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MIT Computer Science and Artificial Intelligence Lab

Aurum: A Large Scale Data Discovery System Based on a Source Retrieval Algebra

Raul Castro Fernandez,
Samuel Madden, Michael Stonebraker
MIT

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Employee gender distribution per department

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```
SELECT department, gender, COUNT(*)
FROM Employee
GROUP BY gender, department;
```

Employee Id	Name	Gender	Department
1001	John	Male	Finance
1002	Mary	Female	Tech
1003	Susan	Female	Finance

Employee gender distribution per department

```
SELECT department, gender, COUNT(*)
FROM Employee
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```

Department	Gender	Count
Finance	Male	1
Finance	Female	1
Tech	Female	1

Employee Id	Name	Gender	Department
1001	John	Male	Finance
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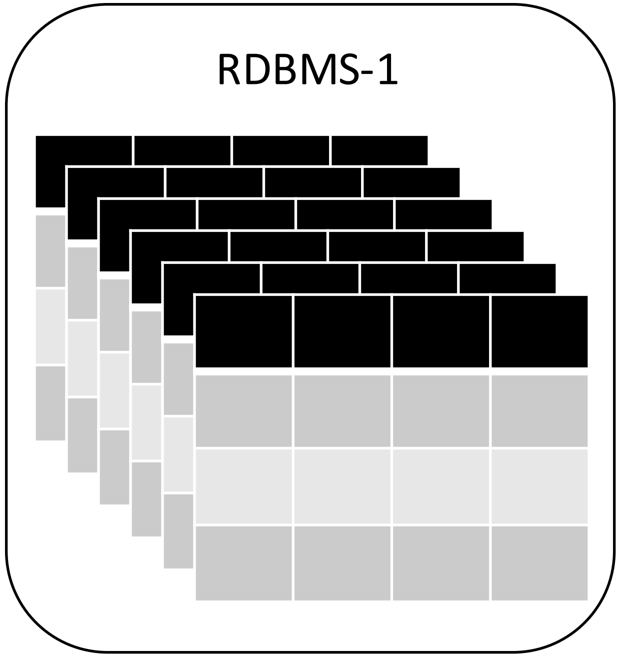
Employee gender distribution per department



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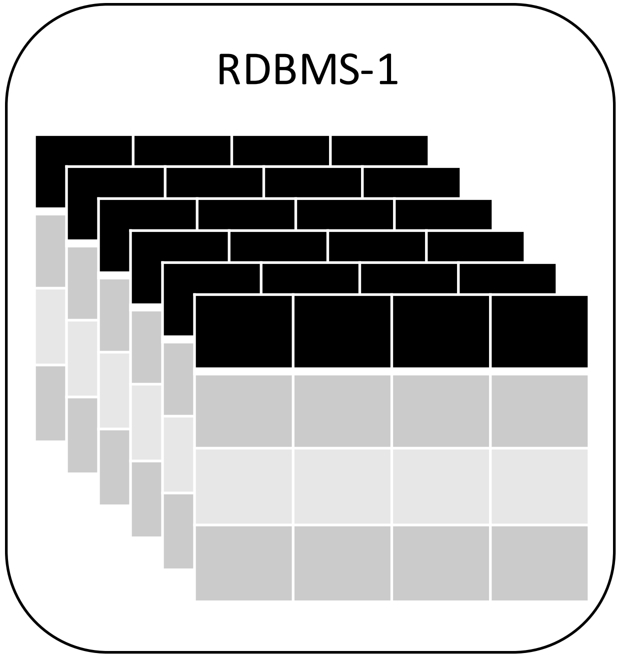

