实验三报告

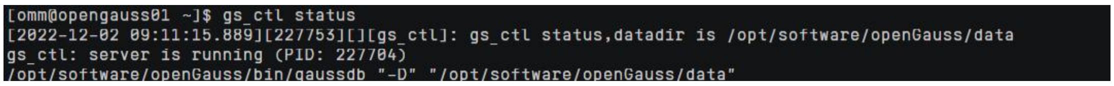
关卡一：openGauss 数据库的编译和安装

1. 关卡验证

步骤 1 首先需要对数据库状态进行验证。

```
[omm@opengauss01 openGauss-server]$ gs_ctl status
```

（截图语句和执行结果）

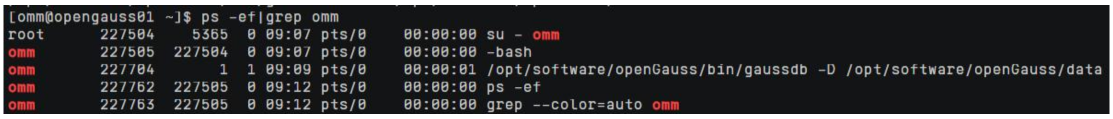


```
[omm@opengauss01 ~]$ gs_ctl status
[2022-12-02 09:11:15.889][227753][][gs_ctl]: gs_ctl status,datadir is /opt/software/openGauss/data
gs_ctl: server is running (PID: 227704)
/opt/software/openGauss/bin/gaussdb "-D" "/opt/software/openGauss/data"
```

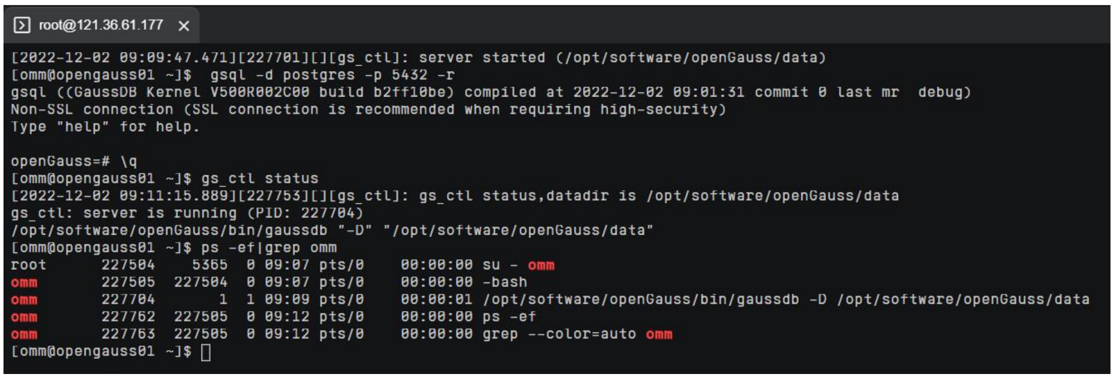
步骤 2 对数据库进程进行截图验证，需包含数据库服务器的主机名。

```
[omm@opengauss01 openGauss-server]$ ps -ef|grep omm
```

（截图语句和执行结果）



```
[omm@opengauss01 ~]$ ps -ef|grep omm
root      227504    5365  0 09:07 pts/0    00:00:00 su - omm
omm       227505  227504  0 09:07 pts/0    00:00:00 -bash
omm       227704       1  1 09:09 pts/0    00:00:01 /opt/software/openGauss/bin/gaussdb -D /opt/software/openGauss/data
omm       227762  227505  0 09:12 pts/0    00:00:00 ps -ef
omm       227763  227505  0 09:12 pts/0    00:00:00 grep --color=auto omm
```



```
root@121.36.61.177
[2022-12-02 09:09:47.471][227701][][gs_ctl]: server started (/opt/software/openGauss/data)
[omm@opengauss01 ~]$  gsql -d postgres -p 5432 -r
gsql ((GaussDB Kernel V500R002C00 build b2ff10be) compiled at 2022-12-02 09:01:31 commit 0 last mr  debug)
Non-SSL connection (SSL connection is recommended when requiring high-security)
Type "help" for help.

openGauss=# \q
[omm@opengauss01 ~]$ gs_ctl status
[2022-12-02 09:11:15.889][227753][][gs_ctl]: gs_ctl status,datadir is /opt/software/openGauss/data
gs_ctl: server is running (PID: 227704)
/opt/software/openGauss/bin/gaussdb "-D" "/opt/software/openGauss/data"
[omm@opengauss01 ~]$ ps -ef|grep omm
root      227504    5365  0 09:07 pts/0    00:00:00 su - omm
omm       227505  227504  0 09:07 pts/0    00:00:00 -bash
omm       227704       1  1 09:09 pts/0    00:00:01 /opt/software/openGauss/bin/gaussdb -D /opt/software/openGauss/data
omm       227762  227505  0 09:12 pts/0    00:00:00 ps -ef
omm       227763  227505  0 09:12 pts/0    00:00:00 grep --color=auto omm
[omm@opengauss01 ~]$ 
```

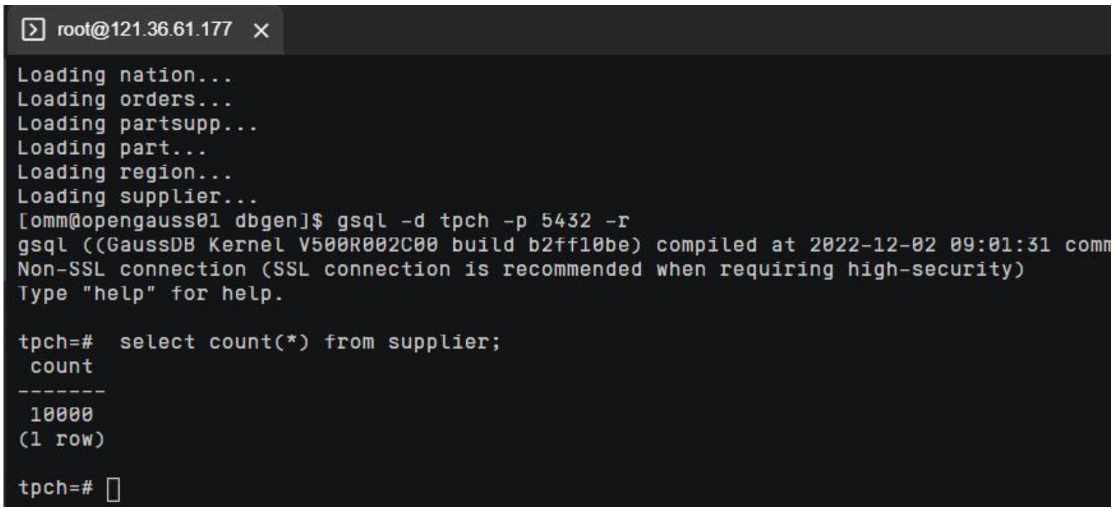
关卡二：openGauss 数据导入及基本操作

1. 关卡验证

步骤 12 登录数据库验证

```
[omm@opengauss01 dbgen]$ gsql -d tpch -p 5432 -r
tpch=# select count(*) from supplier;
```

