Implementing Applications Using Streaming SQL

Ivan Mushketyk

@mushketyk brewing.codes

Kinesis Analytics

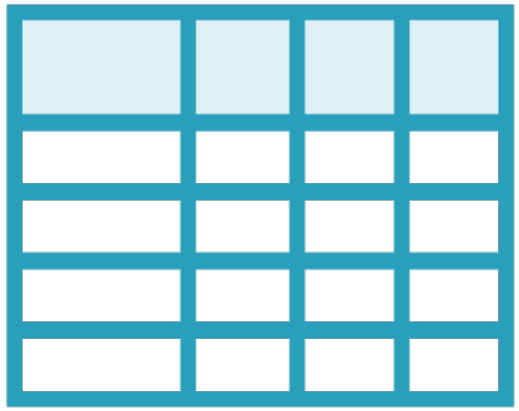
Kinesis Streams

Kinesis Analytics

Kinesis Firehose

Kinesis Analytics

Why Use Kinesis Analytics



ANSI SQL:2008 support

Auto-scalable

Real-time processing

Easy to use

What We Will Implement

Streaming filter

Processing windows

Analytics functions

JOINs on streams

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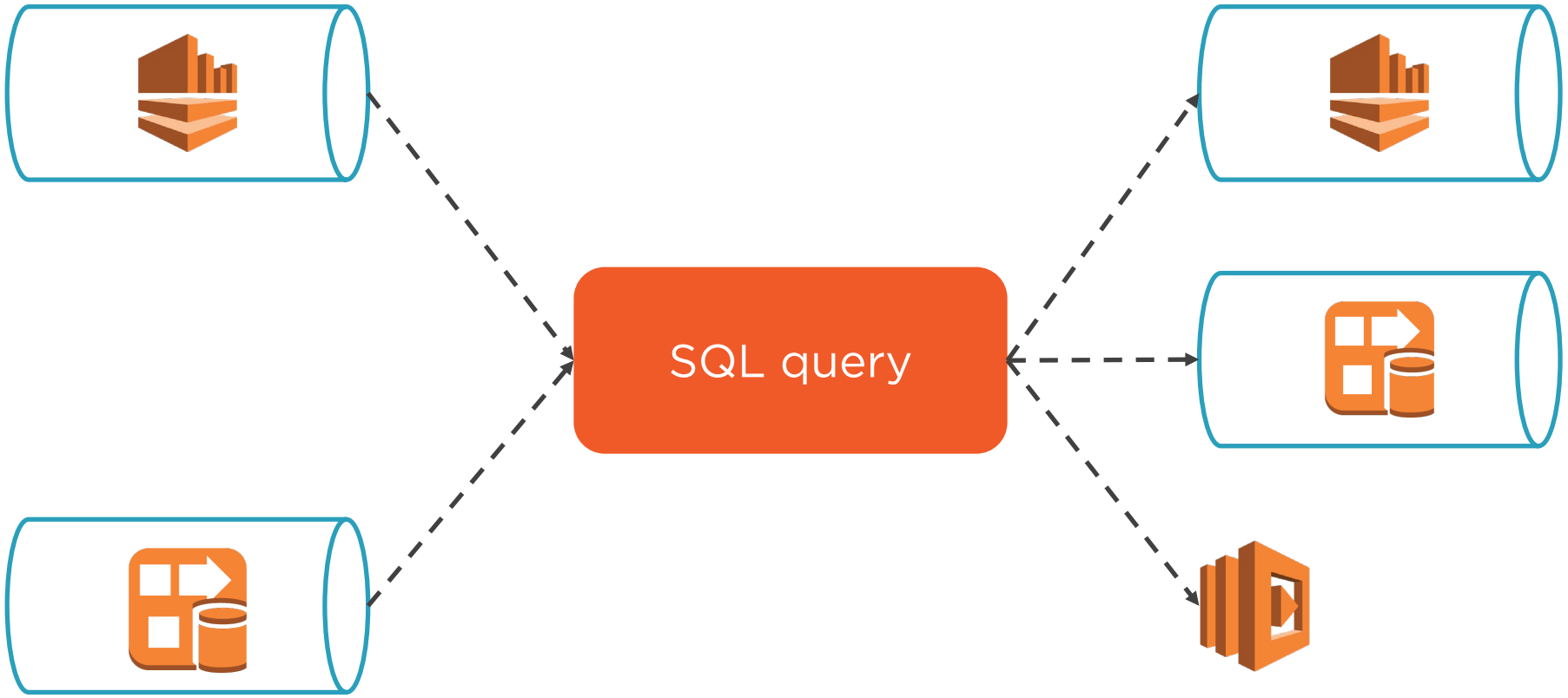
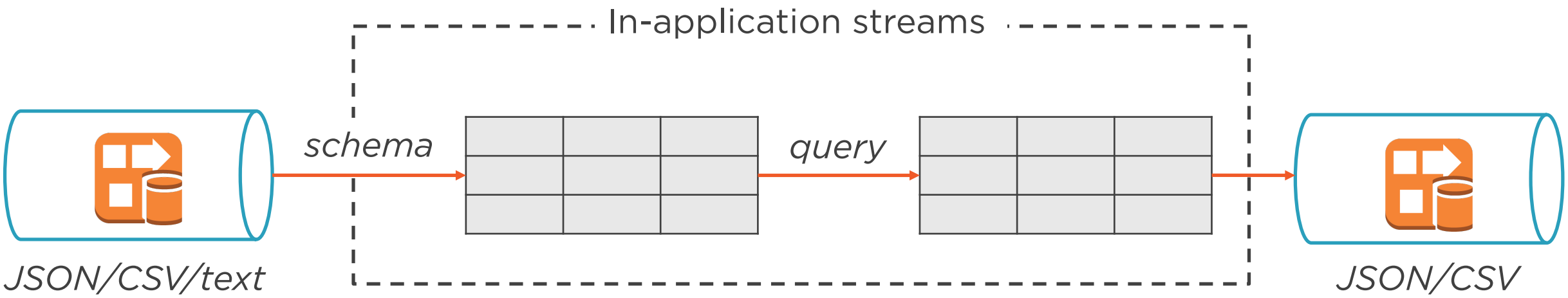
Kinesis Analytics



Flow of Data



CSV Schema

Kinesis records

```
1,The Dark Knight,9.0
2,The Godfather,9.1
3,Alien,8.8
```

Schema

position	type	name
1	INTEGER	id
2	VARCHAR	movie
3	DOUBLE	rating

id	movie	rating
1	The Dark Knight	9.0
2	The Godfather	9.1
3	Alien	8.8

In-application stream

JSON Path

Kinesis record


```
{
    "id": 123,
    "location": {
        "city": "London"
    },
    "records": [
        {
            "value": 1
        },
        {
            "value": 2
        }
    ]
}
```


Schema

path	type	name
$.id	INTEGER	id

id
123

In-application stream

JSON Path

Kinesis record

```
{
    "id": 123,
    "location": {
        "city": "London"
    },
    "records": [
        {
            "value": 1
        },
        {
            "value": 2
        }
    ]
}
```

Schema

path	type	name
$.id	INTEGER	id
$.location.city	VARCHAR	city

id	city
123	London

In-application stream

JSON Path

Kinesis record

```
{
    "id": 123,
    "location": {
        "city": "London"
    },
    "records": [
        {
            "value": 1
        },
        {
            "value": 2
        }
    ]
}
```

Schema

path	type	name
$.id	INTEGER	id
$.location.city	VARCHAR	city
$.records[0:]	VARCHAR	values

id	city	values
123	London	[{"value"}: 1 ...

