Strata Data 2019
San Francisco, CA

Tuning Performance for SQL-on-Anything Analytics

@prestosql @starburstdata

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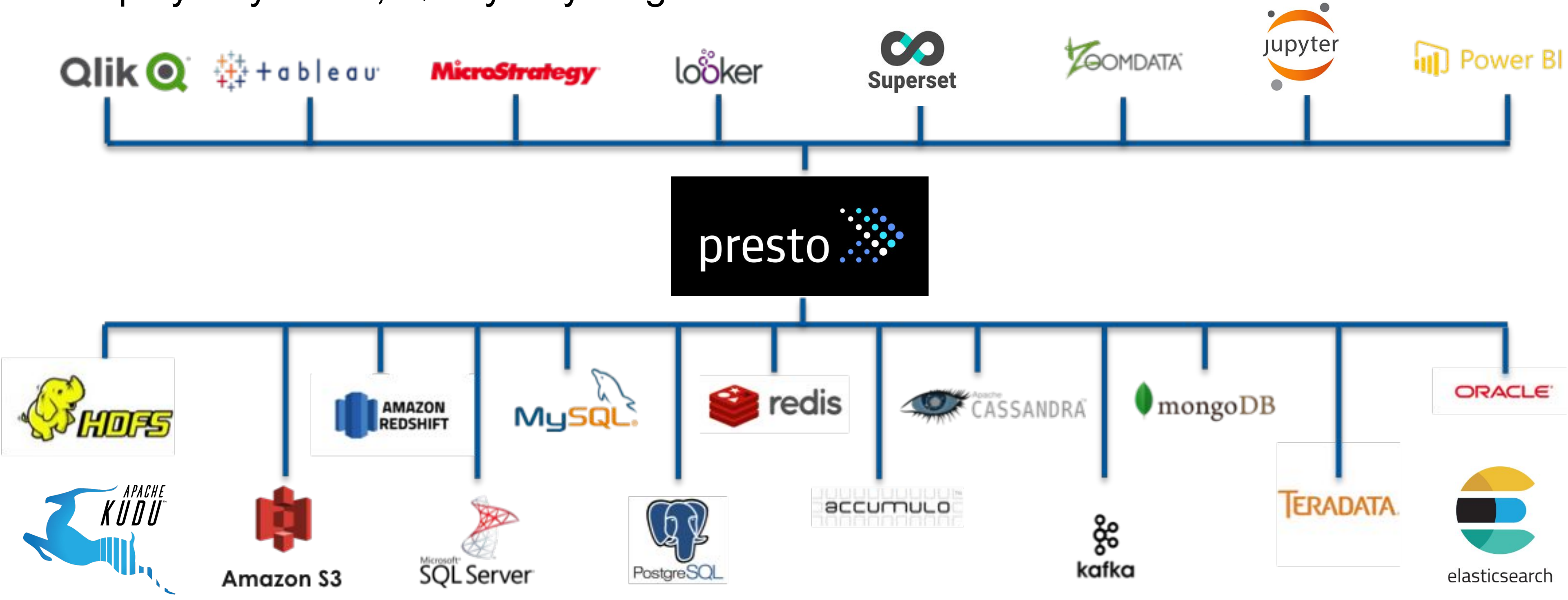
Presto: SQL-on-Anything

Deploy Anywhere, Query Anything



Why Presto?

Community-driven
open source project

High performance ANSI SQL engine

- New Cost-Based Query Optimizer
- Proven scalability
- High concurrency

Separation of compute and storage

- Scale storage and compute independently
- No ETL or data integration necessary to get to insights
- SQL-on-anything

No vendor lock-in

- No Hadoop distro vendor lock-in
- No storage engine vendor lock-in
- No cloud vendor lock-in

Project History

presto

FALL 2012

4 developers start Presto development

FALL 2013

Facebook open sources Presto

SPRING 2015

Teradata joins the community, begins investing heavily in the project

SUMMER 2017

180+ Releases
50+ Contributors
5000+ Commits

WINTER 2017

Starburst is founded by a team of Presto committers, Teradata veterans

WINTER 2019

Presto Software Foundation established

Community

See more at our Wiki

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SHAZAM Pinterest Akamai openspan

NASDAQ Dropbox CUEBIQ NETFLIX LINE

Presto in Production

Facebook: 10,000+ of nodes, HDFS (ORC, RCFile), sharded MySQL, 1000s of users

Uber: 2,000+ nodes (several clusters on premises) with 160K+ queries daily over HDFS (Parquet/ORC)

Twitter: 2,000+ nodes (several clusters on premises and GCP), 20K+ queries daily (Parquet)

LinkedIn: 500+ nodes, 200K+ queries daily over HDFS (ORC), and ~1000 users

Lyft: *------ redacted due to the quiet period for the IPO -----------*

Netflix: 300+ nodes in AWS, 100+ PB in S3 (Parquet)

Yahoo! Japan: 200+ nodes for HDFS (ORC), and ObjectStore

FINRA: 120+ nodes in AWS, 4PB in S3 (ORC), 200+ users

Starburst Data

The Presto Experts.

