Hive Bucketing in Apache Spark

Tejas Patil

Facebook

Agenda

- Why bucketing ?
- Why is shuffle bad ?
- How to avoid shuffle ?
- When to use bucketing ?
- Spark's bucketing support
- Bucketing semantics of Spark vs Hive
- Hive bucketing support in Spark
- SQL Planner improvements

Why bucketing ?

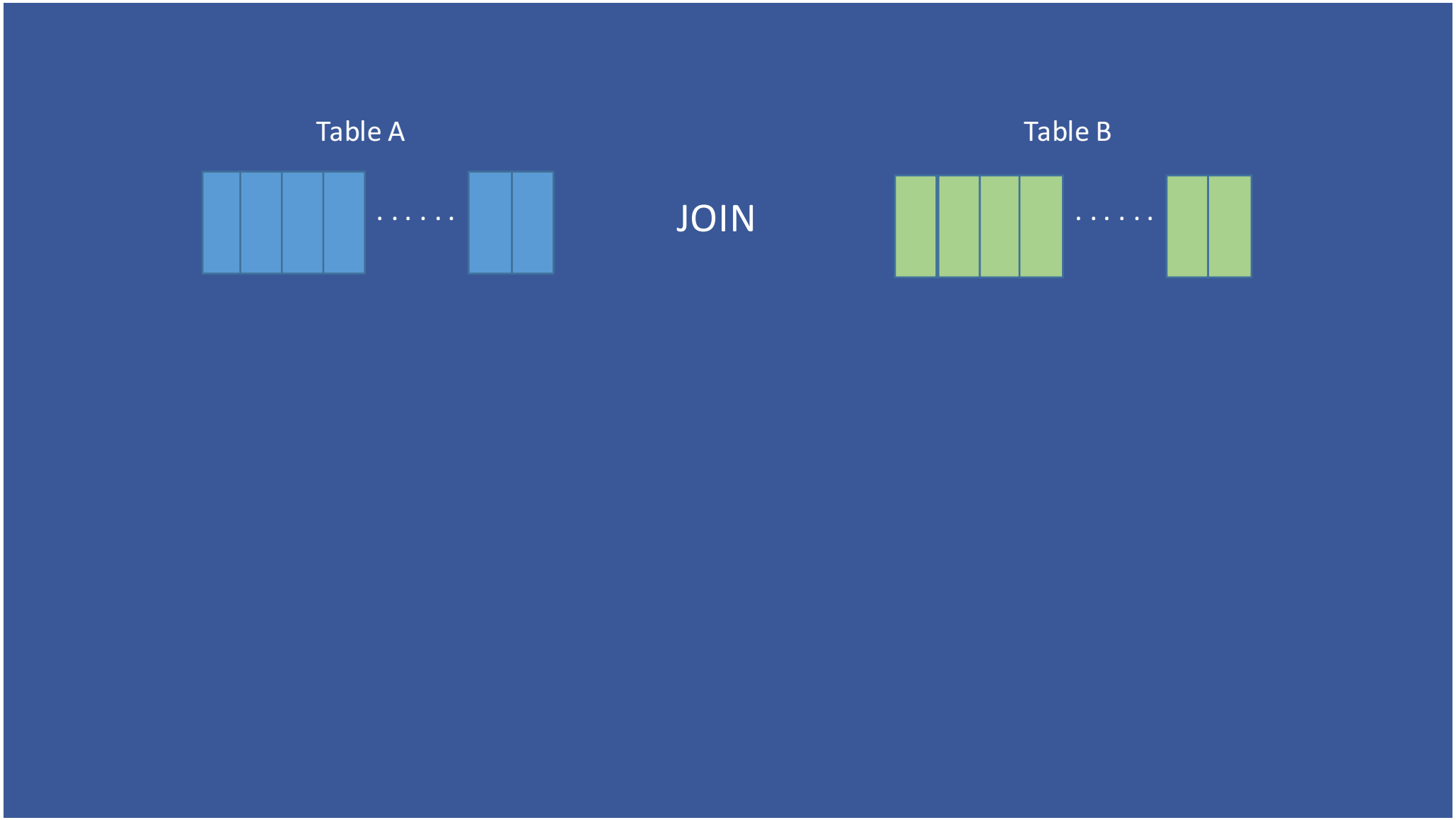
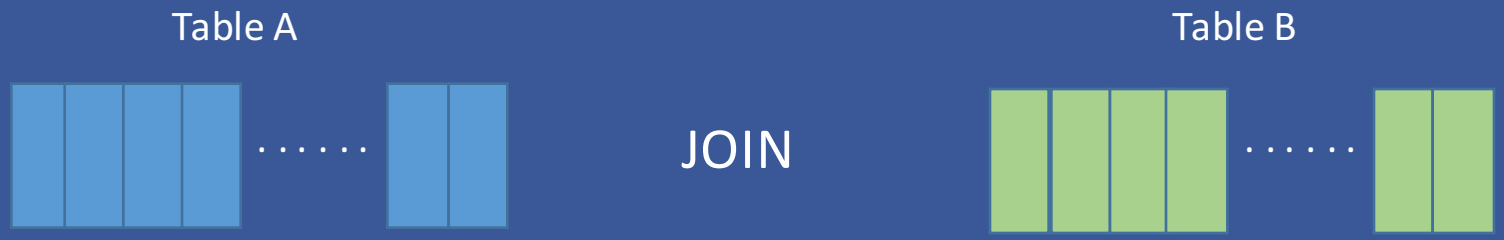
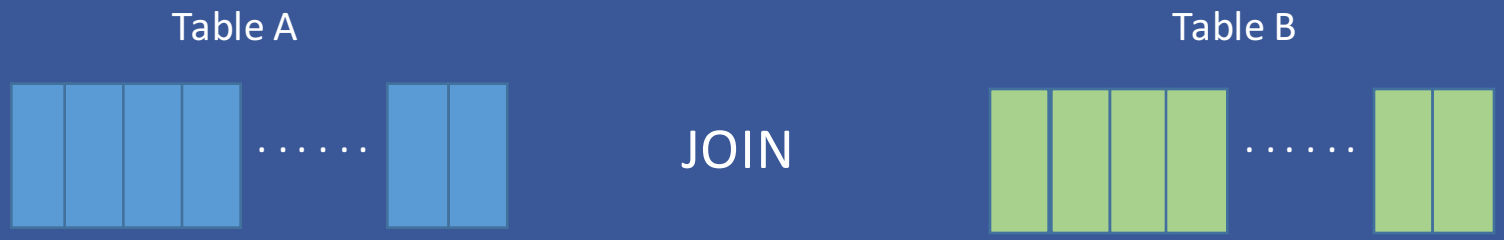


Table A
JOIN
Table B



Broadcast hash join

- Ship smaller table to all nodes
- Stream the other table



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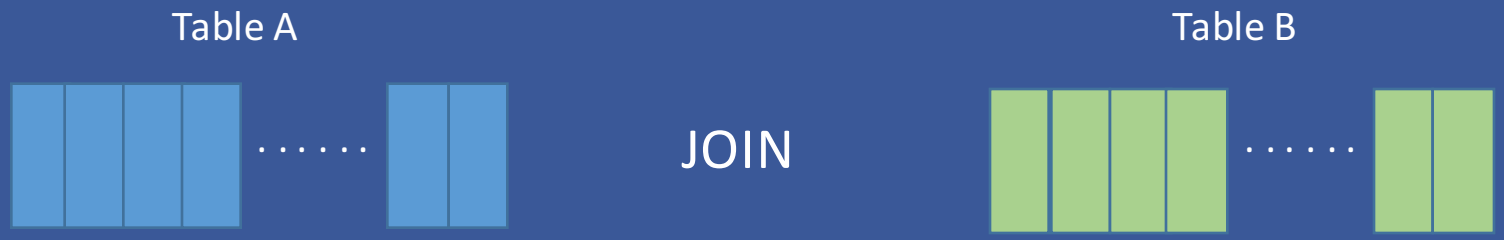

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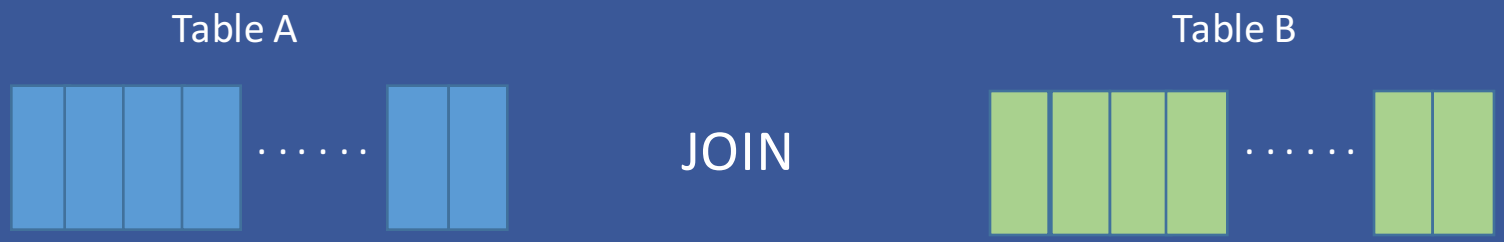

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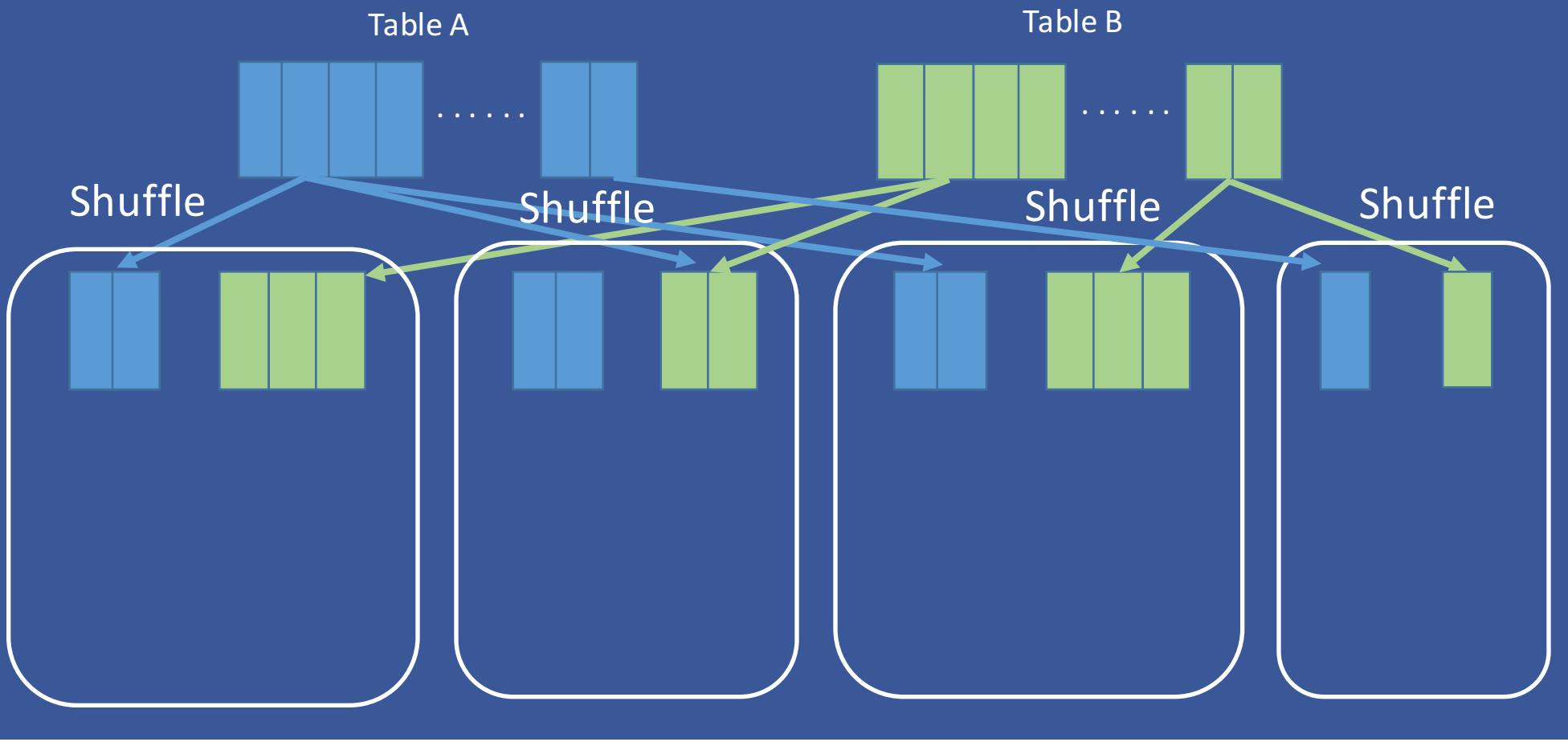

