Stream Analytics with SQL on Apache Flink®

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About me

- Apache Flink PMC member
  - Contributing since day 1 at TU Berlin
  - Focusing on Flink's relational APIs since 1.5 years

- Co-founder of data Artisans
- Co-author of "Stream Processing with Apache Flink"
  - Work in progress…
- PhD in Computer Science

dataArtisans

dA
PLATFORM

Original creators of
Apache Flink®

Providers of the
dA Platform, a supported
Flink distribution

Apache Flink

- Platform for scalable stream processing
- Fast
  - Low latency and high throughput
- Accurate
  - Stateful streaming processing in event time
  - Exactly-once state guarantees
- Reliable
  - Highly available cluster setup
  - Snapshot and restart applications

Powered by Flink

Flink’s DataStream API

- The DataStream API is very expressive
  - Application logic implemented as user-defined functions
  - Windows, triggers, evictors, state, timers, async calls, …

- Many applications follow similar patterns
  - Do not require the expressiveness of the DataStream API
  - Can be specified more concisely and easily with a DSL

- Q: What’s the most popular DSL for data processing?

SQL!

- Many good reasons to use SQL
  - Declarative specification
  - Effective optimization
  - Efficient execution
  - “Everybody” knows SQL

- But does SQL work for streams as well?

SQL was not designed for streams

- Relations are bounded (multi-)sets. ↔ Streams are infinite sequences.
- DBMS can access all data. ↔ Streaming data arrives over time.
- SQL queries return a result and complete. ↔ Streaming queries continuously emit results and never complete.

Some RDBMS do it anyway ☺

- Materialized views (MV) are similar to regular views, but persisted to disk or memory
  - Used to speed-up analytical queries
  - MVs must be updated when the base tables change

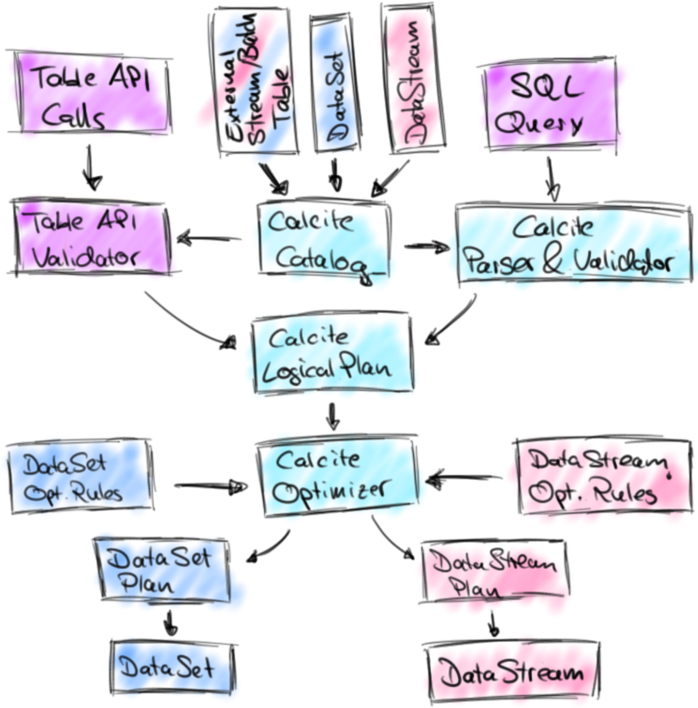
- MV maintenance is very similar to SQL on streams
  - Base table updates are a changelog stream
  - MV definition is SQL query to evaluate
  - MV is query result

Apache Flink's Relational APIs

- *Standard* SQL & LINQ-style Table API
- *Unified* APIs for batch & streaming data

A query specifies exactly the same result regardless whether its input is static batch data or streaming data.

- Common translation layers
  - Optimization based on Apache Calcite
  - Type system & code-generation
  - Table sources & sinks



Show me Code!

```
val tableApiResult: Table = tEnv
   .scan("sensors")
   .window(Tumble over 1.hour on 'mtime as 'w)
   .groupBy('w, 'room)
   .select('room, 'w.end, 'temp.avg as 'avgTemp)
```

sensors can be a
- CSV file,
- MySQL table,
- Kafka topic, ...

