MariaDB & MySQL community event,
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# MariaDB 10.0 Optimizer

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# MySQL/MariaDB Optimizer history

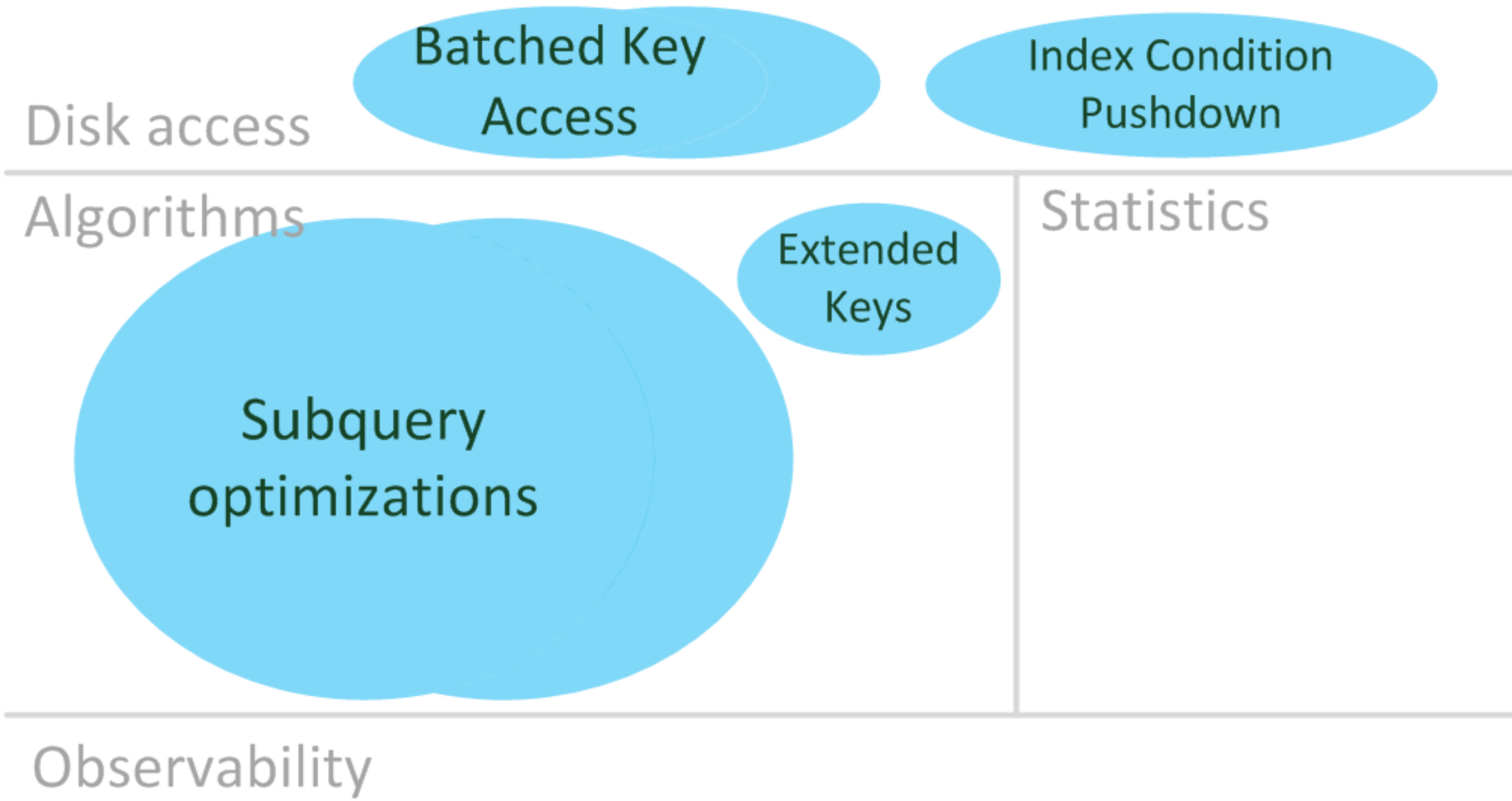