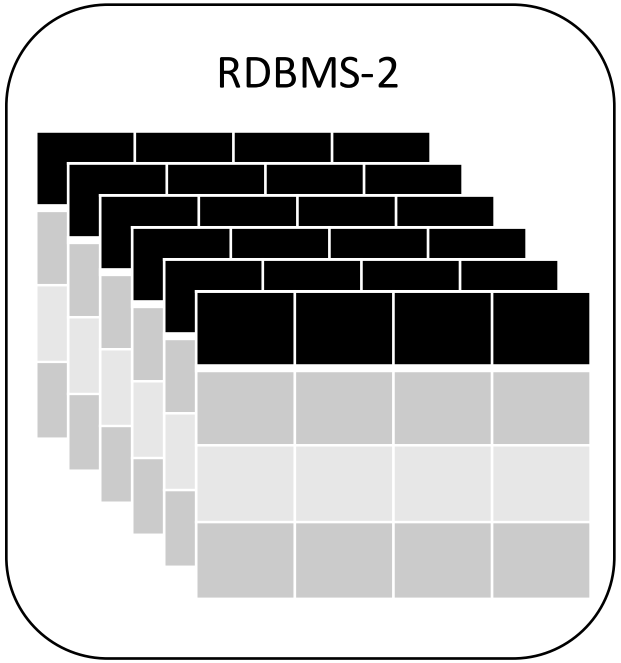

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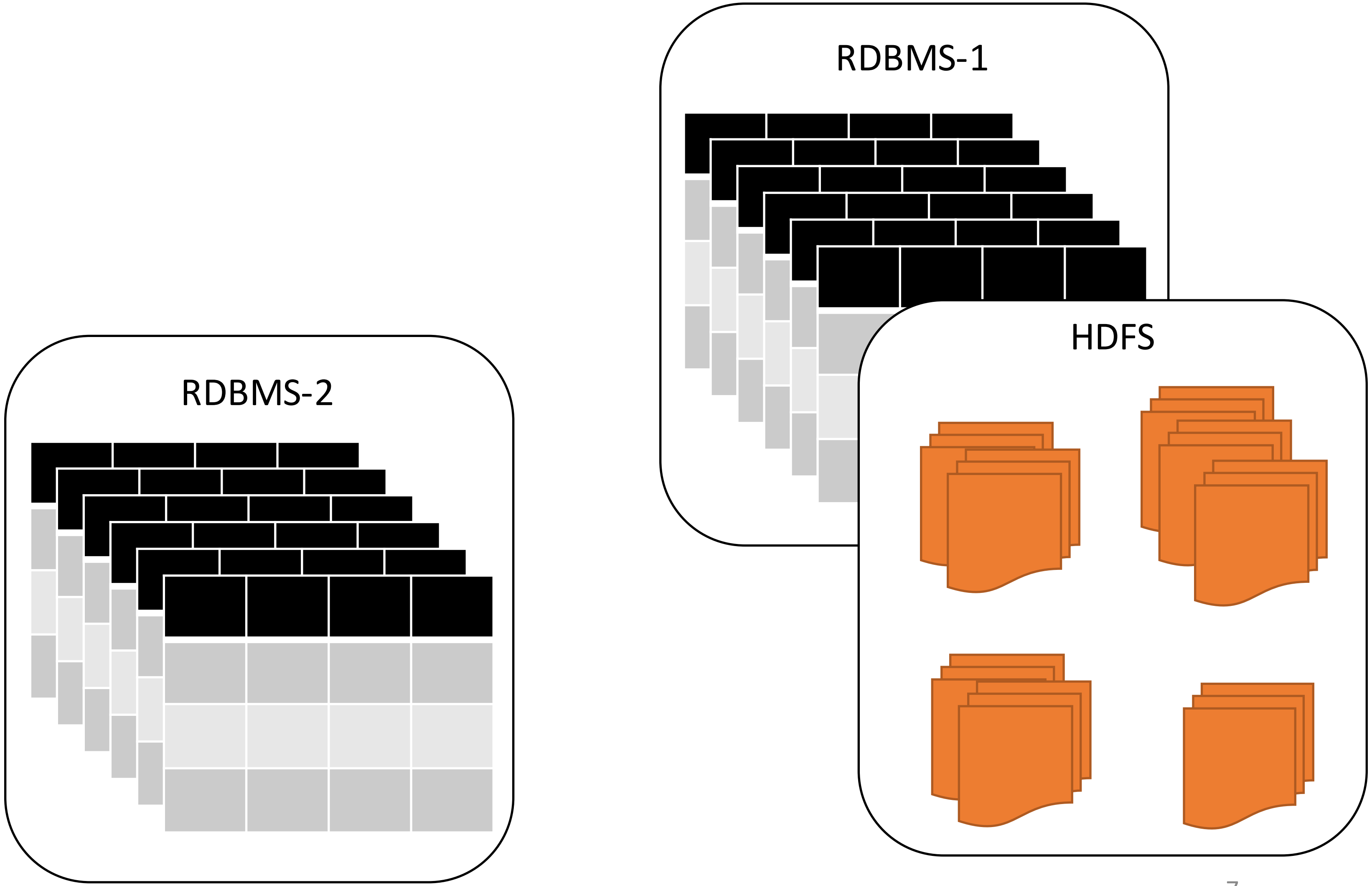