（截图语句和执行结果）

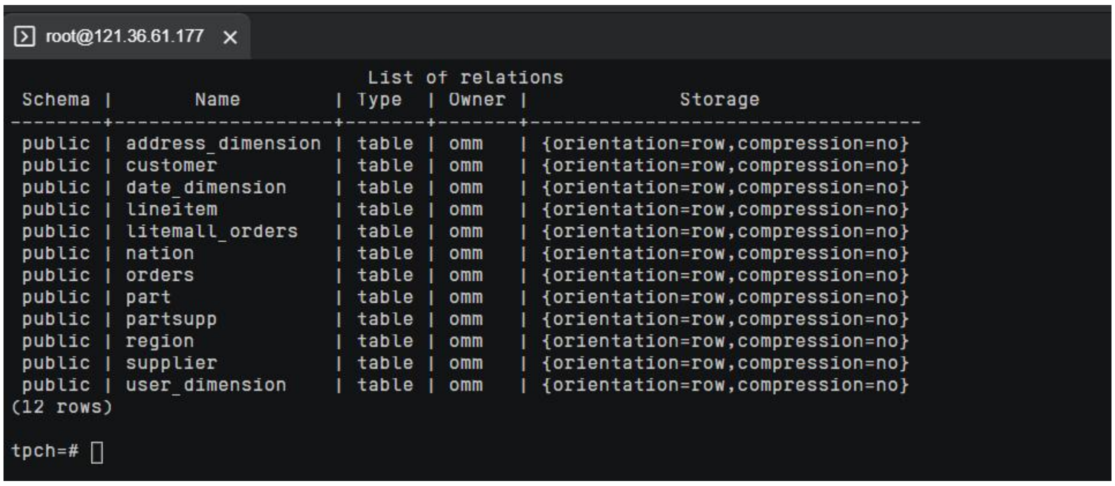


```
Loading nation...
Loading orders...
Loading partsupp...
Loading part...
Loading region...
Loading supplier...
[omm@opengauss01 dbgen]$ gsql -d tpch -p 5432 -r
gsql ((GaussDB Kernel V500R002C00 build b2ff10be) compiled at 2022-12-02 09:01:31 comm
Non-SSL connection (SSL connection is recommended when requiring high-security)
Type "help" for help.

tpch=#  select count(*) from supplier;
 count
-------
 10000
(1 row)

tpch=# 
```

步骤 21 登录数据库进行验证

```
[omm@opengauss01 ~]$ gsql -d tpch -p 5432 -r
tpch=# \dt
```

（截图语句和执行结果）

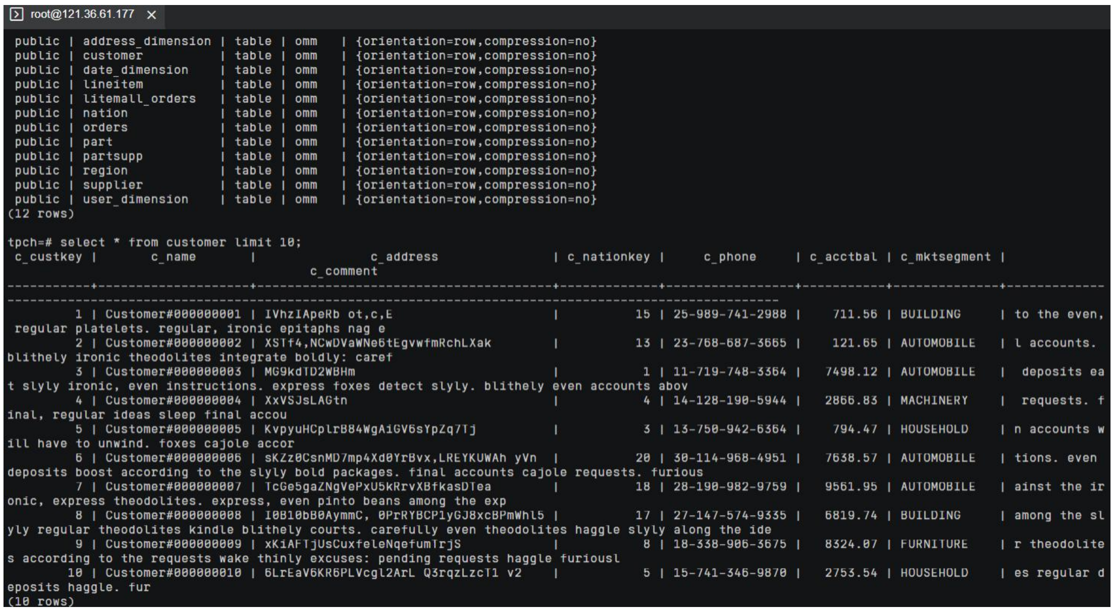


```
                              List of relations
 Schema |        Name        | Type  | Owner |             Storage
--------+--------------------+-------+-------+----------------------------------
 public | address_dimension  | table | omm   | {orientation=row,compression=no}
 public | customer           | table | omm   | {orientation=row,compression=no}
 public | date_dimension     | table | omm   | {orientation=row,compression=no}
 public | lineitem           | table | omm   | {orientation=row,compression=no}
 public | litemall_orders    | table | omm   | {orientation=row,compression=no}
 public | nation             | table | omm   | {orientation=row,compression=no}
 public | orders             | table | omm   | {orientation=row,compression=no}
 public | part               | table | omm   | {orientation=row,compression=no}
 public | partsupp           | table | omm   | {orientation=row,compression=no}
 public | region             | table | omm   | {orientation=row,compression=no}
 public | supplier           | table | omm   | {orientation=row,compression=no}
 public | user_dimension     | table | omm   | {orientation=row,compression=no}
(12 rows)

tpch=# 
```

步骤 22 查询 customer 表的数据

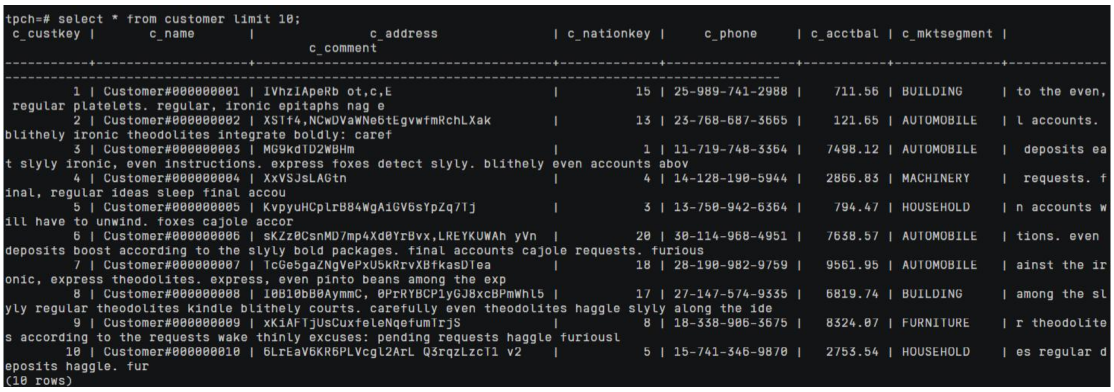
```
tpch=# select * from customer limit 10;
```

