阿里云
分析型数据库MySQL版

性能白皮书

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格式	说明	样例
	该类警示信息将导致系统重大变更甚至故障，或者导致人身伤害等结果。	 **禁止：** 重置操作将丢失用户配置数据。
	该类警示信息可能会导致系统重大变更甚至故障，或者导致人身伤害等结果。	 **警告：** 重启操作将导致业务中断，恢复业务时间约十分钟。
	用于警示信息、补充说明等，是用户必须了解的内容。	 **注意：** 权重设置为0，该服务器不会再接受新请求。
	用于补充说明、最佳实践、窍门等，不是用户必须了解的内容。	 **说明：** 您也可以通过按Ctrl + A选中全部文件。
>	多级菜单递进。	单击**设置** > **网络** > **设置网络类型**。
粗体	表示按键、菜单、页面名称等UI元素。	在**结果确认**页面，单击**确定**。
Courier字体	命令。	执行cd /d C:/window命令，进入Windows系统文件夹。
斜体	表示参数、变量。	bae log list --instanceid Instance_ID
[]或者[a|b]	表示可选项，至多选择一个。	ipconfig [-all|-t]
{}或者{a|b}	表示必选项，至多选择一个。	switch {active|stand}

目录

1 产品概述

分析型数据库MySQL版（AnalyticDB for MySQL）是云端托管的PB级高并发实时数据仓库，是专注于服务OLAP领域的数据仓库。在数据存储模型上，采用关系模型进行数据存储，可以使用SQL进行自由灵活的计算分析，无需预先建模。利用云端的无缝伸缩能力，AnalyticDB for MySQL版在处理百亿条甚至更多量级的数据时真正实现毫秒级计算。

AnalyticDB for MySQL提供了按量付费和包年包月两种付费方式，您可以根据业务压力配置AnalyticDB for MySQL集群的规格。其中：

- 按量付费集群支持随时进行规格的扩缩容。
- 包年包月集群支持随时扩容和续费时扩缩容。

本次性能测试基于阿里云基础环境，分别在同等（或接近）硬件配置和同等数据规模下，对比AnalyticDB for MySQL与MySQL、Presto、Spark、Impala基于标准TPC-H的测试对比。

TPC-H是由TPC委员会制定发布，用于评测数据库的分析查询能力。TPC-H查询包含八张数据表和二十二条复杂SQL查询，大多数查询包含多表Join、子查询和Group By等。

2 测试方法

2.1 测试环境

下表列出了本次性能测试所使用的环境信息。

说明:

测试基础环境均在阿里云申请。

产品	规格	架构	CPU	MEM	存储	版本
AnalyticDB for MySQL	analyticdb.c8.xlarge.n1	2组C8（每组3个节点）	48 核（每节点8核）	384GB（每节点64G）	SSD云盘，400GB	AnalyticDB for MySQL 3.0
MySQL	mysql.x8.13large.2c	1个节点	52核	384GB	SSD云盘，400GB	MySQL 8.0
Presto	• master：ecs.g6.6xlarge • worker：ecs.se1ne.2xlarge	• master：1个节点 • worker：6个节点	• master：24核 • worker：48 核（每节点8核）	• master：96GB • worker：384GB（每节点64G）	• master：SSD云盘，120GB • worker：SSD云盘，80GB X 4块	• HDFS：2.8.5 • YARN：2.8.5 • Presto：0.228
Spark	• master：ecs.g5.6xlarge • worker：ecs.se1ne.2xlarge	• master：1个节点 • worker：6个节点	• master：24核 • worker：48 核（每节点8核）	• master：96GB • worker：384GB（每节点64G）	• master：SSD云盘，120GB • worker：SSD云盘，120GB X 1块	• HDFS：2.8.5 • YARN：2.8.5 • Presto：2.4.3

产品	规格	架构	CPU	MEM	存储	版本
Impala	• master：ecs.g6.6xlarge • worker：ecs.se1ne.2xlarge	• master：1个节点 • worker：6个节点	• master：24核 • worker：48核（每节点8核）	• master：96GB • worker：384GB（每节点64G）	• master：SSD云盘，120GB • worker：SSD云盘，80GB X 4块	• HDFS：2.8.5 • YARN：2.8.5 • Presto：2.12.2

2.2 测试场景

本文介绍AnalyticDB for MySQL性能测试的场景信息。

AnalyticDB for MySQL性能测试的场景信息包含：

1. 构建数据结构
   - AnalyticDB for MySQL
   - MySQL
   - Presto
   - Spark
   - Impala
2. 数据初始化
   a. 构建数据
   b. 导入数据
3. TPC-H测试集

2.3 测试方法

测试方法使用自定义脚本，依次执行TPC-H测试集。

测试优化

为保证顺利完成测试，在对个产品进行测试之前，进行了必要的配置优化。

- AnalyticDB for MySQL

  缺失配置，未进行配置优化。

- MySQL
  - 数据库参数取自阿里云默认模板。
  - 数据结构在原有基础上，增加了部分索引，请参见MySQL。
- Presto

  部分执行参数做了以下调整。

```
task.concurrency=128
exchange.max-reponse-size=16MB
query.max-memory-per-node=2GB
task.max-partial-aggregation-memory=32MB
exchange.max-buffer-size=128MB
query.max-total-memory-per-node=4GB
sink.max-buffer-size=64MB
```

- Spark

  部分执行参数做了以下调整。

```
spark-sql --num-executors 12
--executor-cores 3
--executor-memory 16G
```

- Impala

  配置EMR，关闭内存限制即disable_pool_mem_limits值为true。

测试方法

> **说明：**
>
> - 测试前，均执行两轮测试集作为预热环节。
> - 连续执行三轮测试，取三次测试结果的平均值。

您可以参照MySQL测试脚本示例，编写其他测试脚本。

```
while [ $n -lt 23 ]
do
 echo "query ${n} starting"
 time mysql -f tpch <tpch_${n}.sql
 echo "query $n ended!"
 n=`expr ${n} + 1`
done
```

2.4 测试指标

测试指标包括整个TPC-H测试集和单条SQL的执行时长。

3 测试结果

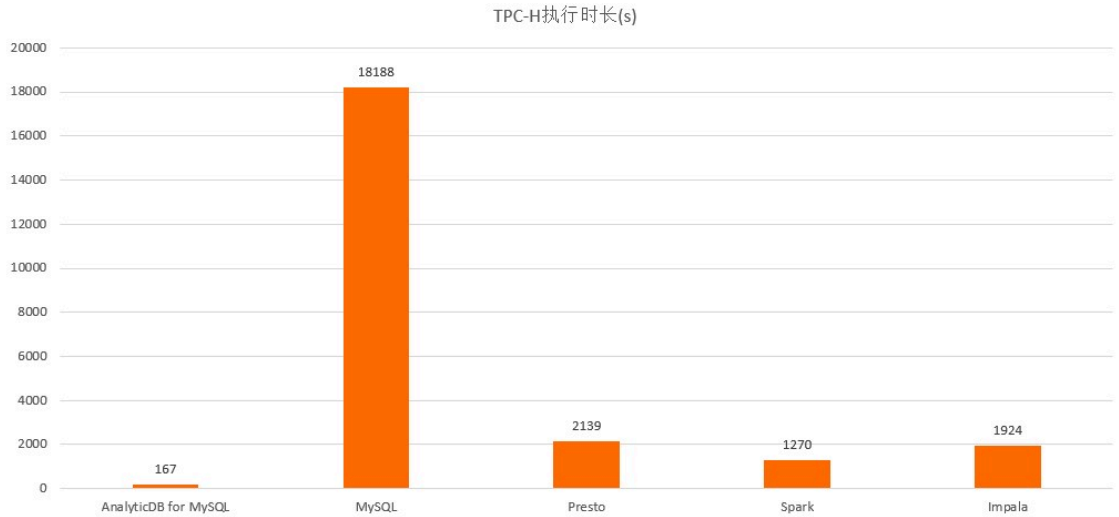
本文介绍AnalyticDB for MySQL、MySQL、Presto、Spark以及Impala的性能测试结果。

