腾讯云 | 云+社区 intel

腾讯云 ClickHouse 性能调优及实践

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二、 常见ClickHouse实时分析场景

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ClickHouse简介

1 完备的DBMS功能

- DDL(数据定义语言)
- DML(数据操作语言)
- 权限控制
- 数据备份与恢复
- 分布式管理

2 列式存储与数据压缩

- 极大地节约了IO带宽
- 压缩比高（支持LZ4, ZSTD)

3 向量化执行引擎

- 分布式计算
- 多核并行计算
- 向量化执行与SIMD
- 动态代码生成

4 SQL支持

- 对用户友好的SQL语法
- 内置功能齐全的分析统计函数
- 丰富的数据结构支持，字典、json, array, bitmap等

5 数据存储

- 自管理数据存储，不依赖其他组件
- 主键索引/二级索引
- 数据集分片(sharding)
- 数据分区(partition)
- 数据容灾
- TTL支持

6 性能卓越

- 无论是查询还是写入，性能极其卓越

一、 QQ音乐PB级数据实时分析带来的挑战

- Hive离线分析仅能满足T+1定时报表单一场景
- Hive无法满足QQ音乐多角色（产品、运营人员等）对实时交互分析的诉求

时效性 低

- 基于Hive跑离线任务需要**数小时**
- 分析结果价值随着时间推移而迅速降低

易用性 低

- 数据分析需求来源于 产品、运营、市场 多方人员
- 由于分析门槛高，**产品、运营、市场 人员无法自主分析**

流程效率 低

- 分析需求均需由分析师完成，需排期、沟通、建模、分析、可视化等流程
- 整套流程常需几周时间， 分析结果不及时

一、 QQ音乐PB级数据实时分析带来的挑战

ClickHouse集群现状

- **集群规模**

近万核，**PB级存储**、十万亿级别记录量。每天过千亿数据落地入库保存（实时流水、离线中间表等约700张表）。

- **性能指标**

查询千亿、万亿流水的请求可在**数秒内**完成。

ClickHouse

Superset

业务价值

- **实时性**

复杂交互分析秒级完成（如分版本、分平台DAU，营收及其他多口径业务指标）。

- **易用性**

利用Superset可自主DIY各类报表，当前SuperSet过万图表中，**超一半由产品、研发、运营、研究员、财务等非数据同学创建**。

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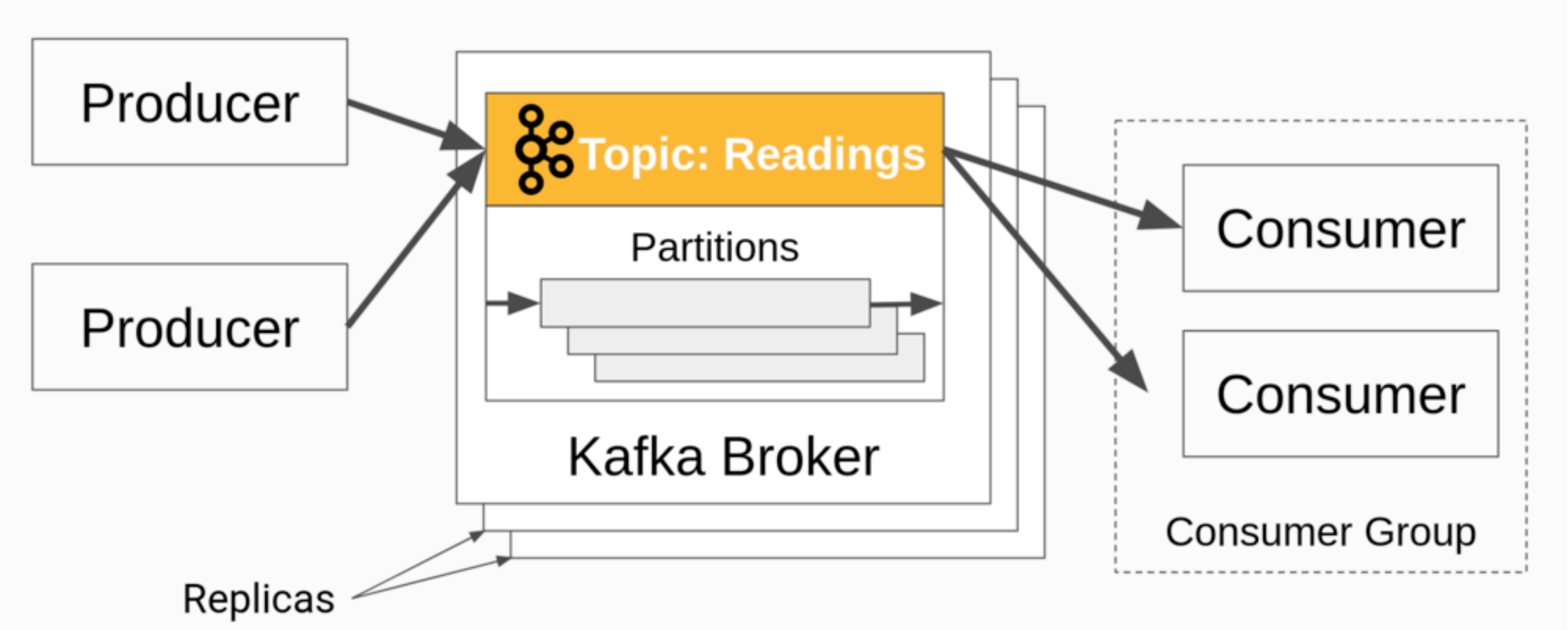
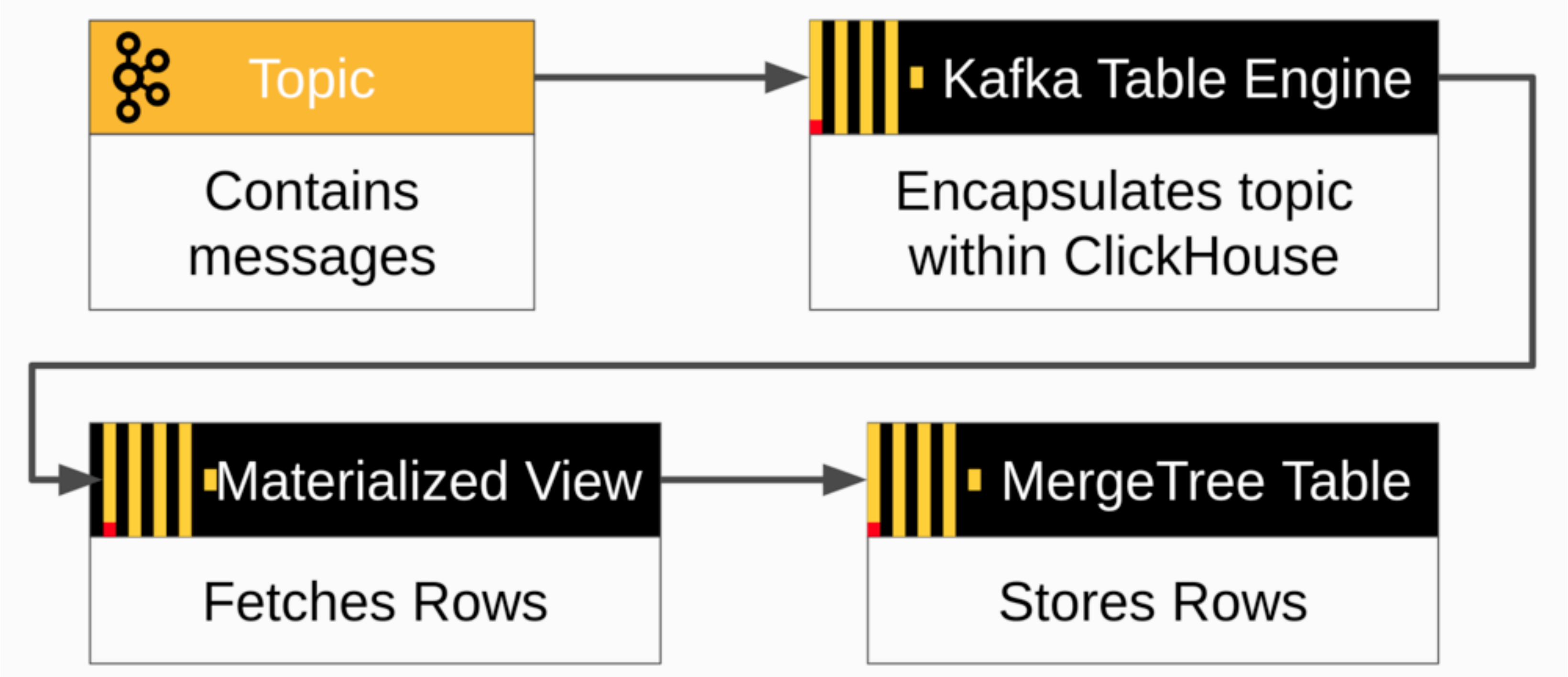
场景1： 物化视图应用：数据摄入



三、 常见ClickHouse实时分析场景举例

场景1： 物化视图应用：数据摄入



Topic

Contains messages

Kafka Table Engine

Encapsulates topic within ClickHouse

Materialized View

Fetches Rows

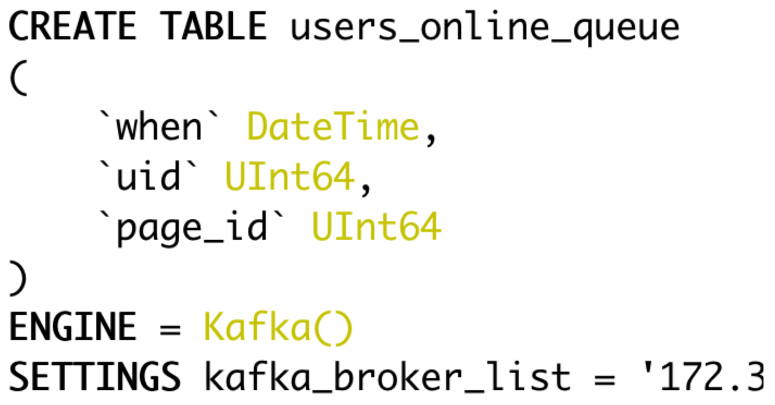
MergeTree Table

Stores Rows

三、 常见ClickHouse实时分析场景举例

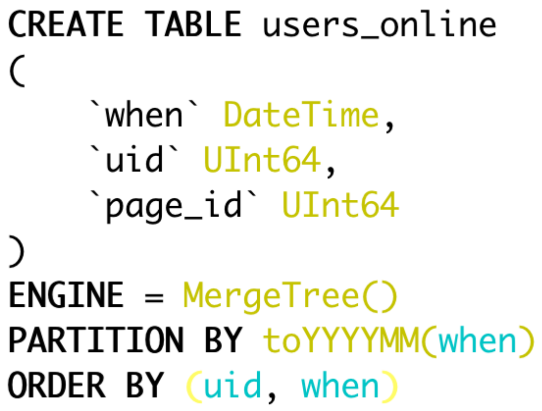
场景1： 物化视图应用：数据摄入

1 创建Kafka表引擎，监听数据



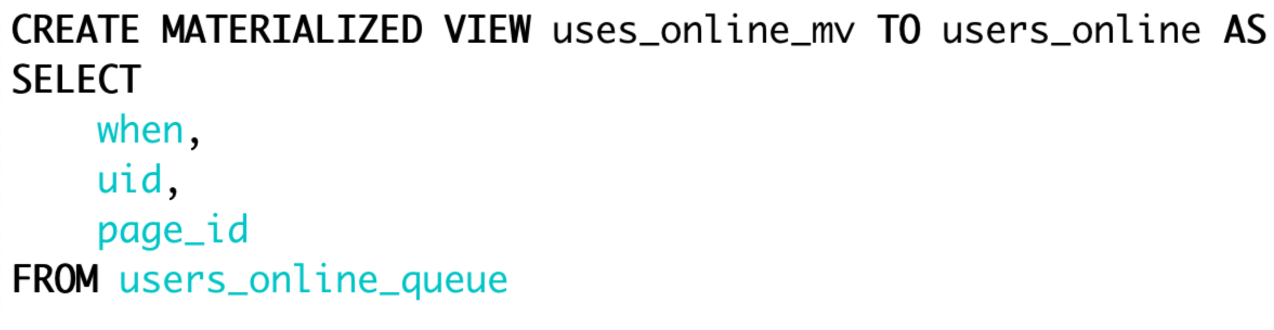
```
CREATE TABLE users_online_queue
(
    `when` DateTime,
    `uid` UInt64,
    `page_id` UInt64
)
ENGINE = Kafka()
SETTINGS kafka_broker_list = '172.3
```

2 创建目标表，存储数据



```
CREATE TABLE users_online
(
    `when` DateTime,
    `uid` UInt64,
    `page_id` UInt64
)
ENGINE = MergeTree()
PARTITION BY toYYYYMM(when)
ORDER BY (uid, when)
```

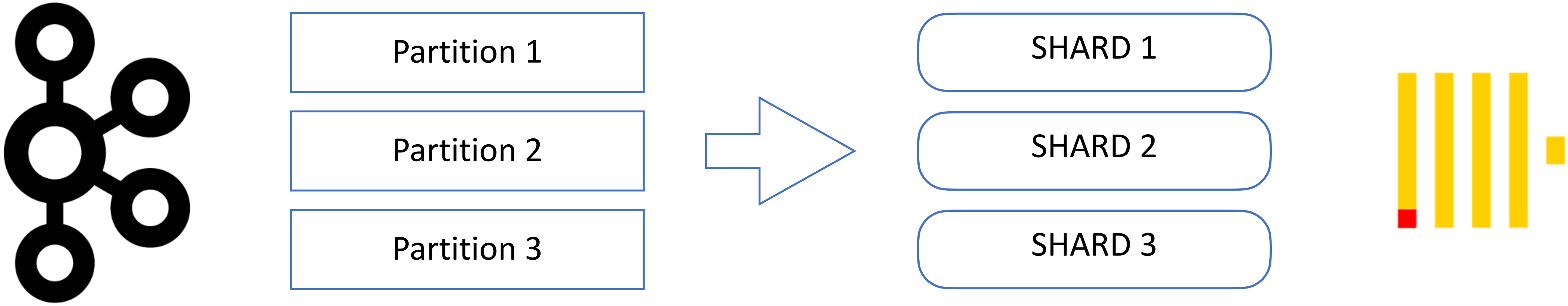
3 创建物化视图，摄取数据



```
CREATE MATERIALIZED VIEW uses_online_mv TO users_online AS
SELECT
    when,
    uid,
    page_id
FROM users_online_queue
```