Disk access

Algorithms

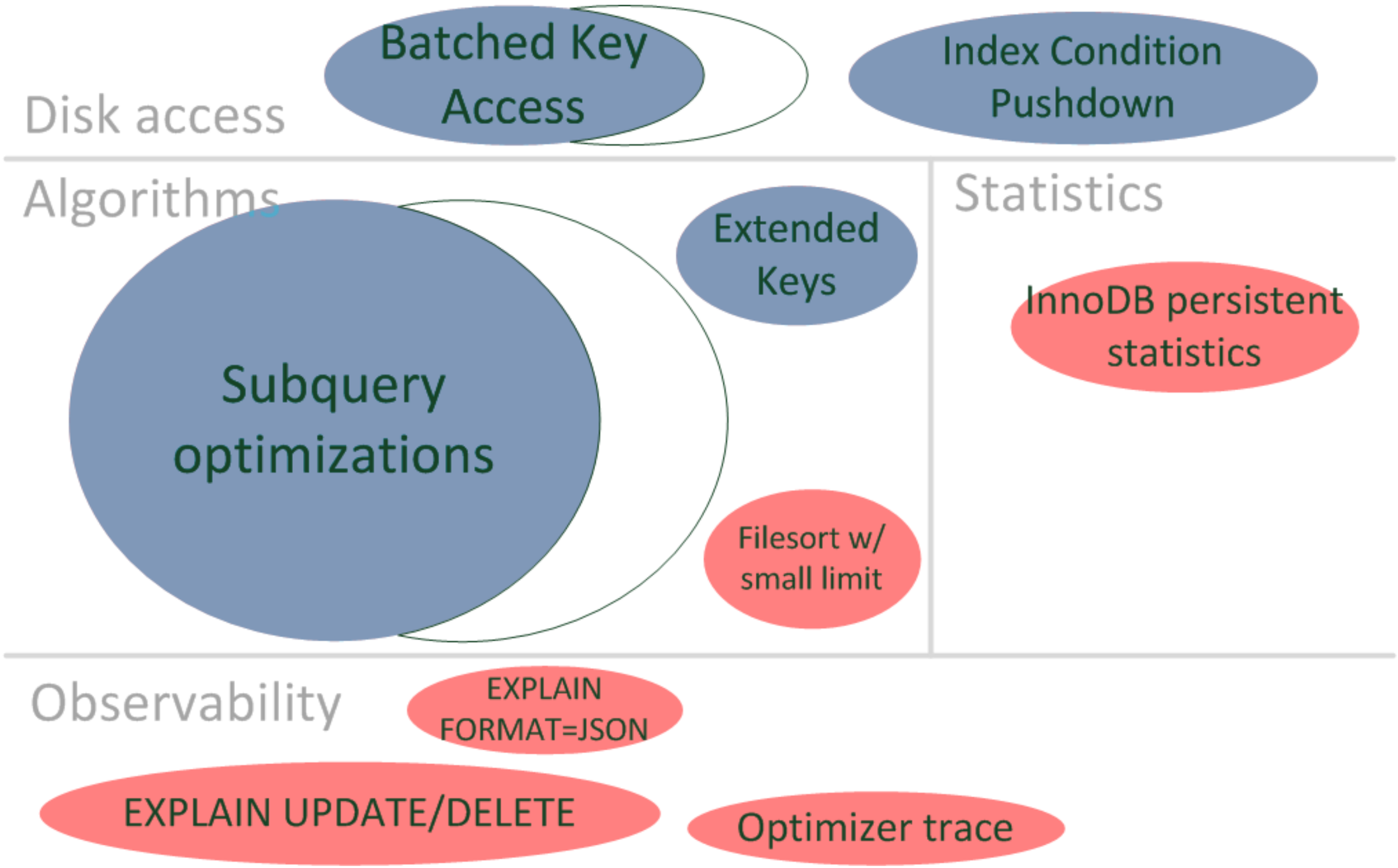
Statistics

Observability

# MariaDB 5.5


Disk access
Batched Key Access
Index Condition Pushdown
Algorithms
Extended Keys
Subquery optimizations
Statistics
Observability

