# 腾讯云数据仓库 TCHouse-C

# 性能测试

腾讯云

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# 测试方案介绍

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## 前言

本文为您介绍如何使用 Star Schema 数据集对腾讯云 TCHouse-C 进行性能测试，给出数据导入及性能测试的参考方案。

## 准备工作

### 购买实例

参照 快速入门 购买腾讯云 TCHouse-C 实例，可选择标准型、高性能型、大存储型，软件建议选择22.8及以后版本。

### 准备测试机器

准备能够访问腾讯云 TCHouse-C 服务的 Linux 系统机器，并在该机器上安装 clickhouse-client 工具。测试机器需要能够访问腾讯云 TCHouse-C 服务，至少需1.5TB存储空间。在测试机器上安装`clickhouse client`工具，请参见 安装文档 。
在购买实例后，请在控制台中调整参数如下：

| 参数名称 | 所载文件 | 作用 | 建议值 |
| --- | --- | --- | --- |
| max_threads | users.xml | 单个查询允许使用的线程数 | CPU 核数 |
| max_insert_threads | users.xml | 单次写入允许使用的线程数据 | CPU 核数 |
| max_memory_usage \| users.xml | 单次查询允许使用的内存最大值 | 总内存数 | 10GB |
| background_pool_size | users.xml | MergeTree 引擎后台任务线程池大小 | CPU 核数*2 |
| max_thread_pool_size | config.xml | 全局线程池最大分配线程数量 | 20000 |
| max_open_files | config.xml | 允许进程打开的最大文件句柄上 | 1000000 |
| mark_cache_size | config.xml | mark 文件缓存大小 | 10737418240 |

具体参数调整，请参见 参数配置 。

> ⚠ 注意：调整完成后，请重启集群。

## 测试步骤

### 确认软件版本

使用 clickhouse client 访问腾讯云 TCHouse-C 服务，查看软件版本。

```
clickhouse client --host $HOST --port $PORT -q "select version()"
```

> ⚠ 注意：请确保软件版本大于22.8.*。

### 准备数据生成工具

```
$ git clone git@github.com:vadimtk/ssb-dbgen.git$ cd ssb-dbgen$ make
```

### 生成测试数据

ssb-dbgen工具支持两种规模的数据，使用参数 -s 100 可以生成约6亿行规模的数据，使用参数 -s 1000 可以生成约60亿行规模的数据。建议采用 -s 1000 .

```
$ ./dbgen -s 1000 -T c$ ./dbgen -s 1000 -T l$ ./dbgen -s 1000 -T p$ ./dbgen -s 1000 -T s
```

### 创建数据库表

在腾讯云 TCHouse-C 控制台上，获取服务入口信息：访问IP地址和服务端口。分别记录为 HOST 和 PORT。
使用 clickhouse client 工具链接腾讯云 TCHouse-C 服务，执行如下 SQL：

```
CREATE TABLE customer
(
        C_CUSTKEY       UInt32,
        C_NAME          String,
        C_ADDRESS       String,
        C_CITY          LowCardinality(String),
        C_NATION        LowCardinality(String),
        C_REGION        LowCardinality(String),
        C_PHONE         String,
        C_MKTSEGMENT    LowCardinality(String)
)
ENGINE = MergeTree ORDER BY (C_CUSTKEY);

CREATE TABLE lineorder
```

```
(
    LO_ORDERKEY          UInt32,
    LO_LINENUMBER        UInt8,
    LO_CUSTKEY           UInt32,
    LO_PARTKEY           UInt32,
    LO_SUPPKEY           UInt32,
    LO_ORDERDATE         Date,
    LO_ORDERPRIORITY     LowCardinality(String),
    LO_SHIPPRIORITY      UInt8,
    LO_QUANTITY          UInt8,
    LO_EXTENDEDPRICE     UInt32,
    LO_ORDTOTALPRICE     UInt32,
    LO_DISCOUNT          UInt8,
    LO_REVENUE           UInt32,
    LO_SUPPLYCOST        UInt32,
    LO_TAX               UInt8,
    LO_COMMITDATE        Date,
    LO_SHIPMODE          LowCardinality(String)
)
ENGINE = MergeTree PARTITION BY toYear(LO_ORDERDATE) ORDER BY (LO_ORDERDAT
E, LO_ORDERKEY);

CREATE TABLE part
(
        P_PARTKEY     UInt32,
        P_NAME        String,
        P_MFGR        LowCardinality(String),
        P_CATEGORY    LowCardinality(String),
        P_BRAND       LowCardinality(String),
        P_COLOR       LowCardinality(String),
        P_TYPE        LowCardinality(String),
        P_SIZE        UInt8,
        P_CONTAINER   LowCardinality(String)
)
ENGINE = MergeTree ORDER BY P_PARTKEY;

CREATE TABLE supplier
(
        S_SUPPKEY     UInt32,
        S_NAME        String,
        S_ADDRESS     String,
        S_CITY        LowCardinality(String),
        S_NATION      LowCardinality(String),
        S_REGION      LowCardinality(String),
        S_PHONE       String
```

```
)
ENGINE = MergeTree ORDER BY S_SUPPKEY;
```

