PostgreSQL Snapper Lab

The PostgreSQL Snapper tool enables periodic collection (snapping) of PostgreSQL performance related statistics and metrics. The config file used by the tool can be customized to add and remove database dictionary views and queries to be snapped as required. Snapper collects and stores the PostgreSQL database metrics in separate OS level files to have minimal impact on the database. These files can be loaded into another PostgreSQL instance by the loader script for doing analysis.

Snapper tool can be installed following the **Quick Start** instructions documented in Snapper Github. For the purpose of **"Aurora PostgreSQL Performance Package"** workshop, the Snapper CloudFormation stack is already setup in your AWS Account.

! Note: To allow Snapper to collect PostgreSQL statistics while a load test is running or database is doing some activity, you need to run this lab **in conjunction** with Lab6:RDS Performance Insights in which you will generate database load using pgbech. The "**Setup and Configuration**" section below should be completed before you start Lab6:RDS Performance Insights to schedule Snapper to run every 1 minute and capture workload statistics. Then head to Lab6:RDS Performance Insights and complete it. After Lab6:RDS Performance Insights is complete, you can come back to this lab to finish rest of the steps.

The lab contains the following tasks and it should take ~**30 minutes** to complete excluding the time needed to complete Lab6:RDS Performance Insights.

1. **Setup and Configuration:** Schedule Snapper to run every 1 minute using an EC2 instance.
2. **Generate Load on the PostgreSQL database:** Head to Lab6:RDS Performance Insights and complete it to generate load on Aurora PostgreSQL using pgbench.
3. **Package Snapper output:** Once the load test is over, package the Snapper output so that it can be loaded to another PostgreSQL database.
4. **Import Snapper output:** Import Snapper output to another PostgreSQL database. For the purpose of this lab, we will use the same Aurora PostgreSQL cluster from which we captured the statistics.
5. **Analyze performance metrics of the PostgreSQL database:** Snapper comes with a set of sample queries for analysis. You will use some of those queries to do analysis and derive insights like top tables and indexes by size, top SQLs by elapsed time, top tables by sequential scans, Foreign Keys with no indexes and Table bloat analysis.

Setup and Configuration

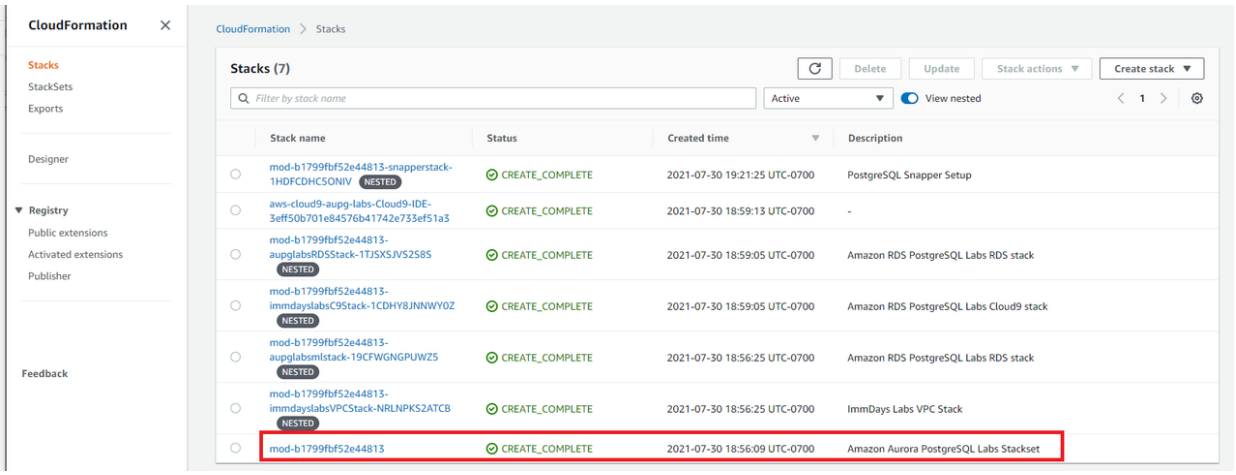
In this step, you will complete the pre-requisites for Snapper and schedule it using an EC2 instance to run every 1 minute.