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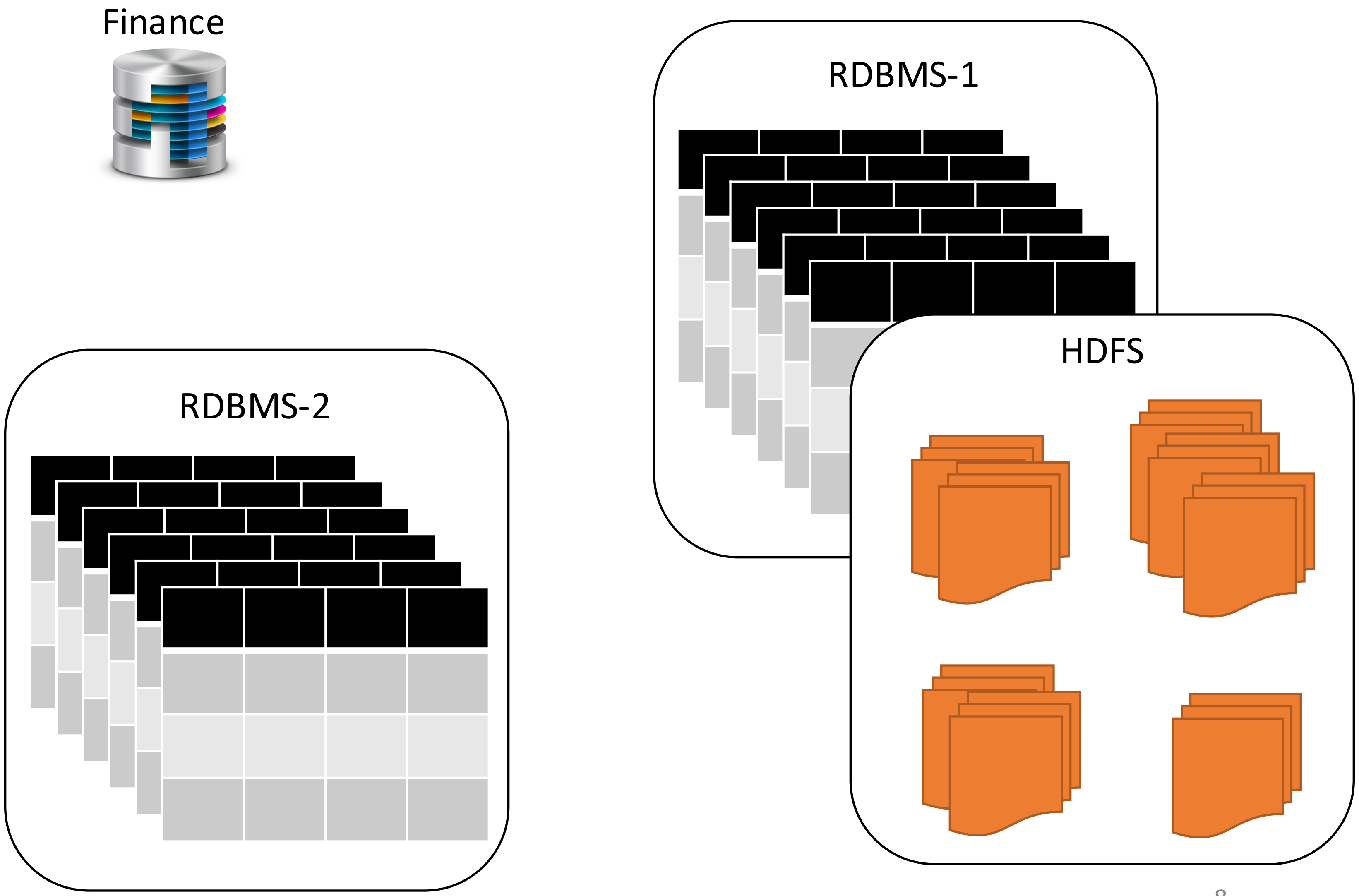