（截图语句和执行结果）



root@121.36.61.177

```
 public | address_dimension | table | omm   | {orientation=row,compression=no}
 public | customer          | table | omm   | {orientation=row,compression=no}
 public | date_dimension    | table | omm   | {orientation=row,compression=no}
 public | lineitem          | table | omm   | {orientation=row,compression=no}
 public | litemall_orders   | table | omm   | {orientation=row,compression=no}
 public | nation            | table | omm   | {orientation=row,compression=no}
 public | orders            | table | omm   | {orientation=row,compression=no}
 public | part              | table | omm   | {orientation=row,compression=no}
 public | partsupp          | table | omm   | {orientation=row,compression=no}
 public | region            | table | omm   | {orientation=row,compression=no}
 public | supplier          | table | omm   | {orientation=row,compression=no}
 public | user_dimension    | table | omm   | {orientation=row,compression=no}
(12 rows)

tpch=# select * from customer limit 10;
 c_custkey |       c_name       |                c_address                | c_nationkey |     c_phone     | c_acctbal | c_mktsegment |
                                         c_comment
-----------+--------------------+-----------------------------------------+-------------+-----------------+-----------+--------------+------------
---------------------------------------------------------------------------------------------------------------
         1 | Customer#000000001 | IVhzIApeRb ot,c,E                       |          15 | 25-989-741-2988 |    711.56 | BUILDING     | to the even,
 regular platelets. regular, ironic epitaphs nag e
         2 | Customer#000000002 | XSTf4,NCwDVaWNe6tEgvwfmRchLXak          |          13 | 23-768-687-3665 |    121.65 | AUTOMOBILE   | l accounts.
blithely ironic theodolites integrate boldly: caref
         3 | Customer#000000003 | MG9kdTD2WBHm                            |           1 | 11-719-748-3364 |   7498.12 | AUTOMOBILE   |  deposits ea
t slyly ironic, even instructions. express foxes detect slyly. blithely even accounts abov
         4 | Customer#000000004 | XxVSJsLAGtn                             |           4 | 14-128-190-5944 |   2866.83 | MACHINERY    |  requests. f
inal, regular ideas sleep final accou
         5 | Customer#000000005 | KvpyuHCplrB84WgAiGV6sYpZq7Tj            |           3 | 13-750-942-6364 |    794.47 | HOUSEHOLD    | n accounts w
ill have to unwind. foxes cajole accor
         6 | Customer#000000006 | sKZz0CsnMD7mp4Xd0YrBvx,LREYKUWAh yVn     |          20 | 30-114-968-4951 |   7638.57 | AUTOMOBILE   | tions. even
deposits boost according to the slyly bold packages. final accounts cajole requests. furious
         7 | Customer#000000007 | TcGe5gaZNgVePxU5kRrvXBfkasDTea          |          18 | 28-190-982-9759 |   9561.95 | AUTOMOBILE   | ainst the ir
onic, express theodolites. express, even pinto beans among the exp
         8 | Customer#000000008 | I0B10bB0AymmC, 0PrRYBCP1yGJ8xcBPmWhl5   |          17 | 27-147-574-9335 |   6819.74 | BUILDING     | among the sl
yly regular theodolites kindle blithely courts. carefully even theodolites haggle slyly along the ide
         9 | Customer#000000009 | xKiAFTjUsCuxfeleNqefumTrjS              |           8 | 18-338-906-3675 |   8324.07 | FURNITURE    | r theodolite
s according to the requests wake thinly excuses: pending requests haggle furiousl
        10 | Customer#000000010 | 6LrEaV6KR6PLVcgl2ArL Q3rqzLzcT1 v2      |           5 | 15-741-346-9870 |   2753.54 | HOUSEHOLD    | es regular d
eposits haggle. fur
(10 rows)
```



```
tpch=# select * from customer limit 10;
 c_custkey |       c_name       |                c_address                | c_nationkey |     c_phone     | c_acctbal | c_mktsegment |
                                         c_comment
-----------+--------------------+-----------------------------------------+-------------+-----------------+-----------+--------------+------------
---------------------------------------------------------------------------------------------------------------
         1 | Customer#000000001 | IVhzIApeRb ot,c,E                       |          15 | 25-989-741-2988 |    711.56 | BUILDING     | to the even,
 regular platelets. regular, ironic epitaphs nag e
         2 | Customer#000000002 | XSTf4,NCwDVaWNe6tEgvwfmRchLXak          |          13 | 23-768-687-3665 |    121.65 | AUTOMOBILE   | l accounts.
blithely ironic theodolites integrate boldly: caref
         3 | Customer#000000003 | MG9kdTD2WBHm                            |           1 | 11-719-748-3364 |   7498.12 | AUTOMOBILE   |  deposits ea
t slyly ironic, even instructions. express foxes detect slyly. blithely even accounts abov
         4 | Customer#000000004 | XxVSJsLAGtn                             |           4 | 14-128-190-5944 |   2866.83 | MACHINERY    |  requests. f
inal, regular ideas sleep final accou
         5 | Customer#000000005 | KvpyuHCplrB84WgAiGV6sYpZq7Tj            |           3 | 13-750-942-6364 |    794.47 | HOUSEHOLD    | n accounts w
ill have to unwind. foxes cajole accor
         6 | Customer#000000006 | sKZz0CsnMD7mp4Xd0YrBvx,LREYKUWAh yVn     |          20 | 30-114-968-4951 |   7638.57 | AUTOMOBILE   | tions. even
deposits boost according to the slyly bold packages. final accounts cajole requests. furious
         7 | Customer#000000007 | TcGe5gaZNgVePxU5kRrvXBfkasDTea          |          18 | 28-190-982-9759 |   9561.95 | AUTOMOBILE   | ainst the ir
onic, express theodolites. express, even pinto beans among the exp
         8 | Customer#000000008 | I0B10bB0AymmC, 0PrRYBCP1yGJ8xcBPmWhl5   |          17 | 27-147-574-9335 |   6819.74 | BUILDING     | among the sl
yly regular theodolites kindle blithely courts. carefully even theodolites haggle slyly along the ide
         9 | Customer#000000009 | xKiAFTjUsCuxfeleNqefumTrjS              |           8 | 18-338-906-3675 |   8324.07 | FURNITURE    | r theodolite
s according to the requests wake thinly excuses: pending requests haggle furiousl
        10 | Customer#000000010 | 6LrEaV6KR6PLVcgl2ArL Q3rqzLzcT1 v2      |           5 | 15-741-346-9870 |   2753.54 | HOUSEHOLD    | es regular d
eposits haggle. fur
(10 rows)
```

2. 思考题

数据初始化中出现了 TPC-H，这是什么?

答：TPC-H 是 TPC 提供的一个 benchmark，用来模拟一个现实中的商业应用，可以生成一堆虚构的数据，且自带一些查询，可以导入到各种数据库中来模拟现实需求，检查性能

关卡三：openGauss 的 AI4DB 特性应用

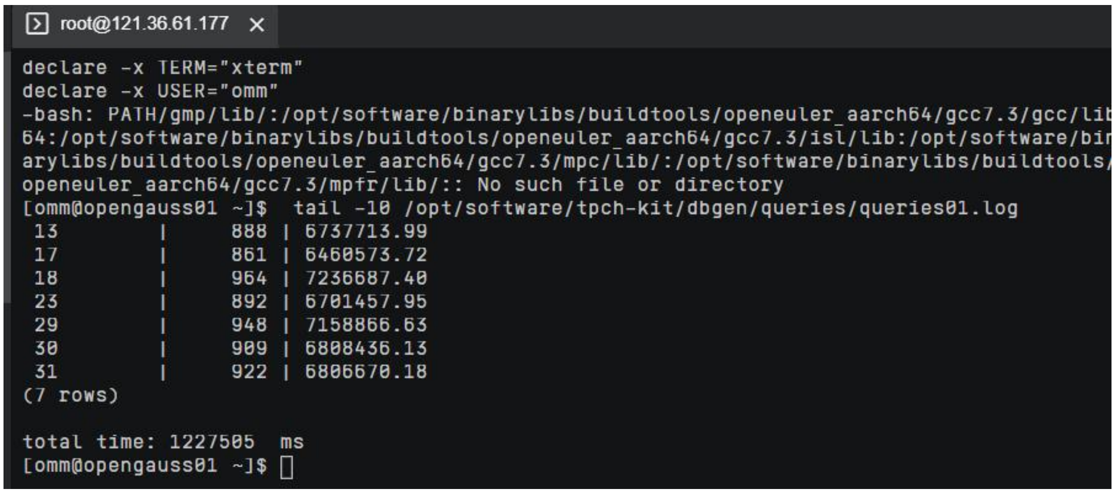
1. 关卡验证

(1) 使用 X-Tuner 进行参数优化

步骤 2 在原来 CloudShell 连接窗口中查看 queries01.log。

```
[omm@opengauss01 ~]$ tail -10 /opt/software/tpch-kit/dbgen/queries/queries01.log
```