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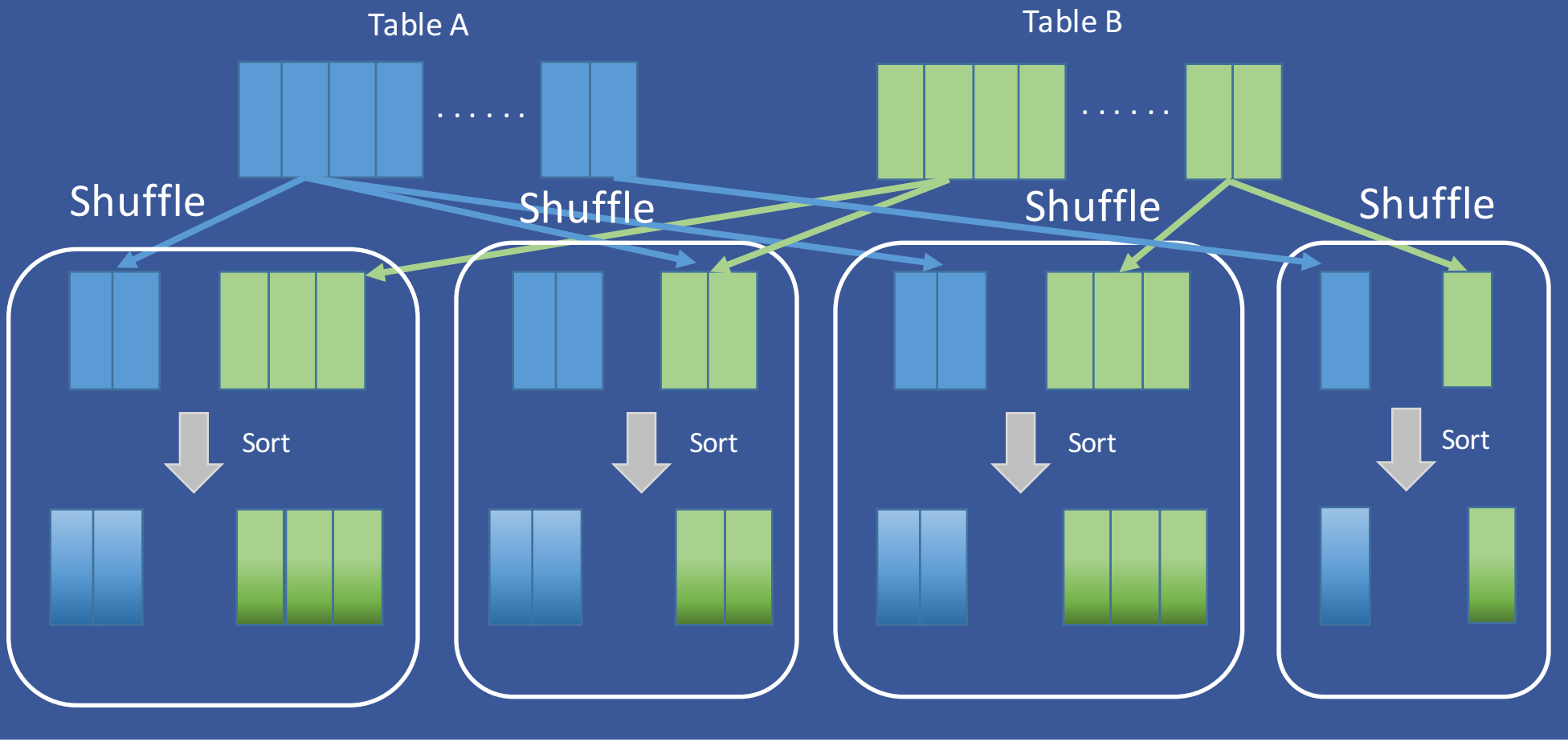

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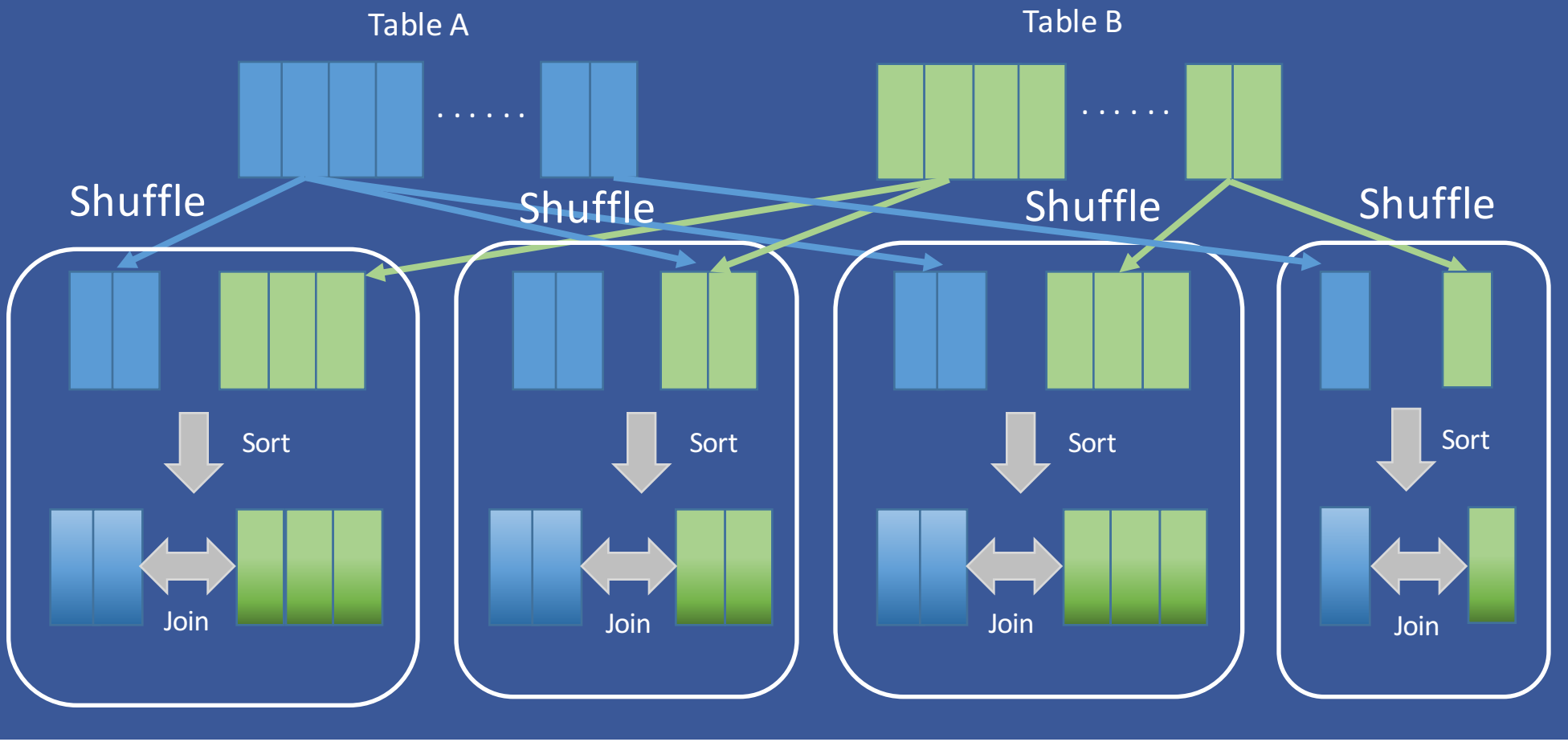

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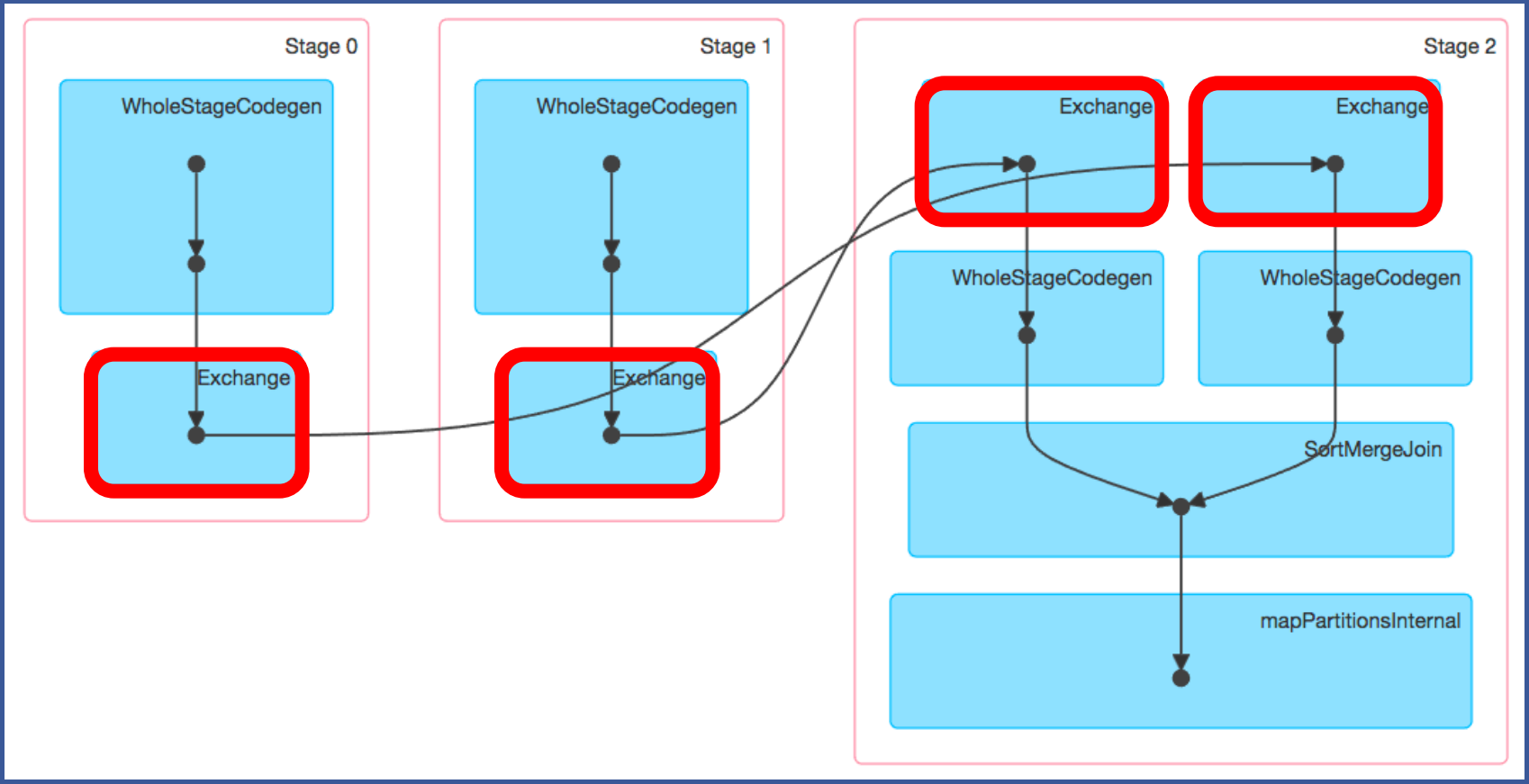