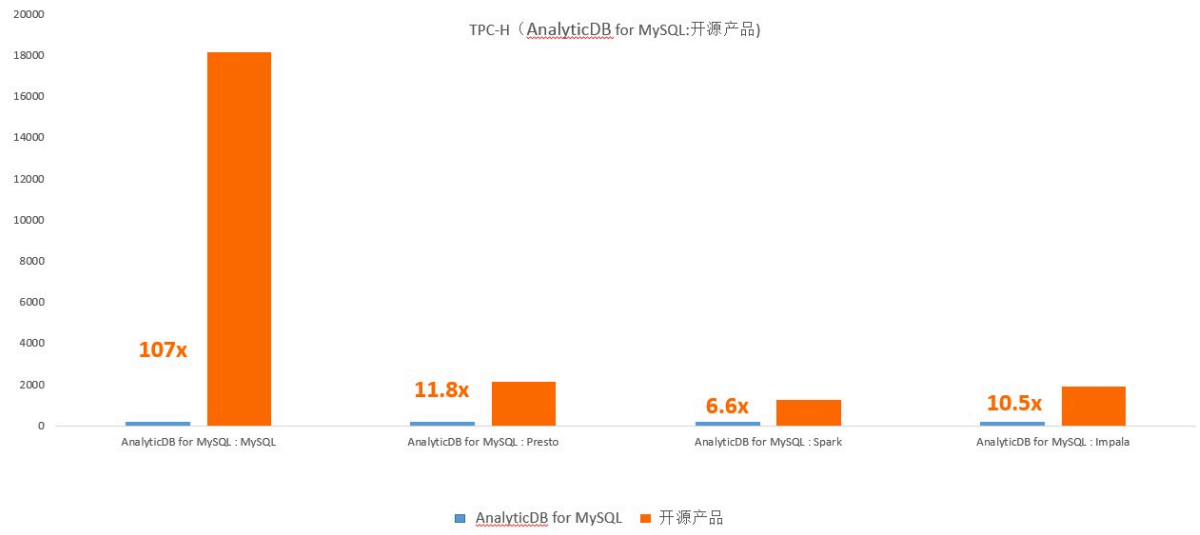
测试样本	执行时间（s）								
	AnalyticDB for MySQL	MySQL	执行时间提升倍数	Presto	执行时间提升倍数	Spark	执行时间提升倍数	Impala	执行时间提升/降低倍数
tpch_sql1	19.959	900.535	44.12	130.83	5.55	64.088	2.211	6.080	-0.695
tpch_sql2	0.889	4.135	3.65	44.94	49.55	41.219	45.366	18.660	19.990
tpch_sql3	4.368	156.144	34.75	121.21	26.75	41.913	8.595	93.240	20.346
tpch_sql4	7.506	34.811	3.64	115.68	14.41	24.764	2.299	138.240	17.417
tpch_sql5	4.563	55.333	11.13	-	-	67.922	13.885	-	-
tpch_sql6	0.186	166.924	896.44	91.62	491.58	10.462	55.247	1.440	6.742
tpch_sql7	3.444	81.284	22.60	143.34	40.62	162.78	46.265	136.350	38.591
tpch_sql8	6.701	92.881	12.86	-	-	77.574	10.576	277.470	40.407
tpch_sql9	37.154	417.531	10.24	-	-	100.33	1.700	300.480	7.087
tpch_sql10	4.503	322.436	70.60	127.17	27.24	46.066	9.230	44.670	8.920
tpch_sql11	1.056	21.790	19.63	39.91	36.79	49.354	45.737	2.380	1.254
tpch_sql12	2.270	14,656.916	11,539.88	120.28	93.71	21.242	15.726	5.260	3.142
tpch_sql13	7.303	517.782	69.90	34.43	3.71	34.51	3.725	88.200	11.077
tpch_sql14	4.634	43.885	68.22	94.69	148.35	20.322	31.054	7.980	11.587
tpch_sql15	5.922	149.901	76.99	179.16	92.22	23.899	11.434	3.650	0.899

测试样本	执行时间（s）								
	AnalyticDB for MySQL	MySQL	执行时间提升倍数	Presto	执行时间提升倍数	Spark	执行时间提升倍数	Impala	执行时间提升/降低倍数
tpch_sql1	16.940	45.487	22.45	25.92	12.36	79.557	40.009	7.180	2.701
tpch_sql15	7.128	20.985	3.09	210.68	40.08	116.033	21.627	46.650	8.097
tpch_sql18	26.591	236.179	7.88	-	-	119.788	3.505	158.340	4.955
tpch_sql12	2.566	15.867	5.18	97.32	36.93	21.68	7.449	11.080	3.318
tpch_sql20	3.537	71.311	19.16	116.28	31.88	43.971	11.432	20.300	4.739
tpch_sql21	18.946	162.672	7.59	201.77	9.65	80.793	3.264	509.870	25.912
tpch_sql22	2.159	13.323	0.86	32.9	3.60	21.832	2.050	46.220	5.456
总时长（s）	167.325	18,188.112	107.70	2139.423	11.79	1270.099	6.591	1923.74	10.497

说明：

- Impala中不允许HAVING中有子查询，tpch_sql5没有执行。
- Presto在部分示例中出现了OOM，无法完成查询。




TPC-H（AnalyticDB for MySQL:开源产品）
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
107x
11.8x
6.6x
10.5x
AnalyticDB for MySQL : MySQL
AnalyticDB for MySQL : Presto
AnalyticDB for MySQL : Spark
AnalyticDB for MySQL : Impala
AnalyticDB for MySQL
开源产品

4 性能测试指导

4.1 构建数据结构

4.1.1 AnalyticDB for MySQL

本文介绍AnalyticDB for MySQL性能测试的场景信息。

本次性能测试将在AnalyticDB for MySQL中创建以下八张数据表。

- CUSTOMER表

```
CREATE TABLE `CUSTOMER` (
 `C_CUSTKEY` int NOT NULL,
 `C_NAME` varchar NOT NULL,
 `C_ADDRESS` varchar NOT NULL,
 `C_NATIONKEY` int NOT NULL,
 `C_PHONE` varchar NOT NULL,
 `C_ACCTBAL` decimal(12, 2) NOT NULL,
 `C_MKTSEGMENT` varchar NOT NULL,
 `C_COMMENT` varchar NOT NULL,
 primary key (c_custkey)
)
DISTRIBUTE BY HASH(`c_custkey`)
INDEX_ALL='Y';
```

- LINEITEM表

```
CREATE TABLE `LINEITEM` (
 `L_ORDERKEY` bigint NOT NULL,
 `L_PARTKEY` int NOT NULL,
 `L_SUPPKEY` int NOT NULL,
 `L_LINENUMBER` bigint NOT NULL,
 `L_QUANTITY` decimal(12, 2) NOT NULL,
 `L_EXTENDEDPRICE` decimal(12, 2) NOT NULL,
 `L_DISCOUNT` decimal(12, 2) NOT NULL,
 `L_TAX` decimal(12, 2) NOT NULL,
 `L_RETURNFLAG` varchar NOT NULL,
 `L_LINESTATUS` varchar NOT NULL,
 `L_SHIPDATE` date NOT NULL,
 `L_COMMITDATE` date NOT NULL,
 `L_RECEIPTDATE` date NOT NULL,
 `L_SHIPINSTRUCT` varchar NOT NULL,
 `L_SHIPMODE` varchar NOT NULL,
 `L_COMMENT` varchar NOT NULL,
 primary key (l_orderkey,l_linenumber,l_shipdate)
)
DISTRIBUTE BY HASH(`l_orderkey`)
PARTITION BY VALUE(`date_format(l_shipdate, '%Y%m')`)
LIFECYCLE 90
INDEX_ALL='Y';
```

- NATION表

```
CREATE TABLE `NATION` (
```

```
 `N_NATIONKEY` int NOT NULL,
 `N_NAME` varchar NOT NULL,
 `N_REGIONKEY` int NOT NULL,
 `N_COMMENT` varchar,
 primary key (n_nationkey)
) DISTRIBUTE BY BROADCAST INDEX_ALL='Y';
```