Founded by Presto committers:

- Over 4 years of contributions to Presto
- Presto distro for on-prem and cloud env
- Supporting large customers in production
- Enterprise subscription add-ons (ODBC, Ranger, Sentry, Oracle, Teradata)

Notable features contributed:

- ANSI SQL syntax enhancements
- Execution engine improvements
- Security integrations
- Spill to disk
- Cost-Based Optimizer

https://www.starburstdata.com/presto-enterprise/

Performance

Built for Performance

Query Execution Engine:

- MPP-style **pipelined** in-memory execution
- **Columnar** and **vectorized** data processing
- Runtime query **bytecode compilation**
- Memory **efficient** data structures
- Multi-threaded multi-core execution
- Optimized readers for **columnar formats** (ORC and Parquet)
- Predicate and column projection **pushdown**
- Now also **Cost-Based Optimizer**

CBO in a nutshell

Presto Cost-Based Optimizer includes:

- support for **statistics** stored in Hive Metastore
- **join reordering** based on selectivity estimates and cost
- automatic **join type** selection (repartitioned vs broadcast)
- automatic left/right side selection for joined tables

https://www.starburstdata.com/technical-blog/

Statistics & Cost

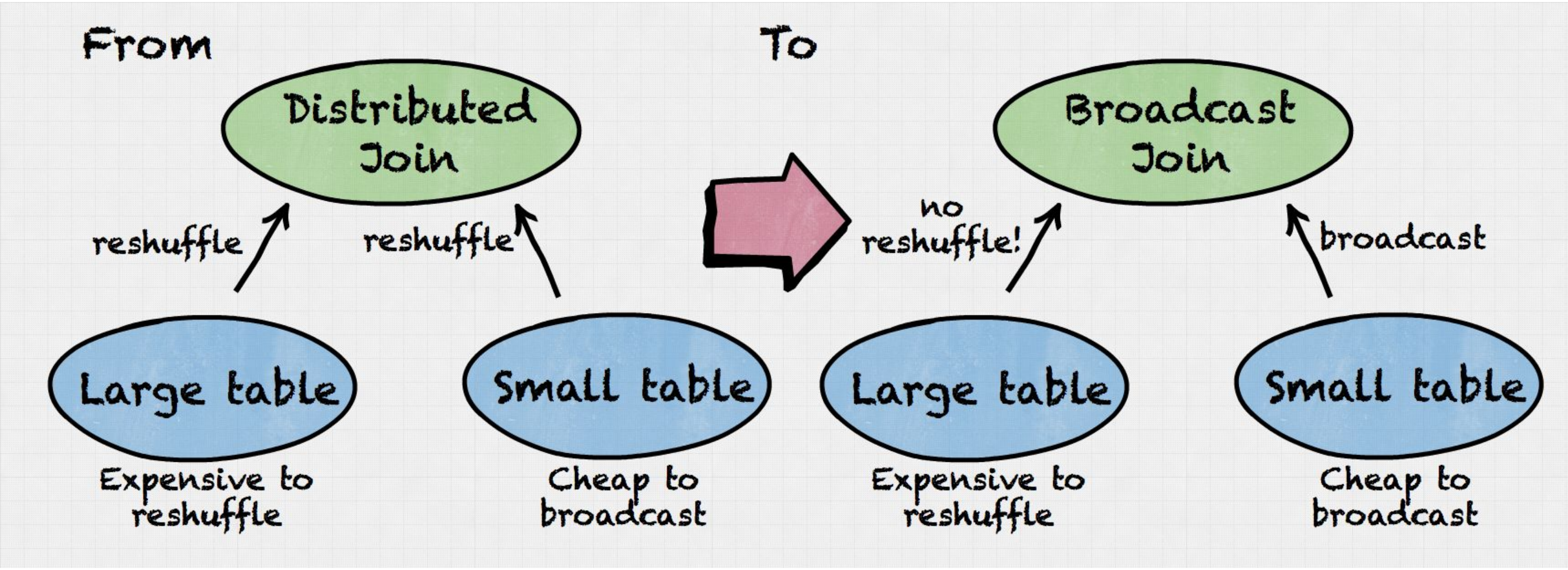
Hive Metastore statistics:

- number of rows in a table
- number of distinct values in a column
- fraction of NULL values in a column
- minimum/maximum value in a column
- average data size for a column

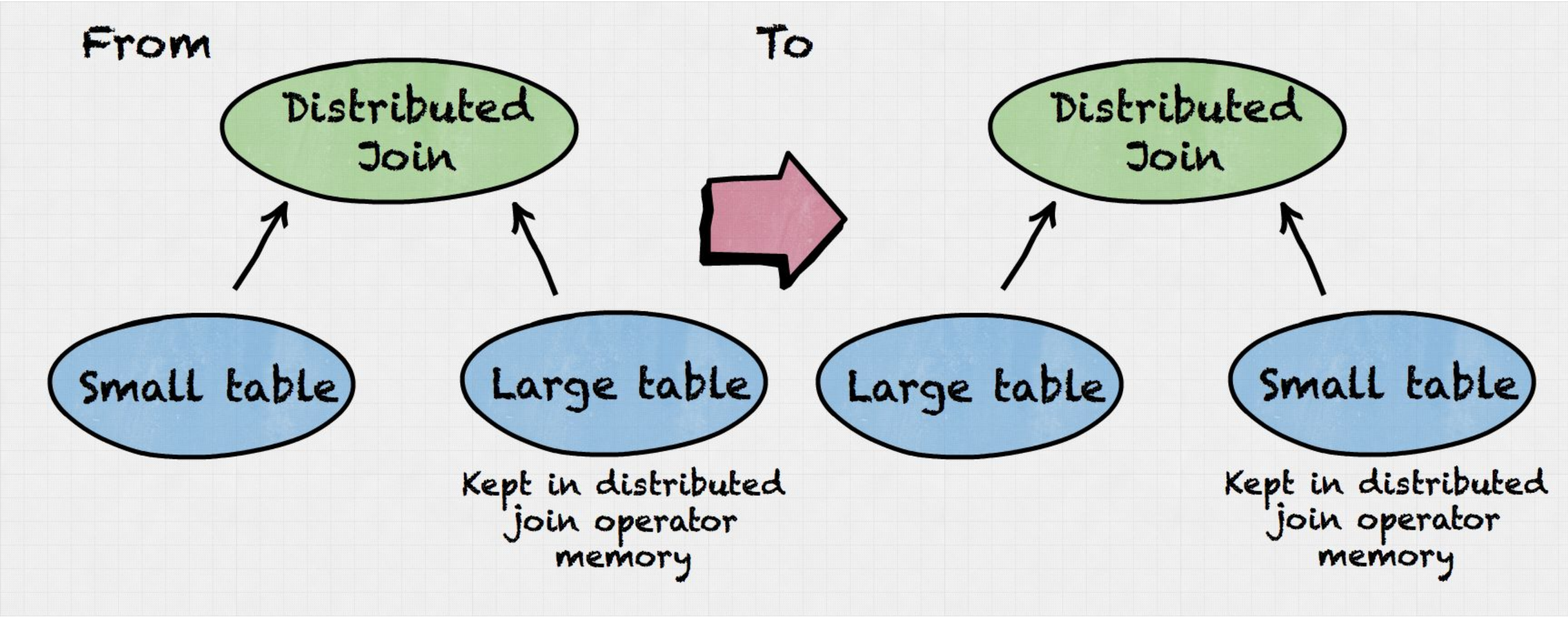
Cost calculation includes:

- CPU
- Memory
- Network I/O

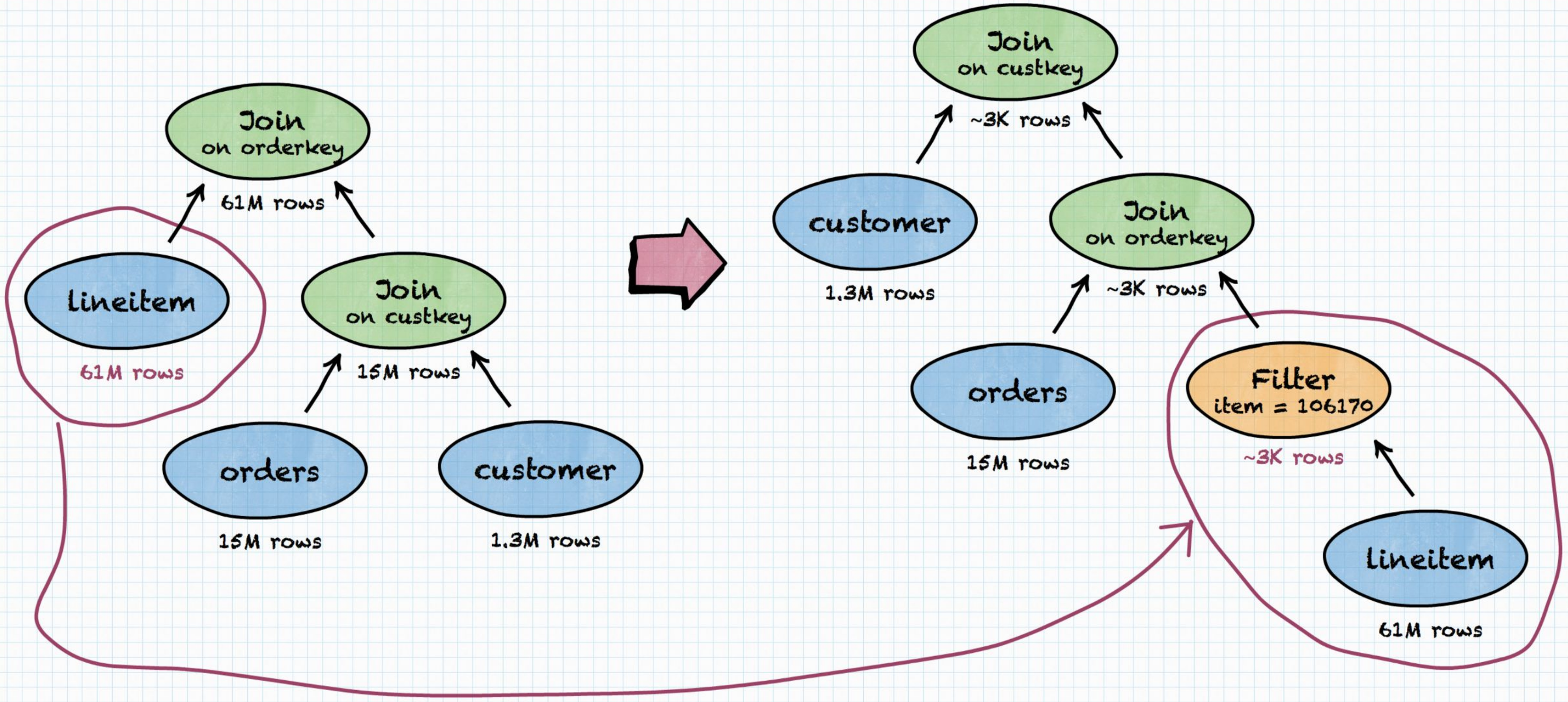
Join type selection



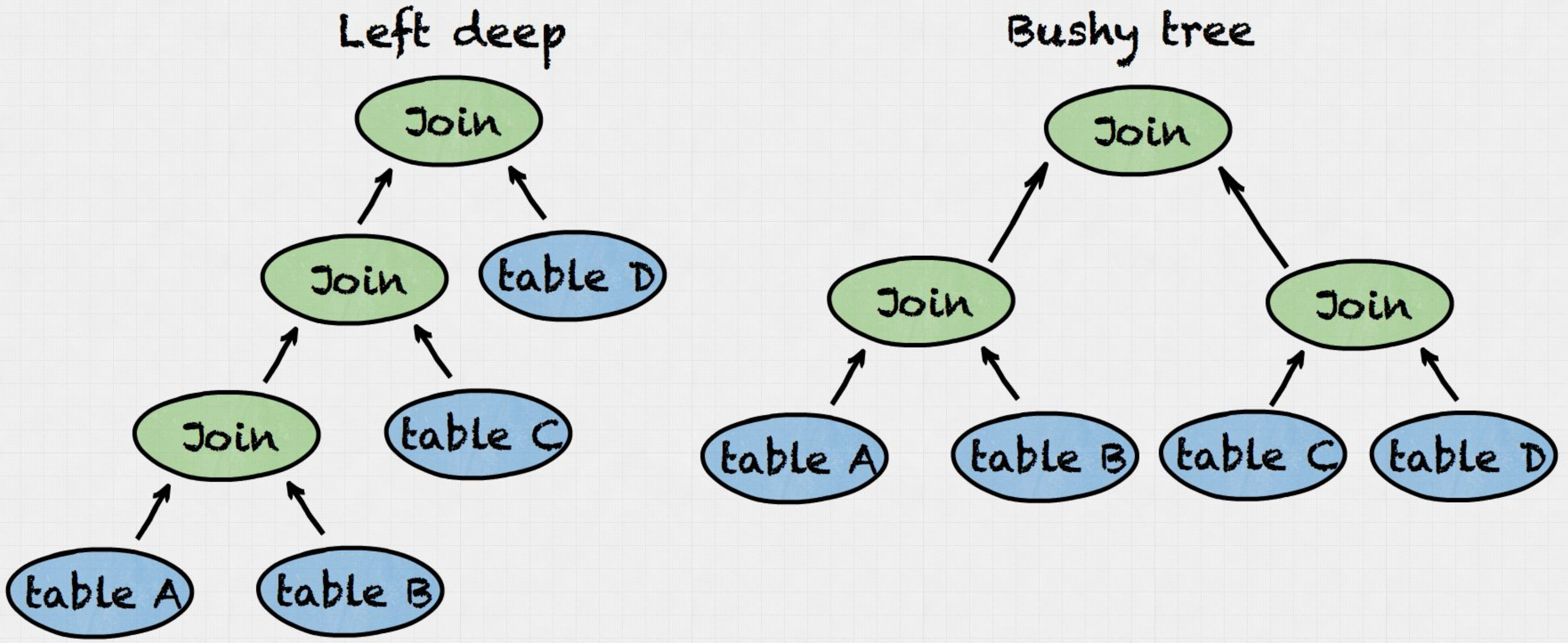
Join left/right side decision



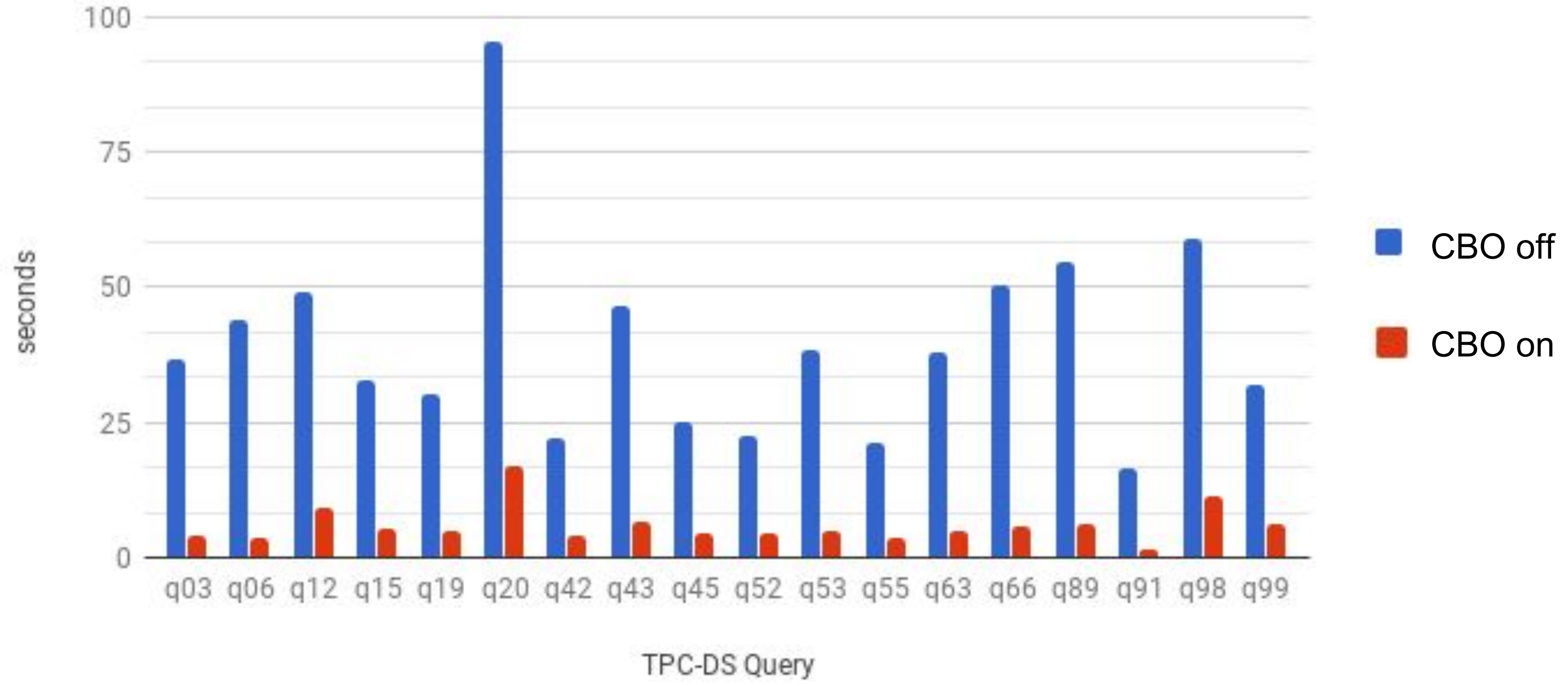
Join reordering with filter



Join tree shapes



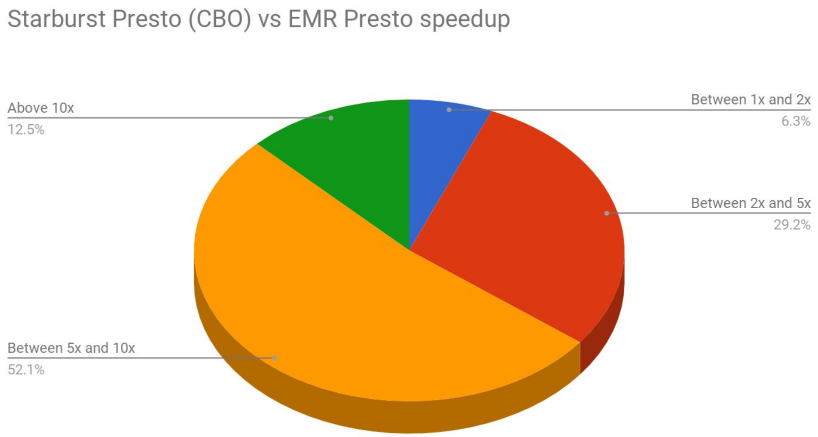
Benchmark results

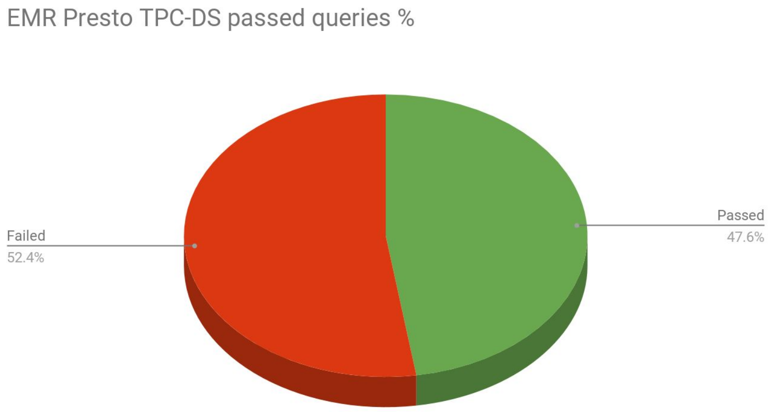


https://www.starburstdata.com/presto-benchmarks/

Benchmark results

- on average 7x improvement vs EMR Presto
- EMR Presto cannot execute many TPC-DS queries
- All TPC-DS queries pass on Starburst Presto





https://www.starburstdata.com/presto-aws/

Recent CBO enhancements