（截图执行语句和结果）

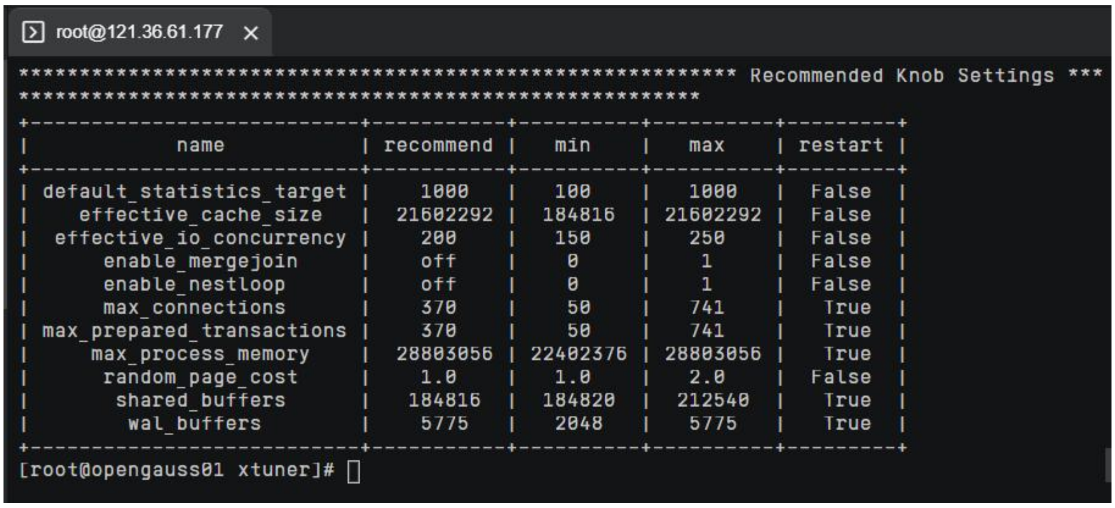


```
root@121.36.61.177
declare -x TERM="xterm"
declare -x USER="omm"
-bash: PATH/gmp/lib/:/opt/software/binarylibs/buildtools/openeuler_aarch64/gcc7.3/gcc/lib
64:/opt/software/binarylibs/buildtools/openeuler_aarch64/gcc7.3/isl/lib:/opt/software/bin
arylibs/buildtools/openeuler_aarch64/gcc7.3/mpc/lib/:/opt/software/binarylibs/buildtools/
openeuler_aarch64/gcc7.3/mpfr/lib/:: No such file or directory
[omm@opengauss01 ~]$  tail -10 /opt/software/tpch-kit/dbgen/queries/queries01.log
 13         |       888 | 6737713.99
 17         |       861 | 6460573.72
 18         |       964 | 7236687.40
 23         |       892 | 6701457.95
 29         |       948 | 7158866.63
 30         |       909 | 6808436.13
 31         |       922 | 6806670.18
(7 rows)

total time: 1227505  ms
[omm@opengauss01 ~]$ 
```

步骤 3 切换至 root 用户，执行 X-Tuner 进行参数建议优化

```
[omm@opengauss01 ~]$ exit
[root@opengauss01 xtuner]# gs_xtuner recommend --db-name tpch --db-user omm --port 5432
--host 127.0.0.1 --host-user omm
```

（截图执行语句和结果）

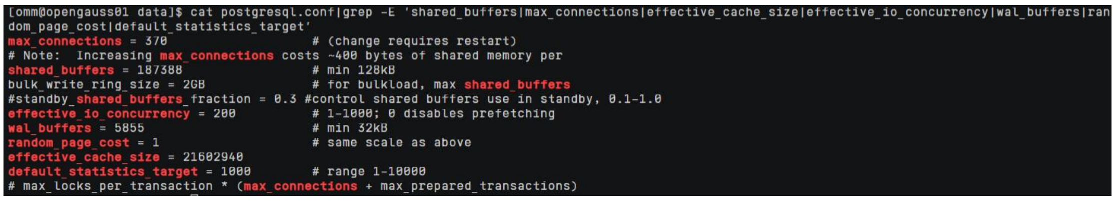


```
root@121.36.61.177
************************************************************ Recommended Knob Settings ***
**********************************************************
+----------------------------+-----------+-----------+-----------+---------+
|            name            | recommend |    min    |    max    | restart |
+----------------------------+-----------+-----------+-----------+---------+
| default_statistics_target  |    1000   |    100    |    1000   |  False  |
|    effective_cache_size    |  21602292 |   184816  |  21602292 |  False  |
|  effective_io_concurrency  |    200    |    150    |    250    |  False  |
|       enable_mergejoin     |    off    |     0     |     1     |  False  |
|       enable_nestloop      |    off    |     0     |     1     |  False  |
|       max_connections      |    370    |     50    |    741    |   True  |
| max_prepared_transactions  |    370    |     50    |    741    |   True  |
|     max_process_memory     |  28803056 |  22402376 |  28803056 |   True  |
|       random_page_cost     |    1.0    |    1.0    |    2.0    |  False  |
|        shared_buffers      |   184816  |   184820  |   212540  |   True  |
|         wal_buffers        |    5775   |    2048   |    5775   |   True  |
+----------------------------+-----------+-----------+-----------+---------+
[root@opengauss01 xtuner]# 
```

步骤 6 获取参数值

```
[omm@opengauss01 ~]$ cd /opt/software/openGauss/data
[omm@opengauss01 data]$ cat postgresql.conf|grep -E
'shared_buffers|max_connections|effective_cache_size|effective_io_concurrency|wal_buffers|rando
m_page_cost|default_statistics_target'
```

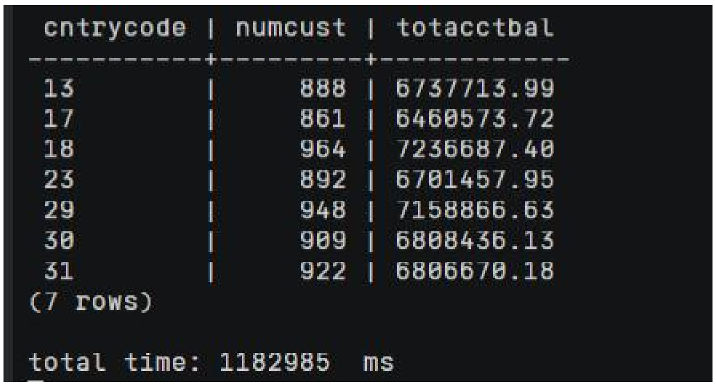
（截图执行语句和结果）



```
[omm@opengauss01 data]$ cat postgresql.conf|grep -E 'shared_buffers|max_connections|effective_cache_size|effective_io_concurrency|wal_buffers|ran
dom_page_cost|default_statistics_target'
max_connections = 370                   # (change requires restart)
# Note:  Increasing max_connections costs ~400 bytes of shared memory per
shared_buffers = 187388                 # min 128kB
bulk_write_ring_size = 2GB              # for bulkload, max shared_buffers
#standby_shared_buffers_fraction = 0.3 #control shared buffers use in standby, 0.1-1.0
effective_io_concurrency = 200          # 1-1000; 0 disables prefetching
wal_buffers = 5855                      # min 32kB
random_page_cost = 1                    # same scale as above
effective_cache_size = 21602940
default_statistics_target = 1000        # range 1-10000
# max_locks_per_transaction * (max_connections + max_prepared_transactions)
```