In-application stream

JSON Path

Kinesis record

```
{
    "id": 123,
    "location": {
        "city": "London"
    },
    "records": [
        {
            "value": 1
        },
        {
            "value": 2
        }
    ]
}
```

Schema

path	type	name
$.id	INTEGER	id
$.location.city	VARCHAR	city
$.records[0:].value	INTEGER	values

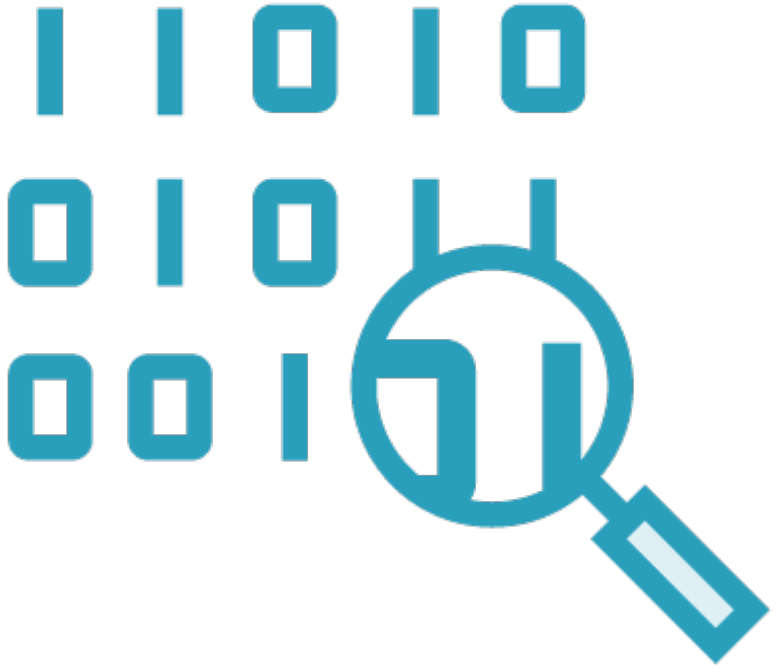
id	city	values
123	London	1
123	London	2

In-application stream

JSON Path Limitations

```
// NOT SUPPORTED
$.sensors[0:].readings[0:].value

// NOT SUPPORTED
$.sensors[0:].name
$.readings[0:]
```

Schema Discovery

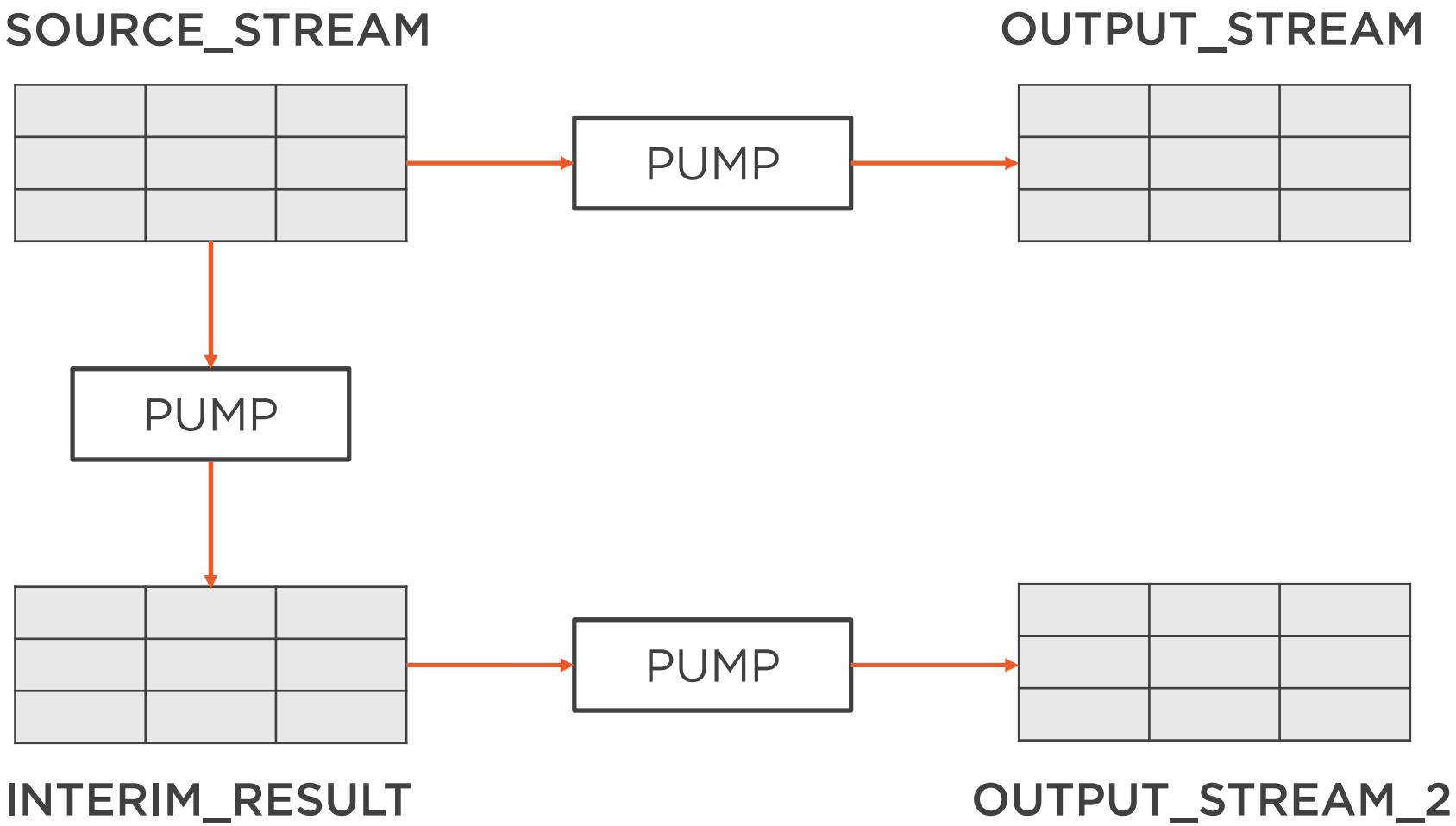


Kinesis automatically discovers schema

Supports CSV/JSON

Good starting point

Streams and Pumps



SQL Query Example

```
CREATE OR REPLACE STREAM "DESTINATION_STREAM" (
   "id" VARCHAR(32),
   "temperature" INTEGER);
CREATE OR REPLACE PUMP "STREAM_PUMP"
   AS INSERT INTO "DESTINATION_STREAM"
SELECT STREAM "id", "temperature"
FROM "SOURCE_SQL_STREAM_001”
WHERE "temperature" > 35;
```

Log Parsing Functions

```
-- Log formats
W3C_LOG_PARSE(string, format_name)
SYS_LOG_PARSE(string)
-- Regex parsing
REGEX_LOG_PARSE(string, regex, columns)
FAST_REGEX_LOG_PARSE(string, regex)
-- Fixed width format
FIXED_COLUMN_LOG_PARSE(string, columns)
-- Parse fields separated with a delimiter
VARIABLE_COLUMN_LOG_PARSE()
```

Additional Data

Additional Kinesis Analytics Fields

- ROWTIME
- Shard id
- Sequence number
- Partition key
- Approximate arrival time