三、 常见ClickHouse实时分析场景举例

场景1： 物化视图应用：数据摄入



Partition 1

Partition 2

Partition 3

SHARD 1

SHARD 2

SHARD 3

场景2：ClickHouse在实时更新场景中的应用

假设某APP 需要在线向用户下发通知，如果用户读取消息后，状态回传后台，并标记已读取。

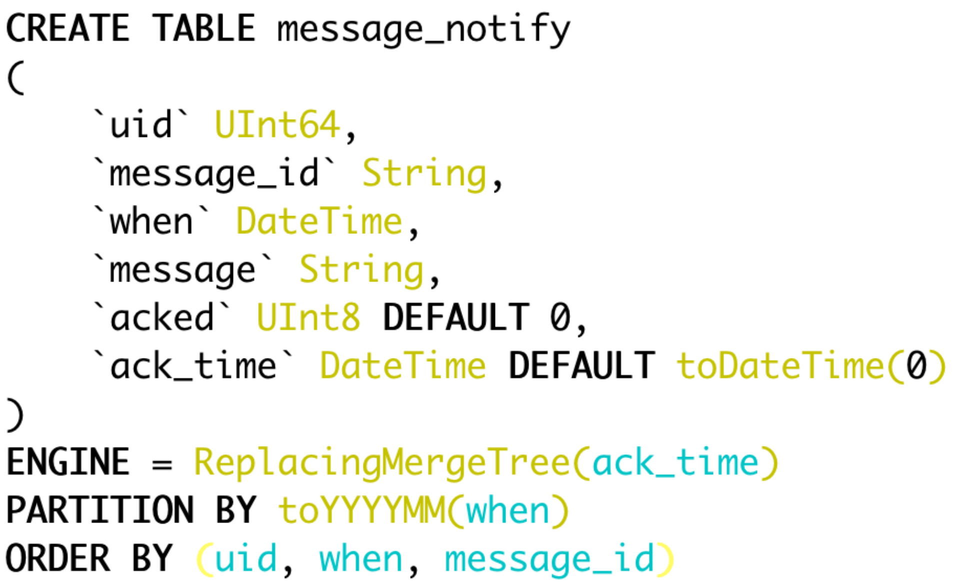
数据实时更新！

查询某用户未读取信息

三、 常见ClickHouse实时分析场景举例

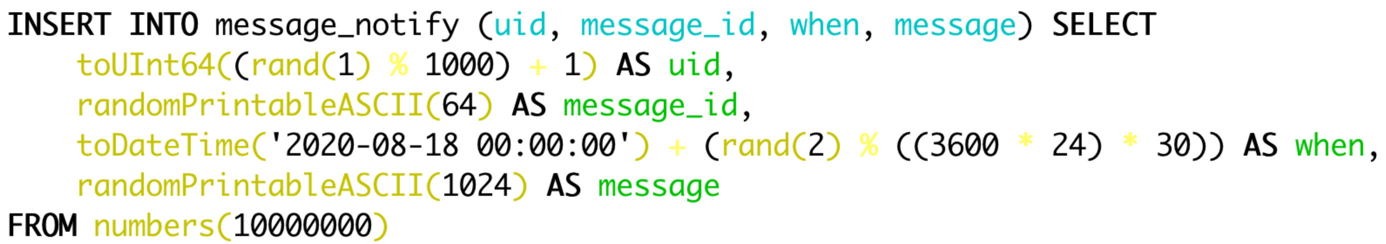
场景2：ClickHouse在实时更新场景中的应用 方案1：ReplacingMergeTree

1 创建明细表

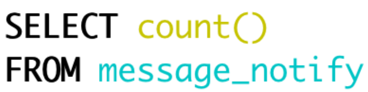


```
CREATE TABLE message_notify
(
    `uid` UInt64,
    `message_id` String,
    `when` DateTime,
    `message` String,
    `acked` UInt8 DEFAULT 0,
    `ack_time` DateTime DEFAULT toDateTime(0)
)
ENGINE = ReplacingMergeTree(ack_time)
PARTITION BY toYYYYMM(when)
ORDER BY (uid, when, message_id)
```

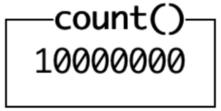
2 插入模拟数据



```
INSERT INTO message_notify (uid, message_id, when, message) SELECT
    toUInt64((rand(1) % 1000) + 1) AS uid,
    randomPrintableASCII(64) AS message_id,
    toDateTime('2020-08-18 00:00:00') + (rand(2) % ((3600 * 24) * 30)) AS when,
    randomPrintableASCII(1024) AS message
FROM numbers(10000000)
```



```
SELECT count()
FROM message_notify
```

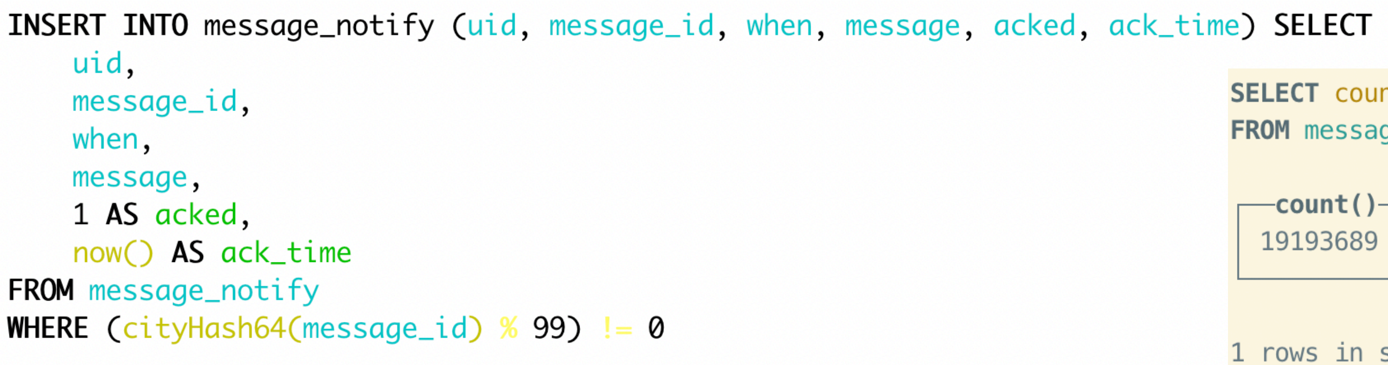


```
┌─count()─┐
│ 10000000 │
└──────────┘
```

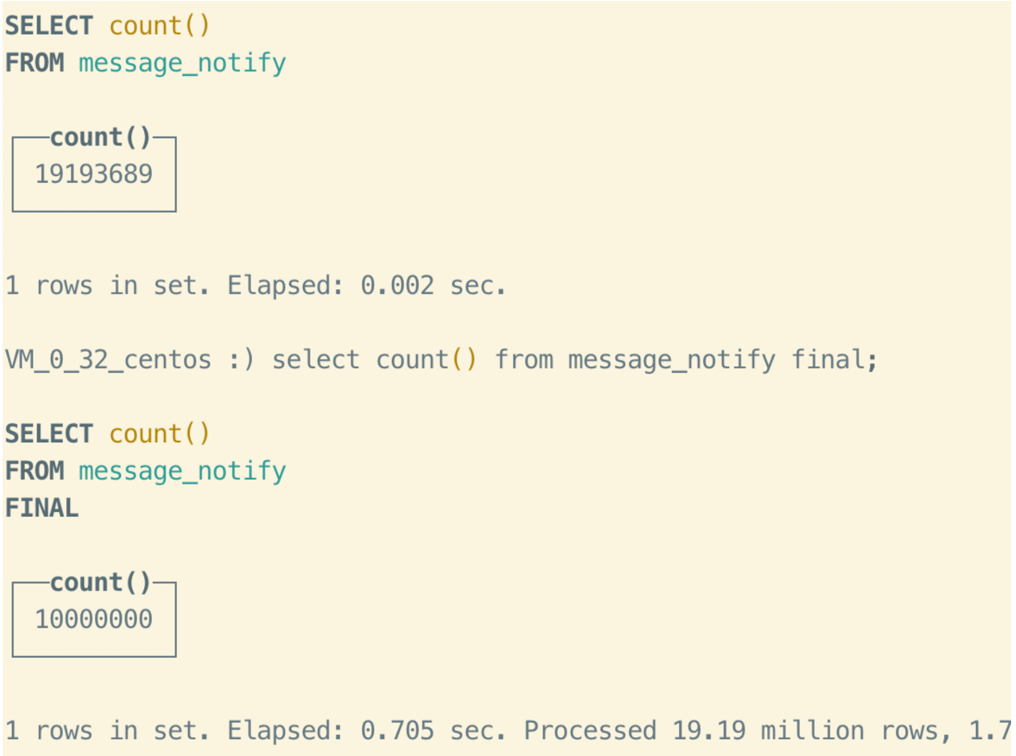
场景2：ClickHouse在实时更新场景中的应用 方案1：ReplacingMergeTree

3 插入模拟数据，模拟用户APP应答

4 查看数据



```
INSERT INTO message_notify (uid, message_id, when, message, acked, ack_time) SELECT
    uid,
    message_id,
    when,
    message,
    1 AS acked,
    now() AS ack_time
FROM message_notify
WHERE (cityHash64(message_id) % 99) != 0
```

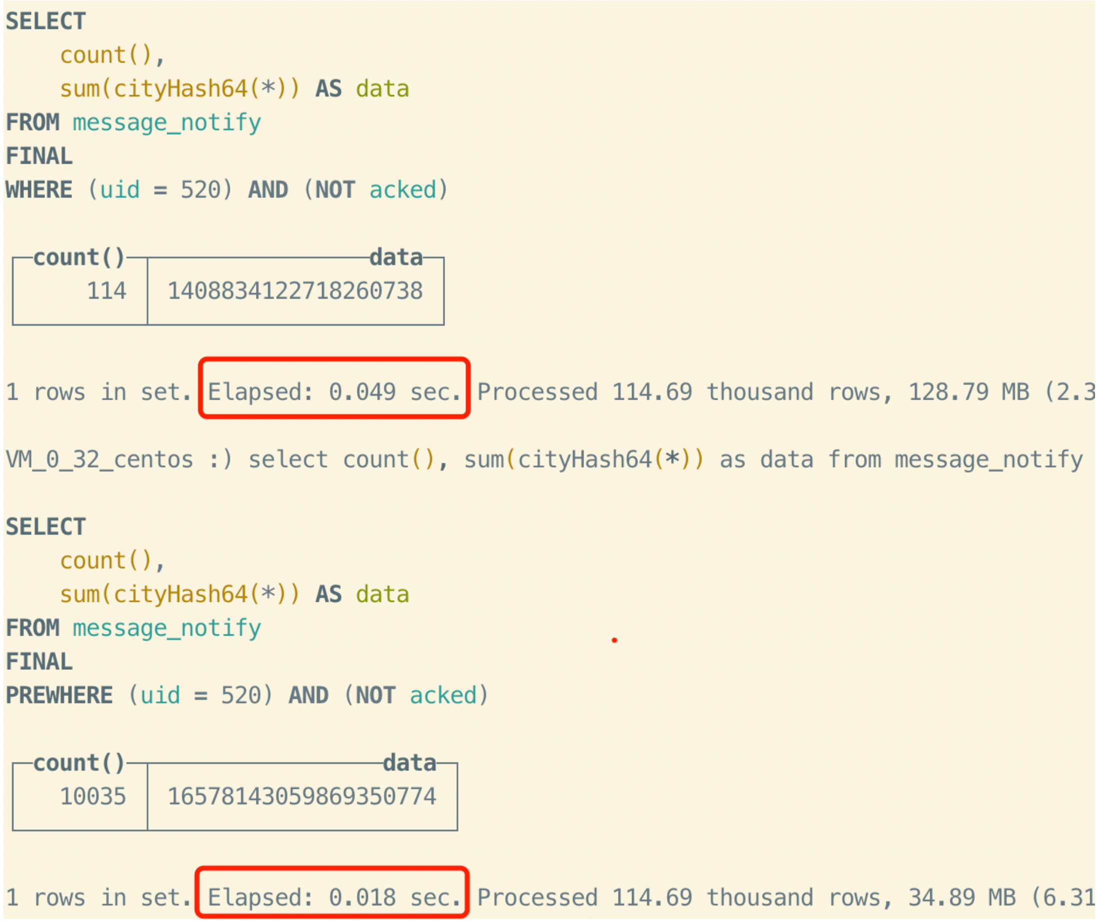


```
SELECT count()
FROM message_notify

┌─count()─┐
│ 19193689 │
└──────────┘

1 rows in set. Elapsed: 0.002 sec.

VM_0_32_centos :) select count() from message_notify final;

SELECT count()
FROM message_notify
FINAL

┌─count()─┐
│ 10000000 │
└──────────┘

1 rows in set. Elapsed: 0.705 sec. Processed 19.19 million rows, 1.7
```

三、 常见ClickHouse实时分析场景举例

场景2：ClickHouse在实时更新场景中的应用 方案1：ReplacingMergeTree

5 查看用户(uid=520) 未读数据

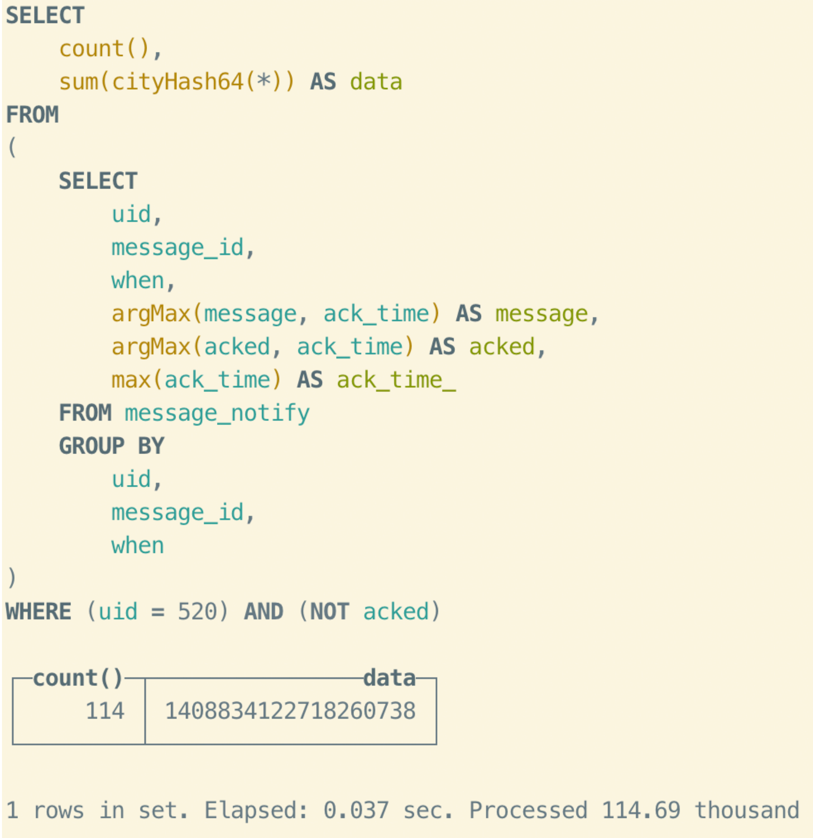


```
SELECT
    count(),
    sum(cityHash64(*)) AS data
FROM message_notify
FINAL
WHERE (uid = 520) AND (NOT acked)

┌─count()─┬─────────────────data─┐
│     114 │ 1408834122718260738 │
└─────────┴─────────────────────┘

1 rows in set. Elapsed: 0.049 sec. Processed 114.69 thousand rows, 128.79 MB (2.3

VM_0_32_centos :) select count(), sum(cityHash64(*)) as data from message_notify

SELECT
    count(),
    sum(cityHash64(*)) AS data
FROM message_notify
FINAL
PREWHERE (uid = 520) AND (NOT acked)

┌─count()─┬──────────────────data─┐
│   10035 │ 16578143059869350774 │
└─────────┴──────────────────────┘

1 rows in set. Elapsed: 0.018 sec. Processed 114.69 thousand rows, 34.89 MB (6.31
```