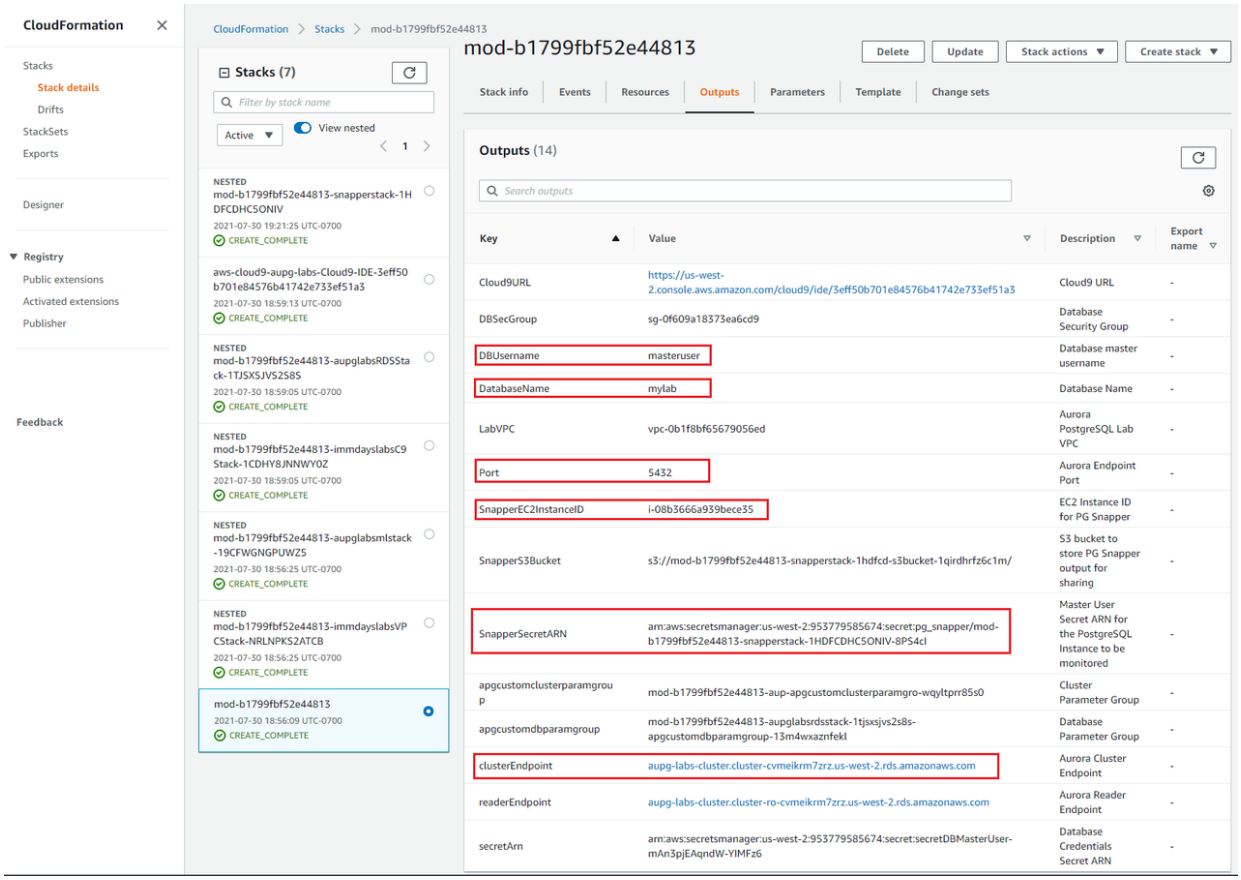
1. Make sure the pre-requisites https://aurora-pg-lab.workshop.aws/lab1.5-client.html are complete before proceeding.
2. Open a Cloud9 terminal window and run the following commands to install **pg_stat_statements** and **aurora_stat_utils** extensions. pg_stat_statements module provides a means for tracking execution statistics of all SQL statements executed by a server. aurora_stat_utils extension provides aurora wait and log related statistics.

```
psql
create extension IF NOT EXISTS pg_stat_statements;
create extension IF NOT EXISTS aurora_stat_utils;
\dx
```

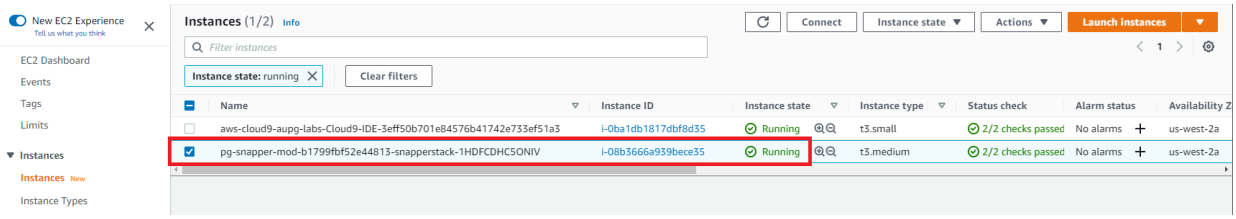
3. In the CloudFormation console, select the CloudFormation stack with description “Amazon Aurora PostgreSQL Labs Stackset” and go to the Output tab. Take a note of the value for the following CloudFormation Output Keys. You will need them during the later steps.

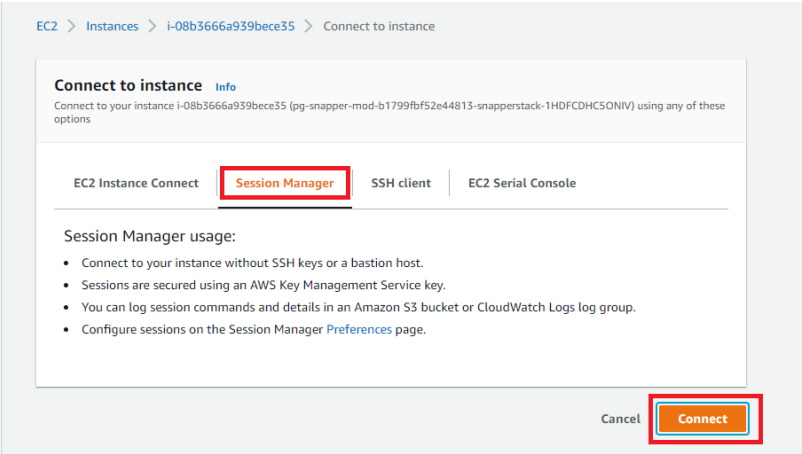
SnapperEC2InstanceID - This is the EC2 instance ID where snapper was setup.
clusterEndpoint - Aurora PostgreSQL cluster endpoint
Port - Aurora PostgreSQL cluster port
DatabaseName - Aurora PostgreSQL database name
DBUsername - Aurora PostgreSQL master user name
SnapperSecretARN - AWS Secrets Manager secret ARN storing Aurora PostgreSQL master user password





4. In the EC2 Dashboard select the Snapper EC2 instance and click Connect. Select **Session Manager** tab and click **Connect** again.