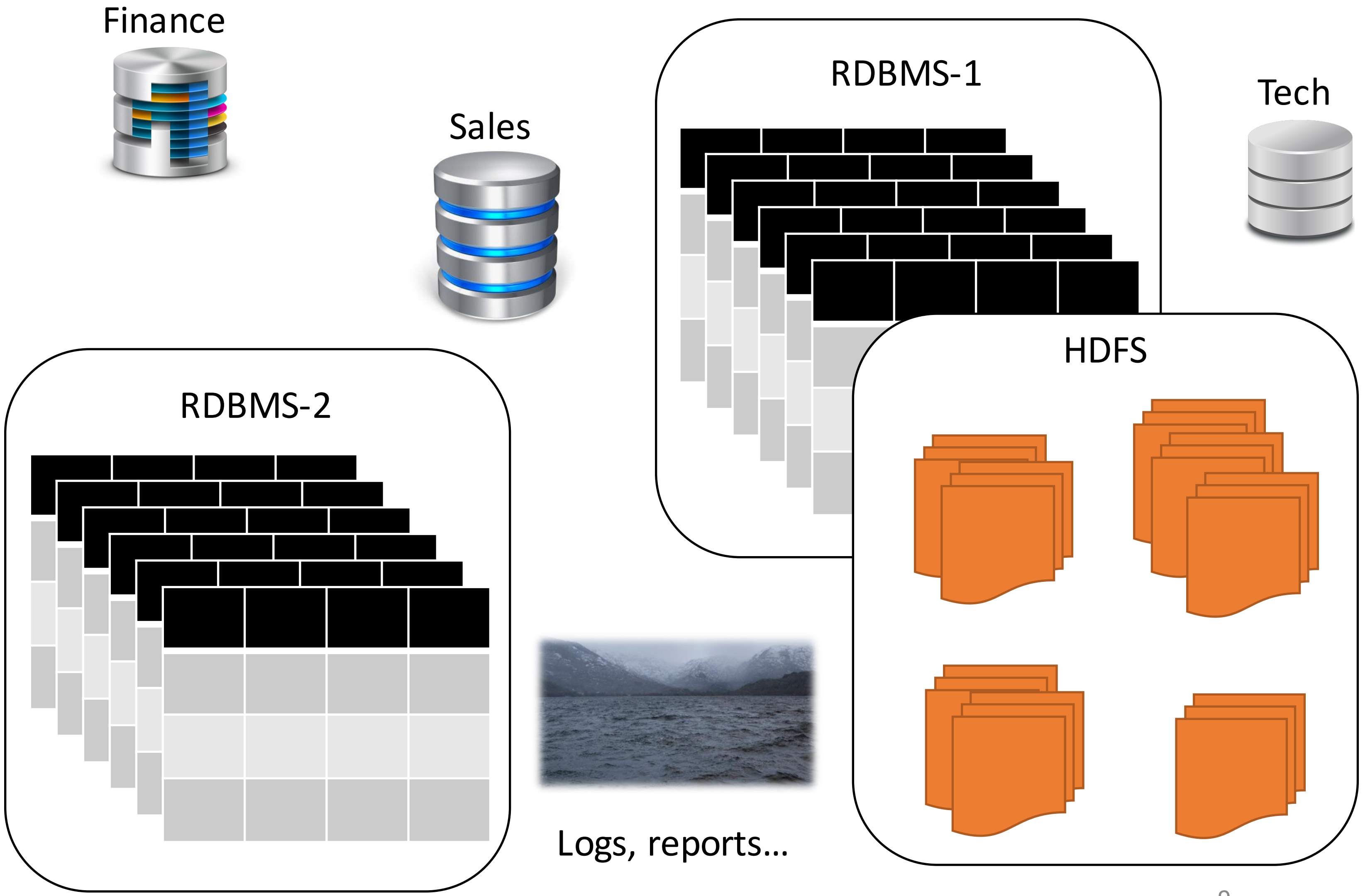
Finance

RDBMS-1

HDFS

RDBMS-2

Employee gender distribution per department



Finance

Sales

RDBMS-1

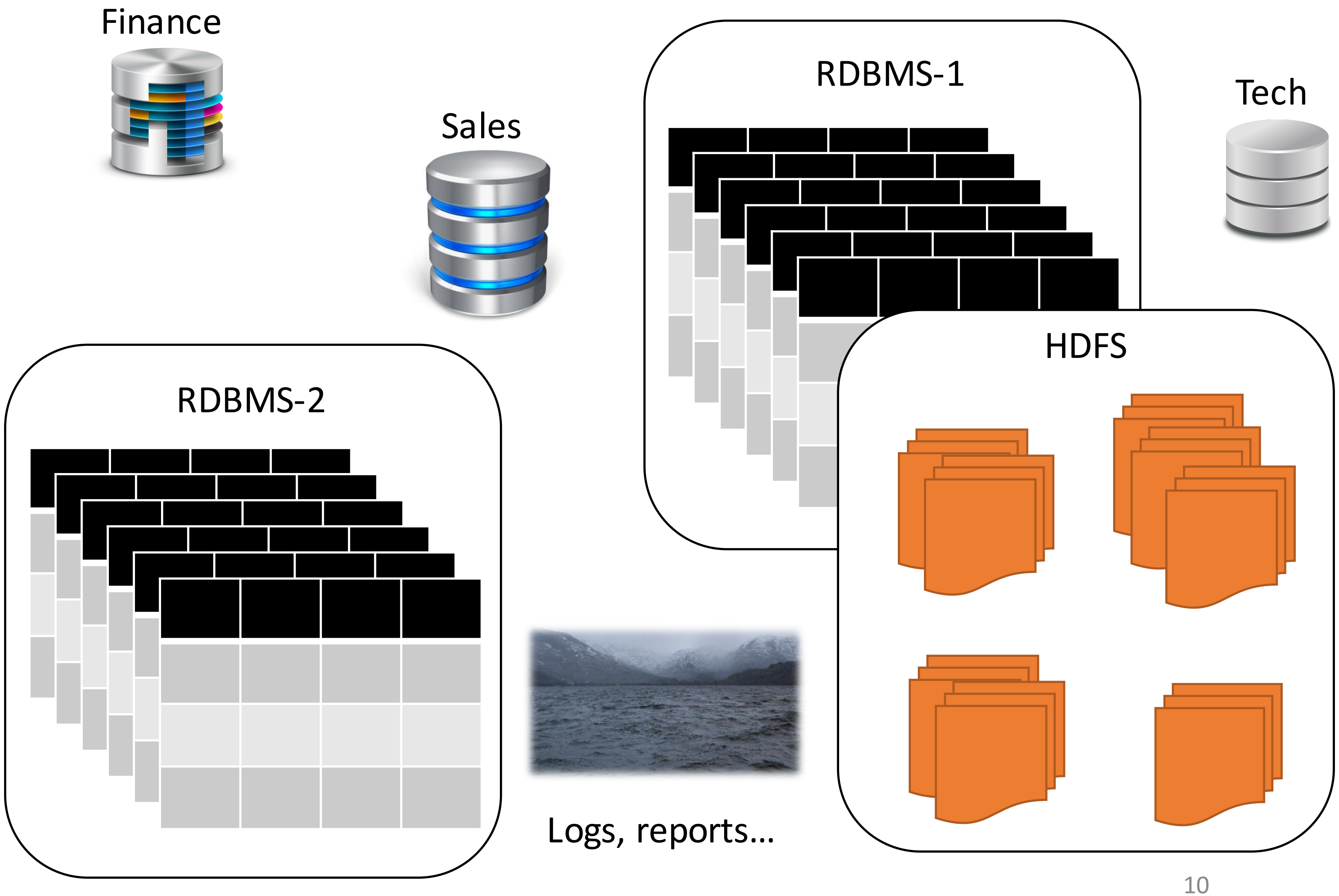
Tech

HDFS

RDBMS-2

Logs, reports…

Employee gender distribution per department



The Modern Company

- Data **heterogeneity**
  - Multiple departments and divisions
  - Data in relational tables, files in data lakes, reports in desktop machines…
- Increasing **data volumes**
  - Millions of tables, hundreds and thousands of databases

The Data Discovery Problem

- How do I **find relevant data** to the question at hand?

- Am I missing important data?

Finance

Sales

Tech

Logs, reports…

The De Facto Approach

- Social Networking
  - Ask other people:
    - " I heard Sam used to work with those datasets, ask him."
  - Not exhaustive
    - Sam:"Some of the datasets must be in the DBX database, the others I don't know…"

No single person in the organization knows about all datasets

What we really need: Declare what you want

```
SELECT department, gender, COUNT(*)
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What we really need: Declare what you want

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SELECT department, gender, COUNT(*)
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Employee Id	Name	Gender	Department
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$> **find_schema_with**(“*department*”, “*gender*”, “*employee*”)

What we really need: Flexibility

```
SELECT department, gender, year COUNT(*)
FROM Employee
GROUP BY gender, department, year;
```

Employee Id	Name	Gender	Department
1001	John	Male	Finance
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What we really need: Flexibility

```
SELECT department, gender, year COUNT(*)
FROM Employee
GROUP BY gender, department, year;
```

Employee Id	Name	Gender	Department	Year
1001	John	Male	Finance	1987
1002	Mary	Female	Tech	1983
1003	Susan	Female	Finance	1988

$> **add_column(“*year*”)**

What we really need: Composable functions

I want to see instances of employees

```
$> search(“Raul Castro”)
```

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I want to see instances of employees

```
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What fields have "*EmployeeID*"
or "*eid*" on their schema?

```
$> search_schema("EmployeeId")
   OR
   search_schema("eid")
```

What we really need: Composing functions

I want to see instances of employees

$> **search**("Raul Castro")

What fields have "*EmployeeID*"
or "*eid*" on their schema?