三、 常见ClickHouse实时分析场景举例

场景2：ClickHouse在实时更新场景中的应用 方案2：Aggregate Functions

1 查看用户(uid=520) 未读数据

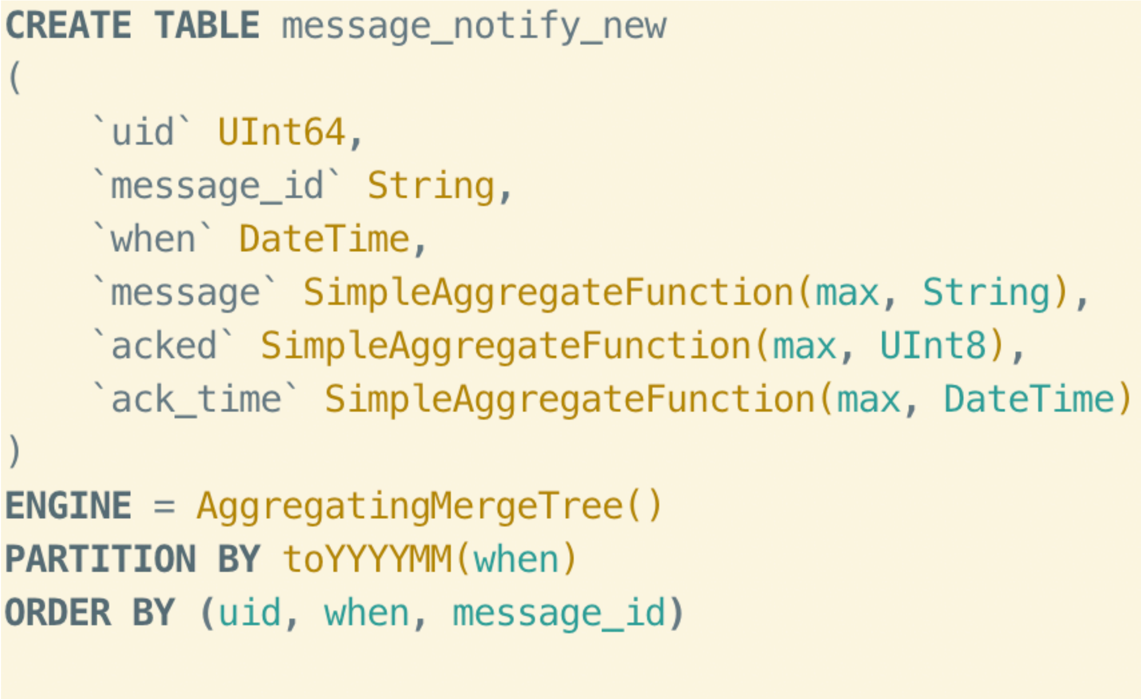


```
SELECT
    count(),
    sum(cityHash64(*)) AS data
FROM
(
    SELECT
        uid,
        message_id,
        when,
        argMax(message, ack_time) AS message,
        argMax(acked, ack_time) AS acked,
        max(ack_time) AS ack_time_
    FROM message_notify
    GROUP BY
        uid,
        message_id,
        when
)
WHERE (uid = 520) AND (NOT acked)

┌─count()─┬────────────────data─┐
│     114 │ 1408834122718260738 │
└─────────┴─────────────────────┘

1 rows in set. Elapsed: 0.037 sec. Processed 114.69 thousand
```

三、 常见ClickHouse实时分析场景举例

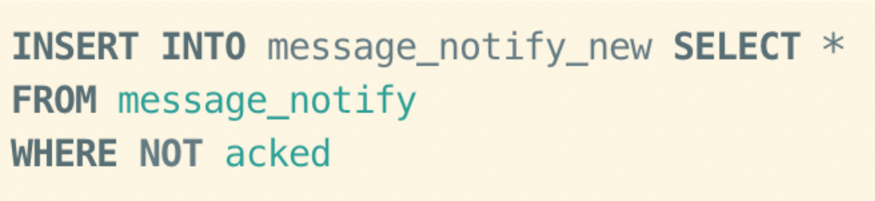
场景2：ClickHouse在实时更新场景中的应用 方案3：AggregatingMergeTree

1 聚合表引擎

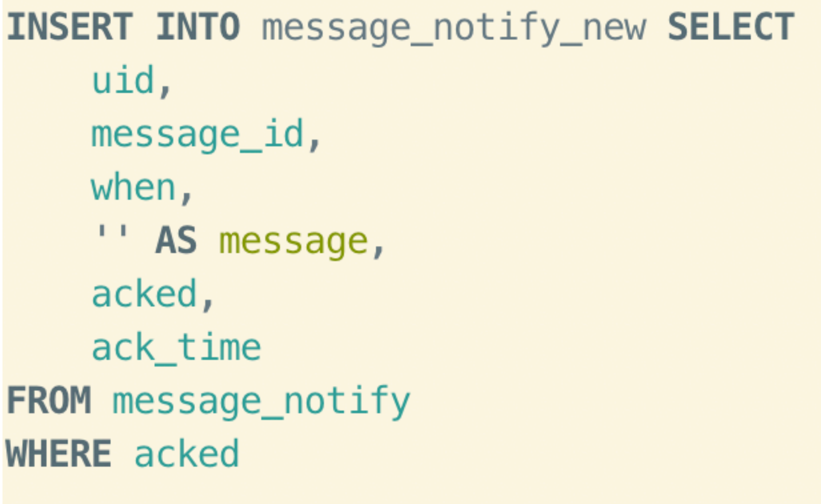


```
CREATE TABLE message_notify_new
(
    `uid` UInt64,
    `message_id` String,
    `when` DateTime,
    `message` SimpleAggregateFunction(max, String),
    `acked` SimpleAggregateFunction(max, UInt8),
    `ack_time` SimpleAggregateFunction(max, DateTime)
)
ENGINE = AggregatingMergeTree()
PARTITION BY toYYYYMM(when)
ORDER BY (uid, when, message_id)
```

2 准备数据



```
INSERT INTO message_notify_new SELECT *
FROM message_notify
WHERE NOT acked
```

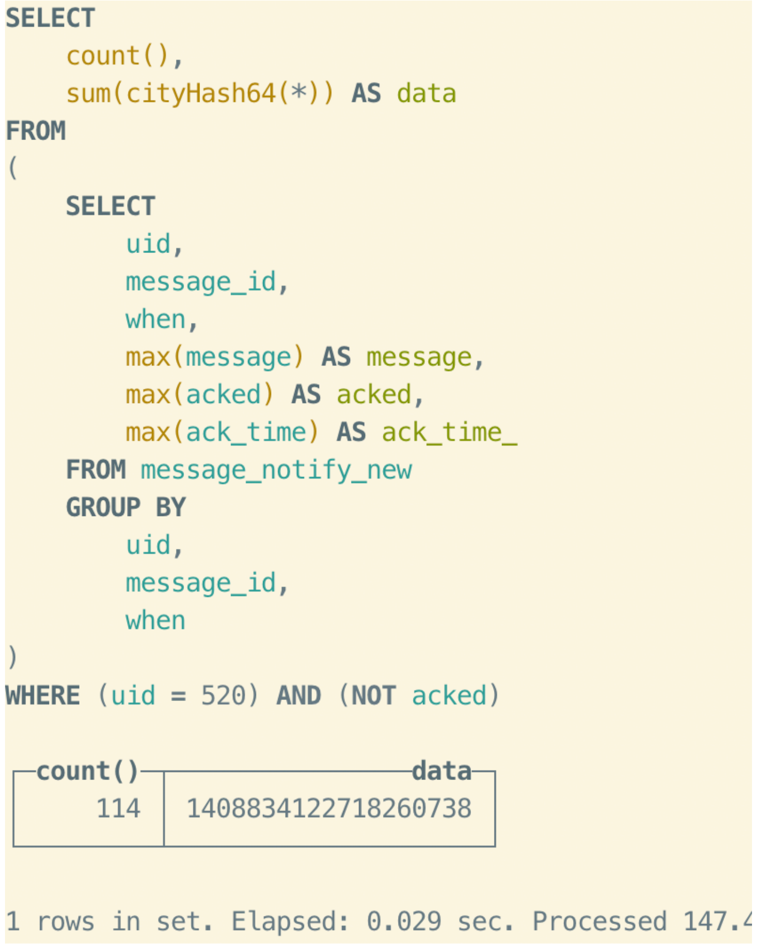


```
INSERT INTO message_notify_new SELECT
    uid,
    message_id,
    when,
    '' AS message,
    acked,
    ack_time
FROM message_notify
WHERE acked
```

三、 常见ClickHouse实时分析场景举例

场景2：ClickHouse在实时更新场景中的应用 方案3：AggregatingMergeTree

3 查看用户(uid=520) 未读数据

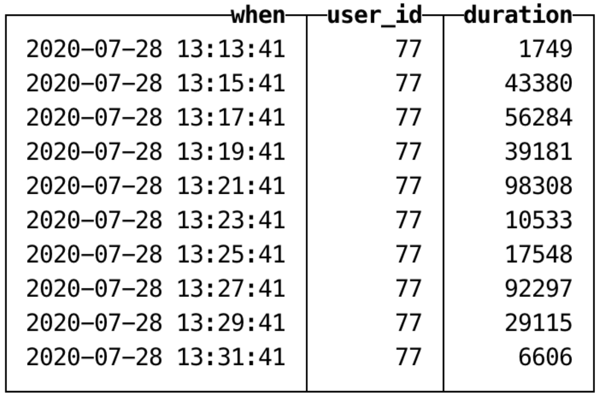


```
SELECT
    count(),
    sum(cityHash64(*)) AS data
FROM
(
    SELECT
        uid,
        message_id,
        when,
        max(message) AS message,
        max(acked) AS acked,
        max(ack_time) AS ack_time_
    FROM message_notify_new
    GROUP BY
        uid,
        message_id,
        when
)
WHERE (uid = 520) AND (NOT acked)

┌─count()─┬─────────────────data─┐
│     114 │ 1408834122718260738 │
└─────────┴──────────────────────┘

1 rows in set. Elapsed: 0.029 sec. Processed 147.4
```

三、 常见ClickHouse实时分析场景举例

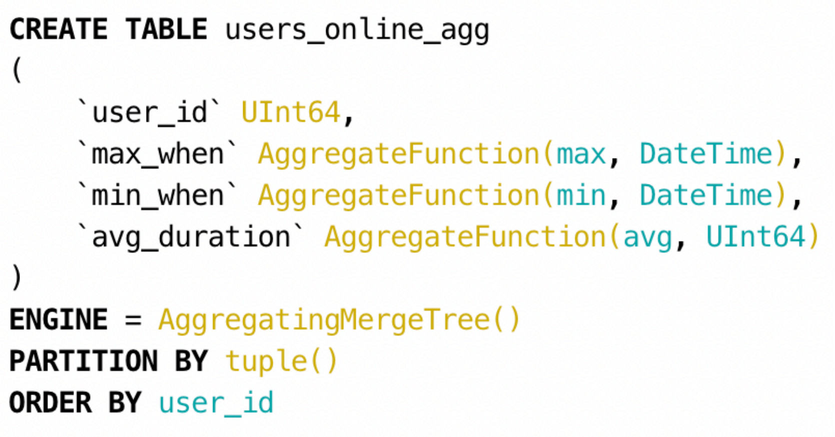
场景3： AggregatingMergeTree 引擎 + 物化视图 应用

1 明细表users_online



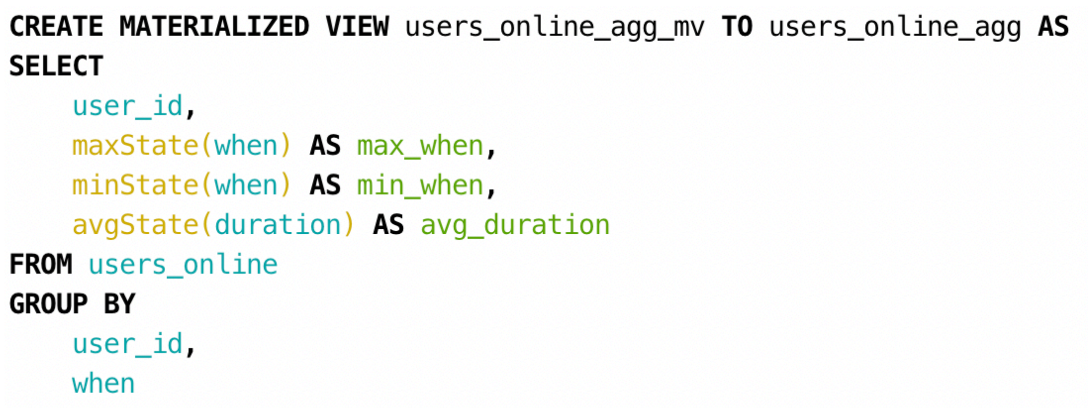
```
┌────────────────when─┬─user_id─┬─duration─┐
│ 2020-07-28 13:13:41 │      77 │     1749 │
│ 2020-07-28 13:15:41 │      77 │    43380 │
│ 2020-07-28 13:17:41 │      77 │    56284 │
│ 2020-07-28 13:19:41 │      77 │    39181 │
│ 2020-07-28 13:21:41 │      77 │    98308 │
│ 2020-07-28 13:23:41 │      77 │    10533 │
│ 2020-07-28 13:25:41 │      77 │    17548 │
│ 2020-07-28 13:27:41 │      77 │    92297 │
│ 2020-07-28 13:29:41 │      77 │    29115 │
│ 2020-07-28 13:31:41 │      77 │     6606 │
└─────────────────────┴─────────┴──────────┘
```

