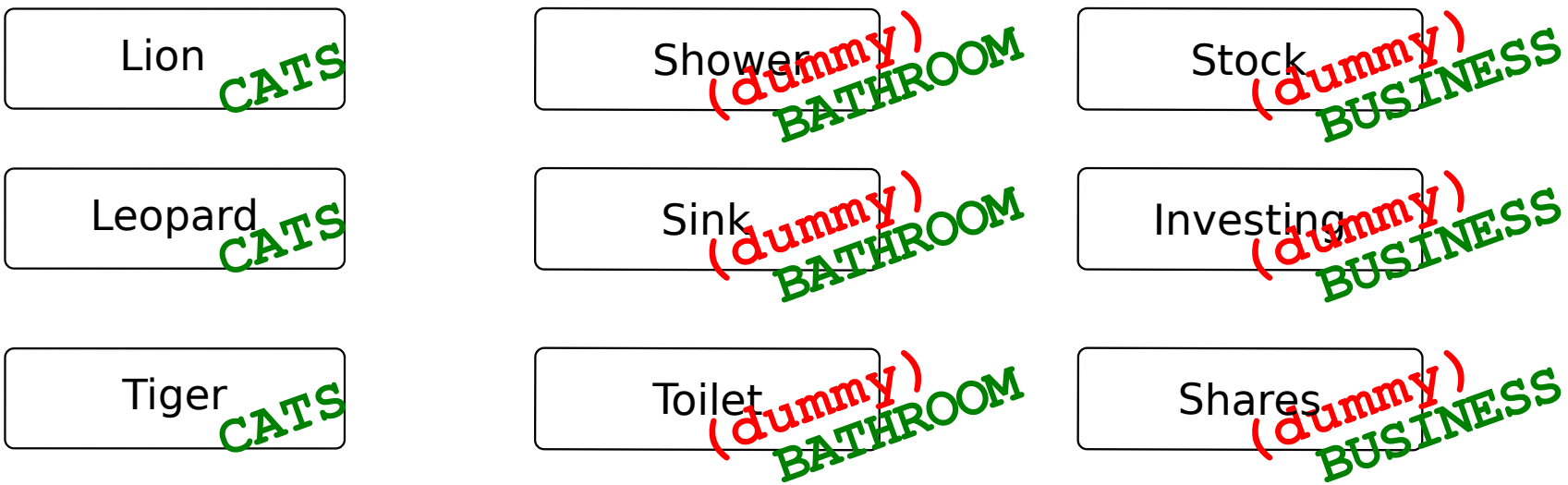

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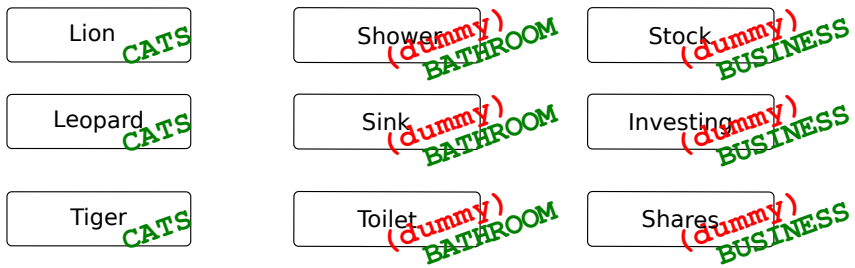

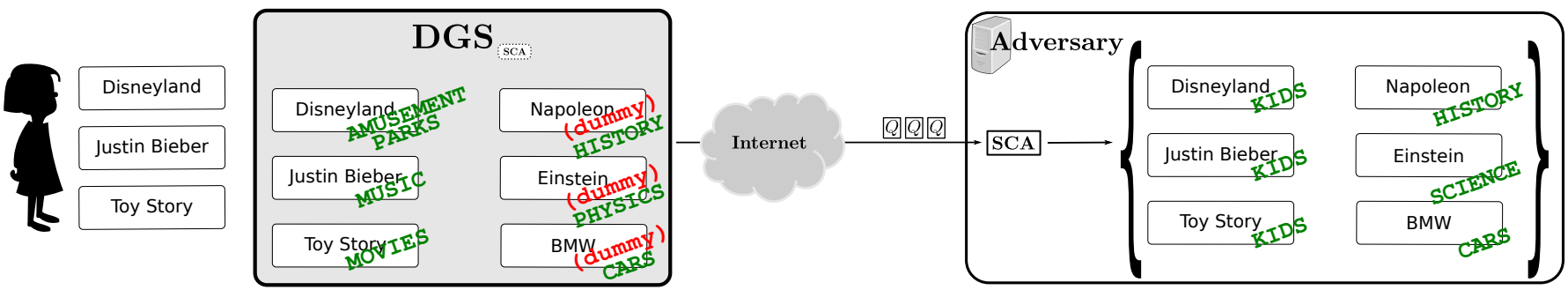

PRAW (A PRivAcy model for the Web) [3]

- Privacy = Dissimilarity.
- Dissimilarity $\propto$ amount of dummy queries.

