CSED 516 Homework 1 Oct 13, 2019 Mengying(Monique) Bi

Turing in:

- SQL for the queries
- Runtime for each query
- Number of rows returned
- First two rows from the result set (or all rows if a query returns fewer than 2 rows)
- A brief discussion of the query runtimes that you observed in different settings

1. Setting up Amazon Redshift (0 points)

2. Ingest Data into Amazon Redshift (0 points)

3. Run Queries

Run each query listed below multiple times.
Plot the average and either min/max or standard deviation.
Use the warm cache timing, which means you discard the first time the query is run.
Go to the Query tab on the AWS web console for your redshift cluster to view the runtime of the queries.

Question 1 (1GB 2 Nodes)

-- 1.1
-- What is the total number of parts offered by each supplier?
-- The query should return the name of the supplier and the total number of parts.

```
SELECT s.s_name AS supplier_name, SUM(ps.ps_availqty) AS Total_part_num
FROM supplier AS s, partsupp AS ps
WHERE ps.ps_suppkey = s.s_suppkey
GROUP BY supplier_name;
```

Result:

supplier_name	total_part_num
Supplier#000007502	420818
Supplier#000007509	421890

Number of Rows: 100000

-- 1.2
-- What is the cost of the most expensive part by any supplier?
-- The query should return only the price of that most expensive part. No need to return the name.

```
SELECT MAX(p.p_retailprice) AS max_price
FROM partsupp AS ps, part AS p
WHERE ps.ps_partkey = p.p_partkey;
```

Result:

max_price
2098.99

Number of Rows: 1

```
-- 1.3
-- What is the cost of the most expensive part for each supplier?
-- The query should return the name of the supplier and the cost of the most
-- expensive part but you do not need to return the name of that part.

SELECT s.s_name AS supplier_name, MAX(p.p_retailprice) AS max_price
FROM supplier AS s, partsupp AS ps, part AS p
WHERE ps.ps_suppkey = s.s_suppkey AND ps.ps_partkey = p.p_partkey
GROUP BY supplier_name;
```

Result:

supplier_name	max_price
Supplier#000007502	2076.98
Supplier#000007509	2083.98

Number of Rows: 100000

```
-- 1.4
-- What is the total number of customers per nation?
-- The query should return the name of the nation and the number of unique customers.

SELECT n.n_name AS nation, count(c.c_custkey) AS total_customer_num
FROM customer AS c, nation AS n
WHERE n.n_nationkey = c.c_nationkey
GROUP BY nation;
```

Result:

nation	total_customer_num
MOZAMBIQUE	5974
ROMANIA	6100

Number of Rows: 25

```
-- 1.5
```

-- What is number of parts shipped between 10 oct, 1996 and 10 nov, 1996 for each supplier?
-- The query should return the name of the supplier and the number of parts

```
SELECT s.s_name AS supplier_name, SUM(l.l_quantity) AS num_of_parts
FROM lineitem AS l, supplier AS s
WHERE l.l_suppkey= s.s_suppkey AND (l.l_shipdate >= '1996-10-10 00:00:00'
AND l.l_shipdate <  '1996-11-11 00:00:00')
GROUP BY supplier_name;
```

Result:

supplier_name	num_of_parts
Supplier#000006515	256
Supplier#000002290	229

Number of Rows: 99966

Question 2 (10GB 2 Nodes)

Change database to 10GB and then run the same queries as in Question 1.

```
DELETE FROM customer;
DELETE FROM lineitem;
DELETE FROM nation;
DELETE FROM orders;
DELETE FROM part;
DELETE FROM partsupp;
DELETE FROM region;
DELETE FROM supplier;
```

```
copy customer from 's3://uwdb/tpch/uniform/10GB/customer.tbl' REGION 'us-west-
2'CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy orders from 's3://uwdb/tpch/uniform/10GB/orders.tbl' REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
```

```
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.1'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.2'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.3'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.4'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.5'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
```

copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.6'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.7'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.8'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.9'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy lineitem from 's3://uwdb/tpch/uniform/10GB-split/lineitem.tbl.10'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';