# MySQL 5.6



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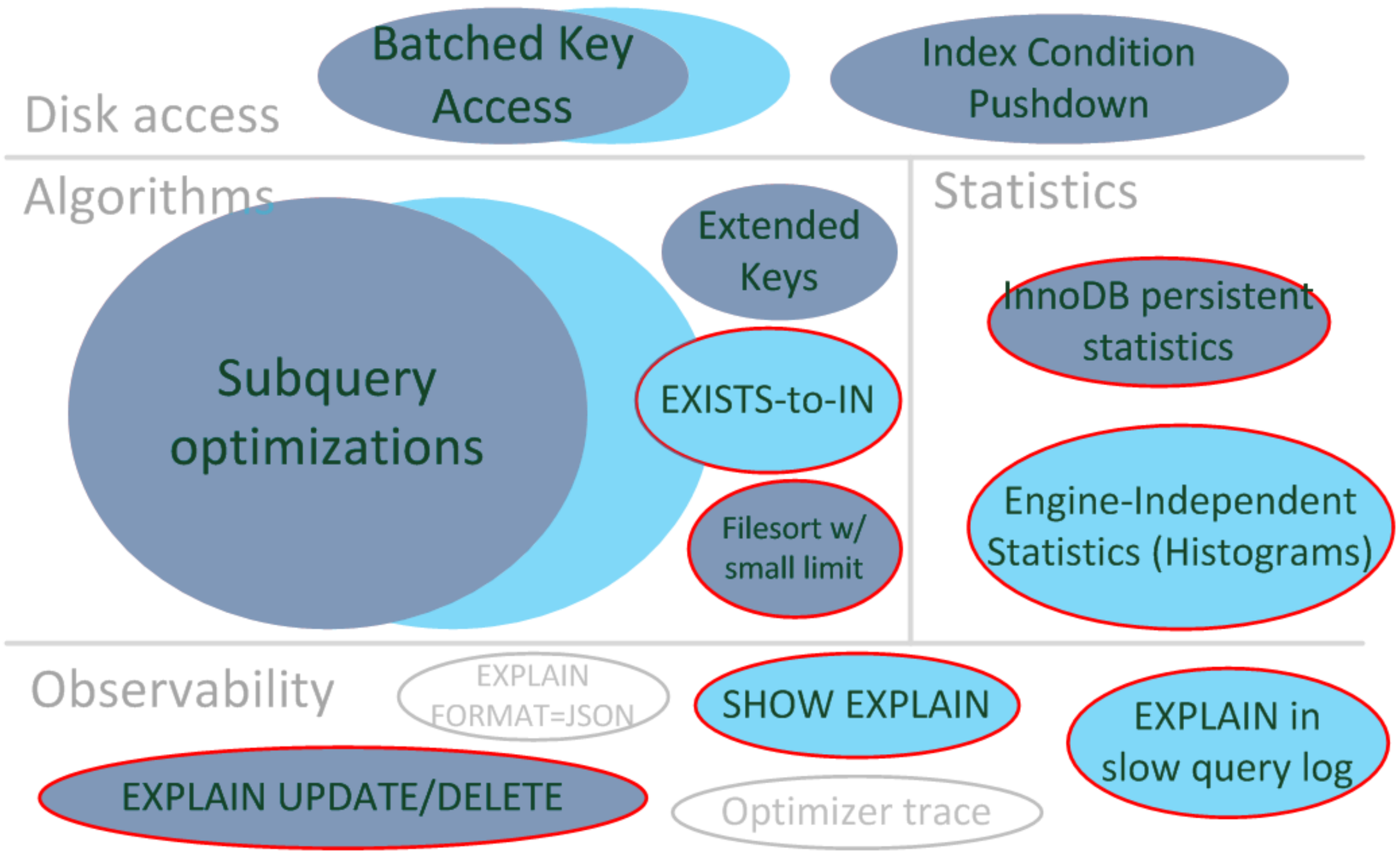
# MariaDB 10.0


Disk access
Batched Key Access
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Subquery optimizations
Extended Keys
EXISTS-to-IN
Filesort w/ small limit
Statistics
InnoDB persistent statistics
Engine-Independent Statistics (Histograms)
Observability
EXPLAIN FORMAT=JSON
SHOW EXPLAIN
EXPLAIN in slow query log
EXPLAIN UPDATE/DELETE
Optimizer trace

# New features in MariaDB 10.0 Optimizer

- Statistics
  - Engine-independent statistics (Histograms)
- Algorithms
  - Subquery optimizations: EXISTS-to-IN
- EXPLAIN improvements
  - SHOW EXPLAIN
  - EXPLAIN in the slow query log
  - EXPLAIN for UPDATE/DELETE