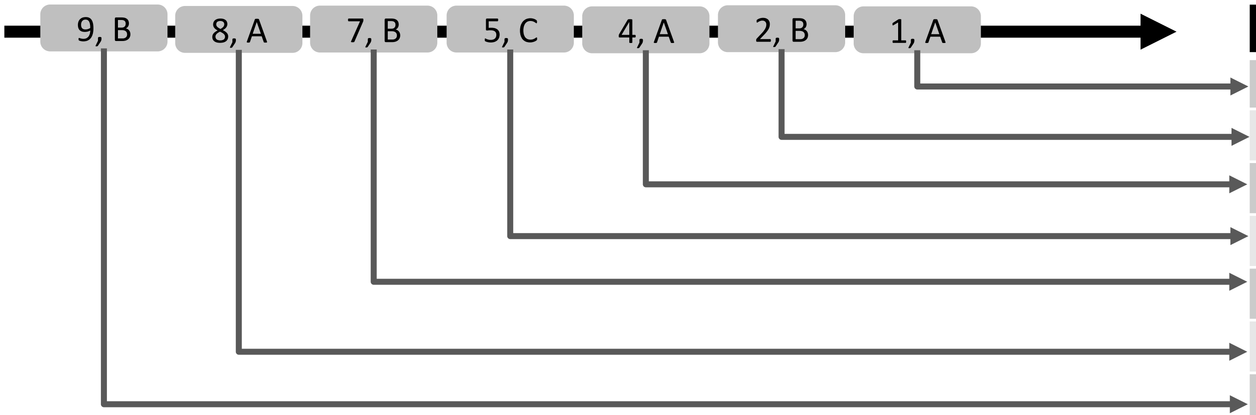
```
val sqlResult: Table = tEnv.sql("""
   |SELECT room,
   |       TUMBLE_END(mtime, INTERVAL '1' HOUR),
   |       AVG(temp) AS avgTemp
   |FROM sensors
   |GROUP BY TUMBLE(mtime, INTERVAL '1' HOUR), room
   """.stripMargin)
```

Continuous Queries

- Core concept is a *"Dynamic Table"*
  - Dynamic tables are changing over time
  - Insert, update, and delete changes
- Dynamic tables can be queries like static batch tables
  - Queries produce new dynamic tables
  - Queries do not terminate
- Stream ↔ Dynamic table conversions

Stream → Dynamic Table

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



time	k
1	A
2	B
4	A
5	C
7	B
8	A
9	B
…	…

Querying a Dynamic Table

- Dynamic tables change over time
  - *A[t]*: Table *A* at time *t*
- Dynamic tables are queried with regular SQL
  - *q(A[t])*: Evaluate query *q* on table *A* at time *t*
- As time progresses, the result is continuously updated
  - Similar to maintaining a materialized view

Querying a Dynamic Table

Table A	
time	k
1	A
2	B
4	A
5	C
7	B
8	A
9	B
11	A
12	C
14	C
15	A

A[5]

A[10]

A[15]

q:

```
SELECT
 k,
 COUNT(k) AS cnt,
 TUMBLE_END(
   time,
   INTERVAL '5' SECONDS)
  AS endT
FROM A
GROUP BY
 k,
 TUMBLE(
  time,
  INTERVAL '5' SECONDS)
```

