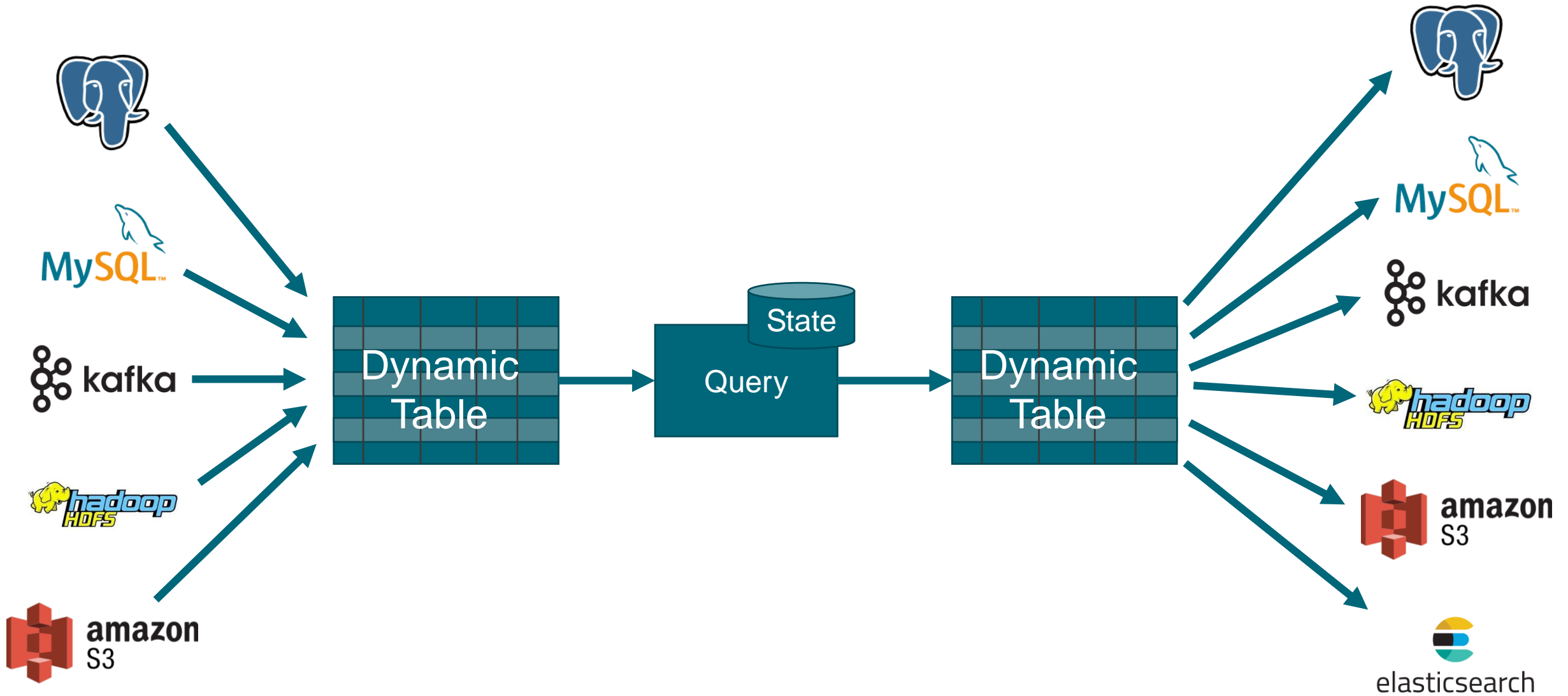


Querying Dynamic Tables with SQL

Flink SQL Training

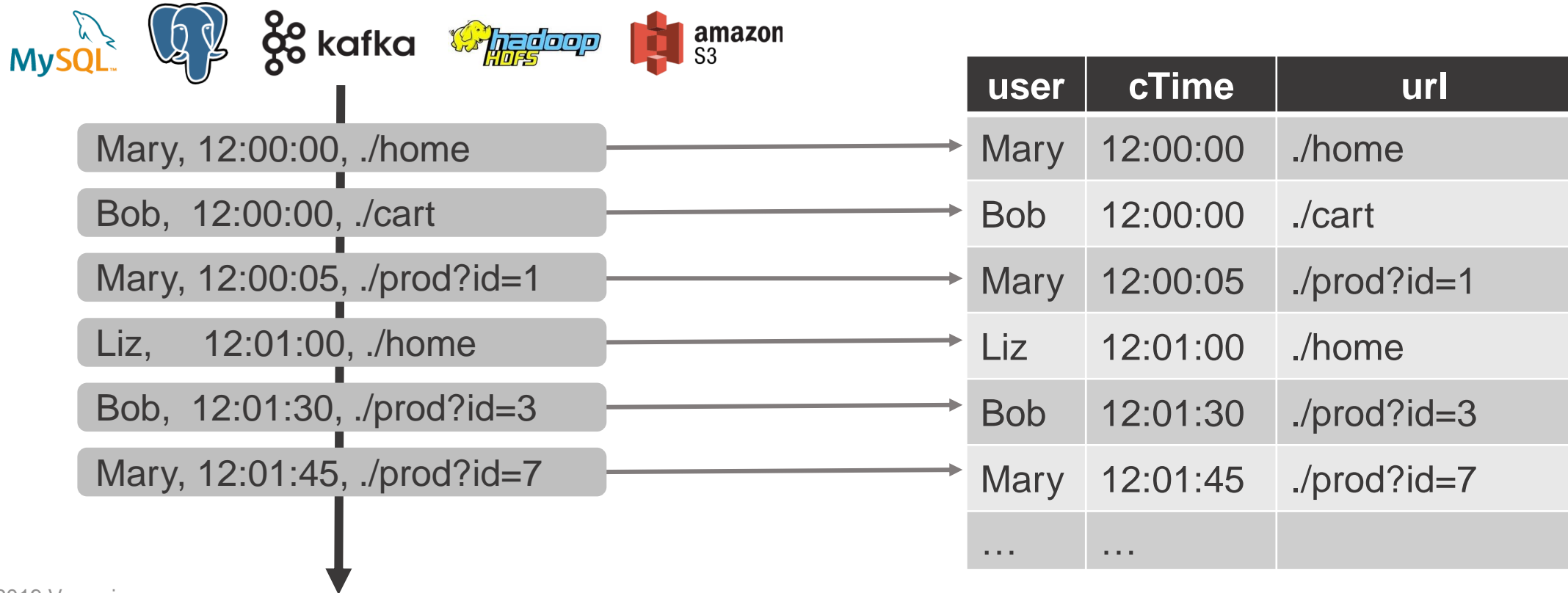
<https://github.com/ververica/sql-training>

Continuous SQL Queries in Flink



Stream → Dynamic Table: INSERT

- Append mode
 - Stream records are appended to table
 - Table grows as more data arrives