copy nation from 's3://uwdb/tpch/uniform/10GB/nation.tbl'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy part from 's3://uwdb/tpch/uniform/10GB/part.tbl'REGION 'us-west-2' CREDENTIALS
'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy partsupp from 's3://uwdb/tpch/uniform/10GB/partsupp.tbl'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy region from 's3://uwdb/tpch/uniform/10GB/region.tbl'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';
copy supplier from 's3://uwdb/tpch/uniform/10GB/supplier.tbl'REGION 'us-west-2'
CREDENTIALS 'aws_iam_role=arn:aws:iam::295193264972:role/RedshiftRole' delimiter '|';

Query 1:
Result:

supplier_name	total_part_num
Supplier#000050002	410759
Supplier#000050005	390050

Number of Rows: 100000

Query 2:
Result:

max_price
2098.99

Number of Rows: 1

Query 3:
Result:

supplier_name	max_price
Supplier#000075003	2098.99
Supplier#000075007	2096.98

Number of Rows: 100000

Query 4:
Result:

nation	total_customer_num
MOZAMBIQUE	59796
ROMANIA	60048

Number of Rows: 25

Query 5:
Result:

supplier_name	num_of_parts
Supplier#000000008	70
Supplier#000000012	42

Number of Rows: 99964

Question 3 (10GB 4 Nodes)

Resize the cluster to 4 nodes and then run the same queries as in Question 1.

Query 1:
Result:

supplier_name	total_part_num
Supplier#000025010	400897
Supplier#000025011	413553

Number of Rows: 100000

Query 2:
Result:

max_price
2098.99

Number of Rows: 1

Query 3:
Result:

supplier_name	max_price
Supplier#000075004	2093.98
Supplier#000075013	2096.97

Number of Rows: 100000

Query 4:
Result:

nation	total_customer_num
IRAN	60101
RUSSIA	60065

Number of Rows: 25

Query 5:
Result:

supplier_name	num_of_parts
Supplier#000000013	150
Supplier#000000105	305

Number of Rows: 99964

Question 4 (1GB 2 Nodes)

-- A customer is considered a Gold customer if they have orders totalling more than $1,000,000.00.
-- Customers with orders totalling between $1,000,000.00 and $500,000.00 are considered Silver.
-- Write a SQL query to compute the number of customers in these two categories.
-- Try different methods of writing the query (only SQL or use a UDF or a View to categorize a user).
-- Discuss your experience with the various methods to carry out such analysis.
-- Use the 1GB data set and the 2-node cluster. (10 points)

-- SQL Only Method

```
SELECT Category, COUNT(customer) as num_of_customer
FROM (
  SELECT CASE WHEN SUM( o_totalprice )> 1000000.00 THEN 'gold_member'
    WHEN SUM(o_totalprice ) <= 1000000.00 AND SUM(o_totalprice ) > 500000.00 THEN
'silver_member'
    ELSE NULL
   END AS Category, c_custkey AS customer
   FROM orders, customer
   WHERE o_custkey = c_custkey
   GROUP BY customer)
WHERE Category is not NULL
GROUP BY Category;
```

Result:

category	num_of_customer
silver_member	8054
gold_member	91037

Number of Rows: 2

-- Create a view method

```
DROP VIEW membership;
CREATE VIEW membership AS
  SELECT c_custkey AS customer,
  CASE WHEN SUM(o_totalprice) > 1000000.00 THEN 'gold_member'
  WHEN SUM(o_totalprice) > 500000.00 AND SUM(o_totalprice) < 1000000.00 THEN
'silver_member'
  ELSE NULL
  END AS Category
FROM customer, orders
WHERE o_custkey = c_custkey
GROUP BY c_custkey;

SELECT Category, COUNT(customer) AS number_of_customer
FROM membership
WHERE Category is not NULL
GROUP BY Category;
```

