A Declarative Approach to Linked Data Anonymization

Position paper

R. Delanaux[1] A. Bonifati[1] M-C. Rousset[2,3] R. Thion[1]

[1]LIRIS-CNRS, Université Claude Bernard Lyon 1

[2]LIG, Université Grenoble-Alpes

[3]Institut Universitaire de France

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Linked Open Data and why anonymize it

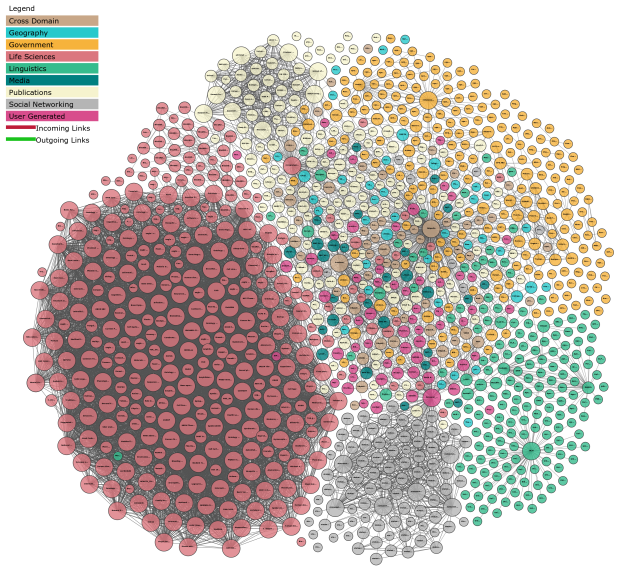
Connected structured datasets are freely accessible...

- E.g.: public transportation
- How do we prevent re-identification?

2 complementary aspects

→ Anonymize sensitive data...
→ ...presented as LOD graphs

Figure: Linked Open Data cloud in 2017 (`http://lod-cloud.net/`)



Current background

Existing anonymization techniques are not fit for the LOD context

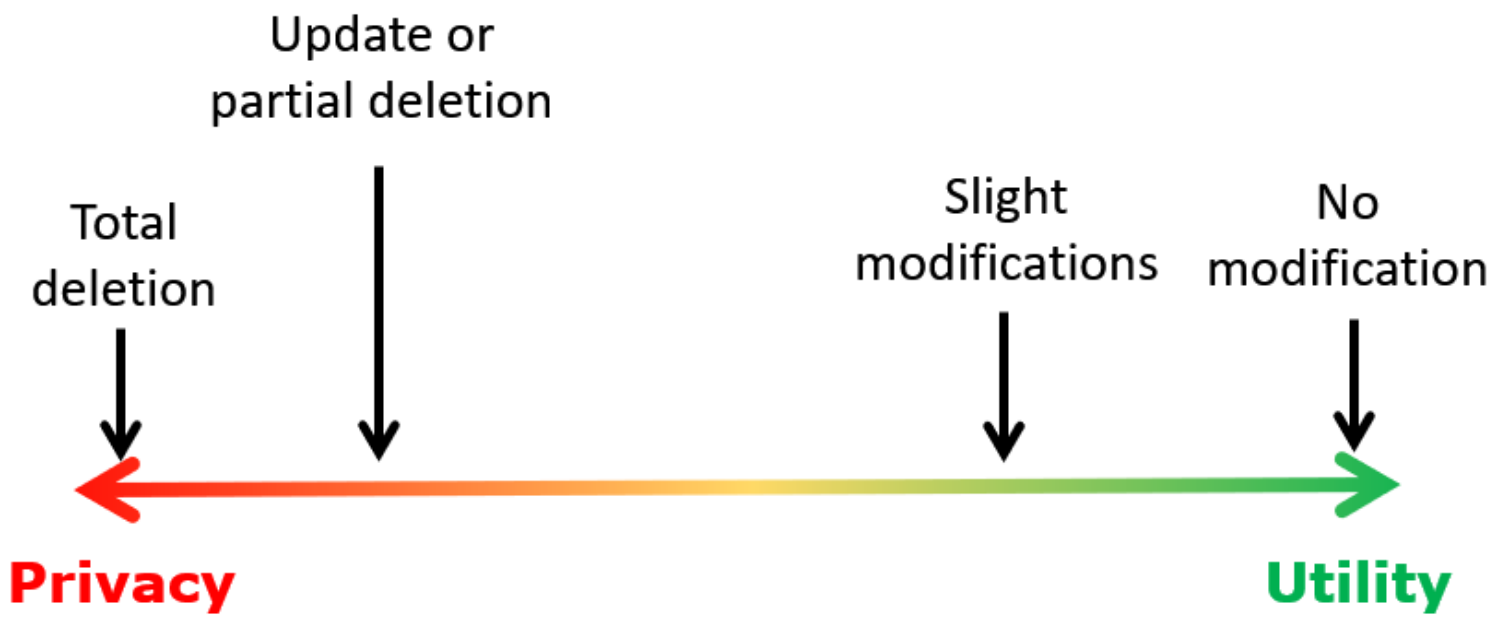
- Adapted to relational databases: k-anonymity and derived methods
- Focused on statistical integrity: Differential privacy ...

