GDPRizer

Retrofitting GDPR Compliance onto Legacy Databases

Archita Agarwal, Marilyn George, Aaron Jeyaraj, Malte Schwarzkopf

mongoDB mongoDB BROWN BROWN

Data Privacy Laws

- EU’s GDPR
- California’s CCPA
- Virginia’s VCDPA
- Japan’s APPI
- Canada’s PIPEDA
- …

GDPR by elasticıstudio from Noun Project

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- …

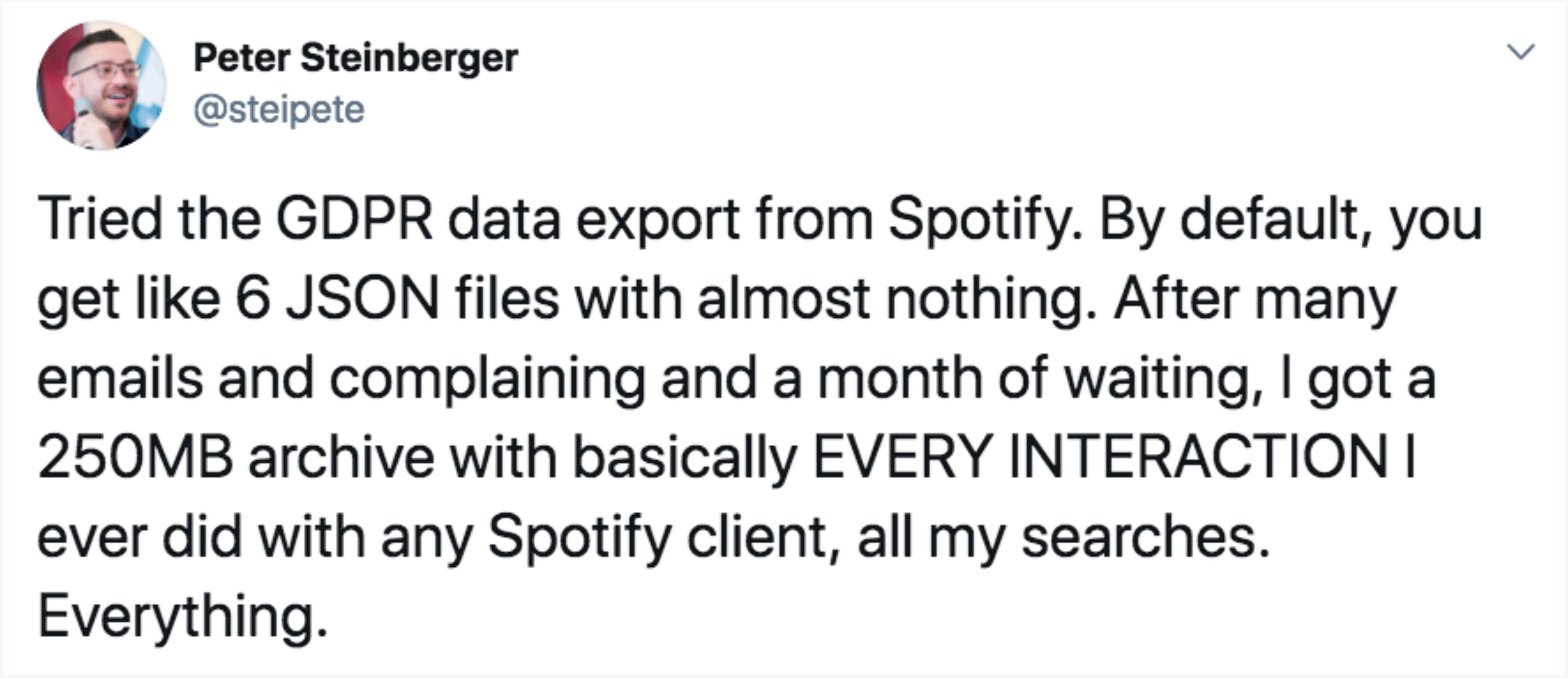
Allow individuals to
request a copy of their data

data access request

GDPR by elasticıstudio from Noun Project

Identifying & retrieving user-data is hard

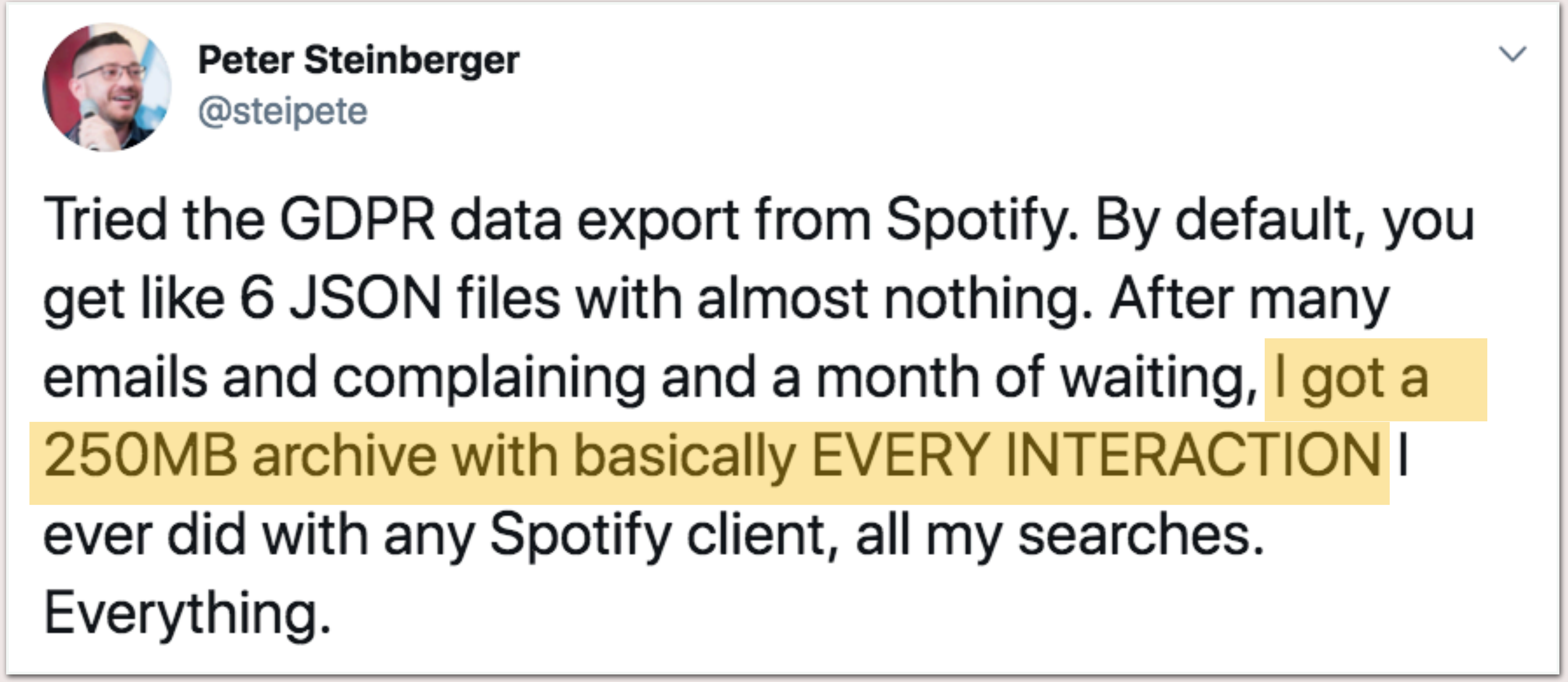
Spotify®



Peter Steinberger
@steipete

Tried the GDPR data export from Spotify. By default, you get like 6 JSON files with almost nothing. After many emails and complaining and a month of waiting, I got a 250MB archive with basically EVERY INTERACTION I ever did with any Spotify client, all my searches. Everything.

Identifying & retrieving user-data is hard



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Why is user-data identification so hard?

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How to identify a user’s information?

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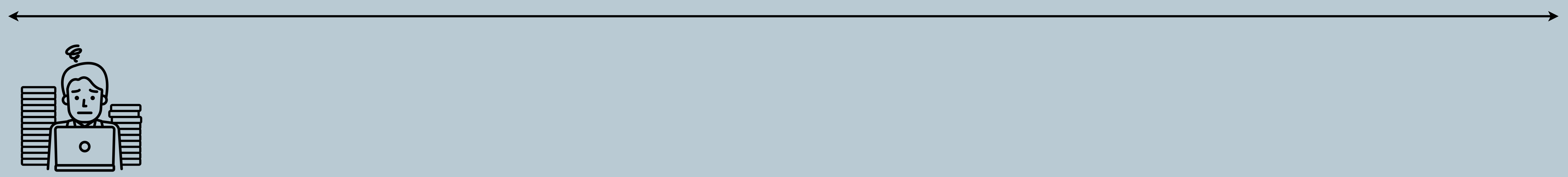
Fully Manual



DBAs identify and write the queries

Hard Work by Llisole from the Noun Project

How to identify a user's information?

Too HARD :-(

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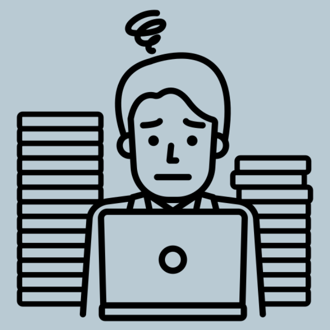

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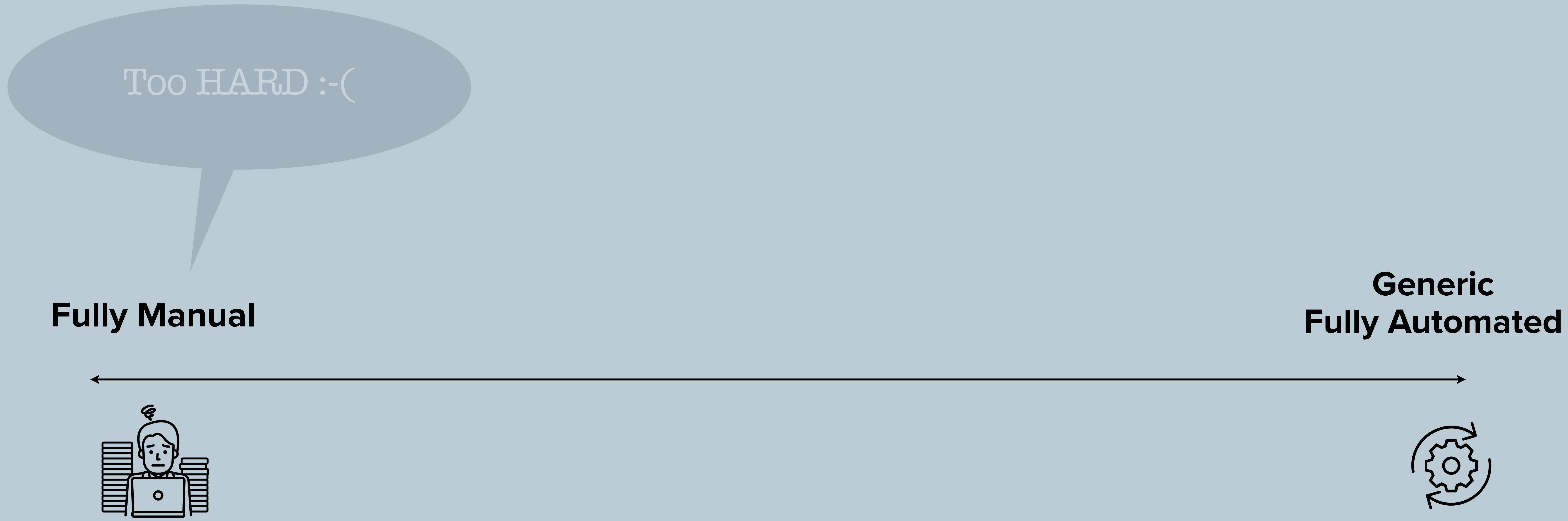

Too HARD :-(

Fully Manual

Generic
Fully Automated

DBAs identify and write
the queries

Hard Work by Llisole from the Noun Project

Automated Solution by ProSymbols from the Noun Project

How to identify a user’s information?

Too HARD :-(

Fully Manual

Likely Impossible :-(

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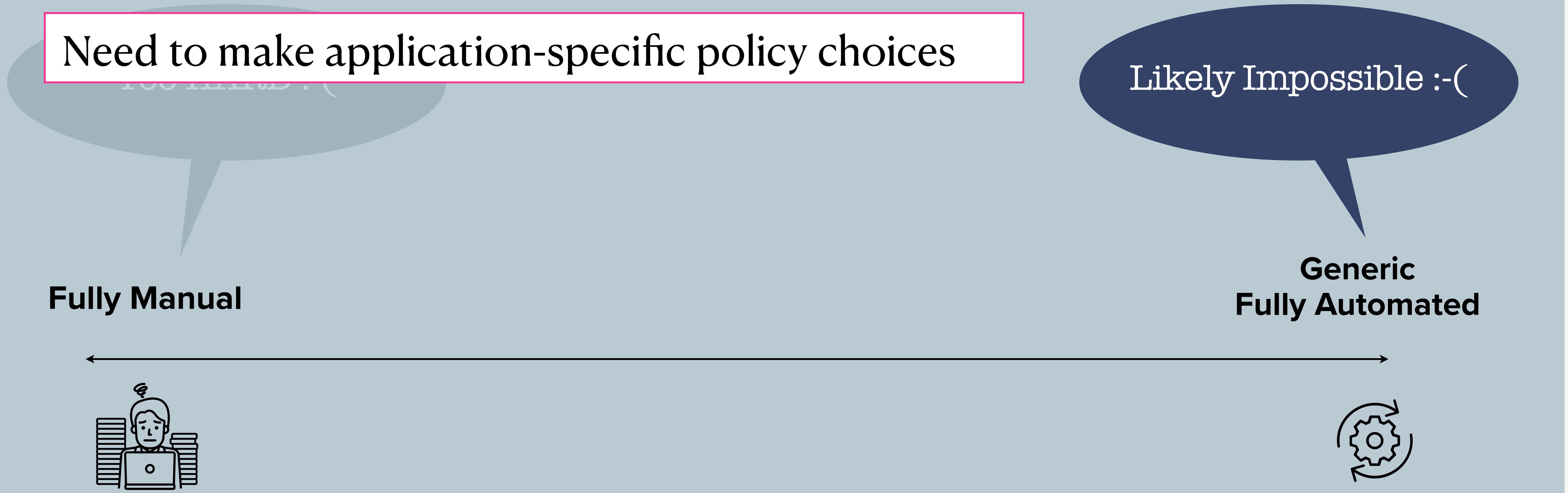
How to identify a user's information?

Need to make application-specific policy choices



Likely Impossible :-(

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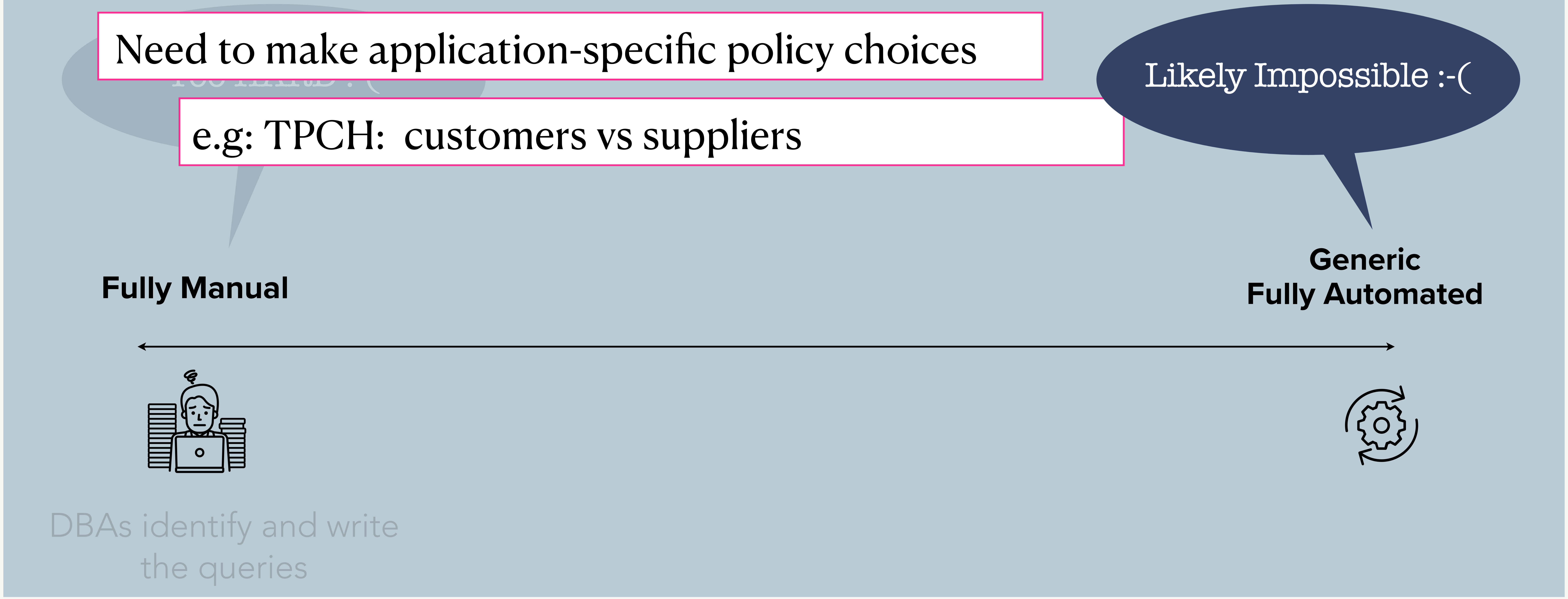
How to identify a user’s information?



Need to make application-specific policy choices

e.g: TPCH: customers vs suppliers

Hard Work by Llisole from the Noun Project
Automated Solution by ProSymbols from the Noun Project

How to identify a user’s information?

Need to make application-specific policy choices

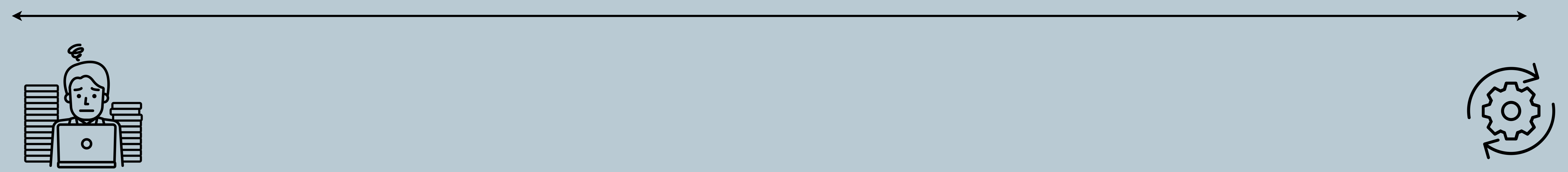
e.g: TPCH: customers vs suppliers

e.g: Should comments on posts be returned to the author?

Likely Impossible :-(

Fully Manual

**Generic
Fully Automated**



DBAs identify and write
the queries

Hard Work by Llisole from the Noun Project

Automated Solution by ProSymbols from the Noun Project

How to identify a user's information?

Too HARD :-(

Likely Impossible :-(

GDPRizer

Fully Manual

Mostly Automated
w/ some Manual Customizations

Generic
Fully Automated

DBAs identify and write
the queries

Hard Work by Llisole from the Noun Project
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Talk Outline

- GDPRizer: Design & Architecture
- Experimental Evaluation
    - Prototype in Python
    - Tested its accuracy on four applications