- Deciding on semi-join distribution type based on cost
- Support for outer joins
- Capping a broadcasted table size
- Various minor fixes in cardinality estimation
- ANALYZE table (native in Presto)
- Stats for AWS Glue Catalog (exclusive from Starburst)

Current and Future work

What’s next for Optimizer

- Stats support
    - Improved stats for Hive
    - Stats for DBMS connectors and NoSQL connectors
    - Tolerate missing / incomplete stats
- Core CBO enhancements
    - Cost more operators
    - Adjust cost model weights based on the hardware
    - Adaptive optimizations
    - Introduce Traits
- Involve connectors in optimizations

Involving Connectors in Optimization

History and Current State

- Original motivation: partition pruning for queries over Hive tables
- Simple range predicates and nullability checks passed to connectors. Modeled as `TupleDomain`

```
((col0 BETWEEN ? AND ?) **OR** (col0 BETWEEN ? and ?) **OR** …))
                          AND
((col1 BETWEEN ? AND ?) **OR** (col1 BETWEEN ? and ?) **OR** …))
                          AND
                          ...
```

History and Current State

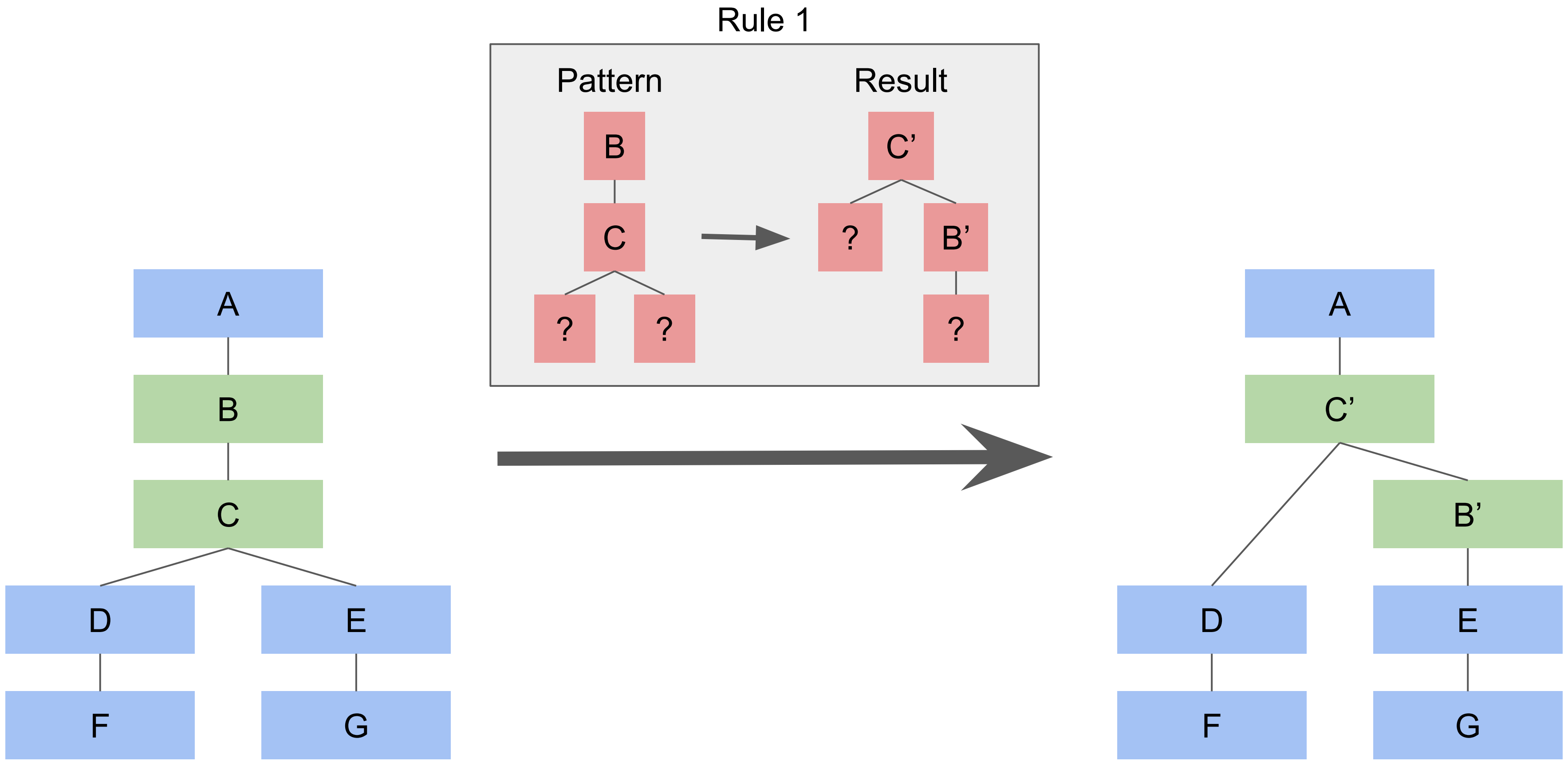
- Partial evaluation of non-trivial expressions
  - Bind only known variables
  - Result in "true/false/null" or "can't tell”. E.g.,