## 导入测试数据

**首先，导入基础表数据：**

```
$ clickhouse client --host $HOST --port $PORT --
query "INSERT INTO customer FORMAT CSV" < customer.tbl
$ clickhouse client --host $HOST --port $PORT --
query "INSERT INTO part FORMAT CSV" < part.tbl
$ clickhouse client --host $HOST --port $PORT --
query "INSERT INTO supplier FORMAT CSV" < supplier.tbl
$ clickhouse client --host $HOST --port $PORT --
query "INSERT INTO lineorder FORMAT CSV" < lineorder.tbl
```

**其次，根据基础表数据生成宽表数据。**

**这里需要注意已经调整了** `max_memory_usage` **和** `max_insert_threads` **参数。**

```
CREATE TABLE lineorder_flat
ENGINE = MergeTree ORDER BY (LO_ORDERDATE, LO_ORDERKEY)
AS SELECT
    l.LO_ORDERKEY AS LO_ORDERKEY,
    l.LO_LINENUMBER AS LO_LINENUMBER,
    l.LO_CUSTKEY AS LO_CUSTKEY,
    l.LO_PARTKEY AS LO_PARTKEY,
    l.LO_SUPPKEY AS LO_SUPPKEY,
    l.LO_ORDERDATE AS LO_ORDERDATE,
    l.LO_ORDERPRIORITY AS LO_ORDERPRIORITY,
    l.LO_SHIPPRIORITY AS LO_SHIPPRIORITY,
    l.LO_QUANTITY AS LO_QUANTITY,
    l.LO_EXTENDEDPRICE AS LO_EXTENDEDPRICE,
    l.LO_ORDTOTALPRICE AS LO_ORDTOTALPRICE,
    l.LO_DISCOUNT AS LO_DISCOUNT,
    l.LO_REVENUE AS LO_REVENUE,
    l.LO_SUPPLYCOST AS LO_SUPPLYCOST,
    l.LO_TAX AS LO_TAX,
    l.LO_COMMITDATE AS LO_COMMITDATE,
    l.LO_SHIPMODE AS LO_SHIPMODE,
    c.C_NAME AS C_NAME,
    c.C_ADDRESS AS C_ADDRESS,
    c.C_CITY AS C_CITY,
    c.C_NATION AS C_NATION,
    c.C_REGION AS C_REGION,
```

```
    c.C_PHONE AS C_PHONE,
    c.C_MKTSEGMENT AS C_MKTSEGMENT,
    s.S_NAME AS S_NAME,
    s.S_ADDRESS AS S_ADDRESS,
    s.S_CITY AS S_CITY,
    s.S_NATION AS S_NATION,
    s.S_REGION AS S_REGION,
    s.S_PHONE AS S_PHONE,
    p.P_NAME AS P_NAME,
    p.P_MFGR AS P_MFGR,
    p.P_CATEGORY AS P_CATEGORY,
    p.P_BRAND AS P_BRAND,
    p.P_COLOR AS P_COLOR,
    p.P_TYPE AS P_TYPE,
    p.P_SIZE AS P_SIZE,
    p.P_CONTAINER AS P_CONTAINER
FROM lineorder AS l
INNER JOIN customer AS c ON c.C_CUSTKEY = l.LO_CUSTKEY
INNER JOIN supplier AS s ON s.S_SUPPKEY = l.LO_SUPPKEY
INNER JOIN part AS p ON p.P_PARTKEY = l.LO_PARTKEY;
```