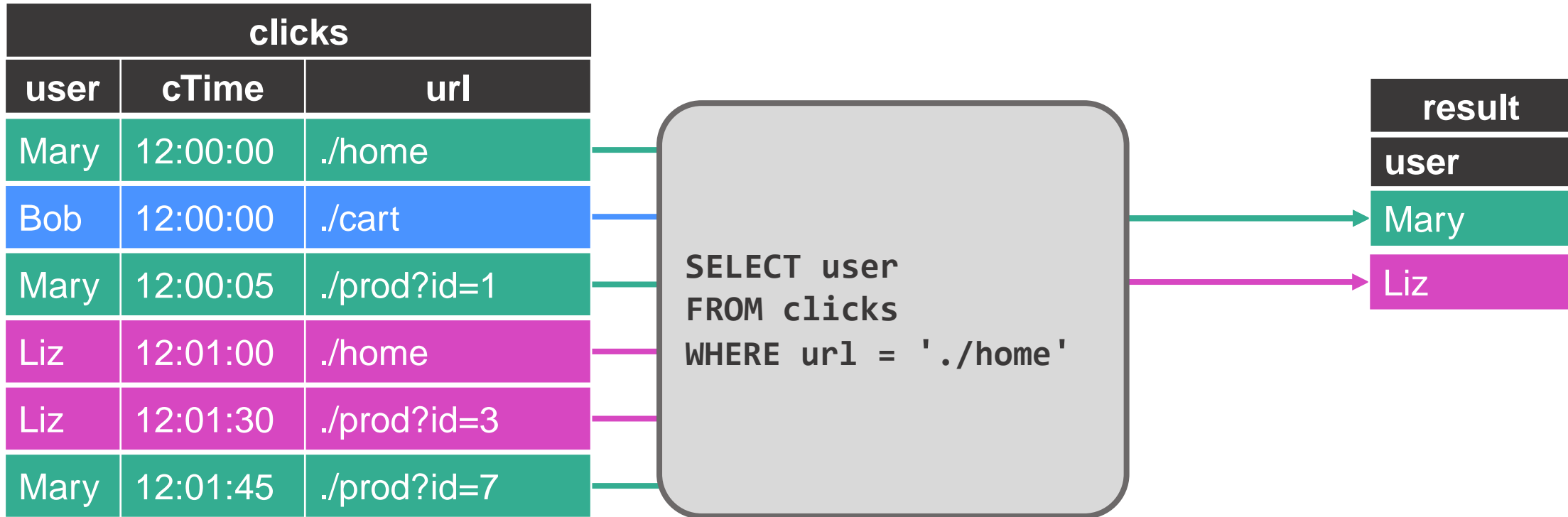


Querying a Dynamic Table with SQL

- Dynamic Tables can be queried with regular SQL
 - No special syntax required
- Results are incrementally computed and updated
 - Query operators maintain state to perform computations

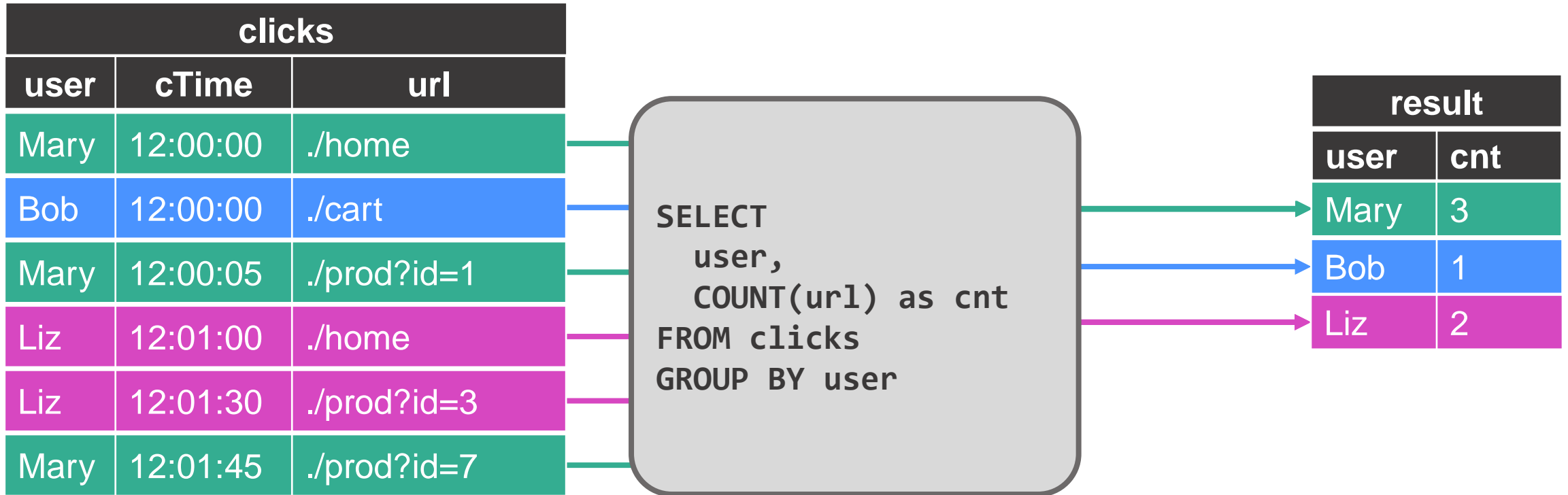


Querying a Dynamic Table



Rows of result table are appended.

Querying a Dynamic Table



Rows of result table are updated.