Result:

category	number_of_customer
silver_member	8054
gold_member	91037

Number of Rows: 2

-- UDF method

```
CREATE FUNCTION membership(float)
  returns VARCHAR
stable
AS $$
  SELECT CASE WHEN $1 > 1000000.00 THEN 'gold_member'
    WHEN $1 > 500000.00 AND $1 <= 1000000.00 THEN 'silver_member'
    ELSE NULL
    END
$$ language sql;

SELECT Category, COUNT(customer) AS num_of_customer
FROM (SELECT membership(SUM(o_totalprice)) AS Category, c_custkey AS customer
   FROM orders, customer
```

```
   WHERE o_custkey = c_custkey
   GROUP BY customer)
WHERE Category IS NOT NULL
GROUP BY Category;
```

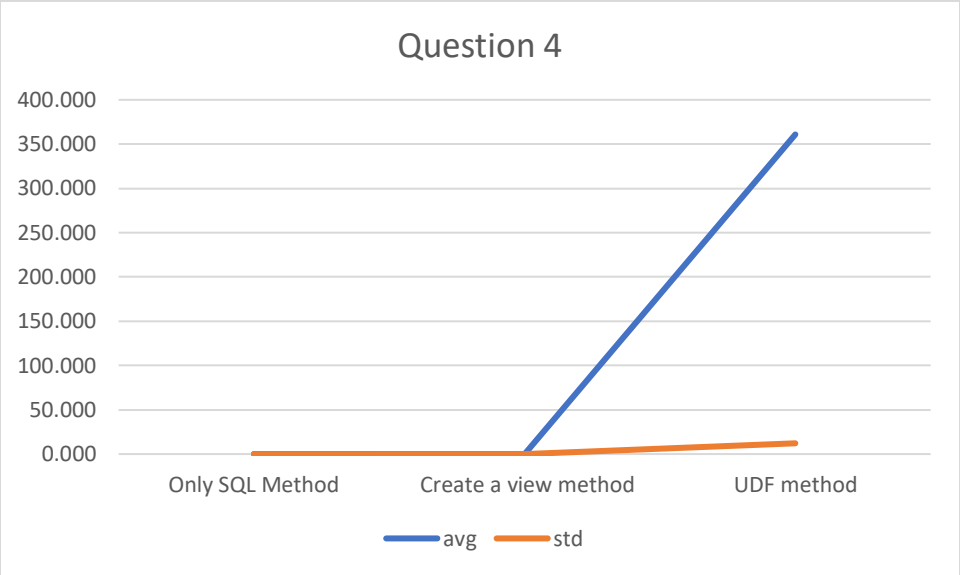
Result:

category	num_of_customer
silver_member	8054
gold_member	91037

Number of Rows: 2

Runtime:

Q4 (in ms)	1	2	3	4	5	6	avg	std
Only SQL Method	0.044	0.046	0.043	0.042	0.037	0.04	0.042	0.003
Create a view method	0.035	0.036	0.041	0.033	0.032	0.034	0.035	0.003
UDF method	344.214	361.985	372.957	357.799	352.456	376.15	360.927	12.153



Discussion:

Using “create a view method” is the method with the shortest runtime, followed by using SQL only method. The runtime doesn’t differ much from each other. However, the User Defined Function method takes way longer, almost 10**4 times of the other two. On the other hand, the code structures of the “view method” and “UDF method” are clearer than using “SQL only” method. Considering the two factors, I would choose to use the “view method” prior to trying other methods.

Question 5 (10GB 2 Nodes External)