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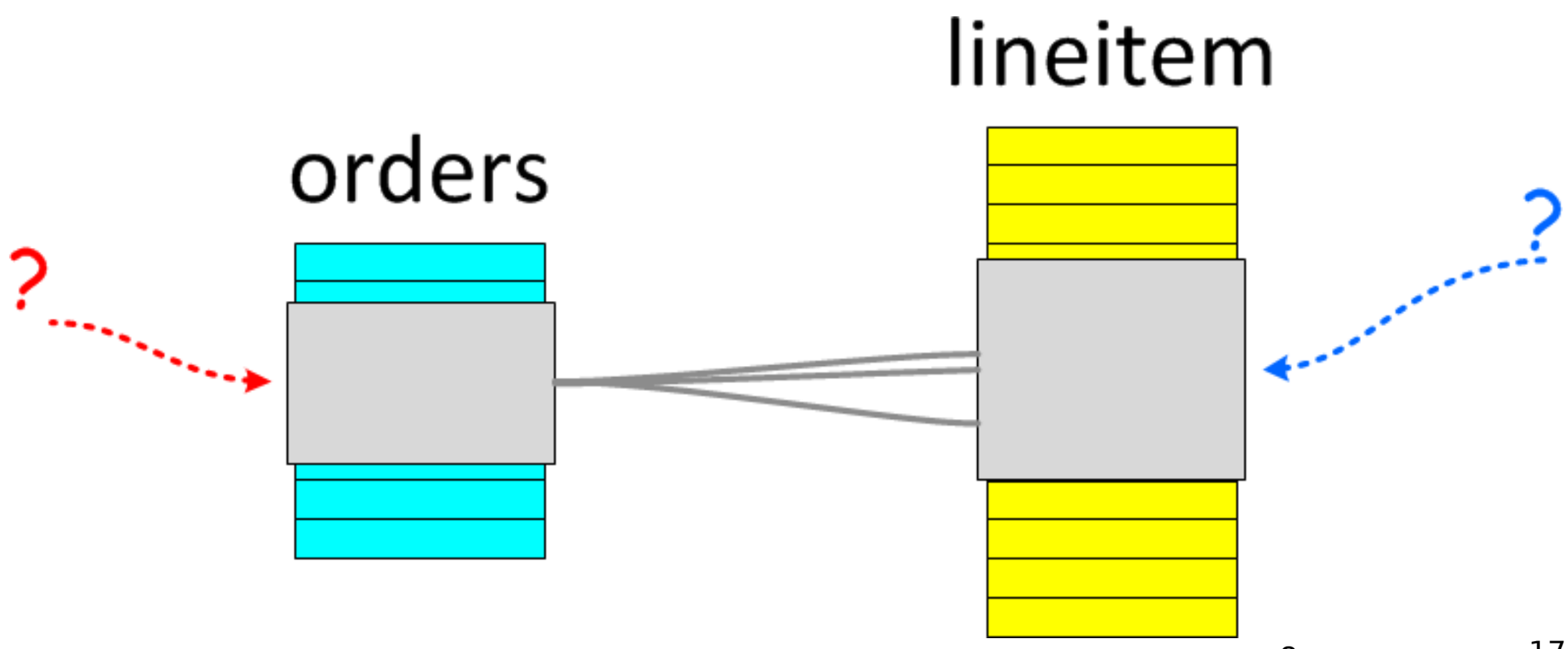
# Query optimizer needs statistics

```
select *
from
   lineitem, orders
where
   o_orderkey=l_orderkey and
   o_orderdate between '1990-01-01' and '1998-12-06' and
   l_extendedprice > 1000000
```



# Sources of statistics

- Total number of rows in table
  - orders - …
  - lineitem -...

```
select *
from
  lineitem, orders
```

- Number of rows that match parts of WHERE

```
where
  o_orderkey=l_orderkey and
  o_orderdate between '1990-01-01' and '1998-12-06' and
  l_extendedprice > 1000000;
```

  - “key CMP const” - range condition
    - Precise estimates
    - Requires an index
      - B-Tree index dives
    - Expensive to get.