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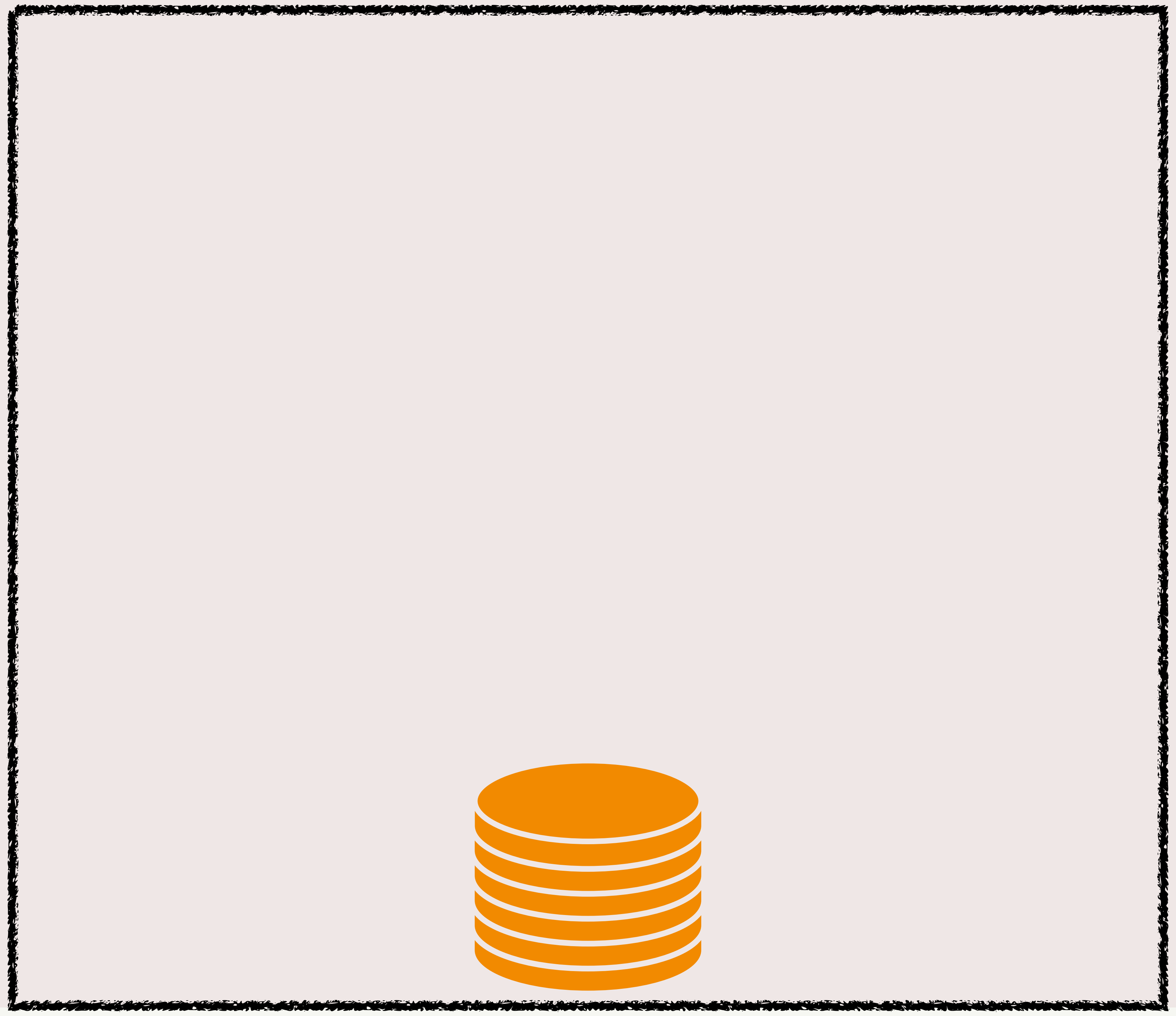
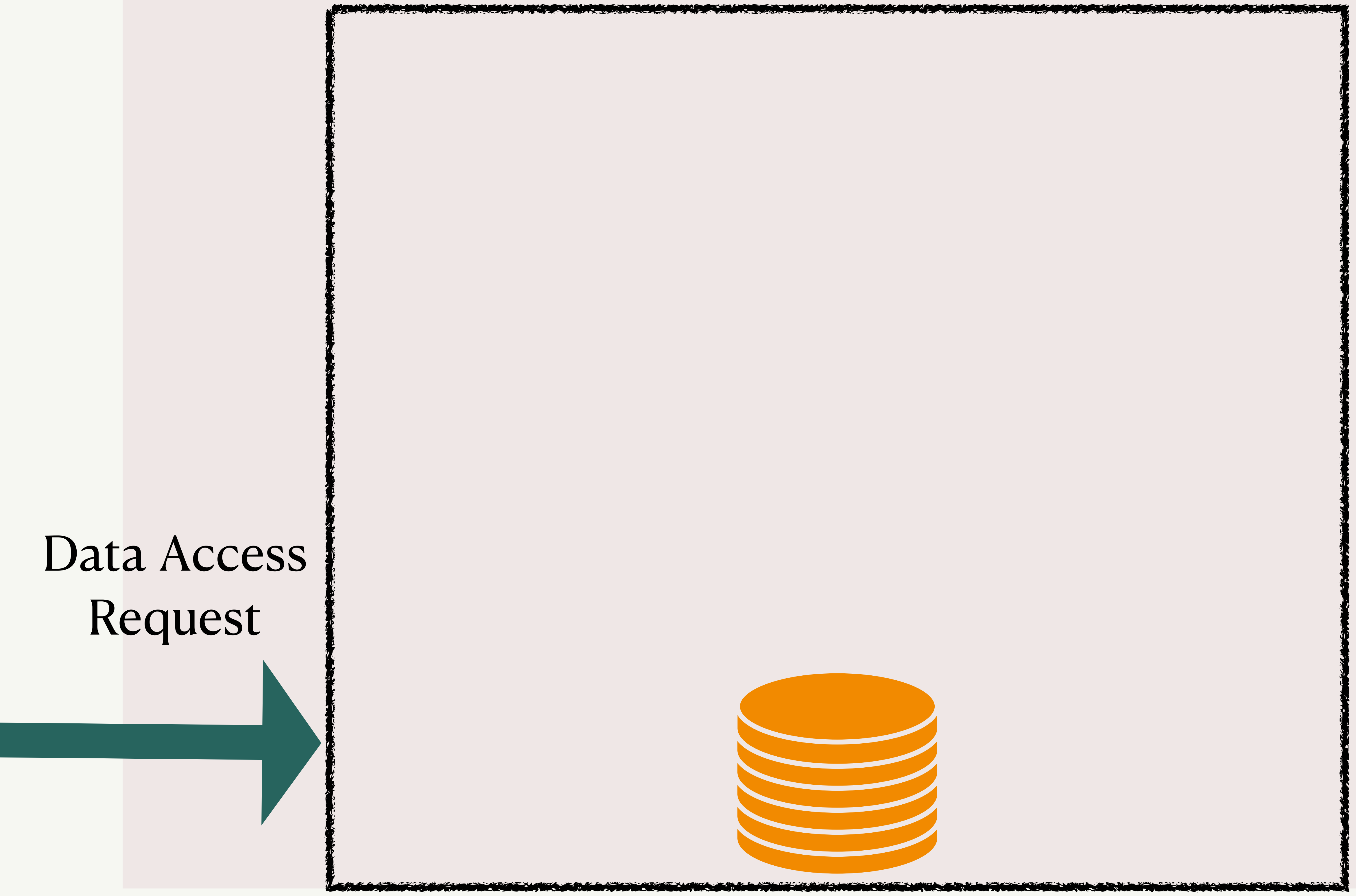
High Level Design of GDPRizer



High Level Design of GDPRizer



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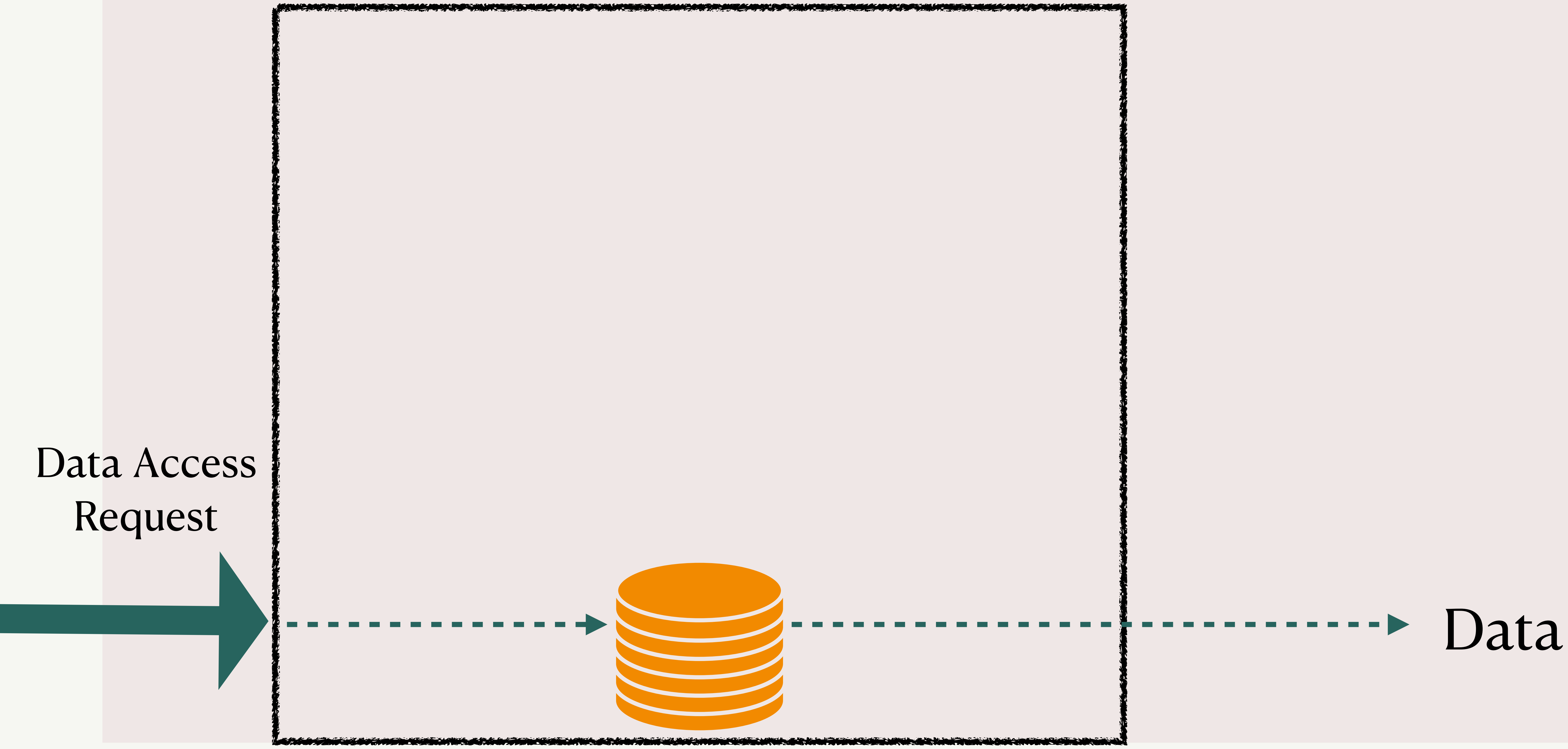
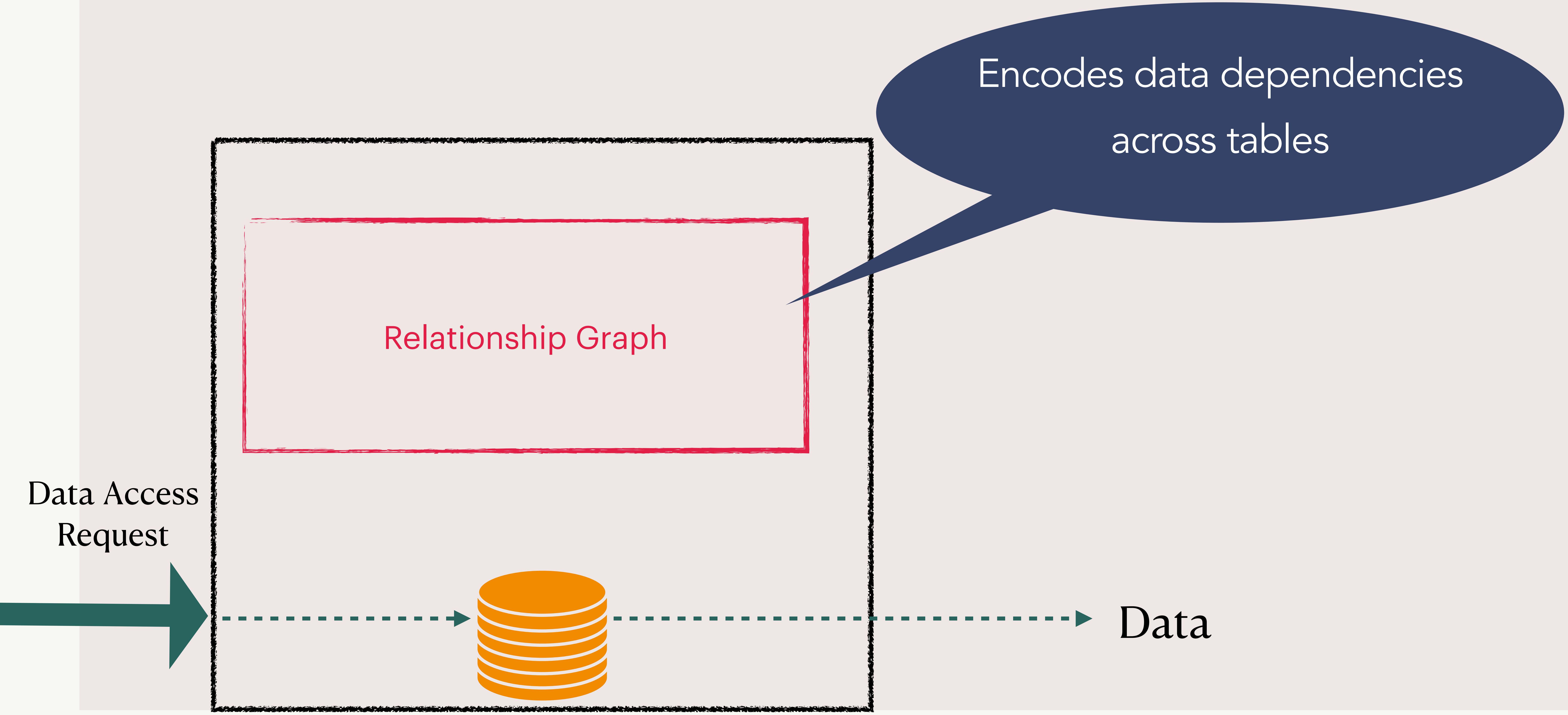
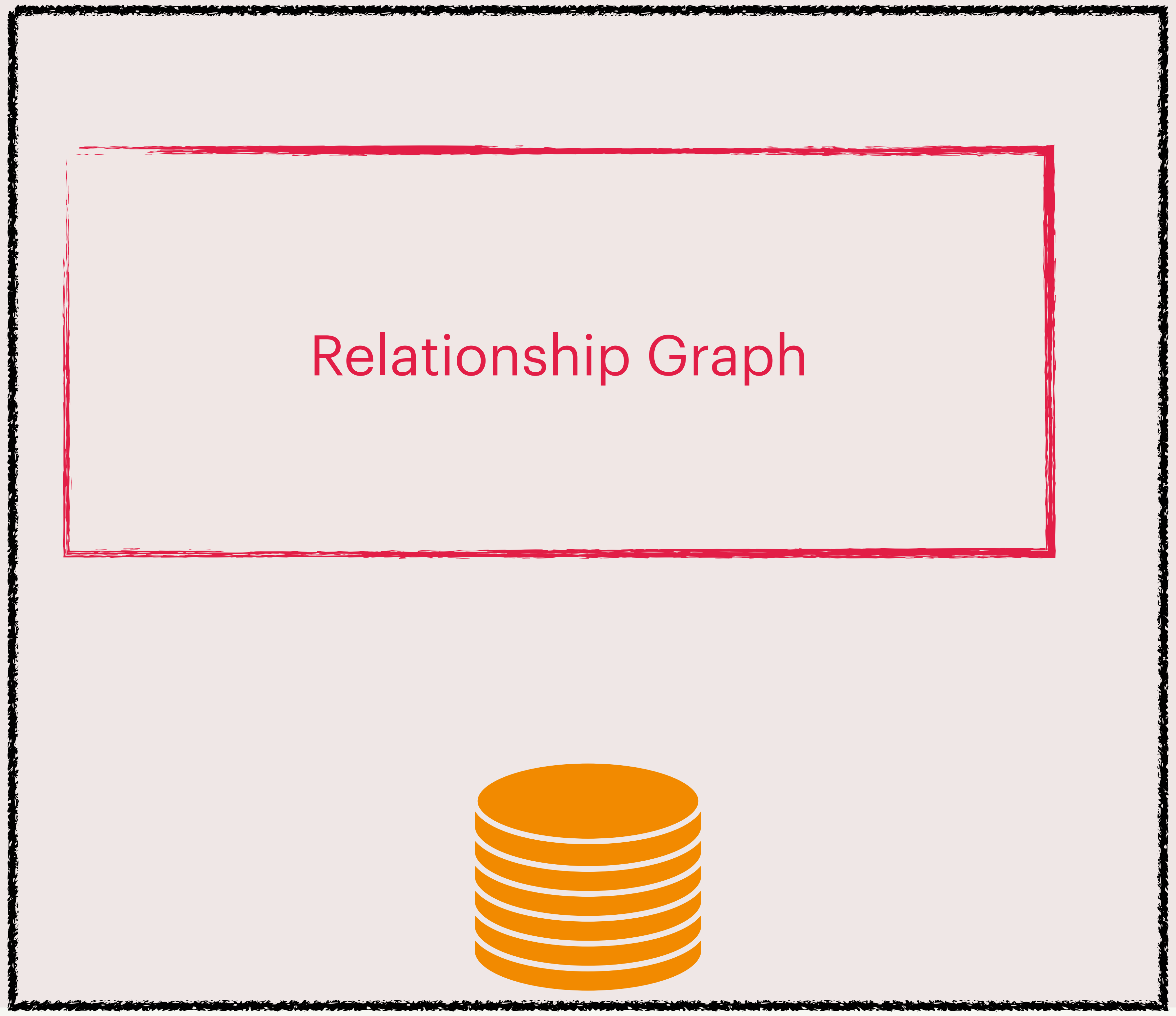


High Level Design of GDPRizer



Relationship Graph

Encodes data dependencies across tables



Relationship Graph

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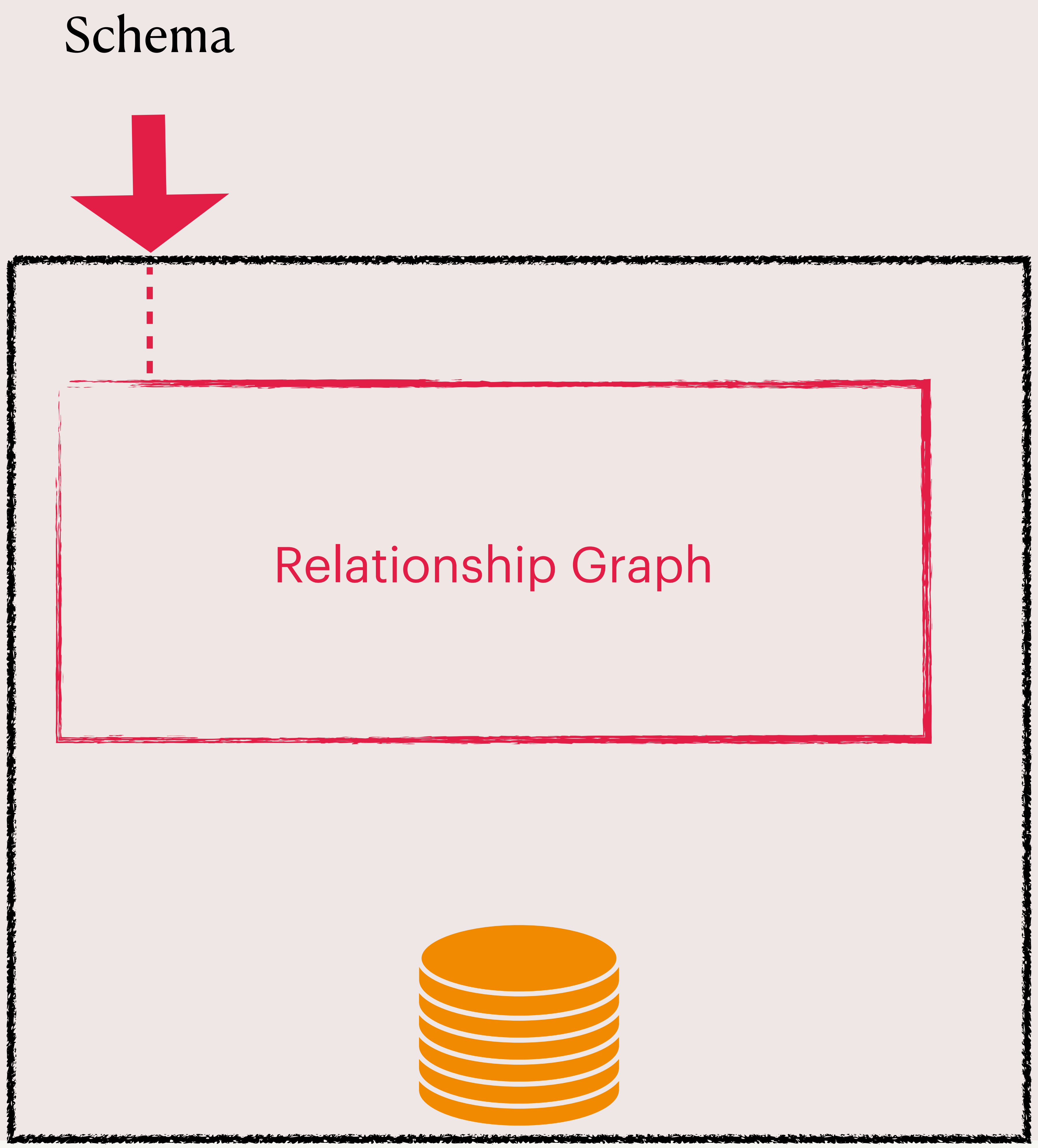


