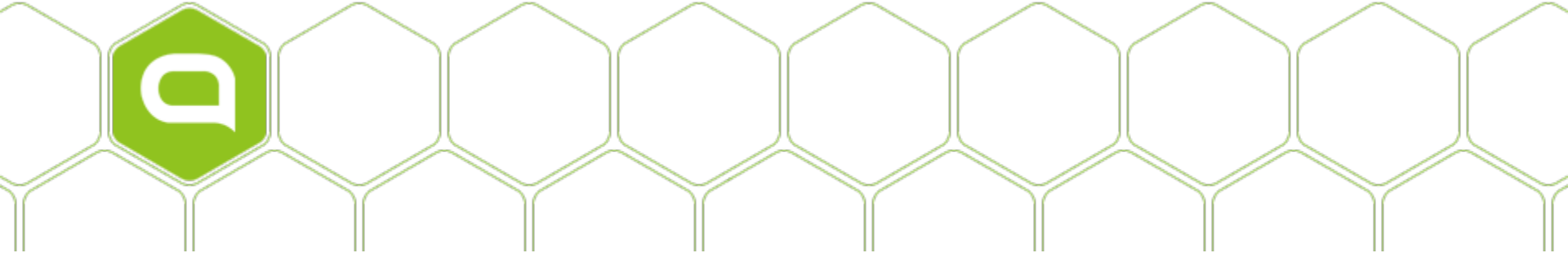
Introduction to Apache Tajo: Data Warehouse for Big Data

Jihoon Son / Gruter inc.



About Me

- Jihoon Son (@jihoonson)
  - Tajo project co-founder
  - Committer and PMC member of Apache Tajo
  - Research engineer at Gruter

Outline

- About Tajo
- Features of the Recent Release
- Demo
- Roadmap

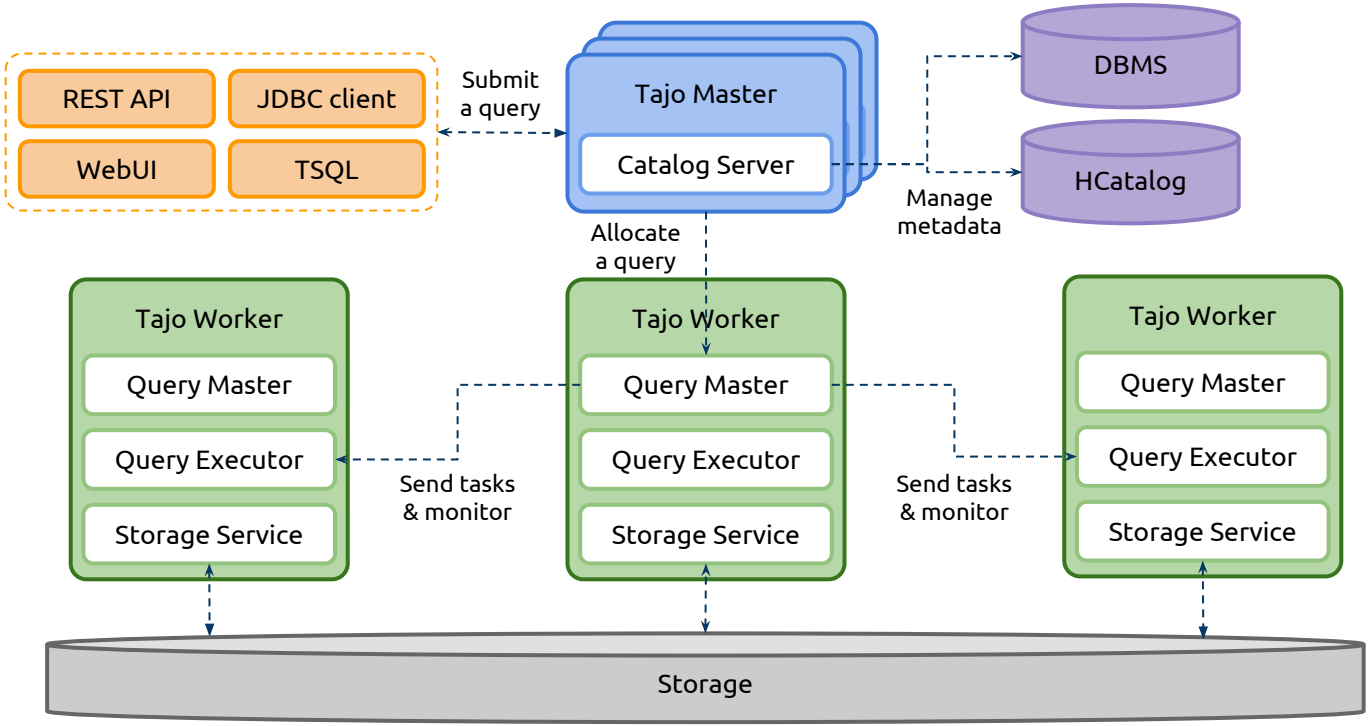
What is Tajo?