$> **search_schema**("EmployeeId")
OR
search_schema("eid")

Show me similar content to this table

$> **content_similar_to**(<table>)

Aurum: Data Discovery at Large

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- Motivation: The Data Discovery Problem
- **Aurum: Overview of the System**
- SRQL: Discovery Algebra
- Building the Metaschema Graph
    - Data profiling and summarization
    - Graph Builder component
- Roadmap

Aurum: Overview of the System

- **Observation**: *X is relevant to Y implies there exists a <u>relationship</u> between X and Y*

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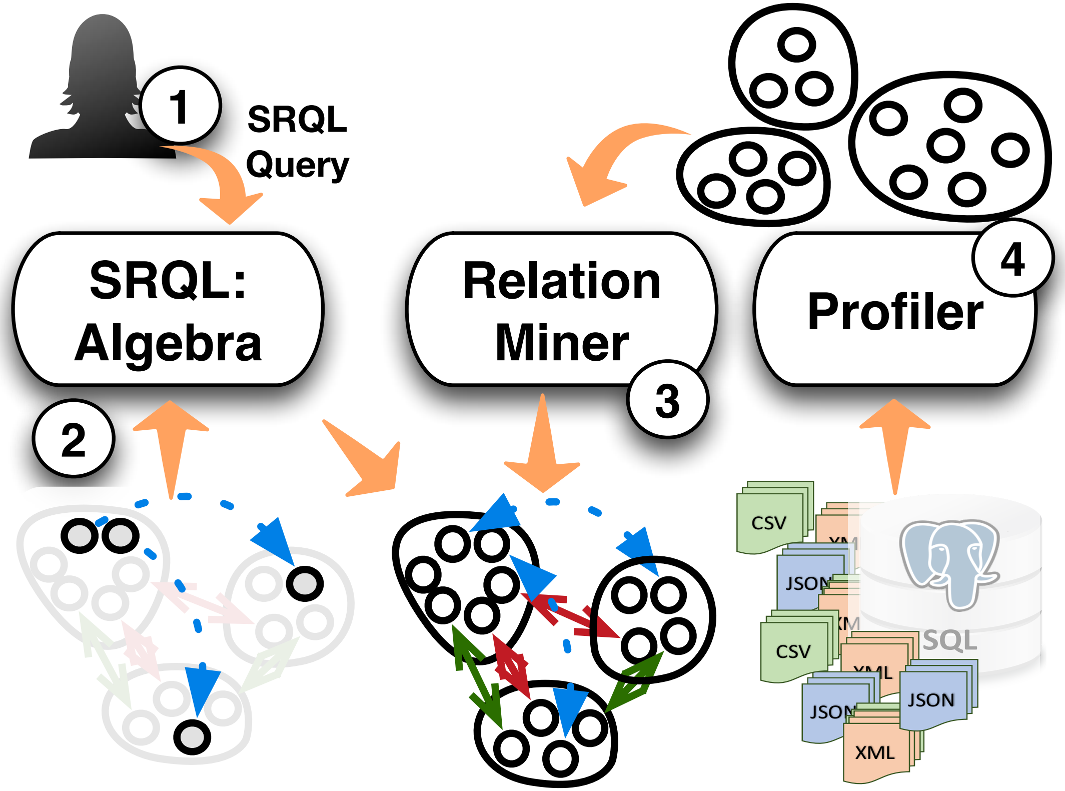
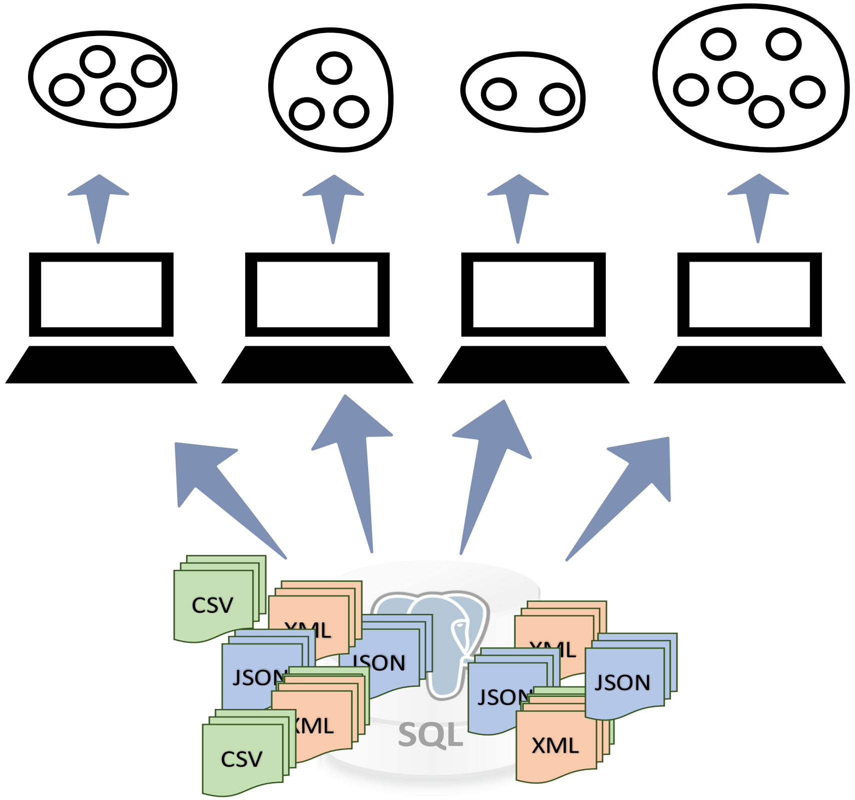
- SRQL algebra
  - Compose discovery queries
- Metaschema graph
  - Expose all relations in the data
- Profiler and Graph Builder
  - Summarize and build the graph fast