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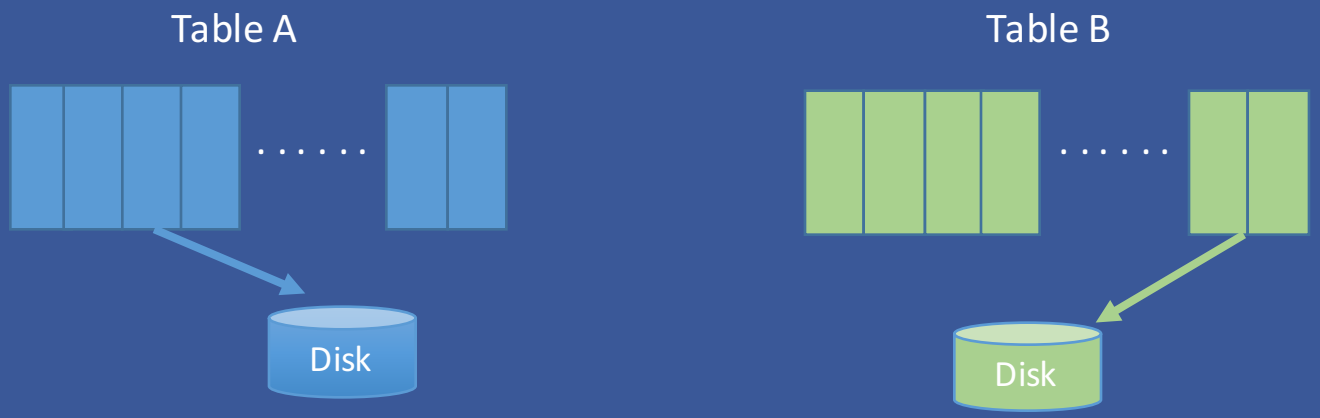
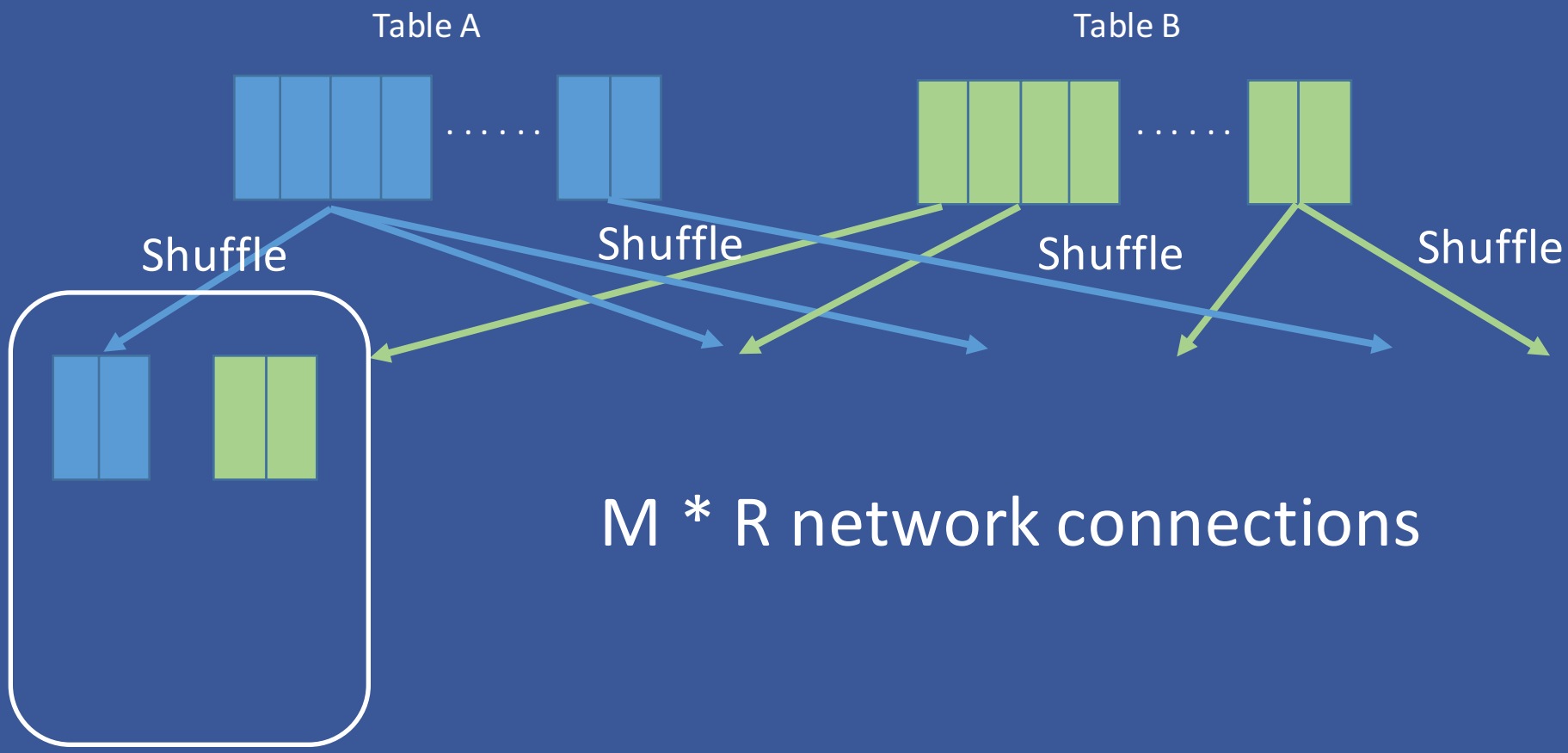


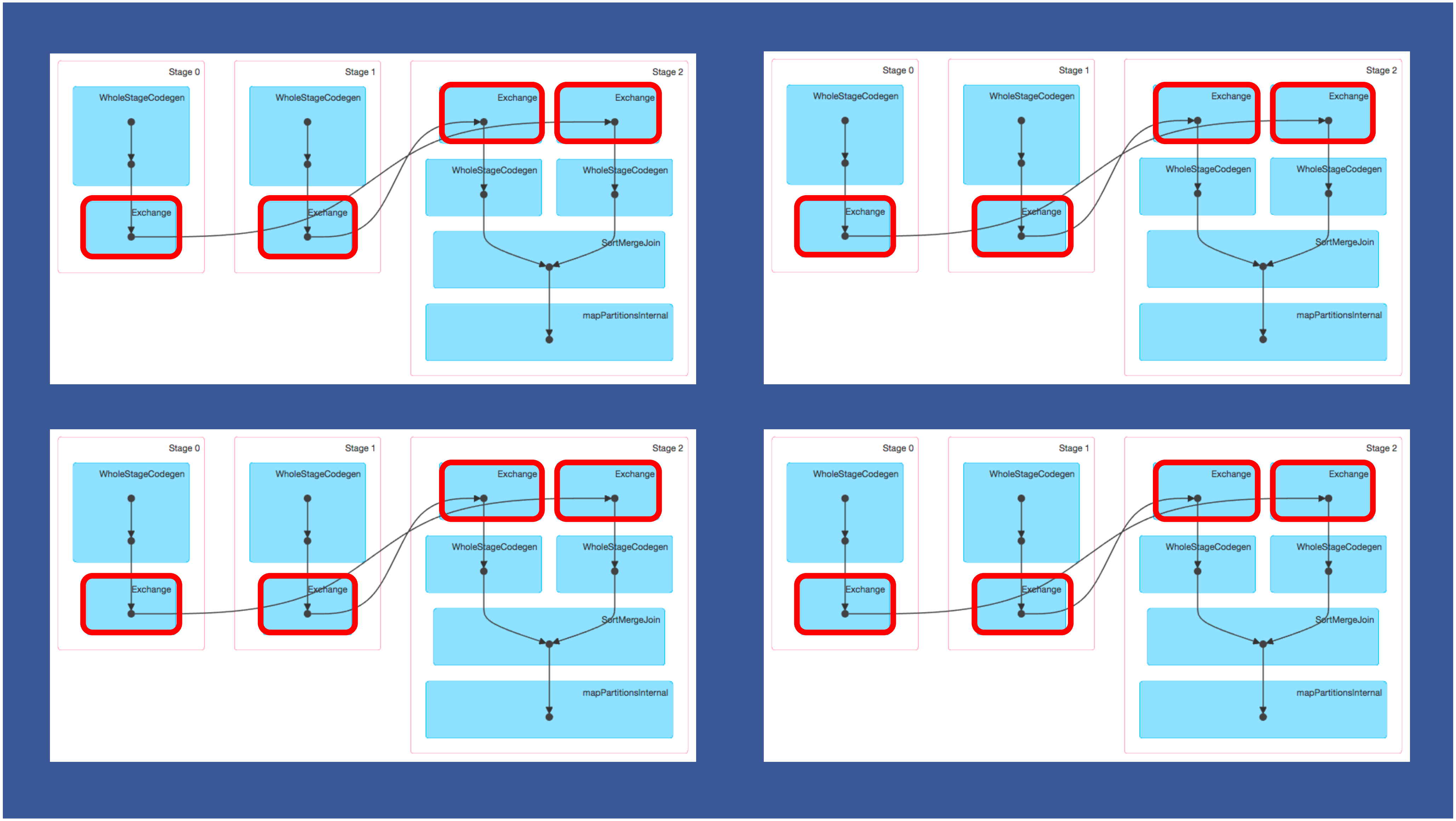
Disk IO for shuffle outputs

Why is shuffle bad ?



M * R network connections

How to avoid shuffle ?


Stage 0
WholeStageCodegen
Exchange
Stage 1
WholeStageCodegen
Exchange
Stage 2
Exchange
Exchange
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SortMergeJoin
mapPartitionsInternal
Stage 0
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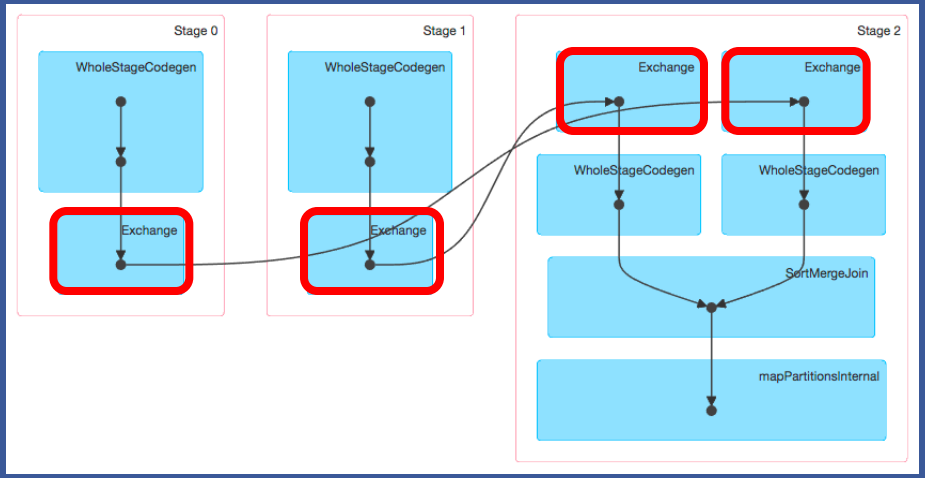
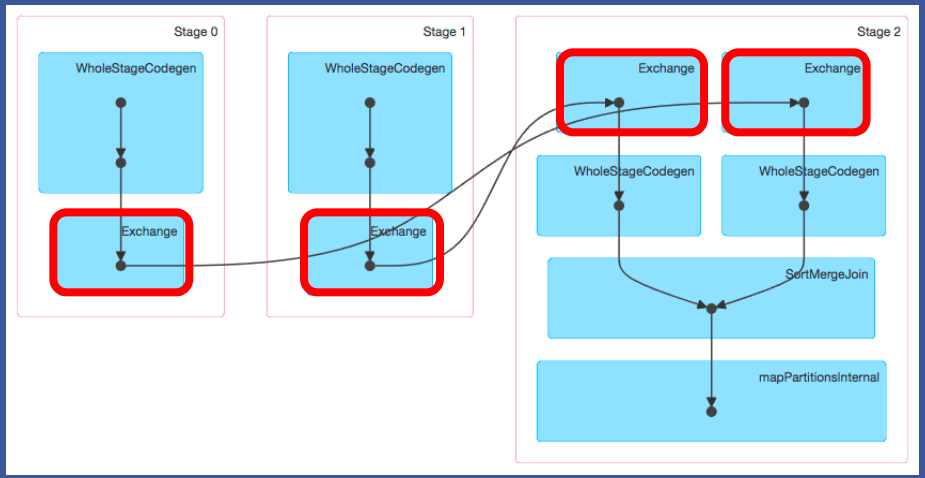
```
student s JOIN attendance a
ON s.id = a.student_id

student s JOIN results r
ON s.id = r.student_id

.....
.....

student s JOIN course_registration c
ON s.id = c.student_id
```





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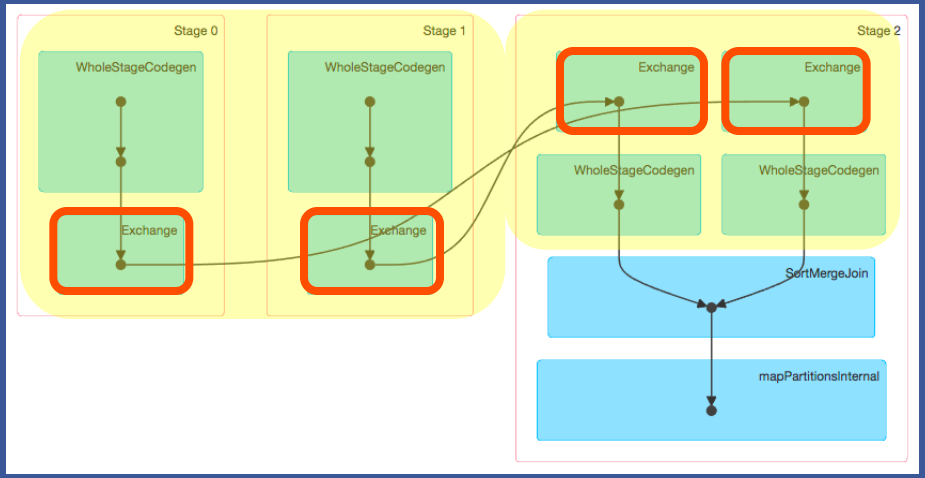