# Sources of statistics (2)

```
where
  o_orderkey=l_orderkey and
  o_orderdate between '1990-01-01' and '1998-12-06' and
  l_extendedprice > 1000000;
```

- **`orders.o_orderkey=...`**
  **`lineitem.l_orderkey=...`**
  - “how many lineitem-s for some $orderkey”?
  - Index statistics
- InnoDB
  - Random sampling (**`innodb_stats_sample_pages`**)
  - At “random” times
- MySQL 5.6: persistent statistics
  - Still random sampling.

# Problems with statistics

- Index statistics: randomness
  - Collected via sampling
  - Different query plans
    - Even for DBT-3 benchmark
  - InnoDB Persistent Statistics is a partial solution
- Not index? no statistics
  - not_indexed_column= 'foo'
  - key_column2= 'bar'.

# MariaDB 10.0: Engine independent statistics

- No random sampling
  - ANALYZE TABLE makes full table scan
    - No auto-updates
  - Statistics is deterministic
- More statistics data
  - #rows in the table (same)
  - Index statistics: cardinality (same)
  - +Statistics on non-indexed columns
    - +MIN/MAX values
    - +Frequency
    - +#NULL values
    - +Histograms.

# New statistics test run

```
select *
from
  lineitem, orders
where
  o_orderkey=l_orderkey and
  o_orderdate between '1990-01-01' and '1998-12-06' and
  l_extendedprice > 1000000
```

| id | select_type | table | type | possible_keys | key | key_len | ref | rows | filtered | Extra |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SIMPLE | orders | ALL | PRIMARY | NULL | NULL | NULL | 1494230 | 100.00 | Using where |
| 1 | SIMPLE | lineitem | ref | PRIMARY,i_... | PRIMARY | 4 | orders.o_orderkey | 2 | 100.00 | Using where |

- 4.2 seconds
- filtered=100%
  - Close to truth for `o_orderdate between ...`
  - Far from truth for `l_extendedprice > 1000000.`

# New statistics test run (2)

- Collect table statistics

```
set histogram_size=200;
set use_stat_tables='preferably'
analyze table lineitem, orders;
+-----------------+---------+----------+-----------------------------------+
| Table           | Op      | Msg_type | Msg_text                          |
+-----------------+---------+----------+-----------------------------------+
| dbt3sf1.lineitem | analyze | status   | Engine-independent statistics collected |
| dbt3sf1.lineitem | analyze | status   | OK                                |
| dbt3sf1.orders   | analyze | status   | Engine-independent statistics collected |
| dbt3sf1.orders   | analyze | status   | OK                                |
+-----------------+---------+----------+-----------------------------------+
```

- Make the optimizer use it

```
set optimizer_use_condition_selectivity=4;
```

# New statistics test run (3)

- Re-run the query

```
select *
from
  lineitem, orders
where
  o_orderkey=l_orderkey and
  o_orderdate between '1990-01-01' and '1998-12-06' and
  l_extendedprice > 1000000
```

| id | select_type | table | type | possible_keys | key | key_len | ref | rows | filtered | Extra |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | SIMPLE | lineitem | ALL | PRIMARY,i_... | NULL | NULL | NULL | 6001215 | 0.50 | Using where |
| 1 | SIMPLE | orders | eq_ref | PRIMARY | PRIMARY | 4 | lineitem.l_orderkey | 1 | 99.50 | Using where |

- lineitem.filtered=0.5% - `l_extendedprice > 1000000`
- 1.5 sec (from 4.2 sec)
  - Can be more for many-table joins.

# New statistics summary

- Persistent, stable statistics
- Statistics for
  - Indexes
  - Columns (Histograms)
- Need to enable it and collect manually

1. Collect statistics

```
set histogram_size=...;
set use_stat_tables='preferably'  -- 'complementary'
analyze table tbl [persistent for columns (...) indexes (...)]
```

2. Make optimizer use it

```
set optimizer_use_condition_selectivity = 4;
```

3. Watch EXPLAIN EXTENDED, filtered%.

# Further details

- Documentation update pending
  - Will blog
- Percona Live talk today:
  - **MariaDB Optimizer: See? No indexes!**
  - 4:30PM - 5:20PM @ Ballroom E.