5. Session Manager uses **ssm-user** user to connect to the EC2 instance by default. Change user to **ec2-user** by running the following command:

```
sudo su -l ec2-user
```

6. Review the Snapper script usage by running the following command.

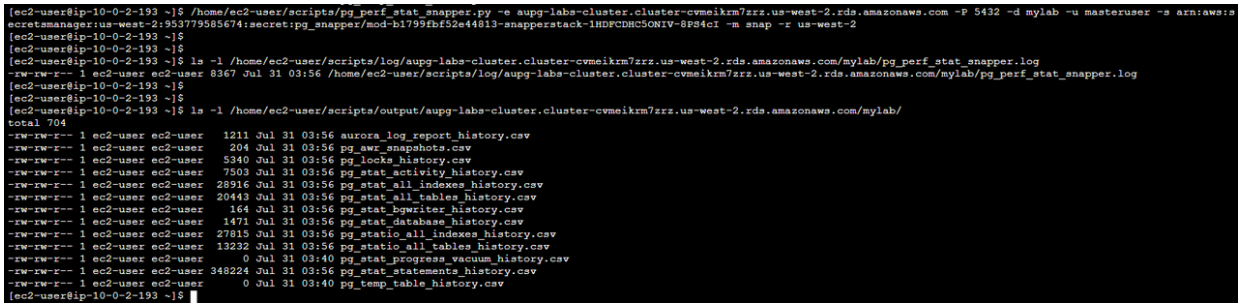
```
[ec2-user@ip-172-31-14-11 ~]$ /home/ec2-user/scripts/pg_perf_stat_snapper.py -h

usage: pg_perf_stat_snapper.py [-h] -e ENDPOINT -P PORT -d DBNAME -u USER -s
                               SECRETARN -m MODE [-o OUTPUTDIR] -r REGION

Snap PostgreSQL performance statistics and exit

optional arguments:
  -h, --help            show this help message and exit
  -e ENDPOINT, --endpoint ENDPOINT
                        PostgreSQL Instance Endpoint (default: None)
  -P PORT, --port PORT  Port (default: None)
  -d DBNAME, --dbname DBNAME
                        Database Name where Application objects are stored
                        (default: None)
  -u USER, --user USER  Database UserName (default: None)
  -s SECRETARN, --SecretARN SECRETARN
                        AWS Secrets Manager stored Secret ARN (default: None)
  -m MODE, --mode MODE  Mode in which the script will run: Specify either snap
                        or package (default: None)
  -o OUTPUTDIR, --outputdir OUTPUTDIR
                        Output Directory (default:
                        /home/ec2-user/scripts/output)
  -r REGION, --region REGION
                        AWS region (default: None)
```

7. Run the Snapper script manually once using the following command and review the log file generated under **/home/ec2-user/scripts/log/** sub-directory. By default, all the output will be stored under **/home/ec2-user/scripts/output/** sub-directory.

> */home/ec2-user/scripts/pg_perf_stat_snapper.py -e <PostgreSQL Instance EndPoint. Cloudformation Output Key: clusterEndpoint> -P <Database Port. Cloudformation Output Key: Port> -d <Database Name where Application objects are stored. Cloudformation Output key: DatabaseName> -u <Master UserName. Cloudformation Output Key: DBUsername> -s <AWS Secretes Manager ARN. Cloudformation Output Key: SnapperSecretARN> -m snap -r <AWS Region for e.g. us-west-2>*

e.g.

> */home/ec2-user/scripts/pg_perf_stat_snapper.py -e aupg-labs-cluster.cluster-cvmeikrm7zrz.us-west-2.rds.amazonaws.com -P 5432 -d mylab -u masteruser -s arn:aws:secretsmanager:us-west-2:953779585674:secret:pg_snapper/mod-b1799fbf52e44813-snapperstack-1HDFCDHC5ONIV-8PS4cI -m snap -r us-west-2*



8. Schedule the Snapper script in crontab to run every 1 minute using crontab.

```
crontab -e
```

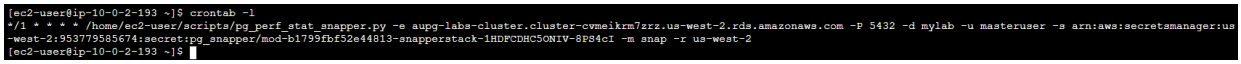
Press **i** to enter insert mode and Paste the following in the editor.

> */1 * * * * /home/ec2-user/scripts/pg_perf_stat_snapper.py -e <PostgreSQL Instance EndPoint. Cloudformation Output Key: clusterEndpoint> -P <Database Port. Cloudformation Output Key: Port> -d <Database Name where Application objects are stored. Cloudformation Output key: DatabaseName> -u <Master UserName. Cloudformation Output Key:DBUsername> -s <AWS Secretes Manager ARN. Cloudformation Output Key: SnapperSecretARN> -m snap -r <AWS Region for e.g. us-west-2>*

Enter **:wq!** to save and exit the editor.