- Tajo / tá:zo / 타조
  - An ostrich in Korean
  - The world's fastest two-legged animal

What is Tajo?

- Apache Top-level Project
  - Big data warehouse system
    - ANSI-SQL compliant
    - Mature SQL features
      - Various types of join, window functions
  - Rapid query execution with own distributed DAG engine
    - Low latency, and long running batch queries with a single system
    - Fault-tolerance
  - Beyond SQL-on-Hadoop
    - Support various types of storage

Architecture Overview



Who are Using Tajo?

- Use cases: replacement of commercial DW
  - 1st telco in South Korea
    - Replacement of long-running ETL workloads on several TB datasets
    - Lots of daily reports about user behavior
    - Ad-hoc analysis on TB datasets
  - Benefits
    - Simplified architecture for data analysis
      - An unified system for DW ETL, OLAP, and Hadoop ETL
    - Much less cost, more data analysis within same SLA
      - Saved license fee of commercial DW

Who are Using Tajo?

- Use cases: data discovery
  - Music streaming service (26 million users)
    - Analysis of purchase history for target marketing
  - Benefits
    - Interactive query on large datasets
    - Data analysis with familiar BI tools

Recent Release: 0.11

- Feature highlights
  - Query federation
  - JDBC-based storage support
  - Self-describing data formats support
  - Multi-query support
  - More stable and efficient join execution
  - Index support
  - Python UDF/UDAF support

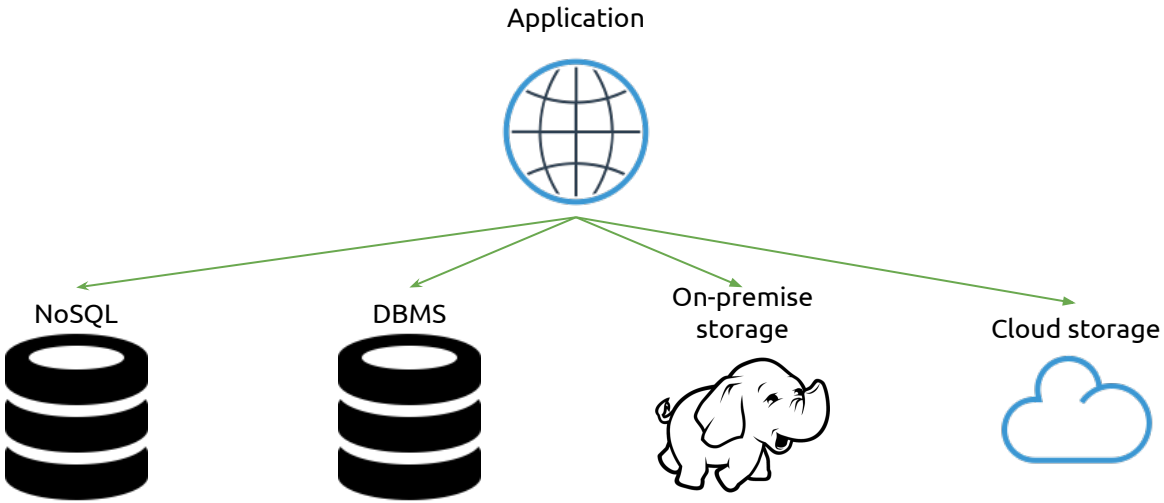
Recent Release: 0.11

- Today's topic
  - Query federation
  - JDBC-based storage support
  - Self-describing data formats support
  - Multi-query support
  - More stable and efficient join execution
  - Index support
  - Python UDF/UDAF support

Query Federation with Tajo

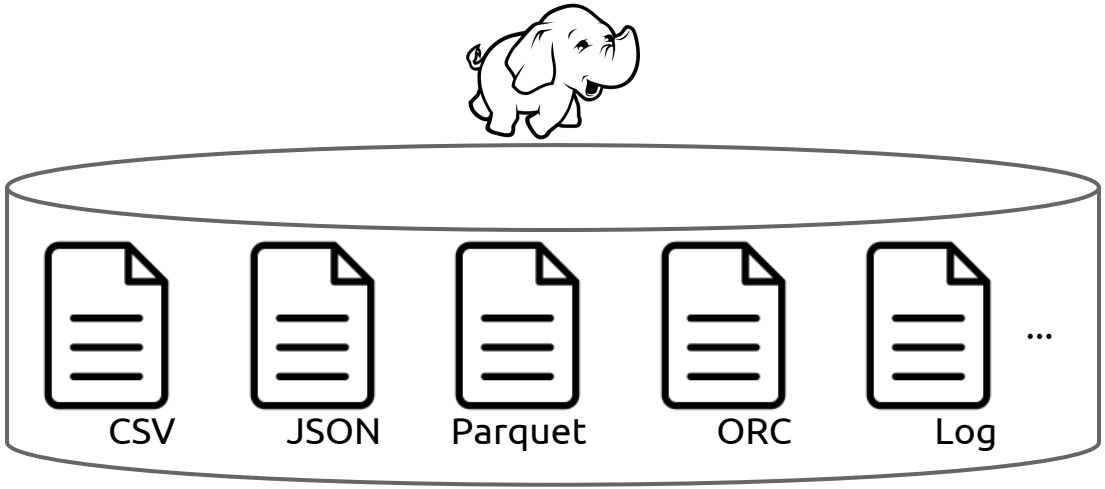
Your Data

- Your data might be spread on multiple heterogeneous sites
  - Cloud, DBMS, Hadoop, NoSQL, …