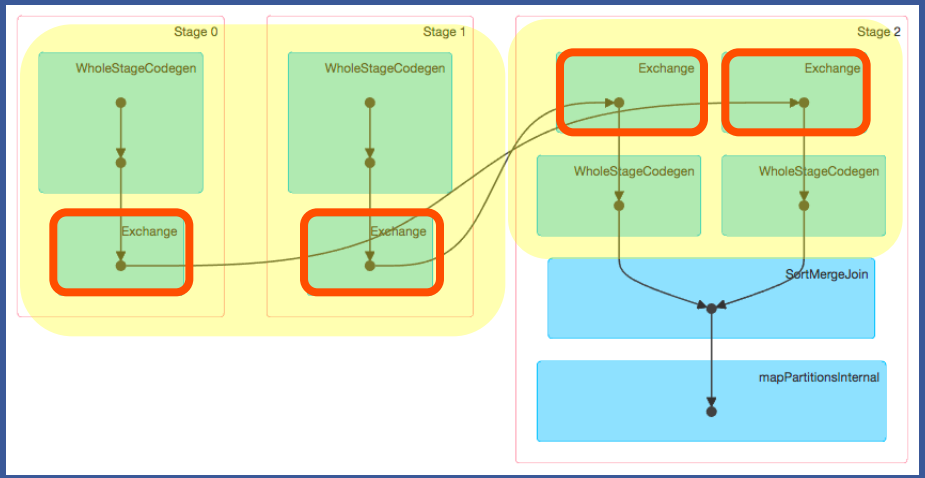

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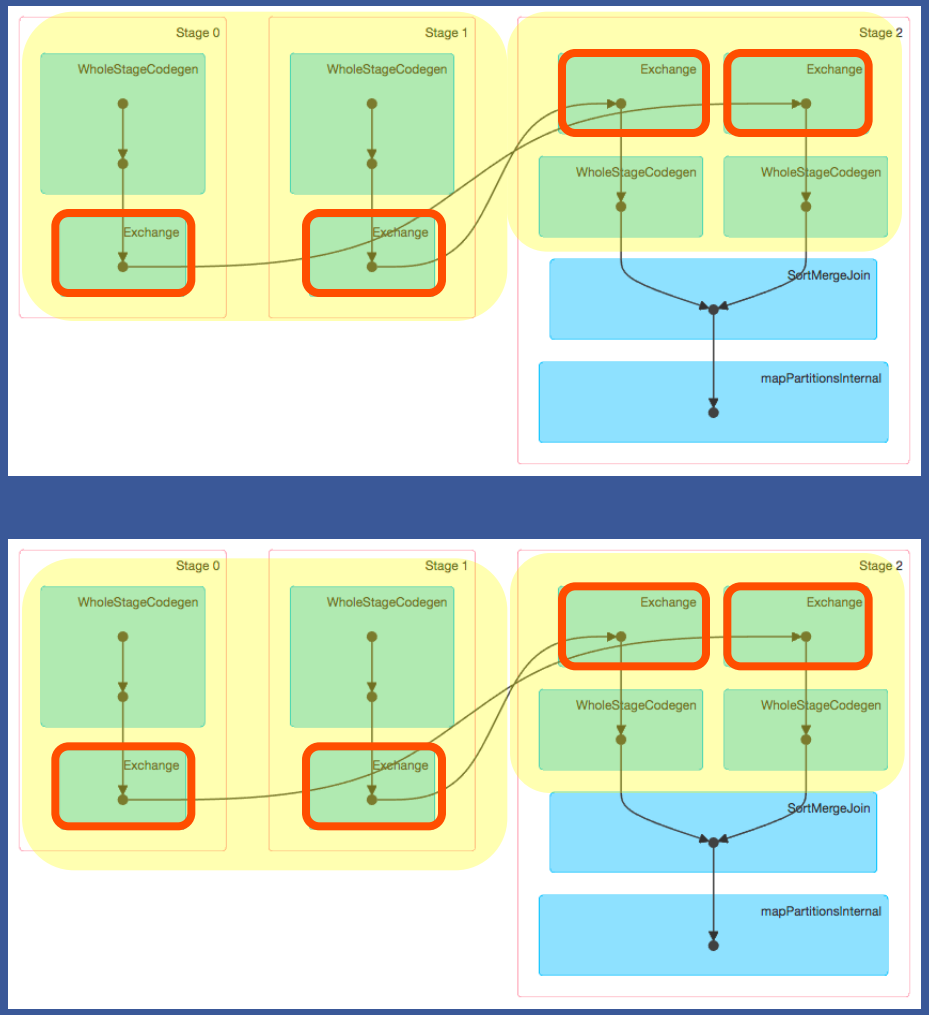
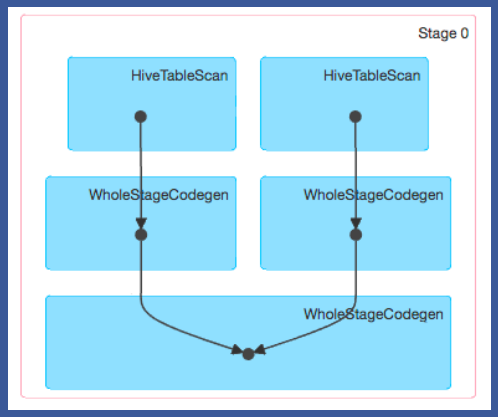
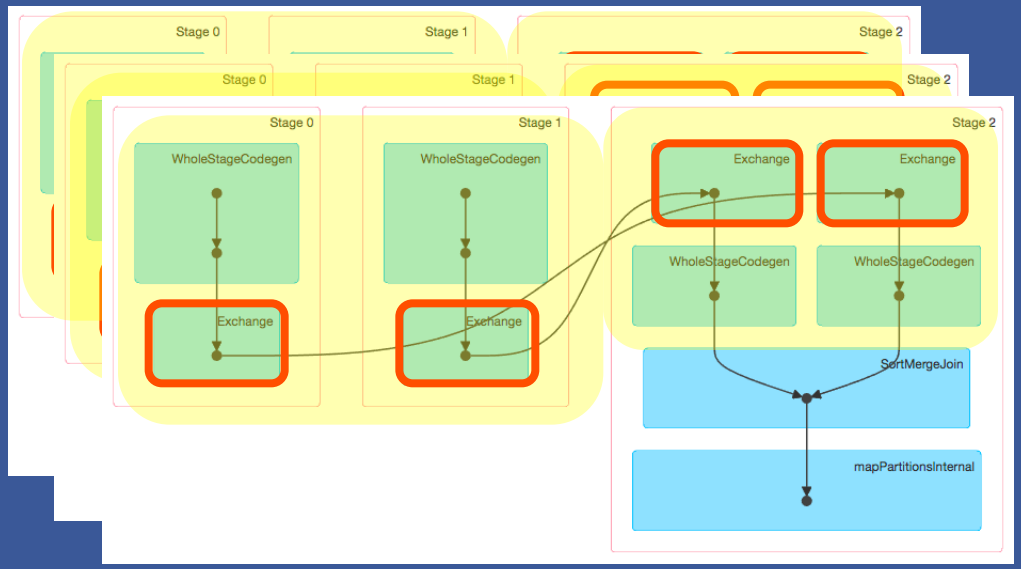
Pre-compute at table creation



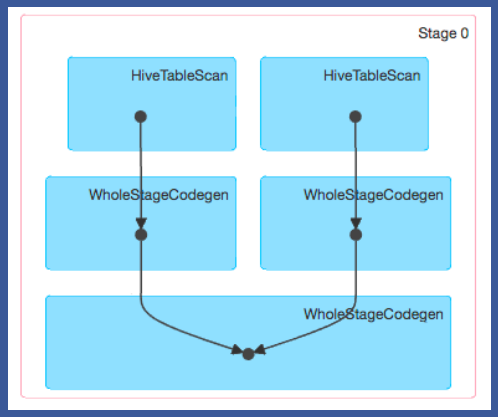
Bucketing =
pre-(shuffle + sort) inputs
on join keys



Without bucketing



Job(s) populating input table



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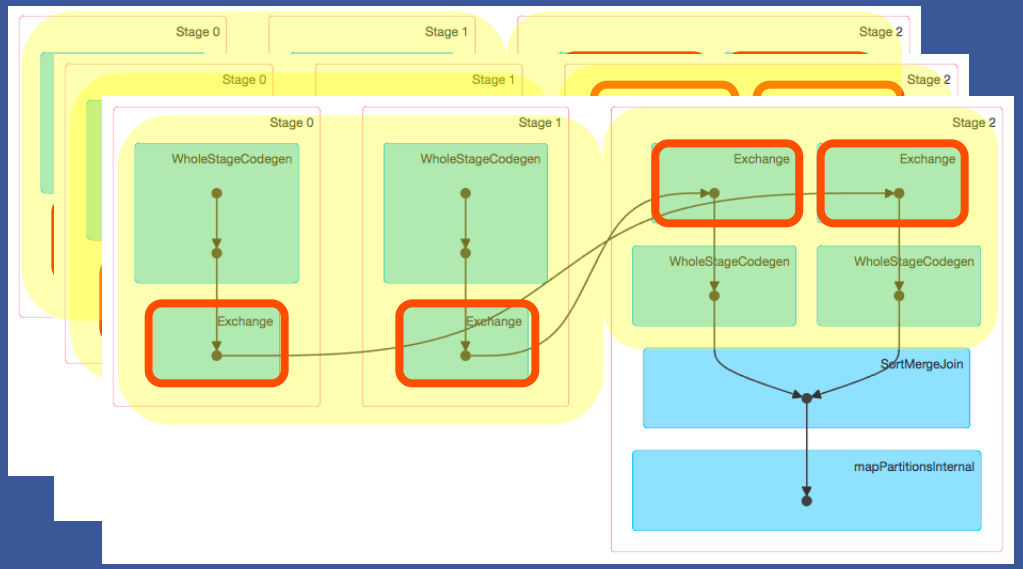