Error in-application stream

Lambda Preprocessing

Aggregate Functions

Average

Count

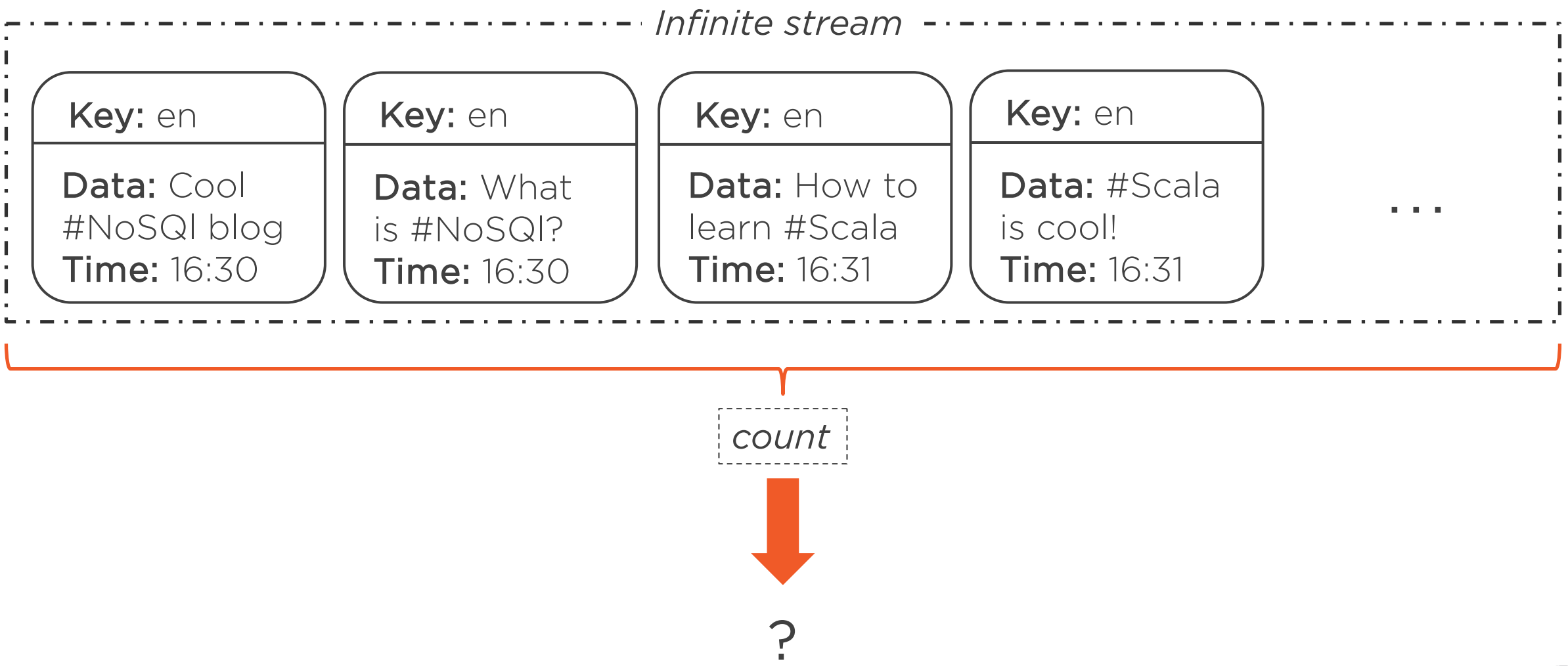
Count distinct

Min

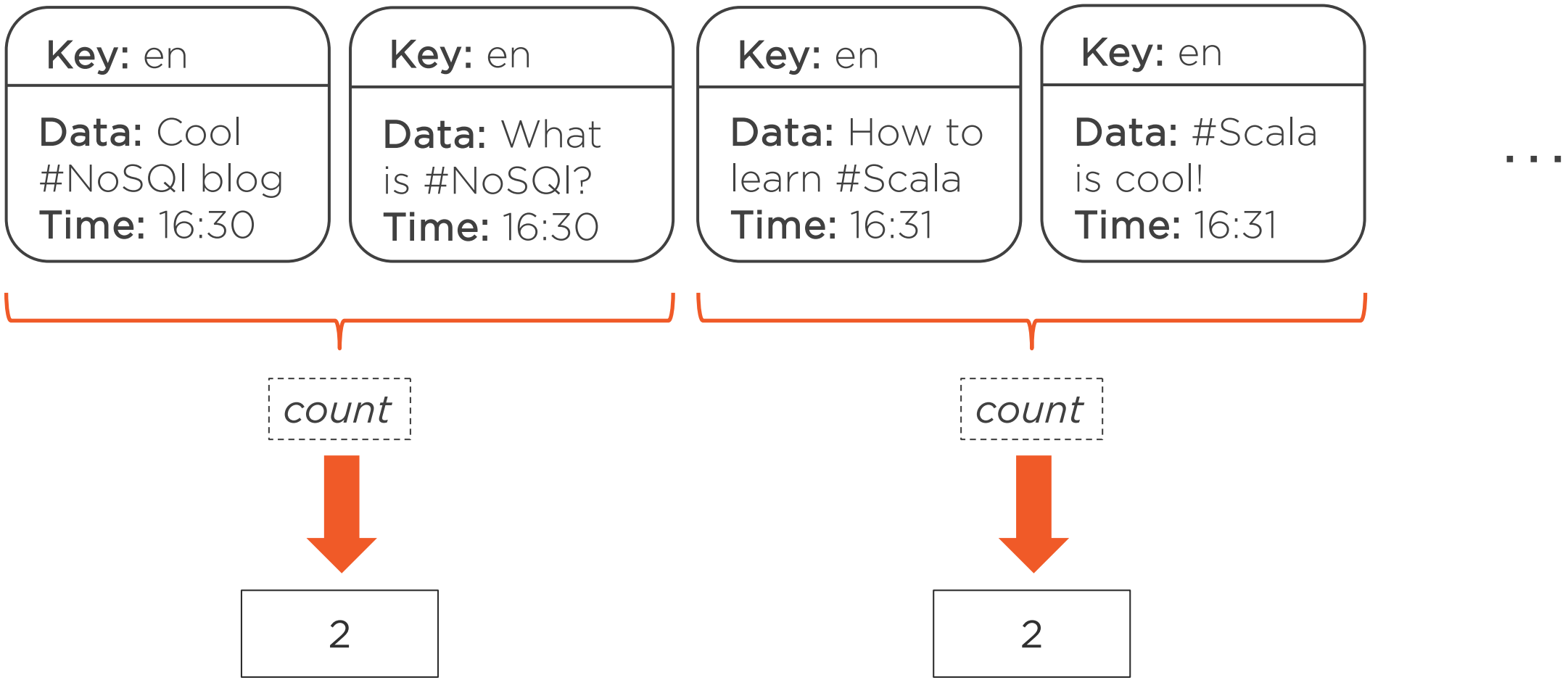
Max

Sum

Aggregate Functions



Aggregate Functions



Windows in Kinesis Analytics

Tumbling Window

Non-overlapping

Output results at fixed intervals

Sliding Windows

Overlapping

Output results when outcome changes

Tumbling Windows

count

count	time
3	16:30

count

count	time
2	16:31

Query Example

```
SELECT STREAM COUNT(*) AS "count"
FROM TweetsStream
GROUP BY
    FLOOR(TweetsStream.ROWTIME TO MINUTE);
    -- 15th Jan 2018 18:30:01 -> 15th Jan 2018 18:30:00
    -- 15th Jan 2018 18:30:25 -> 15th Jan 2018 18:30:00
    -- 15th Jan 2018 18:30:58 -> 15th Jan 2018 18:30:00
```

Query Example with the STEP Function

```
SELECT STREAM COUNT(*) AS "count"
FROM TweetsStream
GROUP BY
  STEP(TweetsStream.ROWTIME BY INTERVAL '30' SECOND);
```

Partition by Column

count

lang	count	time
en	2	16:30
fr	1	16:30

count

lang	count	time
en	1	16:31
jp	1	16:31

Query Example

```
SELECT STREAM "lang", COUNT(*) AS "count”
FROM TweetsStream
GROUP BY
  "lang",
  FLOOR(TweetsStream.ROWTIME TO MINUTE);
```