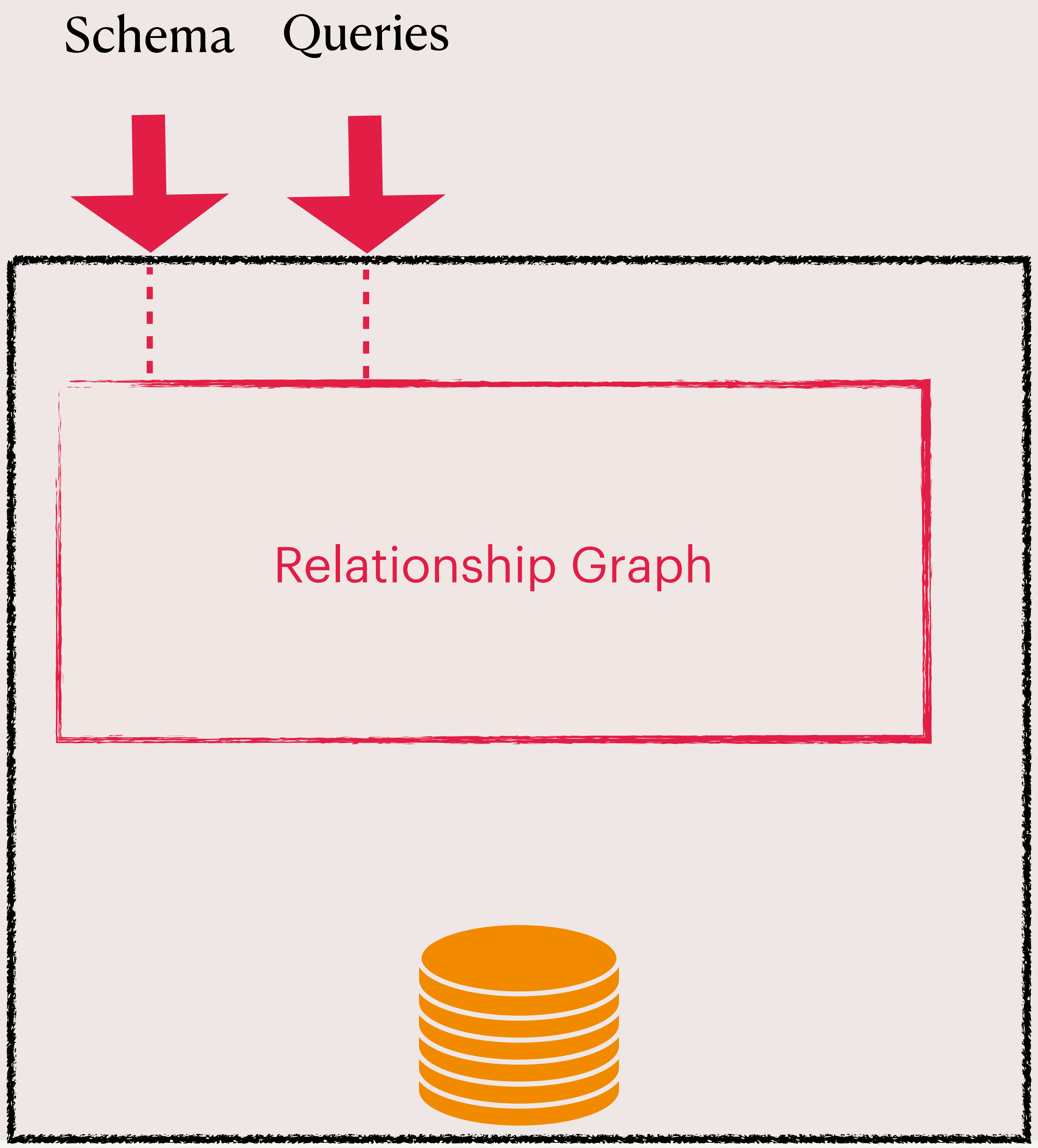
Schema

Relationship Graph

Encodes data dependencies across tables

Explicit foreign-key constraints

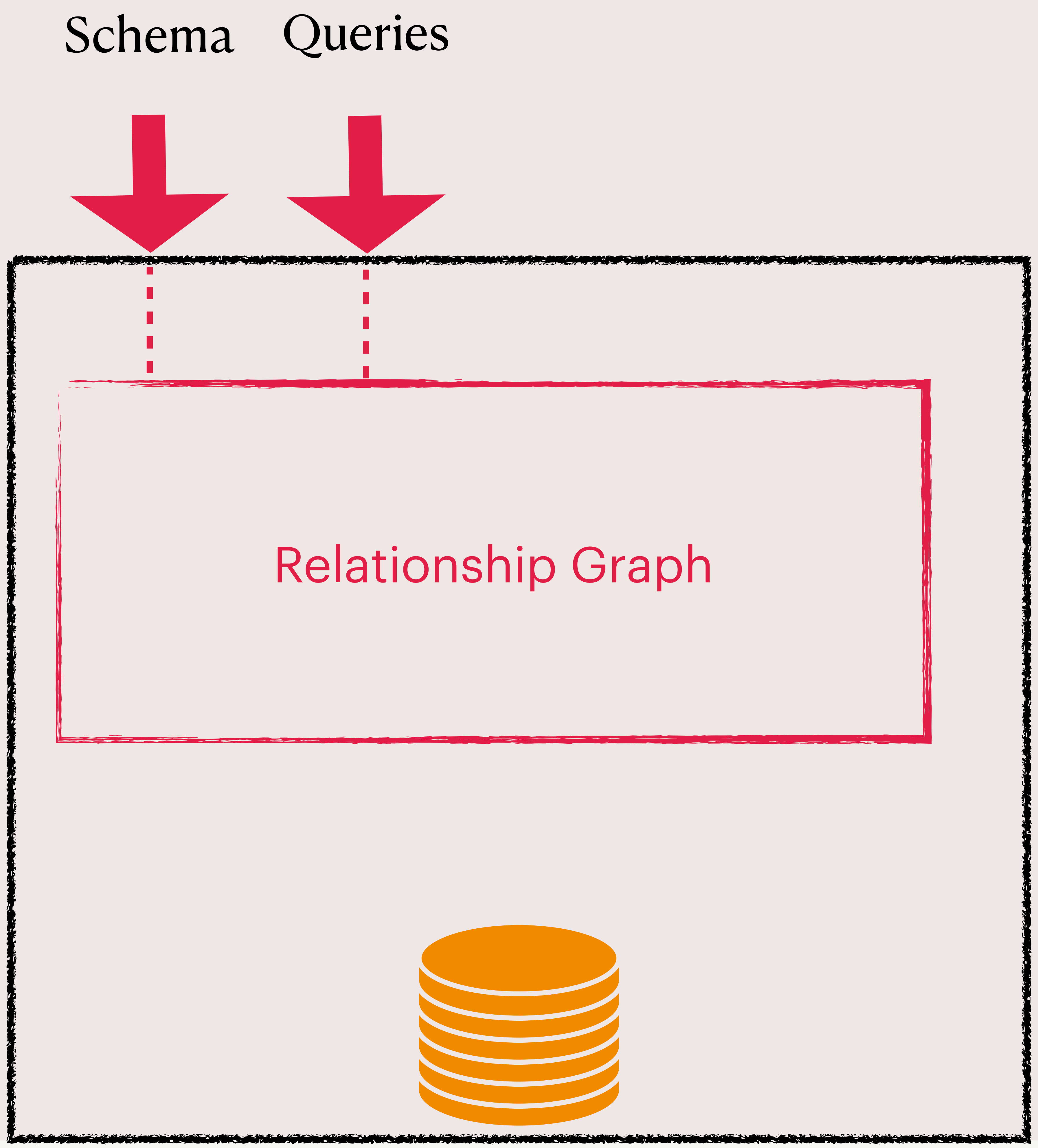
Relationship Graph



Encodes data dependencies across tables

Joins in Queries

Relationship Graph



Encodes data dependencies across tables

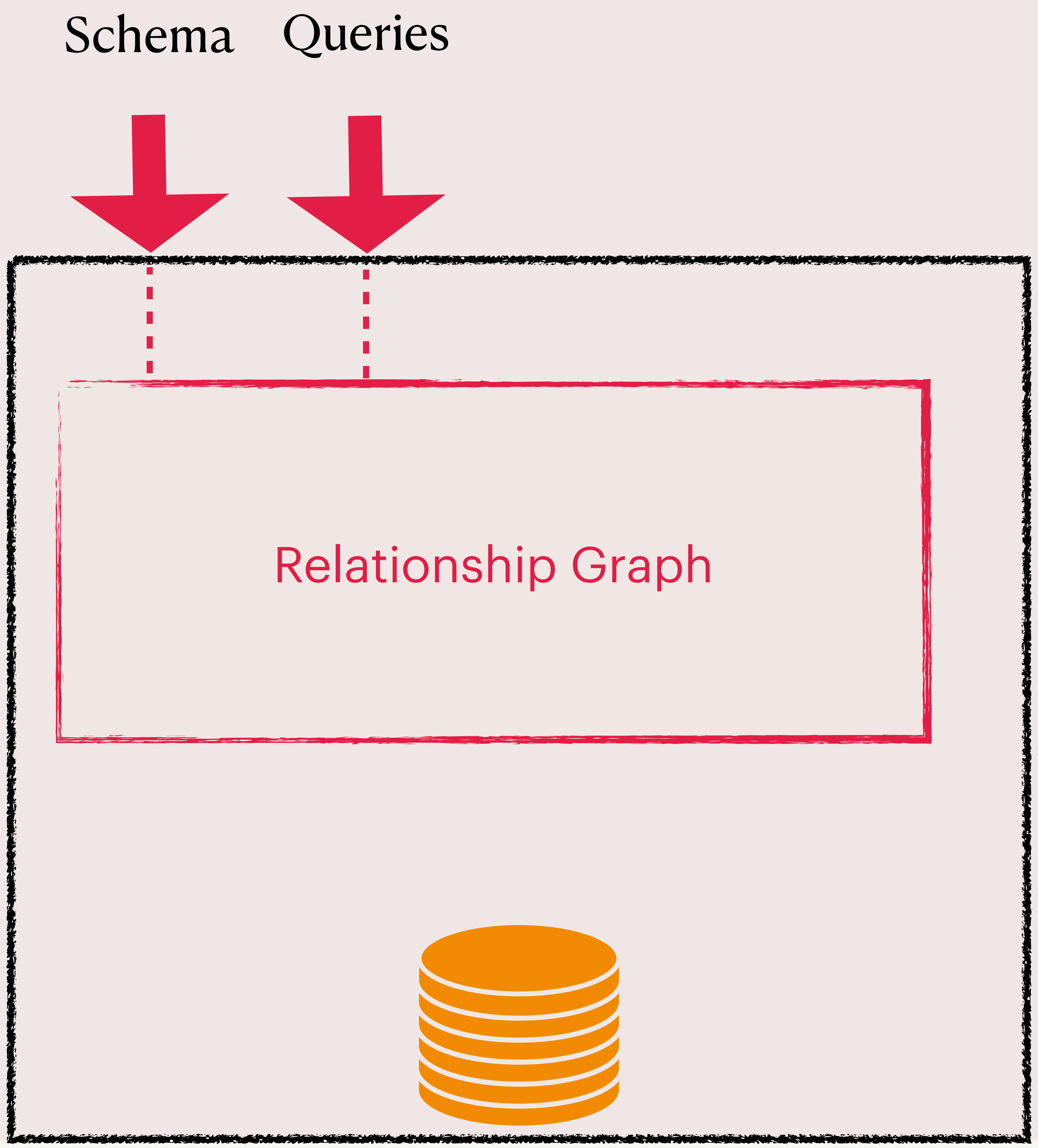
Joins in Queries

SELECT * FROM Paper, ContactInfo

WHERE

Paper.leadContactId = ContactInfo.contactId

Relationship Graph



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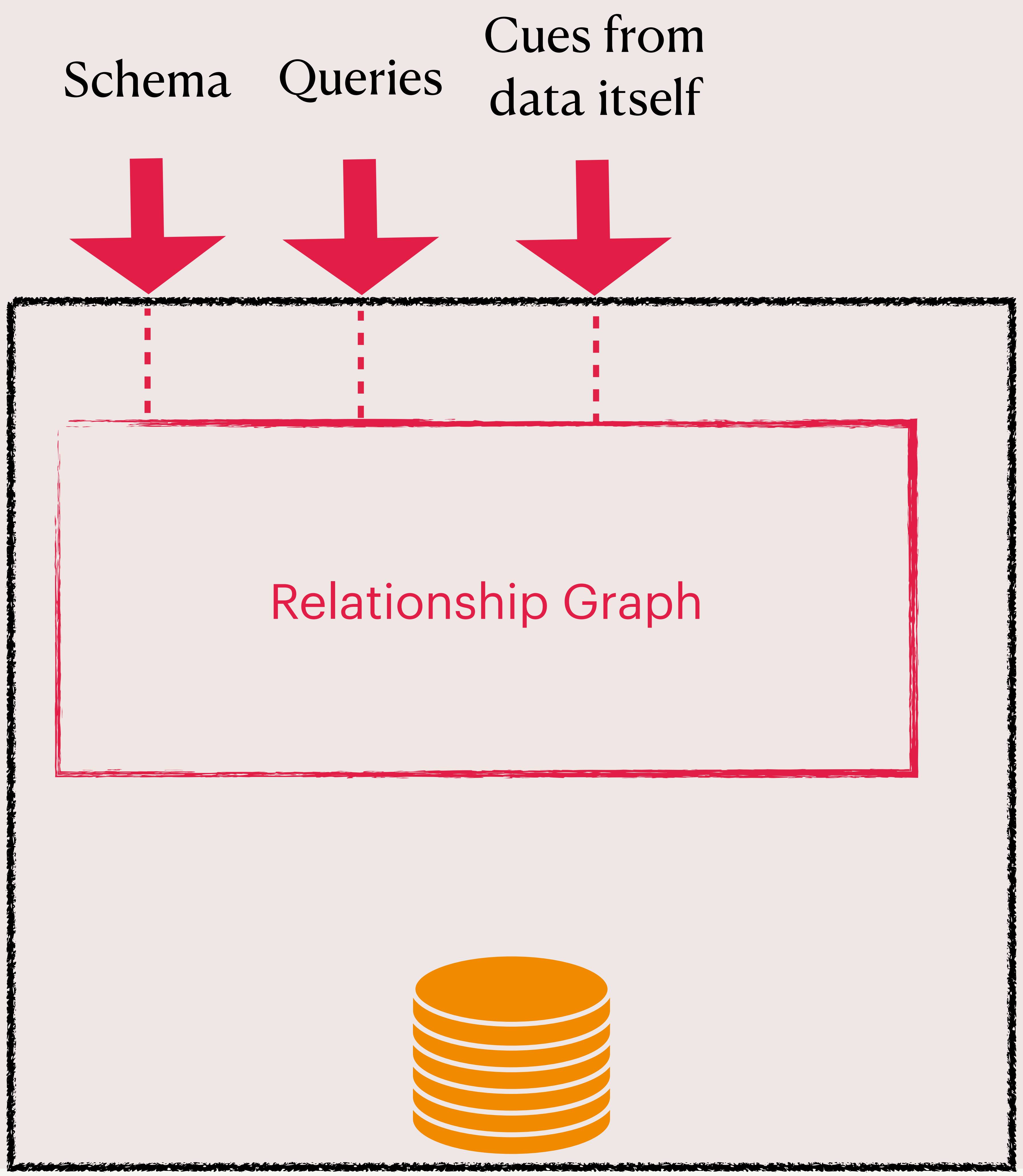


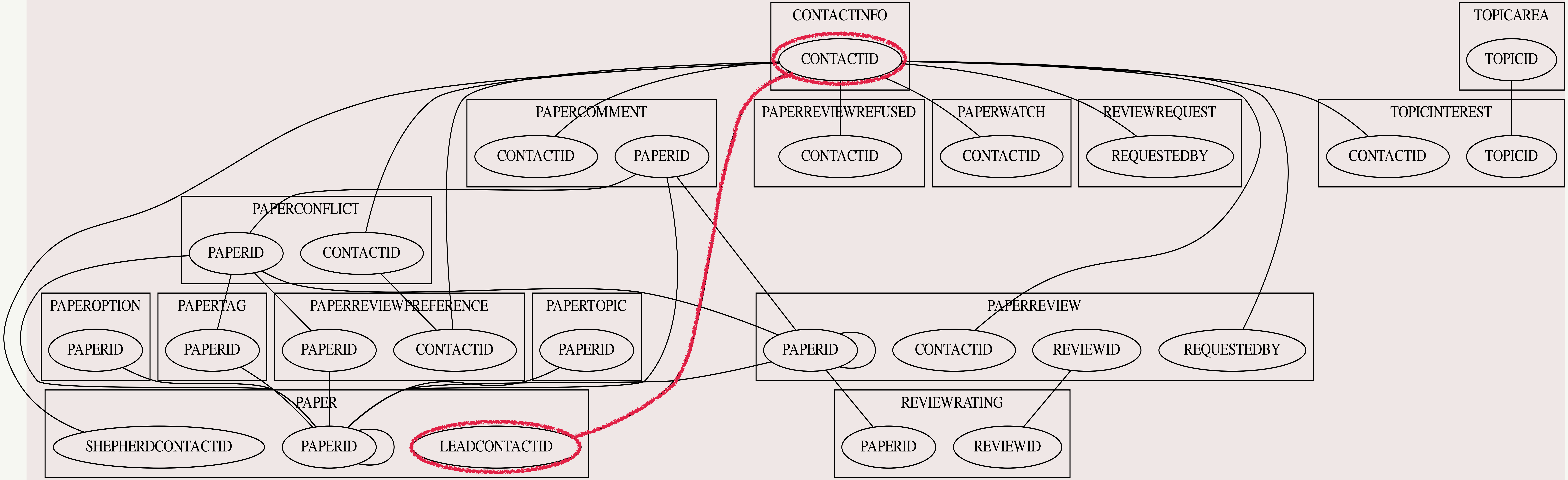
Encodes data dependencies across tables

Rich literature on identifying functional dependencies in data

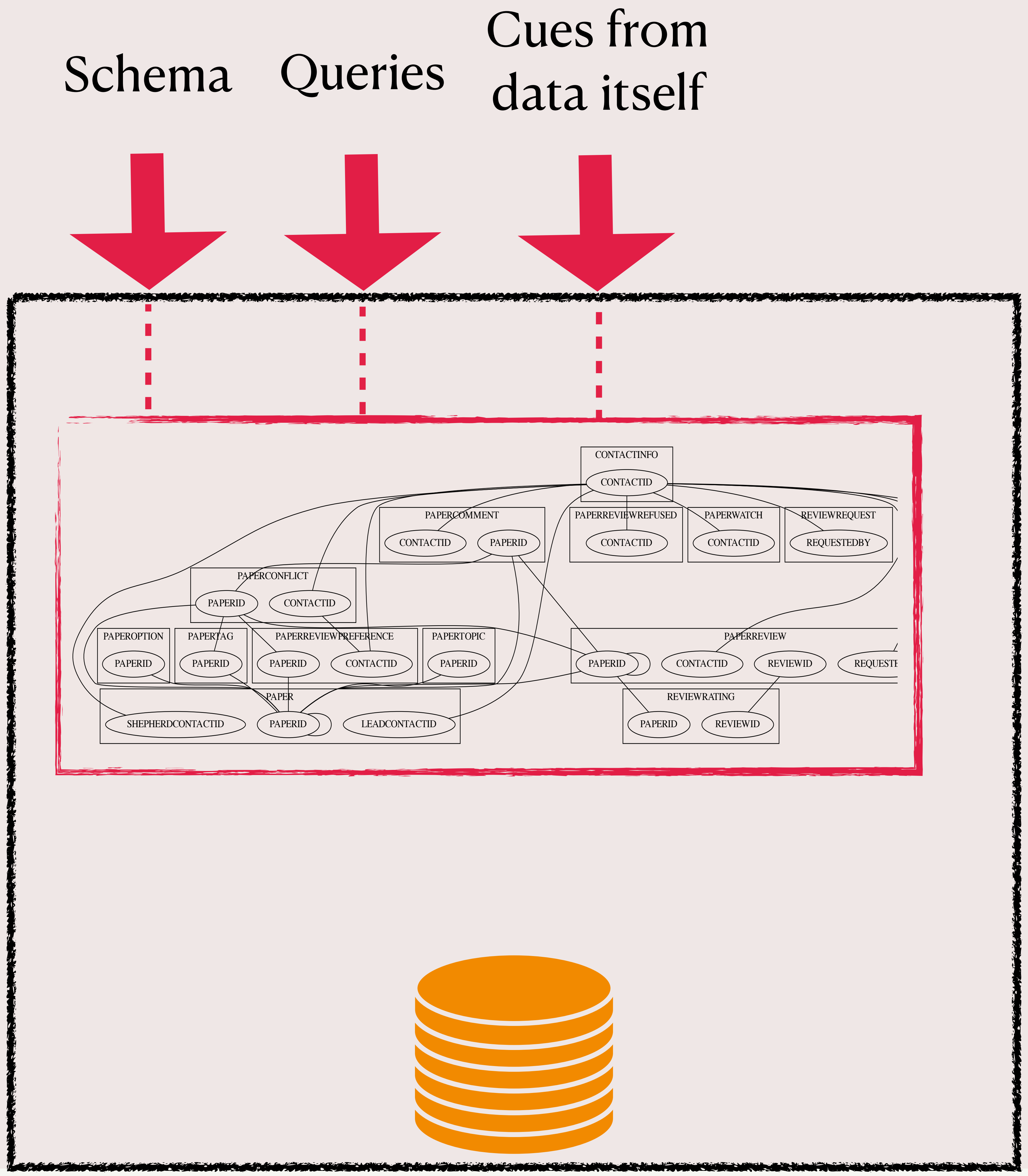
See survey by Abedjan et al., VLDB 2015

Relationship Graph of HotCRP

Using only the joins in queries



Service Data Access Request

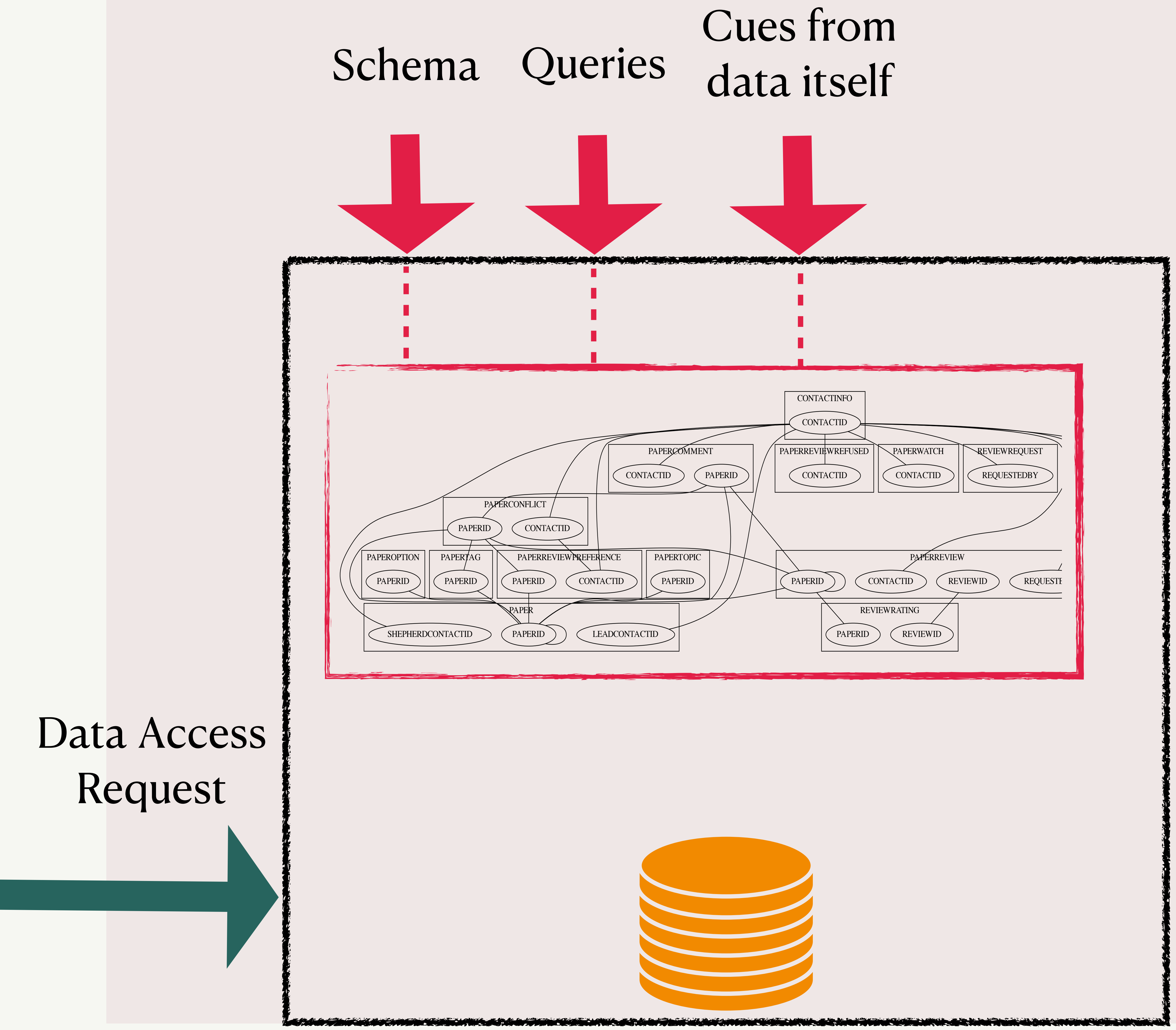


Schema

Queries

Cues from data itself

Service Data Access Request



Schema

Queries

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Data Access Request

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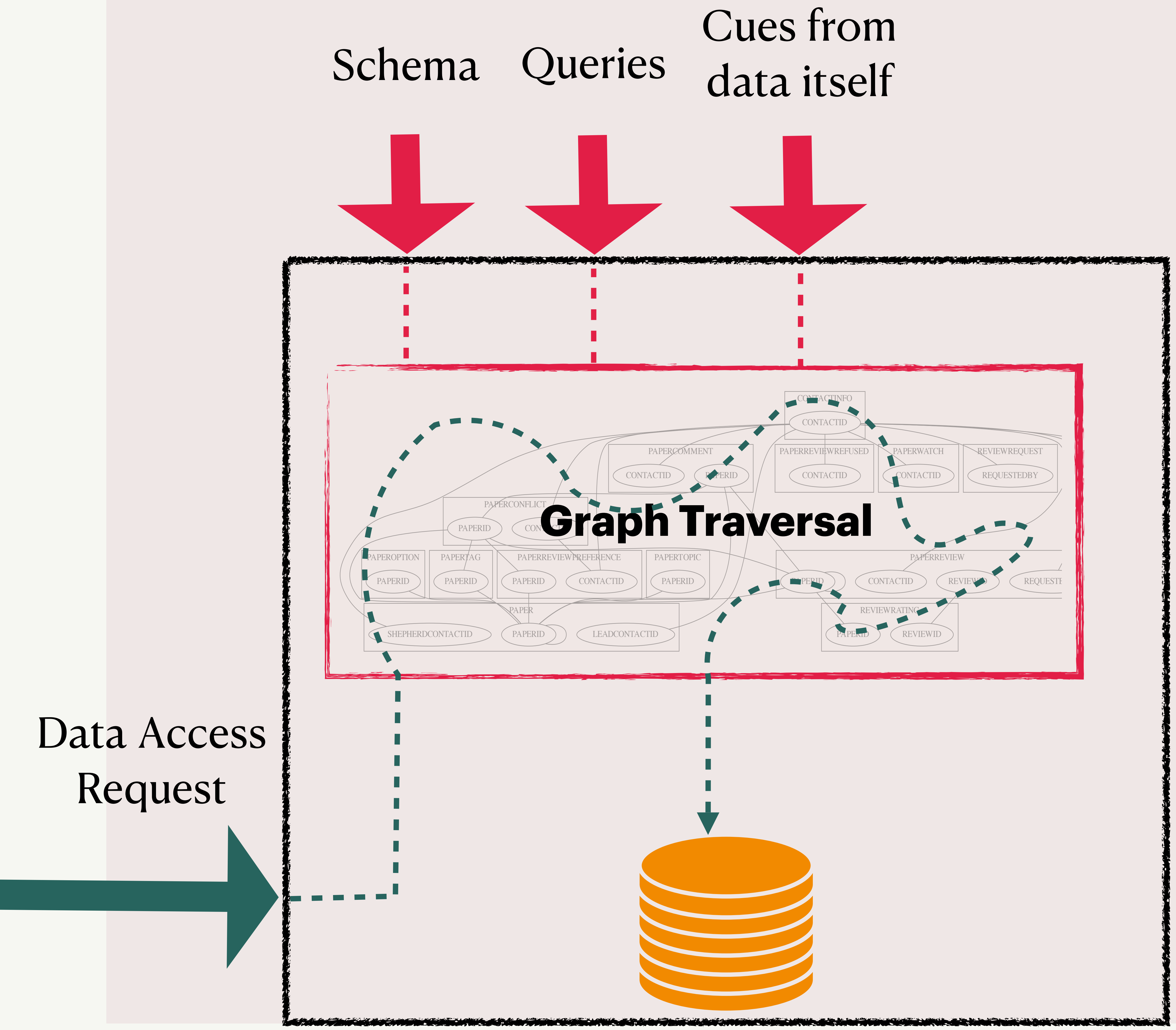