Dynamic Table → Stream

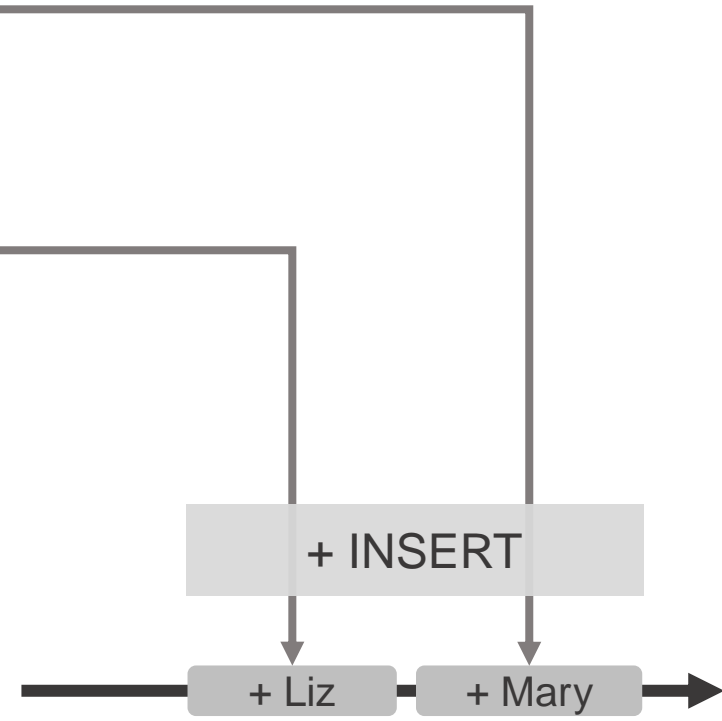
- Converting a dynamic table into a stream
- Dynamic tables might update or delete existing rows
- Updates must be encoded in outgoing stream



Dynamic Table → Stream: INSERT-only

| clicks | |
|--------|-------------|
| user | url |
| Mary | ./home |
| Bob | ./cart |
| Mary | ./prod?id=1 |
| Liz | ./home |
| Bob | ./prod?id=3 |

```
SELECT user
FROM clicks
WHERE url = './home'
```