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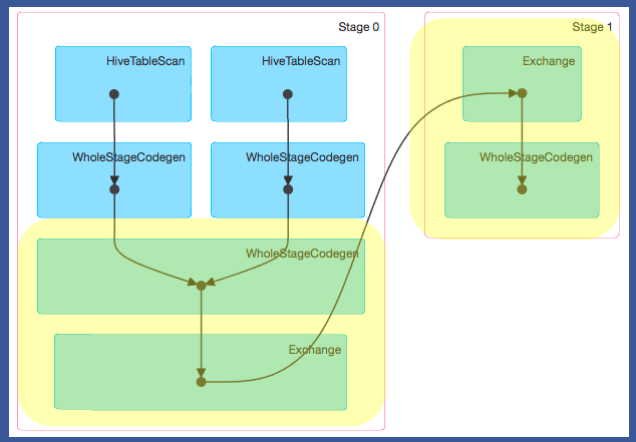
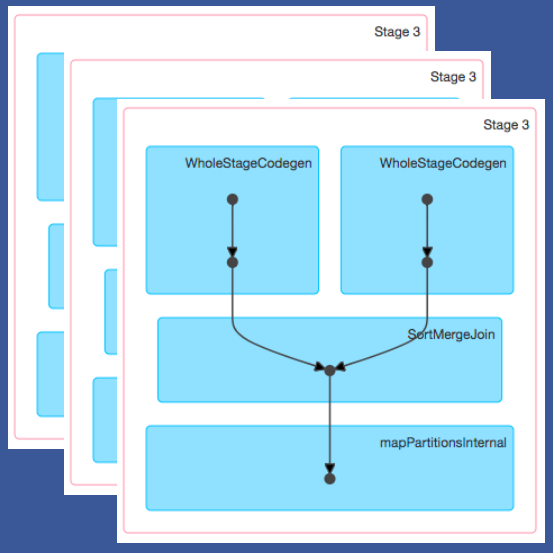
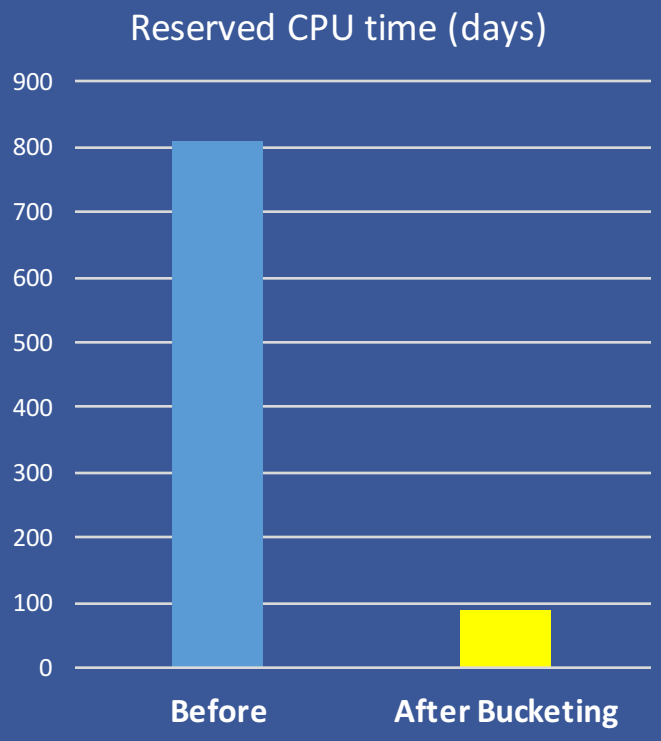
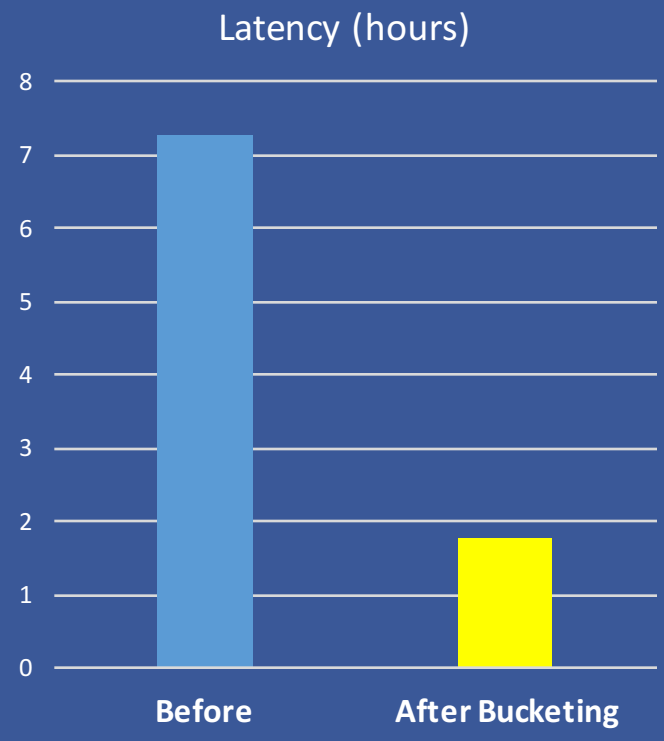


With bucketing



Performance comparison





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- Tables used frequently in JOINs with same key
  - Student -> student_id
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  - Users -> user_id

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…. => Dimension tables

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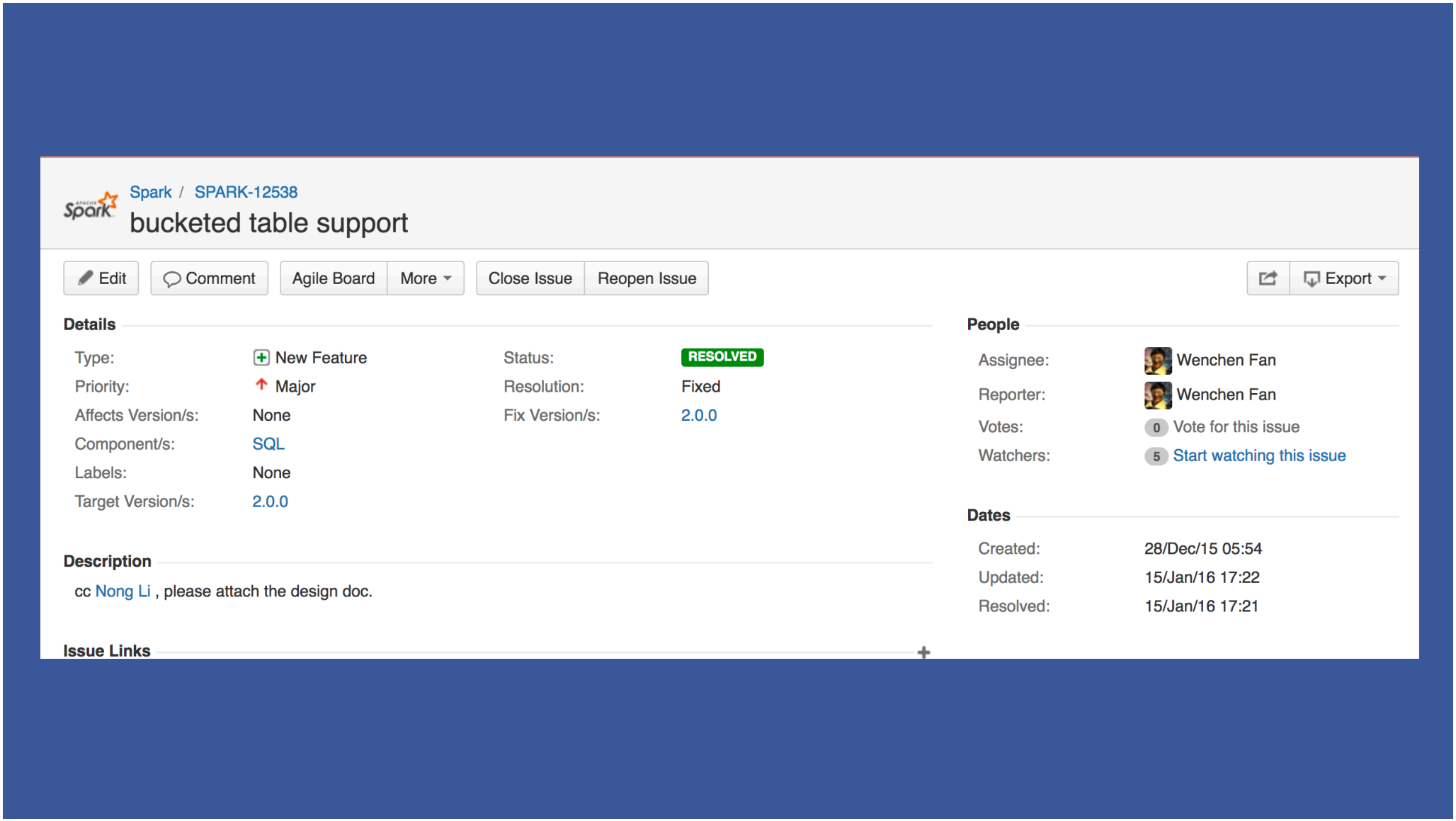
- Indexing capability

Spark’s bucketing support


Spark / SPARK-12538
bucketed table support
Edit
Comment
Agile Board
More
Close Issue
Reopen Issue
Export
Details
Type: New Feature
Priority: Major
Affects Version/s: None
Component/s: SQL
Labels: None
Target Version/s: 2.0.0
Status: RESOLVED
Resolution: Fixed
Fix Version/s: 2.0.0
Description
cc Nong Li , please attach the design doc.
Issue Links
People
Assignee: Wenchen Fan
Reporter: Wenchen Fan
Votes: 0 Vote for this issue
Watchers: 5 Start watching this issue
Dates
Created: 28/Dec/15 05:54
Updated: 15/Jan/16 17:22
Resolved: 15/Jan/16 17:21

Creation of bucketed tables

via Dataframe API

```
df.write
  .bucketBy(numBuckets,  "col1", ...)
  .sortBy("col1", ...)
  .saveAsTable("bucketed_table")
```

Creation of bucketed tables

via SQL statement

```
CREATE TABLE bucketed_table(
    column1 INT,
    ...
) USING parquet
CLUSTERED BY (column1, …)
SORTED BY (column1, …)
INTO `n` BUCKETS
```

Check bucketing spec

```
scala> sparkContext.sql("DESC  FORMATTED student").collect.foreach(println)
[# col_name,data_type,comment]
[student_id,int,null]
[name,int,null]
[# Detailed Table Information,,]
[Database,default,]
[Table,table1,]
[Owner,tejas,]
[Created,Fri May 12 08:06:33  PDT 2017,]
[Type,MANAGED,]
[Num Buckets,64,]
[Bucket Columns,[`student_id`],]
[Sort Columns,[`student_id`],]
[Properties,[serialization.format=1],]
[Serde Library,org.apache.hadoop.hive.serde2.lazy.LazySimpleSerDe,]
[InputFormat,org.apache.hadoop.mapred.SequenceFileInputFormat,]
```