Schema

Queries

Cues from
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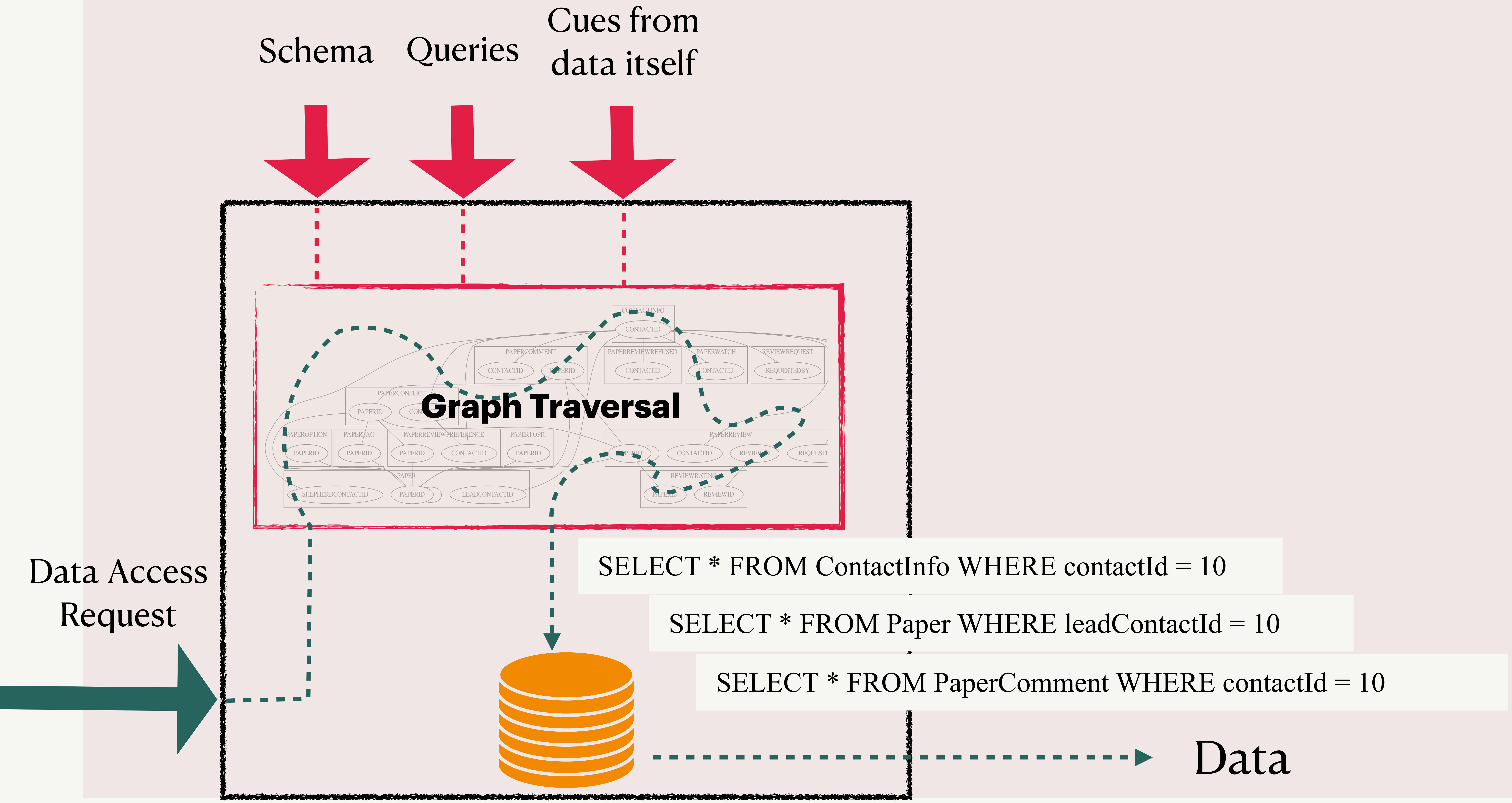
Graph Traversal

Data Access
Request

Service Data Access Request



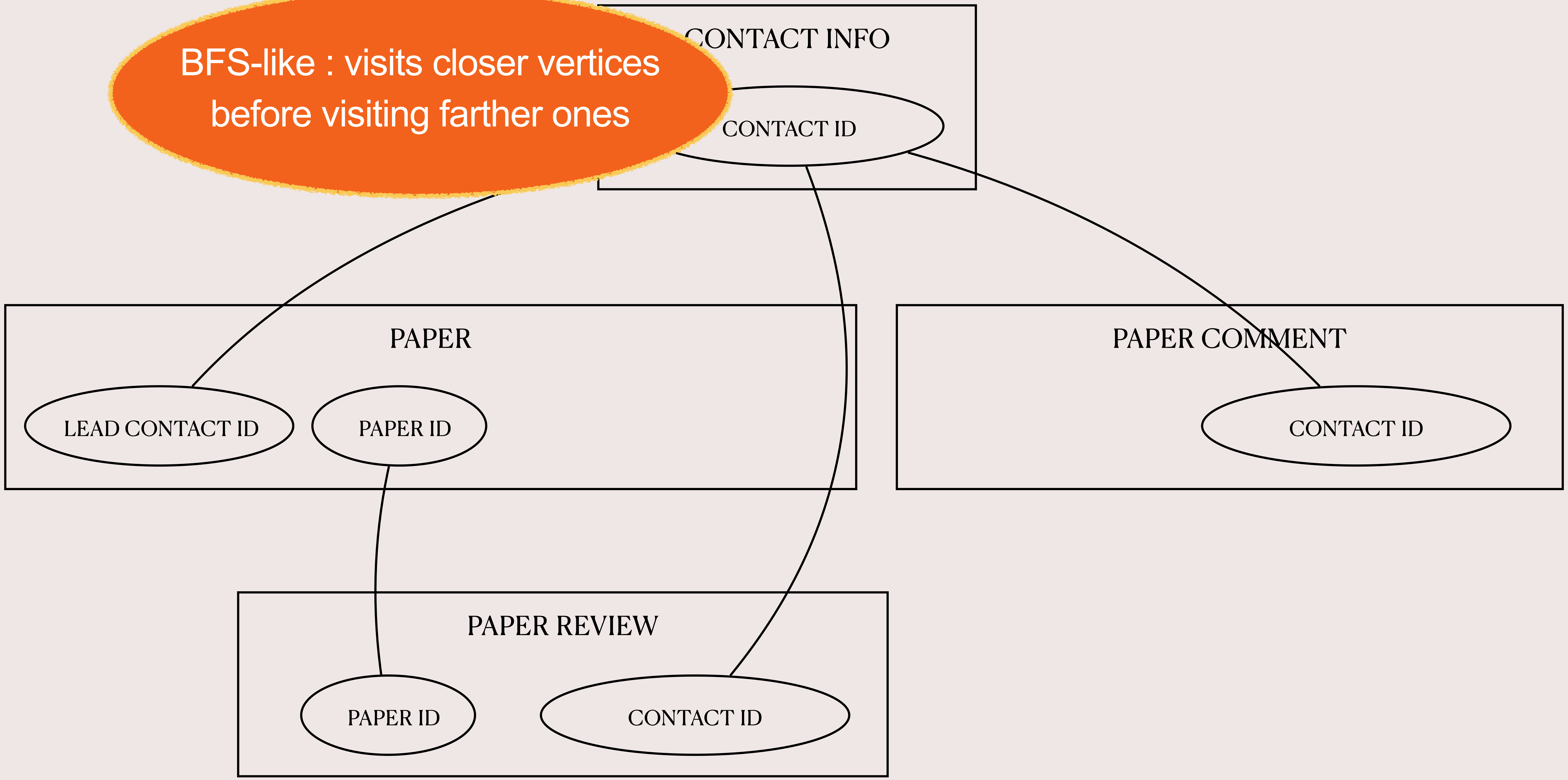
SELECT * FROM ContactInfo WHERE contactId = 10

SELECT * FROM Paper WHERE leadContactId = 10

SELECT * FROM PaperComment WHERE contactId = 10

Graph Traversal: Access Request for contactID = 10

BFS-like : visits closer vertices before visiting farther ones



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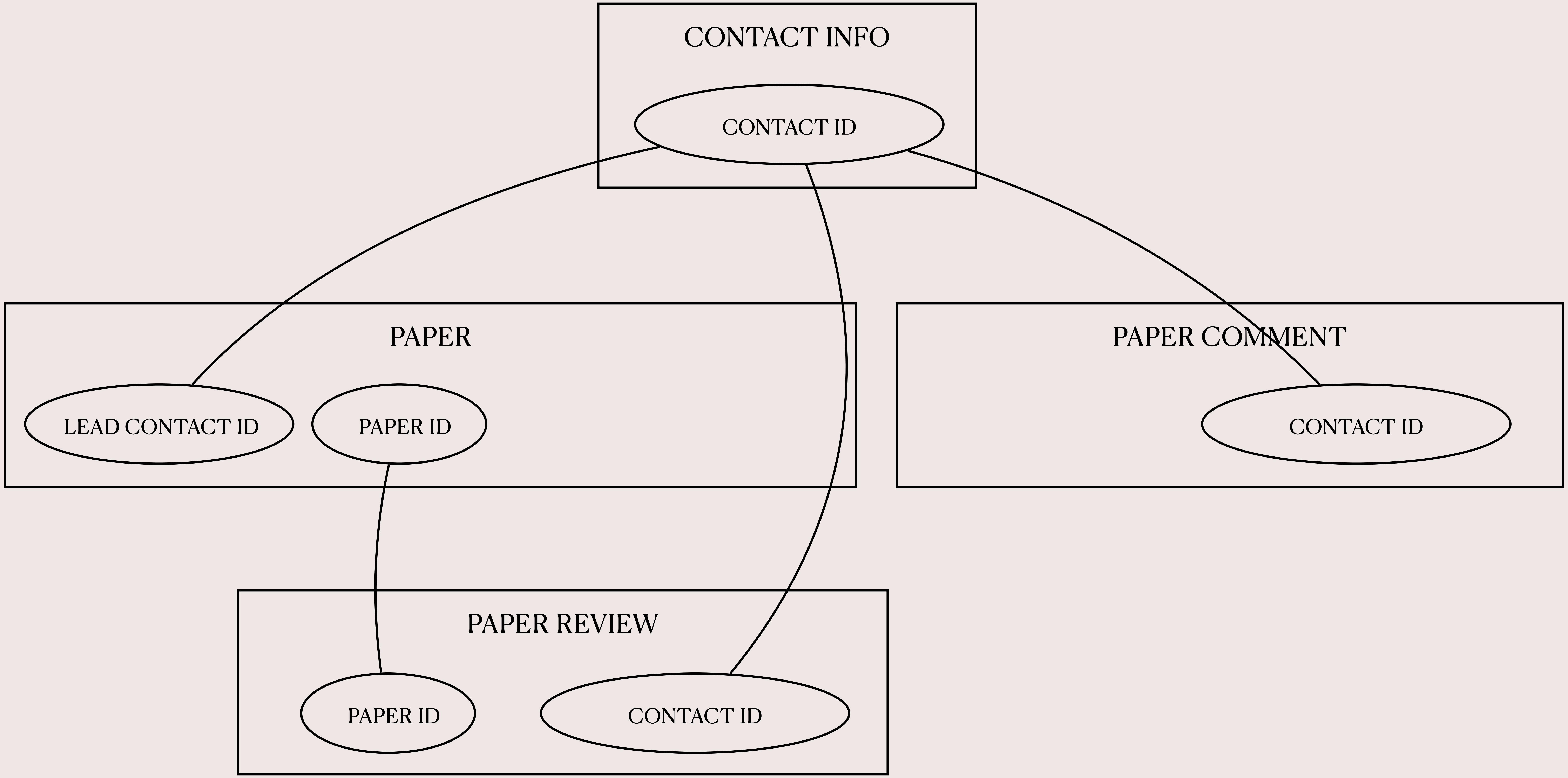

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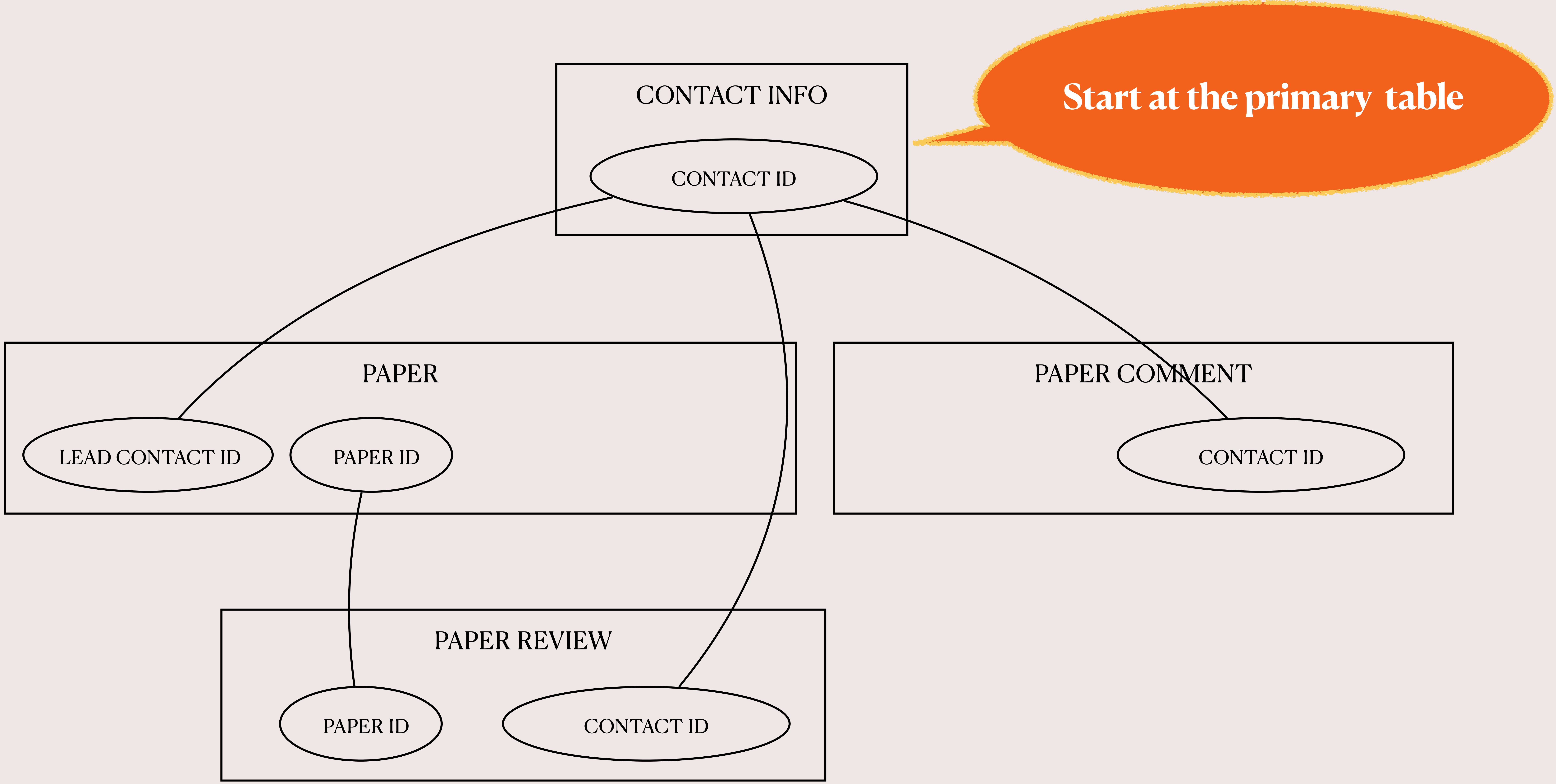
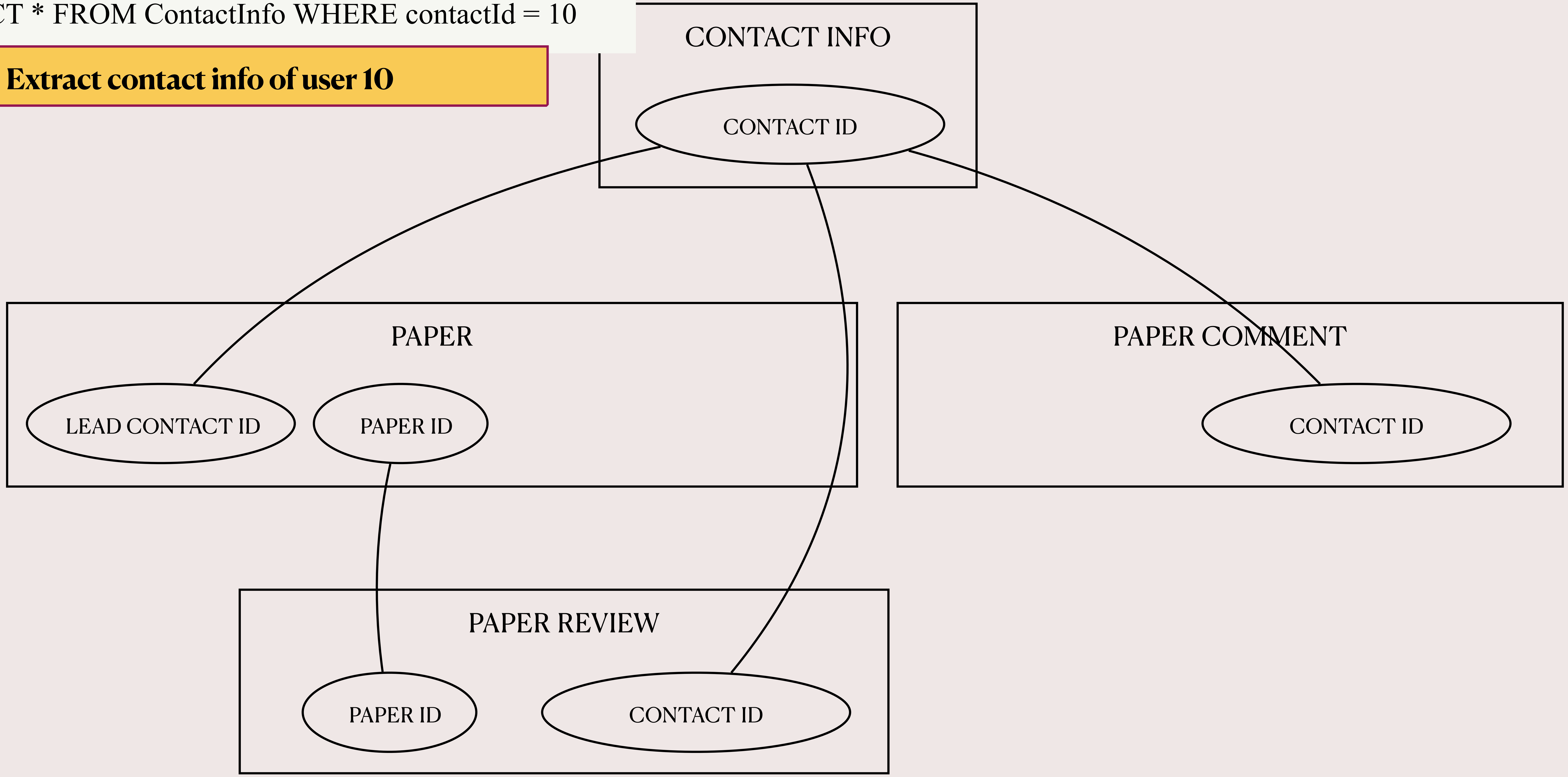