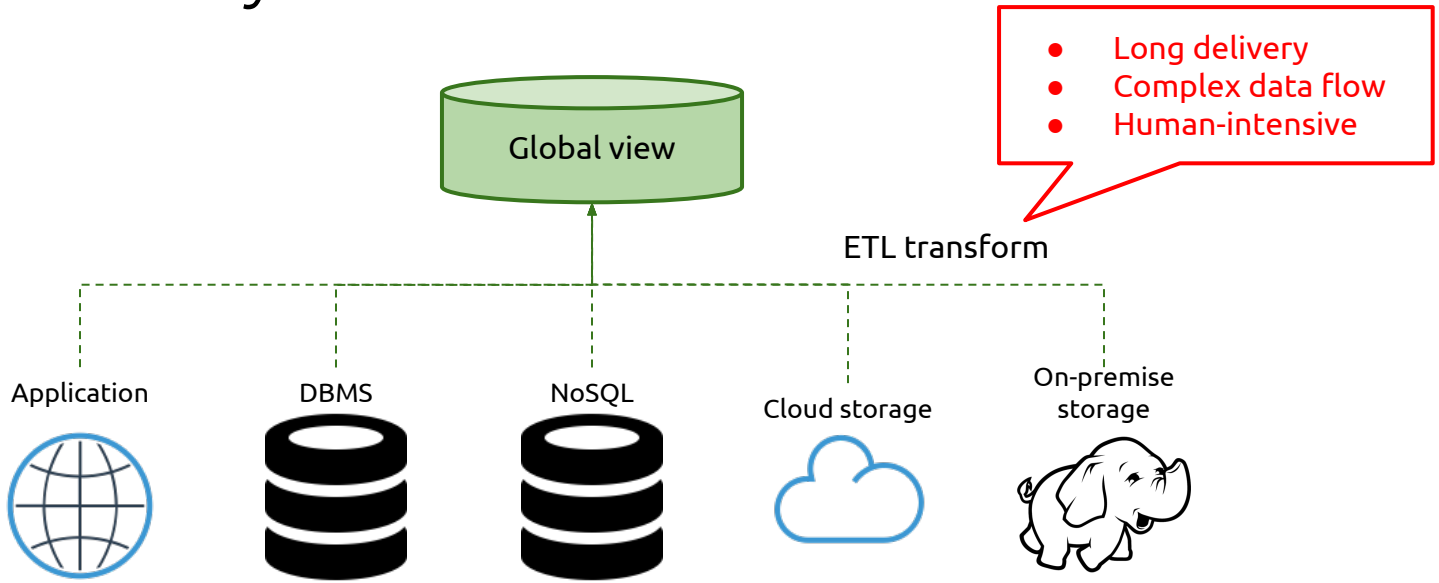
Your Data

- Even in a single site, your data might be stored in different data formats



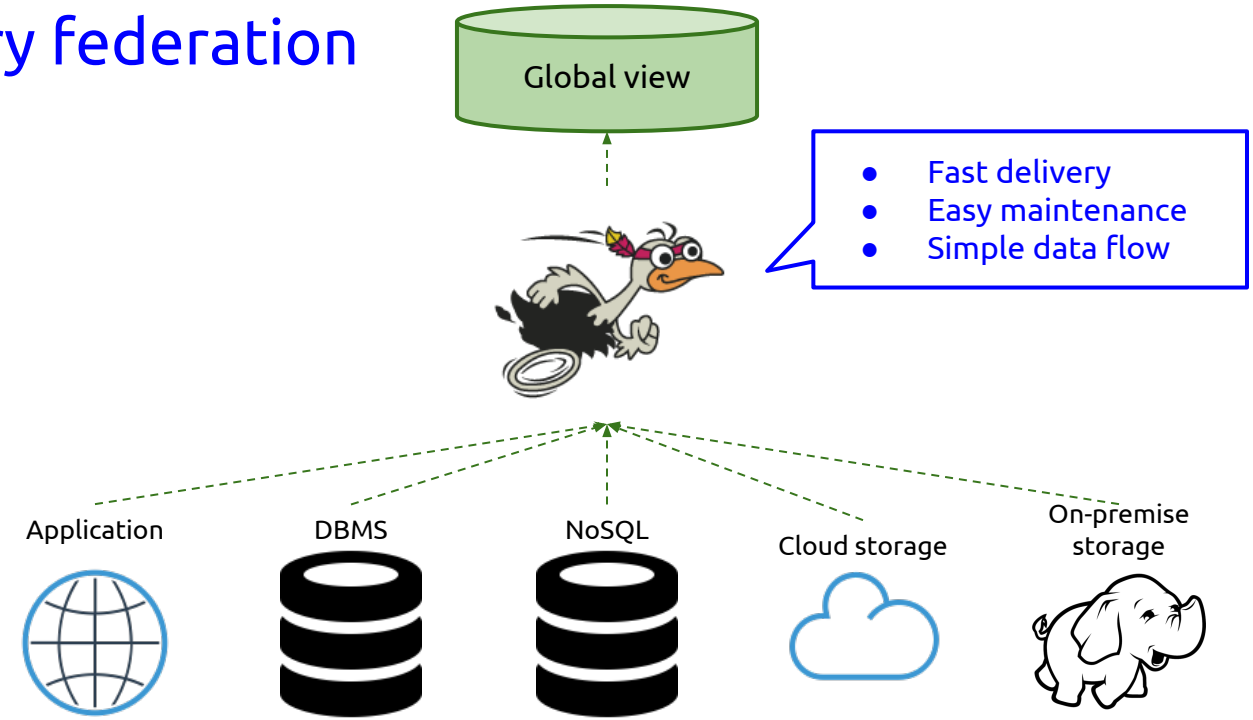
Your Data

- How to analyze distributed data?
  - Traditionally ...



Your Data with Tajo

- Query federation



Storage and Data Format Support

Create Table

```
> CREATE EXTERNAL TABLE archive1 (id BIGINT, ...) USING text WITH
('text.delimiter'='|') LOCATION 'hdfs://localhost:8020/archive1';

> CREATE EXTERNAL TABLE user (user_id BIGINT, ...) USING orc WITH
('orc.compression.kind'='snappy') LOCATION 's3://user';

> CREATE EXTERNAL TABLE table1 (key TEXT, ...) USING hbase LOCATION
'hbase:zk://localhost:2181/uptodate';

> ...
```

Storage URI

Data format

Create Table

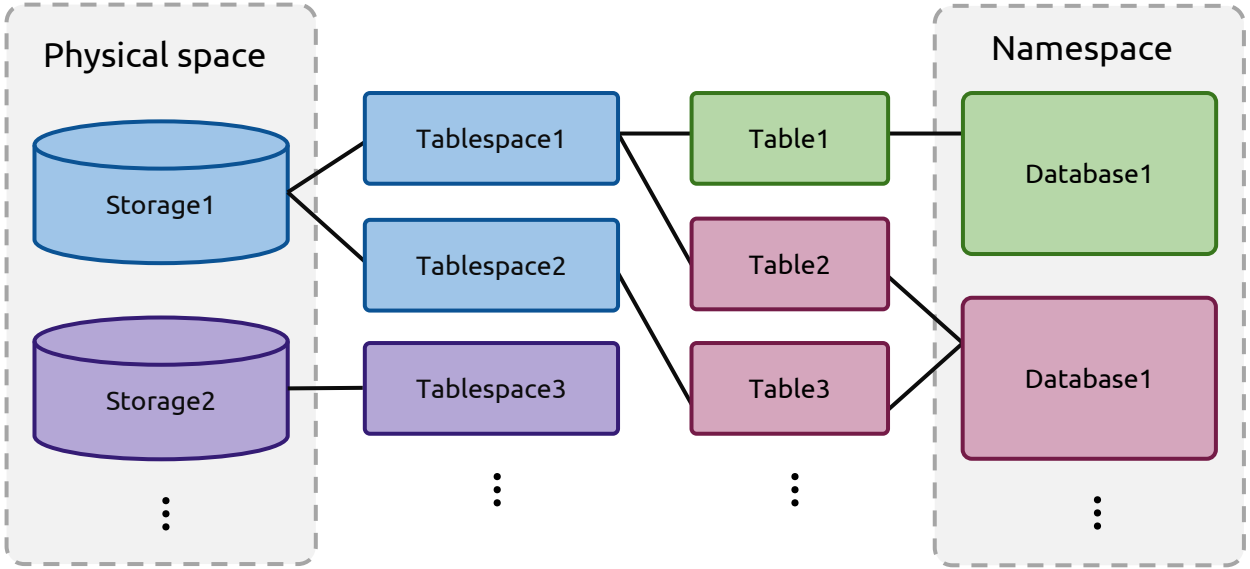
```
> CREATE EXTERNAL TABLE archive1 (id BIGINT, ...) USING text WITH ('text.
delimiter'='|','text.null'='\\N','compression.codec'='org.apache.hadoop.io.compress.
SnappyCodec','timezone'='UTC+9','text.skip.headerlines'='2') LOCATION 'hdfs://localhost:
8020/tajo/warehouse/archive1';

> CREATE EXTERNAL TABLE archive2 (id BIGINT, ...) USING text WITH ('text.
delimiter'='|','text.null'='\\N','compression.codec'='org.apache.hadoop.io.compress.
SnappyCodec','timezone'='UTC+9','text.skip.headerlines'='2') LOCATION 'hdfs://localhost:
8020/tajo/warehouse/archive2';

> CREATE EXTERNAL TABLE archive3 (id BIGINT, ...) USING text WITH ('text.
delimiter'='|','text.null'='\\N','compression.codec'='org.apache.hadoop.io.compress.
SnappyCodec','timezone'='UTC+9','text.skip.headerlines'='2') LOCATION 'hdfs://localhost:
8020/tajo/warehouse/archive3';

> ...
```