2 创建聚合表



```
CREATE TABLE users_online_agg
(
    `user_id` UInt64,
    `max_when` AggregateFunction(max, DateTime),
    `min_when` AggregateFunction(min, DateTime),
    `avg_duration` AggregateFunction(avg, UInt64)
)
ENGINE = AggregatingMergeTree()
PARTITION BY tuple()
ORDER BY user_id
```

3 创建物化视图

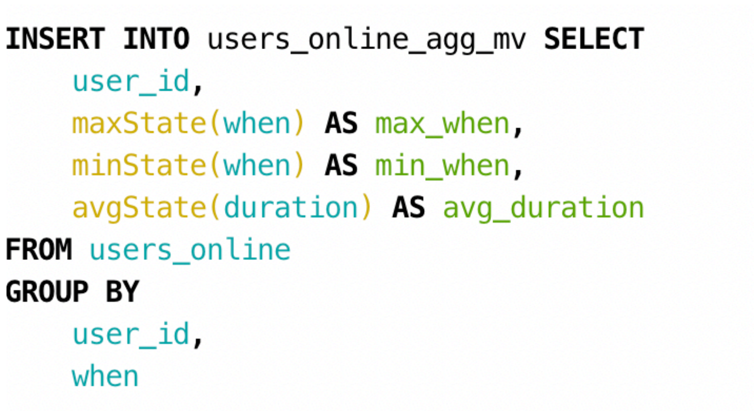


```
CREATE MATERIALIZED VIEW users_online_agg_mv TO users_online_agg AS
SELECT
    user_id,
    maxState(when) AS max_when,
    minState(when) AS min_when,
    avgState(duration) AS avg_duration
FROM users_online
GROUP BY
    user_id,
    when
```

三、 常见ClickHouse实时分析场景举例

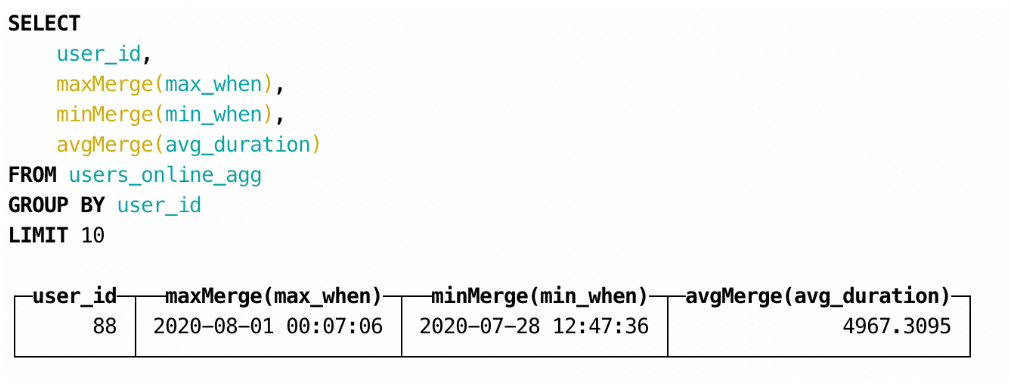
场景3： AggregatingMergeTree 引擎 + 物化视图 应用

4 导入存量数据



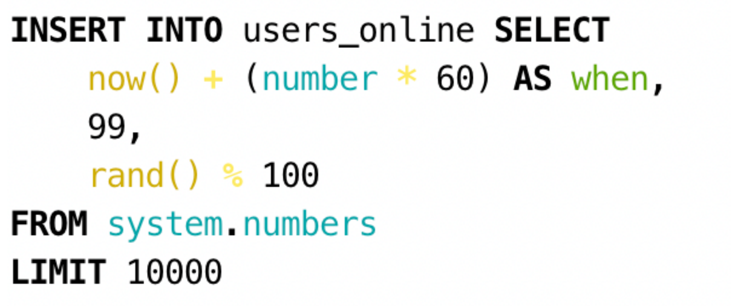
```
INSERT INTO users_online_agg_mv SELECT
    user_id,
    maxState(when) AS max_when,
    minState(when) AS min_when,
    avgState(duration) AS avg_duration
FROM users_online
GROUP BY
    user_id,
    when
```

5 查询聚合表中数据

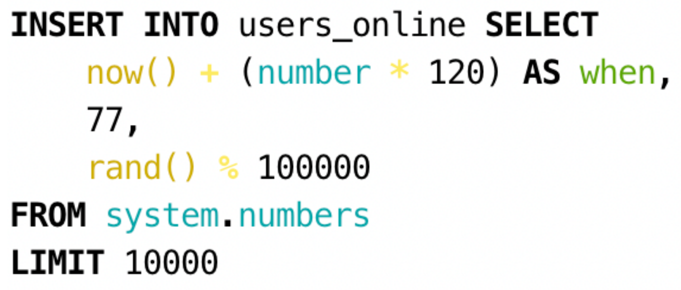


```
SELECT
    user_id,
    maxMerge(max_when),
    minMerge(min_when),
    avgMerge(avg_duration)
FROM users_online_agg
GROUP BY user_id
LIMIT 10

┌─user_id─┬───maxMerge(max_when)─┬───minMerge(min_when)─┬─avgMerge(avg_duration)─┐
│      88 │ 2020-08-01 00:07:06 │ 2020-07-28 12:47:36 │              4967.3095 │
└─────────┴─────────────────────┴─────────────────────┴────────────────────────┘
```

6 导入增量数据



```
INSERT INTO users_online SELECT
    now() + (number * 60) AS when,
    99,
    rand() % 100
FROM system.numbers
LIMIT 10000
```

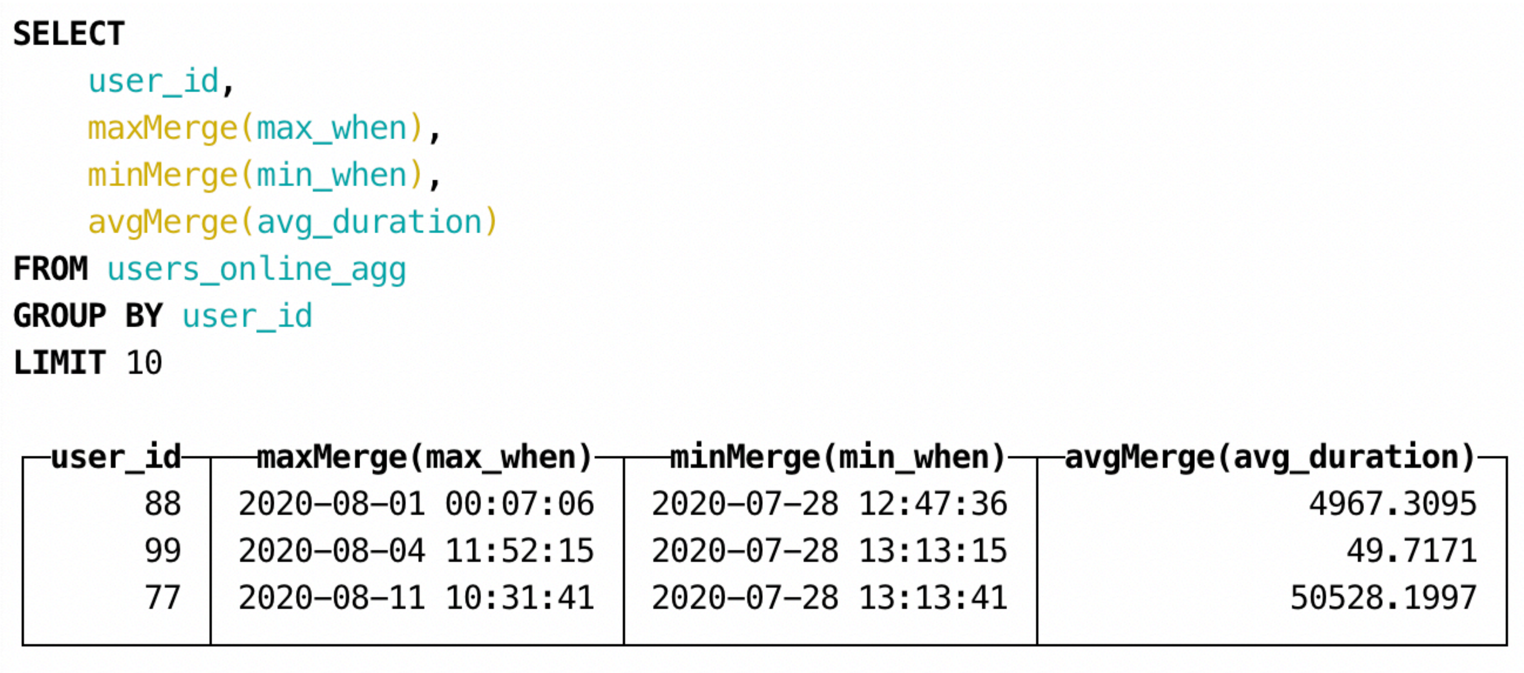


```
INSERT INTO users_online SELECT
    now() + (number * 120) AS when,
    77,
    rand() % 100000
FROM system.numbers
LIMIT 10000
```

三、 常见ClickHouse实时分析场景举例

场景3： AggregatingMergeTree 引擎 + 物化视图 应用

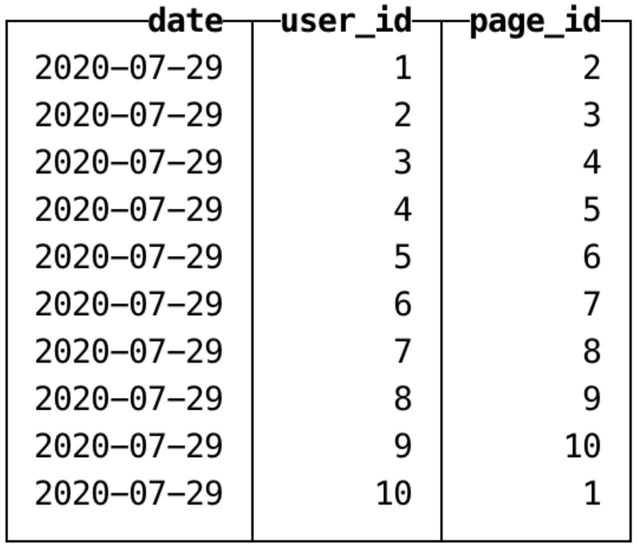
7 查询增量数据



```
SELECT
    user_id,
    maxMerge(max_when),
    minMerge(min_when),
    avgMerge(avg_duration)
FROM users_online_agg
GROUP BY user_id
LIMIT 10

┌─user_id─┬──maxMerge(max_when)─┬──minMerge(min_when)─┬─avgMerge(avg_duration)─┐
│      88 │ 2020-08-01 00:07:06 │ 2020-07-28 12:47:36 │              4967.3095 │
│      99 │ 2020-08-04 11:52:15 │ 2020-07-28 13:13:15 │                49.7171 │
│      77 │ 2020-08-11 10:31:41 │ 2020-07-28 13:13:41 │             50528.1997 │
└─────────┴─────────────────────┴─────────────────────┴────────────────────────┘
```

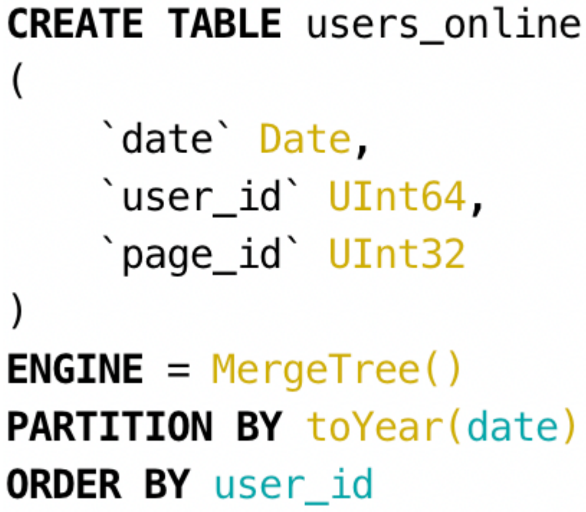
场景4： Aggregate Function 应用举例（bitmap系列）案例1：用户留存计算

Bitmap 在处理用户/会员统计，广告投放/用户画像等领域有非常便捷的应用。



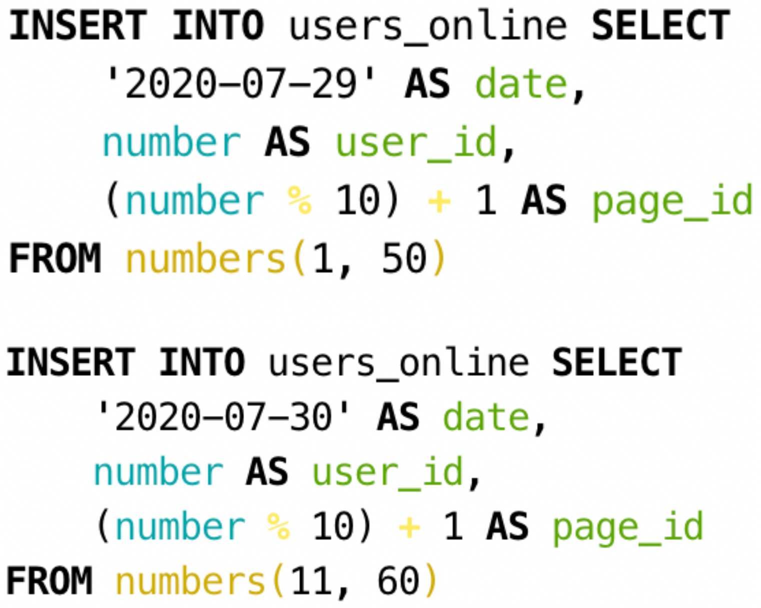
```
┌───────date─┬─user_id─┬─page_id─┐
│ 2020-07-29 │       1 │       2 │
│ 2020-07-29 │       2 │       3 │
│ 2020-07-29 │       3 │       4 │
│ 2020-07-29 │       4 │       5 │
│ 2020-07-29 │       5 │       6 │
│ 2020-07-29 │       6 │       7 │
│ 2020-07-29 │       7 │       8 │
│ 2020-07-29 │       8 │       9 │
│ 2020-07-29 │       9 │      10 │
│ 2020-07-29 │      10 │       1 │
└────────────┴─────────┴─────────┘
```

1 创建明细表



```
CREATE TABLE users_online
(
    `date` Date,
    `user_id` UInt64,
    `page_id` UInt32
)
ENGINE = MergeTree()
PARTITION BY toYear(date)
ORDER BY user_id
```

