Blink’s Improvements to Flink SQL &Table API

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About Us

- **Xiaowei Jiang**
  - 2014-now Alibaba
  - 2010-2014 Facebook
  - 2002-2010 Microsoft
  - 2000-2002 Stratify
- **Shaoxuan Wang**
  - 2015-now Alibaba
  - 2014-2015 Facebook
  - 2010-2014 Broadcom

Agenda

- Background
- Why SQL & Table API
- Blink SQL & Table API (Selected Topics)

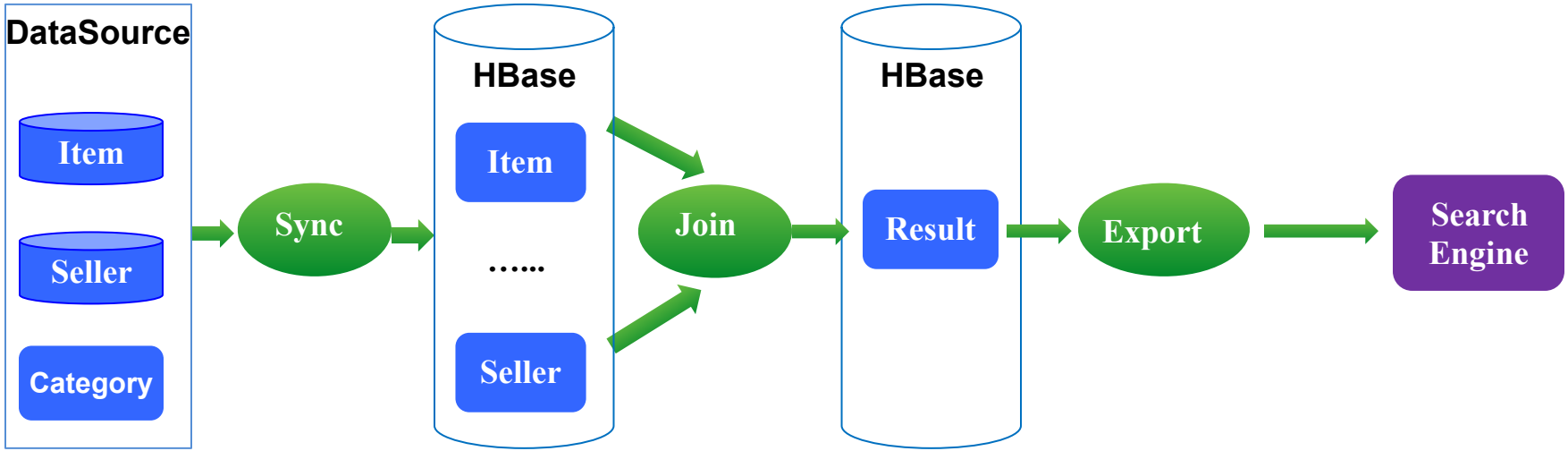
Background About Alibaba

- **Alibaba Group**
  - Operates the world's largest e-commerce platform
  - Recorded GMV of $394 Billion in year 2015, $17.8 billion worth of GMV on Nov 11, 2016
- **Alibaba Search**
  - Personalized search and recommendation
  - Major driver for user's traffic

What is Blink?

- **Blink – A project to make Flink work well for large scale production at Alibaba**
  - **Run on Thousands of Nodes In Production**
  - **Support Key Production Scenarios, such as Search and Recommendation**
  - **Compatible with Flink API and Ecosystem**

Documents Building for Search



Why Flink SQL & Table API

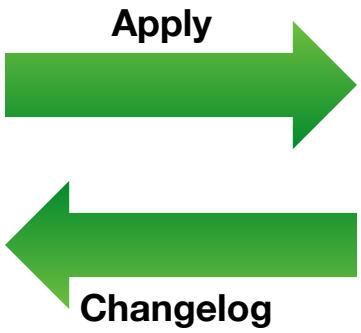
- **Unify batch and streaming**
  - Flink currently offers DataSet API for batch and DataStream API for streaming
  - We want a single API that can run in both batch and streaming mode

- **Simplify user code**
  - Users only describe the semantics of their data processing
  - Leave hard optimization problems to the system
  - SQL is proven to be good at describing data processing
  - Table API makes multi-statement data processing easy to write
  - Table API also makes it possible/easy to extend standard SQL when necessary

Stream-Table Duality

Stream

word	count
Hello	1
World	1
Hello	2
Bark	1
Hello	3



Dynamic Table

word	count
Hello	3
World	1
Bark	1

Dynamic Tables

Apply Changelog Stream to Dynamic Table

- **Append Mode**: each stream record is an insert modification to the dynamic table. Hence, all records of a stream are appended to the dynamic table
- **Update Mode**: a stream record can represent an insert, update, or delete modification on the dynamic table (append mode is in fact a special case of update mode)