Too tedious!

Introduction to Tablespace

- Tablespace
  - Registered storage space
  - A tablespace is identified by an unique URI
  - Configurations and policies are shared by all tables in a tablespace
    - Storage type
    - Default data format and supported data formats
  - It allows users to reuse registered storage configurations and policies

Tablespaces, Databases, and Tables



Tablespace Configuration

```
{
  "spaces" : {
    "warehouse" : {
       "uri" : "hdfs://localhost:8020/tajo/warehouse",
       "configs" : [
         {'text.delimiter'='|'},
         {'text.null'='\\N'},
         {'compression.codec'='org.apache.hadoop.io.compress.SnappyCodec'},
         {'timezone'='UTC+9'},
         {'text.skip.headerlines'='2'}
       ]
    },
    "hbase1" : {
      "uri" : "hbase:zk://localhost:2181/table1"
    }
  }
}
```

Tablespace name

Tablespace URI

Create Table

```
> CREATE TABLE archive1 (id BIGINT, ...) TABLESPACE warehouse;
```

Tablespace name

Data format is omitted. Default data format is TEXT.

```
"warehouse" : {
   "uri" : "hdfs://localhost:8020/tajo/warehouse",
   "configs" : [
    {'text.delimiter'='|'},
    {'text.null'='\\N'},
    {'compression.codec'='org.apache.hadoop.io.compress.SnappyCodec'},
    {'timezone'='UTC+9'},
    {'text.skip.headerlines'='2'}
  ]
},
```

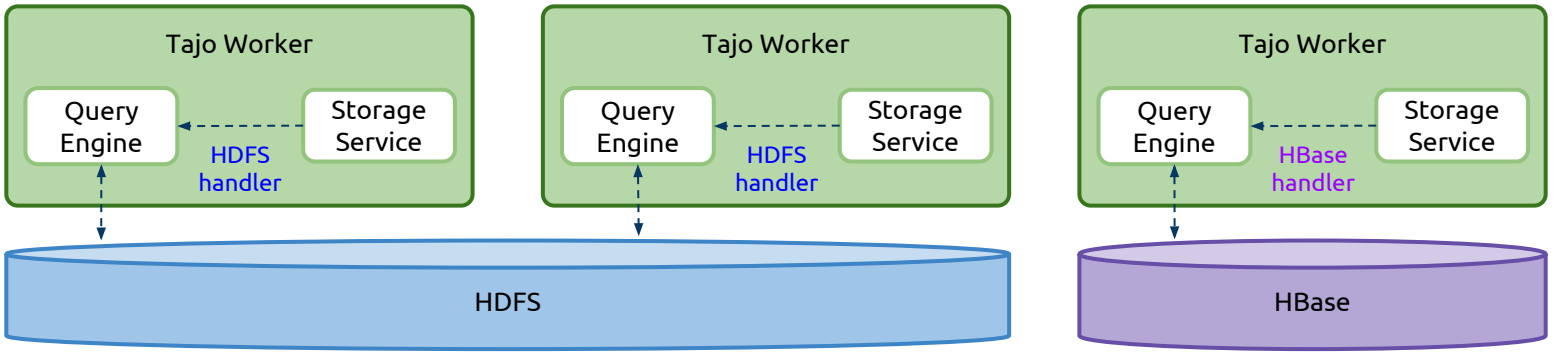
Create Table

```
> CREATE TABLE archive1 (id BIGINT, ...) TABLESPACE warehouse;

> CREATE TABLE archive2 (id BIGINT, ...) TABLESPACE warehouse;

> CREATE TABLE archive3 (id BIGINT, ...) TABLESPACE warehouse;

> CREATE TABLE user (user_id BIGINT, ...) TABLESPACE aws USING orc
WITH ('orc.compression.kind'='snappy');

> CREATE TABLE table1 (key TEXT, ...) TABLESPACE hbase1;

> ...
```

Querying on Different Data Silos

- How does a worker access different data sources?
  - Storage service
    - Return a proper handler for underlying storage