Time in Tumbling Windows

ROWTIME

Approximate arrival time

Creation time

Monotonic Time

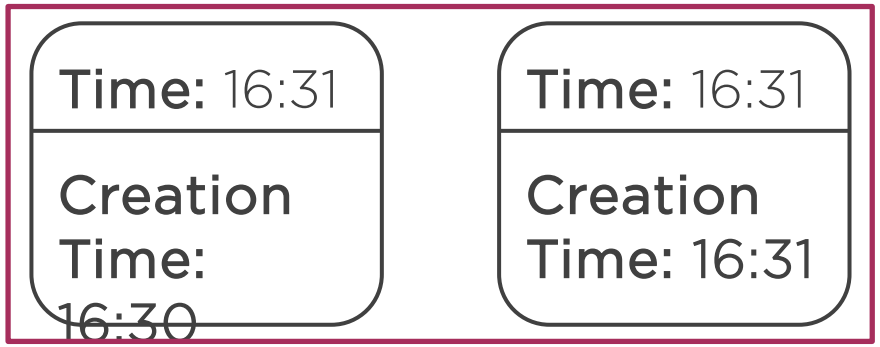
Monotonic time

- ROWTIME
- Approximate arrival time

Solutions

- Use MONOTONIC function
- Group using two time fields

Grouping Using Two Time Fields



count

count

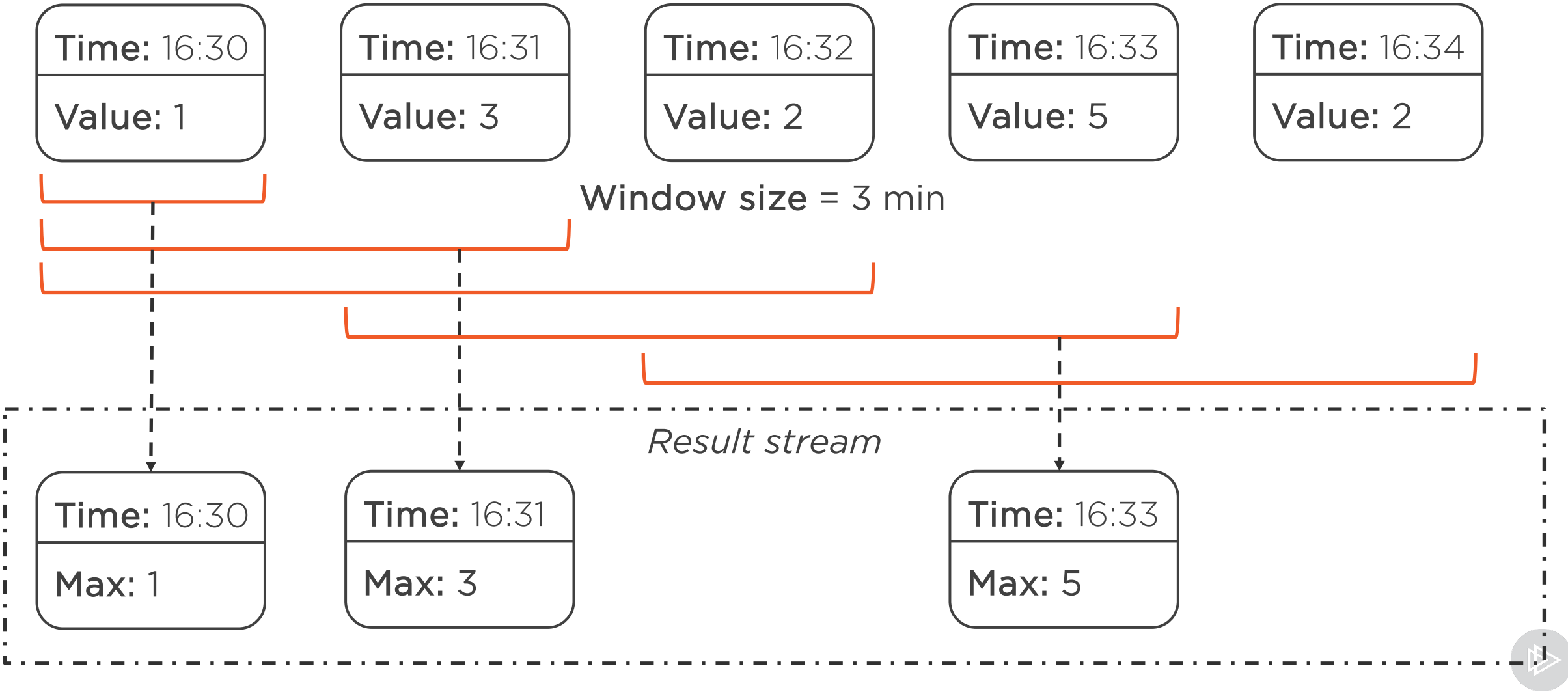
time	created at	count
16:30	16:30	2
16:30	16:29	1

time	created at	count
16:31	16:31	1
16:31	16:30	1

Group by Creation Time

```
SELECT STREAM
  FLOOR(TweetsStream.ROWTIME TO MINUTE) AS ingestion_time,
  FLOOR(TweetsStream.creation_time TO MINUTE) AS creation_time,
  COUNT(*) AS "count"
FROM TweetsStream
GROUP BY
  FLOOR(TweetsStream.ROWTIME TO MINUTE)
  FLOOR(TweetsStream.creation_time TO MINUTE);
```

Sliding Window



Sliding Window Computation

When the first item is added to the window

When a new item is added and result is changed

When a new item is added and result is not changed

When an old item is removed

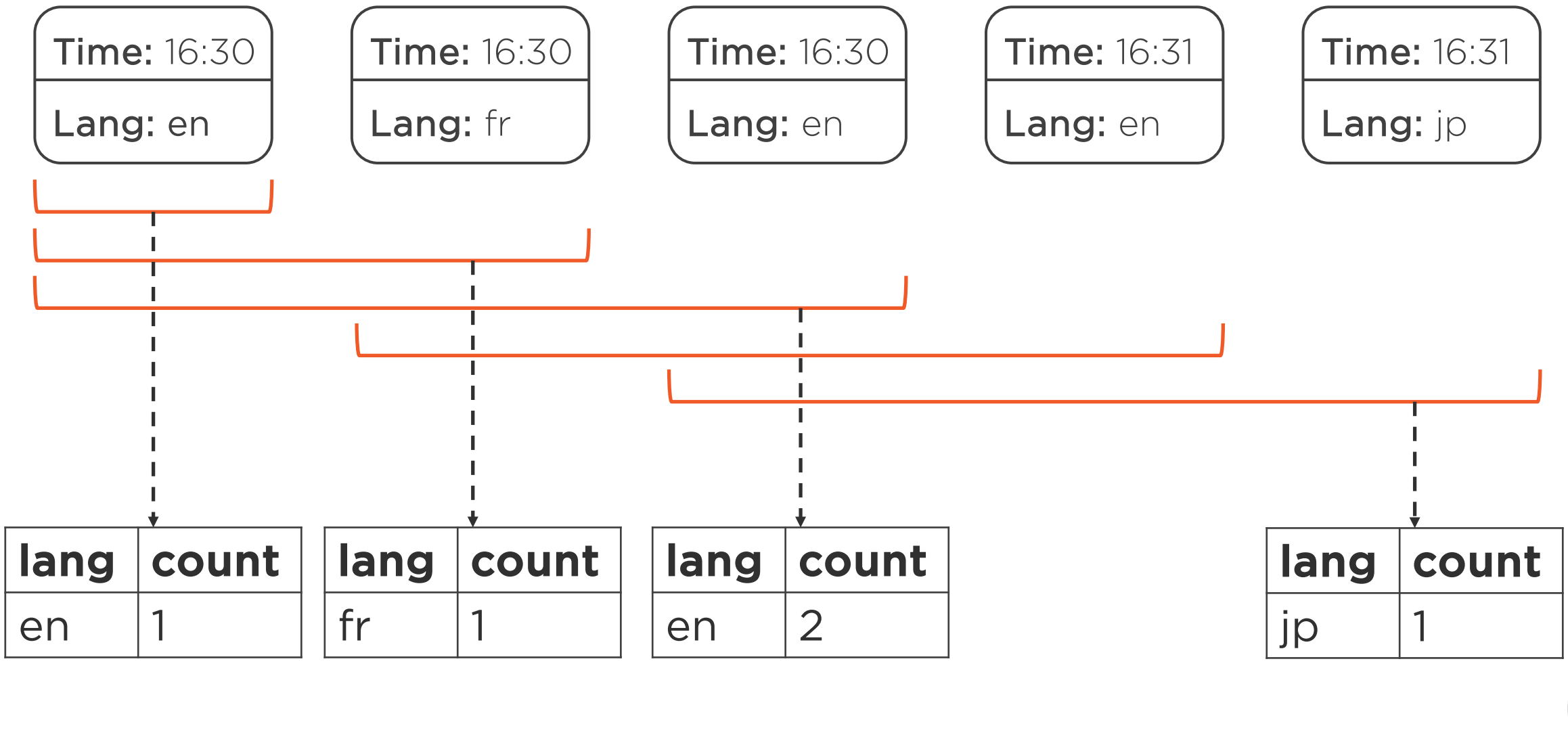
Time Sliding Window

```
SELECT STREAM
  COUNT(*) OVER rangeWindow AS "count"
FROM tweetsStream
WINDOW rangeWindow AS (
  RANGE INTERVAL '10' SECOND PRECEDING);

SELECT STREAM
  COUNT(*) OVER (
    RANGE INTERVAL '10' SECOND PRECEDING) AS "count"
FROM tweetsStream;
```

Row Sliding Window

```
SELECT STREAM
  AVG(CHAR_LENGTH("text")) OVER last100 AS "count"
FROM tweetsStream
WINDOW last100 AS (
  ROWS 100 PRECEDING);
```