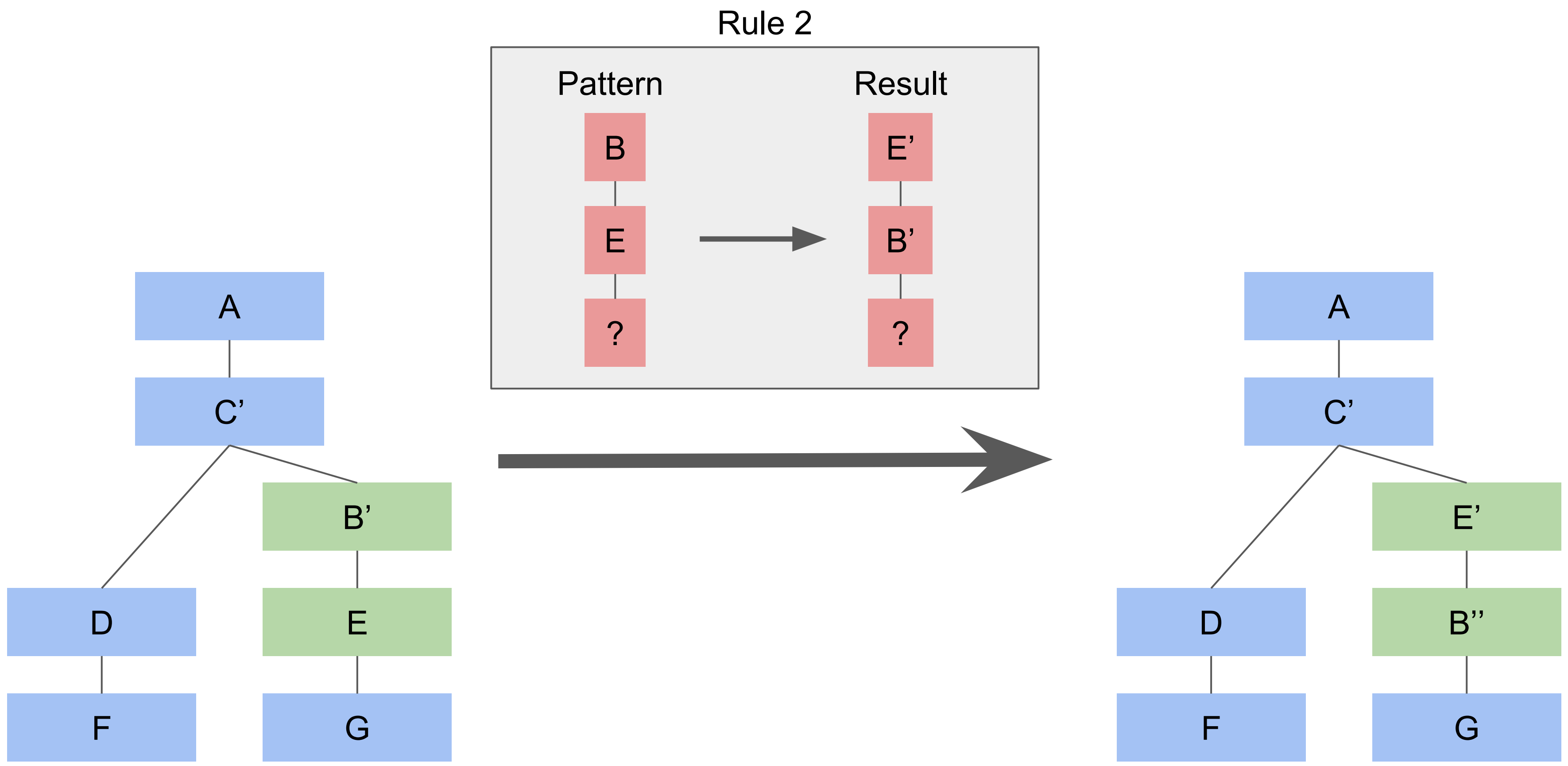
```
f(a, b) := lower(a) LIKE ‘john%’ AND b = 1

f(‘Mary’,   ?) ⟶ false ⟶ can prune
f(‘John S’, ?) ⟶ b = 1 ⟶ ¯\_(ツ)_/¯
```

Beyond Simple Filter Pushdown...