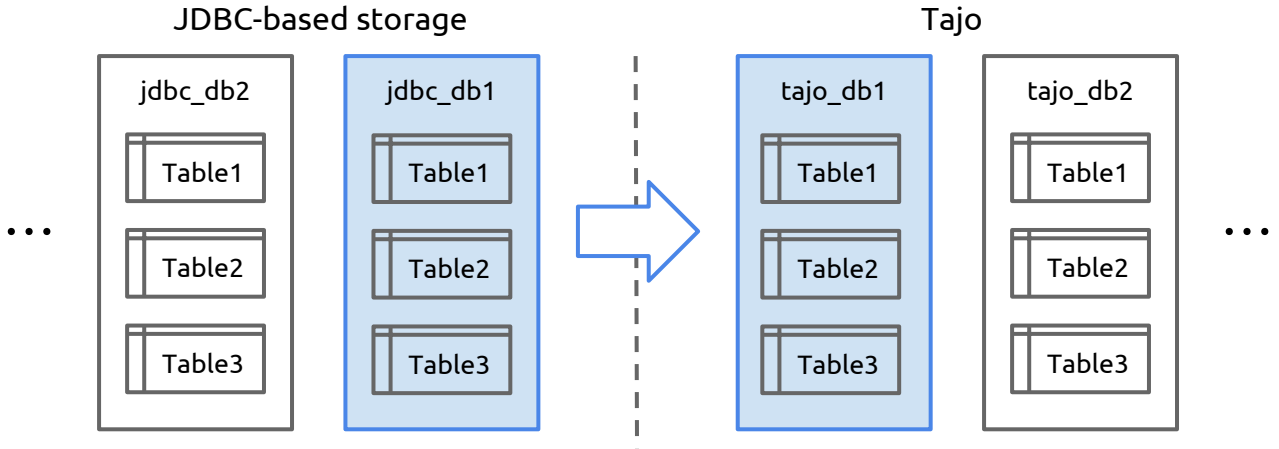
```
> SELECT ... FROM hdfs_table, hbase_table, ...
```



JDBC-based Storage Support

JDBC-based Storage

- Storage providing the JDBC interface
  - PostgreSQL, MySQL, MariaDB, ...
- Databases of JDBC-based storage are mapped to Tajo databases



Tablespace Configuration

```
{
  "spaces": {
    "pgsql_db1": {
      "uri": "jdbc:postgresql://hostname:port/db1"

      "configs": {
        "mapped_database": "tajo_db1"
        "connection_properties": {
          "user":     "tajo",
          "password": "xxxx"
        }
      }
    }
  }
}
```

Tablespace name

PostgreSQL database name

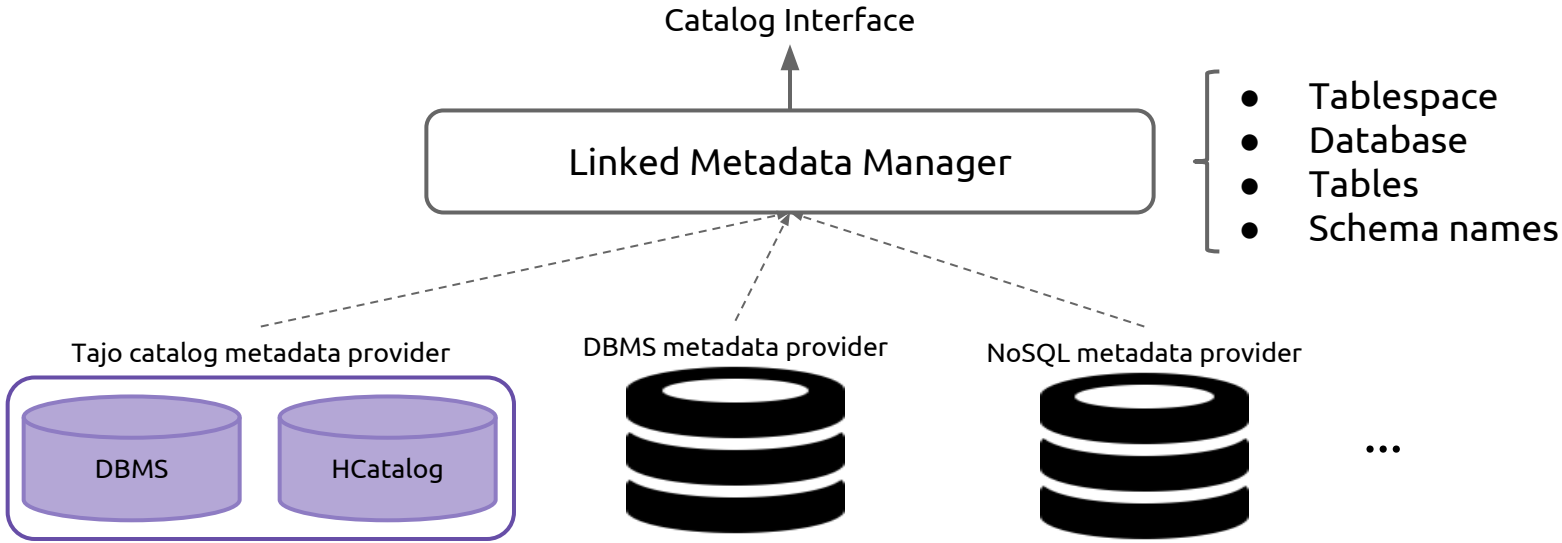
Tajo database name

Return to Query Federation

- How to correlate data on JDBC-based storage and others?
  - Need to have a global view of metadata across different storage types
    - Tajo also has its own metadata for its data
    - Each JDBC-based storage has own metadata for its data
    - Each NoSQL storage has metadata for its data
    - …