## 优化查询（可选）

腾讯云 TCHouse-C 提供了预计算能力，加速执行。这里使用 PROJECTION 来加速查询。执行如下 SQL：

```
ALTER TABLE lineorder_flat
ADD PROJECTION p1
(
    SELECT
        toYear(LO_ORDERDATE) AS year,
        sum(LO_REVENUE)
    GROUP BY
        year,
        P_BRAND,
        P_CATEGORY,
        S_REGION
);
ALTER TABLE lineorder_flat
ADD PROJECTION p2
(
    SELECT
        toYear(LO_ORDERDATE) AS year,
        sum(LO_REVENUE)
    GROUP BY
        year,
```

```
        C_NATION,
        S_NATION,
        C_REGION,
        S_REGION
);
ALTER TABLE lineorder_flat
ADD PROJECTION p3
(
    SELECT
        toYear(LO_ORDERDATE) AS year,
        sum(LO_REVENUE)
    GROUP BY
        year,
        C_CITY,
        S_CITY
);
ALTER TABLE lineorder_flat
ADD PROJECTION p4
(
    SELECT
        toYear(LO_ORDERDATE) AS year,
        sum(LO_REVENUE)
    GROUP BY
        year,
        C_NATION,
        C_CITY,
        S_NATION,
        S_CITY
);
ALTER TABLE lineorder_flat
ADD PROJECTION p5
(
    SELECT
        toYear(LO_ORDERDATE) AS year,
        sum(LO_REVENUE - LO_SUPPLYCOST) AS profit
    GROUP BY
        year,
        C_NATION,
        C_REGION,
        S_REGION,
        P_MFGR,
        P_MFGR
);
ALTER TABLE lineorder_flat
ADD PROJECTION p6
```

```
    (
        SELECT
            toYear(LO_ORDERDATE) AS year,
            sum(LO_REVENUE - LO_SUPPLYCOST)
        GROUP BY
            year,
            S_NATION,
            P_CATEGORY,
            C_REGION,
            S_REGION,
            P_MFGR
    );
    ALTER TABLE lineorder_flat
    ADD PROJECTION p7
    (
        SELECT
            toYear(LO_ORDERDATE) AS year,
            sum(LO_REVENUE - LO_SUPPLYCOST)
        GROUP BY
            year,
            S_CITY,
            P_BRAND,
            S_NATION,
            P_CATEGORY
    );
```

执行上述 SQL 后，需要对存量数据进行处理，使 PROJECTION 在存量数据上生效。执行如下 SQL：

```
ALTER TABLE lineorder_flat MATERIALIZE PROJECTION p1;
ALTER TABLE lineorder_flat MATERIALIZE PROJECTION p2;
ALTER TABLE lineorder_flat MATERIALIZE PROJECTION p3;
ALTER TABLE lineorder_flat MATERIALIZE PROJECTION p4;
ALTER TABLE lineorder_flat MATERIALIZE PROJECTION p5;
ALTER TABLE lineorder_flat MATERIALIZE PROJECTION p6;
ALTER TABLE lineorder_flat MATERIALIZE PROJECTION p7;
```

> ⚠ **注意：** 该步骤是可选的，使用优化后，性能提升非常明显。

## 执行测试 SQL 并统计执行时间数据

Q1.1

```
SELECT sum(LO_EXTENDEDPRICE * LO_DISCOUNT) AS revenue
```

```
FROM lineorder_flat
WHERE toYear(LO_ORDERDATE) = 1993 AND LO_DISCOUNT BETWEEN 1 AND 3 AND L
O_QUANTITY < 25;
```

Q1.2

```
SELECT sum(LO_EXTENDEDPRICE * LO_DISCOUNT) AS revenue
FROM lineorder_flat
WHERE toYYYYMM(LO_ORDERDATE) = 199401 AND LO_DISCOUNT BETWEEN 4 AND 6
AND LO_QUANTITY BETWEEN 26 AND 35;
```