Bucketing config

```
SET spark.sql.sources.bucketing.enabled=true
```

[SPARK-15453] Extract bucketing info in FileSourceScanExec

```
SELECT * FROM tableA JOIN tableB ON tableA.i= tableB.i AND tableA.j= tableB.j
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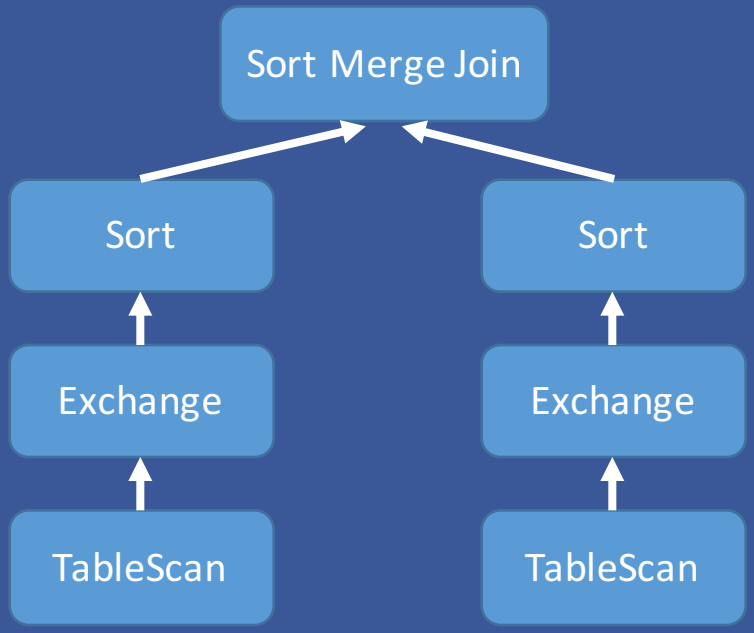

Join on [i,j], [i,j] respectively of relations

Sort on columns (i, j)

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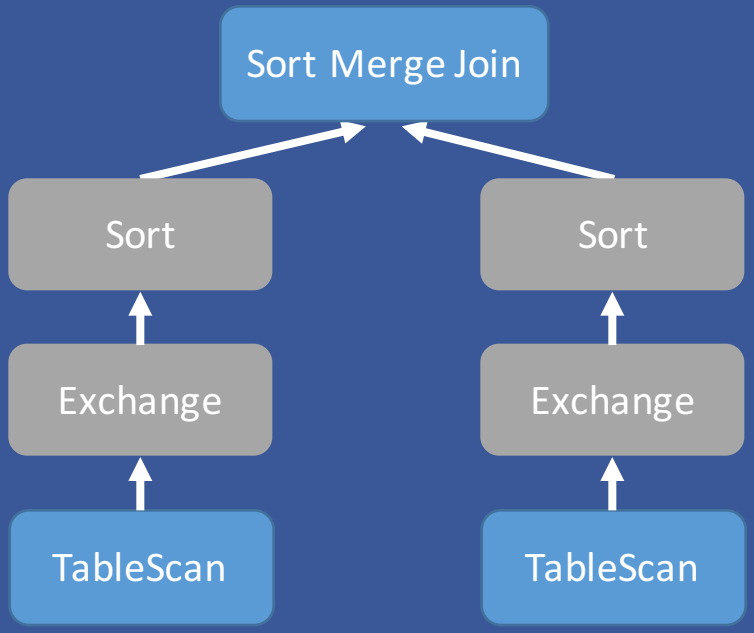

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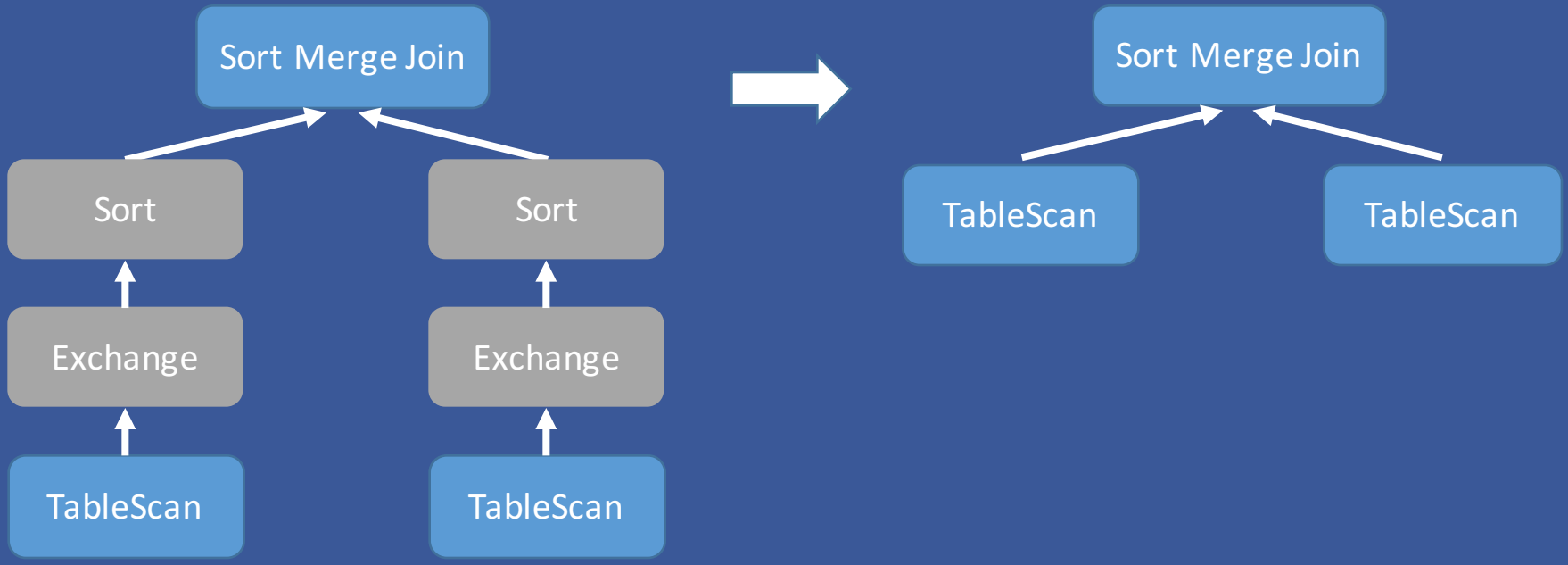

Bucketing semantics of Spark vs Hive

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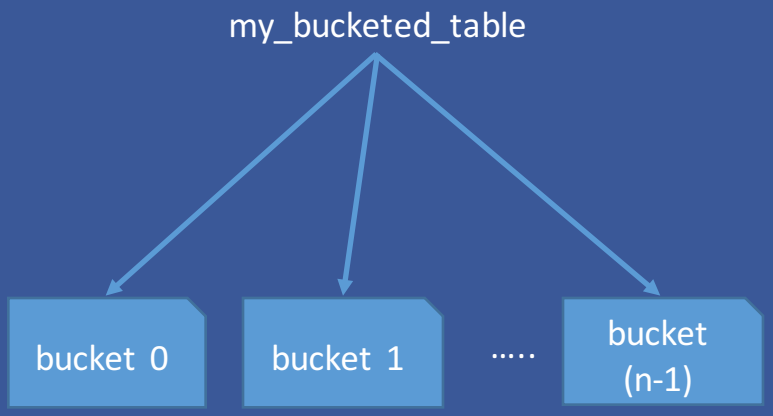
Hive



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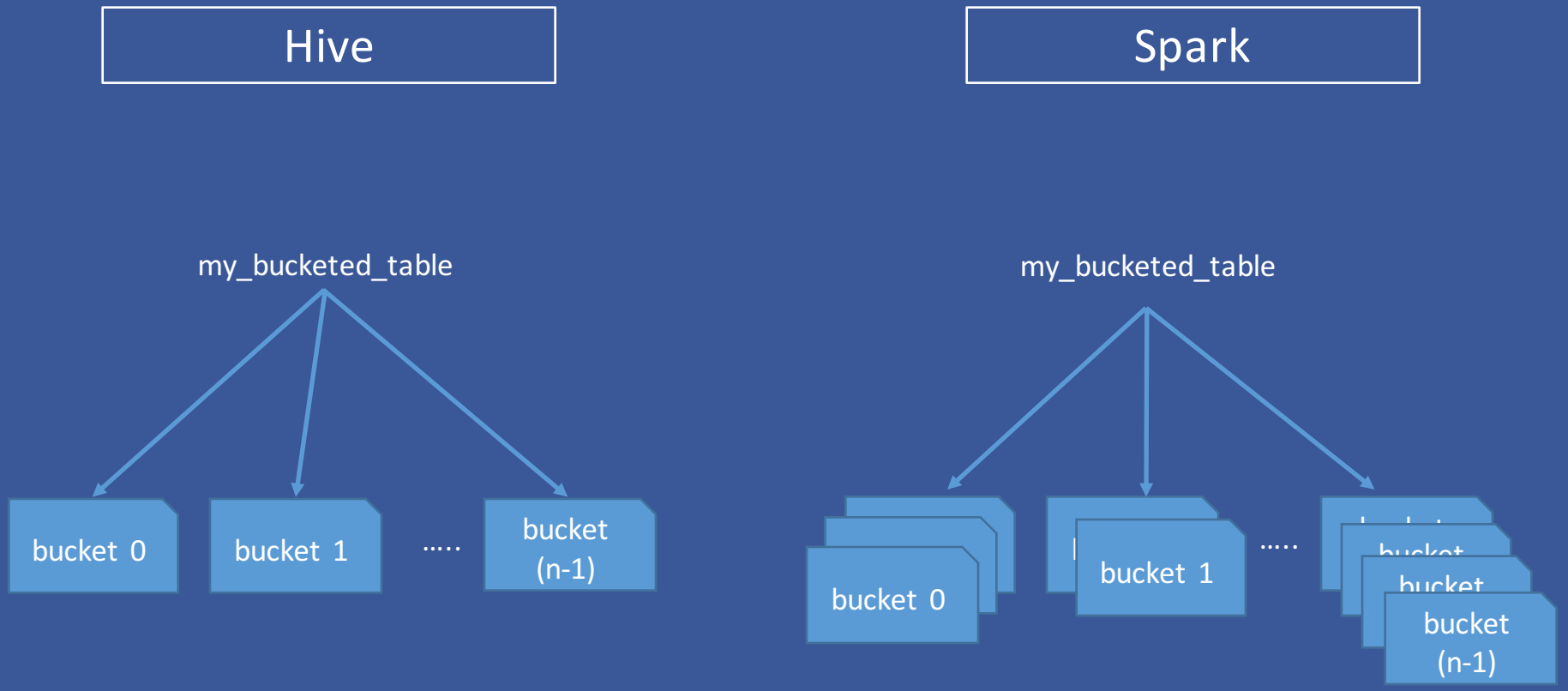

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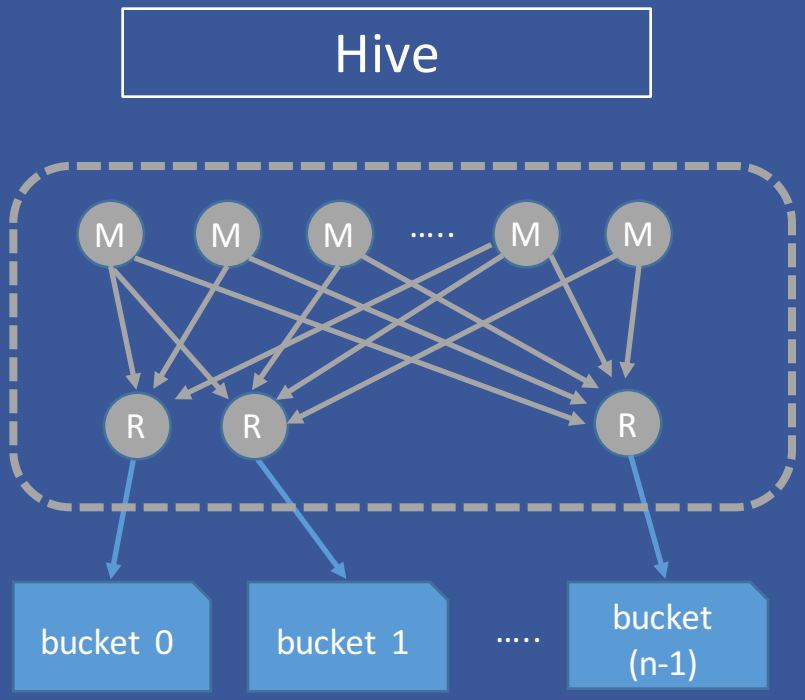

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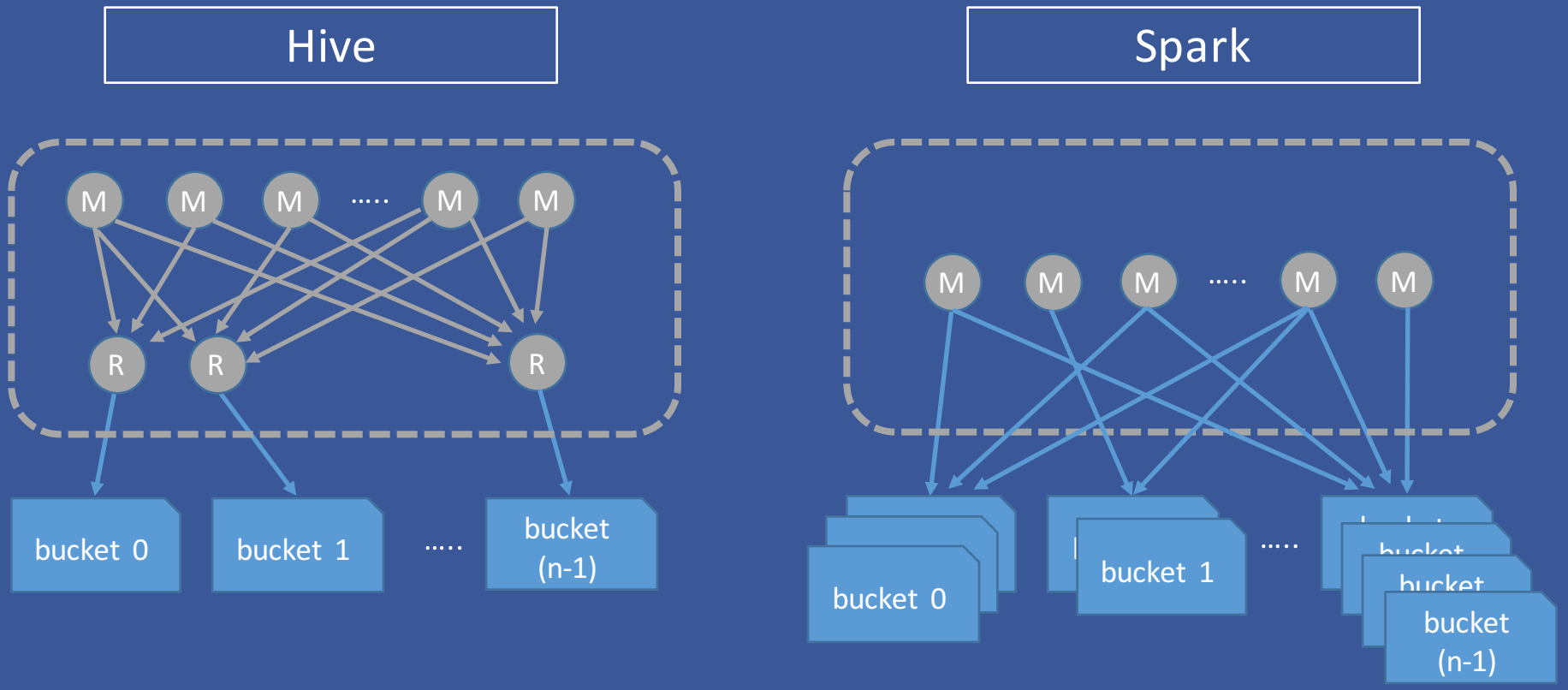

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Hashing function	Hive's inbuilt hash	Murmur3Hash

[SPARK-19256] Hive bucketing support

- Introduce Hive's hashing function [SPARK-17495]
- Enable creating hive bucketed tables [SPARK-17729]
- Support Hive's `Bucketed file format`
- Propagate Hive bucketing information to planner [SPARK-17654]
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Merged in upstream

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FB-prod (6 months)

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SQL Planner improvements

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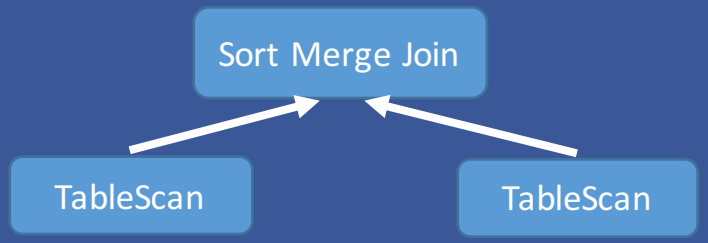

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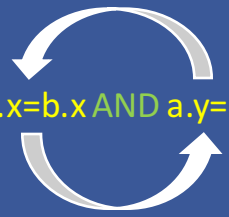

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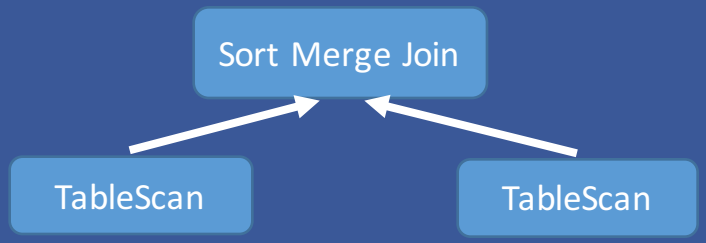

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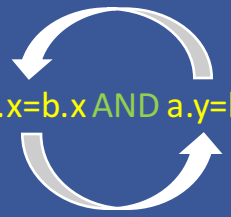

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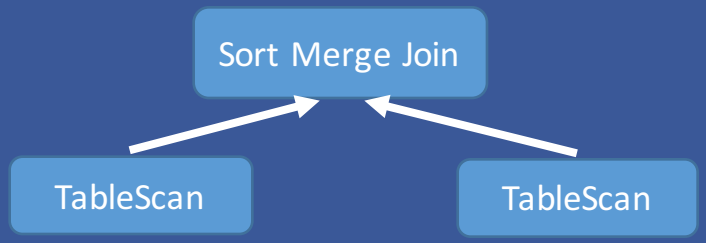

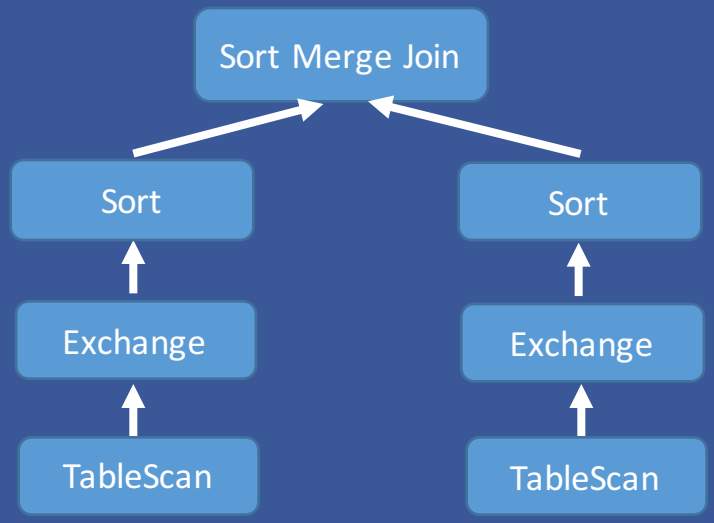

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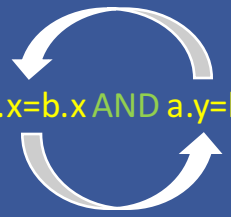

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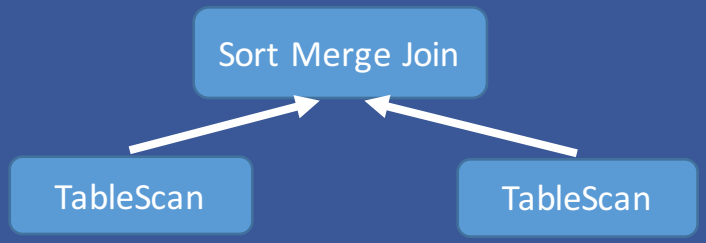

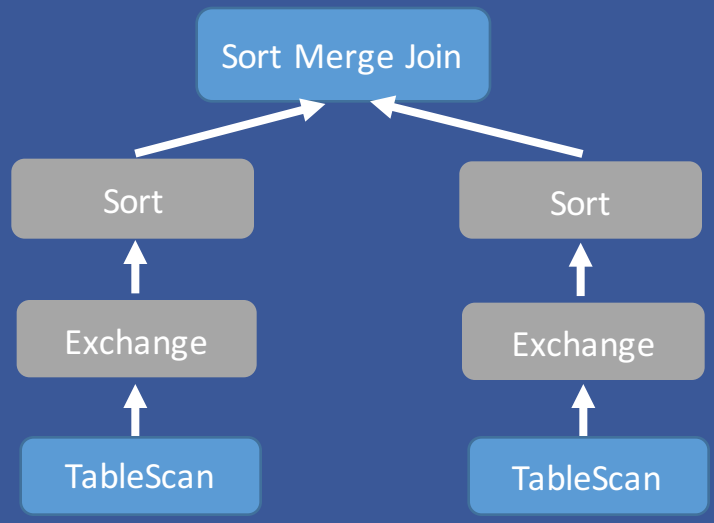

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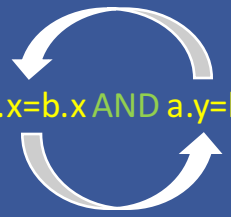

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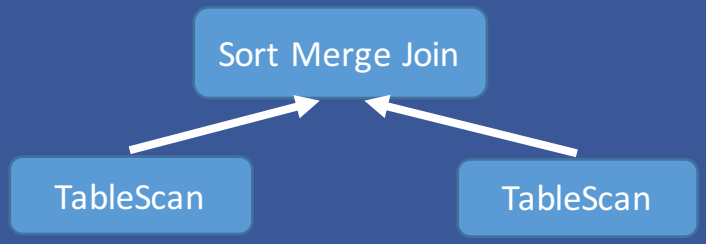

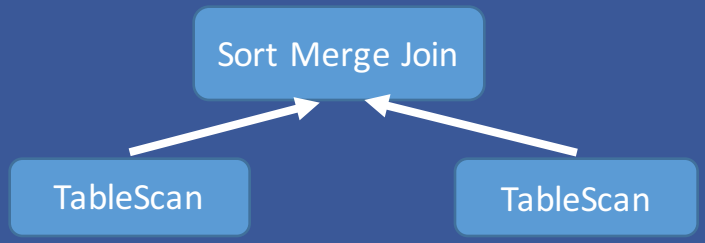

[SPARK-17271] Planner adds un-necessary Sort even if child ordering is semantically same as required ordering

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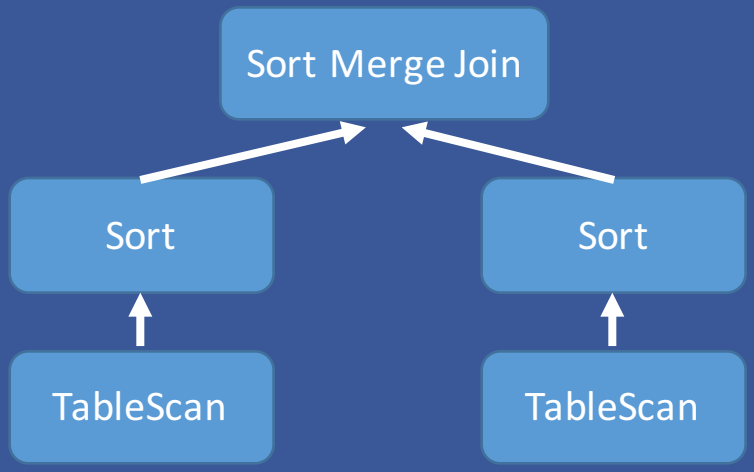

Join on [col1], [col1] respectively of relations

Sort on columns (a.col1 and b.col1)

Already bucketed on column `col1`

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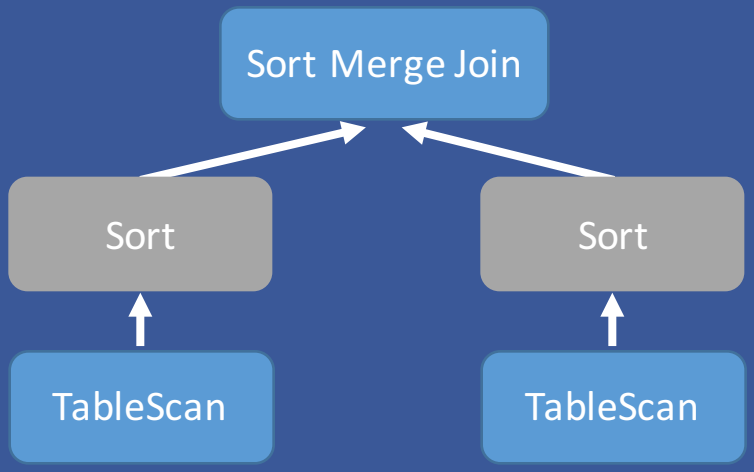

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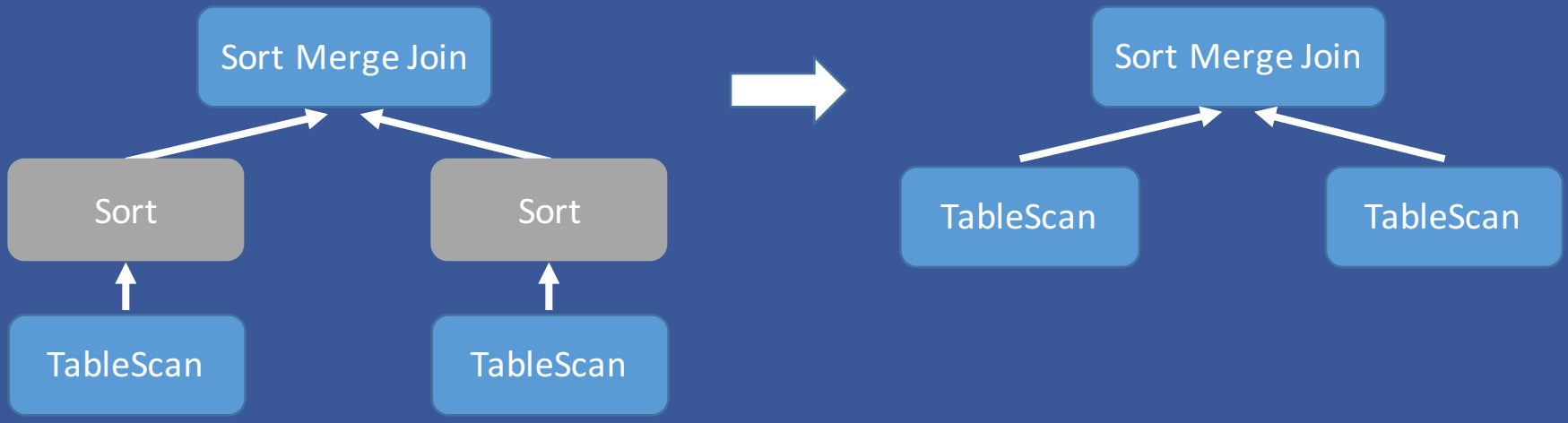

[SPARK-17698] Join predicates should not contain filter clauses