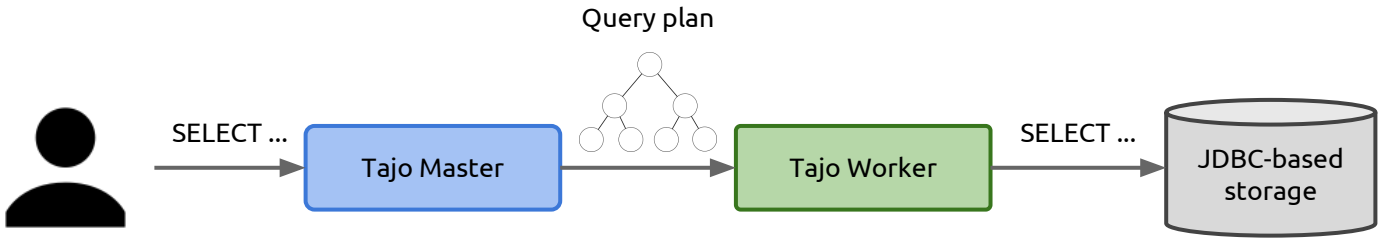
Metadata Federation

- Federating metadata of underlying storage



Querying on JDBC-based Storage

- A plan is converted into a SQL string
- Query generation
  - Diverse SQL syntax of different types of storage
  - Different SQL builder for each storage type

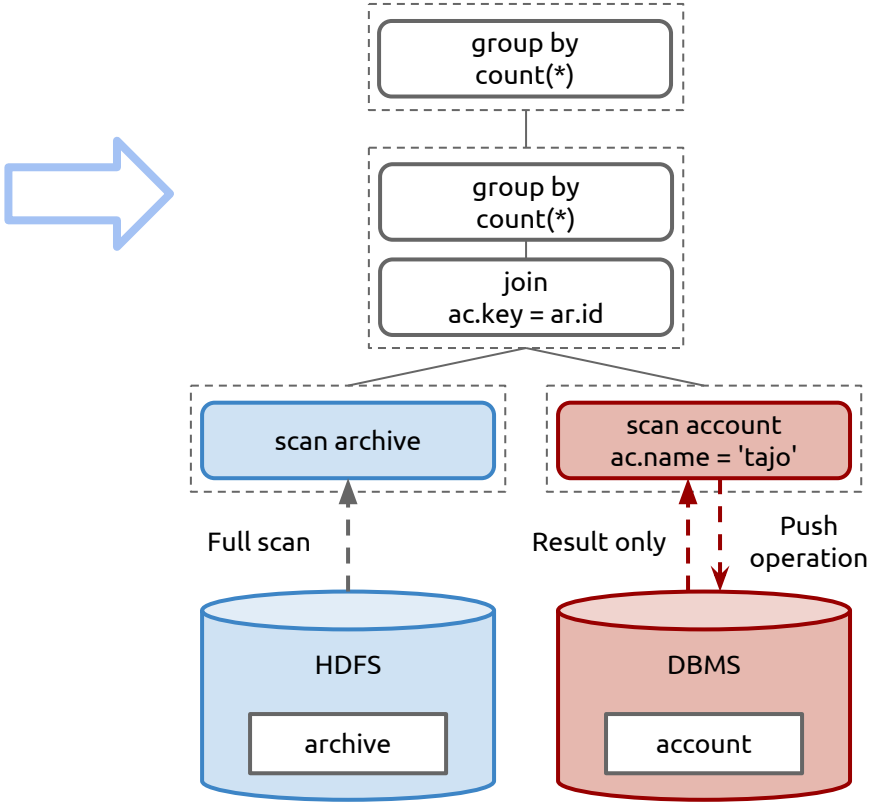


Operation Push Down

- Tajo can exploit the processing capability of underlying storage
  - DBMSs, MongoDB, HBase, …
- Operations are pushed down into underlying storage
  - Leveraging the advanced features provided by underlying storage
    - Ex) DBMSs' query optimization, index, ...