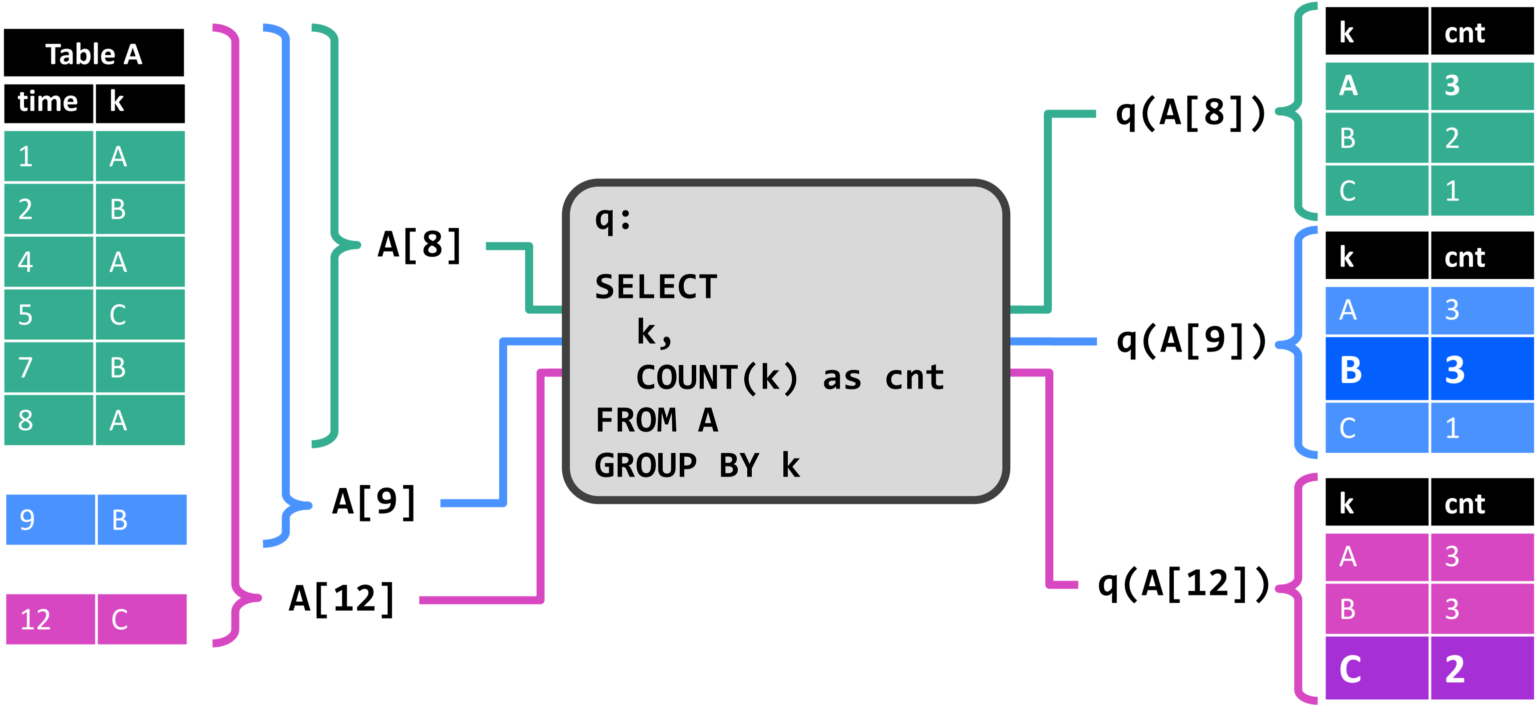
q(A[5])

q(A[10])

q(A[15])