```
SELECT a.id, b.id FROM table1 a FULL OUTER JOIN table2 b ON a.id = b.id AND a.id='1' AND b.id='1'
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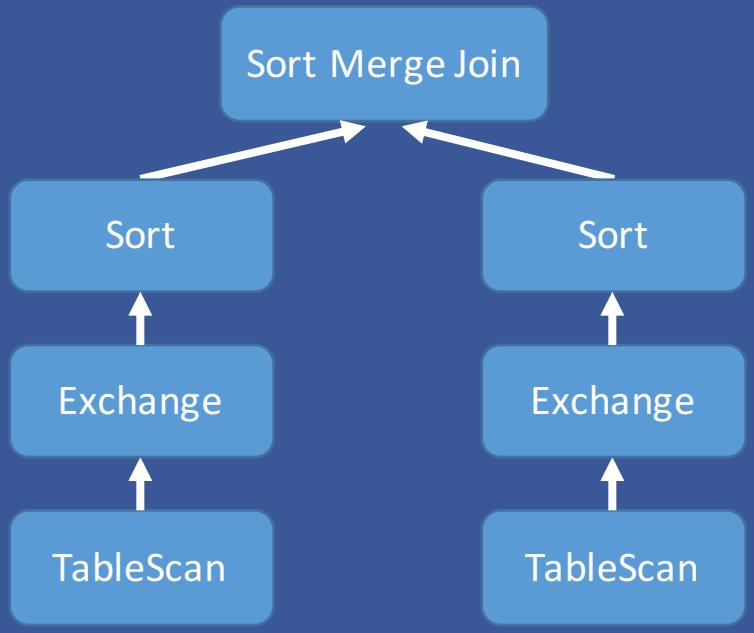