# New features in MariaDB 10.0 Optimizer

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- Algorithms
  - Subquery optimizations: EXISTS-to-IN
- EXPLAIN improvements
  - SHOW EXPLAIN
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  - EXPLAIN for UPDATE/DELETE

# Subquery optimizations background

- Traditional way: “straightforward” subquery execution

```
select * from customer
where
  customer.c_acctbal < 0 and
  exists (select 1
          from orders
          where
            orders.o_custkey= customer.c_custkey AND
            orders.o_orderDATE between $DAY1 and $DAY2)
```

| id | select_type | table | type | possible_keys | key | key_len | ref | rows | Extra |
|---|---|---|---|---|---|---|---|---|---|
| 1 | PRIMARY | customer | ALL | c_acctbal,i_c_acctbal_nationkey | NULL | NULL | NULL | 150303 | Using where |
| 2 | DEPENDENT SUBQUERY | orders | ref | i_o_orderdate,i_o_custkey | i_o_custkey | 5 | customer.c_custkey | 7 | Using where |

# Subquery optimizations background

- Traditional way: “straightforward” subquery execution

```
select * from customer
where
  customer.c_acctbal < 0 and
  exists (select 1
          from orders
          where
            orders.o_custkey= customer.c_custkey AND
            orders.o_orderDATE between $DAY1 and $DAY2)
```

- Outer-to-inner execution
- Every subquery re-execution re-runs it from the start
  - MariaDB 5.5 added subquery predicate cache.

# MariaDB 5.5, MySQL 5.6

Lots of optimizations for IN (SELECT ...)

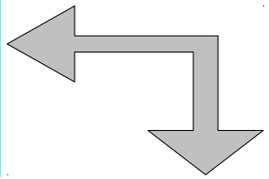
- Materialization
  - Subquery must be uncorrelated
- Semi-join optimizations
  - Both inner-to-outer and outer-to-inner execution
  - Materialization
  - Join-like execution methods

```
select * from customer
where
  customer.c_acctbal < 0 and
  customer.c_custkey IN (select orders.o_custkey
                         from orders
                         where
                            orders.o_orderDATE between ...)
```

# MariaDB 10.0 – EXISTS subqueries

1.Convert EXISTS into semi-join

```
select * from customer
where
  customer.c_acctbal < 0 and
  exists (select 1
          from orders
          where
            orders.o_custkey= customer.c_custkey AND
            orders.o_orderDATE between $DAY1 and $DAY2)
```



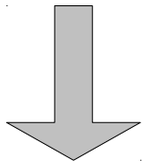
Semi-join optimizations

- Both inner-to-outer and outer-to-inner execution
- Join-like execution methods

# MariaDB 10.0 – EXISTS subqueries

2. Convert **trivially-correlated** EXISTS into IN

```
EXISTS (select 1
        from orders
        where
          orders.o_custkey=customer.c_custkey AND
          orders.o_orderDATE between $DAY1 and $DAY2)
```



```
orders.o_custkey IN (select customer.c_custkey
                     from orders
                     where
                       orders.o_orderDATE between $DAY1 and $DAY2)
```

Uncorrelated subquery => can use Materialization

# EXISTS-to-IN summary

- Enables new subquery optimizations for EXISTS
  - WHERE EXISTS(...) gets semi-joins
    - Inner-to-outer execution
  - Trivially-correlated EXISTS get Materialization
- How to use
  - `set optimizer_switch='exists_to_in=on'`
  - Enjoy

# New features in MariaDB 10.0 Optimizer

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# SHOW EXPLAIN

- Shows EXPLAIN of a running query

```
client1> select count(*) from customer, orders, nation where c_custkey=o_custkey and c_nationkey=n_nationkey ...
```

```
client2> show processlist;
+----+------+-----------+------+---------+------+--------------+-------------------------------------------------------
| Id | User | Host      | db   | Command | Time | State        | Info
+----+------+-----------+------+---------+------+--------------+-------------------------------------------------------
|  2 | root | localhost | test | Query   |    0 | init         | show processlist
|  3 | root | localhost | db   | Query   |    4 | Sending data | select count(*) from customer, orders, nation where ...
+----+------+-----------+------+---------+------+--------------+-------------------------------------------------------
```

```
client2> show explain for 3;
+------+-------------+----------+------+---------------+---------------+---------+-----------------------+-------+-------------
| id   | select_type | table    | type | possible_keys | key           | key_len | ref                   | rows  | Extra
+------+-------------+----------+------+---------------+---------------+---------+-----------------------+-------+-------------
|    1 | SIMPLE      | nation   | ALL  | PRIMARY       | NULL          | NULL    | NULL                  |    25 | Using where
|    1 | SIMPLE      | customer | ref  | i_c_nationkey | i_c_nationkey | 5       | db.nation.n_nationkey | 83512 | Using index
|    1 | SIMPLE      | orders   | ref  | i_o_custkey   | i_o_custkey   | 5       | db.customer.c_custkey |     8 | Using index
+------+-------------+----------+------+---------------+---------------+---------+-----------------------+-------+-------------
3 rows in set, 1 warning (0.00 sec)

client2> show warnings;
+-------+------+-------------------------------------------------------------------------------------------------------------
| Level | Code | Message
+-------+------+-------------------------------------------------------------------------------------------------------------
| Note  | 1003 | select count(*) from customer, orders, nation where c_custkey=o_custkey and c_nationkey=n_nationkey and n_name
+-------+------+-------------------------------------------------------------------------------------------------------------
```