q(A)		
k	cnt	endT
A	2	5
B	1	5
C	1	5
A	1	10
B	2	10
A	2	15
C	2	15

Querying a Dynamic Table



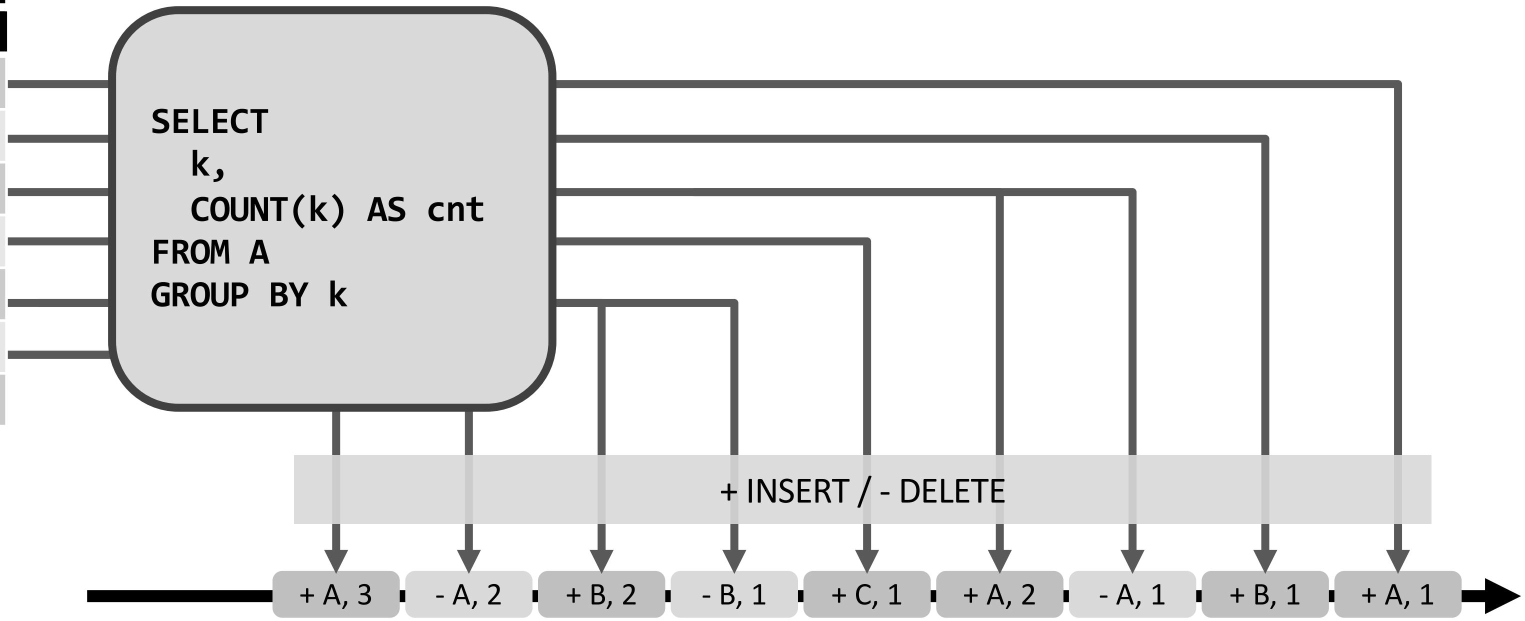
Dynamic Table → Stream

- Converting a dynamic table into a stream
  - Dynamic tables can be updated
  - Updates must be encoded in outgoing stream