- ORDERS表

```
CREATE TABLE `ORDERS` (
 `O_ORDERKEY` bigint NOT NULL,
 `O_CUSTKEY` int NOT NULL,
 `O_ORDERSTATUS` varchar NOT NULL,
 `O_TOTALPRICE` decimal(12, 2) NOT NULL,
 `O_ORDERDATE` date NOT NULL,
 `O_ORDERPRIORITY` varchar NOT NULL,
 `O_CLERK` varchar NOT NULL,
 `O_SHIPPRIORITY` int NOT NULL,
 `O_COMMENT` varchar NOT NULL,
 primary key (o_orderkey,o_orderdate)
)
DISTRIBUTE BY HASH(`o_orderkey`)
PARTITION BY VALUE(`date_format(O_ORDERDATE, '%Y%m')`)
LIFECYCLE 90
INDEX_ALL='Y';
```

- PART表

```
CREATE TABLE `PART` (
 `P_PARTKEY` int NOT NULL,
 `P_NAME` varchar NOT NULL,
 `P_MFGR` varchar NOT NULL,
 `P_BRAND` varchar NOT NULL,
 `P_TYPE` varchar NOT NULL,
 `P_SIZE` int NOT NULL,
 `P_CONTAINER` varchar NOT NULL,
 `P_RETAILPRICE` decimal(12, 2) NOT NULL,
 `P_COMMENT` varchar NOT NULL,
 primary key (p_partkey)
)
DISTRIBUTE BY HASH(`p_partkey`)
INDEX_ALL='Y';
```

- PARTSUPP表

```
CREATE TABLE `PARTSUPP` (
 `PS_PARTKEY` int NOT NULL,
 `PS_SUPPKEY` int NOT NULL,
 `PS_AVAILQTY` int NOT NULL,
 `PS_SUPPLYCOST` decimal(12, 2) NOT NULL,
 `PS_COMMENT` varchar NOT NULL,
 primary key (ps_partkey,ps_suppkey)
)
DISTRIBUTE BY HASH(`ps_partkey`)
INDEX_ALL='Y';
```

- REGION表

```
CREATE TABLE `REGION` (
 `R_REGIONKEY` int NOT NULL,
 `R_NAME` varchar NOT NULL,
 `R_COMMENT` varchar,
```

```
 primary key (r_regionkey)
)
DISTRIBUTE BY BROADCAST
INDEX_ALL='Y';
```

- SUPPLIER表

```
CREATE TABLE `SUPPLIER` (
 `S_SUPPKEY` int NOT NULL,
 `S_NAME` varchar NOT NULL,
 `S_ADDRESS` varchar NOT NULL,
 `S_NATIONKEY` int NOT NULL,
 `S_PHONE` varchar NOT NULL,
 `S_ACCTBAL` decimal(12, 2) NOT NULL,
 `S_COMMENT` varchar NOT NULL,
 primary key (s_suppkey)
)
DISTRIBUTE BY HASH(`s_suppkey`)
INDEX_ALL='Y';
```

4.1.2 MySQL

本文介绍MySQL性能测试的场景信息。

本次性能测试将在MySQL中创建以下八张数据表。

- CUSTOMER表

```
CREATE TABLE `customer` (
  `C_CUSTKEY` int(11) NOT NULL,
  `C_NAME` varchar(25) NOT NULL,
  `C_ADDRESS` varchar(40) NOT NULL,
  `C_NATIONKEY` int(11) NOT NULL,
  `C_PHONE` varchar(15) NOT NULL,
  `C_ACCTBAL` decimal(12,2) NOT NULL,
  `C_MKTSEGMENT` varchar(10) NOT NULL,
  `C_COMMENT` varchar(117) NOT NULL,
  PRIMARY KEY (`C_CUSTKEY`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

- LINEITEM表

```
CREATE TABLE `lineitem` (
  `L_ORDERKEY` bigint(20) NOT NULL,
  `L_PARTKEY` int(11) NOT NULL,
  `L_SUPPKEY` int(11) NOT NULL,
  `L_LINENUMBER` bigint(20) NOT NULL,
  `L_QUANTITY` decimal(12,2) NOT NULL,
  `L_EXTENDEDPRICE` decimal(12,2) NOT NULL,
  `L_DISCOUNT` decimal(12,2) NOT NULL,
  `L_TAX` decimal(12,2) NOT NULL,
  `L_RETURNFLAG` varchar(1) NOT NULL,
  `L_LINESTATUS` varchar(1) NOT NULL,
  `L_SHIPDATE` date NOT NULL,
  `L_COMMITDATE` date NOT NULL,
  `L_RECEIPTDATE` date NOT NULL,
  `L_SHIPINSTRUCT` varchar(25) NOT NULL,
  `L_SHIPMODE` varchar(10) NOT NULL,
  `L_COMMENT` varchar(44) NOT NULL,
  PRIMARY KEY (`L_ORDERKEY`,`L_LINENUMBER`,`L_SHIPDATE`)
```

```
) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

- NATION表

```
CREATE TABLE `nation` (
  `N_NATIONKEY` int(11) NOT NULL,
  `N_NAME` varchar(25) NOT NULL,
  `N_REGIONKEY` int(11) NOT NULL,
  `N_COMMENT` varchar(152) DEFAULT NULL,
  PRIMARY KEY (`N_NATIONKEY`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

- ORDERS表

```
CREATE TABLE `orders` (
  `O_ORDERKEY` bigint(20) NOT NULL,
  `O_CUSTKEY` int(11) NOT NULL,
  `O_ORDERSTATUS` varchar(1) NOT NULL,
  `O_TOTALPRICE` decimal(12,2) NOT NULL,
  `O_ORDERDATE` date NOT NULL,
  `O_ORDERPRIORITY` varchar(15) NOT NULL,
  `O_CLERK` varchar(15) NOT NULL,
  `O_SHIPPRIORITY` int(11) NOT NULL,
  `O_COMMENT` varchar(79) NOT NULL,
  PRIMARY KEY (`O_ORDERKEY`,`O_ORDERDATE`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

- PART表

```
CREATE TABLE `part` (
  `P_PARTKEY` int(11) NOT NULL,
  `P_NAME` varchar(55) NOT NULL,
  `P_MFGR` varchar(25) NOT NULL,
  `P_BRAND` varchar(10) NOT NULL,
  `P_TYPE` varchar(25) NOT NULL,
  `P_SIZE` int(11) NOT NULL,
  `P_CONTAINER` varchar(10) NOT NULL,
  `P_RETAILPRICE` decimal(12,2) NOT NULL,
  `P_COMMENT` varchar(23) NOT NULL,
  PRIMARY KEY (`P_PARTKEY`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

- PARTSUPP表

```
CREATE TABLE `partsupp` (
  `PS_PARTKEY` int(11) NOT NULL,
  `PS_SUPPKEY` int(11) NOT NULL,
  `PS_AVAILQTY` int(11) NOT NULL,
  `PS_SUPPLYCOST` decimal(12,2) NOT NULL,
  `PS_COMMENT` varchar(199) NOT NULL,
  PRIMARY KEY (`PS_PARTKEY`,`PS_SUPPKEY`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

- REGION表

```
CREATE TABLE `region` (
  `R_REGIONKEY` int(11) NOT NULL,
  `R_NAME` varchar(25) NOT NULL,
  `R_COMMENT` varchar(152) DEFAULT NULL,
  PRIMARY KEY (`R_REGIONKEY`)
```

```
) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

- SUPPLIER表

```
CREATE TABLE `supplier` (
  `S_SUPPKEY` int(11) NOT NULL,
  `S_NAME` varchar(25) NOT NULL,
  `S_ADDRESS` varchar(40) NOT NULL,
  `S_NATIONKEY` int(11) NOT NULL,
  `S_PHONE` varchar(15) NOT NULL,
  `S_ACCTBAL` decimal(12,2) NOT NULL,
  `S_COMMENT` varchar(101) NOT NULL,
  PRIMARY KEY (`S_SUPPKEY`)
) ENGINE=InnoDB DEFAULT CHARSET=utf8;
```

在100GB数据规模下，缺省MySQL表结构无法完成全部测试，可以通过增加索引提升数据查询性能。本手册性能白皮书中公布的数据，均为有索引情况下的测试结果。