2 插入模拟数据



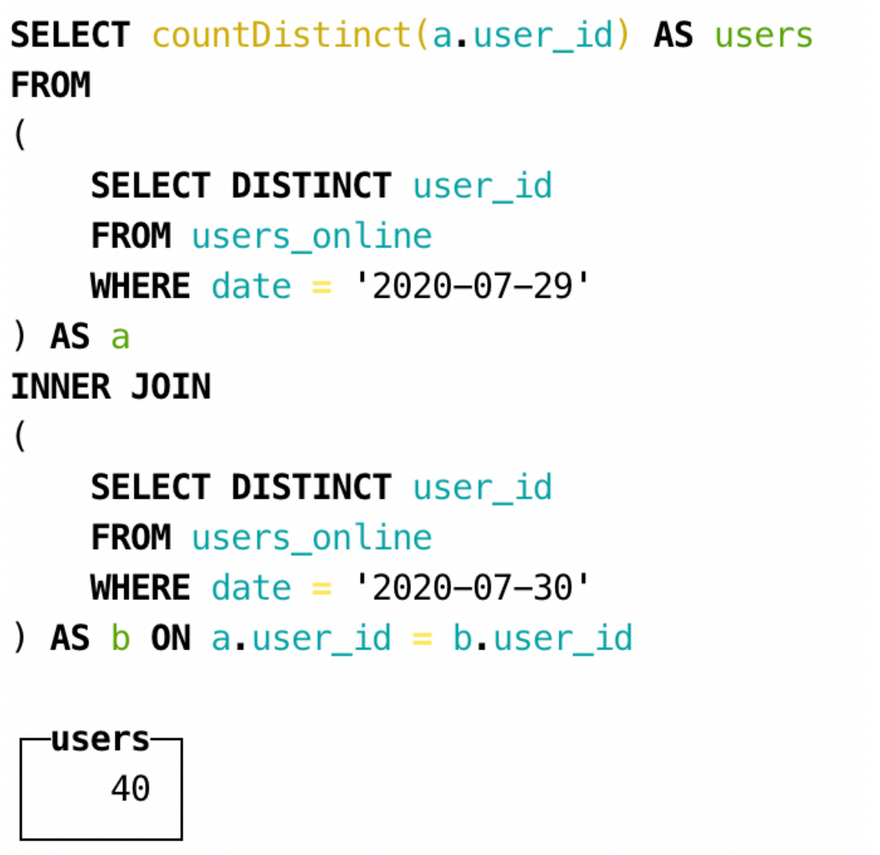
```
INSERT INTO users_online SELECT
    '2020-07-29' AS date,
    number AS user_id,
    (number % 10) + 1 AS page_id
FROM numbers(1, 50)

INSERT INTO users_online SELECT
    '2020-07-30' AS date,
    number AS user_id,
    (number % 10) + 1 AS page_id
FROM numbers(11, 60)
```

三、 常见ClickHouse实时分析场景举例

场景4： Aggregate Function 应用举例（bitmap系列）案例1：用户留存计算

2 查询用户日存留(常规方法)

举个例子~



```
SELECT countDistinct(a.user_id) AS users
FROM
(
    SELECT DISTINCT user_id
    FROM users_online
    WHERE date = '2020-07-29'
) AS a
INNER JOIN
(
    SELECT DISTINCT user_id
    FROM users_online
    WHERE date = '2020-07-30'
) AS b ON a.user_id = b.user_id
```

```
┌users┐
│   40 │
└──────┘
```

大表JOIN，COUNT DISTINCT 都很慢，并且容易OOM

三、 常见ClickHouse实时分析场景举例

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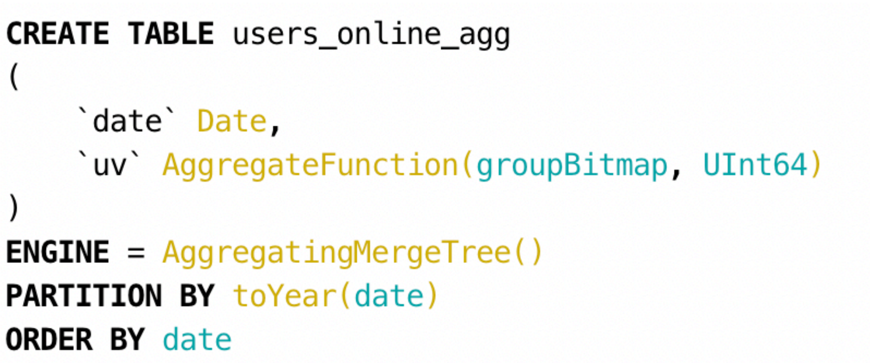
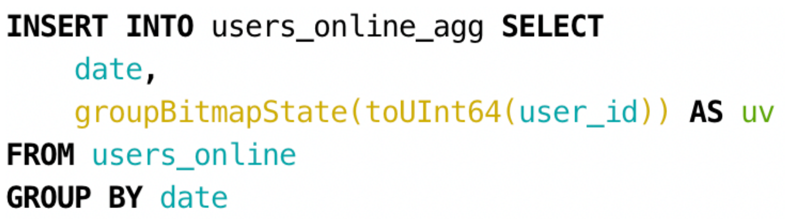
场景4： Aggregate Function 应用举例（bitmap系列）案例1：用户留存计算

3 使用聚合函数bitmap方案， 创建聚合表



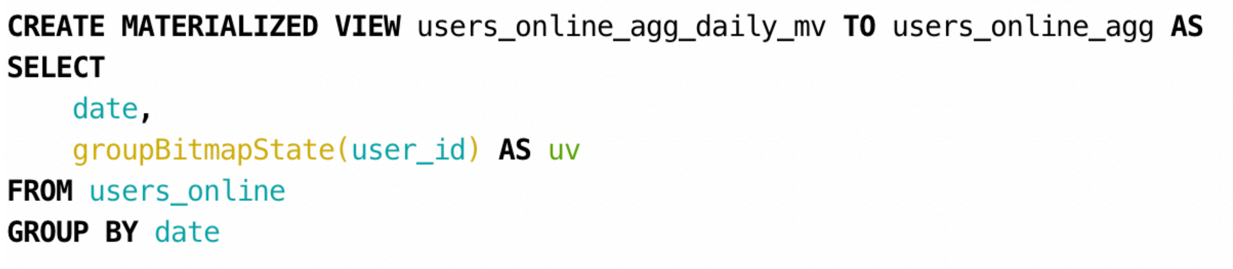
```
CREATE TABLE users_online_agg
(
    `date` Date,
    `uv` AggregateFunction(groupBitmap, UInt64)
)
ENGINE = AggregatingMergeTree()
PARTITION BY toYear(date)
ORDER BY date
```

4 导入历史数据



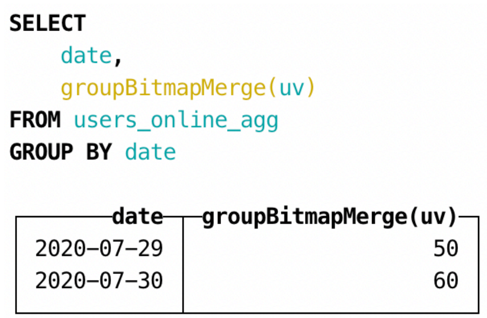
```
INSERT INTO users_online_agg SELECT
    date,
    groupBitmapState(toUInt64(user_id)) AS uv
FROM users_online
GROUP BY date
```

4 创建物化视图管理明细表与聚合表



```
CREATE MATERIALIZED VIEW users_online_agg_daily_mv TO users_online_agg AS
SELECT
    date,
    groupBitmapState(user_id) AS uv
FROM users_online
GROUP BY date
```

5 查询聚合表数据



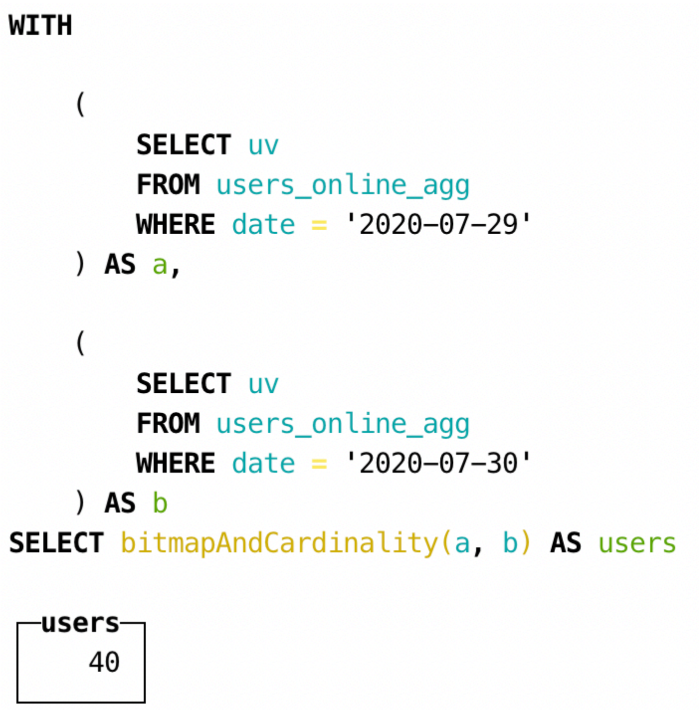
```
SELECT
    date,
    groupBitmapMerge(uv)
FROM users_online_agg
GROUP BY date

┌───────date─┬─groupBitmapMerge(uv)─┐
│ 2020-07-29 │                   50 │
│ 2020-07-30 │                   60 │
└────────────┴──────────────────────┘
```

通过BITMAP的位运算，对大规模用户(亿级）而言，位运算秒出结果

三、 常见ClickHouse实时分析场景举例

场景4： Aggregate Function 应用举例（bitmap系列）案例1：用户留存计算

6 使用聚合函数



```
WITH

    (
        SELECT uv
        FROM users_online_agg
        WHERE date = '2020-07-29'
    ) AS a,

    (
        SELECT uv
        FROM users_online_agg
        WHERE date = '2020-07-30'
    ) AS b
SELECT bitmapAndCardinality(a, b) AS users
```

```
┌users┐
│   40│
└─────┘
```

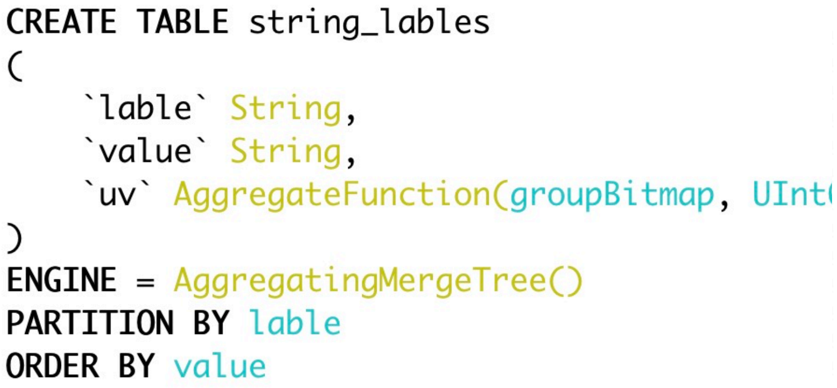
优势：

1. 计算量降低，速度快，资源消耗小

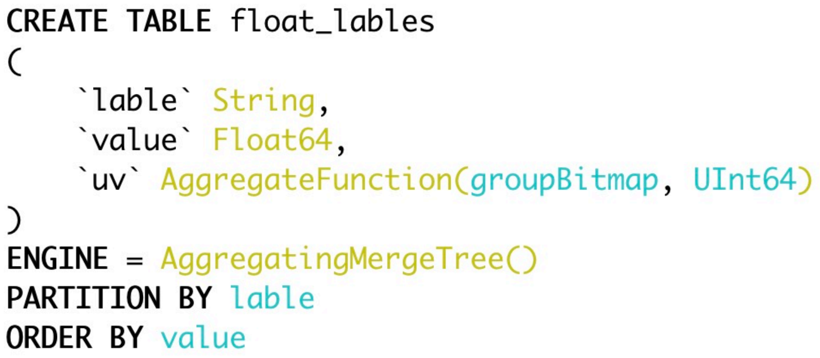
通过BITMAP的位运算，对大规模用户(亿级）而言，位运算秒出结果

场景4： Aggregate Function 应用举例（bitmap系列）案例2：广告投放/用户画像应用

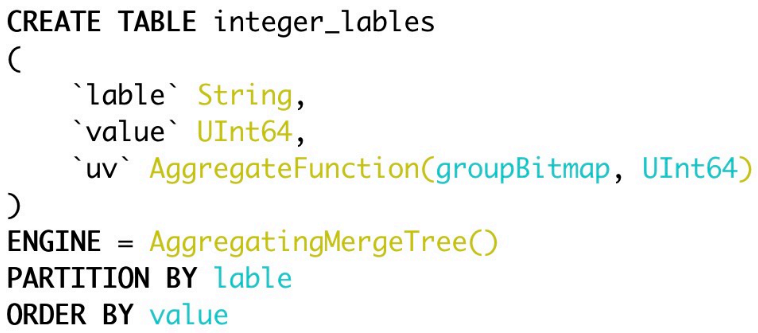
1 创建标签表



```
CREATE TABLE string_lables
(
    `lable` String,
    `value` String,
    `uv` AggregateFunction(groupBitmap, UInt
)
ENGINE = AggregatingMergeTree()
PARTITION BY lable
ORDER BY value
```



```
CREATE TABLE float_lables
(
    `lable` String,
    `value` Float64,
    `uv` AggregateFunction(groupBitmap, UInt64)
)
ENGINE = AggregatingMergeTree()
PARTITION BY lable
ORDER BY value
```

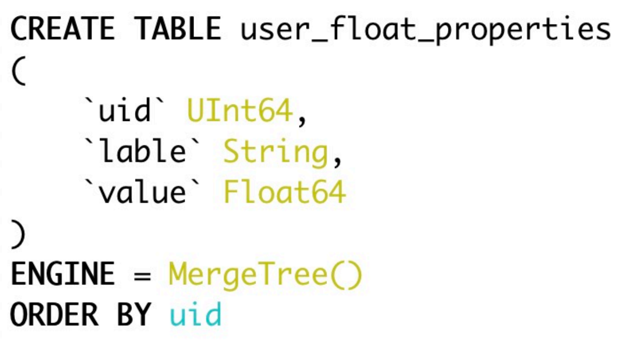


```
CREATE TABLE integer_lables
(
    `lable` String,
    `value` UInt64,
    `uv` AggregateFunction(groupBitmap, UInt64)
)
ENGINE = AggregatingMergeTree()
PARTITION BY lable
ORDER BY value
```