What can we do with LOD data?

- Existing data modeling and querying standards: RDF graphs, SPARQL queries
- Usage is different for LOD than for relational DB (w.r.t. statistics, for example)
- $\Rightarrow$ We need techniques to keep data integrity, and adapted to LOD graphs

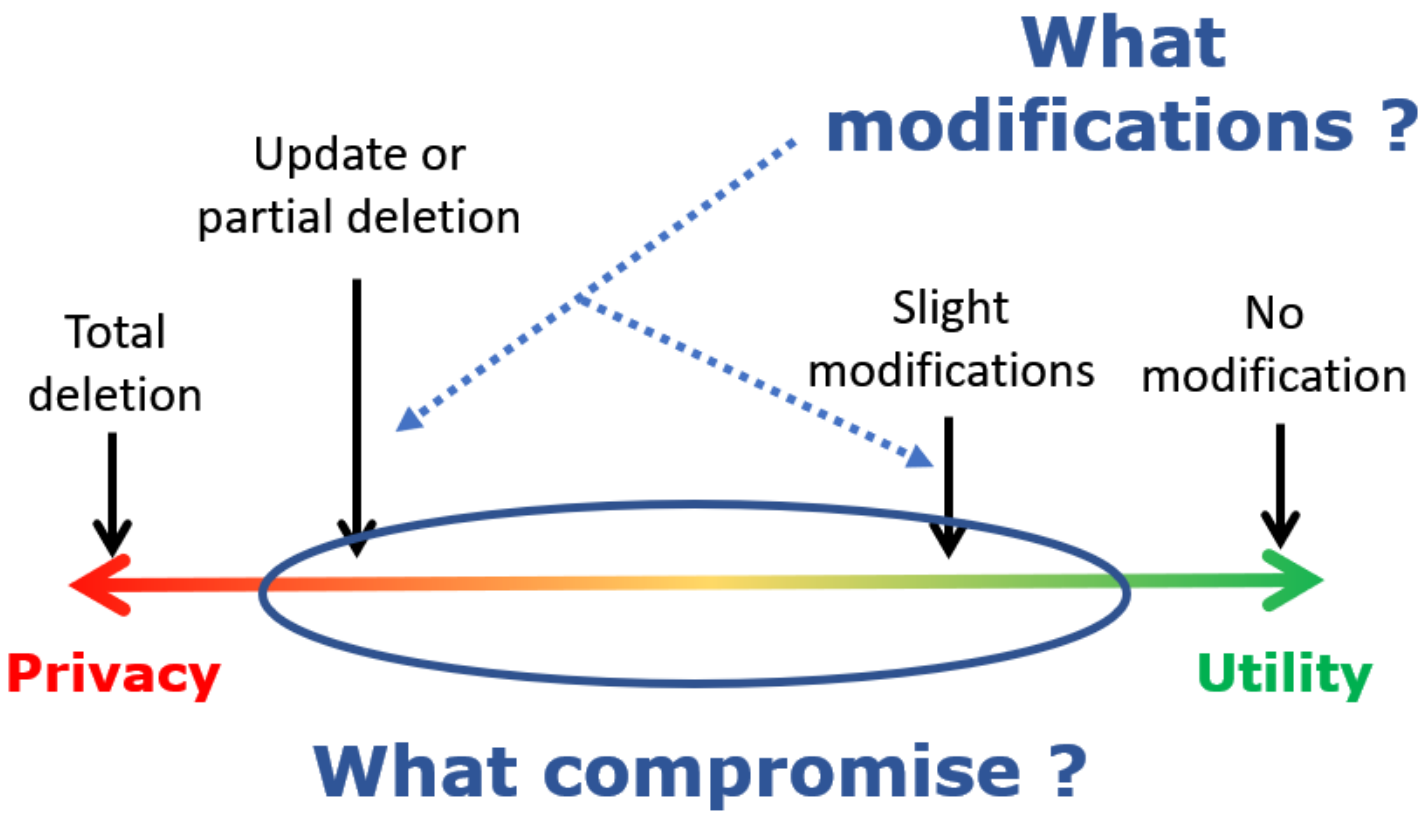
Summary

Figure: A classic problem: balancing data privacy and data utility



Summary

Figure: A classic problem: balancing data privacy and data utility



Summary

Our positioning: *a* **complete**, **static**, **query-based framework** *to handle constraints, operators and graph anonymization*