```
create index idx_li_sd on lineitem(l_shipdate);
create index idx_li_rf_ls on lineitem(l_returnflag,l_linestatus);
create index idx_p_pk on part(p_partkey);
create index idx_ps_pk on partsupp(ps_partkey);
create index idx_s_sk on supplier(s_suppkey);
create index idx_ps_sk on partsupp(ps_suppkey);
create index idx_p_s on part(p_size);
create index idx_p_t on part(p_type);
create index idx_s_nk on supplier(s_nationkey);
create index idx_n_nk on nation(n_nationkey);
create index idx_n_rk on nation(n_regionkey);
create index idx_r_rk on region(r_regionkey);
create index idx_r_n on region(r_name);
create index idx_ps_sc on partsupp(ps_supplycost);
create index idx_c_mk on customer(c_mktsegment);
create index idx_c_ck on customer(c_custkey);
create index idx_o_ck on orders(o_custkey);
create index idx_li_ok on lineitem(l_orderkey);
create index idx_o_ok on orders(o_orderkey);
create index idx_o_od on orders(o_orderdate);
create index idx_o_op on orders(o_orderpriority);
create index idx_li_sk on lineitem(l_suppkey);
create index idx_c_nk on customer(c_nationkey);
create index idx_li_dc on lineitem(l_discount);
create index idx_li_q on lineitem(l_quantity);
create index idx_n_n on nation(n_name);
create index idx_li_rf on lineitem(l_returnflag);
create index idx_li_sm on lineitem(l_shipmode);
create index idx_li_cd on lineitem(l_commitdate);
create index idx_li_rd on lineitem(l_receiptdate);
create index idx_li_pk on lineitem(l_partkey);
create index idx_p_b on part(p_brand);
create index idx_p_c on part(p_container);
```

```
create index idx_o_os on orders(o_orderstatus);
```

4.1.3 Presto

本文介绍Presto性能测试的场景信息。

创建外表

本次性能测试将在Presto中创建以下八张文本格式的外表。

- CUSTOMER表

```
create external table customer(
  c_custkey integer,
  c_name varchar(25),
  c_address varchar(40),
  c_nationkey integer,
  c_phone char(15),
  c_acctbal decimal(15, 2),
  c_mktsegment char(10),
  c_comment varchar(117)
) row format delimited fields terminated by '|' location '/.../customer' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- LINEITEM表

```
create external table lineitem(
  l_orderkey integer,
  l_partkey integer,
  l_suppkey integer,
  l_linenumber integer,
  l_quantity decimal(15, 2),
  l_extendedprice decimal(15, 2),
  l_discount decimal(15, 2),
  l_tax decimal(15, 2),
  l_returnflag char(1),
  l_linestatus char(1),
  l_shipdate date,
  l_commitdate date,
  l_receiptdate date,
  l_shipinstruct char(25),
  l_shipmode char(10),
  l_comment varchar(44)
) row format delimited fields terminated by '|' location '/.../lineitem' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- NATION表

```
create external table nation(
  n_nationkey integer,
  n_name char(25),
  n_regionkey integer,
  n_comment varchar(152)
) row format delimited fields terminated by '|' location '/.../nation' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
```

```
);
```

- ORDERS表

```
create external table orders(
  o_orderkey integer,
  o_custkey integer,
  o_orderstatus char(1),
  o_totalprice decimal(15, 2),
  o_orderdate date,
  o_orderpriority char(15),
  o_clerk char(15),
  o_shippriority integer,
  o_comment varchar(79)
) row format delimited fields terminated by '|' location '/.../orders' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- PART表

```
create external table part(
  p_partkey integer,
  p_name varchar(55),
  p_mfgr char(25),
  p_brand char(10),
  p_type varchar(25),
  p_size integer,
  p_container char(10),
  p_retailprice decimal(15, 2),
  p_comment varchar(23)
) row format delimited fields terminated by '|' location '/.../part' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- PARTSUPP表

```
create external table partsupp(
  ps_partkey integer,
  ps_suppkey integer,
  ps_availqty integer,
  ps_supplycost decimal(15, 2),
  ps_comment varchar(199)
) row format delimited fields terminated by '|' location '/.../partsupp' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- REGION表

```
create external table region(
  r_regionkey integer,
  r_name char(25),
  r_comment varchar(152)
) row format delimited fields terminated by '|' location '/.../region/' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
```

```
);
```

- SUPPLIER表

```
create external table supplier(
  s_suppkey integer,
  s_name char(25),
  s_address varchar(40),
  s_nationkey integer,
  s_phone char(15),
  s_acctbal decimal(15, 2),
  s_comment varchar(101)
) row format delimited fields terminated by '|' location '/.../supplier/' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

创建表

本次性能测试将在Presto中创建以下八张内表。

- CUSTOMER表

```
create table customer(
        c_custkey     integer,
        c_name        varchar(25),
        c_address     varchar(40),
        c_nationkey   integer,
        c_phone       char(15),
        c_acctbal     decimal(15,2),
        c_mktsegment  char(10),
        c_comment     varchar(117)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- LINEITEM表

```
create table lineitem
(
    l_orderkey    integer,
    l_partkey     integer,
    l_suppkey     integer,
    l_linenumber  integer,
    l_quantity    decimal(15,2),
    l_extendedprice  decimal(15,2),
    l_discount    decimal(15,2),
    l_tax         decimal(15,2),
    l_returnflag  char(1),
    l_linestatus  char(1),
    l_shipdate    date,
    l_commitdate  date,
    l_receiptdate date,
    l_shipinstruct char(25),
    l_shipmode     char(10),
    l_comment      varchar(44)
)
stored as parquet
```

```
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- NATION表

```
create table nation(
      n_nationkey  integer,
      n_name       char(25),
      n_regionkey  integer,
      n_comment    varchar(152)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- ORDERS表

```
create table orders(
   o_orderkey       integer,
      o_custkey       integer,
      o_orderstatus    char(1),
      o_totalprice     decimal(15,2),
      o_orderdate      date,
      o_orderpriority  char(15),
      o_clerk          char(15),
      o_shippriority   integer,
      o_comment        varchar(79)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- PART表

```
create table part(
      p_partkey     integer,
      p_name        varchar(55),
      p_mfgr        char(25),
      p_brand       char(10),
      p_type        varchar(25),
      p_size        integer,
      p_container   char(10),
      p_retailprice decimal(15,2),
      p_comment     varchar(23)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- PARTSUPP表

```
create table partsupp(
   ps_partkey     integer,
      ps_suppkey     integer,
      ps_availqty    integer,
      ps_supplycost  decimal(15,2),
      ps_comment     varchar(199)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- REGION表

```
create table region(
   r_regionkey  integer,
```

```
    r_name      char(25),
    r_comment    varchar(152)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- SUPPLIER表

```
create table supplier(
    s_suppkey     integer,
    s_name       char(25),
    s_address     varchar(40),
    s_nationkey   integer,
    s_phone      char(15),
    s_acctbal     decimal(15,2),
    s_comment     varchar(101)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

4.1.4 Spark

本文介绍Spark性能测试的场景信息。

创建外表

本次性能测试将在Spark中创建以下八张文本格式的外表。

- CUSTOMER表

```
create external table customer(
  c_custkey integer,
  c_name varchar(25),
  c_address varchar(40),
  c_nationkey integer,
  c_phone char(15),
  c_acctbal decimal(15, 2),
  c_mktsegment char(10),
  c_comment varchar(117)
) row format delimited fields terminated by '|' location '/.../customer' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- LINEITEM表

```
create external table lineitem(
  l_orderkey integer,
  l_partkey integer,
  l_suppkey integer,
  l_linenumber integer,
  l_quantity decimal(15, 2),
  l_extendedprice decimal(15, 2),
  l_discount decimal(15, 2),
  l_tax decimal(15, 2),
  l_returnflag char(1),
  l_linestatus char(1),
  l_shipdate date,
  l_commitdate date,
  l_receiptdate date,
```

```
  l_shipinstruct char(25),
  l_shipmode char(10),
  l_comment varchar(44)
) row format delimited fields terminated by '|' location '/.../lineitem' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- NATION表