步骤 7 再次执行步骤 2，对比优化前的执行时间。

（截图执行语句和结果）

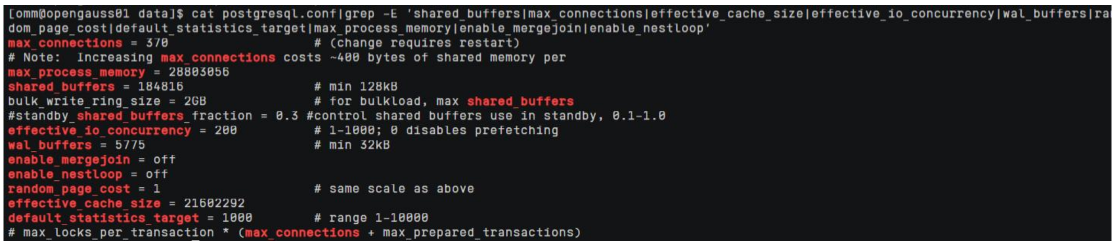


```
 cntrycode | numcust | totacctbal
-----------+---------+------------
 13        |     888 | 6737713.99
 17        |     861 | 6460573.72
 18        |     964 | 7236687.40
 23        |     892 | 6701457.95
 29        |     948 | 7158866.63
 30        |     909 | 6808436.13
 31        |     922 | 6806670.18
(7 rows)

total time: 1182985  ms
```

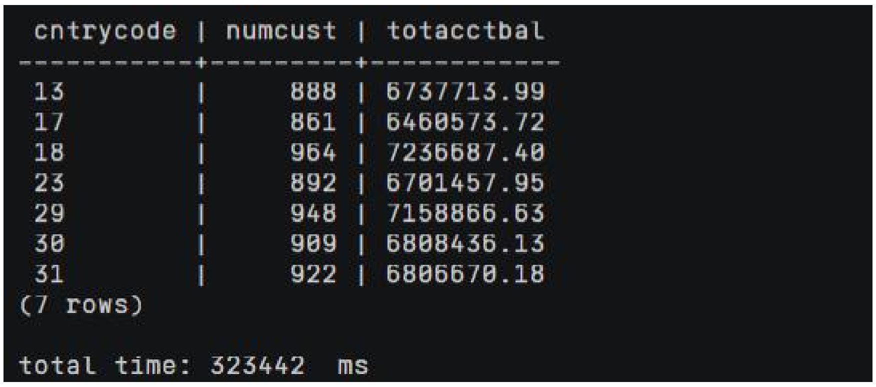
步骤 8 【附加题】有兴趣的同学可以尝试并截图记录于此。

（截图执行语句和结果）

gs_guc set -D /opt/software/openGauss/data/ -c "shared_buffers = 184816" -c "max_connections = 370" -c "max_prepared_transactions = 370" -c "effective_cache_size = 21602292" -c"effective_io_concurrency = 200" -c "wal_buffers = 5775" -c "random_page_cost = 1" -c "default_statistics_target = 1000" -c "max_process_memory = 28803056" -c "enable_mergejoin = off" -c "enable_nestloop = off"



```
[omm@opengauss01 data]$ cat postgresql.conf|grep -E 'shared_buffers|max_connections|effective_cache_size|effective_io_concurrency|wal_buffers|ra
dom_page_cost|default_statistics_target|max_process_memory|enable_mergejoin|enable_nestloop'
max_connections = 370                   # (change requires restart)
# Note:  Increasing max_connections costs ~400 bytes of shared memory per
max_process_memory = 28803056
shared_buffers = 184816                 # min 128kB
bulk_write_ring_size = 2GB              # for bulkload, max shared_buffers
#standby_shared_buffers_fraction = 0.3 #control shared buffers use in standby, 0.1-1.0
effective_io_concurrency = 200          # 1-1000; 0 disables prefetching
wal_buffers = 5775                      # min 32kB
enable_mergejoin = off
enable_nestloop = off
random_page_cost = 1                    # same scale as above
effective_cache_size = 21602292
default_statistics_target = 1000        # range 1-10000
# max_locks_per_transaction * (max_connections + max_prepared_transactions)
```



```
 cntrycode | numcust | totacctbal
-----------+---------+------------
 13        |     888 | 6737713.99
 17        |     861 | 6460573.72
 18        |     964 | 7236687.40
 23        |     892 | 6701457.95
 29        |     948 | 7158866.63
 30        |     909 | 6808436.13
 31        |     922 | 6806670.18
(7 rows)

total time: 323442  ms
```

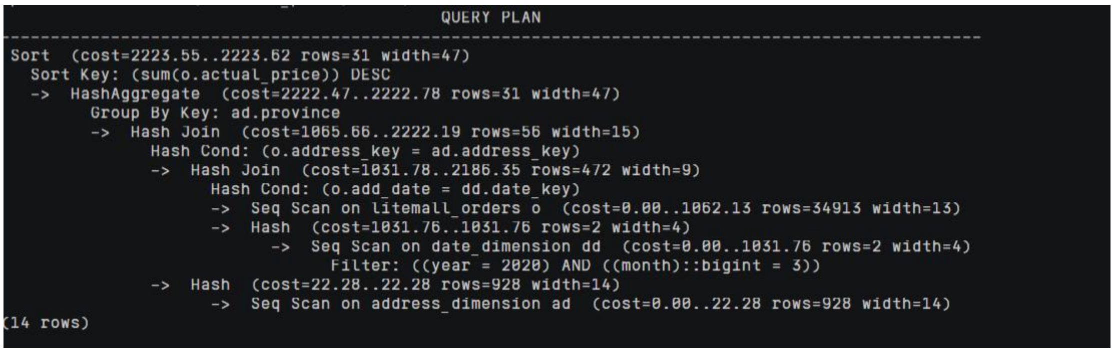
（2）Index-advisor：索引推荐

步骤 4 使用 explain，对该 SQL 加以分析

```
tpch=# EXPLAIN
```

```
SELECT ad.province AS province, SUM(o.actual_price) AS GMV
  FROM litemall_orders o,
       address_dimension ad,
       date_dimension dd
 WHERE o.address_key = ad.address_key
   AND o.add_date = dd.date_key
   AND dd.year = 2020
   AND dd.month = 3
 GROUP BY ad.province
 ORDER BY SUM(o.actual_price) DESC;
```