- Dereference expressions. E.g., `x.a > 5`
- Array/map subscript. E.g., `a[‘key’] = 10`
- Complex filters and projections
- Aggregations
- Joins
- Limit: ~~https://github.com/prestosql/presto/pull/421~~
- Sampling
- Others…

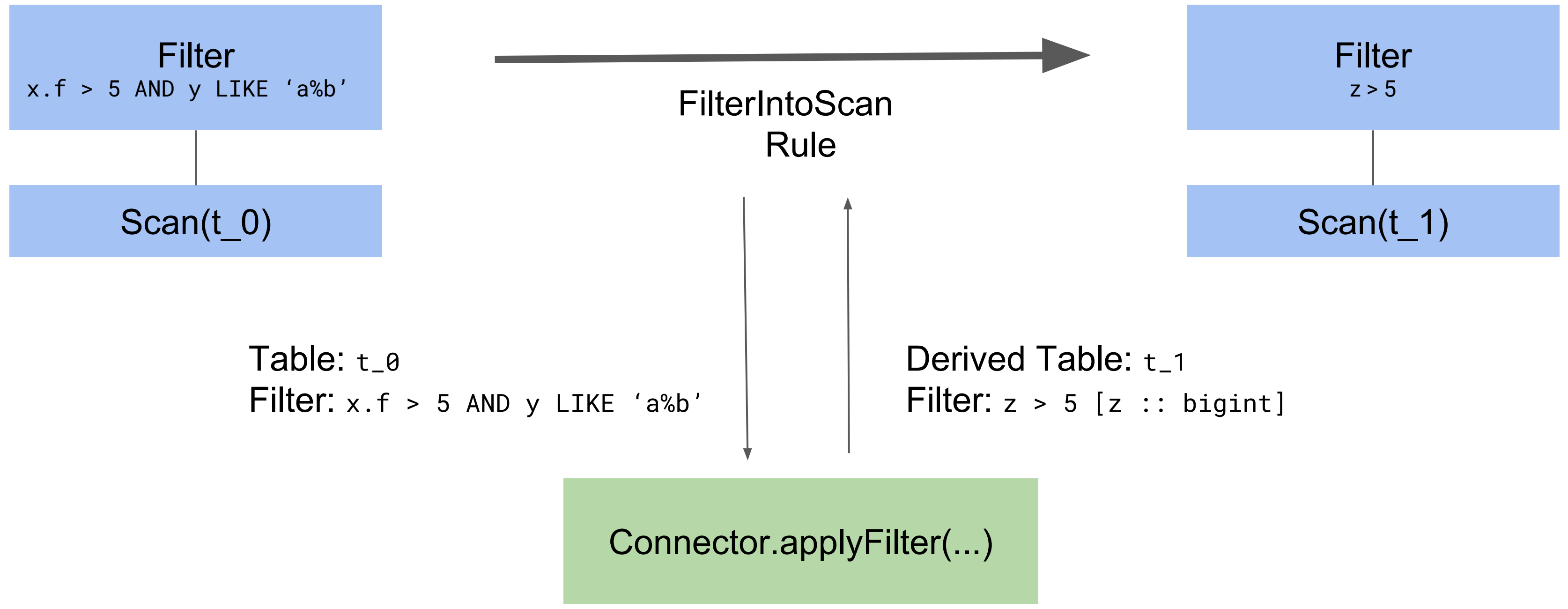
https://github.com/prestosql/presto/issues/18


Rule 1
Pattern
Result
B
C
?
?
C'
?
B'
?
A
B
C
D
E
F
G
A
C'
B'
D
E
F
G


Rule 2
Pattern
Result
B
E
?
E'
B'
?
A
C'
B'
D
E
F
G
A
C'
E'
D
B''
F
G

```
SELECT count(*)
FROM t
WHERE x.f > 5 AND y LIKE ‘a%b’
```

```
Table t
   x :: row(f bigint, g bigint)
   y :: varchar(10)
```



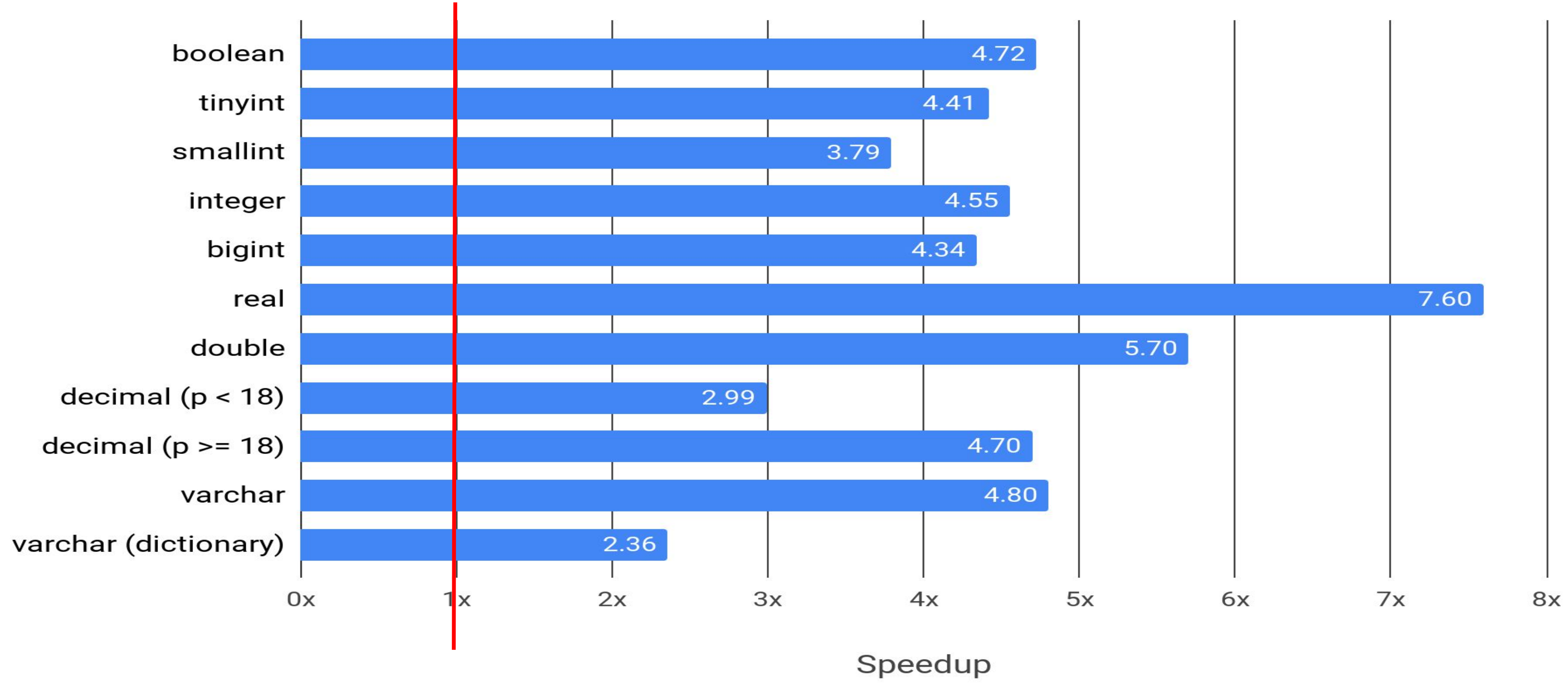
New Connector APIs

```
applyFilter(ConnectorTableHandle table, Expression filter)

applyLimit(ConnectorTableHandle table, long limit)

applyAggregation(ConnectorTableHandle table, List<Aggregation> aggregates)

applySampling(ConnectorTableHandle table, double samplingRate)

...
```