```
create external table nation(
  n_nationkey integer,
  n_name char(25),
  n_regionkey integer,
  n_comment varchar(152)
) row format delimited fields terminated by '|' location '/.../nation' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- ORDERS表

```
create external table orders(
  o_orderkey integer,
  o_custkey integer,
  o_orderstatus char(1),
  o_totalprice decimal(15, 2),
  o_orderdate date,
  o_orderpriority char(15),
  o_clerk char(15),
  o_shippriority integer,
  o_comment varchar(79)
) row format delimited fields terminated by '|' location '/.../orders' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- PART表

```
create external table part(
  p_partkey integer,
  p_name varchar(55),
  p_mfgr char(25),
  p_brand char(10),
  p_type varchar(25),
  p_size integer,
  p_container char(10),
  p_retailprice decimal(15, 2),
  p_comment varchar(23)
) row format delimited fields terminated by '|' location '/.../part' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- PARTSUPP表

```
create external table partsupp(
  ps_partkey integer,
  ps_suppkey integer,
  ps_availqty integer,
  ps_supplycost decimal(15, 2),
  ps_comment varchar(199)
```

```
) row format delimited fields terminated by '|' location '/.../partsupp' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- REGION表

```
create external table region(
  r_regionkey integer,
  r_name char(25),
  r_comment varchar(152)
) row format delimited fields terminated by '|' location '/.../region/' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

- SUPPLIER表

```
create external table supplier(
  s_suppkey integer,
  s_name char(25),
  s_address varchar(40),
  s_nationkey integer,
  s_phone char(15),
  s_acctbal decimal(15, 2),
  s_comment varchar(101)
) row format delimited fields terminated by '|' location '/.../supplier/' TBLPROPERTIES(
  'serialization.null.format' = '',
  'serialization.encoding' = 'latin1'
);
```

创建表

本次性能测试将在Spark中创建以下八张内表。

- CUSTOMER表

```
create table customer(
        c_custkey     integer,
        c_name        varchar(25),
        c_address     varchar(40),
        c_nationkey   integer,
        c_phone       char(15),
        c_acctbal     decimal(15,2),
        c_mktsegment  char(10),
        c_comment     varchar(117)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- LINEITEM表

```
create table lineitem
(
    l_orderkey    integer,
    l_partkey     integer,
    l_suppkey     integer,
    l_linenumber  integer,
    l_quantity    decimal(15,2),
    l_extendedprice  decimal(15,2),
```

```
    l_discount    decimal(15,2),
    l_tax         decimal(15,2),
    l_returnflag  char(1),
    l_linestatus  char(1),
    l_shipdate    date,
    l_commitdate  date,
    l_receiptdate date,
    l_shipinstruct char(25),
    l_shipmode     char(10),
    l_comment      varchar(44)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- NATION表

```
create table nation(
        n_nationkey  integer,
        n_name       char(25),
        n_regionkey  integer,
        n_comment    varchar(152)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- ORDERS表

```
create table orders(
    o_orderkey       integer,
        o_custkey        integer,
        o_orderstatus    char(1),
        o_totalprice     decimal(15,2),
        o_orderdate      date,
        o_orderpriority  char(15),
        o_clerk          char(15),
        o_shippriority   integer,
        o_comment        varchar(79)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- PART表

```
create table part(
        p_partkey     integer,
        p_name        varchar(55),
        p_mfgr        char(25),
        p_brand       char(10),
        p_type        varchar(25),
        p_size        integer,
        p_container   char(10),
        p_retailprice decimal(15,2),
        p_comment     varchar(23)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- PARTSUPP表

```
create table partsupp(
    ps_partkey     integer,
        ps_suppkey     integer,
```

```
    ps_availqty    integer,
    ps_supplycost  decimal(15,2),
    ps_comment     varchar(199)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- REGION表

```
create table region(
  r_regionkey  integer,
  r_name       char(25),
  r_comment    varchar(152)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- SUPPLIER表

```
create table supplier(
  s_suppkey     integer,
  s_name        char(25),
  s_address     varchar(40),
  s_nationkey   integer,
  s_phone       char(15),
  s_acctbal     decimal(15,2),
  s_comment     varchar(101)
)
stored as parquet
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

4.1.5 Impala

本文介绍Impala性能测试的场景信息。

创建外表

本次性能测试将在Impala中创建以下八张外表。

- CUSTOMER表

```
CREATE EXTERNAL TABLE customer
  (
    C_CUSTKEY INT,
    C_NAME STRING,
    C_ADDRESS STRING,
    C_NATIONKEY INT,
    C_PHONE STRING,
    C_ACCTBAL DOUBLE,
    C_MKTSEGMENT STRING,
    C_COMMENT STRING
  ) ROW FORMAT DELIMITED FIELDS TERMINATED BY '|'
  STORED AS TEXTFILE LOCATION '/.../customer';
```

- LINEITEM表

```
CREATE EXTERNAL TABLE lineitem
  (
    L_ORDERKEY INT,
    L_PARTKEY INT,
```

```
    L_SUPPKEY INT,
    L_LINENUMBER INT,
    L_QUANTITY DOUBLE,
    L_EXTENDEDPRICE DOUBLE,
    L_DISCOUNT DOUBLE,
    L_TAX DOUBLE,
    L_RETURNFLAG STRING,
    L_LINESTATUS STRING,
    L_SHIPDATE STRING,
    L_COMMITDATE STRING,
    L_RECEIPTDATE STRING,
    L_SHIPINSTRUCT STRING,
    L_SHIPMODE STRING,
    L_COMMENT STRING
  ) ROW FORMAT DELIMITED FIELDS TERMINATED BY '|'
  STORED AS TEXTFILE LOCATION '/.../lineitem';
```

- NATION表

```
CREATE EXTERNAL TABLE nation
  (
   N_NATIONKEY INT,
  N_NAME STRING,
  N_REGIONKEY INT,
  N_COMMENT STRING
  )
  ROW FORMAT DELIMITED FIELDS TERMINATED BY '|'
  STORED AS TEXTFILE LOCATION '/.../nation'
```

- ORDERS表

```
CREATE EXTERNAL TABLE orders
  (
    O_ORDERKEY INT,
    O_CUSTKEY INT,
    O_ORDERSTATUS STRING,
    O_TOTALPRICE DOUBLE,
    O_ORDERDATE STRING,
    O_ORDERPRIORITY STRING,
    O_CLERK STRING,
    O_SHIPPRIORITY INT,
    O_COMMENT STRING
  ) ROW FORMAT DELIMITED FIELDS TERMINATED BY '|'
  STORED AS TEXTFILE LOCATION '/.../orders';
```

- PART表

```
CREATE EXTERNAL TABLE part
  (
    P_PARTKEY INT,
    P_NAME STRING,
    P_MFGR STRING,
    P_BRAND STRING,
    P_TYPE STRING,
    P_SIZE INT,
    P_CONTAINER STRING,
    P_RETAILPRICE DOUBLE,
    P_COMMENT STRING
  ) ROW FORMAT DELIMITED FIELDS TERMINATED BY '|'
```

```
  STORED AS TEXTFILE LOCATION '/.../part';
```

- PARTSUPP表

```
CREATE EXTERNAL TABLE partsupp
  (
   PS_PARTKEY INT,
   PS_SUPPKEY INT,
   PS_AVAILQTY INT,
   PS_SUPPLYCOST DOUBLE,
   PS_COMMENT STRING
  ) ROW FORMAT DELIMITED FIELDS TERMINATED BY '|'
  STORED AS TEXTFILE LOCATION '/.../partsupp';
```

- REGION表

```
CREATE EXTERNAL TABLE region
  (
   R_REGIONKEY INT,
   R_NAME STRING,
   R_COMMENT STRING
  )
  ROW FORMAT DELIMITED FIELDS TERMINATED BY '|'
  STORED AS TEXTFILE LOCATION '/.../region';
```

- SUPPLIER表

```
CREATE EXTERNAL TABLE supplier
  (
   S_SUPPKEY INT,
   S_NAME STRING,
   S_ADDRESS STRING,
   S_NATIONKEY INT,
   S_PHONE STRING,
   S_ACCTBAL DOUBLE,
   S_COMMENT STRING
  ) ROW FORMAT DELIMITED FIELDS TERMINATED BY '|'
  STORED AS TEXTFILE LOCATION '/.../supplier';
```