Verify that crontab was successfully installed by running the following command.

```
crontab -l
```



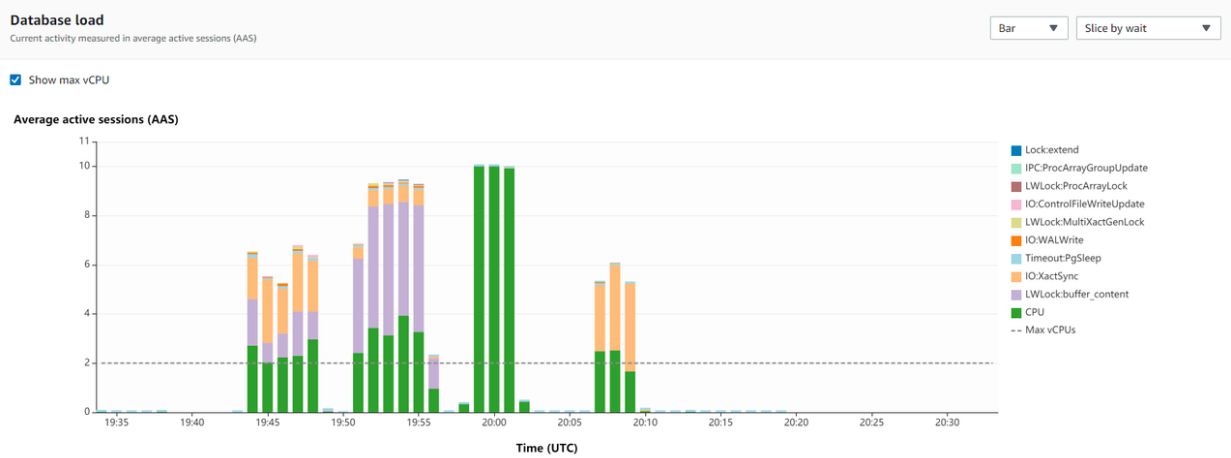
Generate Load on the PostgreSQL database

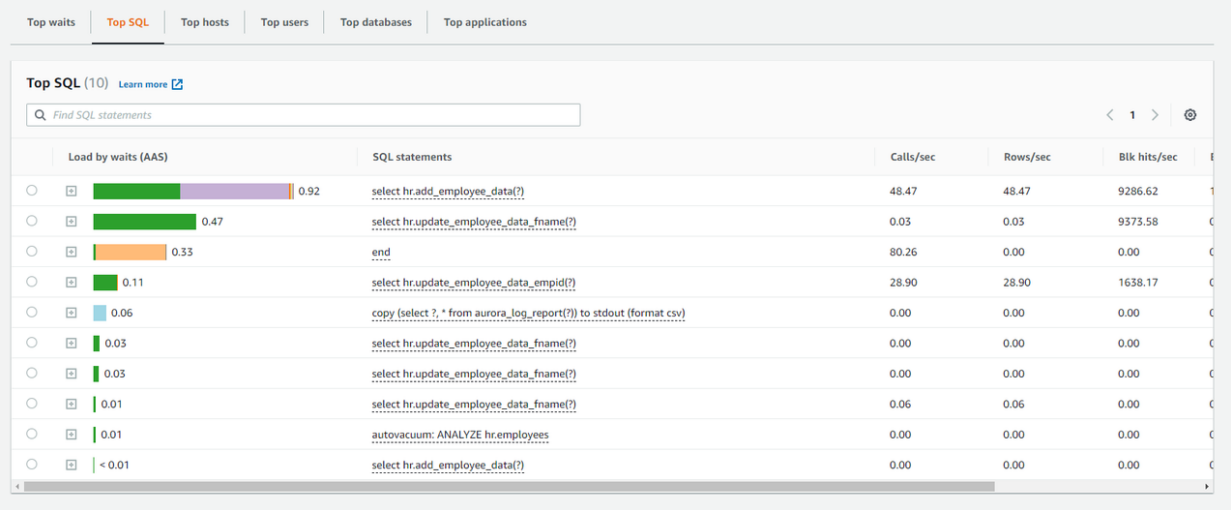
Proceed to Lab6:RDS Performance Insights now and complete it to generate load on the database. Once you are done with that lab, come back to this lab to finish rest of the steps.

Package the Snapper output

In this step, you will package the Snapper output so that it can be loaded to another PostgreSQL database.

By completing Lab6:RDS Performance Insights, you generated some load on the Aurora PostgreSQL database as shown by RDS Performance Insights dashboard below.





Since Snapper was scheduled using crontab, it has been collecting PostgreSQL statistics every 1 minute. Go ahead and comment out the Snapper job in crontab since we have already collected all the required PostgreSQL performance statistics for analysis. We will package the output next so that we can load it into a PostgreSQL database for processing.

1. If your EC2 session was lost, reconnect using Session Manager and change user to **ec2-user** by running the following command:

```
sudo su -l ec2-user
```

2. Edit the crontab and comment out the Snapper job

```
crontab -e
```

Press **i** to enter insert mode. Enter # to comment out the entry as follows:

> *#*/1 * * * * /home/ec2-user/scripts/pg_perf_stat_snapper.py -e <PostgreSQL Instance EndPoint. Cloudformation Output Key: clusterEndpoint> -P <Database Port. Cloudformation Output Key: Port> -d <Database Name where Application objects are stored. Cloudformation Output key: DatabaseName> -u <Master UserName. Cloudformation Output*

> *Key:DBUsername> -s <AWS Secretes Manager ARN. Cloudformation Output Key: SnapperSecretARN> -m snap -r <AWS Region for e.g. us-west-2>*

Enter **:wq!** to save and exit the editor.

Verify that crontab was successfully installed by running the following command.