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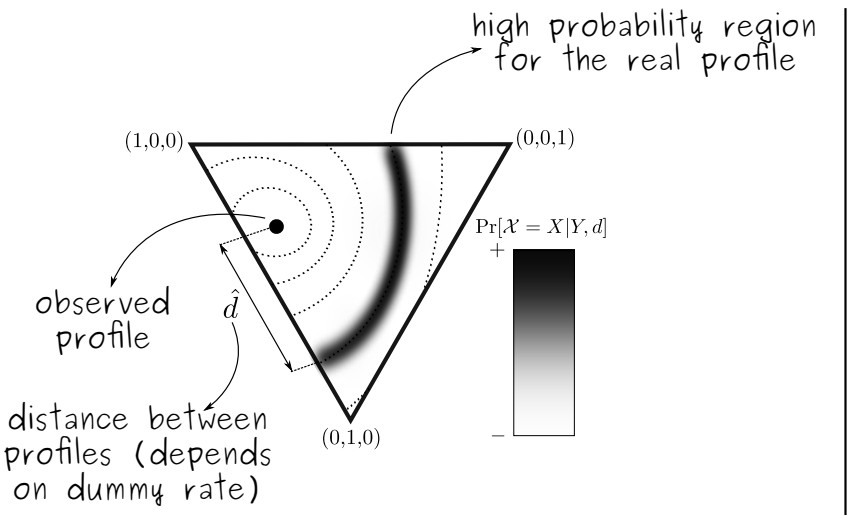

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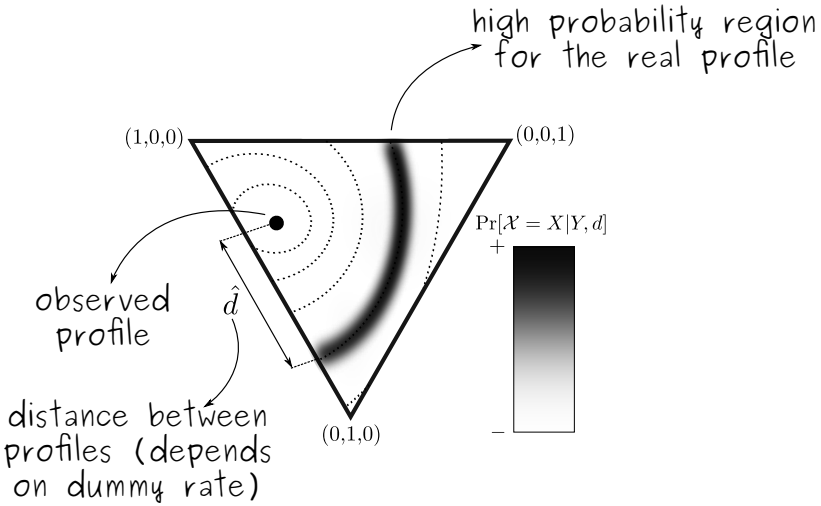
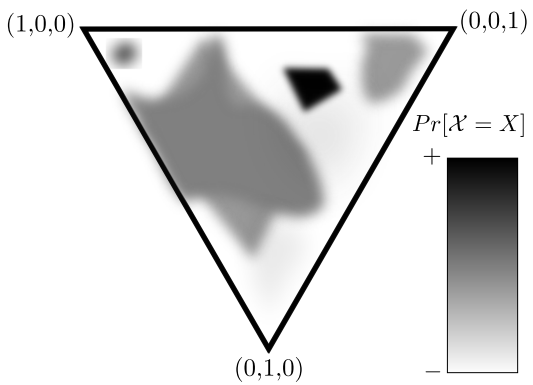


Considering prior information $\Pr[\mathcal{X} = X]$:



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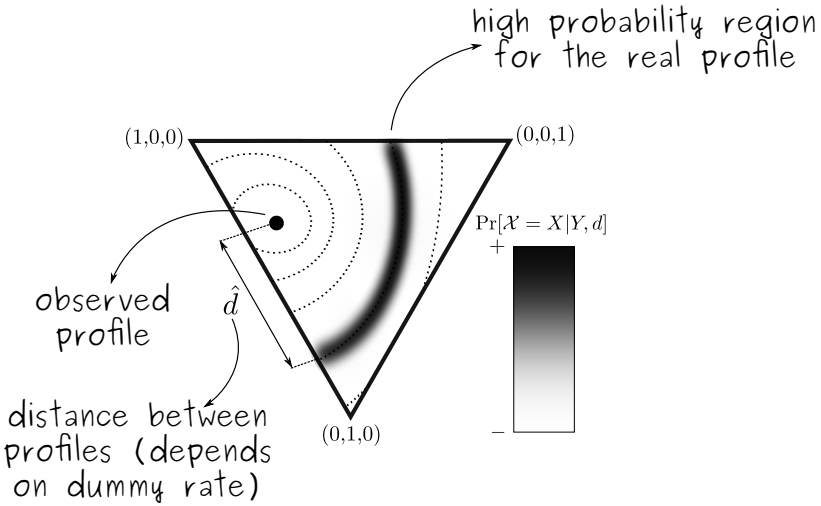

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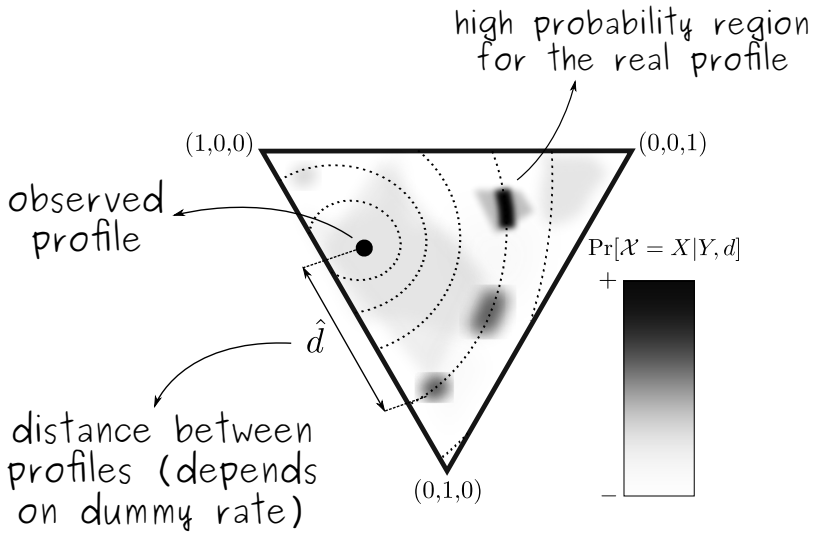

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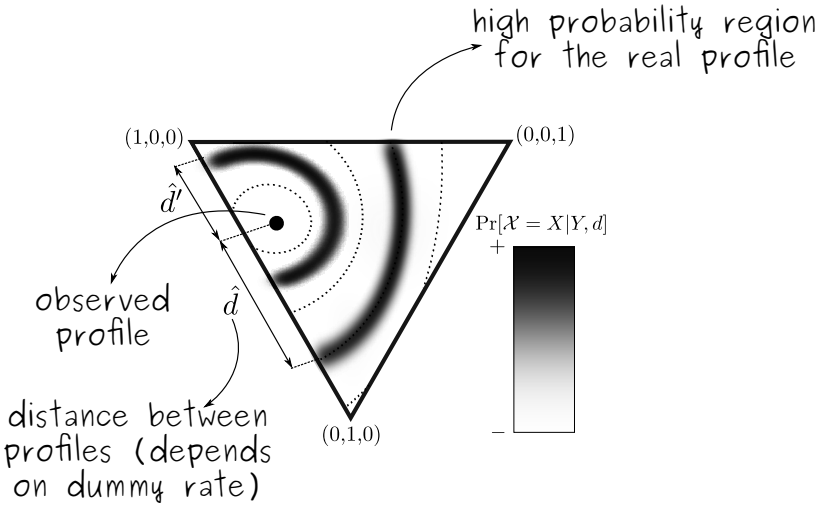