（截图执行语句和结果）

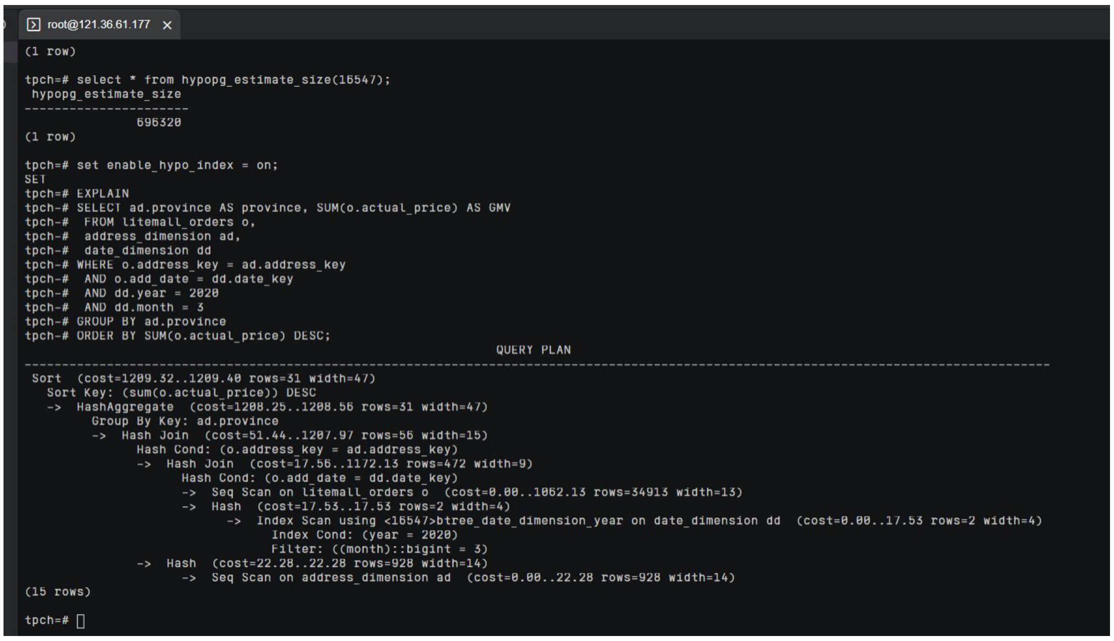


```
                                               QUERY PLAN
-------------------------------------------------------------------------------------------------
 Sort  (cost=2223.55..2223.62 rows=31 width=47)
   Sort Key: (sum(o.actual_price)) DESC
   ->  HashAggregate  (cost=2222.47..2222.78 rows=31 width=47)
         Group By Key: ad.province
         ->  Hash Join  (cost=1065.66..2222.19 rows=56 width=15)
               Hash Cond: (o.address_key = ad.address_key)
               ->  Hash Join  (cost=1031.78..2186.35 rows=472 width=9)
                     Hash Cond: (o.add_date = dd.date_key)
                     ->  Seq Scan on litemall_orders o  (cost=0.00..1062.13 rows=34913 width=13)
                     ->  Hash  (cost=1031.76..1031.76 rows=2 width=4)
                           ->  Seq Scan on date_dimension dd  (cost=0.00..1031.76 rows=2 width=4)
                                 Filter: ((year = 2020) AND ((month)::bigint = 3))
               ->  Hash  (cost=22.28..22.28 rows=928 width=14)
                     ->  Seq Scan on address_dimension ad  (cost=0.00..22.28 rows=928 width=14)
(14 rows)
```

步骤 9 使用 explain，对该 SQL 加以分析

```
tpch=# EXPLAIN
SELECT ad.province AS province, SUM(o.actual_price) AS GMV
  FROM litemall_orders o,
       address_dimension ad,
       date_dimension dd
 WHERE o.address_key = ad.address_key
   AND o.add_date = dd.date_key
   AND dd.year = 2020
   AND dd.month = 3
 GROUP BY ad.province
 ORDER BY SUM(o.actual_price) DESC;
```

（截图执行语句和结果）

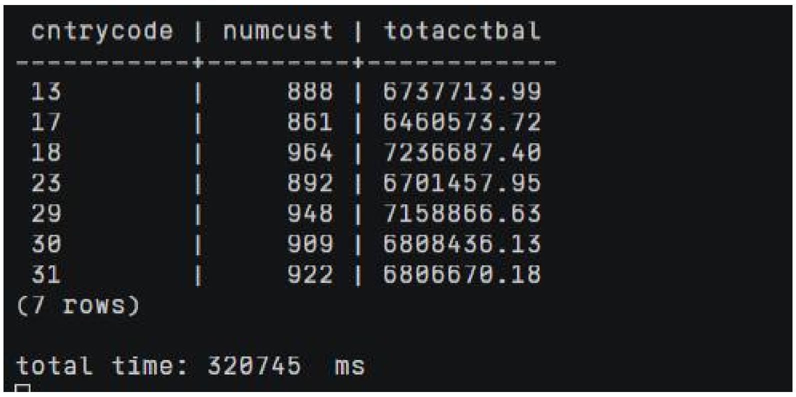


root@121.36.61.177

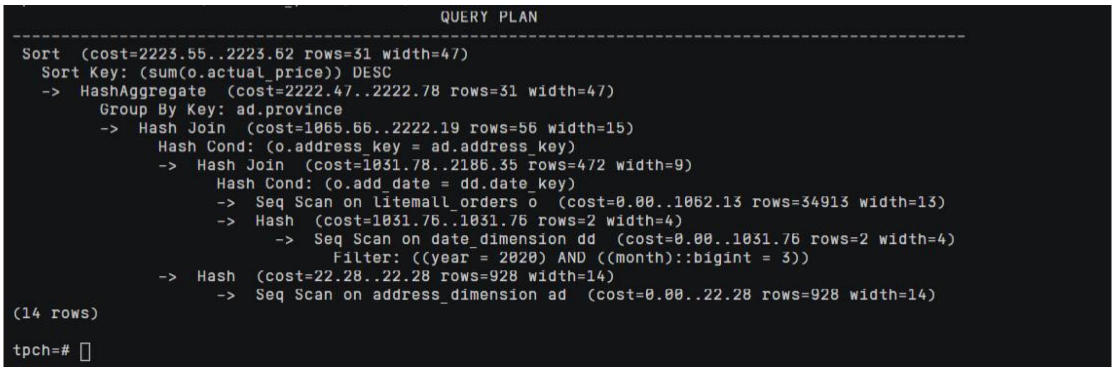
```
(1 row)

tpch=# select * from hypopg_estimate_size(16547);
 hypopg_estimate_size
----------------------
               696320
(1 row)

tpch=# set enable_hypo_index = on;
SET
tpch=# EXPLAIN
tpch-# SELECT ad.province AS province, SUM(o.actual_price) AS GMV
tpch-#  FROM litemall_orders o,
tpch-#  address_dimension ad,
tpch-#  date_dimension dd
tpch-# WHERE o.address_key = ad.address_key
tpch-#  AND o.add_date = dd.date_key
tpch-#  AND dd.year = 2020
tpch-#  AND dd.month = 3
tpch-# GROUP BY ad.province
tpch-# ORDER BY SUM(o.actual_price) DESC;
                                                                QUERY PLAN
-------------------------------------------------------------------------------------------------------------------------------------------
 Sort  (cost=1209.32..1209.40 rows=31 width=47)
   Sort Key: (sum(o.actual_price)) DESC
   ->  HashAggregate  (cost=1208.25..1208.56 rows=31 width=47)
         Group By Key: ad.province
         ->  Hash Join  (cost=51.44..1207.97 rows=56 width=15)
               Hash Cond: (o.address_key = ad.address_key)
               ->  Hash Join  (cost=17.56..1172.13 rows=472 width=9)
                     Hash Cond: (o.add_date = dd.date_key)
                     ->  Seq Scan on litemall_orders o  (cost=0.00..1062.13 rows=34913 width=13)
                     ->  Hash  (cost=17.53..17.53 rows=2 width=4)
                           ->  Index Scan using <16547>btree_date_dimension_year on date_dimension dd  (cost=0.00..17.53 rows=2 width=4)
                                 Index Cond: (year = 2020)
                                 Filter: ((month)::bigint = 3)
               ->  Hash  (cost=22.28..22.28 rows=928 width=14)
                     ->  Seq Scan on address_dimension ad  (cost=0.00..22.28 rows=928 width=14)
(15 rows)

tpch=# 
```