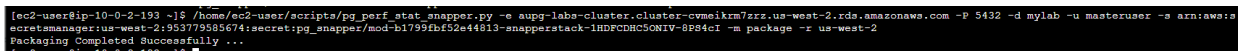
```
crontab -l
```

3. Package the snapper output by running the following command:

> */home/ec2-user/scripts/pg_perf_stat_snapper.py -e <PostgreSQL Instance EndPoint. Cloudformation Output Key: clusterEndpoint> -P <Database Port. Cloudformation Output Key: Port> -d <Database Name where Application objects are stored. Cloudformation Output key: DatabaseName> -u <Master UserName. Cloudformation Output Key:DBUsername> -s <AWS Secretes Manager ARN. Cloudformation Output Key: SnapperSecretARN> -m package -r <AWS Region for e.g. us-west-2>*

for e.g.

> */home/ec2-user/scripts/pg_perf_stat_snapper.py -e aupg-labs-cluster.cluster-cvmeikrm7zrz.us-west-2.rds.amazonaws.com -P 5432 -d mylab -u masteruser -s arn:aws:secretsmanager:us-west-2:953779585674:secret:pg_snapper/mod-b1799fbf52e44813-snapperstack-1HDFCDHC5ONIV-8PS4cI -m package -r us-west-2*



Import Snapper output

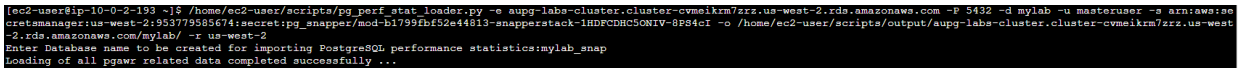
Snapper output can be loaded to any PostgreSQL database for analysis. For this lab, we will import the output to the same Aurora PostgreSQL database from which we collected the statistics. Import the output by running the following:

> */home/ec2-user/scripts/pg_perf_stat_loader.py -e <PostgreSQL Instance EndPoint. Cloudformation Output Key: clusterEndpoint> -P <Database Port. Cloudformation Output Key: Port> -d <Database Name where Application objects are stored. Cloudformation Output key: DatabaseName> -u <Master UserName. Cloudformation Output Key:DBUsername> -s <AWS Secretes Manager ARN. Cloudformation Output Key: SnapperSecretARN> -o <snapper output directory containing the generated output files> -r <AWS Region for e.g. us-west-2>*

for e.g.

> */home/ec2-user/scripts/pg_perf_stat_loader.py -e aupg-labs-cluster.cluster-cvmeikrm7zrz.us-west-2.rds.amazonaws.com -P 5432 -d mylab -u masteruser -s arn:aws:secretsmanager:us-west-2:953779585674:secret:pg_snapper/mod-b1799fbf52e44813-snapperstack-1HDFCDHC5ONIV-8PS4cI -o /home/ec2-user/scripts/output/aupg-labs-cluster.cluster-cvmeikrm7zrz.us-west-2.rds.amazonaws.com/mylab/ -r us-west-2*

When prompted by the script, enter a database name e.g. mylab_snap which Snapper will create and then load all the statistics into it.



Analyze performance metrics of the PostgreSQL database

Now that we have loaded all the Snapper collected statistics, lets analyze the data with sample SQL scripts provided with Snapper and see what insights we can derive.

The analysis can be done from any machine where **psql** is installed and has connectivity to the database where the snapper output was loaded. For this lab, we will use Cloud9, since it was setup with PostgreSQL client software.

1. Open a terminal window in AWS cloud9 and run the following commands to download the sample SQLs provided by Snapper.

```
mkdir -p /home/ec2-user/Snapper
cd /home/ec2-user/Snapper/
svn checkout "https://github.com/aws-samples/aurora-and-database-migration-labs/trunk/
cd SQLs
ls -l
```

2. Connect to the PostgreSQL database where we loaded the snapper output for e.g. mylab_snap.

```
psql
\c <database name where snapper output was loaded e.g. mylab_snap>
```

3. Run the Snapper menu showing list of available SQLs for analsysis.

```
\i snappermenu.sql
```

```
mylab_snap=> \i snappermenu.sql
Pager usage is off.
Default footer is off.


==SNAPSHOT DETAILS==

list_snaps.sql                                  List snapshots available with time window


==SET SNAPSHOT WINDOW==

set_snaps.sql                                   Set Begin and End Snapshot ID for Analysis


==INSTANCE AND DATABASE STATS==

db_and_schema_sizes.sql                         Database and Schema Sizes
tables_and_indexes_tot_size.sql                 Top 20 Tables and Indexes by total Size
cache_hit_ratio.sql                             Cache hit ratio in a time window
db_stats.sql                                    Database Level statistics in a time window
checkpoint_stats_by_snap_id.sql                 Checkpoints stats in a time window
temp_file_by_snap_id.sql                        Temp file stats by Snap ID
temp_table_cnt_by_snap_id.sql                   Temp tables count by Snap ID


==SESSION STATS==

session_cnt.sql                                 Total Sessions and Session count by state in a time window
session_activity_hist.sql                       Sessions activity with wait events in a time window
blockers_and_waiters_hist.sql                   Blocking and Waiting Sessions in a time window
vacuum_history.sql                              Vacuum activity in a time window


==SQL STATS==

top_20_sqls_by_calls.sql                        Top 20 queries by Executions/Calls in a time window
top_20_sqls_by_elapsed_time.sql                 Top 20 queries by Elapsed time in a time window
top_10_sqls_by_cpu_by_snap_id.sql               Top 10 SQL queries by CPU by Snap ID
sql_stat_history.sql                            Execution trend of a query of interest in a time window


==TABLE STATS==

table_cols.sql                                  Details of Table columns
table_pk.sql                                    Details of Table Primary Key
table_fks.sql                                   Details of Foreign Keys referencing the Primary Key of the Parent Table
table_options.sql                               Table Options for fill factor and Vacumming
top_20_tables_by_seq_scans.sql                  Top 20 Tables by number of Sequential or Full scans
top_20_tables_by_dmls.sql                       Top 20 Tables by DML activity
table_bloat.sql                                 Table Bloat Analysis
sqls_touching_table.sql                         List SQLs touching a table


==INDEX STATS==

indexes_on_table.sql                            Indexes on a table
fks_with_no_index.sql                           Foreign Keys with no Index
needed_indexes.sql                              Needed Indexes
top_20_indexes_by_scans.sql                     Top 20 Indexes by number of Scans initiated in the index
top_20_indexes_by_avg_tuple_reads.sql           TOP 20 Indexes by average Tuples Reads/Scan
unused_indexes.sql                              Unused Indexes
duplicate_indexes.sql                           Duplicate Indexes
index_bloat.sql                                 Index Bloat Analysis
```