Derive Changelog Stream from Dynamic Table

- **REDO Mode:** where the stream records the new value of a modified element to redo lost changes of completed transactions
- **REDO+UNDO Mode:** where the stream records the old and the new value of a changed element to undo incomplete transactions and redo lost changes of completed transactions

Stream SQL

Dynamic Tables generalize the concept of Static Tables
SQL serves as the unified way to describe data processing in both batch and streaming

There is no such thing as Stream SQL

Blink SQL & Table API

- Stream-Stream Inner Join
- User Defined Function (UDF)
- User Defined Table Function (UDTF)
- User Defined Aggregate Function (UDAGG)
- Retract (stream only)
- Over Aggregates

A Simple Query: Select and Where

id	name	price	sales	stock
1	Latte	6	1	1000
8	Mocha	8	1	800
4	Breve	5	1	200
7	Tea	4	1	2000
1	Latte	6	2	998

```
SELECT id, name, price, sales, stock
FROM myTable WHERE name = 'Latte'
```

id	name	price	sales	stock
1	Latte	6	1	1000
1	Latte	6	2	998

Stream-Stream Inner Join

id1	name	stock
1	Latte	1000
8	Mocha	800
4	Breve	200
3	Water	5000
7	Tea	2000

id2	price	sales
1	6	1
8	8	1
9	3	1
4	5	1
7	4	1

```
SELECT id1 AS id, name, price, sales, stock
FROM table1 INNER JOIN table2 ON id1 = id2
```

id	name	price	sales	stock
1	Latte	6	1	1000
8	Mocha	8	1	800
4	Breve	5	1	200
7	Tea	4	1	2000

This is proposed and discussed in FLINK-5878

Blink SQL & Table API

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User Defined Function (UDF)

Create and use a UDF is very simple and easy:

```
object AddFunc extends ScalarFunction {
  def eval(a: Long, b: Long): Long = a + b
  @varargs
  def eval(a: Int*): Int = a.sum
}

tEnv.registerTable("MyTable", table)
tEnv.registerFunction("addFunc", AddFunc)
val sqlQuery =
  "SELECT addFunc(long1,long2), addFunc(int1,int2,int3) FROM MyTable"
```

We recently have enhanced UDF/UDTF to let them support variable types and variable arguments (FLINK-5826)

User Defined Table Function (UDTF)

line
Tom#23 Jark#17 David#50

Scalar → Table (multi rows and columns)

name	age
Tom	23
Jack	17
David	50

```
SELECT name, age
FROM myTable,
  LATERAL TABLE(splitFunc(line))
  AS T(name, age)
```

```
case class User(name: String, age: Int)
class SplitFunc extends TableFunction[User] {
  def eval(str: String): Unit = {
    str.split(" ").foreach{ e =>
      val subSplits = e.split("#")
      collect(User(subSplits(0), subSplits(1).toInt))
    }
  }
}
```

We have shipped UDTF in flink 1.2 (FLINK-4469).

User Defined Aggregate Function (UDAGG) - Motivation

Flink has built-in aggregates (count, sum, avg, min, max) for SQL and table API

```
SELECT name, SUM(price), COUNT(sales),
      MAX(price), MIN(price), AVG(price)
FROM myTable
GROUP BY name
```

What if user wants an aggregate that is not covered by built-in aggregates, say a weighted average aggregate?

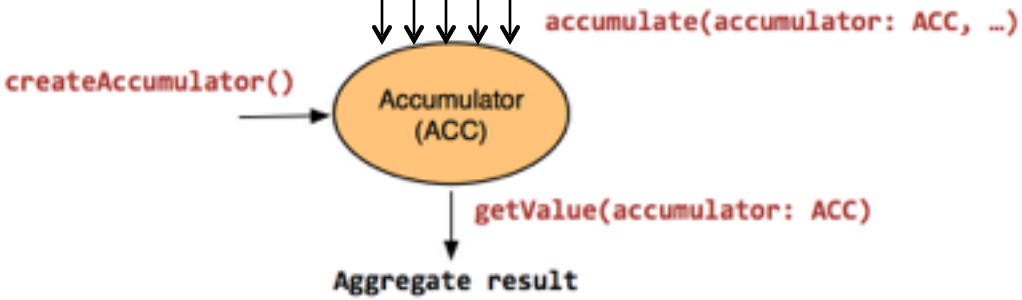
We need an aggregate interface to support user defined aggregate function.