Q1.3

```
SELECT sum(LO_EXTENDEDPRICE * LO_DISCOUNT) AS revenue
FROM lineorder_flat
WHERE toISOWeek(LO_ORDERDATE) = 6 AND toYear(LO_ORDERDATE) = 1994
  AND LO_DISCOUNT BETWEEN 5 AND 7 AND LO_QUANTITY BETWEEN 26 AND 35;
```

Q2.1

```
SELECT
    sum(LO_REVENUE),
    toYear(LO_ORDERDATE) AS year,
    P_BRAND
FROM lineorder_flat
WHERE P_CATEGORY = 'MFGR#12' AND S_REGION = 'AMERICA'
GROUP BY
    year,
    P_BRAND
ORDER BY
    year,
    P_BRAND;
```

Q2.2

```
SELECT
    sum(LO_REVENUE),
    toYear(LO_ORDERDATE) AS year,
    P_BRAND
FROM lineorder_flat
```

```
WHERE P_BRAND >= 'MFGR#2221' AND P_BRAND <= 'MFGR#2228' AND S_REGION =
 'ASIA'
GROUP BY
    year,
    P_BRAND
ORDER BY
    year,
    P_BRAND;
```

Q2.3

```
SELECT
    sum(LO_REVENUE),
    toYear(LO_ORDERDATE) AS year,
    P_BRAND
FROM lineorder_flat
WHERE P_BRAND = 'MFGR#2239' AND S_REGION = 'EUROPE'
GROUP BY
    year,
    P_BRAND
ORDER BY
    year,
    P_BRAND;
```

Q3.1

```
SELECT
    C_NATION,
    S_NATION,
    toYear(LO_ORDERDATE) AS year,
    sum(LO_REVENUE) AS revenue
FROM lineorder_flat
WHERE C_REGION = 'ASIA' AND S_REGION = 'ASIA' AND year >= 1992 AND year <=
1997
GROUP BY
    C_NATION,
    S_NATION,
    year
ORDER BY
    year ASC,
    revenue DESC;
```

Q3.2

```
SELECT
    C_CITY,
    S_CITY,
    toYear(LO_ORDERDATE) AS year,
    sum(LO_REVENUE) AS revenue
FROM lineorder_flat
WHERE C_NATION = 'UNITED STATES' AND S_NATION = 'UNITED STATES' AND year >=
 1992 AND year <= 1997
GROUP BY
    C_CITY,
    S_CITY,
    year
ORDER BY
    year ASC,
    revenue DESC;
```

Q3.3

```
SELECT
    C_CITY,
    S_CITY,
    toYear(LO_ORDERDATE) AS year,
    sum(LO_REVENUE) AS revenue
FROM lineorder_flat
WHERE (C_CITY = 'UNITED KI1' OR C_CITY = 'UNITED KI5') AND (S_CITY = 'UNITED KI1'
 OR S_CITY = 'UNITED KI5') AND year >= 1992 AND year <= 1997
GROUP BY
    C_CITY,
    S_CITY,
    year
ORDER BY
    year ASC,
    revenue DESC;
```

Q3.4

```
SELECT
    C_CITY,
    S_CITY,
    toYear(LO_ORDERDATE) AS year,
    sum(LO_REVENUE) AS revenue
FROM lineorder_flat
```

```
WHERE (C_CITY = 'UNITED KI1' OR C_CITY = 'UNITED KI5') AND (S_CITY = 'UNITED KI1'
 OR S_CITY = 'UNITED KI5') AND toYYYYMM(LO_ORDERDATE) = 199712
GROUP BY
    C_CITY,
    S_CITY,
    year
ORDER BY
    year ASC,
    revenue DESC;
```

Q4.1

```
SELECT
    toYear(LO_ORDERDATE) AS year,
    C_NATION,
    sum(LO_REVENUE - LO_SUPPLYCOST) AS profit
FROM lineorder_flat
WHERE C_REGION = 'AMERICA' AND S_REGION = 'AMERICA' AND (P_MFGR = 'MFGR#
1' OR P_MFGR = 'MFGR#2')
GROUP BY
    year,
    C_NATION
ORDER BY
    year ASC,
    C_NATION ASC;
```