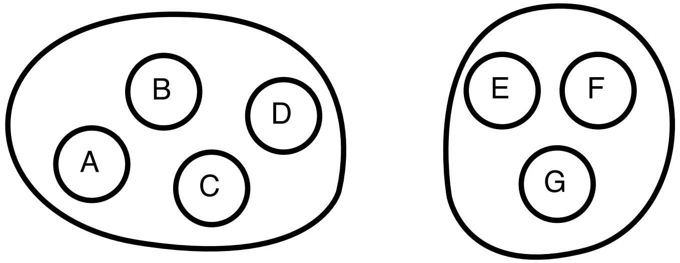
Profiler: Taming the Scale with Data Summaries

- **Goal:** Summarize *large* volumes of *heterogeneous* data
- High-Performance, scalable architecture
  - Read-once approach, sketches for O(n) operation
  - Distributed processing to scale to clusters
- A summary represents the **minimum discoverable element**



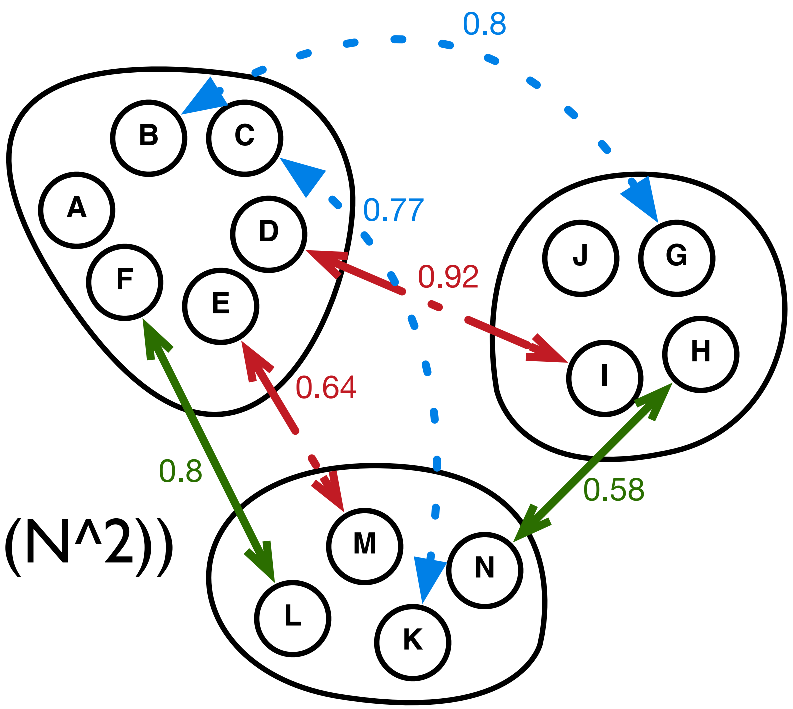
Profiler: Summary Grain and Content

- Minimum discoverable element: column
- Each summary is a **node** in the graph
  - Signatures: minhash, TF-IDF, or IQR+ - median
  - Data type, entity, cardinality, …
- Hierarchies represented with **hyperedges**
  - e.g., columns of a table



Graph Builder: Building the Metaschema Graph

- **Goal:** Mine relations of the underlying data
- **Edges** represent relations between nodes
  - Attribute name similarity, content similarity, PKFK…
- Scalable methods to extract relationships
  - LSH-hash signatures to avoid pairwise comparison (O(N^2))
  - e.g., minutes instead of weeks



SRQL: Discovery Algebra

- A SRQL query is a combination of ***data discovery primitives***
  - Lookup, edge, hyperedge, set and path primitives

similarTables(t: table) = schemaSim(t) AND contentSim(t)