Start at the primary table

Graph Traversal: Access Request for contactID = 10

SELECT * FROM ContactInfo WHERE contactId = 10

Q1: Extract contact info of user 10



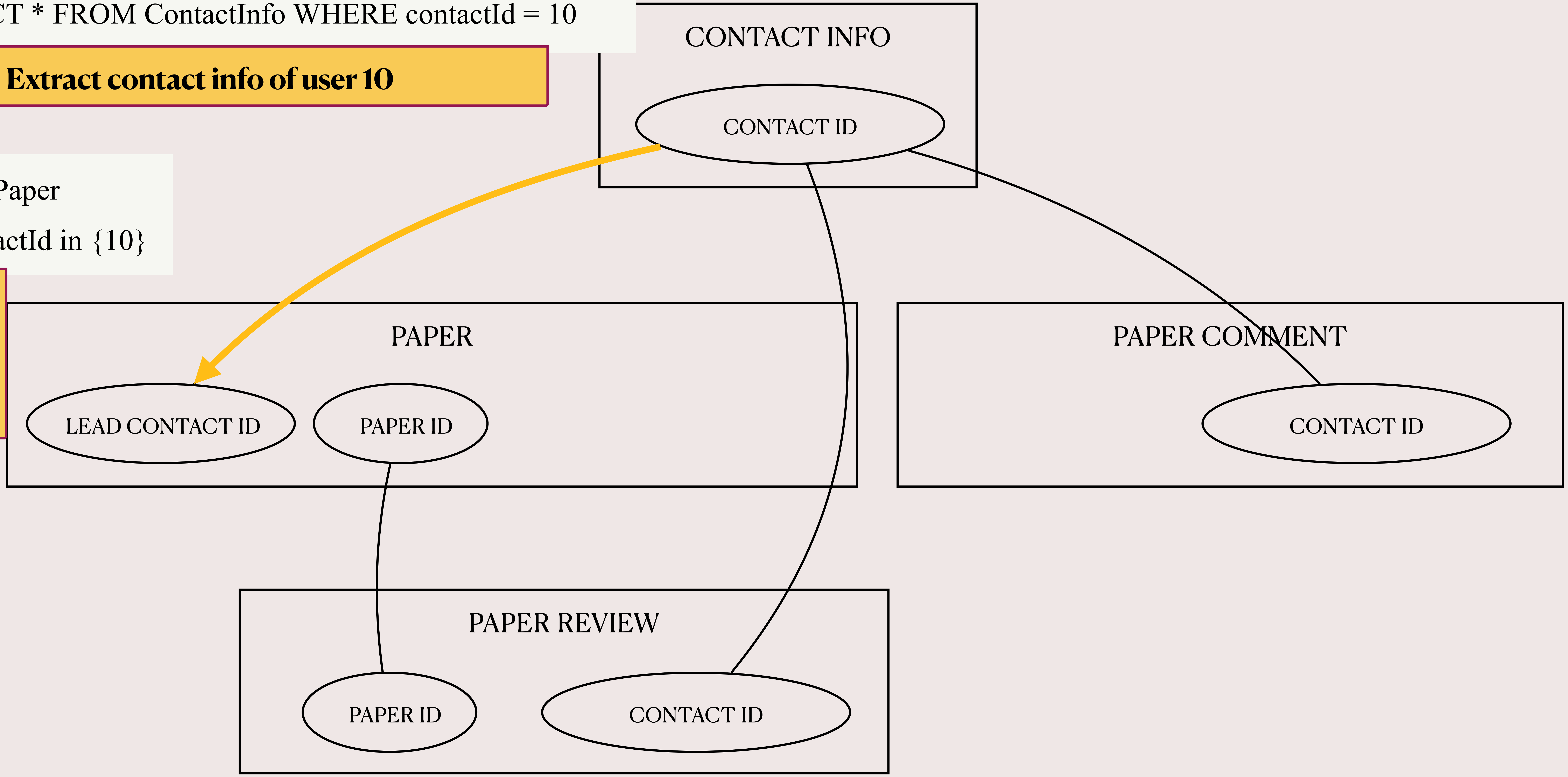
Graph Traversal: Access Request for contactID = 10

```
SELECT * FROM ContactInfo WHERE contactId = 10
```

Q1: Extract contact info of user 10

```
SELECT * FROM Paper
WHERE LeadContactId in {10}
```

Q2: Extract all the papers user 10 wrote



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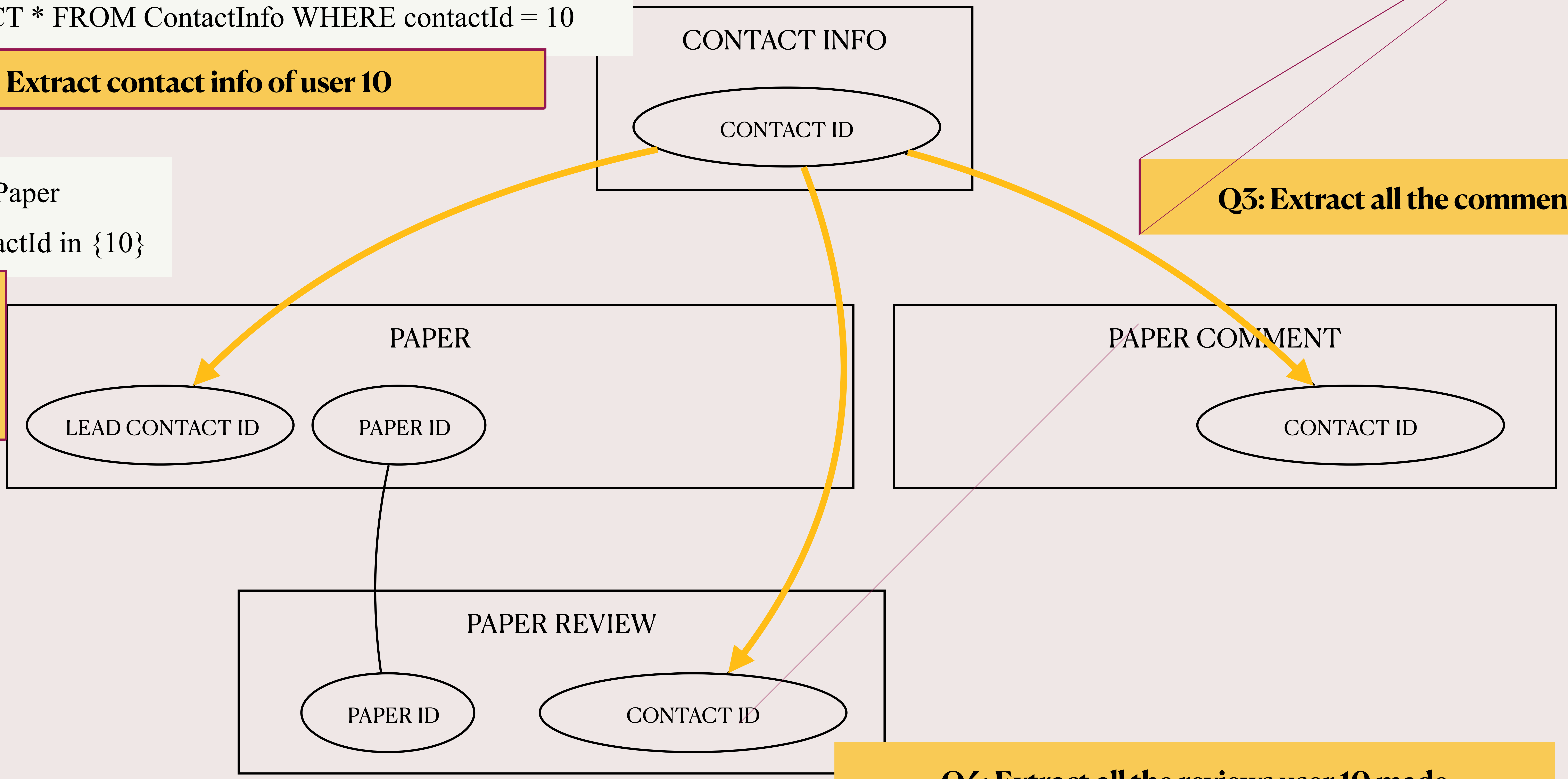

```
SELECT * FROM ContactInfo WHERE contactId = 10
```

Q1: Extract contact info of user 10

```
SELECT * FROM Paper
WHERE LeadContactId in {10}
```

Q2: Extract all the papers user 10 wrote

Q3: Extract all the comments of user 10

Q4: Extract all the reviews user 10 made

CONTACT INFO

CONTACT ID

PAPER

LEAD CONTACT ID

PAPER ID

PAPER COMMENT

CONTACT ID

PAPER REVIEW

PAPER ID

CONTACT ID

Graph Traversal: Access Request for contactID = 10

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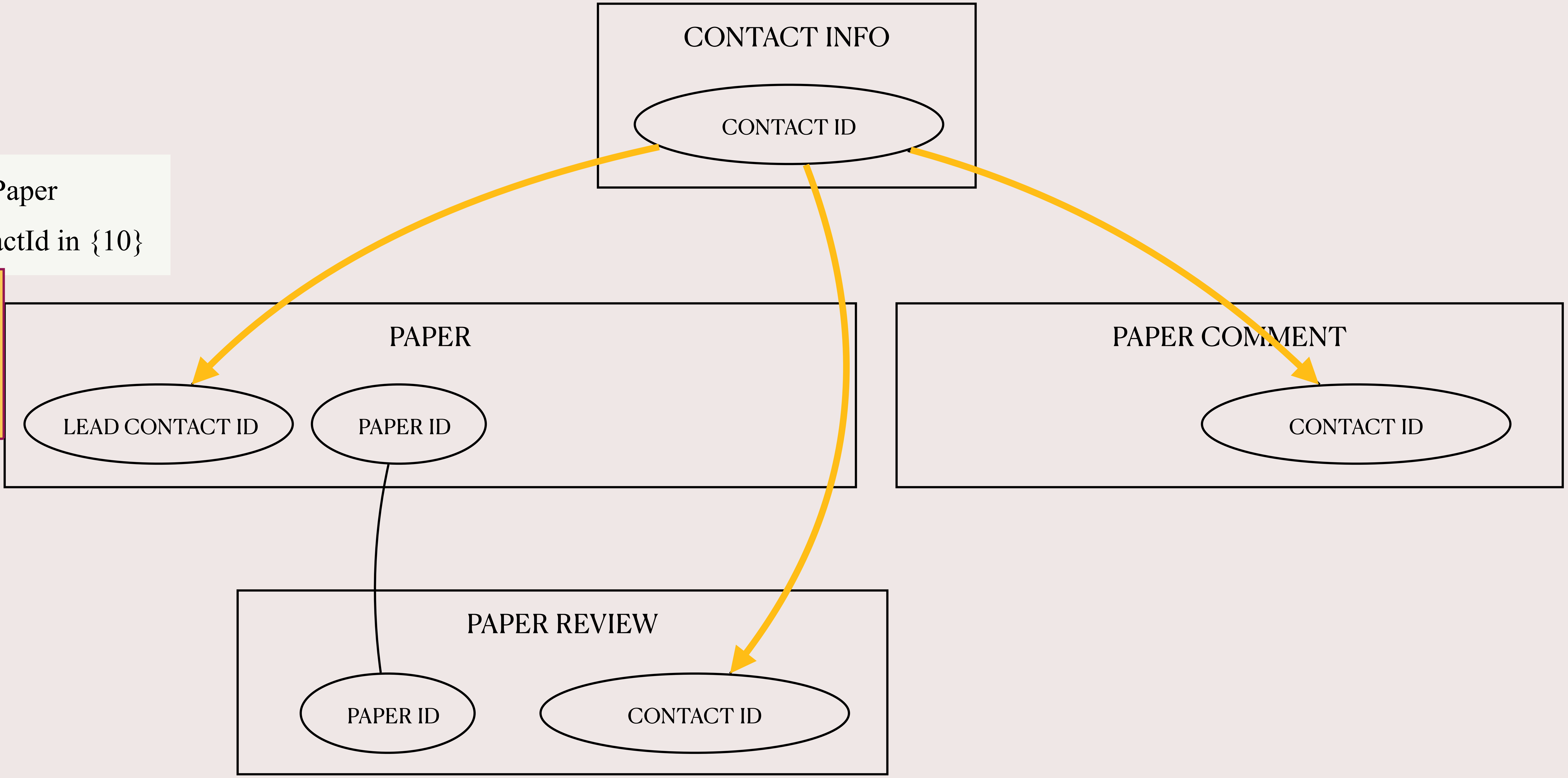
Q2: Extract all the papers user 10 wrote



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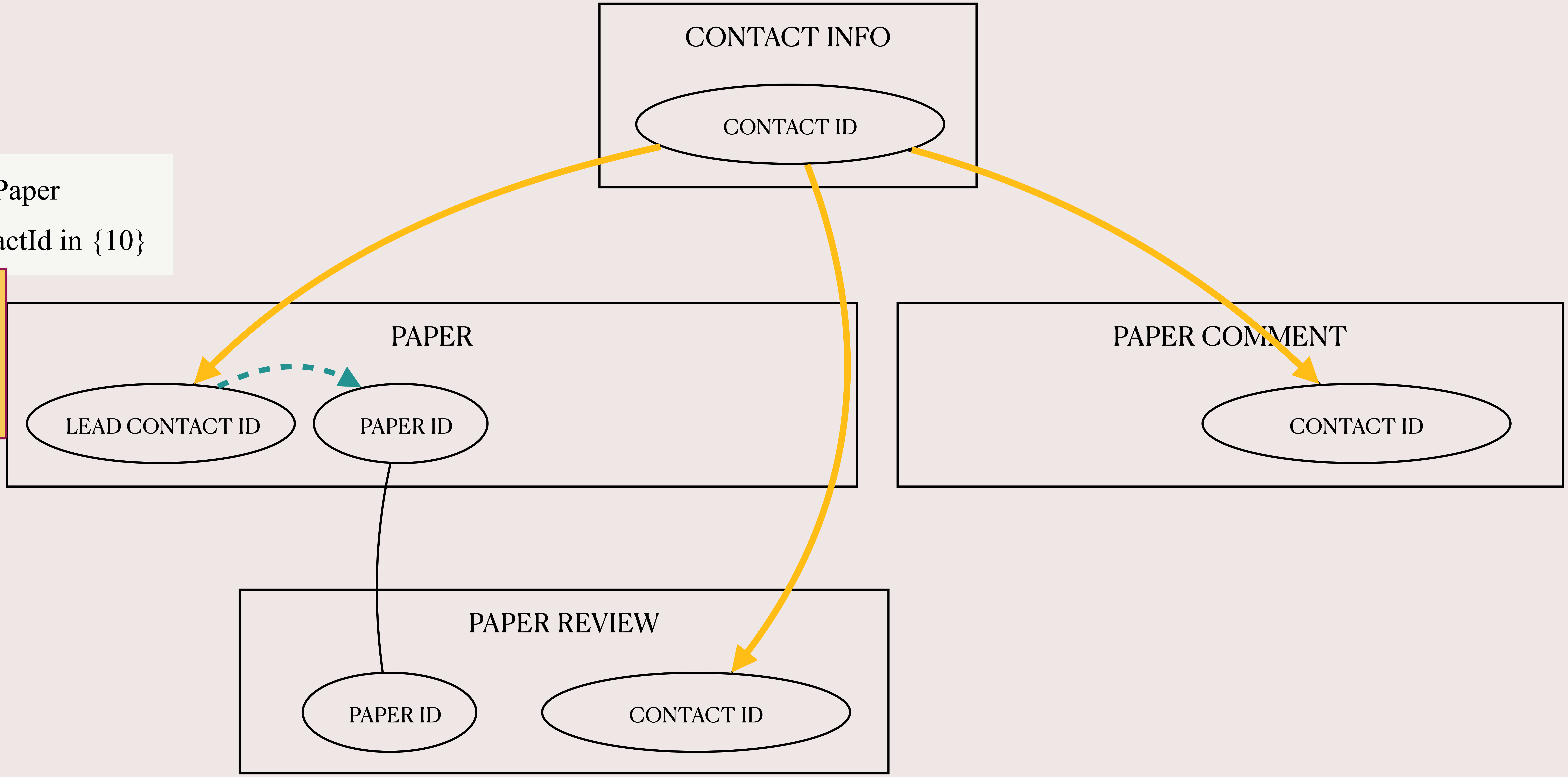

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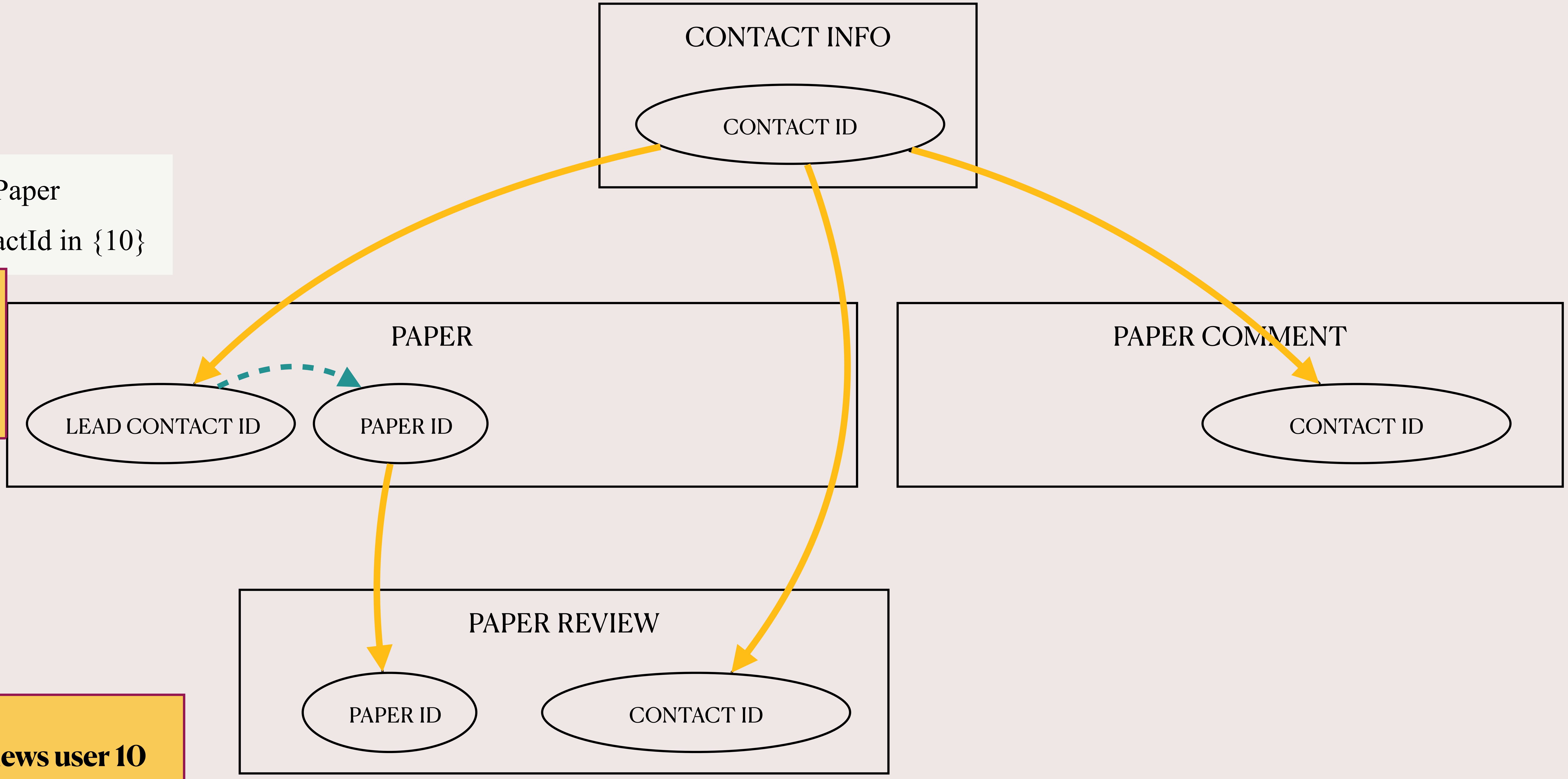


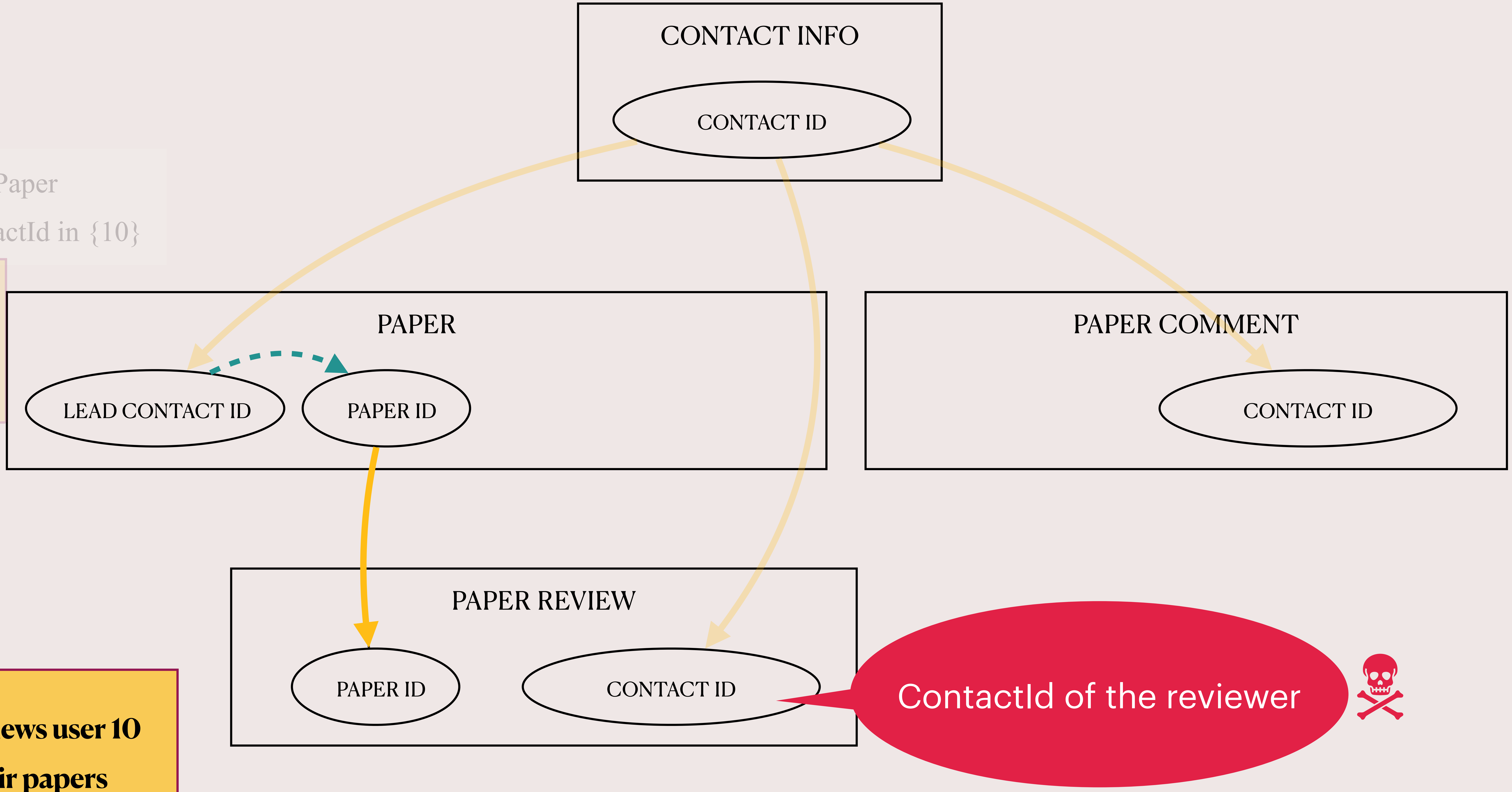
Extract all the reviews user 10 received on their papers