1. *Privacy and utility policies:* objects to handle constraints from the data provider as meaningful queries
2. *Anonymization operators:* operations on RDF graphs as queries
3. *Anonymization problems:* towards complete anonymization framework and algorithms

Query-based policy specification

Policies model data provider constraints

- A policy is a set of queries
- 2 types of policies with opposite semantics: privacy / utility policies

Policy semantics

- A privacy query must **not return any result** on the anonymized graph
- An utility query must **return the same results** on the anonymized graph than on the original graph

Privacy policy

```
SELECT ?n
WHERE {
  ?c  rdf:type          tcl:Journey
  ?c  tcl:user          ?u.
  ?u  rdf:type          tcl:User.
  ?u  foaf:familyName   ?n.
}

SELECT ?u ?lat ?long
WHERE {
  ?c  rdf:type          tcl:Journey.
  ?c  tcl:user          ?u.
  ?c  geo:latitude      ?lat.
  ?c  geo:longitude     ?long.
}
```

Utility policy

```
SELECT ?u ?age
WHERE {
  ?u  rdf:type  tcl:User.
  ?u  foaf:age  ?age.
}
SELECT ?c ?lat ?long
WHERE {
  ?c  rdf:type          tcl:Journey.
  ?c  geo:latitude      ?lat.
  ?c  geo:longitude     ?long.
```

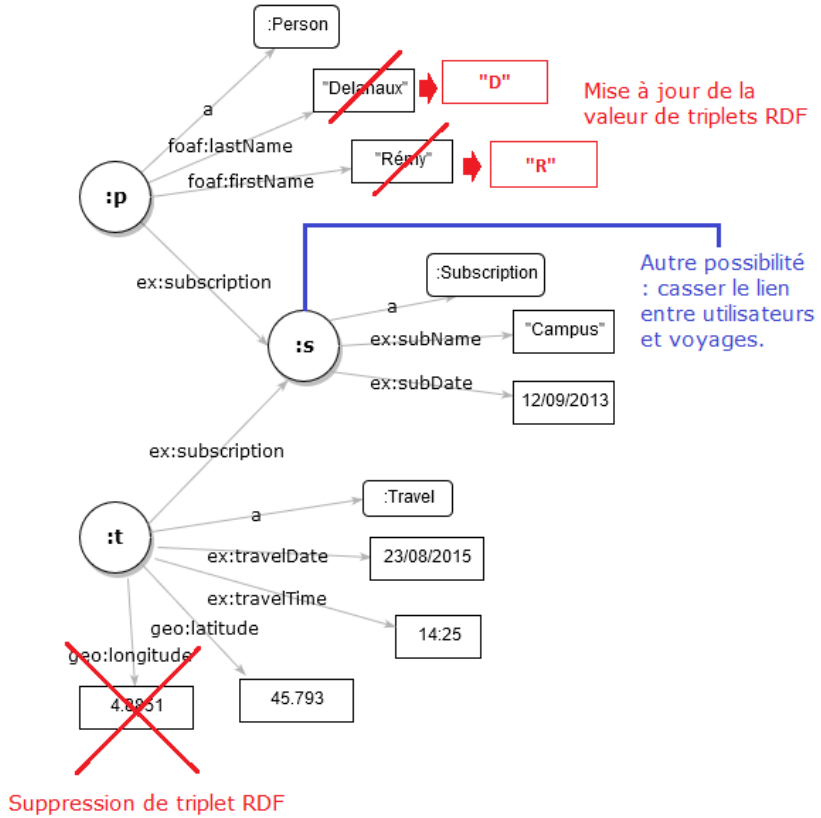
Query-based anonymization operators

Anonymization process = Sequence of **operations**

- Goal: Transform the input graph into a graph satisfying both policies
  - Triple deletion, value replacement, IRI replacement...

Example: Deletion queries

- Defined using SPARQL queries
- DELETE $GPD(\bar{x})$ WHERE $GPW(\bar{x}, \bar{y})$ FILTER C



Full-fledged anonymization system

Problems of interest to be solved using the framework:

1. **Compatibility problem**: define when are policies incompatible and impossible to satisfy at the same time
2. **Candidate anonymizations**: exhibit candidate sequences of operations
3. **Best anonymization**: find the optimal operation sequence
   - Choosing *a relevant partial order binary relation*: compare number of anonymization queries, number of edited items, Jaccard distance between original and updated graph...

Current progress and future prospects

ESWC2018 submission

- Complete framework for a deletion operator
- Graph-independent solution for the candidate anon. problem
- Implementation and experimental study (Python)

Future work

- *Extend coverage* - support more complex queries
- *Extend operators* - more subtle update operations
- *Optimization* - find & apply relevant anonymization measurements
- *Complexity* - evaluate algorithms and their efficiency

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