Performance Benefits (?)

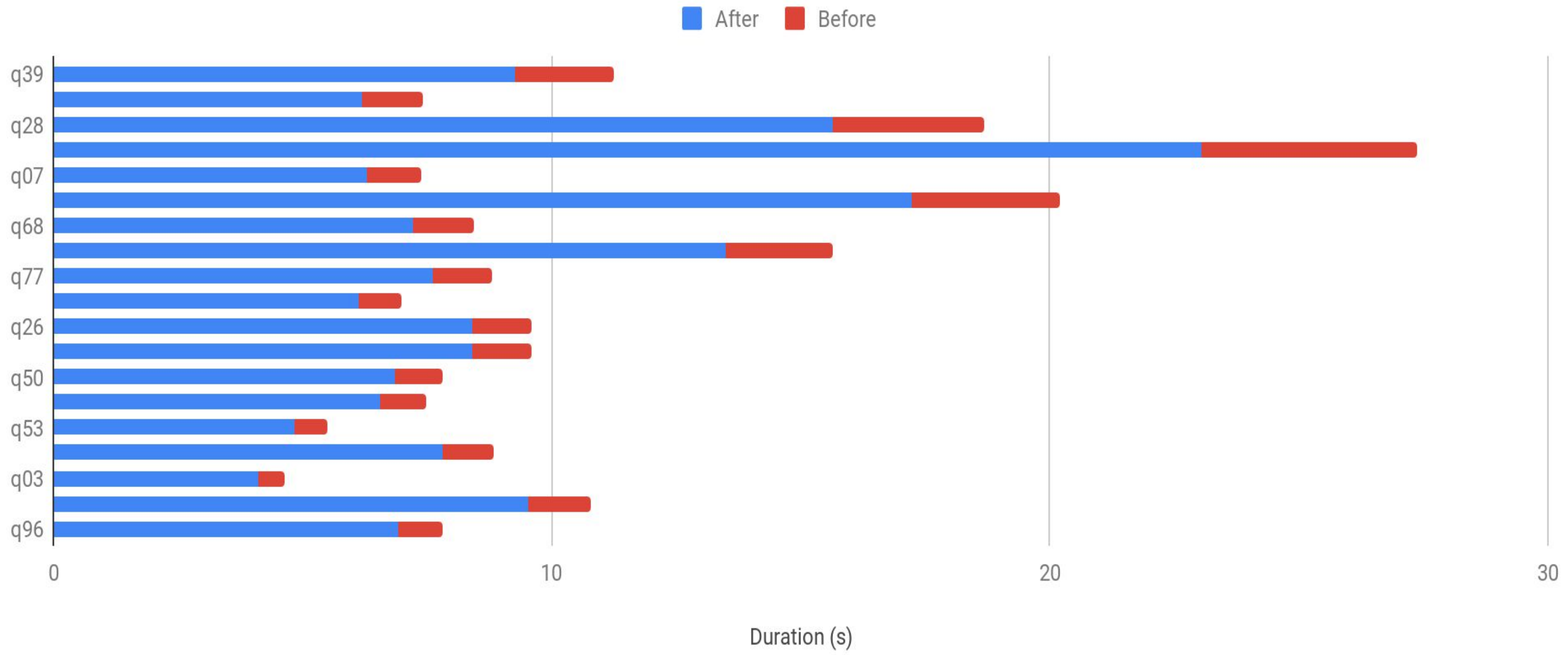
- Better support for sophisticated backend systems
  - Druid, Pinot, ElasticSearch
  - SQL databases
- Improved performance for columnar data formats (Parquet, ORC)

ORC Performance Improvements



https://github.com/prestosql/presto/pull/555

ORC Performance Improvements - TPC-DS



Project Roadmap

- Coordinator HA
- Kubernetes
- Dynamic filtering
- Connectors
    - Phoenix
    - Iceberg
    - Druid
- TIMESTAMP semantics
- And more… https://github.com/prestosql/presto/labels/roadmap

Getting Involved

- Join us on Slack
  - Invite link: https://prestosql.io/community.html
- Github: https://github.io/prestosql/presto
- Website: https://prestosql.io

Further reading

https://www.starburstdata.com/presto-newsletter/

https://fivetran.com/blog/warehouse-benchmark

https://www.concurrencylabs.com/blog/starburst-presto-vs-aws-emr-sql/

http://bytes.schibsted.com/bigdata-sql-query-engine-benchmark/

https://virtuslab.com/blog/benchmarking-spark-sql-presto-hive-bi-processing-googles-cloud-dataproc/

Thank You!

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