Graph Traversal: Access Request for contactID = 10

SELECT * FROM Paper

WHERE LeadContactId in {10}

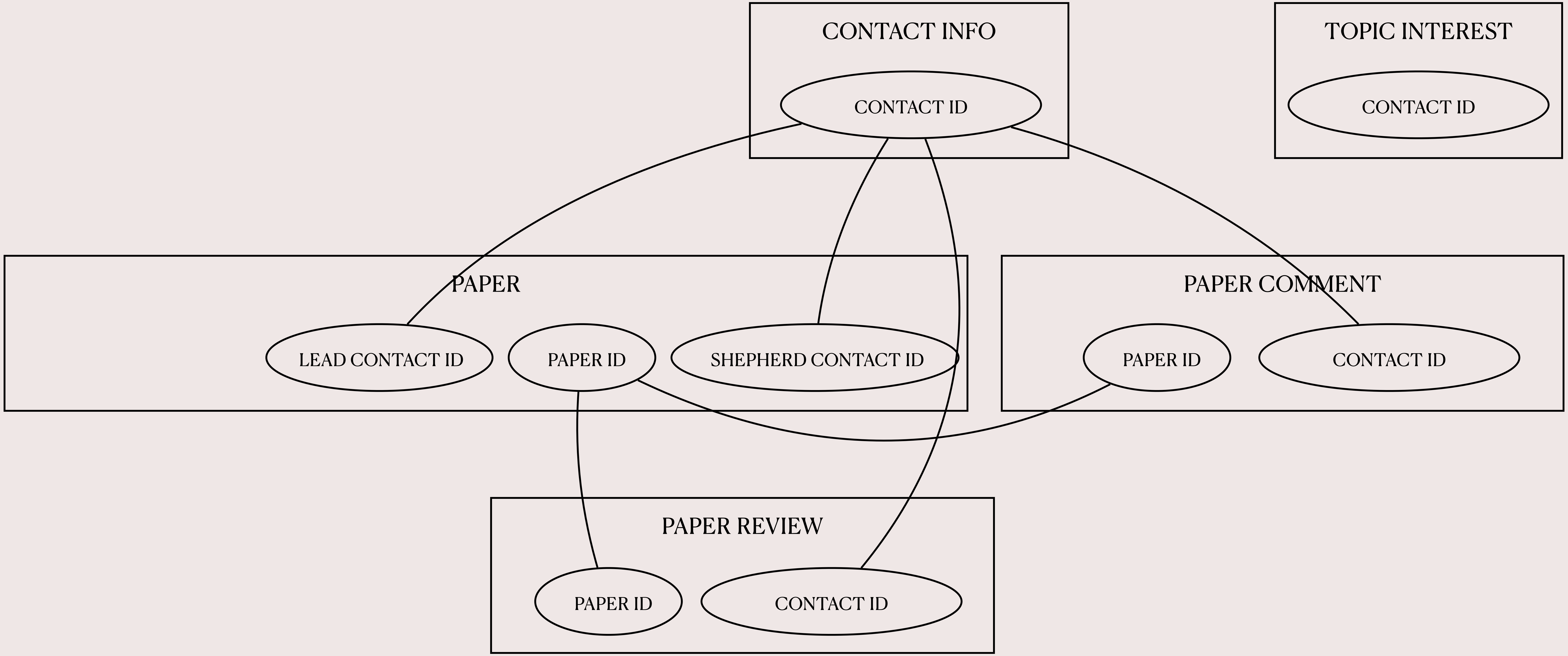
Q2: Extract all the papers user 10 wrote



Extract all the reviews user 10 received on their papers

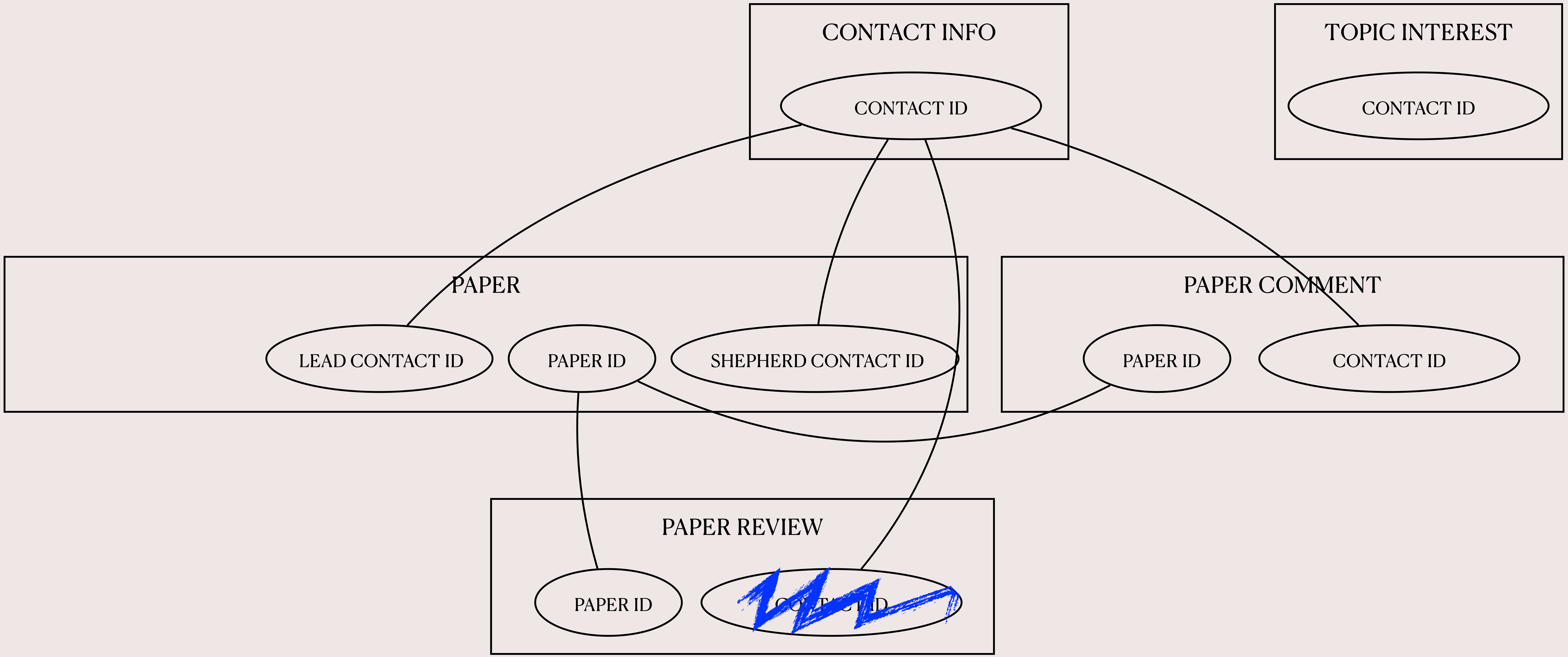
Output 1

Customizations



Customizations

Output 1 Column Filtering



Customizations

Output

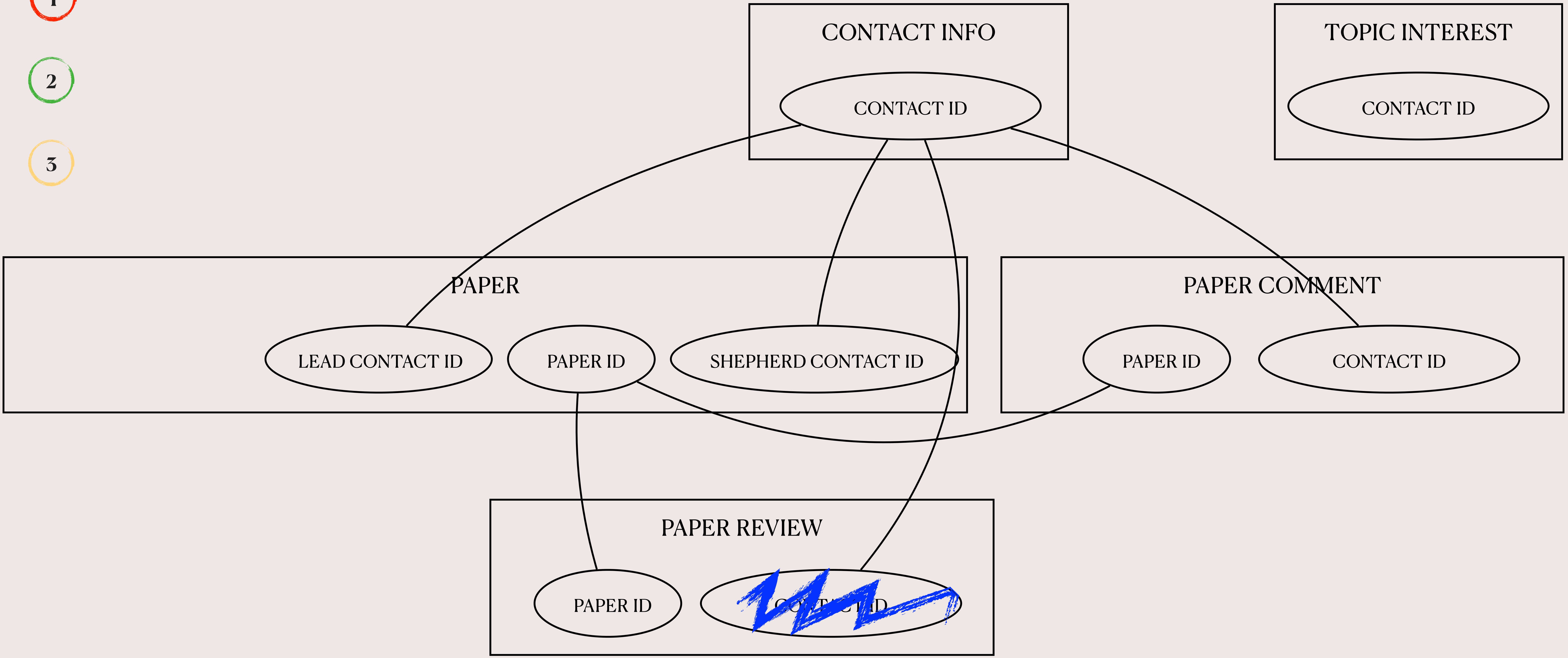
1 Column Filtering

1

Graph

2

3



Customizations

Output

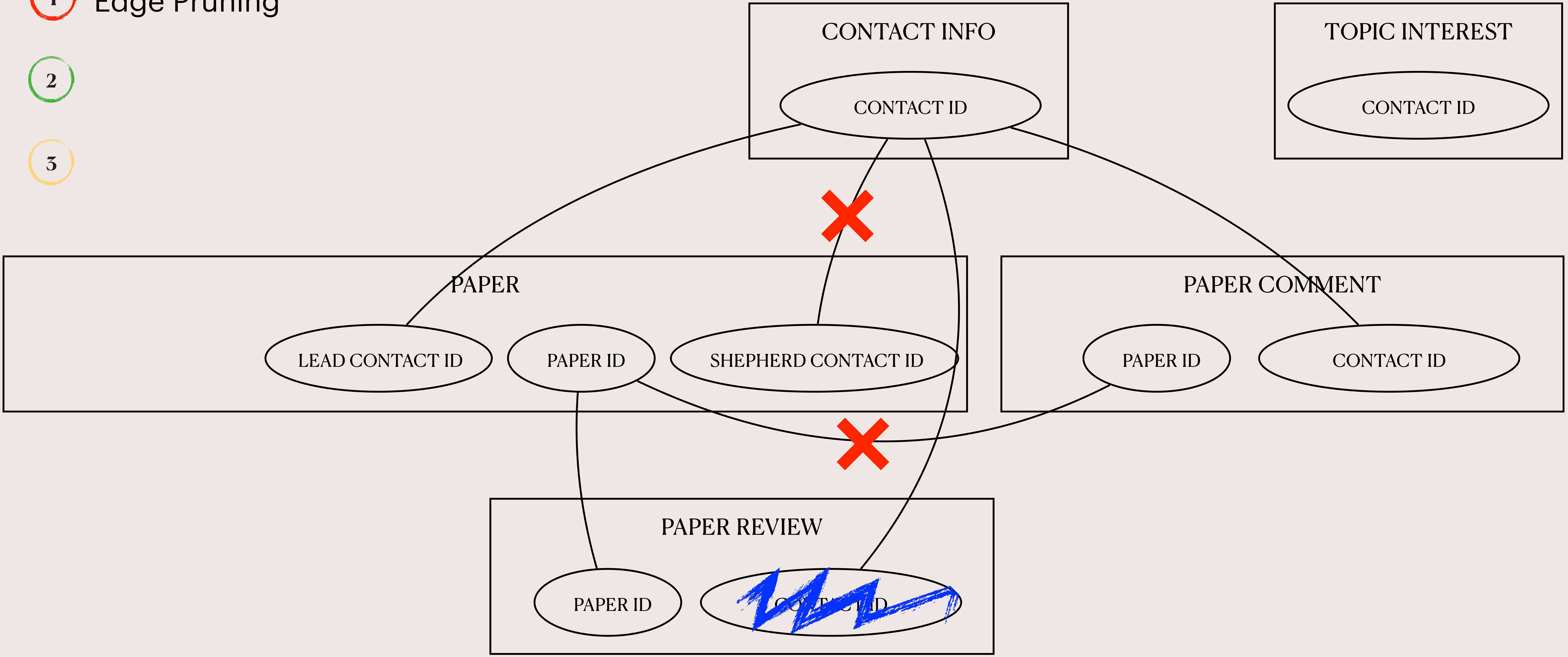
1 Column Filtering

1 Edge Pruning

Graph

2

3



Customizations

Output

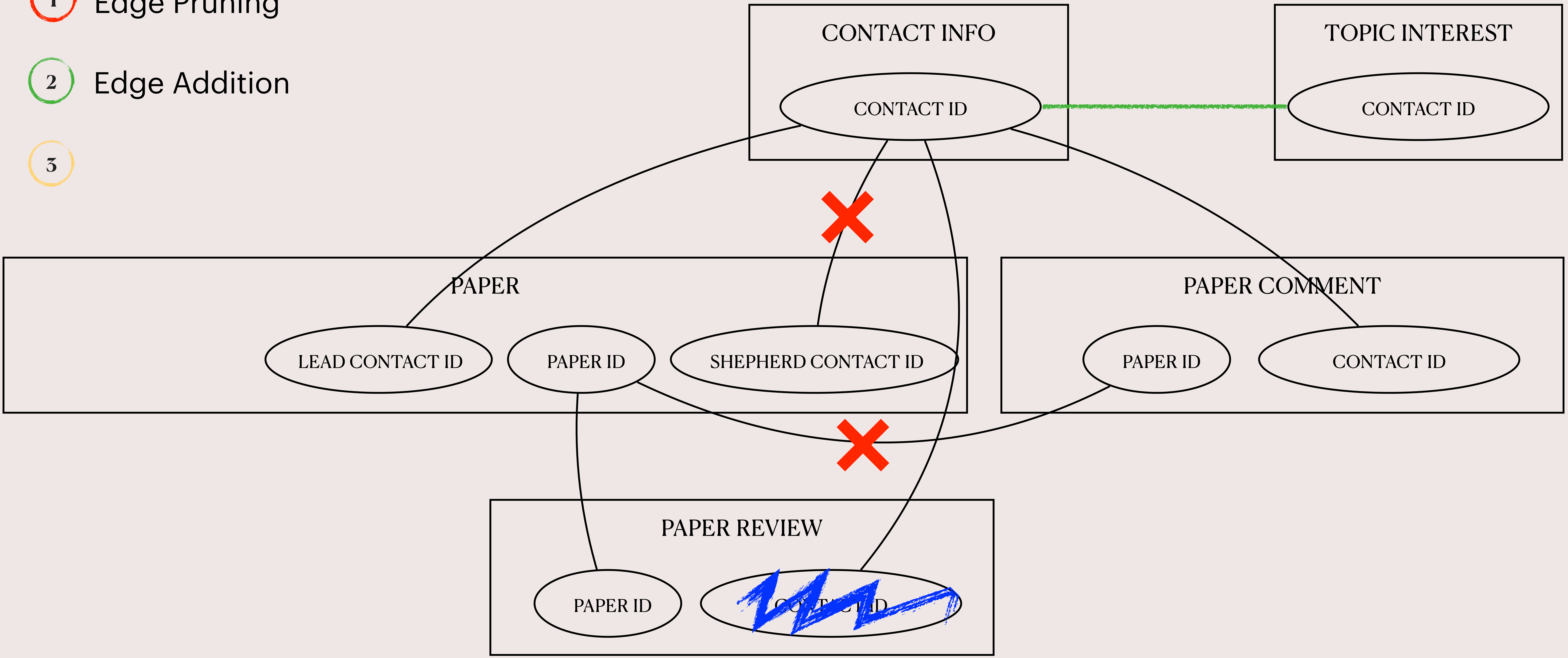
1 Column Filtering

Graph

1 Edge Pruning

2 Edge Addition

3



Customizations

Output

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Graph

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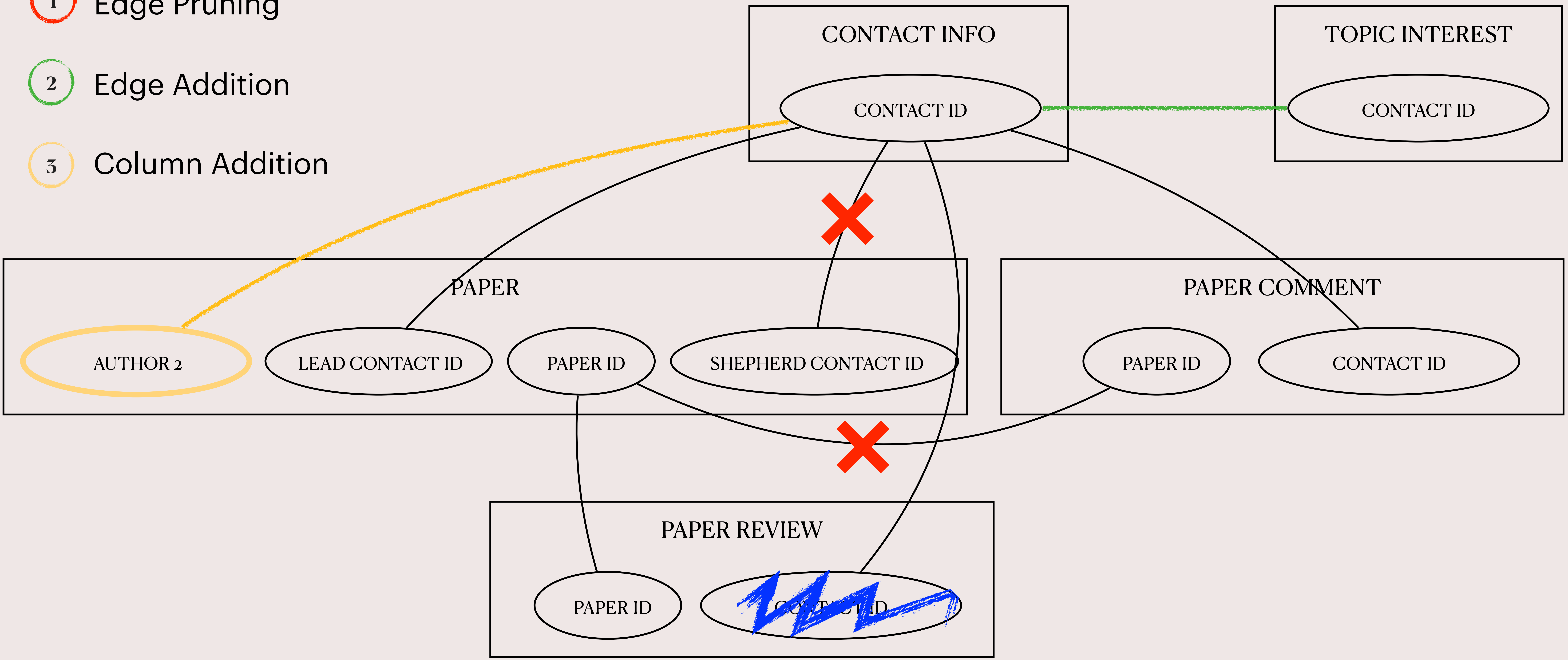
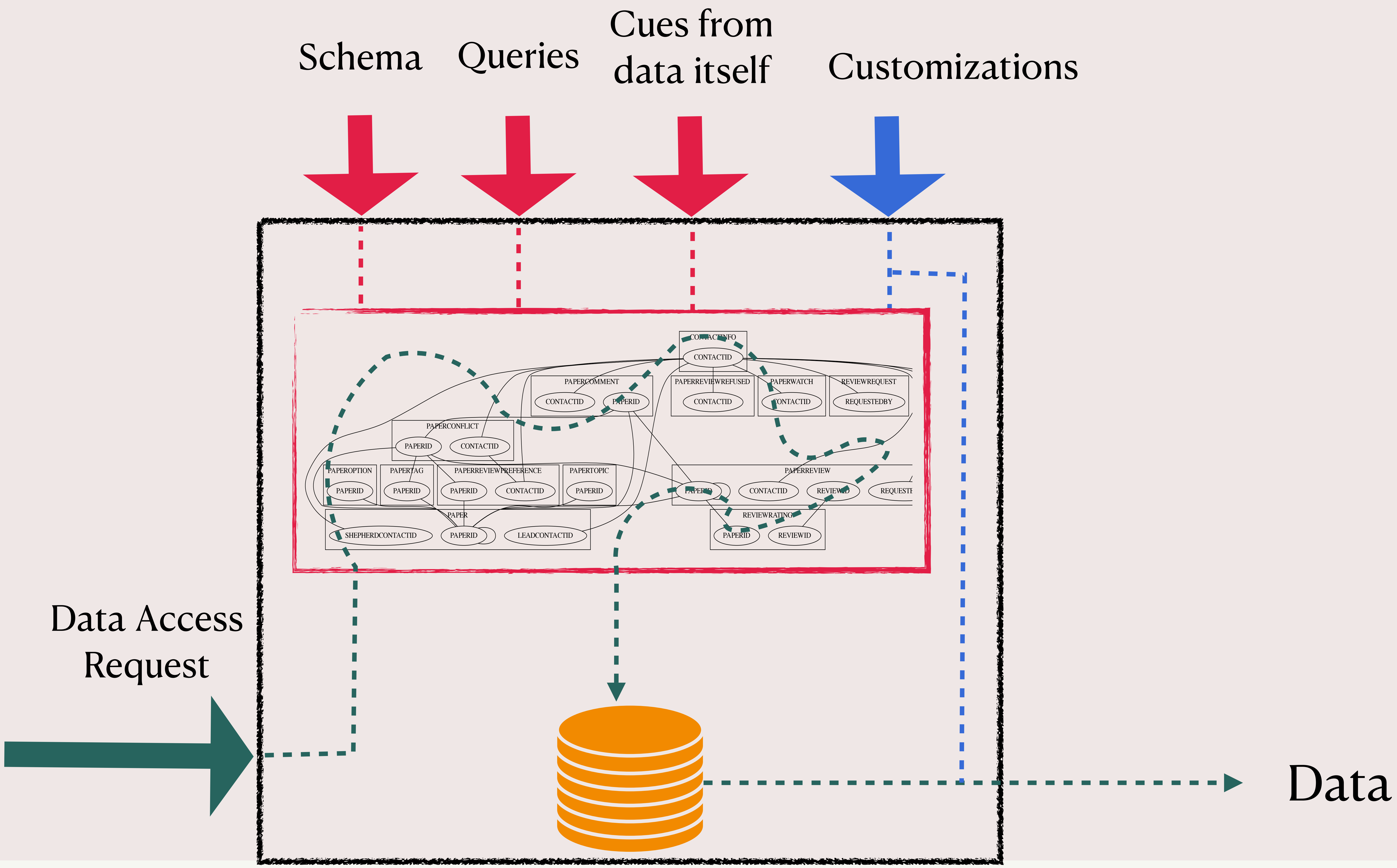
3 Column Addition



GDPRizer: Architecture



Schema

Queries

Cues from data itself

Customizations

Data Access Request

Data

Talk Outline

- GDPRizer: Design & Architecture
- Experimental Evaluation
    - Prototype in Python
    - Tested its accuracy on four applications

Experimental Evaluation

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Q1: Does GDPRizer correctly identify user-data ?