Connect to external database, and then run queries as in Question 1 (needs to add permission 'Glue' to IAM role).

```
create external schema tpchs3
from data catalog
database 'tpchs3'
iam_role 'arn:aws:iam::295193264972:role/RedshiftRole'
create external database if not exists;

create external table tpchs3.customer(
C_CustKey int ,
C_Name varchar(64) ,
C_Address varchar(64) ,
C_NationKey int ,
C_Phone varchar(64) ,
C_AcctBal decimal(13, 2) ,
C_MktSegment varchar(64) ,
C_Comment varchar(120) ,
skip varchar(64))
row format delimited
fields terminated by '|'
stored as textfile
location 's3://uwdb/tpch/athena/customer/'
table properties ('numRows'='1500000');

create external table tpchs3.lineitem(
  L_OrderKey int ,
  L_PartKey int ,
  L_SuppKey int ,
  L_LineNumber int ,
  L_Quantity int ,
  L_ExtendedPrice decimal(13, 2) ,
  L_Discount decimal(13, 2) ,
  L_Tax decimal(13, 2) ,
  L_ReturnFlag varchar(64) ,
  L_LineStatus varchar(64) ,
  L_ShipDate datetime ,
  L_CommitDate datetime ,
  L_ReceiptDate datetime ,
  L_ShipInstruct varchar(64) ,
  L_ShipMode varchar(64) ,
  L_Comment varchar(64) ,
  skip varchar(64))
  row format delimited
```

```
  fields terminated by '|'
  stored as textfile
  location 's3://uwdb/tpch/athena/lineitem/'
  table properties ('numRows'='65984650');

create external table tpchs3.nation(
  N_NationKey int ,
  N_Name varchar(64) ,
  N_RegionKey int ,
  N_Comment varchar(160) ,
  skip varchar(64))
  row format delimited
  fields terminated by '|'
  stored as textfile
  location 's3://uwdb/tpch/athena/nation/'
  table properties ('numRows'='25');

create external table tpchs3.orders(
  O_OrderKey int ,
  O_CustKey int ,
  O_OrderStatus varchar(64) ,
  O_TotalPrice decimal(13, 2) ,
  O_OrderDate datetime ,
  O_OrderPriority varchar(15) ,
  O_Clerk varchar(64) ,
  O_ShipPriority int ,
  O_Comment varchar(80) ,
  skip varchar(64))
  row format delimited
  fields terminated by '|'
  stored as textfile
  location 's3://uwdb/tpch/athena/orders/'
  table properties ('numRows'='15000000');

create external table tpchs3.part(
  P_PartKey int ,
  P_Name varchar(64) ,
  P_Mfgr varchar(64) ,
  P_Brand varchar(64) ,
  P_Type varchar(64) ,
  P_Size int ,
  P_Container varchar(64) ,
  P_RetailPrice decimal(13, 2) ,
  P_Comment varchar(64) ,
  skip varchar(64))
  row format delimited
```

```
  fields terminated by '|'
  stored as textfile
  location 's3://uwdb/tpch/athena/part/'
  table properties ('numRows'='2000000');

create external table tpchs3.partsupp(
  PS_PartKey int ,
  PS_SuppKey int ,
  PS_AvailQty int ,
  PS_SupplyCost decimal(13, 2) ,
  PS_Comment varchar(200) ,
  skip varchar(64))
  row format delimited
  fields terminated by '|'
  stored as textfile
  location 's3://uwdb/tpch/athena/partsupp/'
  table properties ('numRows'='8000000');

create external table tpchs3.region(
  R_RegionKey int ,
  R_Name varchar(64) ,
  R_Comment varchar(160) ,
  skip varchar(64))
  row format delimited
  fields terminated by '|'
  stored as textfile
  location 's3://uwdb/tpch/athena/region/'
  table properties ('numRows'='5');

create external table tpchs3.supplier(
  S_SuppKey int ,
  S_Name varchar(64) ,
  S_Address varchar(64) ,
  S_NationKey int ,
  S_Phone varchar(18) ,
  S_AcctBal decimal(13, 2) ,
  S_Comment varchar(105) ,
  skip varchar(64))
  row format delimited
  fields terminated by '|'
  stored as textfile
  location 's3://uwdb/tpch/athena/supplier/'
  table properties ('numRows'='100000');
```

Query 1:

Result:

supplier_name	total_part_num
Supplier#000060929	378426
Supplier#000085933	421681

Number of Rows: 100000

Query 2:
Result:

max_price
2098.99

Number of Rows: 1

Query 3:
Result:

supplier_name	max_price
Supplier#000037469	1553.46
Supplier#000062470	1553.46

Number of Rows: 100000

Query 4:
Result:

nation	total_customer_num
PERU	59788
CANADA	59849

Number of Rows: 25

Query 5:
Result:

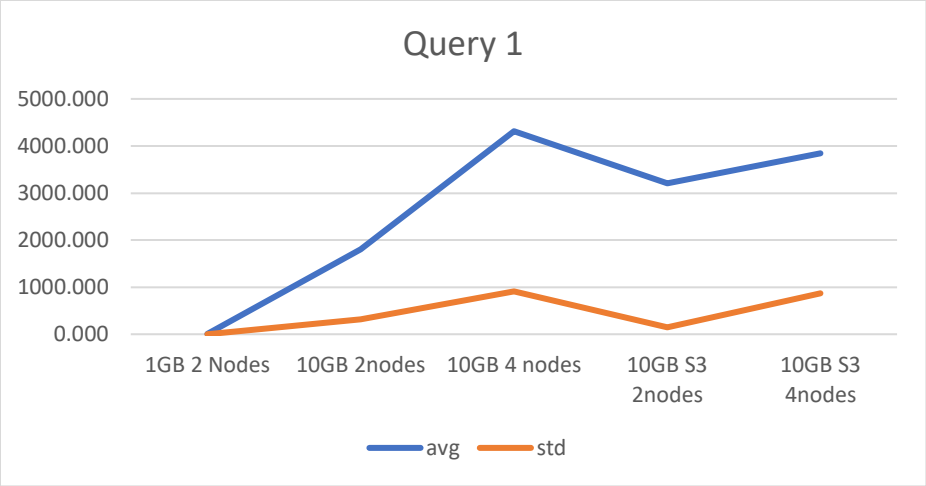
supplier_name	num_of_parts
Supplier#000065196	193
Supplier#000075232	230

Number of Rows: 99964

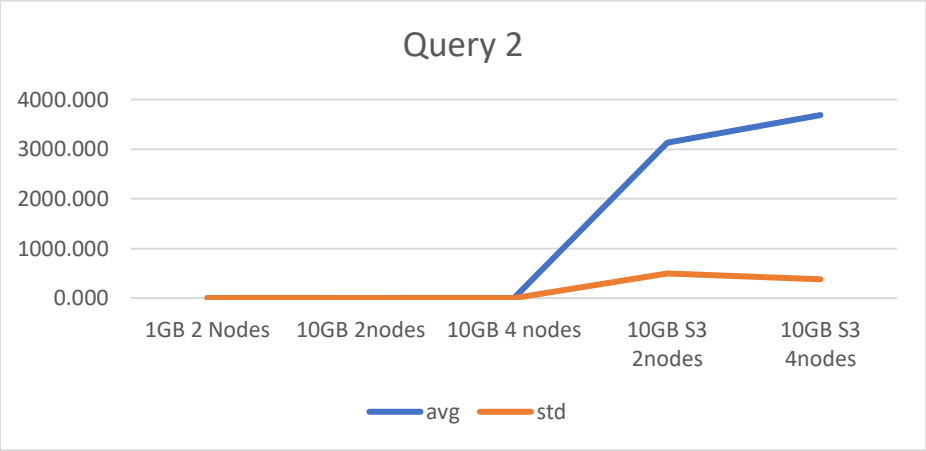
Discussion:

Runtime charts & plots:

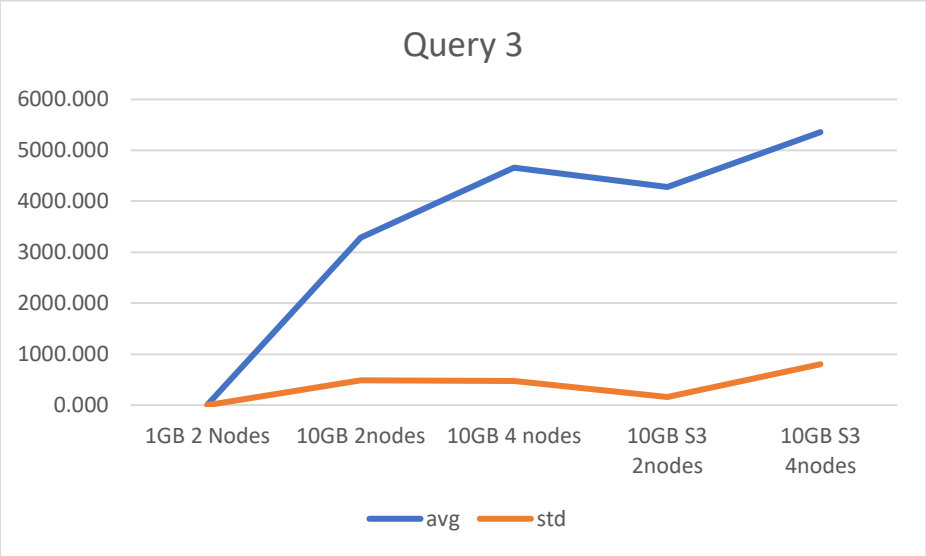
Query 1 (in ms)	1	2	3	4	5	6	avg	std
1GB 2 Nodes	7.111	7.195	7.131	7.073	7.099	6.99	7.100	0.068
10GB 2nodes	1962	1804	1353	2154	2025	1506	1800.667	312.552
10GB 4 nodes	4677	4782	4384	5364	2715	3958	4313.333	910.135
10GB S3 2nodes	3415	3151	3030	3340	3102	3168	3201.000	146.798
10GB S3 4nodes	3556	3149	3435	3263	4272	5426	3850.167	866.775



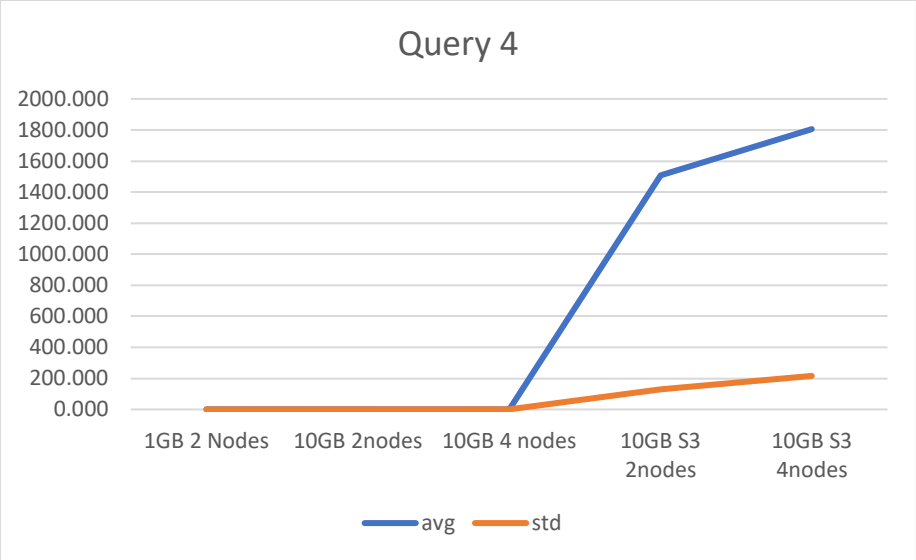
Query 2 (in ms)	1	2	3	4	5	6	avg	std
1GB 2 Nodes	0.031	0.03	0.031	0.032	0.032	0.03	0.031	0.001
10GB 2nodes	0.034	0.034	0.029	0.058	0.032	0.029	0.036	0.011
10GB 4 nodes	0.027	0.024	0.026	0.028	0.026	0.026	0.026	0.001
10GB S3 2nodes	2919	2843	2859	4132	2967	3103	3137.167	496.251
10GB S3 4nodes	3926	3107	3803	3392	4123	3770	3686.833	371.749