Q4.2

```
SELECT
    toYear(LO_ORDERDATE) AS year,
    S_NATION,
    P_CATEGORY,
    sum(LO_REVENUE - LO_SUPPLYCOST) AS profit
FROM lineorder_flat
WHERE C_REGION = 'AMERICA' AND S_REGION = 'AMERICA' AND (year = 1997 OR ye
ar = 1998) AND (P_MFGR = 'MFGR#1' OR P_MFGR = 'MFGR#2')
GROUP BY
    year,
    S_NATION,
    P_CATEGORY
ORDER BY
    year ASC,
    S_NATION ASC,
    P_CATEGORY ASC;
```

Q4.3

```
SELECT
    toYear(LO_ORDERDATE) AS year,
    S_CITY,
    P_BRAND,
    sum(LO_REVENUE - LO_SUPPLYCOST) AS profit
FROM lineorder_flat
WHERE S_NATION = 'UNITED STATES' AND (year = 1997 OR year = 1998) AND P_CATE
GORY = 'MFGR#14'
GROUP BY
    year,
    S_CITY,
    P_BRAND
ORDER BY
    year ASC,
    S_CITY ASC,
    P_BRAND ASC;
```

## 总结

性能测试作为腾讯云 TCHouse-C 业务接入前的重要一环，是性能评估以及资源评估的重要依据。
通常业务面临多种系统选型时，也会进行性能对比测试。在对比测试过程中，需要注意以下几点：

- 腾讯云 TCHouse-C 的一些关键参数会影响性能，务必调整合理，才能充分发挥其性能优势。
- 需要对齐资源。例如，一次性分布式查询，腾讯云 TCHouse-C 只有1/2节点参与计算；而其他系统则是全部节点参与计算。在这种情况下，在等同数据规模下，腾讯云 TCHouse-C 可能性能数据不占优。在这种情况下，可以调整集群备份策略，让所有节点参与计算。
- 腾讯云 TCHouse-C 有很多特有的性能优化机制，开启这些机制，能够明显提升查询性能。

# 测试结果参考

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## 关于 SSB 性能测试

SSB（Star Schema Benchmark）是一个轻量级的数仓场景下的性能测试集。SSB 将 TPC-H 的雪花模式简化为了星型模式，将基准查询由 TPC-H 复杂的 Ad-Hoc 查询改为了结构更固定的 OLAP 查询，主要用于测试在星型模型下，多表关联查询的性能表现。Clickhouse 官方将 SSB 的星型模型打平转化成宽表，改造成了一个单表测试集（以下简称：SSB FLAT）来测试查询引擎的性能。本文将给出腾讯云数据仓库 TCHouse-C 在 SSB 单表数据集上的性能测试结果。

## 性能测试方案

### 监控工具

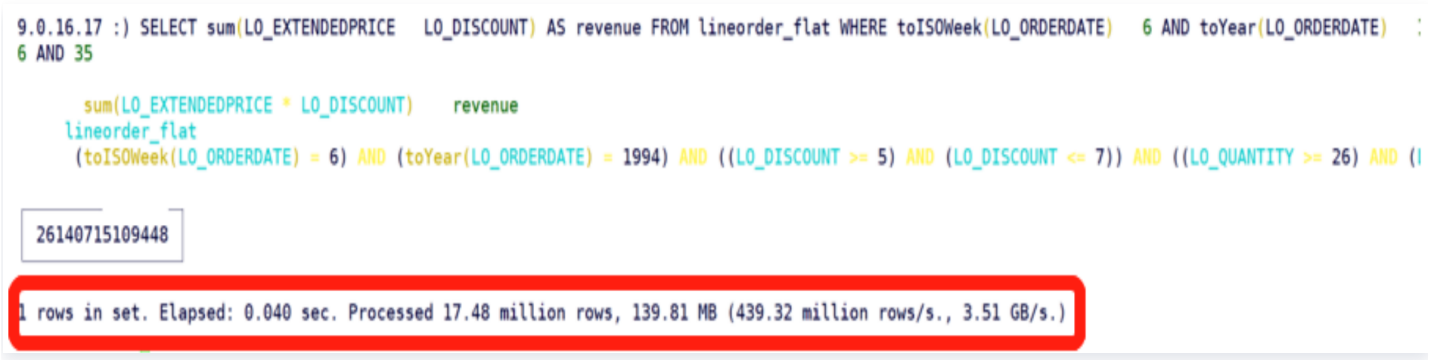
使用腾讯云数据仓库 TCHouse-C 的集群监控页面获取集群和节点监控信息。

### 测试内容

步骤一：使用 dbgen 工具初始化指定大小的数据存放于待测试的机型集群磁盘空间上。
步骤二：在腾讯云上购买TCHouse-C集群，并在该集群中创建所需的表。
步骤三：将步骤一中生成的数据导入到测试集群中。
步骤四：执行基准性能测试 SQL Q1.1-Q4.3指令。
步骤五：反复执行3次基准性能测试 SQL Q1.1-Q4.3指令。
步骤六：记录3次基准 SQL 执行的数据量，时间和速度。