# SHOW EXPLAIN (2)

- SHOW EXPLAIN vs EXPLAIN $query_str
  - Can see exactly what query plan is running
  - EXPLAIN $query_str can be difficult
    - @session_vars
    - Per-connection settings (@@optimizer_switch?)
    - temporary tables
    - Uncommitted changes in a transaction
    - Etc, etc
- MySQL 5.7: EXPLAIN FOR CONNECTION $id

# EXPLAIN in the slow query log

- log_slow_verbosity=explain

**my.cnf**

```
...
slow-query-log
long-query-time=1
log-slow-verbosity=query_plan,explain
```

**$datadir/hostname-slow.log**

```
# Time: 140402  6:55:35
# User@Host: root[root] @ localhost []
# Thread_id: 2  Schema: dbt3sf10  QC_hit: No
# Query_time: 15.532745  Lock_time: 0.378632  Rows_sent: 1  Rows_examined: 661743
# Full_scan: Yes  Full_join: No  Tmp_table: No  Tmp_table_on_disk: No
# Filesort: No  Filesort_on_disk: No  Merge_passes: 0
#
# explain: id    select_type      table    type     possible_keys    key      key_len  ref      rows  Extra
# explain: 1     SIMPLE   nation   ALL      PRIMARY  NULL     NULL     NULL     25       Using where
# explain: 1     SIMPLE   customer ref      i_c_nationkey    i_c_nationkey    5        db.nation.n_nationkey 82649    Us
# explain: 1     SIMPLE   orders   ref      i_o_custkey      i_o_custkey      5        db.customer.c_custkey 7    Using
#
use dbt3sf10;
SET timestamp=1396446935;
select count(*) from customer, orders, nation where c_custkey=o_custkey and c_nationkey=n_nationkey and n_name='GERMA
```

# EXPLAIN in the slow query log (2)

```
# Time: 140402  6:55:35
# User@Host: root[root] @ localhost []
# Thread_id: 2  Schema: dbt3sf10  QC_hit: No
# Query_time: 15.532745  Lock_time: 0.378632  Rows_sent: 1  Rows_examined: 661743
# Full_scan: Yes  Full_join: No  Tmp_table: No  Tmp_table_on_disk: No
# Filesort: No  Filesort_on_disk: No  Merge_passes: 0
#
# explain: id    select_type      table    type     possible_keys    key      key_len  ref      rows  Extra
# explain: 1     SIMPLE   nation   ALL      PRIMARY  NULL     NULL     NULL     25       Using where
# explain: 1     SIMPLE   customer ref      i_c_nationkey    i_c_nationkey    5        db.nation.n_nationkey 82649    Us
# explain: 1     SIMPLE   orders   ref      i_o_custkey      i_o_custkey      5        db.customer.c_custkey 7    Using
#
use dbt3sf10;
SET timestamp=1396446935;
select count(*) from customer, orders, nation where c_custkey=o_custkey and c_nationkey=n_nationkey and n_name='GERMA
```