创建表

本次性能测试将在Impala中创建以下八张表。

- CUSTOMER表

```
DROP TABLE IF EXISTS customer;
CREATe  TABLE customer
  (
   C_CUSTKEY INT,
   C_NAME STRING,
   C_ADDRESS STRING,
   C_NATIONKEY INT,
   C_PHONE STRING,
   C_ACCTBAL DOUBLE,
   C_MKTSEGMENT STRING,
   C_COMMENT STRING
  )  STORED AS PARQUET
```

```
  TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- LINEITEM表

```
DROP TABLE IF EXISTS lineitem;
CREATe  TABLE lineitem
   (
    L_ORDERKEY INT,
    L_PARTKEY INT,
    L_SUPPKEY INT,
    L_LINENUMBER INT,
    L_QUANTITY DOUBLE,
    L_EXTENDEDPRICE DOUBLE,
    L_DISCOUNT DOUBLE,
    L_TAX DOUBLE,
    L_RETURNFLAG STRING,
    L_LINESTATUS STRING,
    L_SHIPDATE STRING,
    L_COMMITDATE STRING,
    L_RECEIPTDATE STRING,
    L_SHIPINSTRUCT STRING,
    L_SHIPMODE STRING,
    L_COMMENT STRING
   )  STORED AS PARQUET
  TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- NATION表

```
DROP TABLE IF EXISTS nation;
CREATe  TABLE nation
  (
    N_NATIONKEY INT,
   N_NAME STRING,
   N_REGIONKEY INT,
   N_COMMENT STRING
  ) STORED AS PARQUET
  TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- ORDERS表

```
DROP TABLE IF EXISTS orders;
CREATe  TABLE orders
   (
    O_ORDERKEY INT,
    O_CUSTKEY INT,
    O_ORDERSTATUS STRING,
    O_TOTALPRICE DOUBLE,
    O_ORDERDATE STRING,
    O_ORDERPRIORITY STRING,
    O_CLERK STRING,
    O_SHIPPRIORITY INT,
    O_COMMENT STRING
   )  STORED AS PARQUET
  TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- PART表

```
DROP TABLE IF EXISTS part;
CREATe  TABLE part
   (
    P_PARTKEY INT,
    P_NAME STRING,
```

```
    P_MFGR STRING,
    P_BRAND STRING,
    P_TYPE STRING,
    P_SIZE INT,
    P_CONTAINER STRING,
    P_RETAILPRICE DOUBLE,
    P_COMMENT STRING
  )  STORED AS PARQUET
 TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- PARTSUPP表

```
DROP TABLE IF EXISTS partsupp;
CREATe  TABLE partsupp
  (
    PS_PARTKEY INT,
    PS_SUPPKEY INT,
    PS_AVAILQTY INT,
    PS_SUPPLYCOST DOUBLE,
    PS_COMMENT STRING
  )  STORED AS PARQUET
 TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- REGION表

```
DROP TABLE IF EXISTS region;
CREATe  TABLE region
  (
    R_REGIONKEY INT,
    R_NAME STRING,
    R_COMMENT STRING
  ) STORED AS PARQUET
 TBLPROPERTIES("parquet.compression"="SNAPPY");
```

- SUPPLIER表

```
DROP TABLE IF EXISTS supplier;
CREATe  TABLE supplier
  (
    S_SUPPKEY INT,
    S_NAME STRING,
    S_ADDRESS STRING,
    S_NATIONKEY INT,
    S_PHONE STRING,
    S_ACCTBAL DOUBLE,
    S_COMMENT STRING
  )  STORED AS PARQUET
```

```
TBLPROPERTIES("parquet.compression"="SNAPPY");
```

4.2 数据初始化

4.2.1 构建数据

性能测试以TPC-H 100GB数据为测试数据，使用标准的DBGEN工具构造样本数据。

从TPC官网下载TPC-H标准的数据生成工具DBGEN，编译后生成二进制可执行文件dbgen。

```
./dbgen -s $scale -C $chunks -S $i -f
```

- -s：指定scale值，例如100GB时scale值为100，1TB时scale值为1000。
- -C：一共分成几个chunk。
- -S:：当前命令生成第几个 chunk。

> **说明：**
> 一条语句只能生成一个 chunk。

更多dbgen使用方法请参见tpch-dbgen。

4.2.2 导入数据

本文介绍如何将TPC-H 100GB测试数据分别导入AnalyticDB for MySQL、MySQL、Presto、Spark以及Impala中。

下表列出了TPC-H测试数据集中的表数据条数。

表名	数据条数
customer	15000000
lineitem	600037902
nation	25
orders	150000000
part	20000000
partsupp	80000000
region	5
supplier	1000000

AnalyticDB for MySQL/MySQL

- 在AnalyticDB for MySQL和MySQL中，使用LOAD DATA导入dbgen生成的文件。

```
LOAD DATA LOCAL INFILE 'customer.tbl' INTO TABLE CUSTOMER
FIELDS TERMINATED BY '|'  LINES TERMINATED BY '\r\n';
LOAD DATA LOCAL INFILE 'orders.tbl'   INTO TABLE ORDERS
FIELDS TERMINATED BY '|'  LINES TERMINATED BY '\r\n';
LOAD DATA LOCAL INFILE 'lineitem.tbl' INTO TABLE LINEITEM
FIELDS TERMINATED BY '|'  LINES TERMINATED BY '\r\n';
LOAD DATA LOCAL INFILE 'nation.tbl'   INTO TABLE NATION
FIELDS TERMINATED BY '|'  LINES TERMINATED BY '\r\n';
LOAD DATA LOCAL INFILE 'partsupp.tbl' INTO TABLE PARTSUPP
FIELDS TERMINATED BY '|'  LINES TERMINATED BY '\r\n';
LOAD DATA LOCAL NFILE 'part.tbl'     INTO TABLE PART
FIELDS TERMINATED BY '|'   LINES TERMINATED BY '\r\n';
LOAD DATA LOCAL INFILE 'region.tbl'   INTO TABLE REGION
FIELDS TERMINATED BY '|'  LINES TERMINATED BY '\r\n';
LOAD DATA LOCAL INFILE 'supplier.tbl' INTO TABLE SUPPLIER
FIELDS TERMINATED BY '|'  LINES TERMINATED BY '\r\n';
```

- 在AnalyticDB for MySQL中，还可以通过OSS外表方式导入测试数据，请参见#unique_21。

Presto/Spark/Impala

在Presto、Spark以及Impala中，可以通过外表方式导入测试数据。

- CUSTOMER表

```
insert overwrite table customer
select
   c_custkey,
      c_name,
      c_address,
      c_nationkey,
      c_phone,
      c_acctbal,
      c_mktsegment,
      c_comment
from ${source_db}.customer;
```

- LINEITEM表

```
insert overwrite table lineitem
select
   l_orderkey,
   l_partkey,
   l_suppkey,
   l_linenumber,
   l_quantity,
   l_extendedprice,
   l_discount,
   l_tax,
   l_returnflag,
   l_linestatus,
   l_shipdate,
   l_commitdate,
   l_receiptdate,
   l_shipinstruct,
   l_shipmode,
```

```
    l_comment
from ${source_db}.lineitem;
```

- NATION表

```
insert overwrite table nation
select
        n_nationkey,
        n_name,
        n_regionkey,
        n_comment
from ${source_db}.nation;
```

- ORDERS表

```
insert overwrite table orders
select
        o_orderkey,
        o_custkey,
        o_orderstatus,
        o_totalprice,
        o_orderdate,
        o_orderpriority,
        o_clerk,
        o_shippriority,
        o_comment
from ${source_db}.orders;
```

- PART表

```
insert overwrite table part
select
        p_partkey,
        p_name,
        p_mfgr,
        p_brand,
        p_type,
        p_size,
        p_container,
        p_retailprice,
        p_comment
from ${source_db}.part;
```