UDAGG – Accumulator (ACC)

id	name	price	sales	stock
1	Latte	6	1	1000
8	Mocha	8	1	800
4	Breve	5	1	200
7	Tea	4	1	2000
1	Latte	6	2	998

```
SELECT name, SUM(price), COUNT(sales),
    MAX(price), MIN(price), AVG(price)
FROM myTable
GROUP BY name
```

UDAGG represents its state using accumulator



UDAGG – Interface

UDAGG Interface

```
Abstract class AggregateFunction[T, ACC] extends UserDefinedFunction {
  def createAccumulator(): ACC
  def getValue(accumulator: ACC): T
}
/* The implementations of accumulate must be declared publicly,
not static and named exactly as "accumulate". accumulate method
can be overloaded */
  def Accumulate(accumulator: ACC, [user defined inputs]): Unit
```

SQL Query

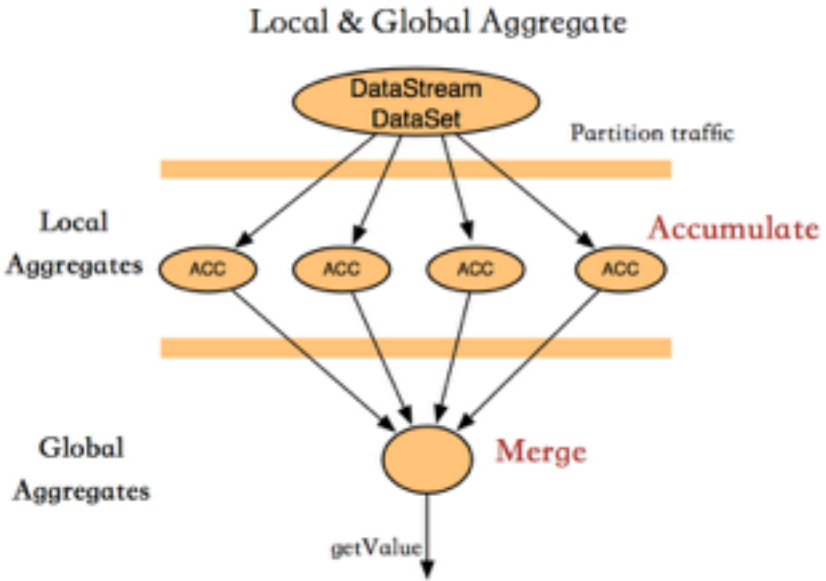
```
SELECT type, weightAvgFun(weight, cnt)
FROM myTable
GROUP BY type
```

UDAGG example: a weighted average

```
public static class WeightedAvgAccum {
  public long sum = 0; public int count = 0; }
public static class WeightedAvg
  extends AggregateFunction<Long, WeightedAvgAccum> {
  @Override
  public WeightedAvgAccum createAccumulator() {
    return new WeightedAvgAccum(); }
  @Override
  public Long getValue(WeightedAvgAccum accumulator) {
    if (accumulator.count == 0) return null;
    else return accumulator.sum/accumulator.count; }
  public void accumulate(
    WeightedAvgAccum accumulator, long iValue, int iWeight) {
    accumulator.sum += iValue * iWeight;
    accumulator.count += iWeight; }
}
```

UDAGG – Merge

How to count the total visits on TaoBao web pages in real time?




```
Abstract class AggregateFunction[T, ACC] extends UserDefinedFunction {
  def createAccumulator(): ACC
  def getValue(accumulator: ACC): T
}
/* The implementations of following methods: accumulate(MUST
have), merge(OPTIONAL) must be declared publicly, not static and
named exactly as "accumulate", "merge"*/
  def Accumulate(accumulator: ACC, [user defined inputs]): Unit
  def merge(it: java.util.iterator[ACC]): ACC
```

Motivated by local & global aggregate (and session window merge etc.), we need a merge method which can merge the partial aggregated accumulator into one single accumulator

UDAGG - Retract - Motivations

```
SELECT
  cnt,
  COUNT(word) AS freq
   FROM  (
      SELECT word,  COUNT(num) AS cnt
          FROM Table GROUP BY word
    ) GROUP BY cnt
```

Stream

word	num
Hello	1
World	1
Bark	1

Keyed Table

word	cnt
Hello	1
World	1
Bark	1

Keyed Table

cnt	freq
1	3

Stream

word	num
Hello	1
World	1
Bark	1
Hello	1

source table adds a new Row

(hello,1)

Keyed Table

word	cnt
Hello	1 -> 2
World	1
Bark	1

Without Retraction

(hello,2)

Keyed Table

cnt	freq
1	3
2	1

Incorrect! This value should be 2

UDAGG - Retract – Motivations

Stream

word	num
Hello	1
World	1
Bark	1
Hello	1

source table adds a new Row

(hello,1)

Keyed Table

word	cnt
Hello	1 -> 2
World	1
Bark	1

Without Retraction

(Hello,2,accumulate)

Incorrect! this value should be 2

Keyed Table

cnt	freq
1	3
2	1

With Retraction

(Hello,1,retract)

(Hello,2,accumulate)