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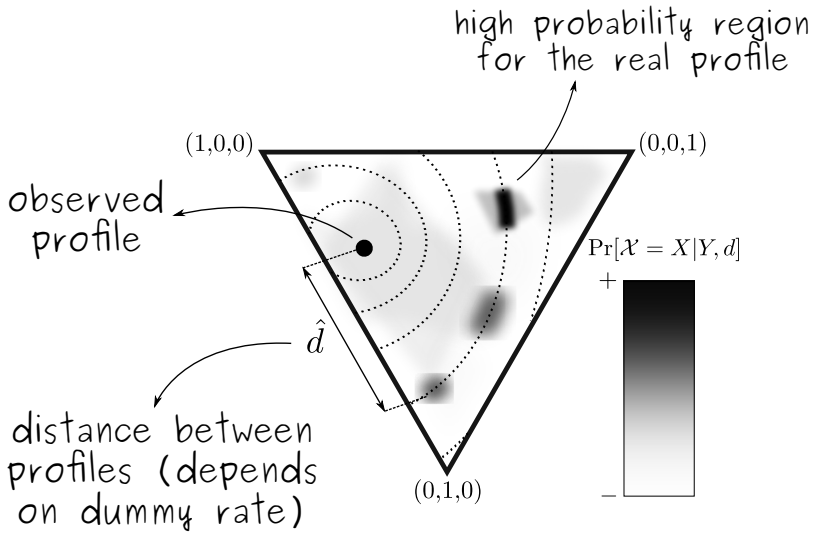

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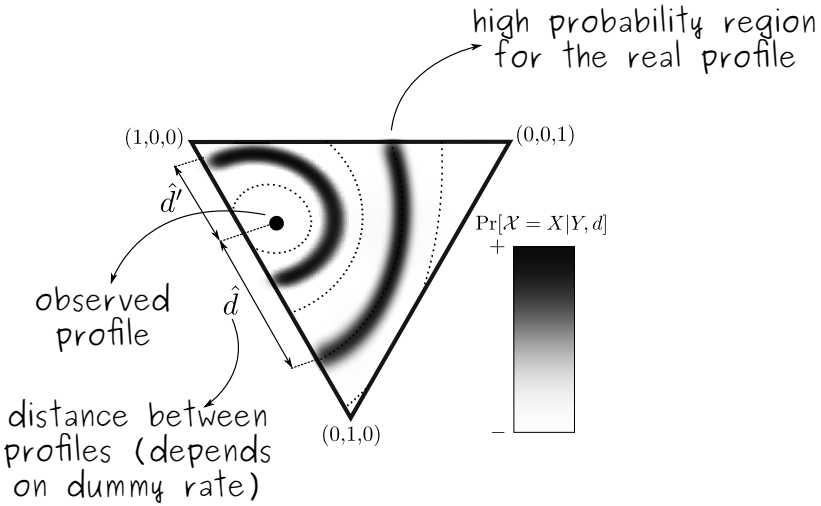

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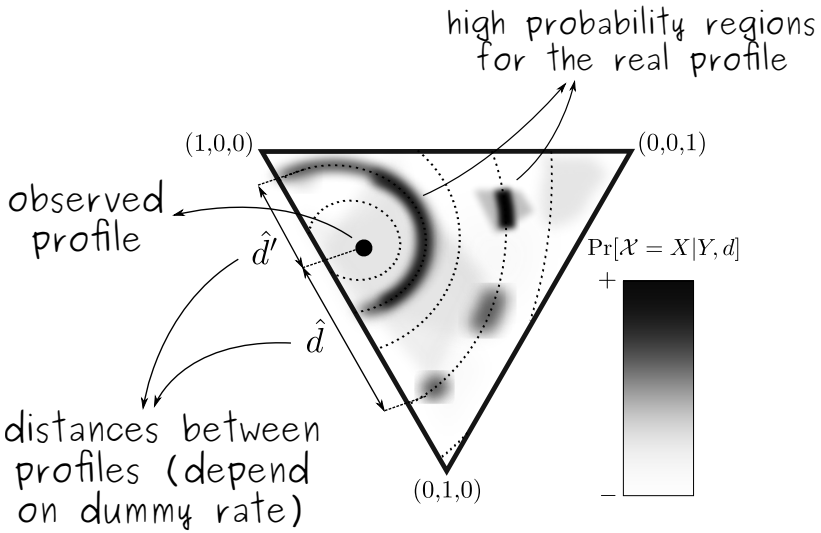

OQF-PIR Optimized Query Forgery for Private Information Retrieval [4]

- Privacy = similarity to population's average profile.
- Exploitable features:
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  - Waterfilling-based DGS.