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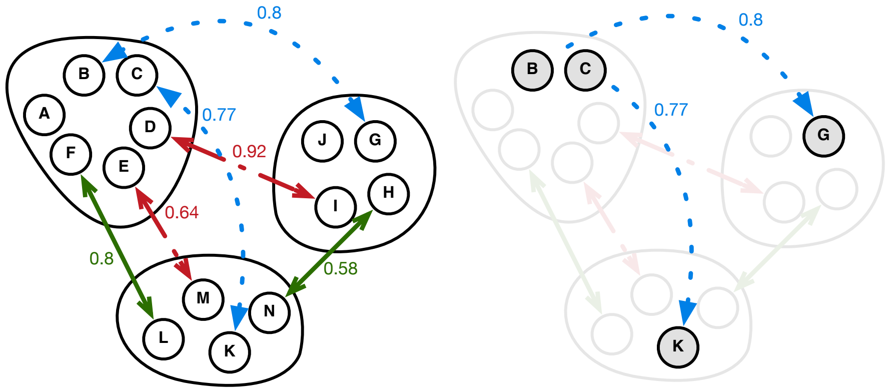
similarTables(t: table) = schemaSim(t) AND contentSim(t)

joinPath(src: table, tgt: table) = paths_between(src, tgt, Relation.PKFK)

SRQL: Discovery Algebra

- IR + Graph traversal to answer queries
  - **Goal:** Answer discovery queries in interactive times
- Ranking
  - Every user has a different **ranking criteria**
- Provenance
  - A SRQL query is a walk in the hypergraph
  - Explain results and debug queries!

Interactivity =
< 150ms



Outline

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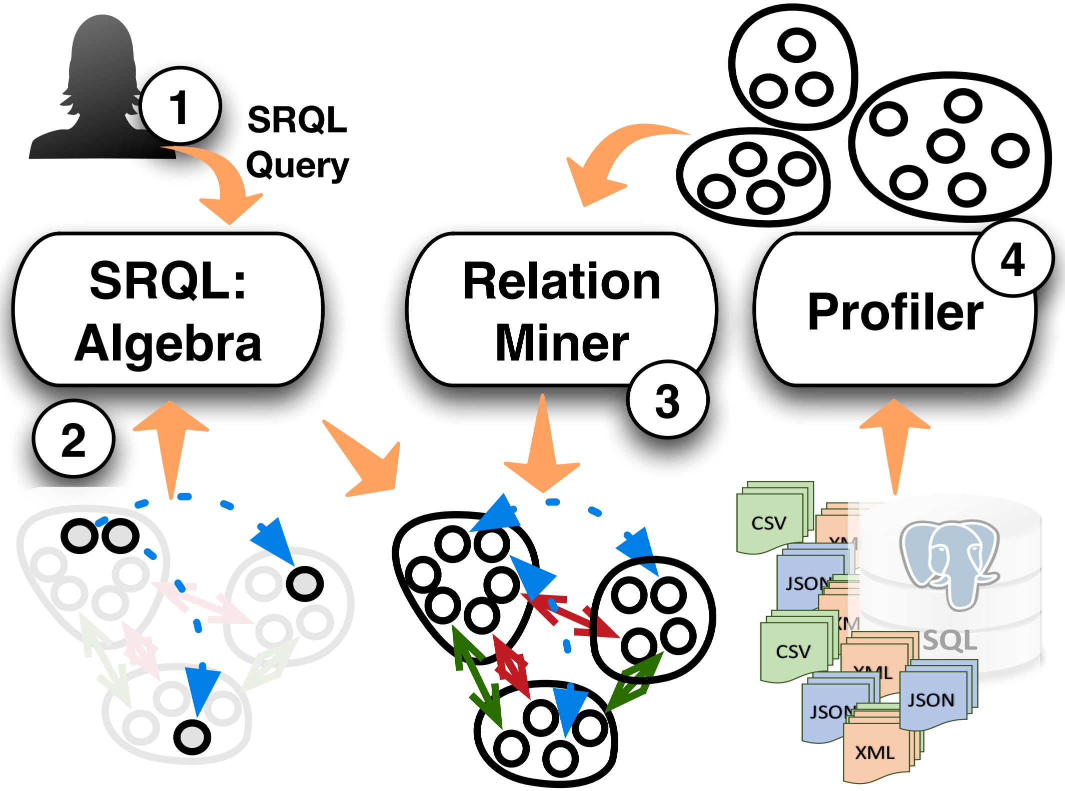
- **Roadmap**

Some Future Work

- Discovering **unstructured data**: PDFs, DOCs, HTML
  - How much unstructured data is in your organization?
- **Semantic** relations, inference
  - Is this behavior related to X?
- How well does my data solve my problems?
  - **Recommend** data, annotations and queries to users.

Aurum: A Large Scale Data Discovery System Based on Relation Retrieval Algebra



Raul Castro Fernandez

raulcf@csail.mit.edu

raulcastrofernandez.com