Partitioning in Sliding Windows



Partitioning in Sliding Windows

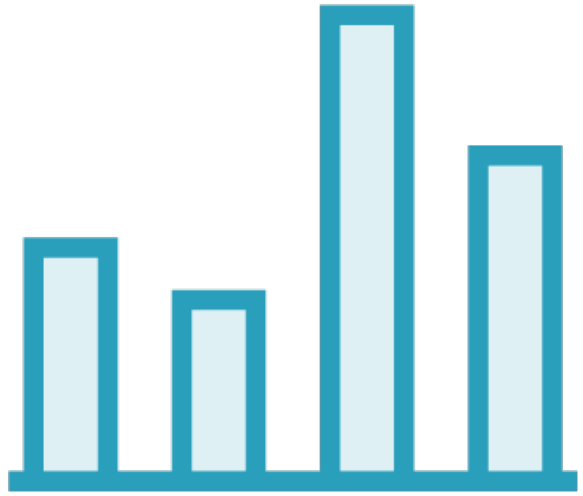
```
SELECT STREAM
  "lang”,
  COUNT(*) OVER rangeWindow AS "count"
FROM tweetsStream
WINDOW rangeWindow AS (
  PARTITION BY "lang"
  RANGE INTERVAL '10' SECOND PRECEDING);
```

Multiple Sliding Windows

```
SELECT STREAM
  COUNT(*) OVER last10Seconds AS "count_in_10”,
  COUNT(*) OVER last60Seconds AS "count_in_60”
FROM tweetsStream
WINDOW last10Seconds AS (
  RANGE INTERVAL '10' SECOND PRECEDING),
WINDOW last60Seconds AS (
  RANGE INTERVAL ’60' SECOND PRECEDING);
```

Kinesis Analytics Functions

Aggregate functions



Statistical functions

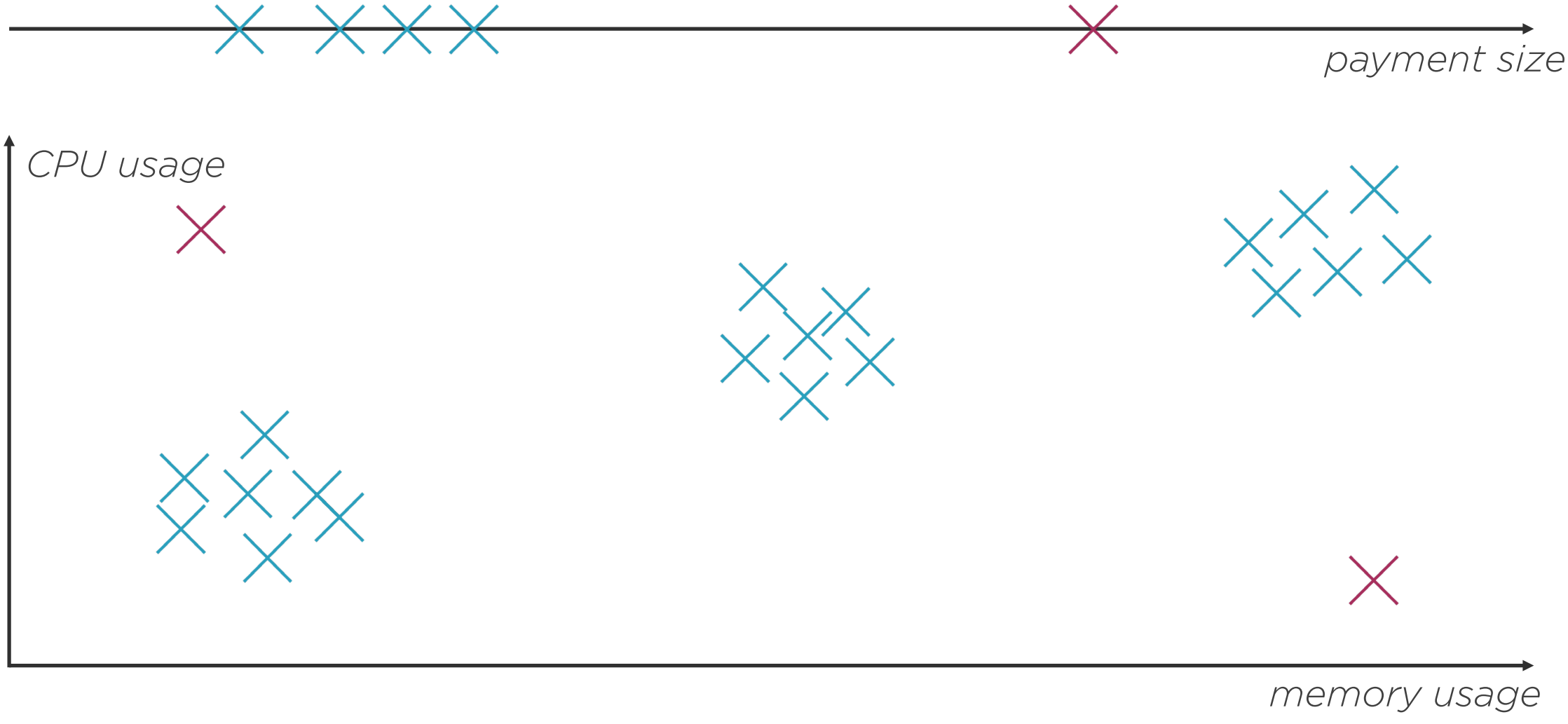
Aggregation Function

```
-- Mathematical functions

AVG()

COUNT()

MAX() / MIN()

-- Kinesis Analytics Functions

COUNT_DISTINCT_ITEMS_TUMBLING(
  stream, columnName, windowSize)
-- Approximate algorithm to find top items

TOP_K_ITEMS_TUMBLING(stream, columnName, K, windowSize)
```

Statistical Functions

```
SELECT STREAM *
FROM TABLE (
  TOP_K_ITEMS_TUMBLING(
    CURSOR(SELECT STREAM * FROM "SOURCE_STREAM"),
    'num_of_retweets', -- name of column
    10,                -- num. of the most frequent items
    60                 -- window size
  )
);
```

Anomaly Detection



Detecting Anomalies

```
RANDOM_CUT_FOREST(
  -- Up to 30 numerical columns
  CURSOR(SELECT STREAM columnName FROM inputStream),
  numberOfTrees = 100,
  subSampleSize = 256, -- to construct a single tree
  timeDecay = 100000,  -- num. of records to consider
  shingleSize = 1,     -- size of a record
  withDirectionality = FALSE -- tells direction
)
-- Score = 0 – no anomalies
-- Score significantly greater than 0 – anomaly
```