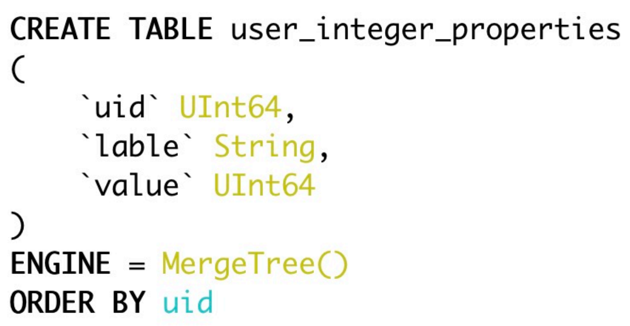
三、 常见ClickHouse实时分析场景举例

场景4： Aggregate Function 应用举例（bitmap系列）案例2：广告投放/用户画像应用

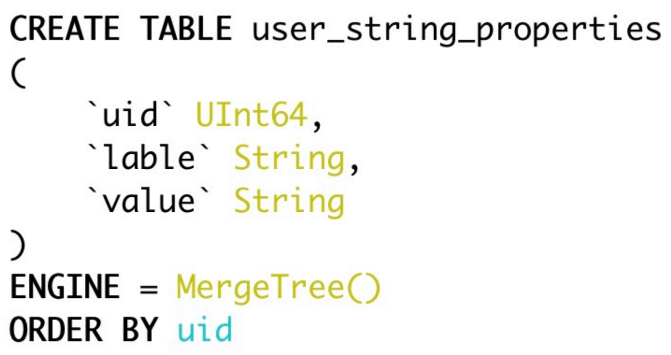
2 创建用户属性表



```
CREATE TABLE user_float_properties
(
    `uid` UInt64,
    `lable` String,
    `value` Float64
)
ENGINE = MergeTree()
ORDER BY uid
```



```
CREATE TABLE user_integer_properties
(
    `uid` UInt64,
    `lable` String,
    `value` UInt64
)
ENGINE = MergeTree()
ORDER BY uid
```



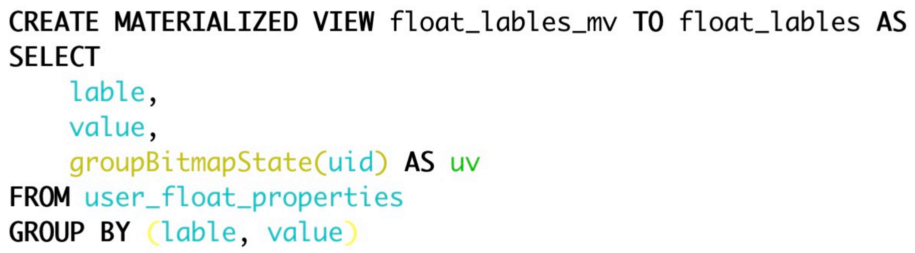
```
CREATE TABLE user_string_properties
(
    `uid` UInt64,
    `lable` String,
    `value` String
)
ENGINE = MergeTree()
ORDER BY uid
```

三、 常见ClickHouse实时分析场景举例

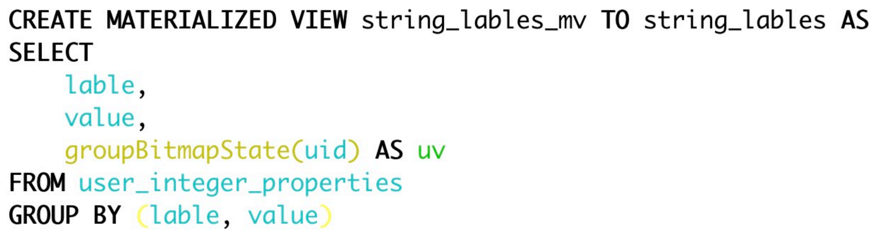
腾讯云 | 云+社区 intel

场景4： Aggregate Function 应用举例（bitmap系列）案例2：广告投放/用户画像应用

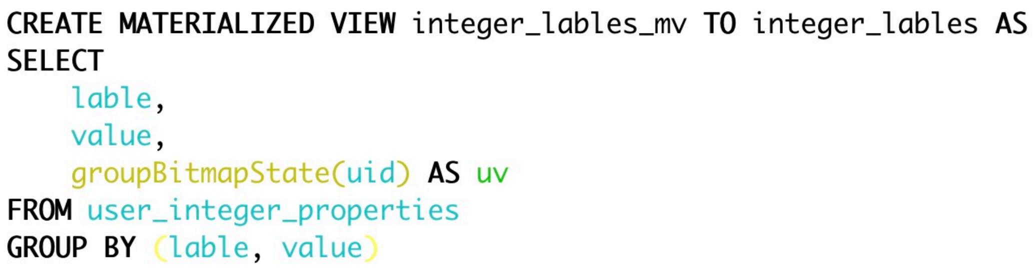
3 创建物化视图，自动聚合数据



```
CREATE MATERIALIZED VIEW float_lables_mv TO float_lables AS
SELECT
    lable,
    value,
    groupBitmapState(uid) AS uv
FROM user_float_properties
GROUP BY (lable, value)
```



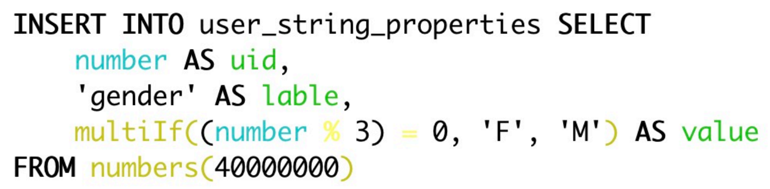
```
CREATE MATERIALIZED VIEW string_lables_mv TO string_lables AS
SELECT
    lable,
    value,
    groupBitmapState(uid) AS uv
FROM user_integer_properties
GROUP BY (lable, value)
```



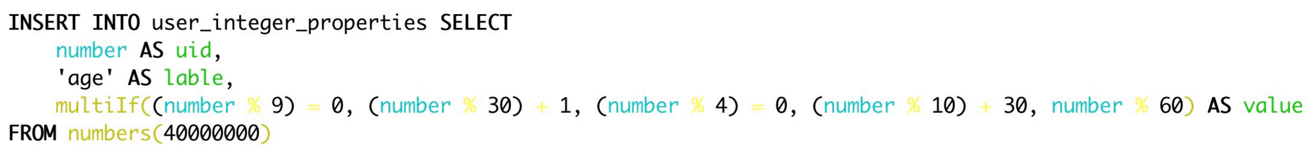
```
CREATE MATERIALIZED VIEW integer_lables_mv TO integer_lables AS
SELECT
    lable,
    value,
    groupBitmapState(uid) AS uv
FROM user_integer_properties
GROUP BY (lable, value)
```

场景4： Aggregate Function 应用举例（bitmap系列）案例2：广告投放/用户画像应用

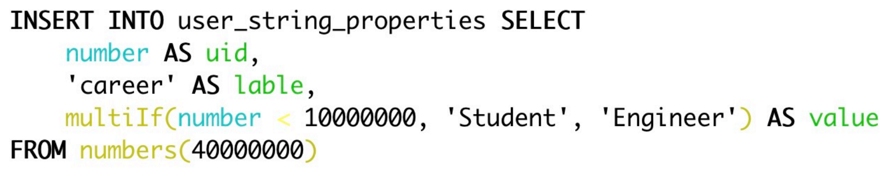
4 插入模拟数据， 4千万条



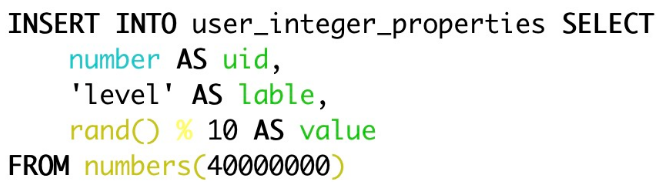
```sql
INSERT INTO user_string_properties SELECT
    number AS uid,
    'gender' AS lable,
    multiIf((number % 3) = 0, 'F', 'M') AS value
FROM numbers(40000000)
```



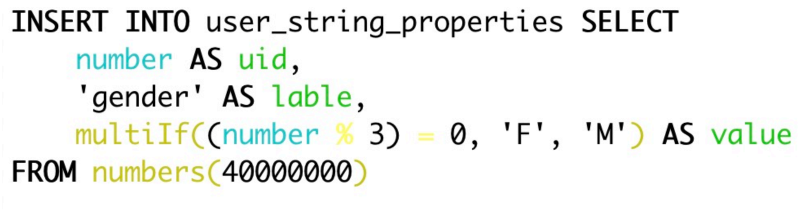
```sql
INSERT INTO user_integer_properties SELECT
    number AS uid,
    'age' AS lable,
    multiIf((number % 9) = 0, (number % 30) + 1, (number % 4) = 0, (number % 10) + 30, number % 60) AS value
FROM numbers(40000000)
```



```sql
INSERT INTO user_string_properties SELECT
    number AS uid,
    'career' AS lable,
    multiIf(number < 10000000, 'Student', 'Engineer') AS value
FROM numbers(40000000)
```



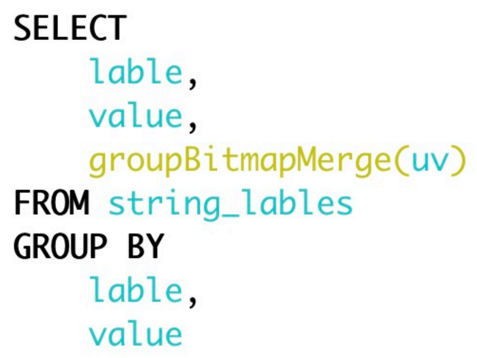
```sql
INSERT INTO user_integer_properties SELECT
    number AS uid,
    'level' AS lable,
    rand() % 10 AS value
FROM numbers(40000000)
```



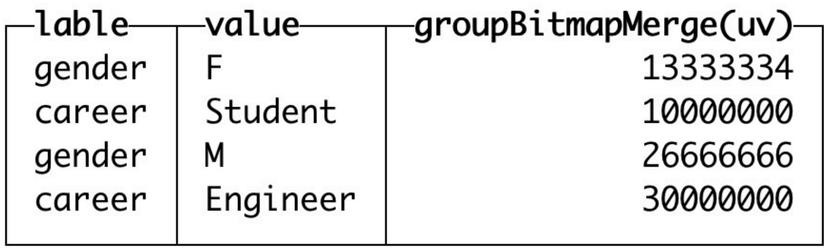
```sql
INSERT INTO user_string_properties SELECT
    number AS uid,
    'gender' AS lable,
    multiIf((number % 3) = 0, 'F', 'M') AS value
FROM numbers(40000000)
```

场景4： Aggregate Function 应用举例（bitmap系列）案例2：广告投放/用户画像应用

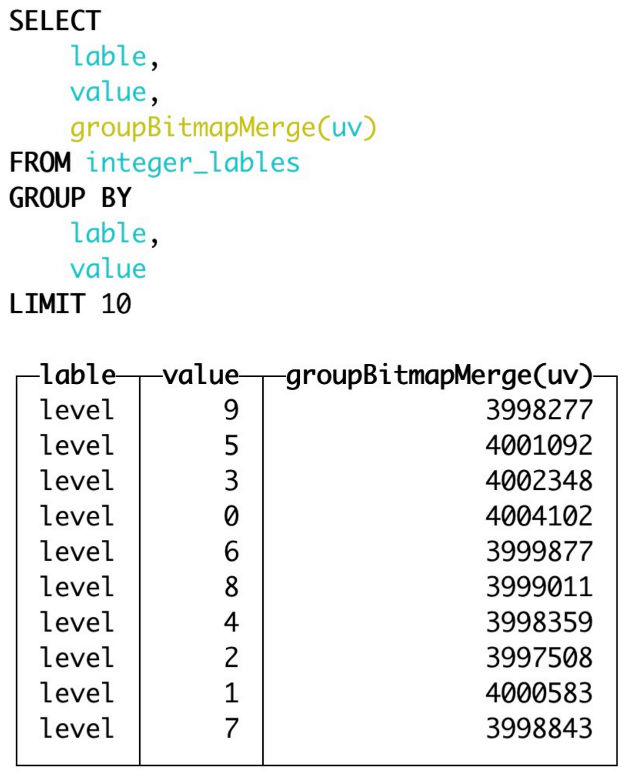
5 观察标签数据



```
SELECT
    lable,
    value,
    groupBitmapMerge(uv)
FROM string_lables
GROUP BY
    lable,
    value
```



```
┌─lable──┬─value────┬─groupBitmapMerge(uv)─┐
│ gender │ F        │             13333334 │
│ career │ Student  │             10000000 │
│ gender │ M        │             26666666 │
│ career │ Engineer │             30000000 │
└────────┴──────────┴──────────────────────┘
```



```
SELECT
    lable,
    value,
    groupBitmapMerge(uv)
FROM integer_lables
GROUP BY
    lable,
    value
LIMIT 10

┌─lable─┬─value─┬─groupBitmapMerge(uv)─┐
│ level │     9 │              3998277 │
│ level │     5 │              4001092 │
│ level │     3 │              4002348 │
│ level │     0 │              4004102 │
│ level │     6 │              3999877 │
│ level │     8 │              3999011 │
│ level │     4 │              3998359 │
│ level │     2 │              3997508 │
│ level │     1 │              4000583 │
│ level │     7 │              3998843 │
└───────┴───────┴──────────────────────┘
```