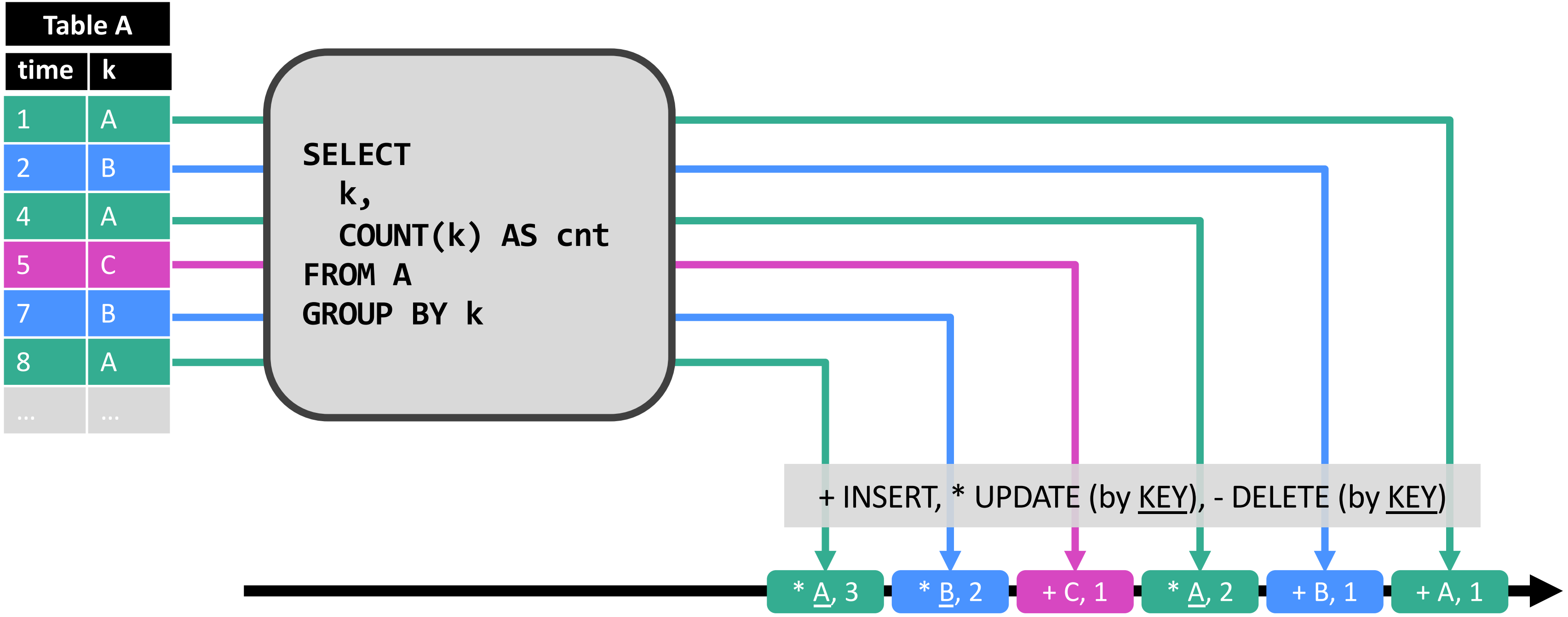
- Conversion of tables to streams inspired by DBMS logs
  - DBMS use logs to restore databases (and tables)
  - Logs are streams of records that encode updates

Dynamic Table → Stream: REDO/UNDO

Table A	
time	k
1	A
2	B
4	A
5	C
7	B
8	A
…	…



Dynamic Table → Stream: REDO



Can We Run Any Query on Dynamic Tables?

- No, there are space and computation constraints ☹
- State size may not grow infinitely as more data arrives

```
SELECT sessionId, count(*) FROM clicks GROUP BY sessionId;
```

- A change of an input table may only trigger a partial re-computation of the result table

```
SELECT userId, RANK() OVER (ORDER BY highScore) FROM users;
```

Bounding the Size of Query State

- Adapt the semantics of the query

```
SELECT sessionId, COUNT(*) AS clickCnt
FROM clicks
WHERE last(ctime, INTERVAL '1' DAY)
GROUP BY sessionId
```

  - Aggregate data of last 24 hours. Discard older data.

- Trade the accuracy of the result for size of state
  - Remove state for keys that became inactive.

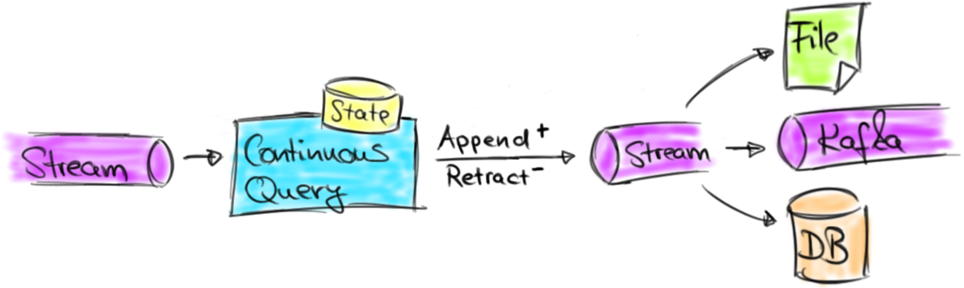
Current State of SQL & Table API

- Flink's relational APIs are rapidly evolving
  - Lots of interest by community and many contributors
  - Used in production at large scale