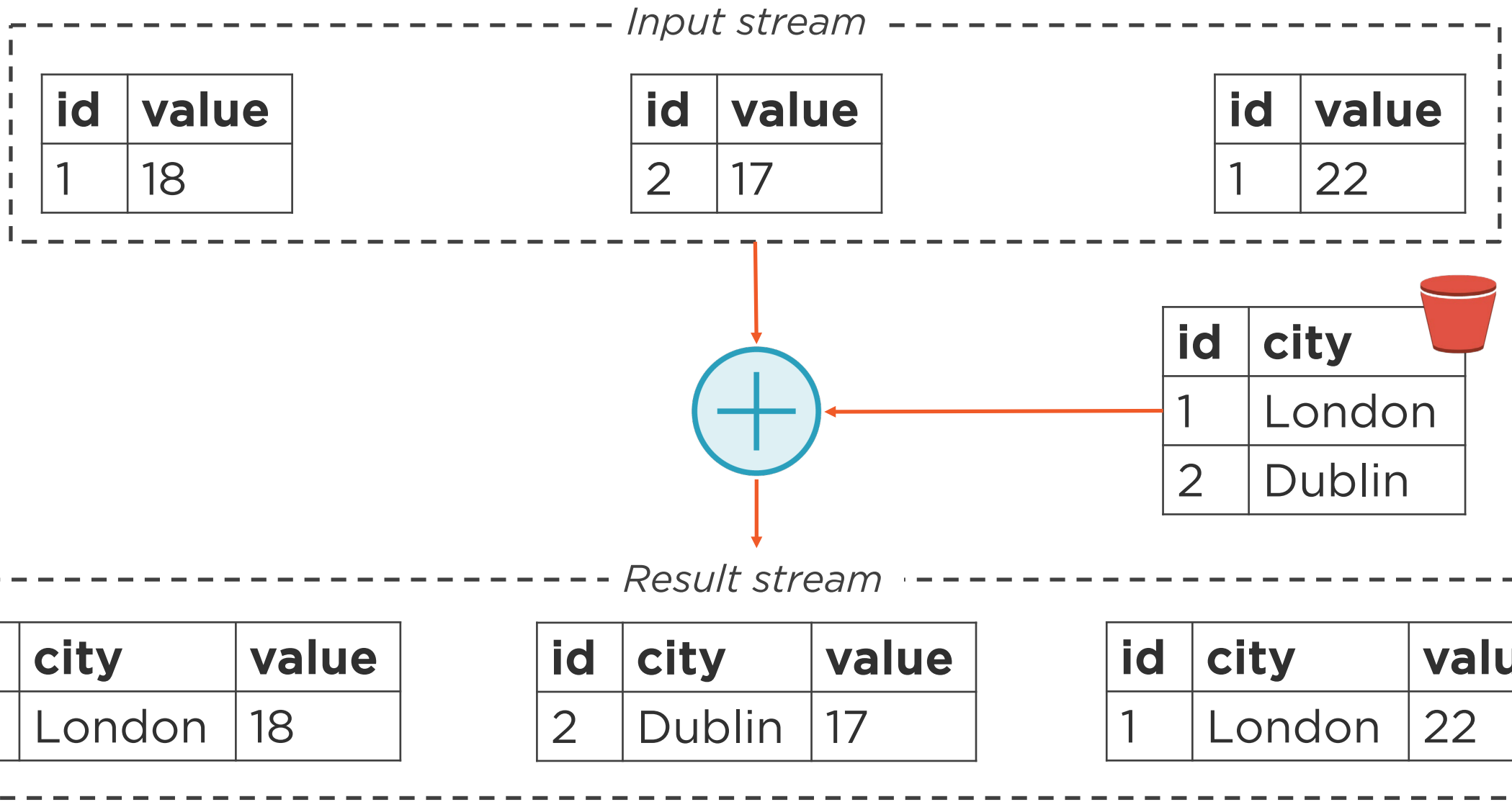
Stream Joins

Static data from S3 bucket

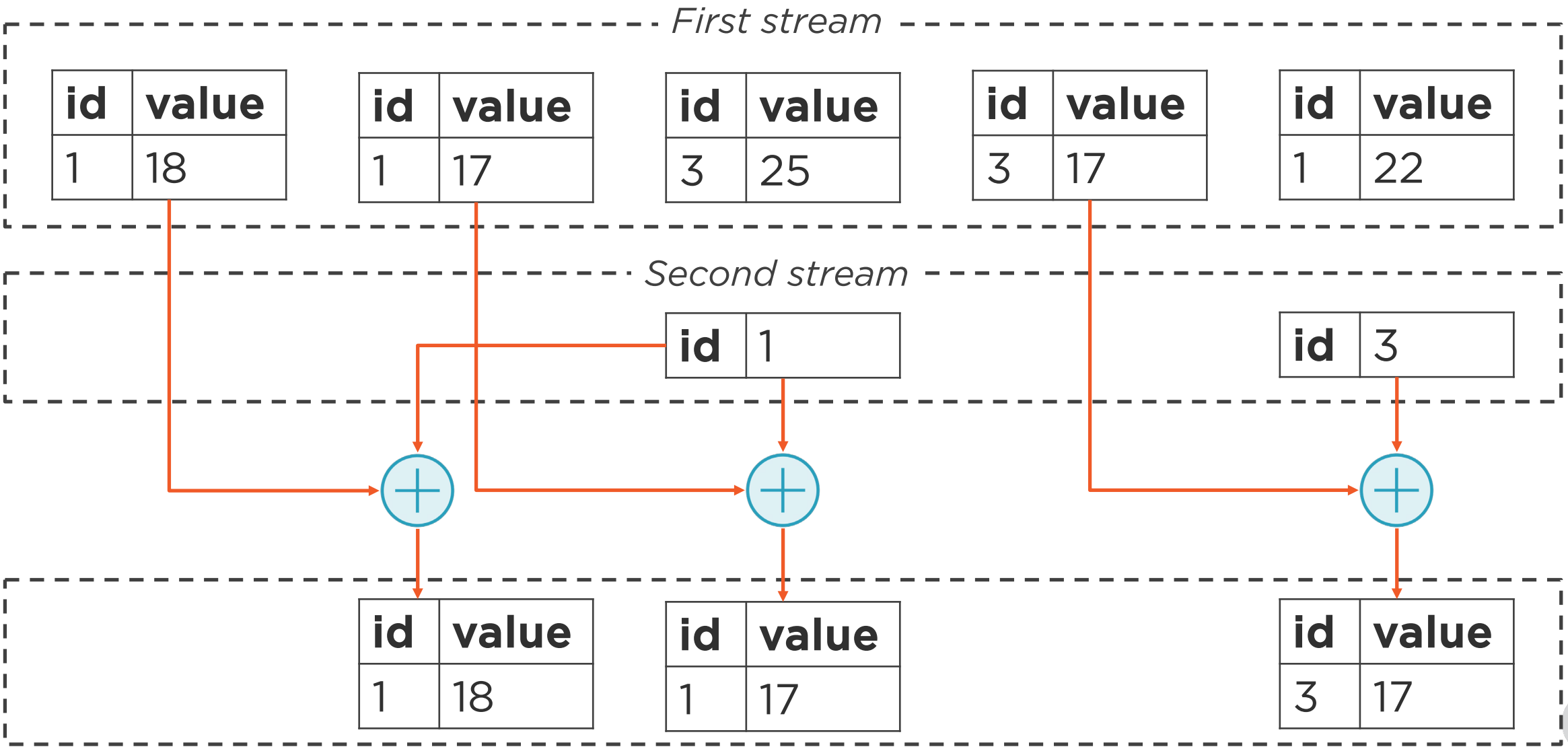
Enrich data stream

Join two streams

Join with Static Data



Join with Stream Data



Filter Removed Tweets

```
SELECT STREAM ”id", ”text”
FROM TWEETS_STREAM AS source
JOIN REMOVED_TWEETS_IDS OVER
  (RANGE INTERVAL '5' MINUTE PRECEDING) AS removed
  ON removed."id" = source."id";
```