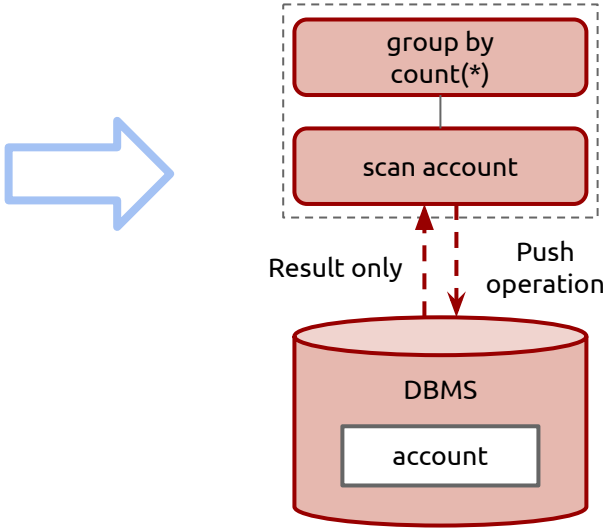
Example 1

```
SELECT
  count(*)
FROM
  account ac, archive ar
WHERE
  ac.key = ar.id and
  ac.name = 'tajo'
```



Example 2

```
SELECT
  ac.name, count(*)
FROM
  account ac
GROUP BY
  ac.name
```



Self-describing Data Formats Support

Self-describing Data Formats

- Some data formats include schema information as well as data
  - JSON, ORC, Parquet, …
- Tajo 0.11 natively supports self-describing data formats
  - Since they already have schema information, Tajo doesn't need to store it aside
  - Instead, Tajo can infer the schema at query execution time

Create Table with Nested Data Format

```
{"title":"Hand of the King","name":{"first_name":"Eddard","last_name":"Stark"}}
{"title":"Assassin","name":{"first_name":"Arya","last_name":"Stark"}}
{"title":"Dancing Master","name":{"first_name":"Syrio","last_name":"Forel"}}
```

```
> CREATE EXTERNAL TABLE schemaful_table (
    title TEXT,
    name RECORD (
      first_name TEXT,
      last_name TEXT
    )
  ) USING json LOCATION 'hdfs:///json_table';
```

Nested type

How about This Data?

{"id":"2937257761","type":"ForkEvent","actor":{"id":1088854,"login":"CAOakleyII","gravatar_id":"","url":"https://api.github.com/users/CAOakleyII","avatar_url":"https://avatars.githubusercontent.com/u/1088854?"},"repo":{"id":11909954,"name":"skycocker/chromebrew","url":"https://api.github.com/repos/skycocker/chromebrew"},"payload":{"forkee":{"id":38339291,"name":"chromebrew","full_name":"CAOakleyII/chromebrew","owner":{"login":"CAOakleyII","id":1088854,"avatar_url":"https://avatars.githubusercontent.com/u/1088854?v=3","gravatar_id":"","url":"https://api.github.com/users/CAOakleyII","html_url":"https://github.com/CAOakleyII","followers_url":"https://api.github.com/users/CAOakleyII/followers","following_url":"https://api.github.com/users/CAOakleyII/following{/other_user}","gists_url":"https://api.github.com/users/CAOakleyII/gists{/gist_id}","starred_url":"https://api.github.com/users/CAOakleyII/starred{/owner}{/repo}","subscriptions_url":"https://api.github.com/users/CAOakleyII/subscriptions","organizations_url":"https://api.github.com/users/CAOakleyII/orgs","repos_url":"https://api.github.com/users/CAOakleyII/repos","events_url":"https://api.github.com/users/CAOakleyII/events{/privacy}","received_events_url":"https://api.github.com/users/CAOakleyII/received_events","type":"User","site_admin":false},"private":false,"html_url":"https://github.com/CAOakleyII/chromebrew","description":"Package manager for Chrome 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...

Create Schemaless Table

```
> CREATE EXTERNAL TABLE schemaless_table (*) USING json LOCATION
'hdfs:///json_table';
```

Allow any schema

That's all!

Schema-free Query Execution

```
> CREATE EXTERNAL TABLE schemaful_table (id BIGINT, name TEXT, ...)
USING text LOCATION 'hdfs:///csv_table;
```

```
> CREATE EXTERNAL TABLE schemaless_table (*) USING json LOCATION
'hdfs:///json_table';
```

```
> SELECT name.first_name, name.last_name from schemaless_table;
```

```
> SELECT title, count(*) FROM schemaful_table, schemaless_table WHERE
name = name.last_name GROUP BY title;
```

Schema Inference

- Table schema is inferred at query time
- Example

Query

```
SELECT
  a, b.b1, b.b2.c1
FROM
  t;
```

Inferred schema

```
(
  a text,
  b record (
    b1 text,
    b2 record (
      c1 text
    )
  )
)
```

Demo

Demo with Command line

Roadmap

Roadmap

- 0.12
  - Improved Yarn integration
  - Authentication support
  - JavaScript stored procedure support
  - Scalar subquery support
  - Hive UDF support

Roadmap

- Next generation (beyond 0.12)
  - Exploiting modern hardware
  - Approximate query processing
  - Genetic query optimization
  - And more …

```
tajo> select question from you;
```