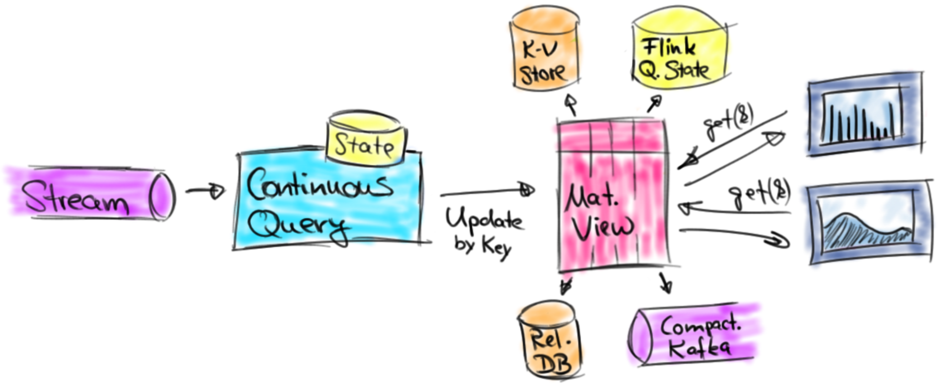
- Features of the upcoming Flink 1.3.0 release
  - GroupBy & Over windowed aggregates
  - Non-windowed aggregates
    (with update changes)
  - User-defined aggregation functions

What can we build with this?

- Continuous ETL & Data Import



- Dashboards & Stateful Microservices



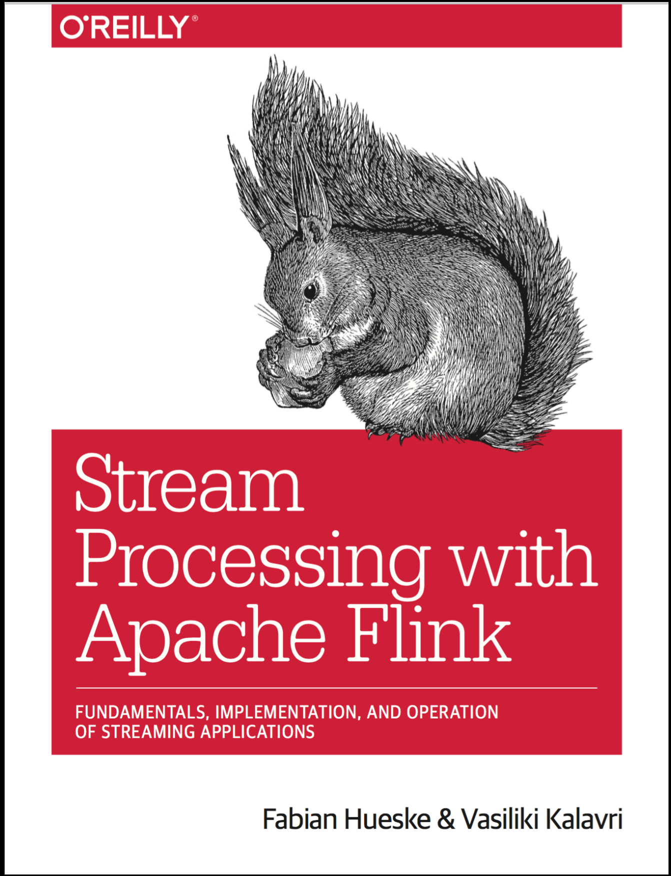
Conclusion

- Table API & SQL support many streaming use cases
  - High-level / declarative specification
  - Automatic optimization and translation
  - Efficient execution

- Updating results enables many exciting applications
  - Materialize a table that is updated by a stream in a KV store

- Check it out!


FLINK
FORWARD
Berlin
11-13 Sep 2017
Flink Forward, the premier conference on Apache Flink®, is coming back to Berlin
Call for Submissions is open



Thank you!

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