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Q2: What is the impact of customizations ?

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1. TPC-H
2. Lobsters
3. HotCRP
4. WordPress

Q1: Does GDPRizer correctly identify user-data ?

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Ground Truth

Wrote our own ground truth queries

Q1: Does GDPRizer correctly identify user-data ?

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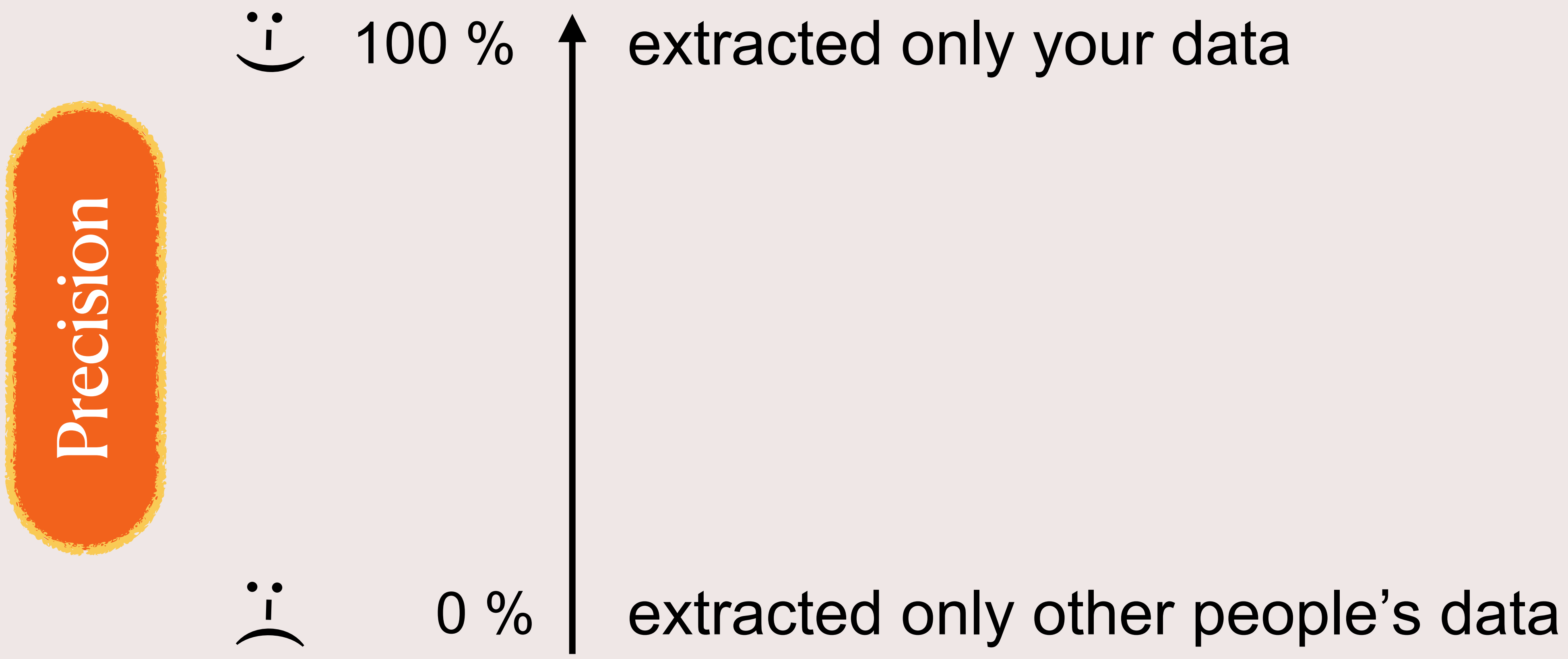
- **Precision**:
- **Recall**:
- **F1-Score**:

Q1: Does GDPRizer correctly identify user-data ?

- **Precision**: Measures what fraction of what GDPRizer extracted was actually user-data
- **Recall**:
- **F1-Score**:



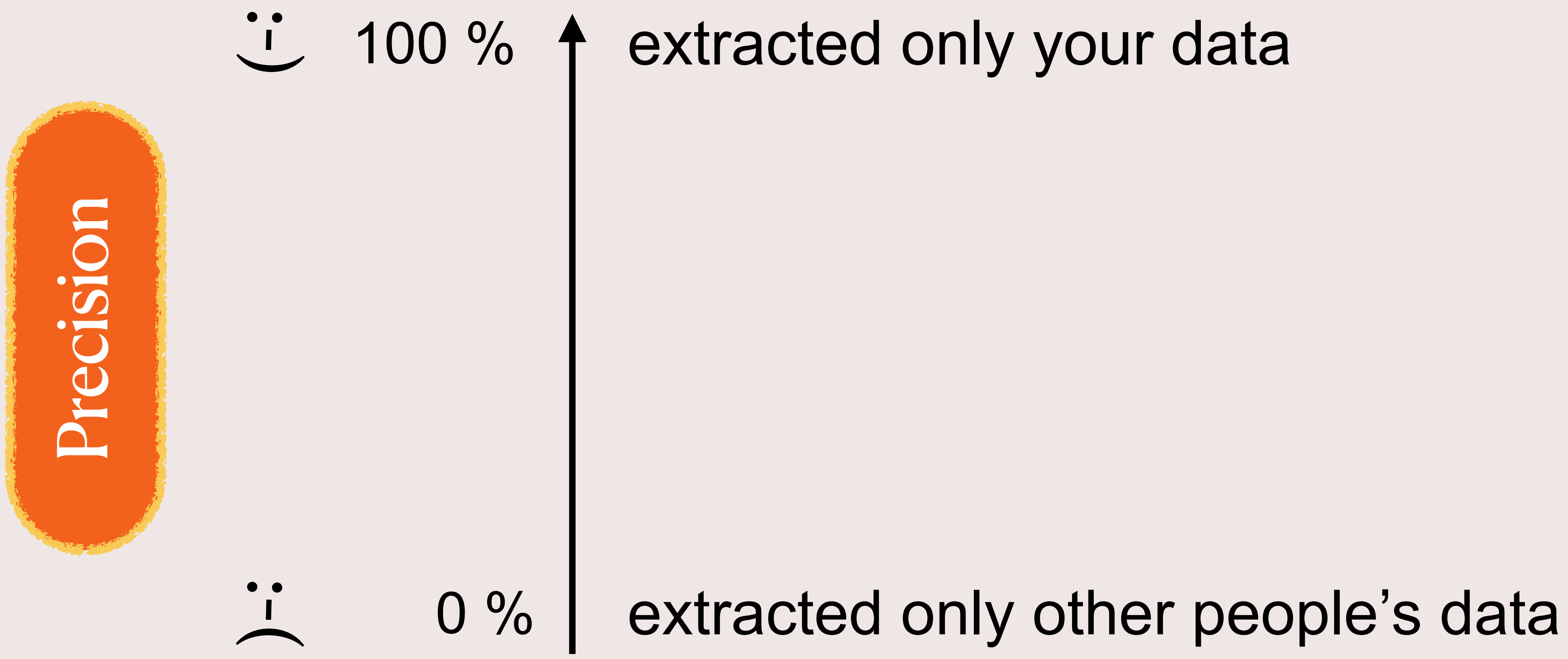
Precision

100 % extracted only your data

0 % extracted only other people's data

Q1: Does GDPRizer correctly identify user-data ?

- **Precision**: Measures what fraction of what GDPRizer extracted was actually user-data
- **Recall**: Measures what fraction of the user-data did GDPRizer manage to extract
- **F1-Score**:



Precision

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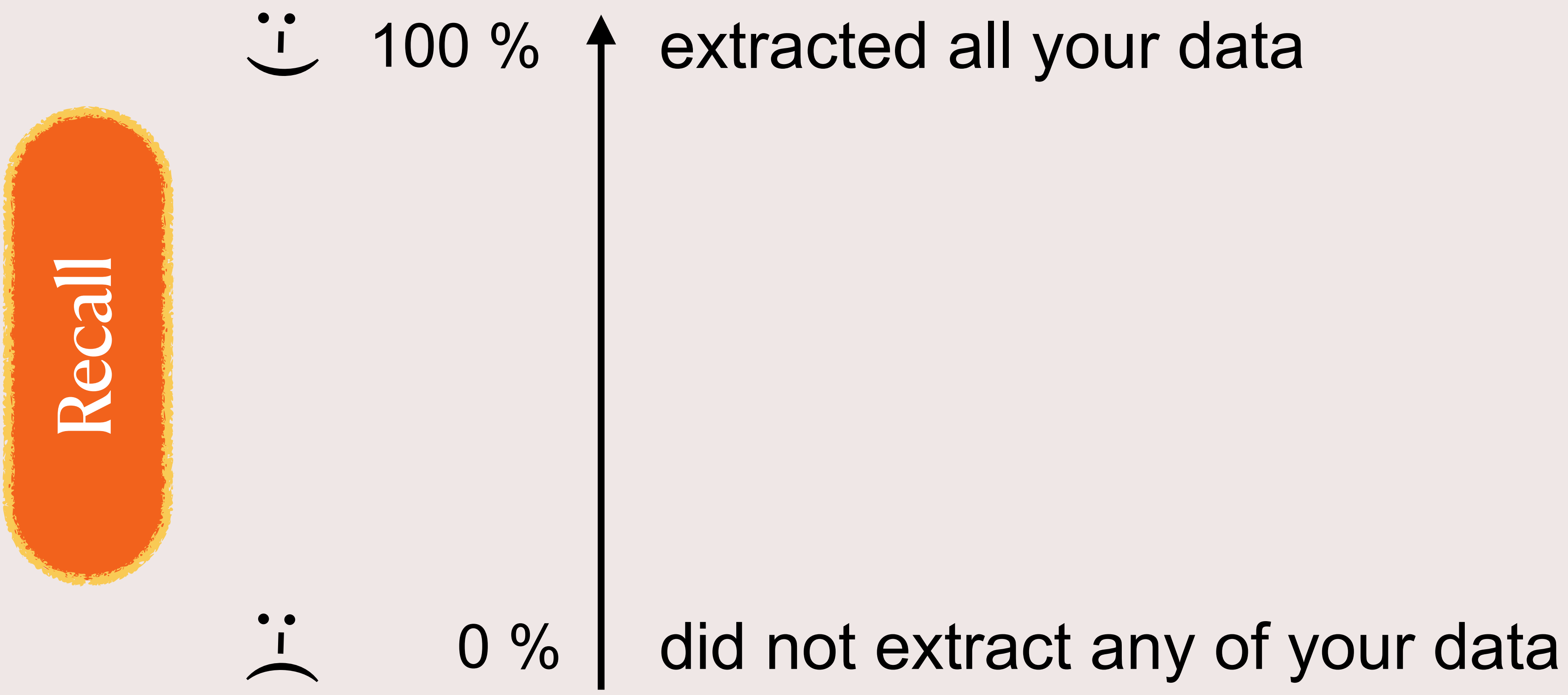


Recall

☺ 100 % extracted all your data

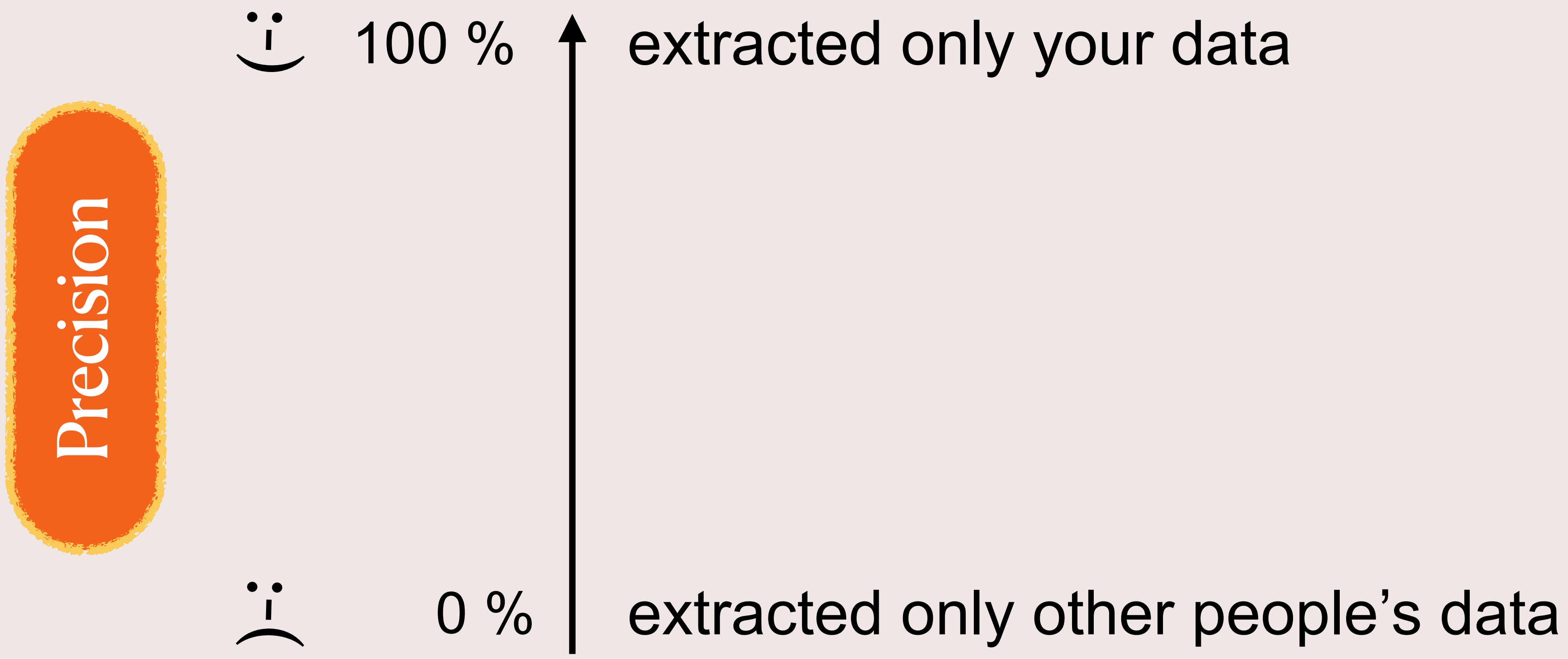
☹ 0 % did not extract any of your data

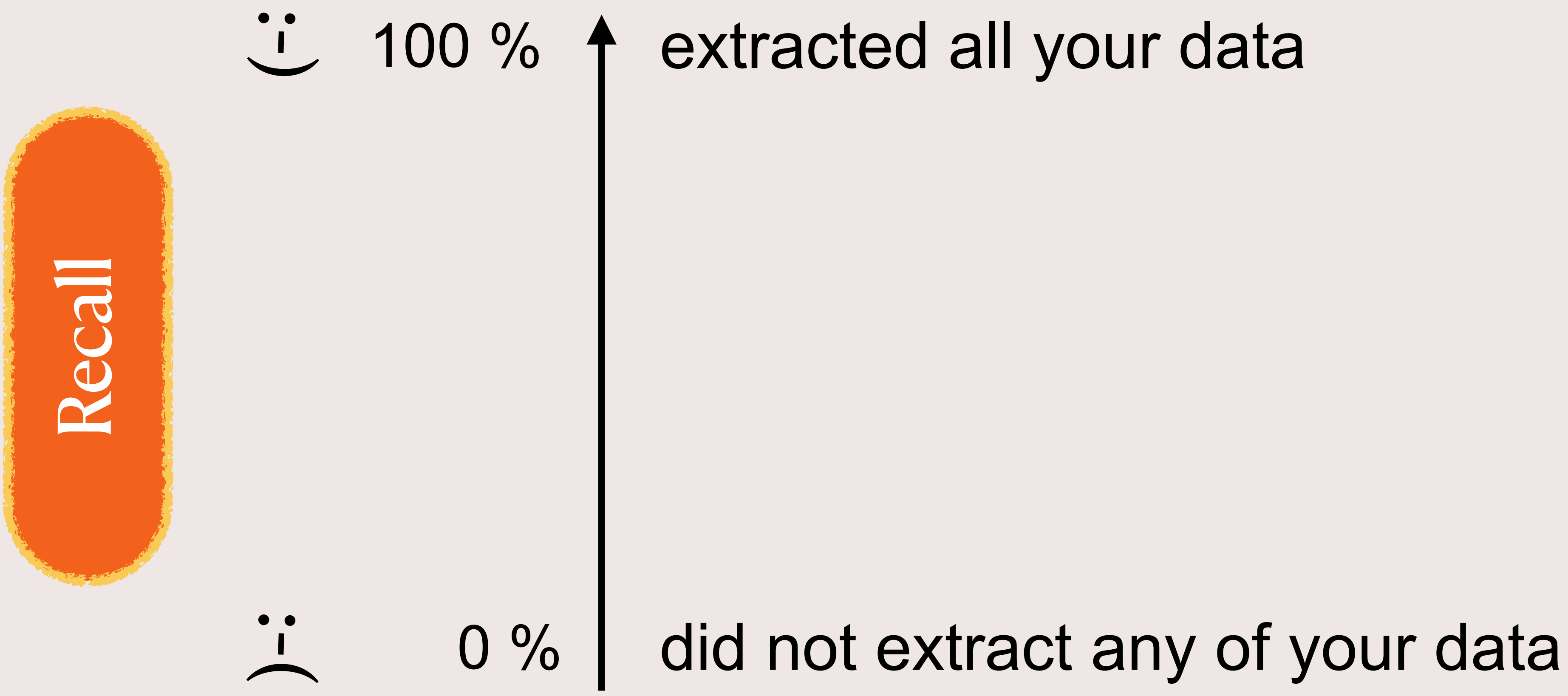
Q1: Does GDPRizer correctly identify user-data ?

- **Precision**: Measures what fraction of what GDPRizer extracted was actually user-data

- **Recall**: Measures what fraction of the user-data did GDPRizer manage to extract

- **F1-Score**: Combination of precision and recall





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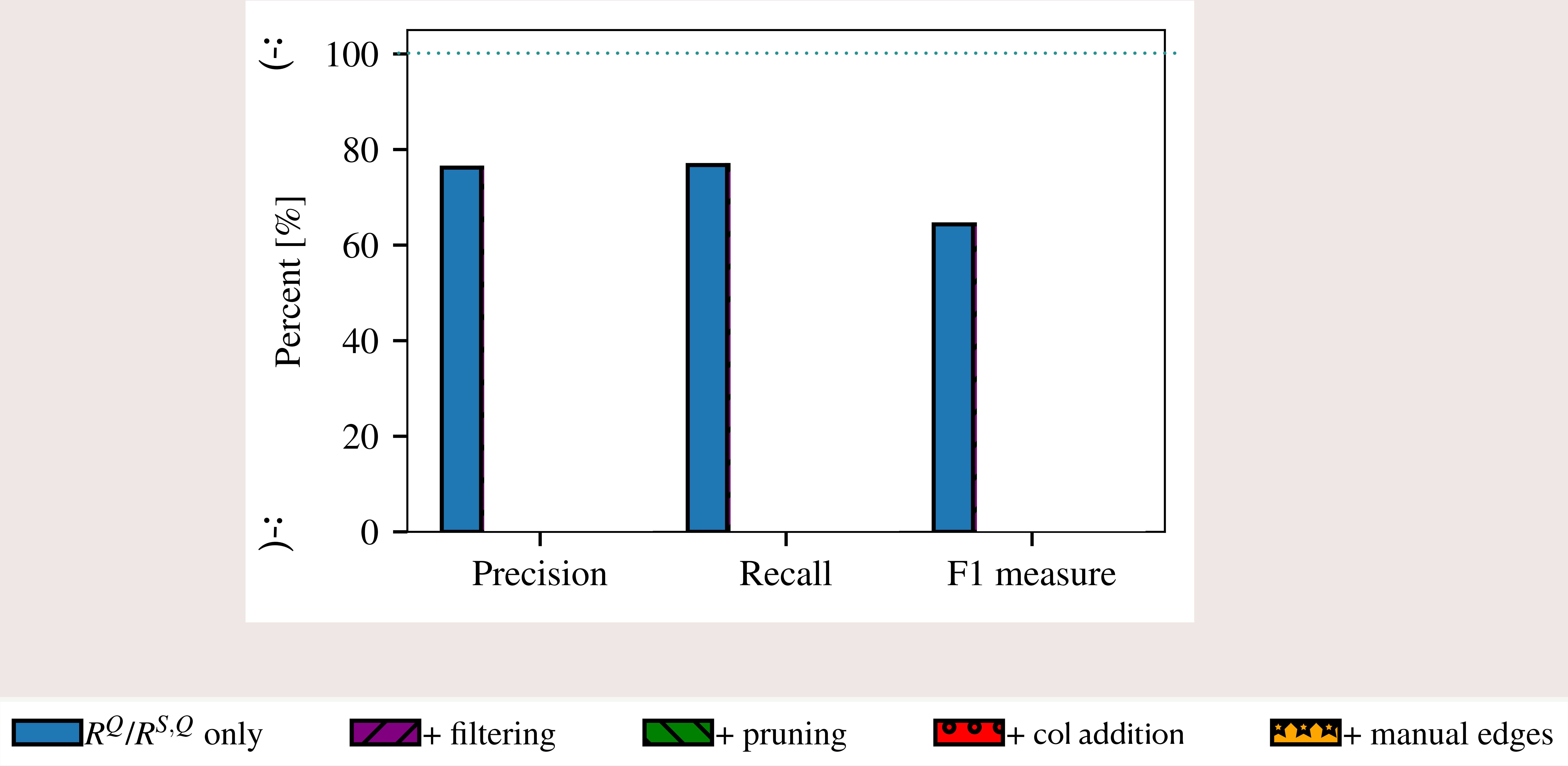
HotCRP