4. List all the available snap IDs and then set the begin and end snap ID for analysis as per your requirement by running the following:

```
\i list_snaps.sql
\i set_snaps.sql
```

For this lab, we can set the begin Snap ID to the minimum snap_id and end Snap ID to the maximum snap_id shown in the list_snaps.sql output.

```
mylab_snap=> \i list_snaps.sql
 snap_id |       sample_start_time       |        sample_end_time
---------+-------------------------------+-------------------------------
       1 | 2021-07-31 19:42:01.853929+00 | 2021-07-31 19:42:06.979376+00
       2 | 2021-07-31 19:43:01.694341+00 | 2021-07-31 19:43:07.056669+00
       3 | 2021-07-31 19:44:01.512056+00 | 2021-07-31 19:44:06.884285+00
       4 | 2021-07-31 19:45:02.424206+00 | 2021-07-31 19:45:07.77129+00
       5 | 2021-07-31 19:46:02.4723+00   | 2021-07-31 19:46:07.791952+00
       6 | 2021-07-31 19:47:02.471167+00 | 2021-07-31 19:47:07.829257+00
       7 | 2021-07-31 19:48:02.621649+00 | 2021-07-31 19:48:07.745697+00
       8 | 2021-07-31 19:49:02.405863+00 | 2021-07-31 19:49:07.542439+00
       9 | 2021-07-31 19:50:02.225921+00 | 2021-07-31 19:50:07.340355+00
      10 | 2021-07-31 19:51:01.867422+00 | 2021-07-31 19:51:07.23372+00
      11 | 2021-07-31 19:52:02.114801+00 | 2021-07-31 19:52:07.462119+00
      12 | 2021-07-31 19:53:02.125023+00 | 2021-07-31 19:53:07.454679+00
      13 | 2021-07-31 19:54:02.35168+00  | 2021-07-31 19:54:07.649471+00
      14 | 2021-07-31 19:55:02.410906+00 | 2021-07-31 19:55:07.750837+00
      15 | 2021-07-31 19:56:02.291247+00 | 2021-07-31 19:56:07.41854+00
      16 | 2021-07-31 19:57:02.303861+00 | 2021-07-31 19:57:07.420602+00
      17 | 2021-07-31 19:58:02.044195+00 | 2021-07-31 19:58:07.647863+00
      18 | 2021-07-31 19:59:02.295996+00 | 2021-07-31 19:59:07.975837+00
      19 | 2021-07-31 20:00:01.683925+00 | 2021-07-31 20:00:07.359834+00
      20 | 2021-07-31 20:01:02.406562+00 | 2021-07-31 20:01:07.812285+00
      21 | 2021-07-31 20:02:02.401635+00 | 2021-07-31 20:02:07.526785+00
      22 | 2021-07-31 20:03:02.127368+00 | 2021-07-31 20:03:07.224645+00
      23 | 2021-07-31 20:04:01.777014+00 | 2021-07-31 20:04:06.90884+00
      24 | 2021-07-31 20:05:02.454367+00 | 2021-07-31 20:05:07.565136+00
      25 | 2021-07-31 20:06:02.286421+00 | 2021-07-31 20:06:07.621813+00
      26 | 2021-07-31 20:07:02.261388+00 | 2021-07-31 20:07:07.893297+00
      27 | 2021-07-31 20:08:02.446604+00 | 2021-07-31 20:08:07.835294+00
      28 | 2021-07-31 20:09:02.27943+00  | 2021-07-31 20:09:07.38857+00
      29 | 2021-07-31 20:10:01.836392+00 | 2021-07-31 20:10:06.965417+00
      30 | 2021-07-31 20:11:01.701827+00 | 2021-07-31 20:11:06.831395+00
      31 | 2021-07-31 20:12:02.365505+00 | 2021-07-31 20:12:07.482436+00
      32 | 2021-07-31 20:13:01.902551+00 | 2021-07-31 20:13:07.03987+00
      33 | 2021-07-31 20:14:02.020914+00 | 2021-07-31 20:14:07.143523+00
      34 | 2021-07-31 20:15:01.552357+00 | 2021-07-31 20:15:06.688599+00
      35 | 2021-07-31 20:16:02.369059+00 | 2021-07-31 20:16:07.500147+00
      36 | 2021-07-31 20:17:02.158305+00 | 2021-07-31 20:17:07.268707+00
      37 | 2021-07-31 20:18:01.880372+00 | 2021-07-31 20:18:07.016943+00
```

```
mylab_snap=> \i set_snaps.sql
enter Begin Snap ID: 1
enter End Snap ID: 37
mylab_snap=>
```