步骤 11 【附加题】有兴趣的同学可以尝试并截图记录于此。

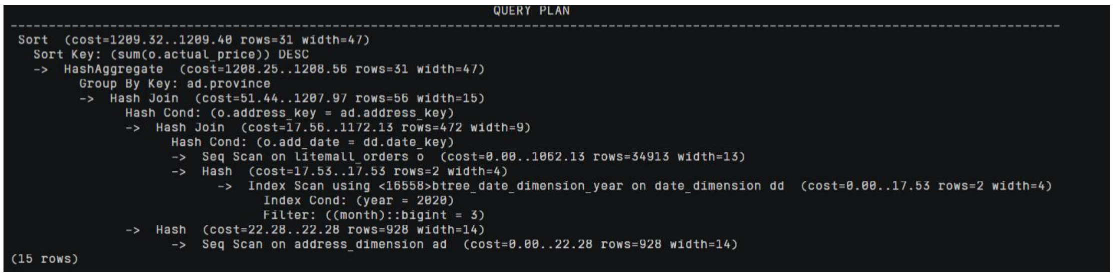
（截图执行语句和结果）



```
 cntrycode | numcust | totacctbal
-----------+---------+------------
 13        |     888 | 6737713.99
 17        |     861 | 6460573.72
 18        |     964 | 7236687.40
 23        |     892 | 6701457.95
 29        |     948 | 7158866.63
 30        |     909 | 6808436.13
 31        |     922 | 6806670.18
(7 rows)

total time: 320745  ms
```



```
                                        QUERY PLAN
-------------------------------------------------------------------------------------------
 Sort  (cost=2223.55..2223.62 rows=31 width=47)
   Sort Key: (sum(o.actual_price)) DESC
   ->  HashAggregate  (cost=2222.47..2222.78 rows=31 width=47)
         Group By Key: ad.province
         ->  Hash Join  (cost=1065.66..2222.19 rows=56 width=15)
               Hash Cond: (o.address_key = ad.address_key)
               ->  Hash Join  (cost=1031.78..2186.35 rows=472 width=9)
                     Hash Cond: (o.add_date = dd.date_key)
                     ->  Seq Scan on litemall_orders o  (cost=0.00..1062.13 rows=34913 width=13)
                     ->  Hash  (cost=1031.76..1031.76 rows=2 width=4)
                           ->  Seq Scan on date_dimension dd  (cost=0.00..1031.76 rows=2 width=4)
                                 Filter: ((year = 2020) AND ((month)::bigint = 3))
               ->  Hash  (cost=22.28..22.28 rows=928 width=14)
                     ->  Seq Scan on address_dimension ad  (cost=0.00..22.28 rows=928 width=14)
(14 rows)

tpch=# 
```



```
                                                                QUERY PLAN
-------------------------------------------------------------------------------------------------------------------------------------------
 Sort  (cost=1209.32..1209.40 rows=31 width=47)
   Sort Key: (sum(o.actual_price)) DESC
   ->  HashAggregate  (cost=1208.25..1208.56 rows=31 width=47)
         Group By Key: ad.province
         ->  Hash Join  (cost=51.44..1207.97 rows=56 width=15)
               Hash Cond: (o.address_key = ad.address_key)
               ->  Hash Join  (cost=17.56..1172.13 rows=472 width=9)
                     Hash Cond: (o.add_date = dd.date_key)
                     ->  Seq Scan on litemall_orders o  (cost=0.00..1062.13 rows=34913 width=13)
                     ->  Hash  (cost=17.53..17.53 rows=2 width=4)
                           ->  Index Scan using <16558>btree_date_dimension_year on date_dimension dd  (cost=0.00..17.53 rows=2 width=4)
                                 Index Cond: (year = 2020)
                                 Filter: ((month)::bigint = 3)
               ->  Hash  (cost=22.28..22.28 rows=928 width=14)
                     ->  Seq Scan on address_dimension ad  (cost=0.00..22.28 rows=928 width=14)
(15 rows)
```

关卡四【附加题】：openGauss 的 DB4AI 特性应用

*本关卡为附加题，有兴趣的同学可以尝试实验并记录于此。

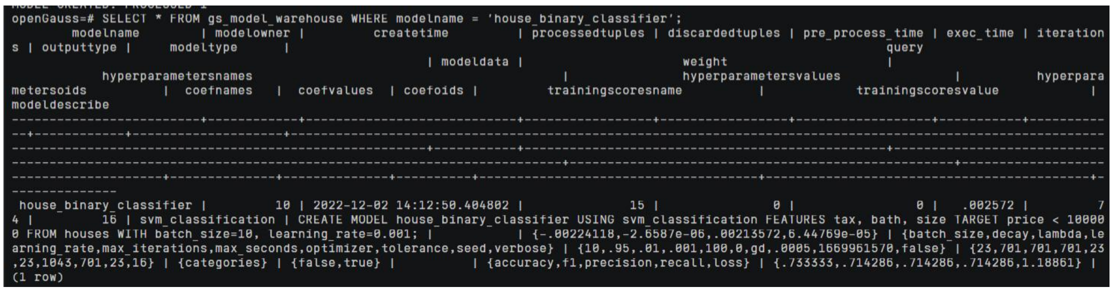
1. 关卡验证

步骤 10 利用训练好的逻辑回归模型预测数据，并与 SVM 算法进行比较，将执行结果截图。

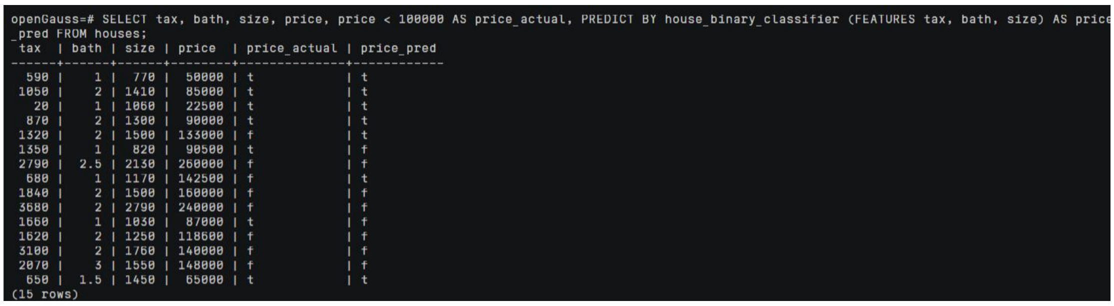
```
openGauss=# SELECT tax, bath, size, price, price < 100000 AS price_actual, PREDICT BY
house_binary_classifier (FEATURES tax, bath, size) AS price_svm_pred, PREDICT BY
house_logistic_classifier (FEATURES tax, bath, size) AS price_logistic_pred FROM houses;
```

（截图执行语句和结果）

Svm 算法:

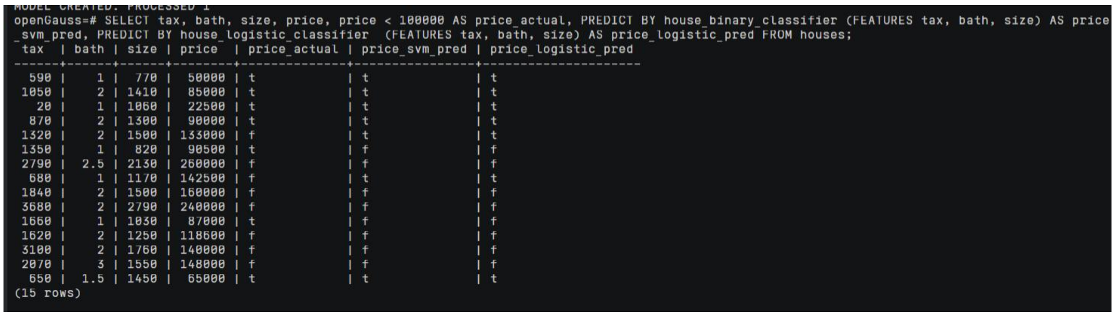


```
openGauss=# SELECT * FROM gs_model_warehouse WHERE modelname = 'house_binary_classifier';
        modelname         | modelowner |         createtime         | processedtuples | discardedtuples | pre_process_time | exec_time | iteration
s | outputtype |      modeltype      |                                                                                                     query
                                           | modeldata |                    weight                    |
         hyperparametersnames                                  |                   hyperparametersvalues                    |             hyperpara
metersoids              |  coefnames   |  coefvalues  | coefoids |          trainingscoresname             |            trainingscoresvalue              |
modeldescribe
-------------------------+------------+----------------------------+-----------------+-----------------+------------------+-----------+---------
--+-------------+--------------------+--------------------------------------------------------------------------------------------------------
--------------------------------------------------------------+-----------+--------------------------------------------------------+---------
--------------------------------------------------------------------+--------------------------------------------------------+-------------------
--------------------+---------------+--------------+-----------+--------------------------------------------------------+-----------------------+-
--------------
 house_binary_classifier |         10 | 2022-12-02 14:12:50.404802 |              15 |               0 |                0 |   .002572 |         7
4 |          16 | svm_classification | CREATE MODEL house_binary_classifier USING svm_classification FEATURES tax, bath, size TARGET price < 10000
0 FROM houses WITH batch_size=10, learning_rate=0.001; |           | {-.00224118,-2.6587e-06,.00213572,6.44769e-05} | {batch_size,decay,lambda,le
arning_rate,max_iterations,max_seconds,optimizer,tolerance,seed,verbose} | {10,.95,.01,.001,100,0,gd,.0005,1669961570,false} | {23,701,701,701,23
,23,1043,701,23,16} | {categories} | {false,true} |          | {accuracy,f1,precision,recall,loss} | {.733333,.714286,.714286,.714286,1.18861} |
(1 row)
```



```
openGauss=# SELECT tax, bath, size, price, price < 100000 AS price_actual, PREDICT BY house_binary_classifier (FEATURES tax, bath, size) AS price
_pred FROM houses;
 tax  | bath | size | price  | price_actual | price_pred
------+------+------+--------+--------------+------------
  590 |    1 |  770 |  50000 | t            | t
 1050 |    2 | 1410 |  85000 | t            | t
   20 |    1 | 1060 |  22500 | t            | t
  870 |    2 | 1300 |  90000 | t            | t
 1320 |    2 | 1500 | 133000 | f            | t
 1350 |    1 |  820 |  90500 | t            | f
 2790 |  2.5 | 2130 | 260000 | f            | f
  680 |    1 | 1170 | 142500 | f            | t
 1840 |    2 | 1500 | 160000 | f            | f
 3680 |    2 | 2790 | 240000 | f            | f
 1660 |    1 | 1030 |  87000 | t            | f
 1620 |    2 | 1250 | 118600 | f            | f
 3100 |    2 | 1760 | 140000 | f            | f
 2070 |    3 | 1550 | 148000 | f            | f
  650 |  1.5 | 1450 |  65000 | t            | t
(15 rows)
```

训练好的逻辑回归模型:



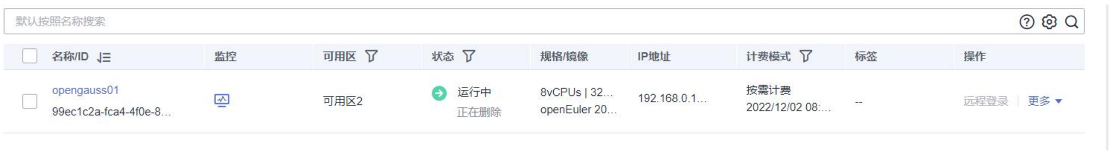
```
openGauss=# SELECT tax, bath, size, price, price < 100000 AS price_actual, PREDICT BY house_binary_classifier (FEATURES tax, bath, size) AS price
_svm_pred, PREDICT BY house_logistic_classifier  (FEATURES tax, bath, size) AS price_logistic_pred FROM houses;
 tax  | bath | size | price  | price_actual | price_svm_pred | price_logistic_pred
------+------+------+--------+--------------+----------------+---------------------
  590 |    1 |  770 |  50000 | t            | t              | t
 1050 |    2 | 1410 |  85000 | t            | t              | t
   20 |    1 | 1060 |  22500 | t            | t              | t
  870 |    2 | 1300 |  90000 | t            | t              | t
 1320 |    2 | 1500 | 133000 | f            | t              | t
 1350 |    1 |  820 |  90500 | t            | f              | f
 2790 |  2.5 | 2130 | 260000 | f            | f              | f
  680 |    1 | 1170 | 142500 | f            | t              | t
 1840 |    2 | 1500 | 160000 | f            | f              | f
 3680 |    2 | 2790 | 240000 | f            | f              | f
 1660 |    1 | 1030 |  87000 | t            | f              | f
 1620 |    2 | 1250 | 118600 | f            | f              | f
 3100 |    2 | 1760 | 140000 | f            | f              | f
 2070 |    3 | 1550 | 148000 | f            | f              | f
  650 |  1.5 | 1450 |  65000 | t            | t              | t
(15 rows)
```

清理工作：资源释放

1. 关卡验证

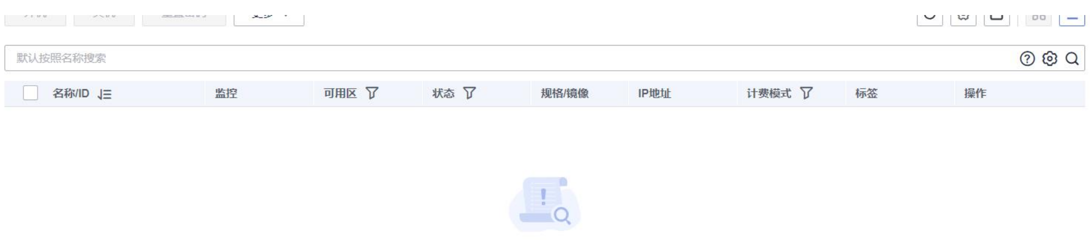
步骤 3 查看到列表中已没有资源时，表示弹性云服务器已删除。

（截图执行语句和结果）



默认按照名称搜索

名称/ID	监控	可用区	状态	规格/镜像	IP地址	计费模式	标签	操作
opengauss01 99ec1c2a-fca4-4f0e-8...		可用区2	运行中 正在删除	8vCPUs | 32... openEuler 20...	192.168.0.1...	按需计费 2022/12/02 08:...	--	远程登录 | 更多



默认按照名称搜索

名称/ID	监控	可用区	状态	规格/镜像	IP地址	计费模式	标签	操作