- PARTSUPP表

```
insert overwrite table partsupp
select
        ps_partkey,
        ps_suppkey,
        ps_availqty,
        ps_supplycost,
        ps_comment
from ${source_db}.partsupp;
```

- REGION表

```
insert overwrite table region
select
        r_regionkey,
        r_name,
        r_comment
```

```
from ${source_db}.region;
```

- SUPPLIER表

```
insert overwrite table supplier
select
   s_suppkey,
   s_name,
   s_address,
   s_nationkey,
   s_phone,
   s_acctbal,
   s_comment
from ${source_db}.supplier;
```

4.3 TPC-H测试集

本次性能测试将分别在AnalyticDB for MySQL、MySQL、Presto、Spark以及Impala中执行以下二十二个查询SQL。

- SQL1

```
select
      l_returnflag,
      l_linestatus,
      sum(l_quantity) as sum_qty,
      sum(l_extendedprice) as sum_base_price,
      sum(l_extendedprice * (1 - l_discount)) as sum_disc_price,
      sum(l_extendedprice * (1 - l_discount) * (1 + l_tax)) as sum_charge,
      avg(l_quantity) as avg_qty,
      avg(l_extendedprice) as avg_price,
      avg(l_discount) as avg_disc,
      count(*) as count_order
from
      lineitem
where
      l_shipdate <= date '1998-12-01' - interval '120' day
group by
      l_returnflag,
      l_linestatus
order by
      l_returnflag,
      l_linestatus;
```

- SQL2

```
select
      s_acctbal,
      s_name,
      n_name,
      p_partkey,
      p_mfgr,
      s_address,
      s_phone,
      s_comment
from
      part,
      supplier,
      partsupp,
```

```
        nation,
        region
where
        p_partkey = ps_partkey
        and s_suppkey = ps_suppkey
        and p_size = 48
        and p_type like '%STEEL'
        and s_nationkey = n_nationkey
        and n_regionkey = r_regionkey
        and r_name = 'EUROPE'
        and ps_supplycost = (
                select
                        min(ps_supplycost)
                from
                        partsupp,
                        supplier,
                        nation,
                        region
                where
                        p_partkey = ps_partkey
                        and s_suppkey = ps_suppkey
                        and s_nationkey = n_nationkey
                        and n_regionkey = r_regionkey
                        and r_name = 'EUROPE'
        )
order by
        s_acctbal desc,
        n_name,
        s_name,
        p_partkey
limit 100;
```

- SQL3

```
select
        l_orderkey,
        sum(l_extendedprice * (1 - l_discount)) as revenue,
        o_orderdate,
        o_shippriority
from
        customer,
        orders,
        lineitem
where
        c_mktsegment = 'MACHINERY'
        and c_custkey = o_custkey
        and l_orderkey = o_orderkey
        and o_orderdate < date '1995-03-23'
        and l_shipdate > date '1995-03-23'
group by
        l_orderkey,
        o_orderdate,
        o_shippriority
order by
        revenue desc,
        o_orderdate
limit 10;
```

- SQL4

```
select
        o_orderpriority,
        count(*) as order_count
```

```
from
    orders
where
    o_orderdate >= date '1996-07-01'
    and o_orderdate < date '1996-07-01' + interval '3' month
    and exists (
        select
            *
        from
            lineitem
        where
            l_orderkey = o_orderkey
            and l_commitdate < l_receiptdate
    )
group by
    o_orderpriority
order by
    o_orderpriority;
```

- SQL5

```
select
    n_name,
    sum(l_extendedprice * (1 - l_discount)) as revenue
from
    customer,
    orders,
    lineitem,
    supplier,
    nation,
    region
where
    c_custkey = o_custkey
    and l_orderkey = o_orderkey
    and l_suppkey = s_suppkey
    and c_nationkey = s_nationkey
    and s_nationkey = n_nationkey
    and n_regionkey = r_regionkey
    and r_name = 'EUROPE'
    and o_orderdate >= date '1996-01-01'
    and o_orderdate < date '1996-01-01' + interval '1' year
group by
    n_name
order by
    revenue desc;
```

- SQL6

```
select
    sum(l_extendedprice * l_discount) as revenue
from
    lineitem
where
    l_shipdate >= date '1996-01-01'
    and l_shipdate < date '1996-01-01' + interval '1' year
    and l_discount between 0.02 - 0.01 and 0.02 + 0.01
    and l_quantity < 24;
```

- SQL7

```
select
    supp_nation,
```

```
    cust_nation,
    l_year,
    sum(volume) as revenue
from
    (
        select
            n1.n_name as supp_nation,
            n2.n_name as cust_nation,
            extract(year from l_shipdate) as l_year,
            l_extendedprice * (1 - l_discount) as volume
        from
            supplier,
            lineitem,
            orders,
            customer,
            nation n1,
            nation n2
        where
            s_suppkey = l_suppkey
            and o_orderkey = l_orderkey
            and c_custkey = o_custkey
            and s_nationkey = n1.n_nationkey
            and c_nationkey = n2.n_nationkey
            and (
                (n1.n_name = 'CANADA' and n2.n_name = 'BRAZIL')
                or (n1.n_name = 'BRAZIL' and n2.n_name = 'CANADA')
            )
            and l_shipdate between date '1995-01-01' and date '1996-12-31'
    ) as shipping
group by
    supp_nation,
    cust_nation,
    l_year
order by
    supp_nation,
    cust_nation,
    l_year;
```

- SQL8

```
select
    o_year,
    sum(case
        when nation = 'BRAZIL' then volume
        else 0
    end) / sum(volume) as mkt_share
from
    (
        select
            extract(year from o_orderdate) as o_year,
            l_extendedprice * (1 - l_discount) as volume,
            n2.n_name as nation
        from
            part,
            supplier,
            lineitem,
            orders,
            customer,
            nation n1,
            nation n2,
            region
        where
            p_partkey = l_partkey
```

```
                and s_suppkey = l_suppkey
                and l_orderkey = o_orderkey
                and o_custkey = c_custkey
                and c_nationkey = n1.n_nationkey
                and n1.n_regionkey = r_regionkey
                and r_name = 'AMERICA'
                and s_nationkey = n2.n_nationkey
                and o_orderdate between date '1995-01-01' and date '1996-12-31'
                and p_type = 'LARGE ANODIZED COPPER'
        ) as all_nations
group by
        o_year
order by
        o_year;
```

- SQL9

```
select
        nation,
        o_year,
        sum(amount) as sum_profit
from
        (
                select
                        n_name as nation,
                        extract(year from o_orderdate) as o_year,
                        l_extendedprice * (1 - l_discount) - ps_supplycost * l_quantity as amount
                from
                        part,
                        supplier,
                        lineitem,
                        partsupp,
                        orders,
                        nation
                where
                        s_suppkey = l_suppkey
                        and ps_suppkey = l_suppkey
                        and ps_partkey = l_partkey
                        and p_partkey = l_partkey
                        and o_orderkey = l_orderkey
                        and s_nationkey = n_nationkey
                        and p_name like '%maroon%'
        ) as profit
group by
        nation,
        o_year
order by
        nation,
        o_year desc;
```

- SQL10

```
select
        c_custkey,
        c_name,
        sum(l_extendedprice * (1 - l_discount)) as revenue,
        c_acctbal,
        n_name,
        c_address,
        c_phone,
        c_comment
from
        customer,
```

```
        orders,
        lineitem,
        nation
where
        c_custkey = o_custkey
        and l_orderkey = o_orderkey
        and o_orderdate >= date '1993-02-01'
        and o_orderdate < date '1993-02-01' + interval '3' month
        and l_returnflag = 'R'
        and c_nationkey = n_nationkey
group by
        c_custkey,
        c_name,
        c_acctbal,
        c_phone,
        n_name,
        c_address,
        c_comment
order by
        revenue desc
limit 20;
```

- SQL11

```
select
        ps_partkey,
        sum(ps_supplycost * ps_availqty) as value
from
        partsupp,
        supplier,
        nation
where
        ps_suppkey = s_suppkey
        and s_nationkey = n_nationkey
        and n_name = 'EGYPT'
group by
        ps_partkey having
                sum(ps_supplycost * ps_availqty) > (
                        select
                                sum(ps_supplycost * ps_availqty) * 0.0001000000
                        from
                                partsupp,
                                supplier,
                                nation
                        where
                                ps_suppkey = s_suppkey
                                and s_nationkey = n_nationkey
                                and n_name = 'EGYPT'
                )
order by
        value desc;
```