5. Lets see the top 20 tables and indexes by total size, by running the following SQL:

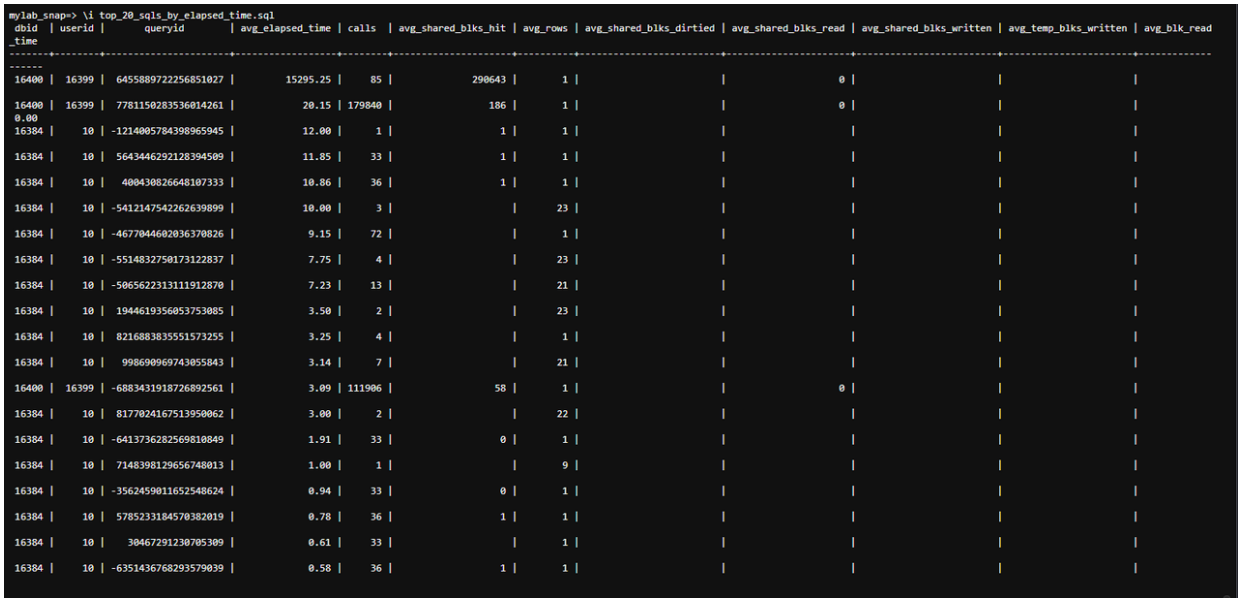
```
\i tables_and_indexes_by_tot_size.sql
```

```
mylab_snap=> \i tables_and_indexes_by_tot_size.sql
  oid  | schema_name |    table_name     |     row_estimate     | total_size | table_size | index_size | toast_size
-------+-------------+-------------------+----------------------+------------+------------+------------+------------
 20516 | public      | pgbench_accounts  |             10000000 | 1495 MB    | 1281 MB    | 214 MB     |
 21056 | hr          | employees         |              4672776 | 746 MB     | 645 MB     | 100 MB     |
 20513 | public      | pgbench_tellers   |                 1000 | 120 kB     | 48 kB      | 40 kB      |
 20519 | public      | pgbench_branches  |                  100 | 56 kB      | 8192 bytes | 16 kB      |
 21053 | hr          | departments       |                   27 | 24 kB      | 8192 bytes | 16 kB      |
 21059 | hr          | job_history       |                   10 | 24 kB      | 8192 bytes | 16 kB      |
 21068 | hr          | regions           |                    4 | 24 kB      | 8192 bytes | 16 kB      |
 21050 | hr          | countries         |                   25 | 24 kB      | 8192 bytes | 16 kB      |
 21065 | hr          | locations         |                   23 | 24 kB      | 8192 bytes | 16 kB      |
 21062 | hr          | jobs              |                   19 | 24 kB      | 8192 bytes | 16 kB      |
 20503 | public      | eventerrormsg     |                    0 | 8192 bytes | 0 bytes    | 0 bytes    | 8192 bytes
 20500 | public      | statusflag        |                    0 | 8192 bytes | 8192 bytes | 0 bytes    |
 20510 | public      | pgbench_history   |                    0 | 0 bytes    | 0 bytes    | 0 bytes    |
 20497 | public      | cloneeventtest    |                    0 | 0 bytes    | 0 bytes    | 0 bytes    |
```

public.pgbench_accounts is the largest table followed by hr.employees.