三、 常见ClickHouse实时分析场景举例

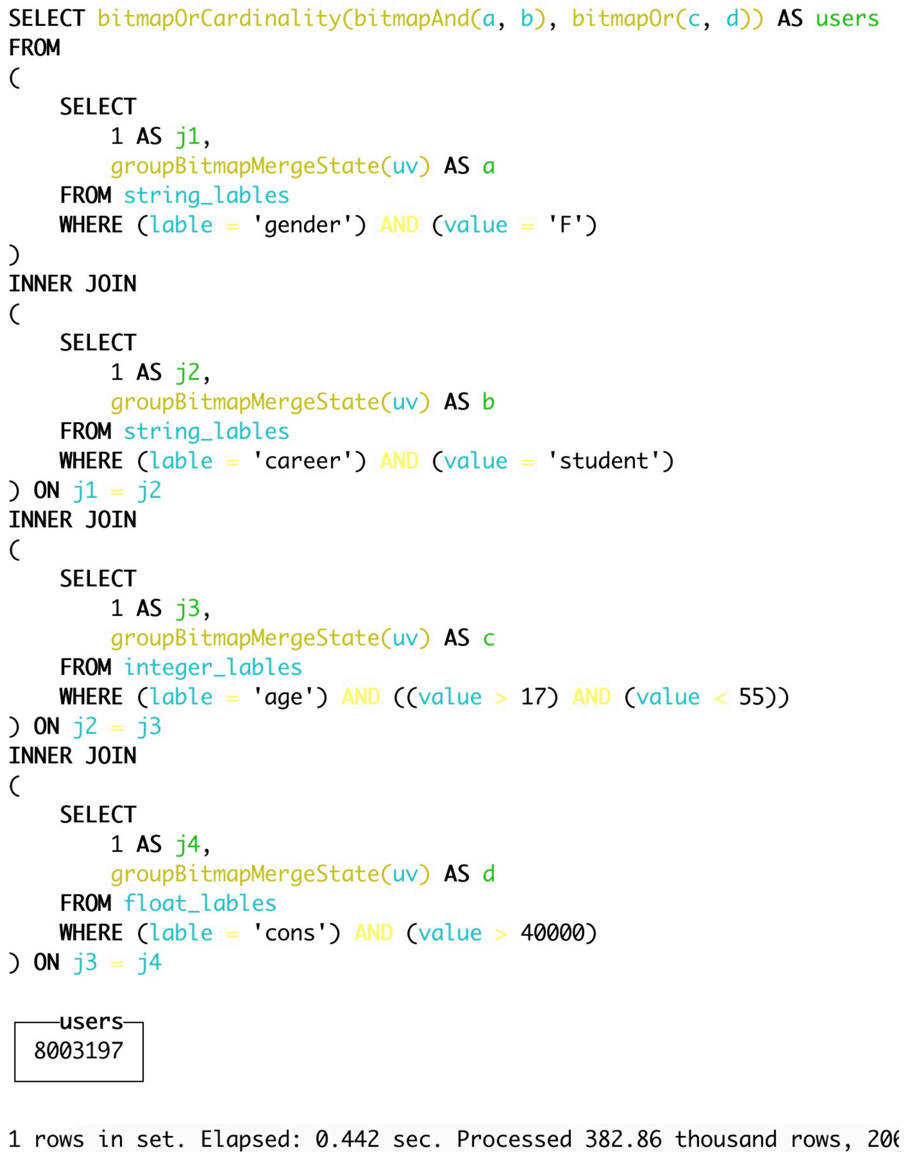
6 查询，按条件圈用户

条件：

（性别 = 女 AND 职业 = 工程师）

OR

(17 < 年龄 < 55 OR 消费 > 40000)



```
SELECT bitmapOrCardinality(bitmapAnd(a, b), bitmapOr(c, d)) AS users
FROM
(
    SELECT
        1 AS j1,
        groupBitmapMergeState(uv) AS a
    FROM string_lables
    WHERE (lable = 'gender') AND (value = 'F')
)
INNER JOIN
(
    SELECT
        1 AS j2,
        groupBitmapMergeState(uv) AS b
    FROM string_lables
    WHERE (lable = 'career') AND (value = 'student')
) ON j1 = j2
INNER JOIN
(
    SELECT
        1 AS j3,
        groupBitmapMergeState(uv) AS c
    FROM integer_lables
    WHERE (lable = 'age') AND ((value > 17) AND (value < 55))
) ON j2 = j3
INNER JOIN
(
    SELECT
        1 AS j4,
        groupBitmapMergeState(uv) AS d
    FROM float_lables
    WHERE (lable = 'cons') AND (value > 40000)
) ON j3 = j4

┌─users─┐
│ 8003197 │
└─────────┘

1 rows in set. Elapsed: 0.442 sec. Processed 382.86 thousand rows, 20(
```

目录

一、 腾讯云ClickHouse在QQ音乐实践

二、 常见ClickHouse实时分析场景

三、 腾讯云ClickHouse性能调优

四、 腾讯云ClickHouse现状与规划

三、 腾讯云ClickHouse性能调优

MergeTree engines

1. INSERT操作是原子的

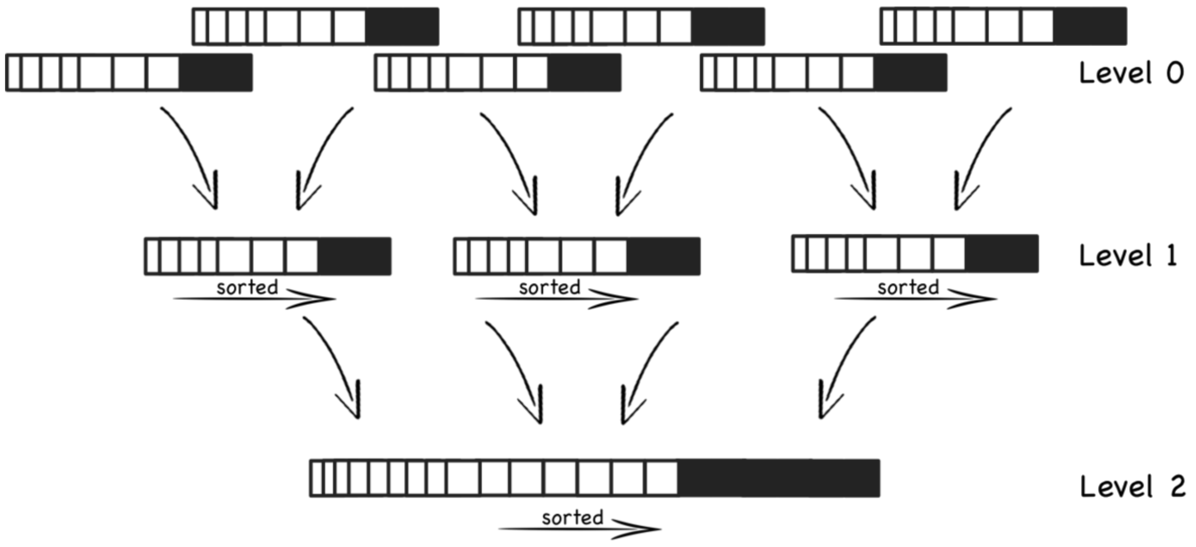
2. SELECT操作异常快

3. 支持主索引/二级索引

4. INSERT/SELECT相互不影响

5. 后台合并数据

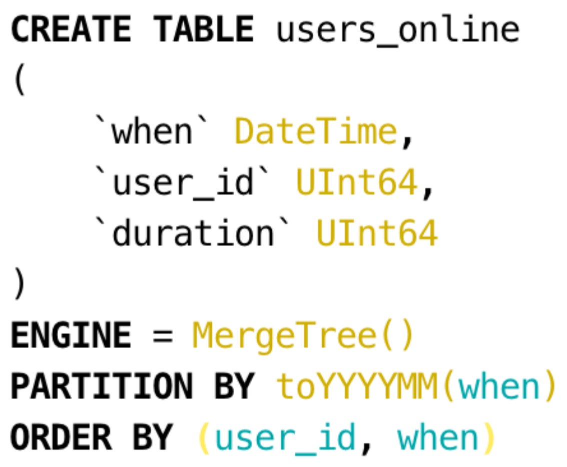
6. 主键不唯一



Compaction continues creating fewer, larger and larger files

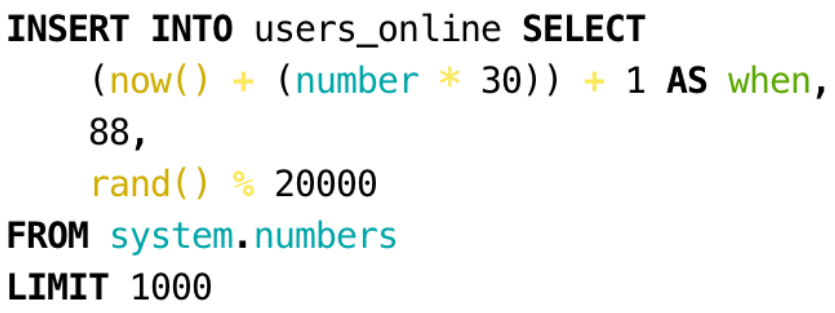
三、 腾讯云ClickHouse性能调优

1 CREATE



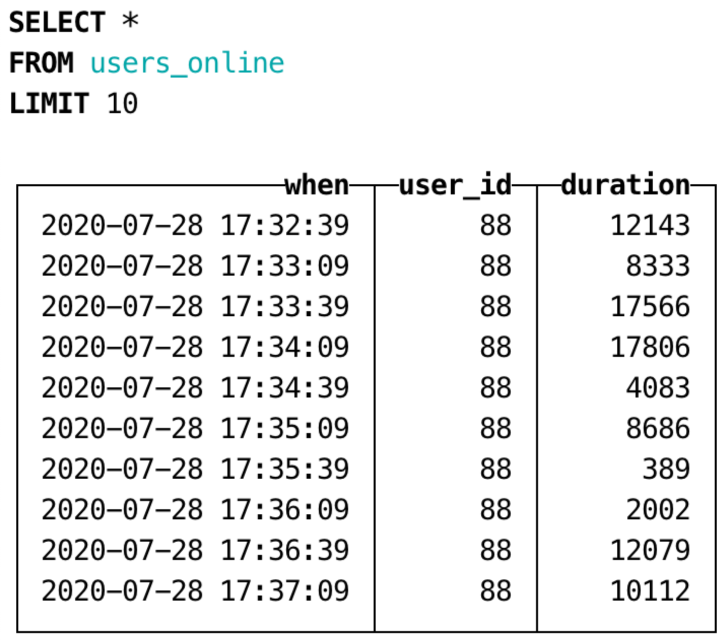
```
CREATE TABLE users_online
(
    `when` DateTime,
    `user_id` UInt64,
    `duration` UInt64
)
ENGINE = MergeTree()
PARTITION BY toYYYYMM(when)
ORDER BY (user_id, when)
```

2 INSERT



```
INSERT INTO users_online SELECT
    (now() + (number * 30)) + 1 AS when,
    88,
    rand() % 20000
FROM system.numbers
LIMIT 1000
```

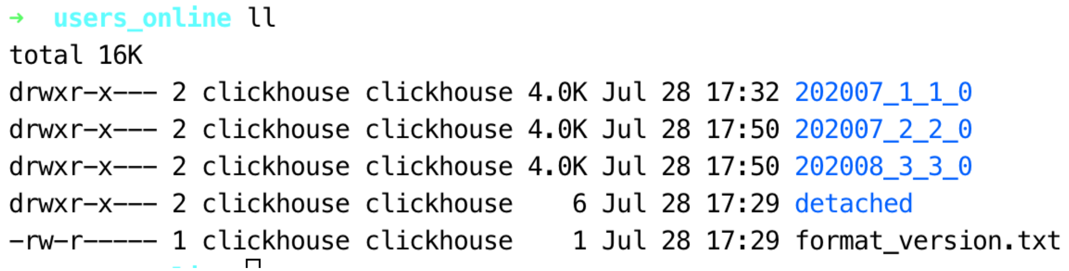
3 SELECT



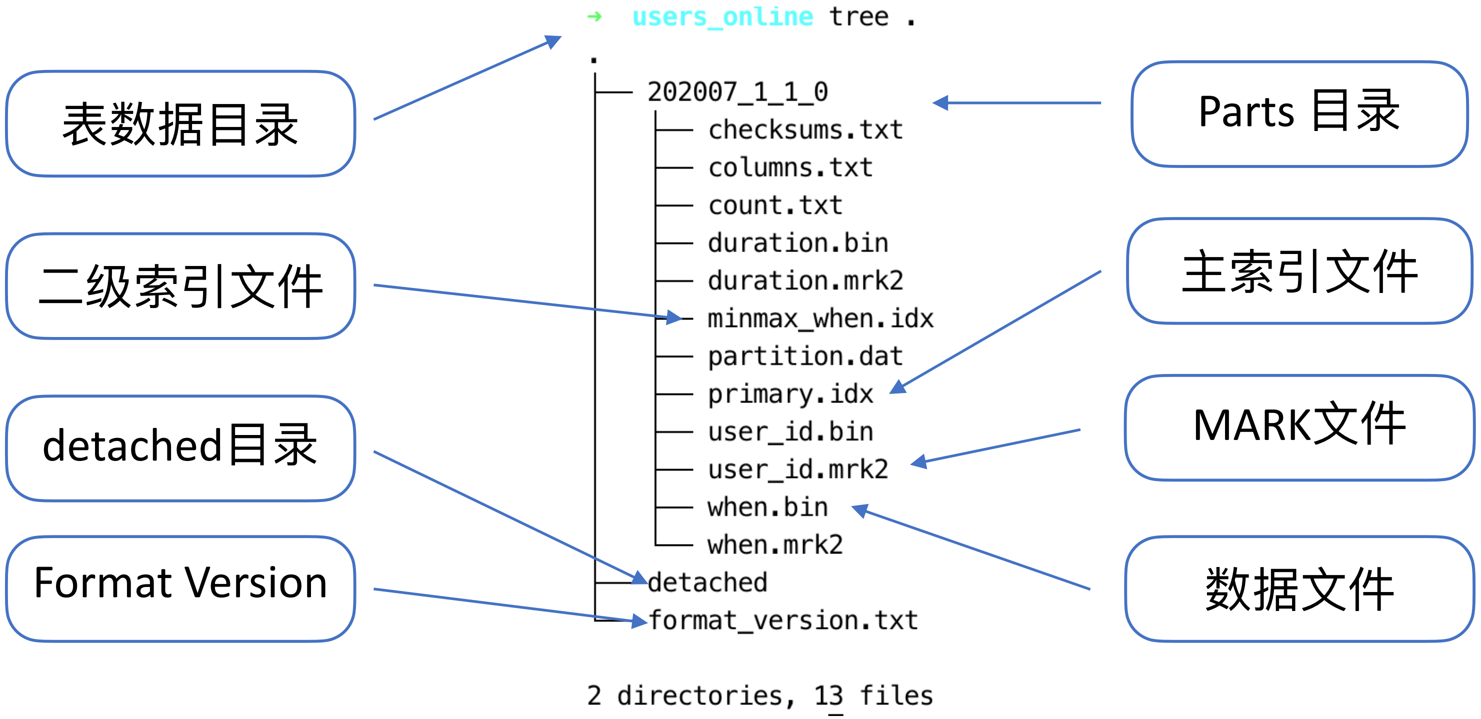
```
SELECT *
FROM users_online
LIMIT 10
```

```
┌────────────────when─┬─user_id─┬─duration─┐
│ 2020-07-28 17:32:39 │      88 │    12143 │
│ 2020-07-28 17:33:09 │      88 │     8333 │
│ 2020-07-28 17:33:39 │      88 │    17566 │
│ 2020-07-28 17:34:09 │      88 │    17806 │
│ 2020-07-28 17:34:39 │      88 │     4083 │
│ 2020-07-28 17:35:09 │      88 │     8686 │
│ 2020-07-28 17:35:39 │      88 │      389 │
│ 2020-07-28 17:36:09 │      88 │     2002 │
│ 2020-07-28 17:36:39 │      88 │    12079 │
│ 2020-07-28 17:37:09 │      88 │    10112 │
└─────────────────────┴─────────┴──────────┘
```