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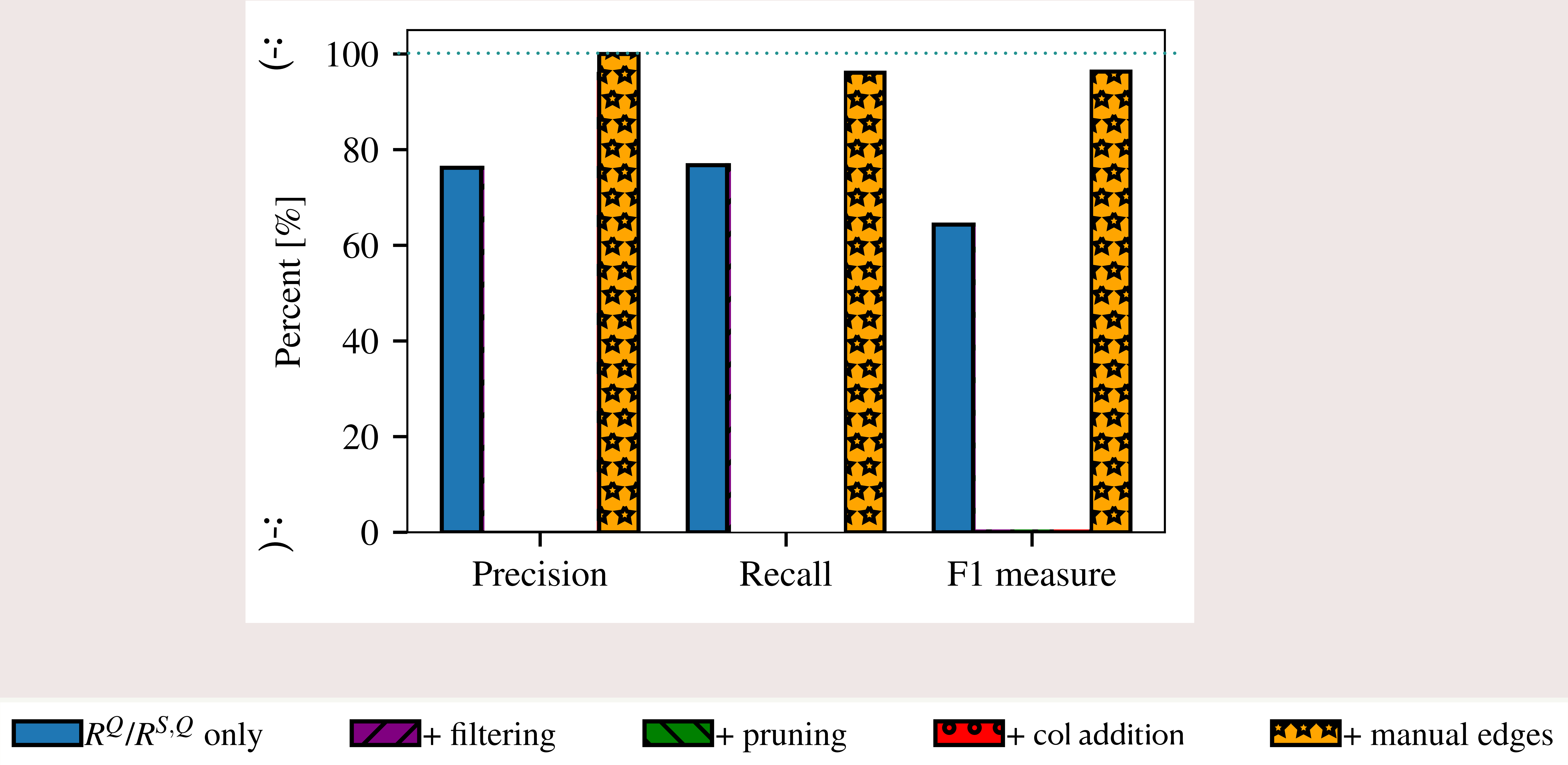
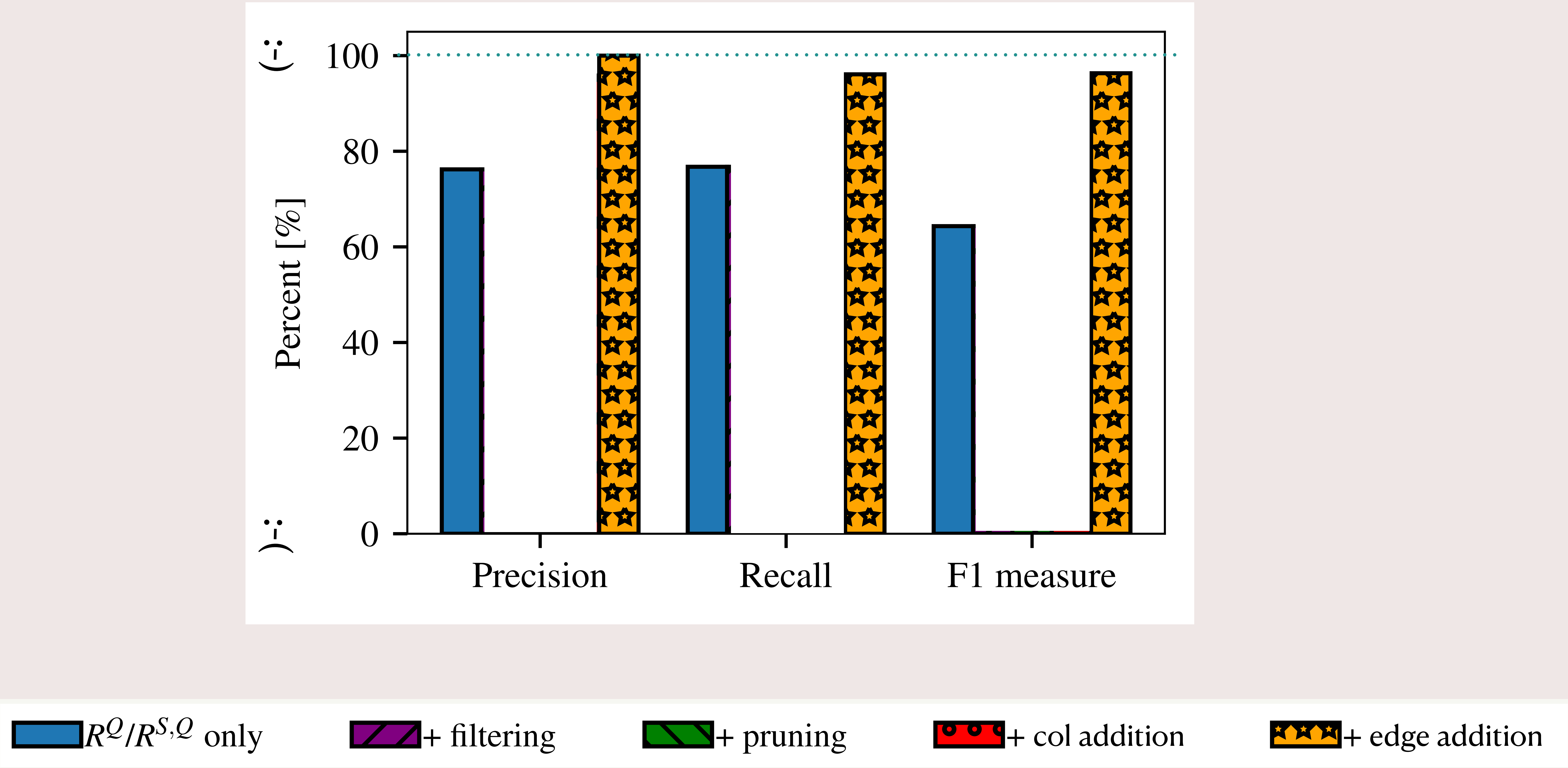


Q2: What is the impact of customizations ?

HotCRP



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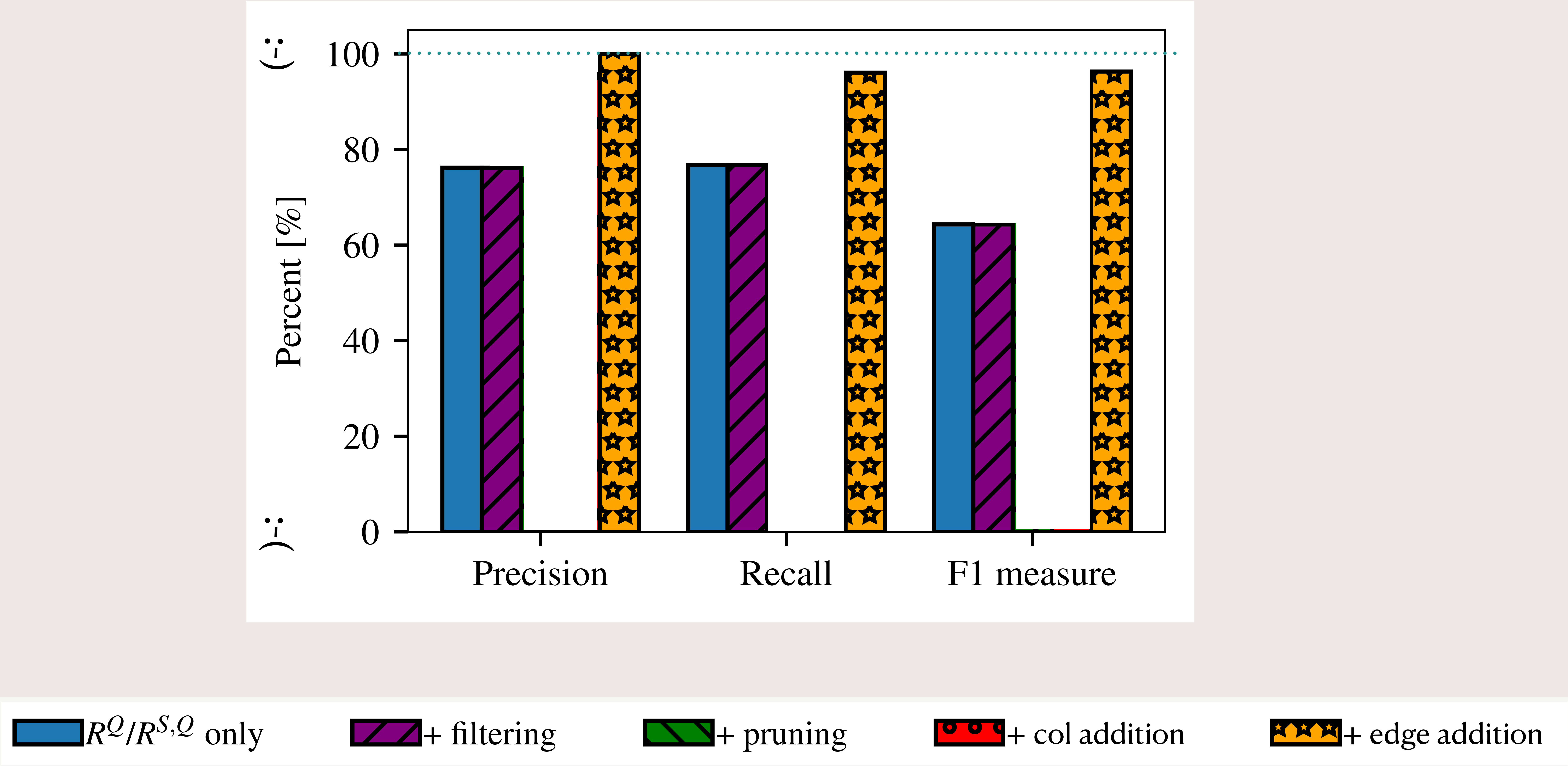

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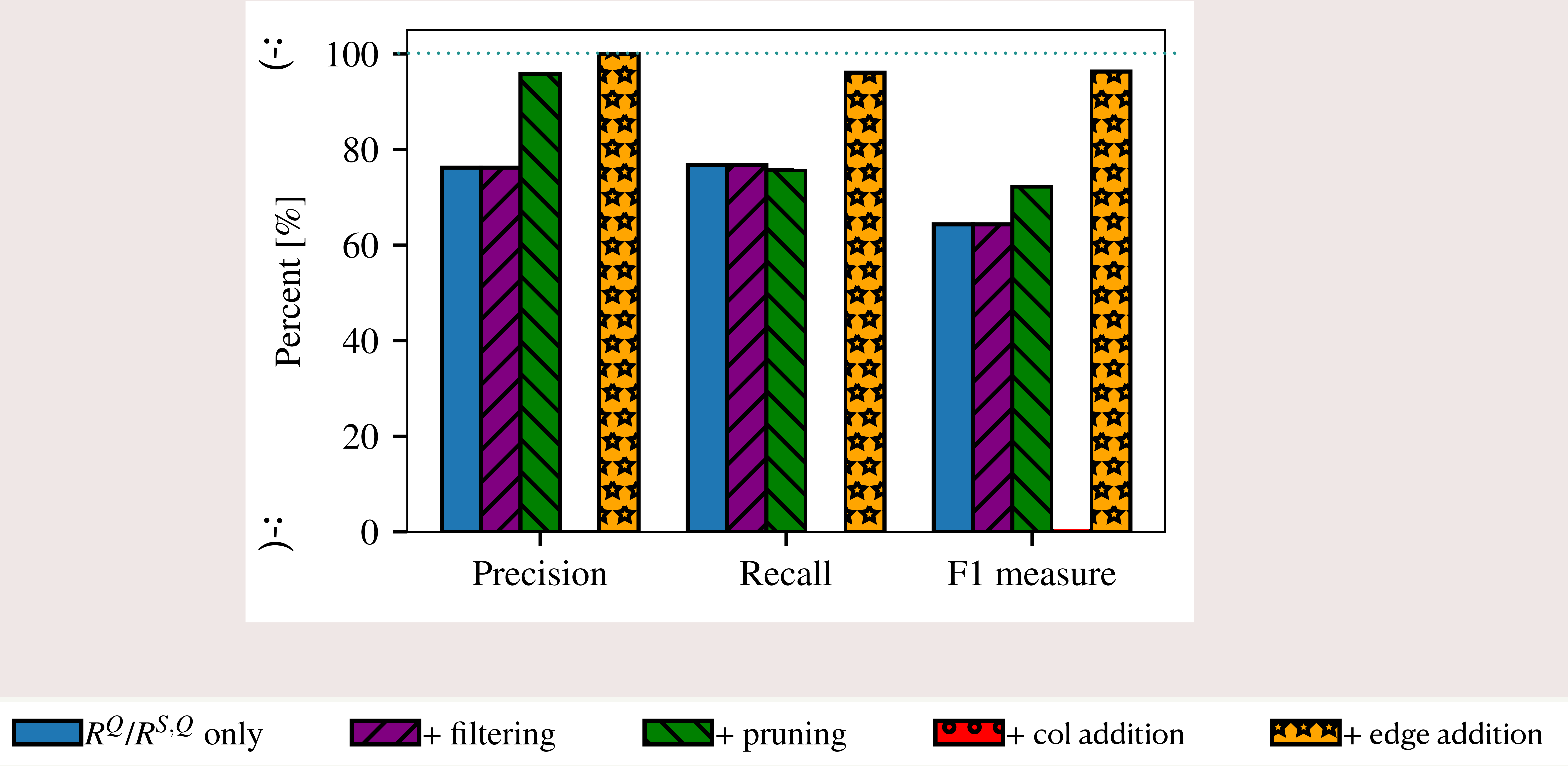
HotCRP



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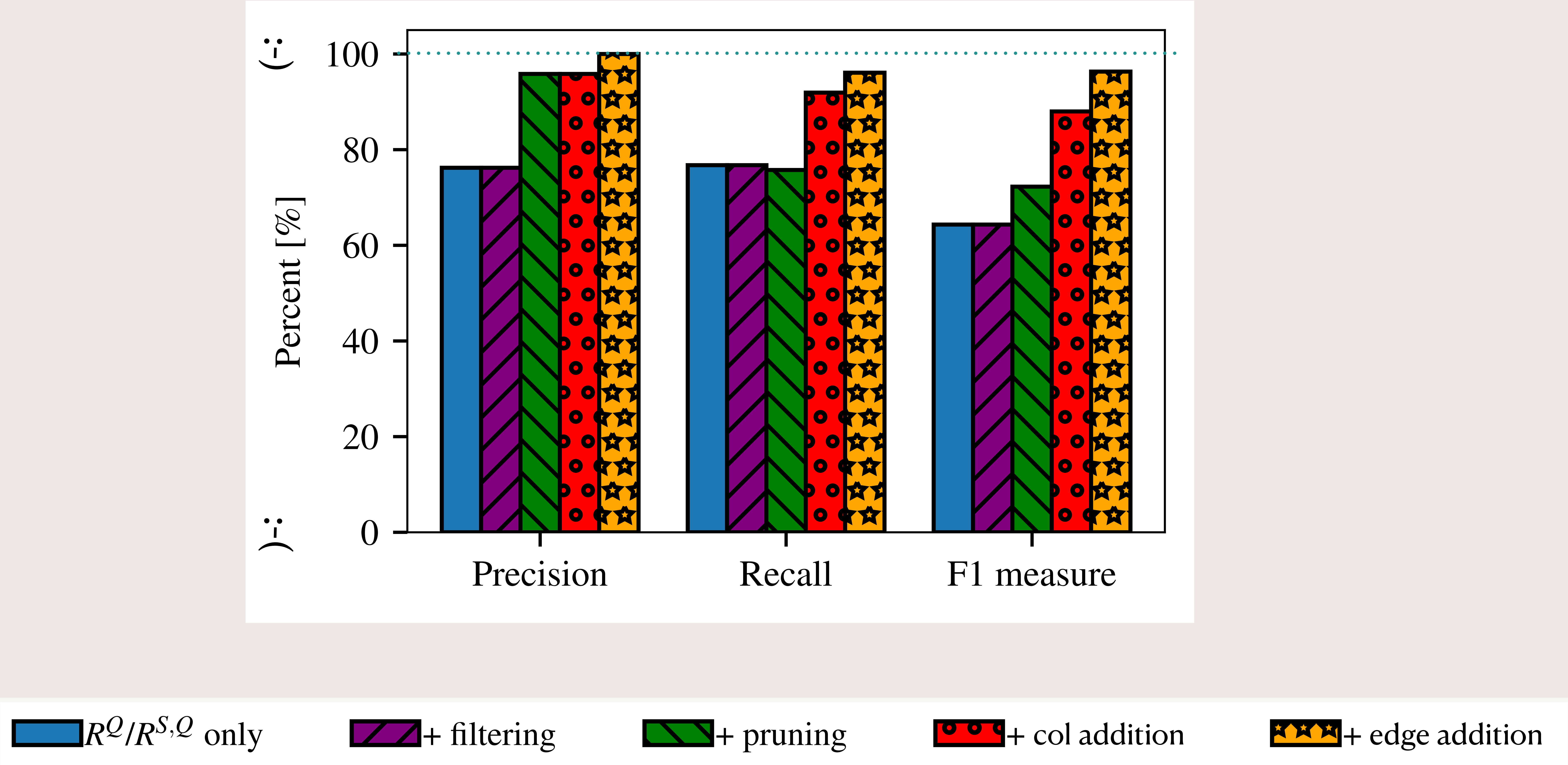

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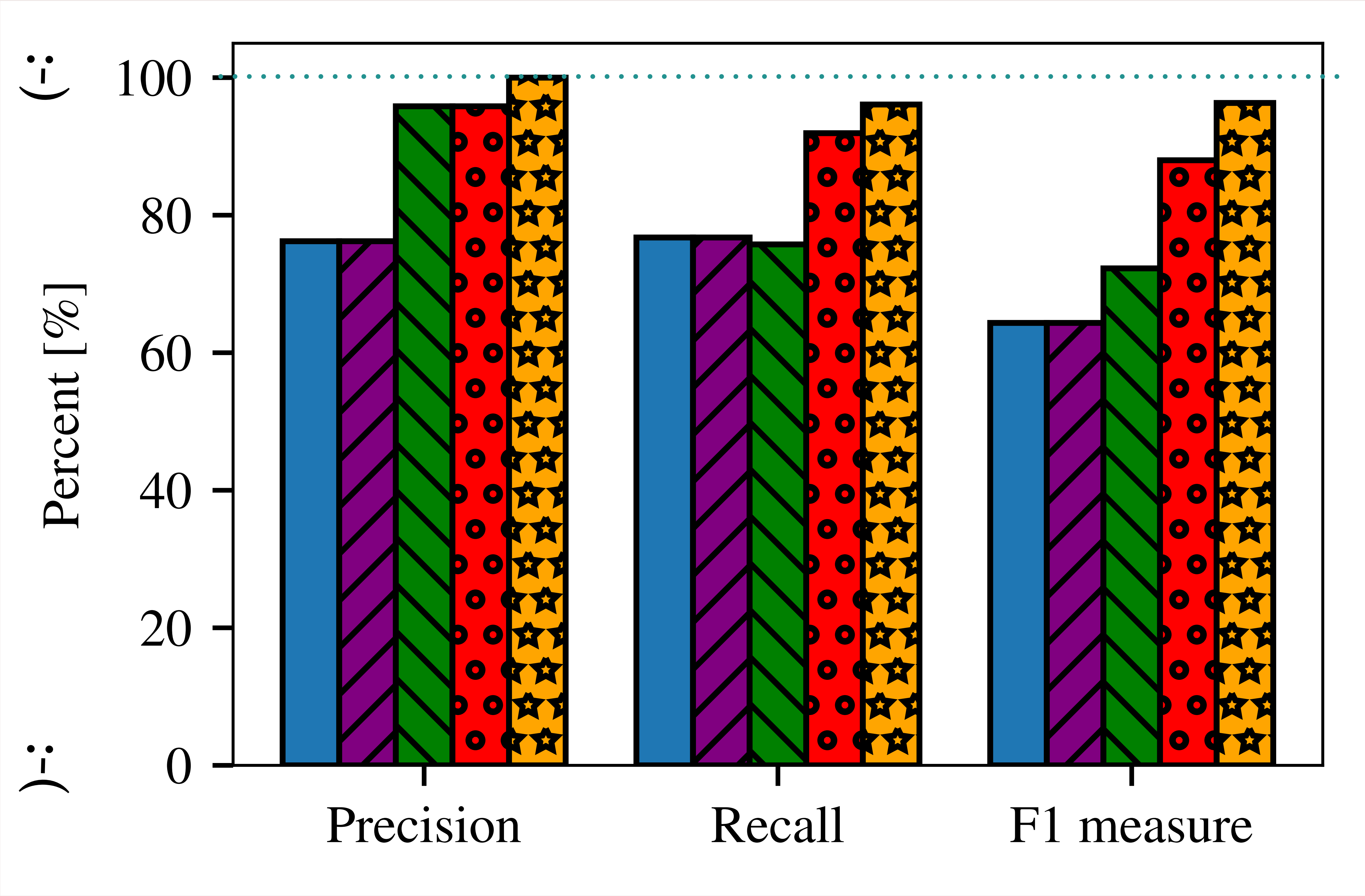

Similar results for all the other applications

Q3: How many customizations are needed ?

	Total number of customizations
TPC-H (customer)	4
TPC-H (supplier)	7
HotCRP	31
Lobsters	16
WordPress	4
WordPress (w/ plugins)	12

Impact of different sources of information

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- More reliable sources of information
  - better relationship graph
  - fewer customizations

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- In our experience,
  - Foreign Keys in Schema > Joins in Queries > Data itself

Conclusion

Conclusion by glyph.faisalovers from Noun Project

Conclusion

- GDPRizer : a tool for user-data extraction in legacy databases

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- A fully-automated, general solution for legacy systems is unlikely

Conclusion by glyph.faisalovers from Noun Project

Conclusion

- GDPRizer : a tool for user-data extraction in legacy databases
- A fully-automated, general solution for legacy systems is unlikely
- Mostly automates user-data identification but still requires some manual input

Conclusion by glyph.faisalovers from Noun Project

Questions?