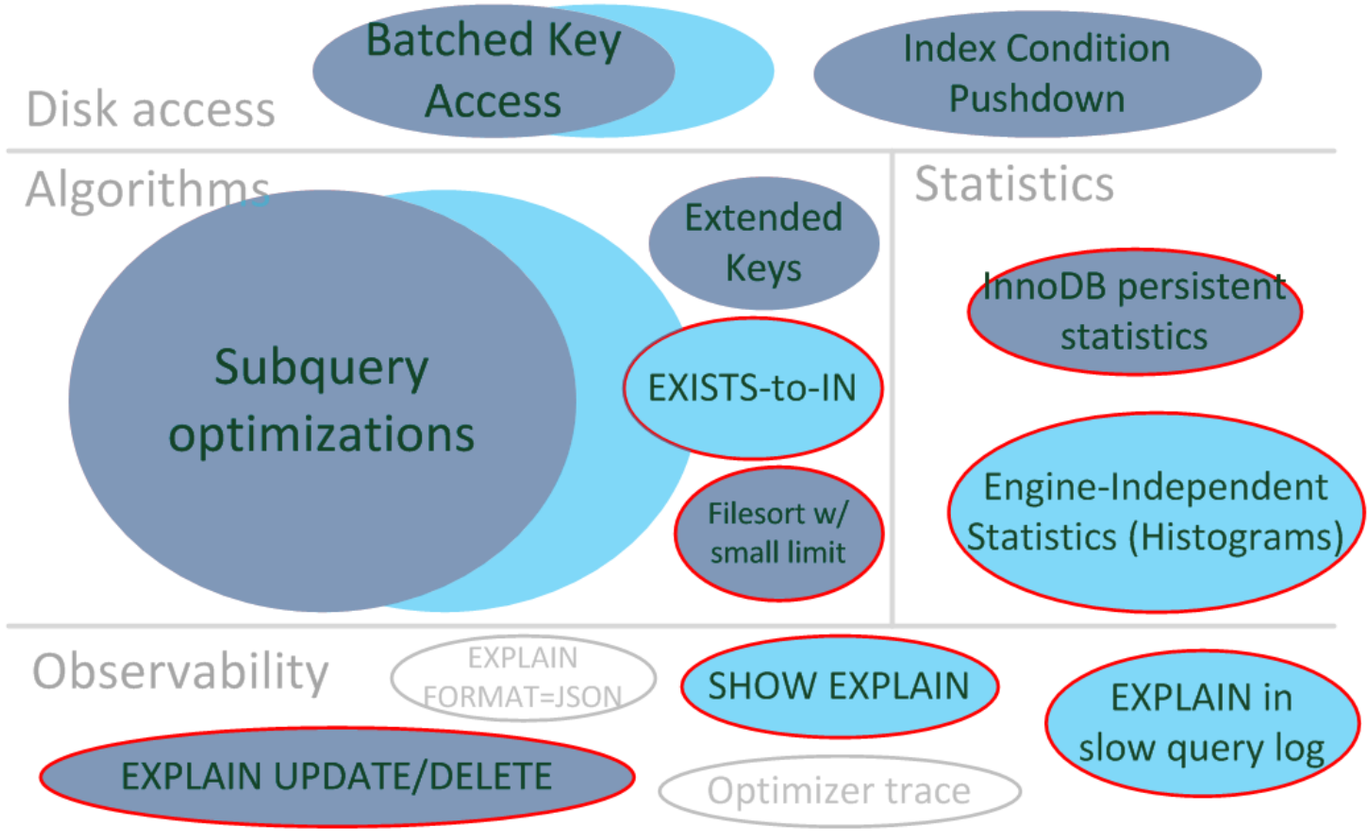
- Machine-parseable
  - Lines start with "**`# explain:`** "
  - Cells are tab-delimited
- Logs with explains are parsed by **`pt-query-digest`**
  - Would like to make it report query plan stats

# Other EXPLAIN improvements

- EXPLAIN UPDATE/DELETE/INSERT
  - MySQL 5.6 → MariaDB 10.0
- Not ported from MySQL 5.6 so far:
  - EXPLAIN FORMAT=JSON
  - Optimizer trace

# MariaDB 10.0 summary

- Porting features from MySQL 5.6
- Also adding our own new features
- Actually leading the development



# Beyond MariaDB 10.0

- EXPLAIN FORMAT=JSON
- EXPLAIN ANALYZE [in the slow query log]
- More statistics
  - More histogram types
  - Observability
  - Better use in the optimizer
- ORDER/GROUP BY … LIMIT: fix the mess
- Your input
  - ...

# Thanks!

Q&A