Kinesis Analytics Pricing

Pay for used computing resources

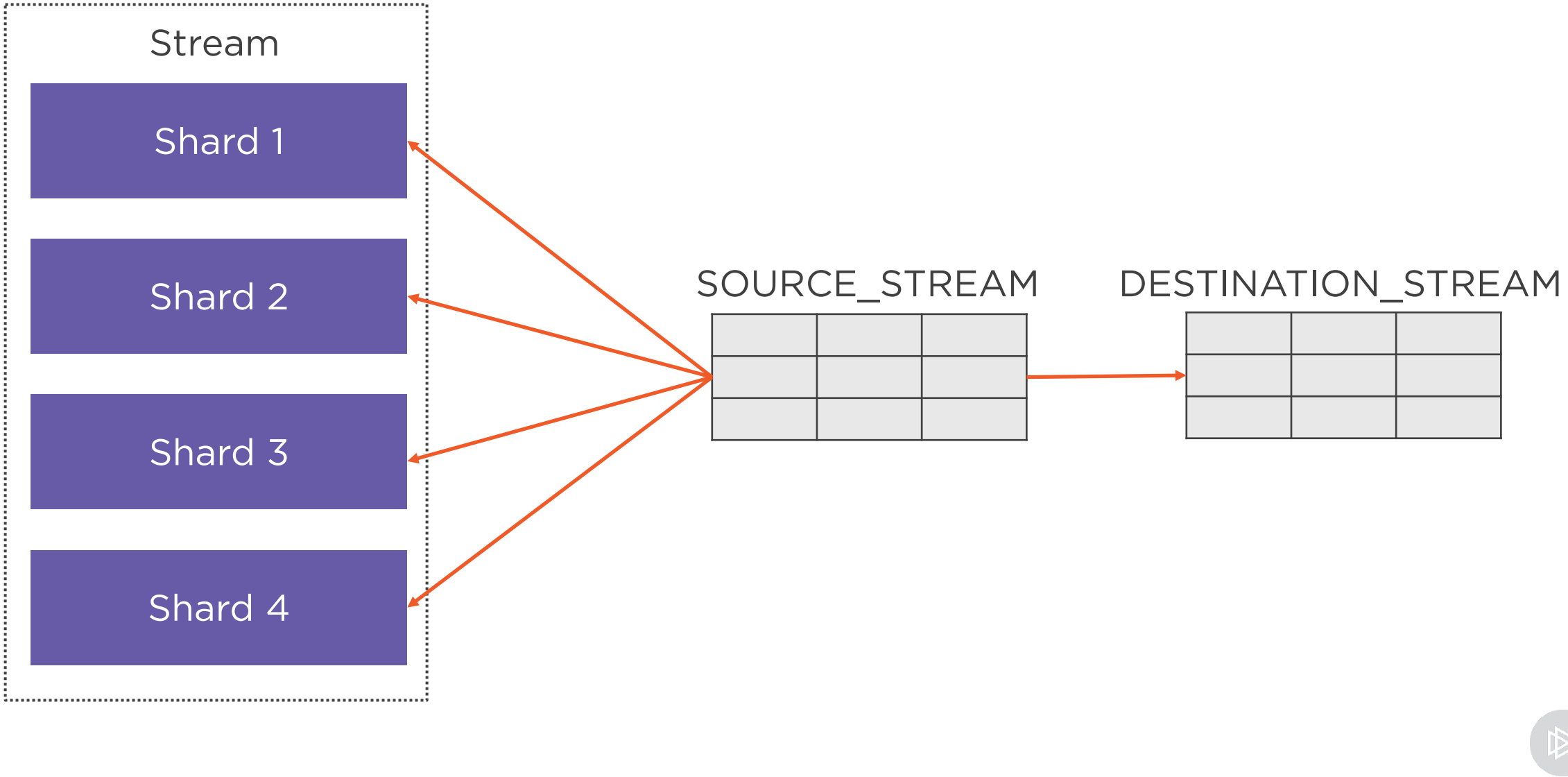
Kinesis Processing Units (KPUs)

- 1 vCPU
- 4 GB of memory
- $0.110 per hour

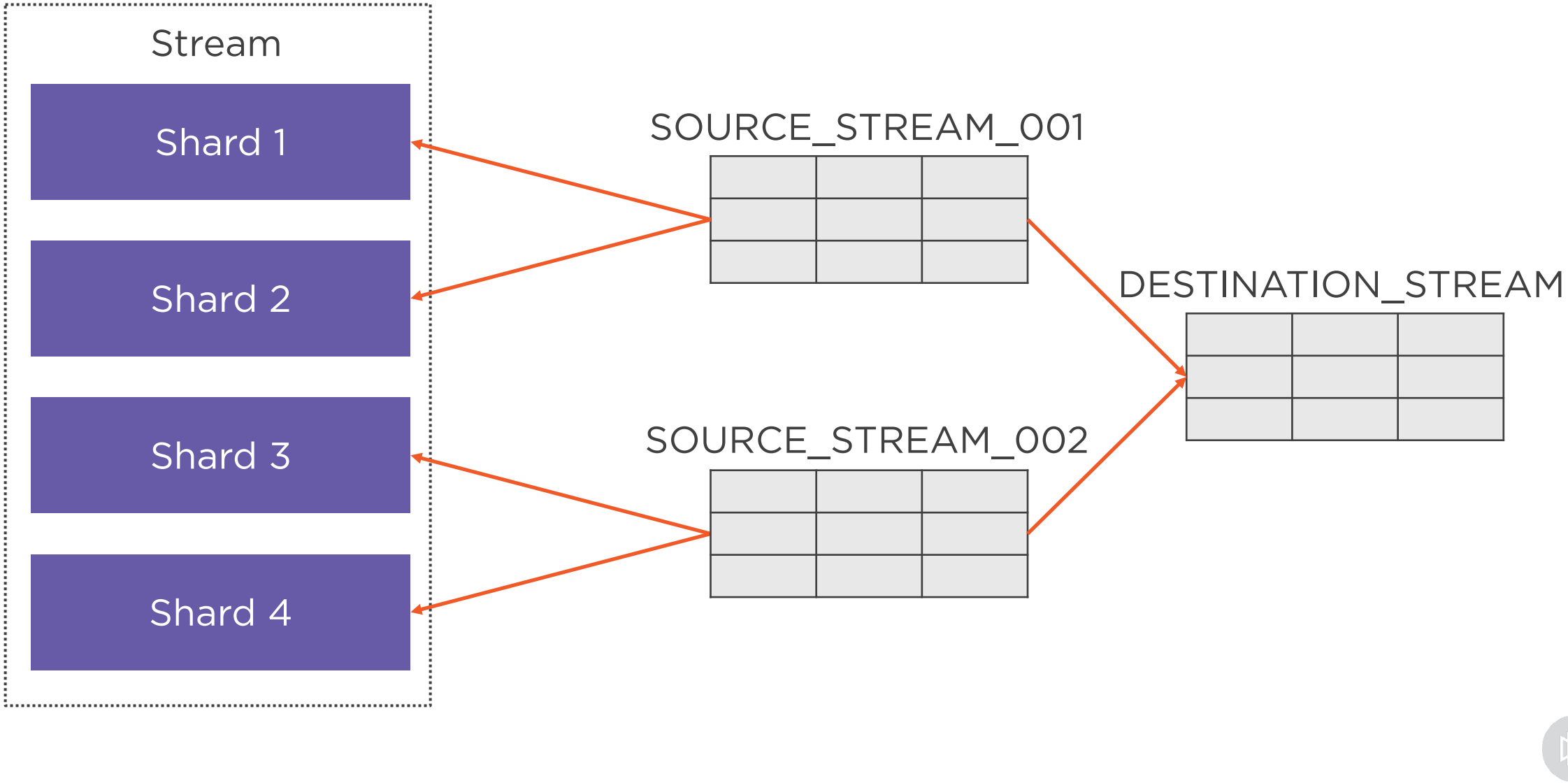
More windows -> more memory

More items -> more CPUs

Source Parallelism



Source Parallelism



When to Use Source Parallelism

Check MillisBehindLatest metric in CloudWatch

MillisBehindLatest is increasing

MillisBehindLatest is above 1 second

Use Kinesis Analytics API or AWS CLI to set parallelism

Source Parallelism Example

```
CREATE OR REPLACE STREAM RESULT ...;

CREATE OR REPLACE PUMP PUMP_1 AS INSERT INTO RESULT
SELECT STREAM * FROM SOURCE_SQL_STREAM_001
WHERE ...;

CREATE OR REPLACE PUMP PUMP_2 AS INSERT INTO RESULT
SELECT STREAM * FROM SOURCE_SQL_STREAM_002
WHERE ...;
```