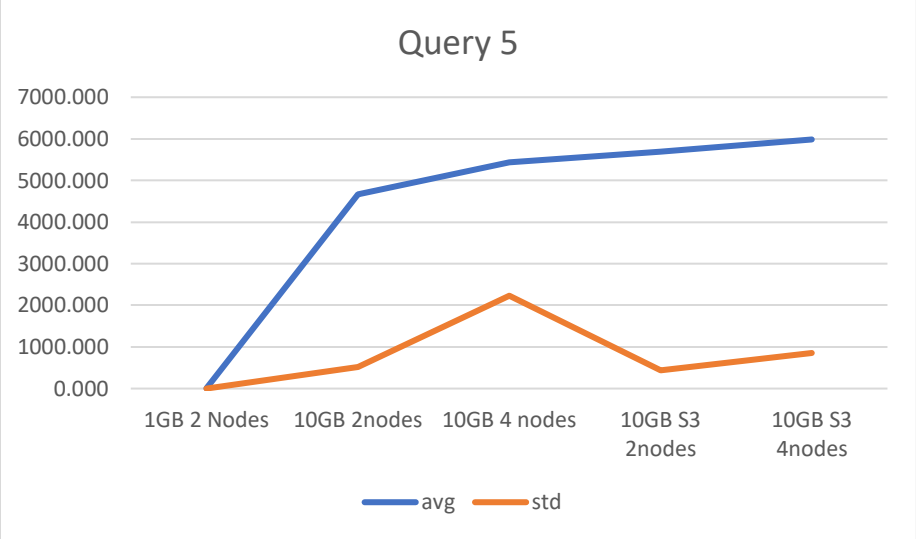
Query 3 (in ms)	1	2	3	4	5	6	avg	std
1GB 2 Nodes	6.316	6.371	6.424	6.411	6.403	6.389	6.386	0.039
10GB 2nodes	3728	3460	2826	3552	3592	2524	3280.333	486.227
10GB 4 nodes	5525	4681	4155	4649	4612	4347	4661.500	469.909
10GB S3 2nodes	4447	4133	4038	4378	4273	4400	4278.167	162.539
10GB S3 4nodes	5025	4411	5655	6686	4798	5565	5356.667	801.989



Query 4 (in ms)	1	2	3	4	5	6	avg	std
1GB 2 Nodes	0.045	0.047	0.046	0.046	0.047	0.045	0.046	0.001
10GB 2nodes	0.047	0.044	0.046	0.047	0.051	0.046	0.047	0.002
10GB 4 nodes	0.042	0.042	0.054	0.044	0.041	0.042	0.044	0.005
10GB S3 2nodes	1376	1595	1417	1698	1551	1398	1505.833	129.070
10GB S3 4nodes	1703	2030	2091	1519	1766	1722	1805.167	215.885



Query 5 (in ms)	1	2	3	4	5	6	avg	std
1GB 2 Nodes	7.164	7.033	6.968	7.021	6.998	7.008	7.032	0.068
10GB 2nodes	4472	5193	4447	5273	4726	3881	4665.333	519.923
10GB 4 nodes	4604	4895	3700	4785	9903	4721	5434.667	2231.040
10GB S3 2nodes	6066	5331	6414	5437	5528	5382	5693.000	442.605
10GB S3 4nodes	7406	5694	6590	5184	5238	5799	5985.167	860.715



Discussion:

By observing the runtime table and plots, we observe there are huge increase for some of the queries when we 1) increase the size of the database, 2) create and connect to external tables.

For query 2 and 4, runtime doesn't change a lot when switching the database from 1GB to 10 GB, or change from 2 nodes to 4 nodes. Primary reasons should be 1) they only have one join, 2) no complicated computation like sum, and 3) results have much less rows comparing to others.

For changing the cluster size from 2 nodes to 4 nodes, I was expecting to see a decrease in runtime, however in some of the cases, it has an increase instead. It's probably because that the process of distributing data to different nodes is taking more time than increasing efficiency.

When switching local database to external, I experienced a huge jump in runtime. It's most likely caused by the communication time fetching data externally.

Another observation is that runtime in the evening is sometimes shorter than during daytime. It is possible that cluster runs faster when it has larger capacity.