- SQL12

```
select
        l_shipmode,
        sum(case
                when o_orderpriority = '1-URGENT'
                        or o_orderpriority = '2-HIGH'
                        then 1
                else 0
        end) as high_line_count,
        sum(case
```

```
            when o_orderpriority <> '1-URGENT'
                and o_orderpriority <> '2-HIGH'
                then 1
            else 0
        end) as low_line_count
from
        orders,
        lineitem
where
        o_orderkey = l_orderkey
        and l_shipmode in ('FOB', 'AIR')
        and l_commitdate < l_receiptdate
        and l_shipdate < l_commitdate
        and l_receiptdate >= date '1997-01-01'
        and l_receiptdate < date '1997-01-01' + interval '1' year
group by
        l_shipmode
order by
        l_shipmode;
```

- SQL13

```
select
        c_count,
        count(*) as custdist
from
        (
            select
                c_custkey,
                count(o_orderkey) as c_count
            from
                customer left outer join orders on
                    c_custkey = o_custkey
                    and o_comment not like '%special%deposits%'
            group by
                c_custkey
        ) c_orders
group by
        c_count
order by
        custdist desc,
        c_count desc;
```

- SQL14

```
select
        100.00 * sum(case
            when p_type like 'PROMO%'
                then l_extendedprice * (1 - l_discount)
            else 0
        end) / sum(l_extendedprice * (1 - l_discount)) as promo_revenue
from
        lineitem,
        part
where
        l_partkey = p_partkey
        and l_shipdate >= date '1997-06-01'
        and l_shipdate < date '1997-06-01' + interval '1' month;
```

- SQL15

```
create view revenue0 (supplier_no, total_revenue) as
```

```
        select
                l_suppkey,
                sum(l_extendedprice * (1 - l_discount))
        from
                lineitem
        where
                l_shipdate >= date '1995-02-01'
                and l_shipdate < date '1995-02-01' + interval '3' month
        group by
                l_suppkey;


select
        s_suppkey,
        s_name,
        s_address,
        s_phone,
        total_revenue
from
        supplier,
        revenue0
where
        s_suppkey = supplier_no
        and total_revenue = (
                select
                        max(total_revenue)
                from
                        revenue0
        )
order by
        s_suppkey;

drop view revenue0;
```

- SQL16

```
select
        p_brand,
        p_type,
        p_size,
        count(distinct ps_suppkey) as supplier_cnt
from
        partsupp,
        part
where
        p_partkey = ps_partkey
        and p_brand <> 'Brand#45'
        and p_type not like 'SMALL ANODIZED%'
        and p_size in (47, 15, 37, 30, 46, 16, 18, 6)
        and ps_suppkey not in (
                select
                        s_suppkey
                from
                        supplier
                where
                        s_comment like '%Customer%Complaints%'
        )
group by
        p_brand,
        p_type,
        p_size
order by
        supplier_cnt desc,
```

```
    p_brand,
    p_type,
    p_size;
```

- SQL17

```
select
    sum(l_extendedprice) / 7.0 as avg_yearly
from
    lineitem,
    part
where
    p_partkey = l_partkey
    and p_brand = 'Brand#51'
    and p_container = 'WRAP PACK'
    and l_quantity < (
        select
            0.2 * avg(l_quantity)
        from
            lineitem
        where
            l_partkey = p_partkey
    );
```

- SQL18

```
select
    c_name,
    c_custkey,
    o_orderkey,
    o_orderdate,
    o_totalprice,
    sum(l_quantity)
from
    customer,
    orders,
    lineitem
where
    o_orderkey in (
        select
            l_orderkey
        from
            lineitem
        group by
            l_orderkey having
                sum(l_quantity) > 312
    )
    and c_custkey = o_custkey
    and o_orderkey = l_orderkey
group by
    c_name,
    c_custkey,
    o_orderkey,
    o_orderdate,
    o_totalprice
order by
    o_totalprice desc,
    o_orderdate
```

```
limit 100;
```

- SQL19

```
select
    sum(l_extendedprice* (1 - l_discount)) as revenue
from
    lineitem,
    part
where
    (
        p_partkey = l_partkey
        and p_brand = 'Brand#52'
        and p_container in ('SM CASE', 'SM BOX', 'SM PACK', 'SM PKG')
        and l_quantity >= 3 and l_quantity <= 3 + 10
        and p_size between 1 and 5
        and l_shipmode in ('AIR', 'AIR REG')
        and l_shipinstruct = 'DELIVER IN PERSON'
    )
    or
    (
        p_partkey = l_partkey
        and p_brand = 'Brand#43'
        and p_container in ('MED BAG', 'MED BOX', 'MED PKG', 'MED PACK')
        and l_quantity >= 12 and l_quantity <= 12 + 10
        and p_size between 1 and 10
        and l_shipmode in ('AIR', 'AIR REG')
        and l_shipinstruct = 'DELIVER IN PERSON'
    )
    or
    (
        p_partkey = l_partkey
        and p_brand = 'Brand#52'
        and p_container in ('LG CASE', 'LG BOX', 'LG PACK', 'LG PKG')
        and l_quantity >= 21 and l_quantity <= 21 + 10
        and p_size between 1 and 15
        and l_shipmode in ('AIR', 'AIR REG')
        and l_shipinstruct = 'DELIVER IN PERSON'
    );
```

- SQL20

```
select
    s_name,
    s_address
from
    supplier,
    nation
where
    s_suppkey in (
        select
            ps_suppkey
        from
            partsupp
        where
            ps_partkey in (
                select
                    p_partkey
                from
                    part
                where
                    p_name like 'drab%'
            )
```

```
                and ps_availqty > (
                    select
                        0.5 * sum(l_quantity)
                    from
                        lineitem
                    where
                        l_partkey = ps_partkey
                        and l_suppkey = ps_suppkey
                        and l_shipdate >= date '1996-01-01'
                        and l_shipdate < date '1996-01-01' + interval '1' year
                )
    )
    and s_nationkey = n_nationkey
    and n_name = 'KENYA'
order by
    s_name;
```

- SQL21

```
select
    s_name,
    count(*) as numwait
from
    supplier,
    lineitem l1,
    orders,
    nation
where
    s_suppkey = l1.l_suppkey
    and o_orderkey = l1.l_orderkey
    and o_orderstatus = 'F'
    and l1.l_receiptdate > l1.l_commitdate
    and exists (
        select
            *
        from
            lineitem l2
        where
            l2.l_orderkey = l1.l_orderkey
            and l2.l_suppkey <> l1.l_suppkey
    )
    and not exists (
        select
            *
        from
            lineitem l3
        where
            l3.l_orderkey = l1.l_orderkey
            and l3.l_suppkey <> l1.l_suppkey
            and l3.l_receiptdate > l3.l_commitdate
    )
    and s_nationkey = n_nationkey
    and n_name = 'PERU'
group by
    s_name
order by
    numwait desc,
    s_name
limit 100;
```

- SQL22

```
select
```

```
        cntrycode,
        count(*) as numcust,
        sum(c_acctbal) as totacctbal
from
        (
                select
                        substring(c_phone from 1 for 2) as cntrycode,
                        c_acctbal
                from
                        customer
                where
                        substring(c_phone from 1 for 2) in
                                ('24', '32', '17', '18', '12', '14', '22')
                        and c_acctbal > (
                                select
                                        avg(c_acctbal)
                                from
                                        customer
                                where
                                        c_acctbal > 0.00
                                        and substring(c_phone from 1 for 2) in
                                                ('24', '32', '17', '18', '12', '14', '22')
                        )
                        and not exists (
                                select
                                        *
                                from
                                        orders
                                where
                                        o_custkey = c_custkey
                        )
        ) as custsale
group by
        cntrycode
order by
        cntrycode;
```

说明:

在Spark中，需要将substring(c_phone from 1 for 2)该写为substring(c_phone, 1, 2)。