数据目录



```
➜  users_online ll
total 16K
drwxr-x--- 2 clickhouse clickhouse 4.0K Jul 28 17:32 202007_1_1_0
drwxr-x--- 2 clickhouse clickhouse 4.0K Jul 28 17:50 202007_2_2_0
drwxr-x--- 2 clickhouse clickhouse 4.0K Jul 28 17:50 202008_3_3_0
drwxr-x--- 2 clickhouse clickhouse    6 Jul 28 17:29 detached
-rw-r----- 1 clickhouse clickhouse    1 Jul 28 17:29 format_version.txt
```



```
➜  users_online tree .
.
├── 202007_1_1_0
│   ├── checksums.txt
│   ├── columns.txt
│   ├── count.txt
│   ├── duration.bin
│   ├── duration.mrk2
│   ├── minmax_when.idx
│   ├── partition.dat
│   ├── primary.idx
│   ├── user_id.bin
│   ├── user_id.mrk2
│   ├── when.bin
│   └── when.mrk2
├── detached
└── format_version.txt

2 directories, 13 files
```

表数据目录

二级索引文件

detached目录

Format Version

Parts 目录

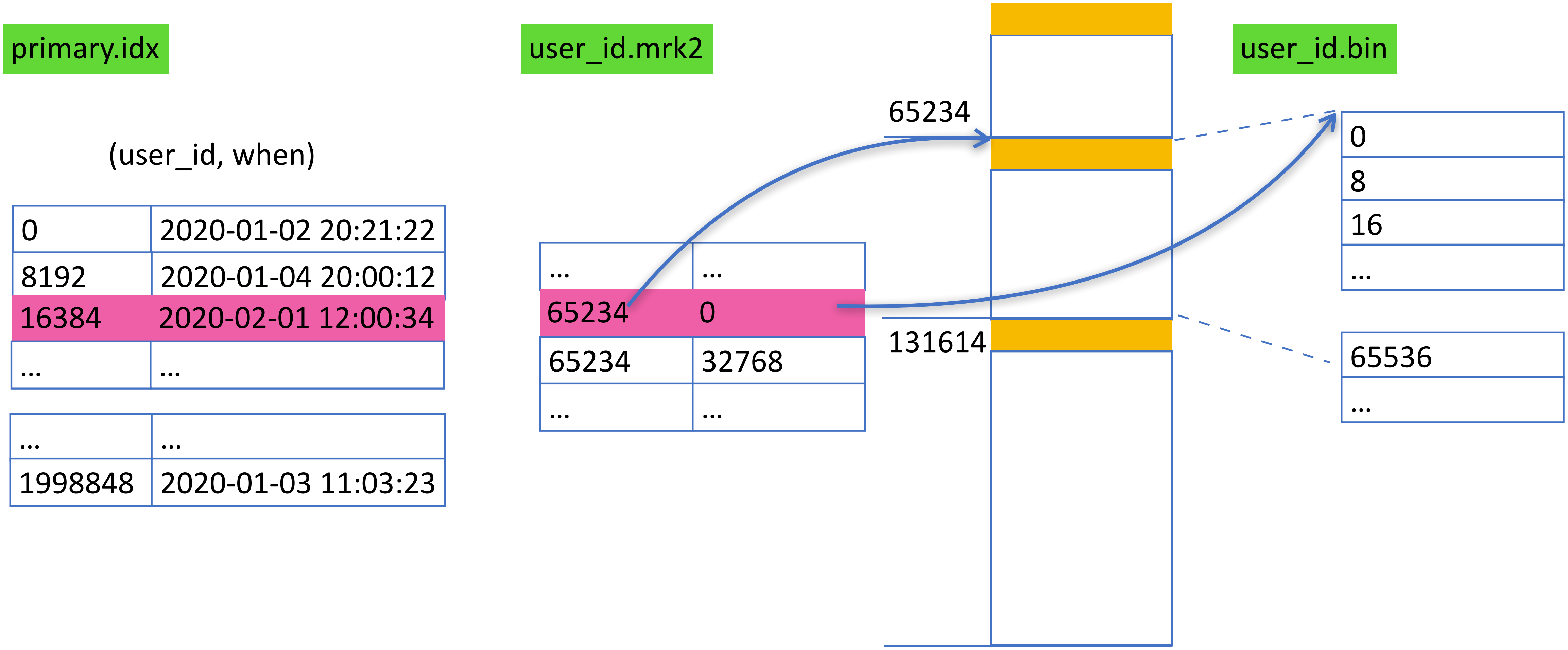
主索引文件

MARK文件

数据文件

三、 腾讯云ClickHouse性能调优

数据索引



primary.idx

(user_id, when)

0	2020-01-02 20:21:22
8192	2020-01-04 20:00:12
16384	2020-02-01 12:00:34
…	…

…	…
1998848	2020-01-03 11:03:23

user_id.mrk2

…	…
65234	0
65234	32768
…	…

user_id.bin

0
8
16
…

65536
…

配置选型

数据节点

CPU： 主频越高越好，通常也建议配置32cores以上的机型

内存：当然内存越大越好，PageCache加速作用越明显。通常建议配置128GB以上内存

磁盘：HDD盘即可，RAID-10，RAID-5，RAID-6或RAID-50。如果查询数据量大，邀请延迟低，上SSD/NVME

ZK节点

ZK节点的负载与集群的数据量成正比。当数据规模在TB级别时，建议为ZK节点选择SSD盘。

基础参数

max_threads: 查询使用的线程数量，默认为核数一半

max_memory_usage: 单次查询允许使用的内存量

max_memory_usage_for_all_users： clickhouse进程允许使用的内存量, 通常需要考虑为OS预留内存

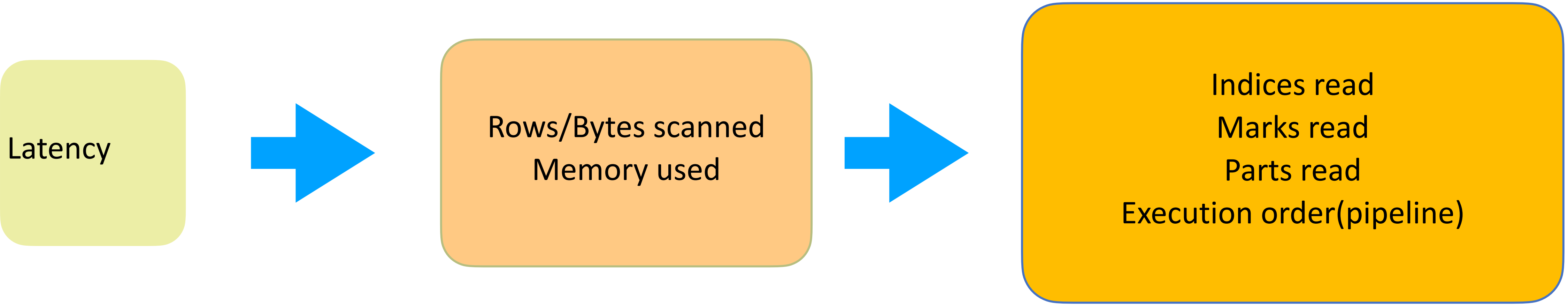
max_bytes_before_external_group_by: GROUP BY 操作使用内存超过该阈值后, 数据会写入磁盘，建议设置为max_memory_usage/2

max_concurrent_queries: 最大并发数限制

max_bytes_before_external_sort: order by 排序溢写磁盘阈值

background_pool_size: 后台线程组

查询优化



Latency

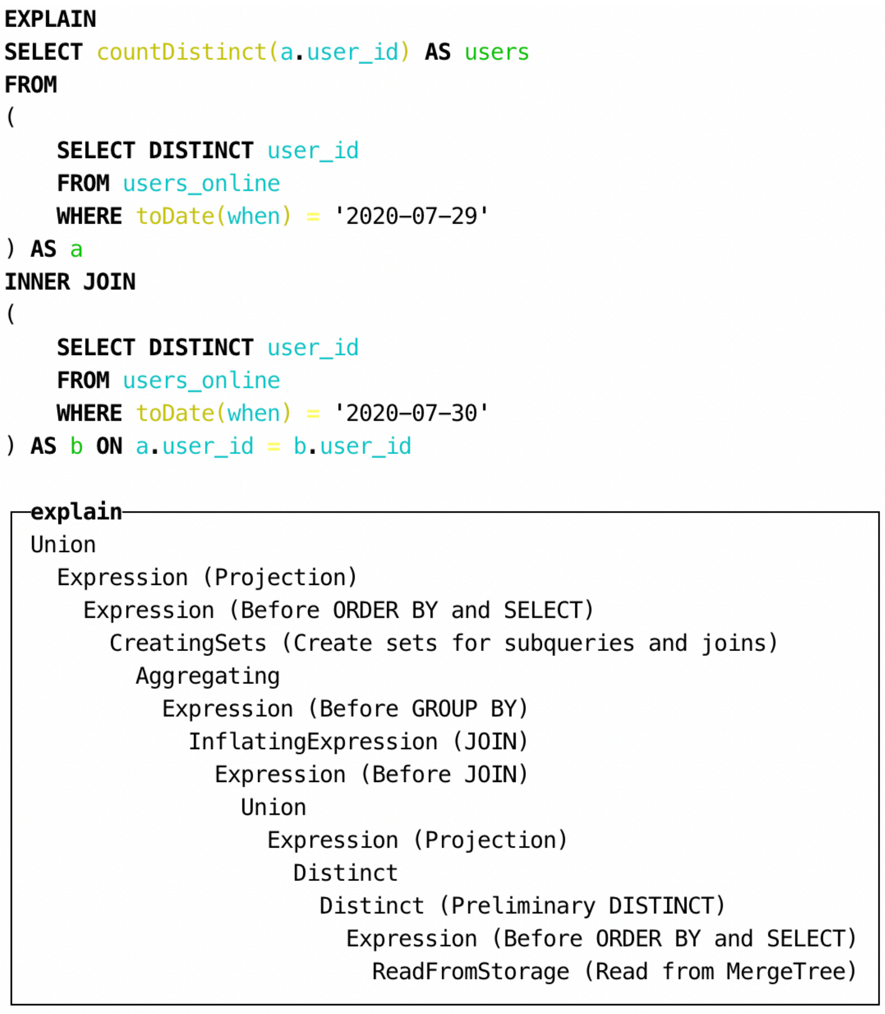
Rows/Bytes scanned
Memory used

Indices read
Marks read
Parts read
Execution order(pipeline)

查询优化

EXPLAIN [AST | SYNTAX | PLAN | PIPELINE] [settings = value, ...,] SELECT ... [FORMAT ...]

Let’s EXPLAIN.



```
EXPLAIN
SELECT countDistinct(a.user_id) AS users
FROM
(
    SELECT DISTINCT user_id
    FROM users_online
    WHERE toDate(when) = '2020-07-29'
) AS a
INNER JOIN
(
    SELECT DISTINCT user_id
    FROM users_online
    WHERE toDate(when) = '2020-07-30'
) AS b ON a.user_id = b.user_id
```

```
┌─explain──────────────────────────────────────────────────────────────┐
│ Union                                                                │
│   Expression (Projection)                                            │
│     Expression (Before ORDER BY and SELECT)                          │
│       CreatingSets (Create sets for subqueries and joins)            │
│         Aggregating                                                  │
│           Expression (Before GROUP BY)                               │
│             InflatingExpression (JOIN)                               │
│               Expression (Before JOIN)                               │
│                 Union                                                │
│                   Expression (Projection)                            │
│                     Distinct                                         │
│                       Distinct (Preliminary DISTINCT)                │
│                         Expression (Before ORDER BY and SELECT)      │
│                           ReadFromStorage (Read from MergeTree)      │
└──────────────────────────────────────────────────────────────────────┘
```

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四、 腾讯云ClickHouse现状与规划

五、 腾讯云ClickHouse现状与规划

1

分钟级构建

- 10分钟构建上百节点大数据集群
- 支持控制台/程序API灵活构建

2

极致弹性

- 集群横向扩展
- 数据均衡 服务

3

极致性能

- 组件深度优化，与物理机构建性能接近
- PB至EB级COS数据高速分析

4

云端运维基础设施保障

- 百余监控指标覆盖(服务器级、服务级)
- 异常事件秒级触达
- Ddos/VPC安全加固

5

云端数据服务无缝连接

- 多源数据支持(云数据库、Ckafka)
- 云端可视化BI工具无缝对接

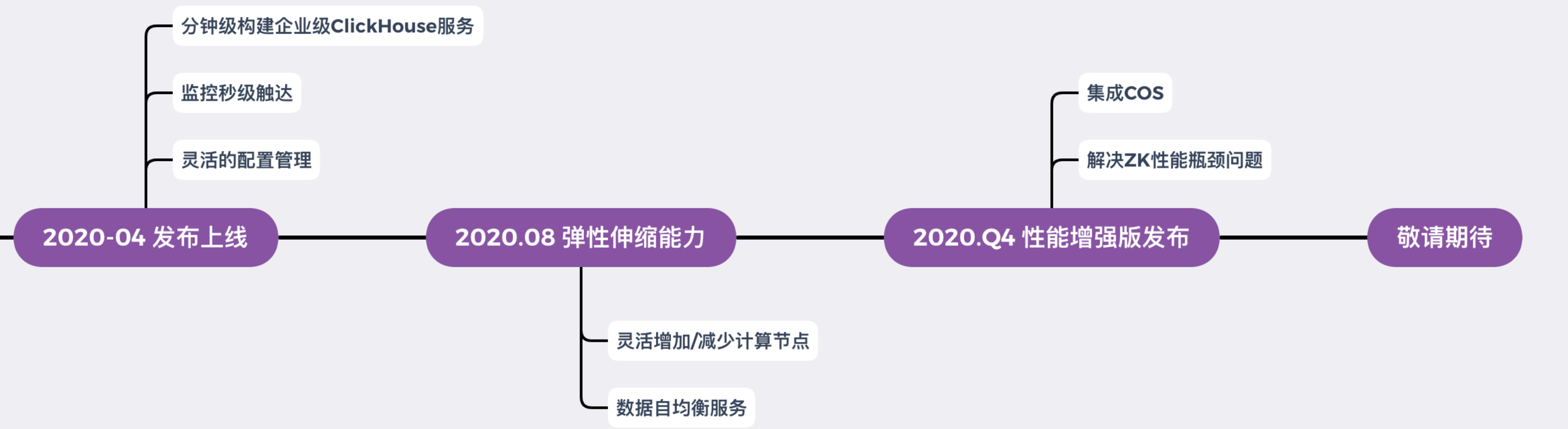
6

持续性技术支撑

- 云厂商雄厚技术支撑
- 线上技术交流(论坛、视频、指南)
- 线下技术沙龙

腾讯云EMR-ClickHouse 提供了集群快速部署，监控运维等企业级功能。方便用户快速构建云上海量数据分析平台。

五、 腾讯云ClickHouse现状与规划



2020-04 发布上线

- 分钟级构建企业级ClickHouse服务
- 监控秒级触达
- 灵活的配置管理

2020.08 弹性伸缩能力

- 灵活增加/减少计算节点
- 数据自均衡服务

2020.Q4 性能增强版发布

- 集成COS
- 解决ZK性能瓶颈问题

敬请期待

欢迎讨论ClickHouse相关问题 ~

pengjian.uestc@gmail.com