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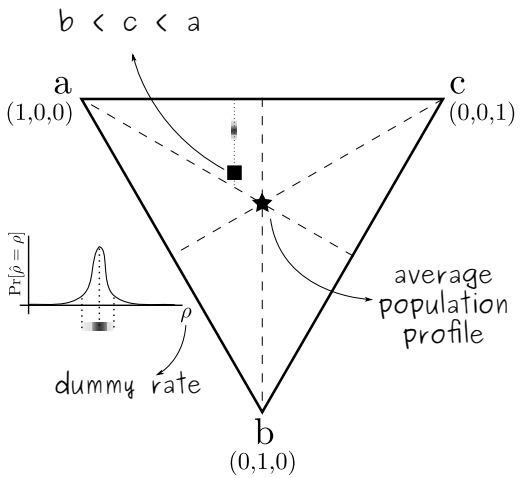

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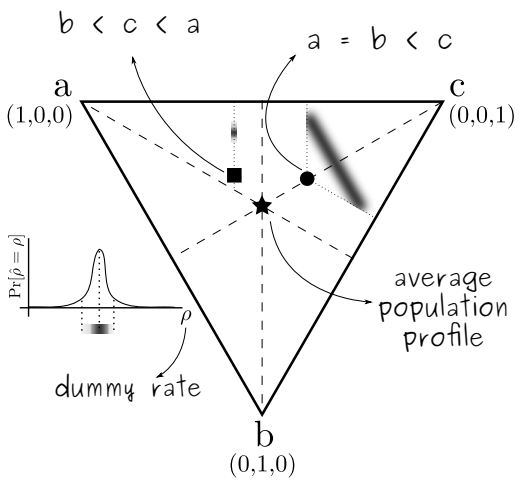

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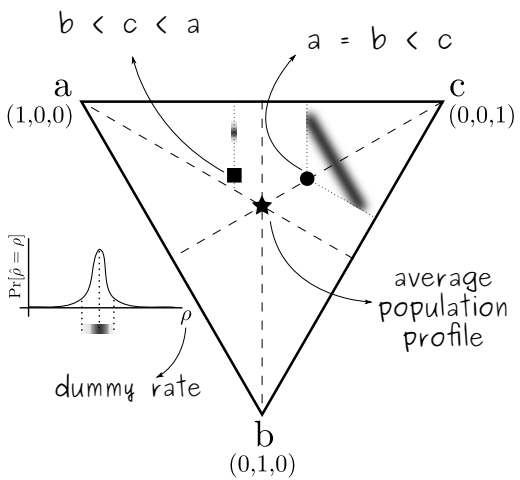

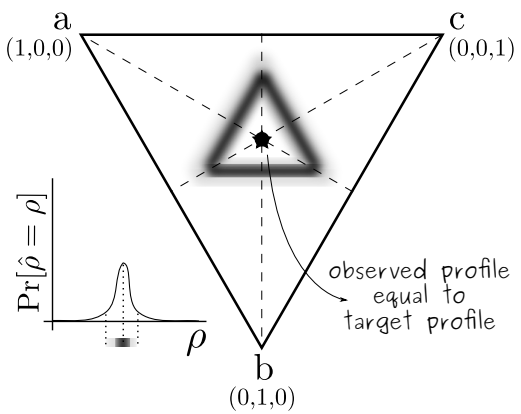

Systems' Analysis Summary

- Two main categories of DGS:
  - Query based.
  - Profile based.
- Different definitions of what privacy means:
  - k-deniability.
  - The (dis)similarity of profiles.
- Ad-hoc analyses and evaluations.

Open problems and future work

- Plausibility of dummy queries, e.g., The dictionary issue.
- Adversarial modelling, e.g., Adversarial SCA issue.

Conclusions

- Abstract model for OB-PWS systems.
- Analysis framework
  $\Rightarrow$ Definition and formalization of relevant privacy properties.
- Analysis of 6 existing OB-PWS systems (4 in this talk).
- Both profile and query based analyses are needed!

Thank you.

Questions?

Main references:

[1] Josep Domingo-Ferrer, Agusti Solanas, and Jordi Castellà-Roca.
h(k)-private information retrieval from privacy-uncooperative queryable databases.
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