Join on [id, id, 1], [id, 1, id] respectively of relations

Sort on columns [id, id, 1] and [id, 1, id]

Shuffle on columns [id, 1, id] and [id, id, 1]

Already bucketed on column [id]

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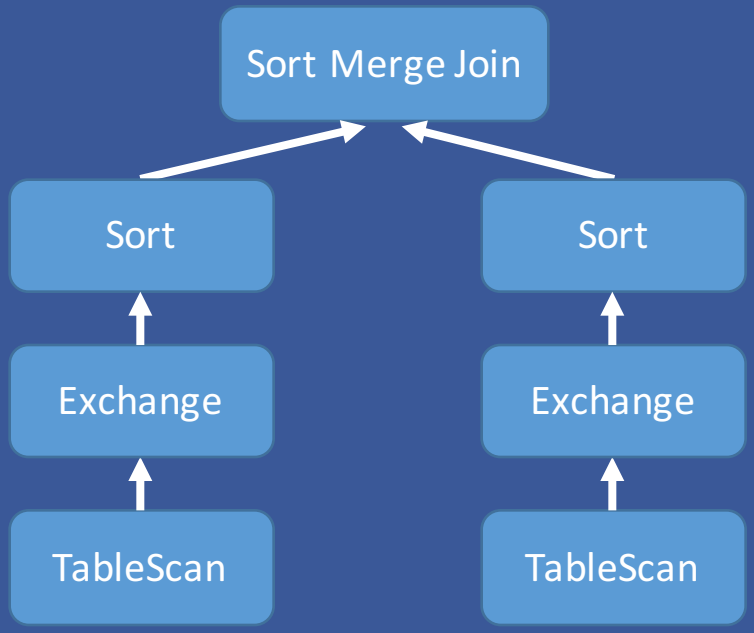

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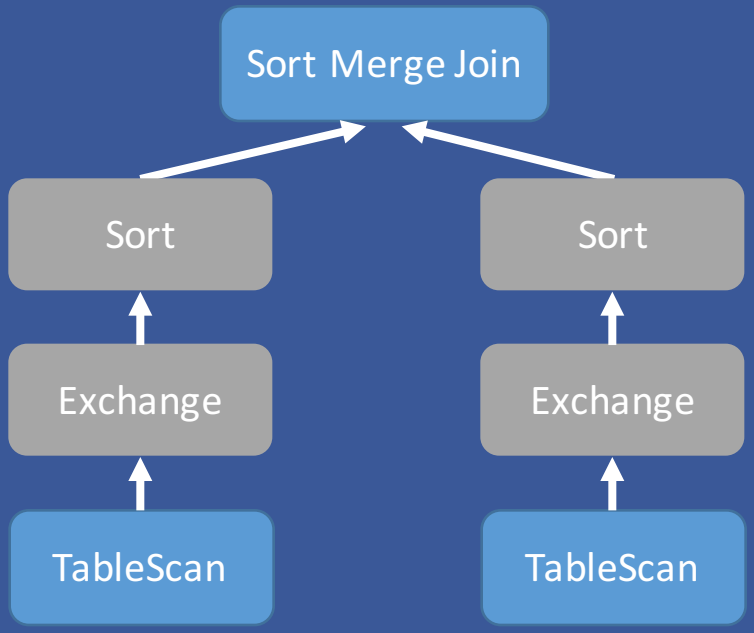

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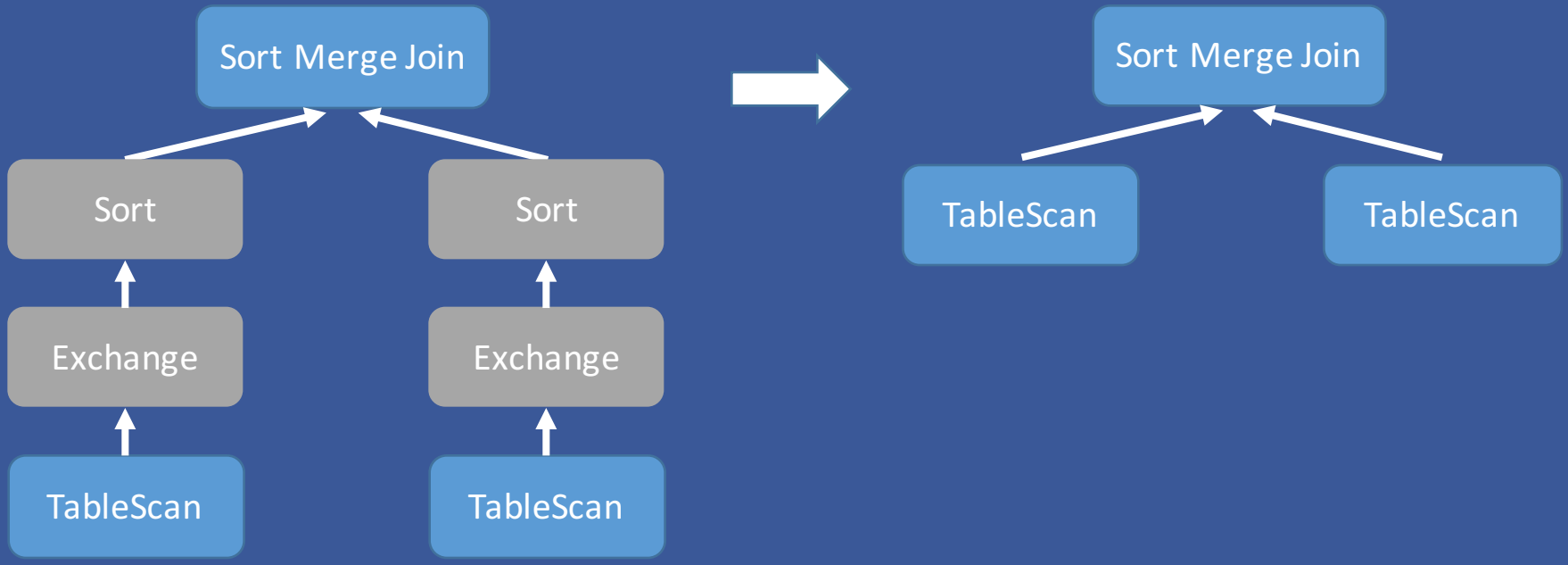

[SPARK-13450] Introduce ExternalAppendOnlyUnsafeRowArray

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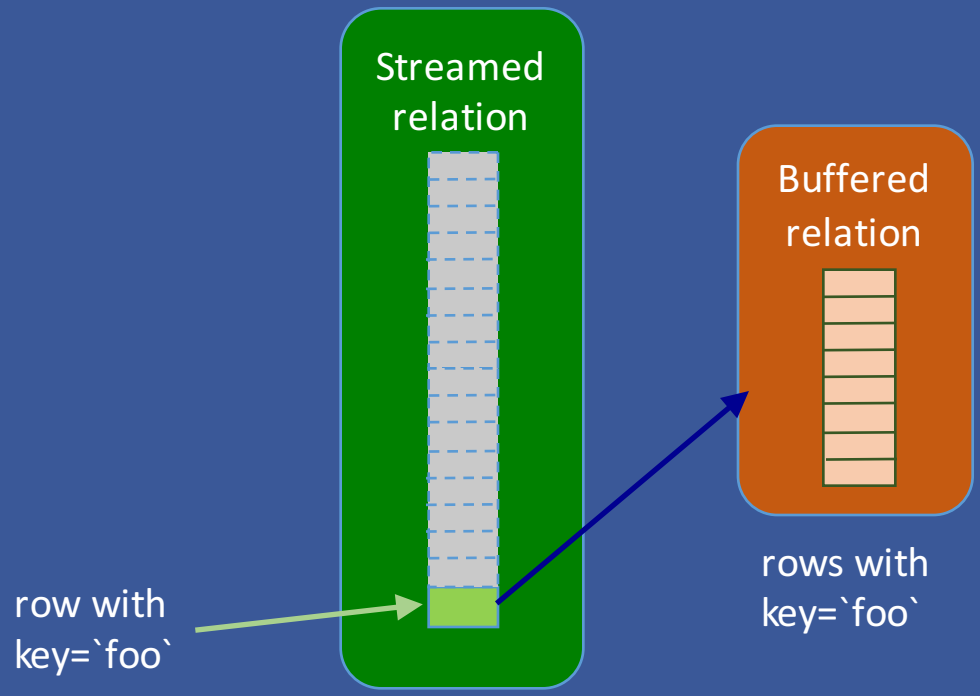
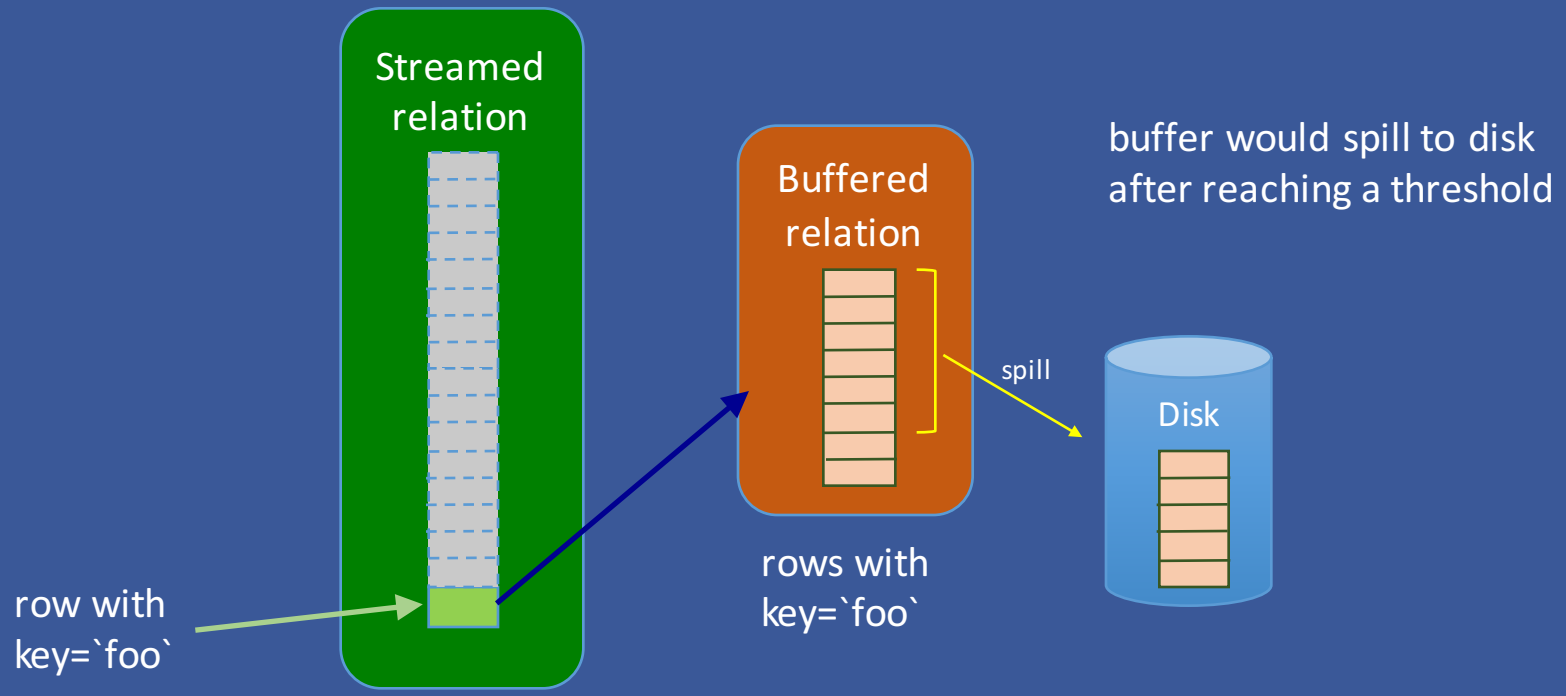


If there are a lot of rows to be buffered (eg. Skew), the query would OOM

[SPARK-13450] Introduce ExternalAppendOnlyUnsafeRowArray



Summary

- Shuffle and sort is costly due to disk and network IO
- Bucketing will pre-(shuffle and sort) the inputs
- Expect at least 2-5x gains after bucketing input tables for joins
- Candidates for bucketing:
  - Tables used frequently in JOINs with same key
  - Loading of data in cumulative tables
- Spark's bucketing is not compatible with Hive's bucketing

Questions ?