MySQL



elasticsearch

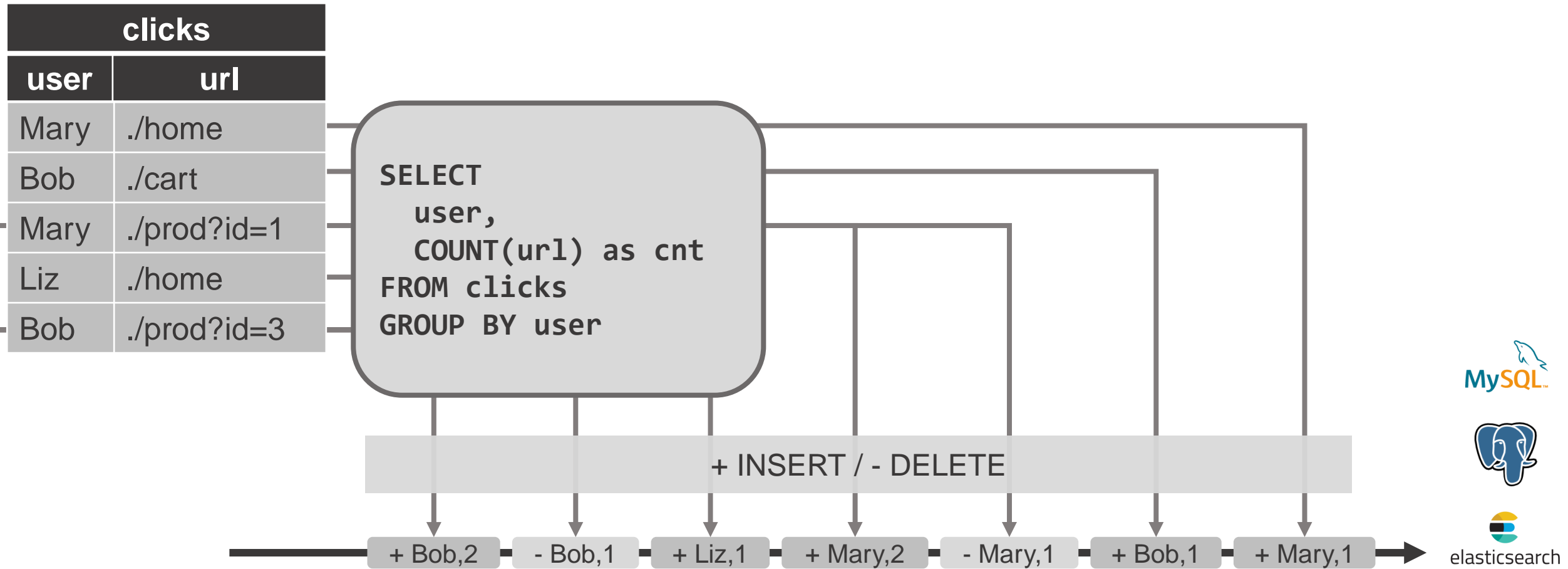
hadoop
HDFS

amazon
S3

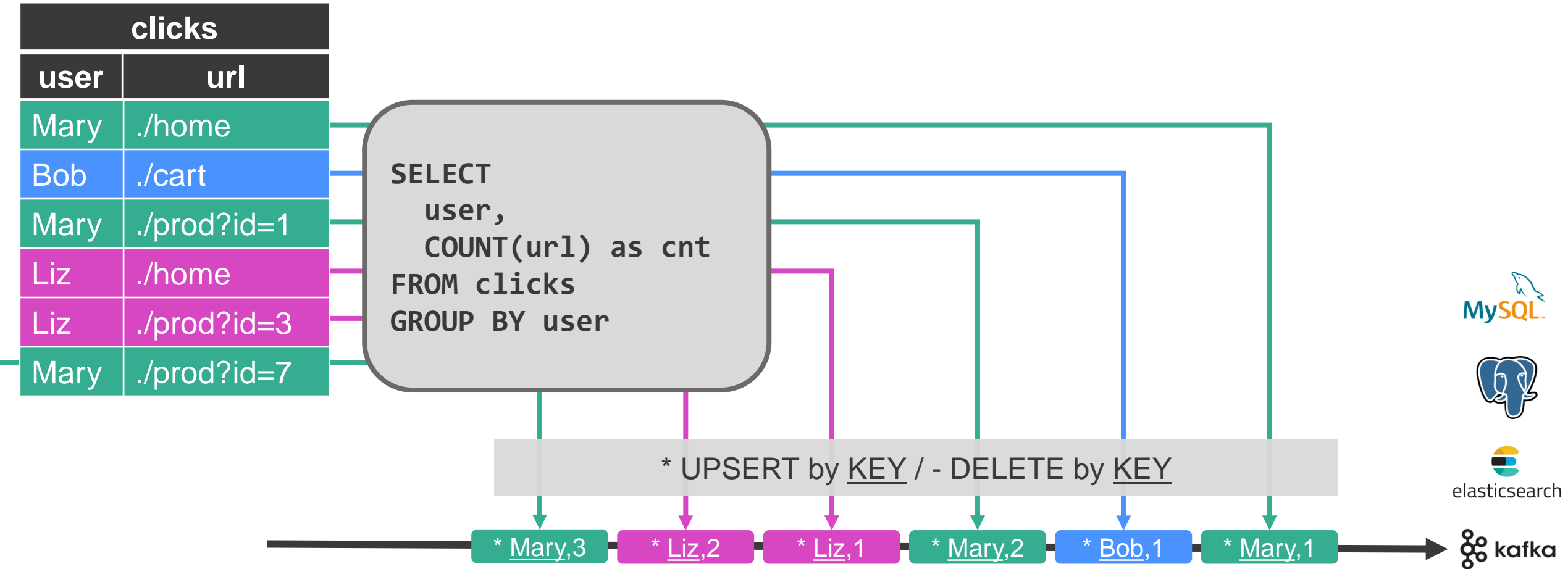
kafka



Dynamic Table → Stream: INSERT+DELETE



Dynamic Table → Stream: UPSERT+DELETE



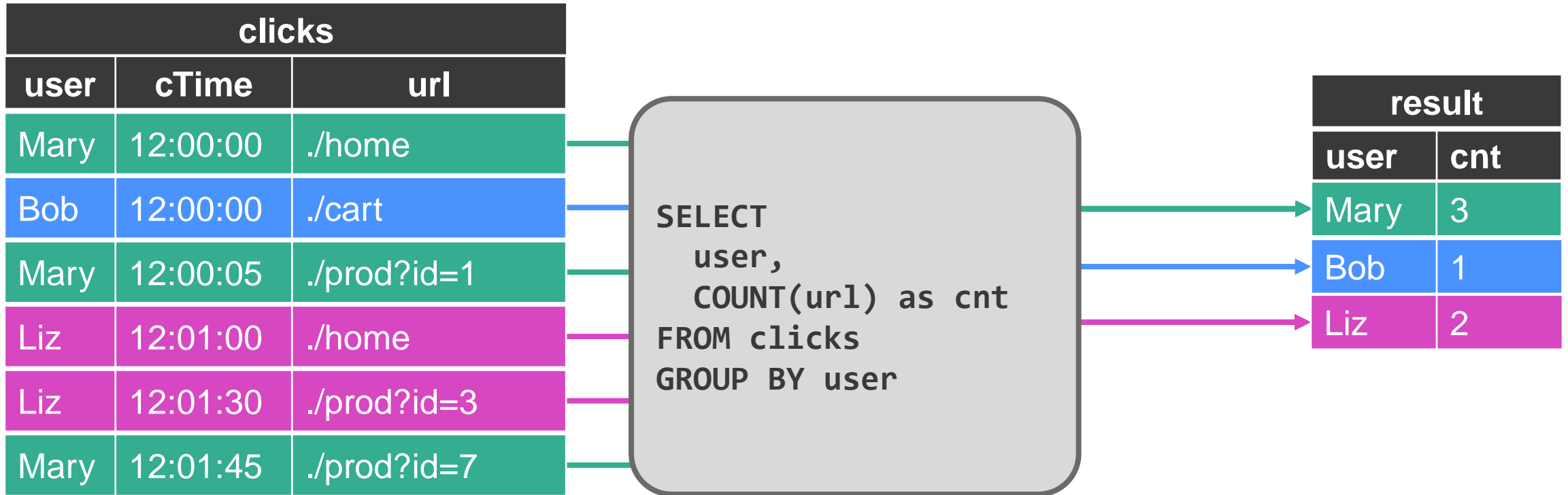
Operators and State

Operator Types

- Stateless operators
 - Filter
 - Projection
- Materializing operators
 - Aggregation
 - Joins
- Temporal operators (discussed in later sessions)
 - Window aggregation (GROUP BY, OVER)
 - Time-based joins (Interval join, Temporal-table join)
 - Pattern matching (MATCH_RECOGNIZE)



Materializing Aggregation



Rows of result table are updated.

Materializing Aggregation

```
SELECT
    user,
    COUNT(url) as cnt
FROM clicks
GROUP BY user
```

- The aggregation needs to maintain a count for every user forever.
 - Every user could click at any point in time
- The aggregation state is growing with every new user
 - For some aggregation functions, state grows with every new input row



Stateful Operators

- Materializing operators
 - Computations are not bound by temporal condition and never complete
 - Input and output records can be updated or deleted