Kinesis Limitations

Row in a stream limited to 50KB

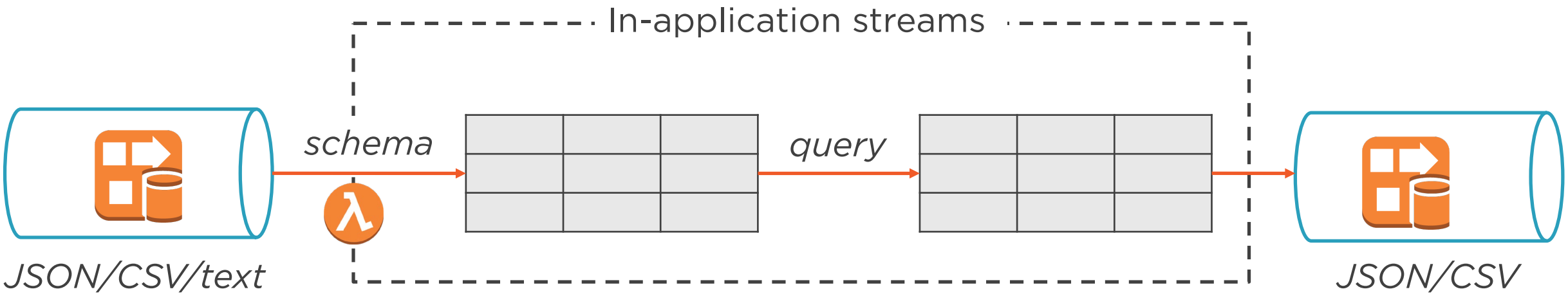
50 Kinesis Analytics applications

Inputs and outputs

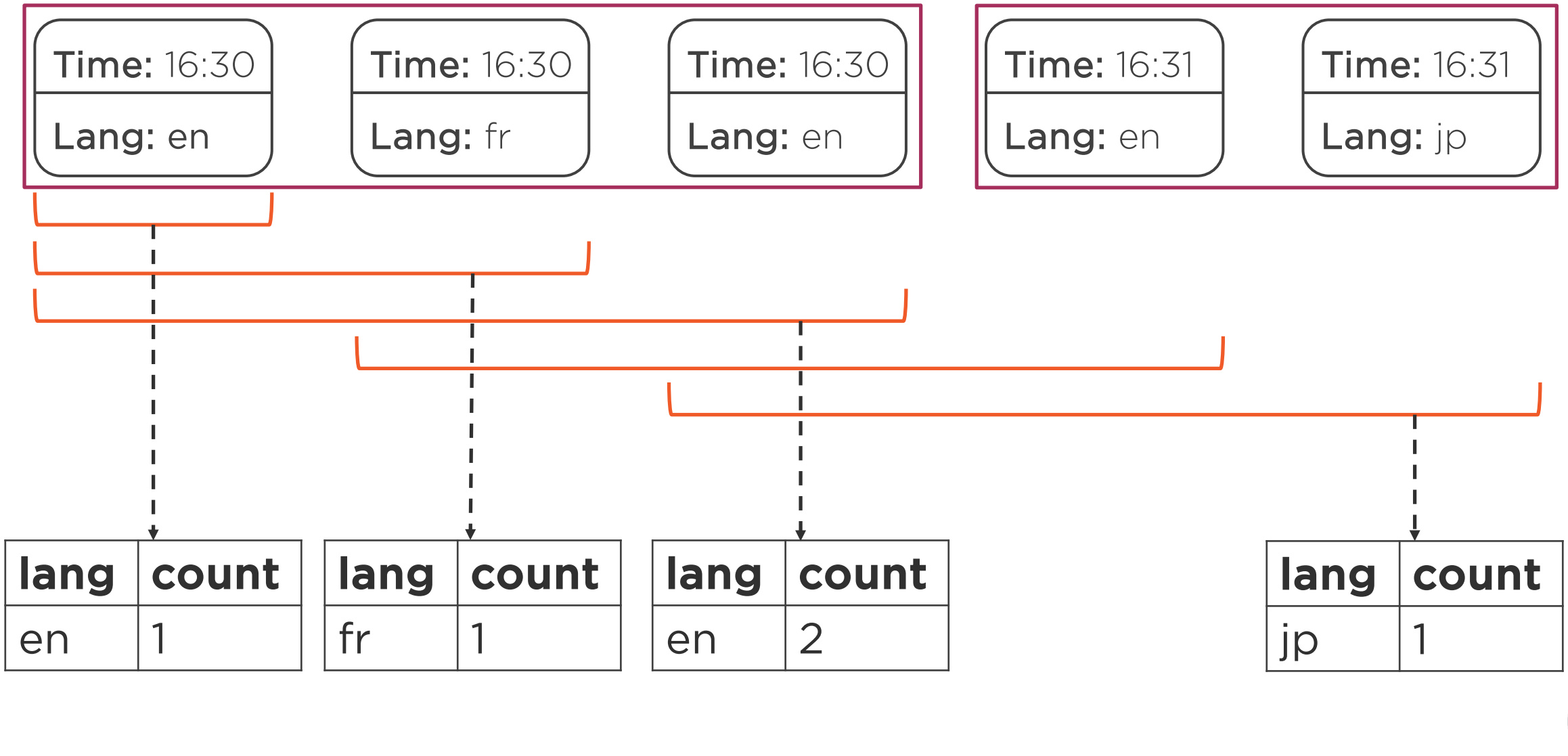
- One streaming source
- One reference source (up to 1 GB)
- Three destinations
- Maximum source parallelism: 64

Up to 8 KPUs (soft limit)

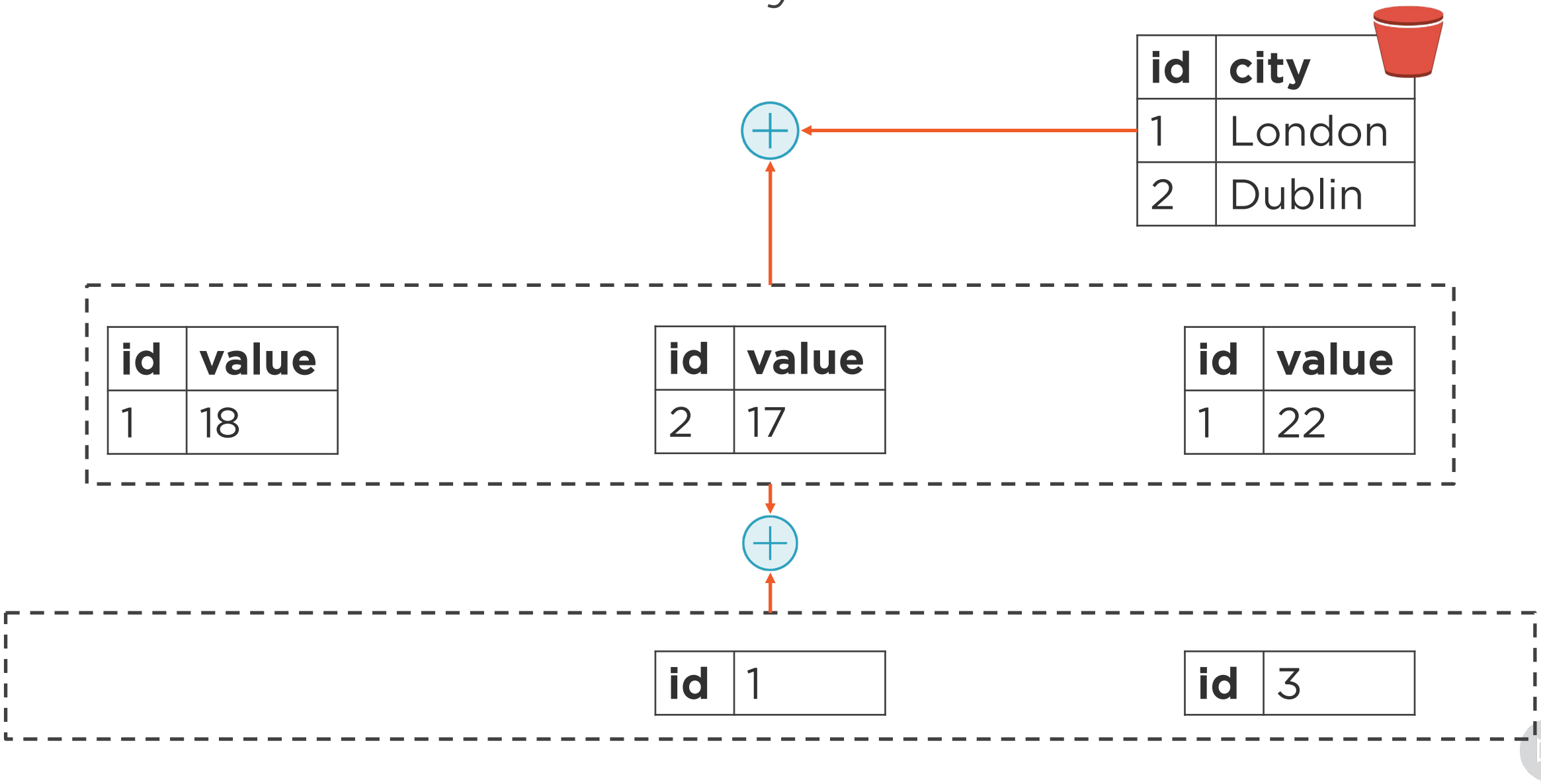
Summary - Kinesis Analytics



Summary - Windows



Summary - Joins



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