### 查看结果

基准 SQL 执行后会输出如下信息，包含：执行查询结果行数、SQL 查询执行消耗的时间 、SQL 查询的记录数量、SQL 查询的数据量、SQL 查询的数据记录数量速率和 SQL 查询的数据量速率。




本次测试采用 SQL 查询执行消耗时间（s）指标项作为输出指标。

## 测试环境

### 硬件环境

本文共针对标准型+高性能云硬盘、标准型+增强型SSD云硬盘、高性能型+NVMe SSD 硬盘、大存储型+SATA HDD 本地硬盘四种机型场景进行性能测试，具体配置如下：

| 机型场景 | 节点规格 |
| --- | --- |
| 标准型 + 高性能云硬盘 | CPU：32 cores<br>内存：128 GB<br>磁盘：高性能云盘7000 GB |
| 标准型 + 增强型 SSD 云硬盘 | CPU：32 cores<br>内存：128 GB<br>磁盘：增强型 SSD 云盘5000 GB |
| 高性能型 + NVMe SSD 硬盘 | CPU：32 cores<br>内存：128 GB<br>磁盘：NVMe SSD 硬盘7140 GB * 2 |
| 大存储型 + SATA HDD 本地硬盘 | CPU：32 cores<br>内存：128 GB<br>磁盘：SATA HDD 本地硬盘44640 GB * 2 |

### 软件版本

腾讯云 TChouse-C 21.8.12.29

## 测试数据集

在 -s 1000参数下，生成的数据集大小为：

| SSB 表名 | 行数 | 备注 |
| --- | --- | --- |
| LINEORDER | 60亿 | 商品订单明细表表 |
| CUSTOMER | 3000万 | 客户信息表 |
| PART | 200万 | 零件信息表 |
| SUPPLIER | 200万 | 供应商信息表 |
| DATE | 2,556 | 日期表 |
| LINEORDER_FLAT | 60亿 | SSB 打平后的宽表 |

## 性能测试结果

| Query 编号 | 标准型 + 高性能云硬盘 | 标准型 + 增强型 SSD 云硬盘 | 高性能型 + NVMe SSD 硬盘 | 大存储型 + SATA HDD 本地硬盘 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q1.1 | 0.99 | 0.88 | 0.28 | 2.21 | | | | | | | | |
| Q1.2 | 0.12 | 0.12 | 0.01 | 0.09 | | | | | | | | |
| Q1.3 | 0.04 | 0.05 | 0.05 | 0.04 | | | | | | | | |
| Q2.1 | 6.63 | 5.94 | 5.96 | 5.91 | | | | | | | | |
| Q2.2 | 5.46 | 4.93 | 1.79 | 4.93 | | | | | | | | |
| Q2.3 | 5.1 | 4.63 | 1.62 | 4.59 | | | | | | | | |
| Q3.1 | 8.74 | 8.3 | 2.74 | 8.19 | | | | | | | | |
| Q3.2 | 6.3 | 5.73 | 1.88 | 5.39 | | | | | | | | |
| Q3.3 | 5.53 | 5.27 | 3.45 | 4.9 | | | | | | | | |
| Q3.4 | 0.13 | 0.13 | 0.06 | 0.1 | | | | | | | | |
| Q4.1 | 8.55 | 7.69 | 5.45 | 11.42 | | | | | | | | |
| Q4.2 | 3.1 | 2.47 | 0.83 | 2.29 | | | | | | | | |
| Q4.3 | 2.46 | 2.28 | 1.43 | 2.02 | | | | | | | | |
| **总** | **53.15** | **48.42** | **25.55** | **52.08** | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 时间 | | | | | | | | | | | | | |