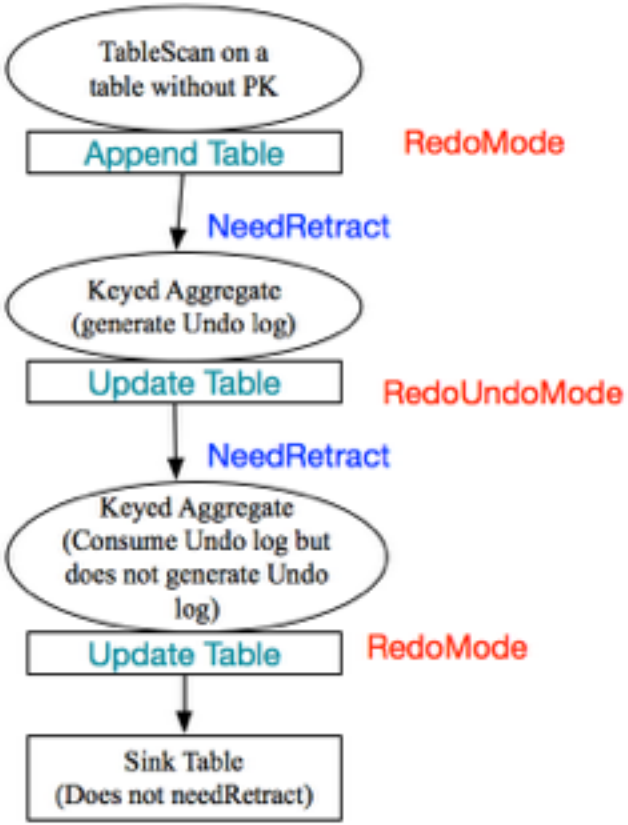
Keyed Table

cnt	freq
1	2
2	1

We need a retract method in UDAGG, which can retract the input values from the accumulator

Retract – Solution

- **Retraction is introduced to handle updates**
- **We use query optimizer to decide where the retraction is needed.**



The design doc and the progress of retract implementation are tracked in FLINK-6047. A FLIP for retract is on the way. We aim to release it in flink-1.3

UDAGG – Summary

```
Abstract class AggregateFunction[T, ACC] extends UserDefinedFunction {
  def createAccumulator(): ACC
  def getValue(accumulator: ACC): T
}
/* The implementations of following methods: accumulate(MUST have),
merge(OPTIONAL), and retract(OPTIONAL) must be declared publicly, not
static and named exactly as "accumulate", “merge”, and “retract” */
  def accumulate(accumulator: ACC, [user defined inputs]): Unit
  def merge(it: java.util.iterator[ACC]): ACC
  def retract(accumulator: ACC, [user defined inputs]): Unit
```

Master JIRA for UDAGG is FLINK-5564. We plan to ship it in release 1.3.

Blink SQL & Table API

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Over Aggregates

Calculate moving average (in the past 5 seconds), and emit the result for each record

time	itemID	price
1000	101	1
3000	201	2
4000	301	3
5000	101	1
5000	401	4
7000	301	3
8000	501	5
10000	101	1

```
SELECT
  time, itemID, MovingAverage(price) OVER
  (
    ORDER BY RowTime()
    RANGE
      BETWEEN INTERVAL '5' SECOND PRECEDING
      AND CURRENT ROW
  ) AS avgPrice
FROM myTable
```

time	itemID	avgPrice
1000	101	1
3000	201	1.5
4000	301	2
5000	101	2.2
5000	401	2.2
7000	301	2.6
8000	401	3
10000	101	2.8

time based Group Aggregate is not able to differentiate two records with the same row time.

Group/Over Aggregates

- **Grouping methods:** Groupby / Over
- **Window types:**
  - ➢ Time/Count + TUMBLE/SESSION/SLIDE window;
  - ➢ OVER Range/Rows window
- **Time types:** Event time; Process time (only for stream)

We have been working closely with team dataArtisans, from the design to the implementation on FLIP11 (FLINK-4557). Upon now, except the unbounded group aggregate, all other group/over aggregates are fully supported via SQL query. We are working on the support for table API.

Current Status of Flink SQL & Table API

- Flink blog: “Continuous Queries on Dynamic Tables” *(posted at https://flink.apache.org/news/2017/04/04/dynamic-tables.html)*
- UDF *(several improvements will be released in 1.3)*
- UDTF *(FLINK-4469, released in 1.2)*
- UDAGG *(FLINK-5564, target for release 1.3)*
- Group/Over Window Aggregate *(FLINK-4557, target for release1.3)*
- Retract *(FLINK-6047, target for release 1.3)*
- Unbounded Stream Group Aggregate *(FLINK-6216, bundled with retract design)*
- Stream-Stream Inner Join *(FLINK-5878, TBD)*

We will keep merging Blink SQL & Table API back to Flink

Q & A

Thank You!