 - Hold records and/or results forever in state
 - State can grow over time (depending on query and data)
- Temporal operators
 - Associate records based on a temporal condition
 - Only accept new records. Previously added records can not be updated or deleted.
 - Hold records and/or results in state until a computation is complete
 - Automatically clean up state as soon as records and results are no longer needed



Managing State Size of Materializing Operators

- Query state might grow indefinitely
 - Depends on query and input tables
- Slowly growing state can be addressed by scaling the query
 - `SELECT user, COUNT(*) FROM logins GROUP BY user;`
- State can be automatically pruned
 - `SELECT session, COUNT(*) FROM clicks GROUP BY session;`
 - Rows and persisted results can be removed after an idle timeout



Idle State Clean Up

- Configure Flink to automatically remove state that was not accessed for x time
 - The query result is not updated when state is removed
- Query result remains consistent if removed state is not needed again
- Query result becomes inconsistent if query needs to access state that was removed!
- Trade the accuracy of the result for size of state



Summary

Summary

- Streams are interpreted as changelog for a Table
 - Flink 1.10 supports INSERT-only stream to table conversion
 - Flink 1.11 will support full changelog conversion
- SQL queries on dynamic tables yield another dynamic table
 - Input and query determines whether resulting dynamic table is append-only or updating
- Dynamic tables can be converted back into streams
 - INSERT-only, INSERT+DELETE, UPSERT+DELETE



Summary

- Use regular SQL to run queries on dynamic tables
 - No need to learn special syntax or semantics
 - Writing and executing queries is easy, BUT...
- Pay attention to the state requirements of your query
 - Depending on query and input data, the state might grow indefinitely
 - Enable idle state pruning to trade off query accuracy and state consumption



Hands On Exercises

Querying Dynamic Tables with SQL

Continue with the hands-on exercises in
“Querying Dynamic Tables with SQL”

<https://github.com/ververica/sql-training/wiki/Querying-Dynamic-Tables-with-SQL>

We are here to help!





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