6. Lets see the top SQL by elapsed time, by running the following SQL:

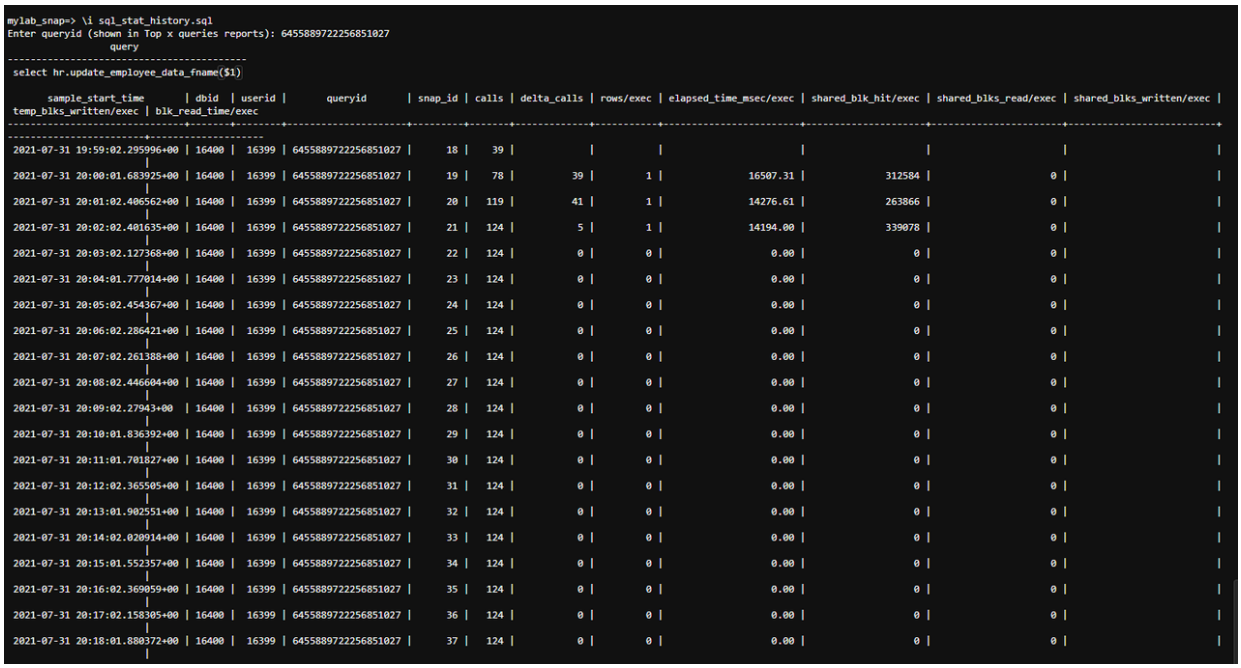
```
\i top_20_sqls_by_elapsed_time.sql
```



```
mylab_snap=> \i top_20_sqls_by_elapsed_time.sql
 dbid  | userid |       queryid        | avg_elapsed_time | calls  | avg_shared_blks_hit | avg_rows | avg_shared_blks_dirtied | avg_shared_blks_read | avg_shared_blks_written | avg_temp_blks_written | avg_blk_read
_time
-------+--------+----------------------+------------------+--------+---------------------+----------+-------------------------+----------------------+-------------------------+-----------------------+-------------
------
 16400 |  16399 | 6455889722256851027 |        15295.25 |     85 |              290643 |        1 |                         |                    0 |                         |                       |
 16400 |  16399 | 7781150283536014261 |           20.15 | 179840 |                 186 |        1 |                         |                    0 |                         |                       |
0.00
 16384 |     10 | -1214005784398965945 |           12.00 |      1 |                   1 |        1 |                         |                      |                         |                       |
 16384 |     10 |  5643446292128394509 |           11.85 |     33 |                   1 |        1 |                         |                      |                         |                       |
 16384 |     10 |   400430826648107333 |           10.86 |     36 |                   1 |        1 |                         |                      |                         |                       |
 16384 |     10 | -5412147542262639899 |           10.00 |      3 |                     |       23 |                         |                      |                         |                       |
 16384 |     10 | -4677044602036370826 |            9.15 |     72 |                     |        1 |                         |                      |                         |                       |
 16384 |     10 | -5514832750173122837 |            7.75 |      4 |                     |       23 |                         |                      |                         |                       |
 16384 |     10 | -5065622313111912870 |            7.23 |     13 |                     |       21 |                         |                      |                         |                       |
 16384 |     10 |  1944619356053753085 |            3.50 |      2 |                     |       23 |                         |                      |                         |                       |
 16384 |     10 |  8216883835551573255 |            3.25 |      4 |                     |        1 |                         |                      |                         |                       |
 16384 |     10 |   9986909693743055843 |            3.14 |      7 |                     |       21 |                         |                      |                         |                       |
 16400 |  16399 | -6883431918726892561 |            3.09 | 111906 |                  58 |        1 |                         |                    0 |                         |                       |
 16384 |     10 |  8177024167513950062 |            3.00 |      2 |                     |       22 |                         |                      |                         |                       |
 16384 |     10 | -6413736282569810849 |            1.91 |     33 |                   0 |        1 |                         |                      |                         |                       |
 16384 |     10 |  7148398129656748013 |            1.00 |      1 |                     |        9 |                         |                      |                         |                       |
 16384 |     10 | -3562459011652548624 |            0.94 |     33 |                   0 |        1 |                         |                      |                         |                       |
 16384 |     10 |  5785233184570382019 |            0.78 |     36 |                   1 |        1 |                         |                      |                         |                       |
 16384 |     10 |    30467291230705309 |            0.61 |     33 |                     |        1 |                         |                      |                         |                       |
 16384 |     10 | -6351436768293579039 |            0.58 |     36 |                   1 |        1 |                         |                      |                         |                       |
```

To see the SQL text and other execution statistics, run the following SQL and pass the queryid of interest shown in the above query output.

```
\i sql_stat_history.sql
```

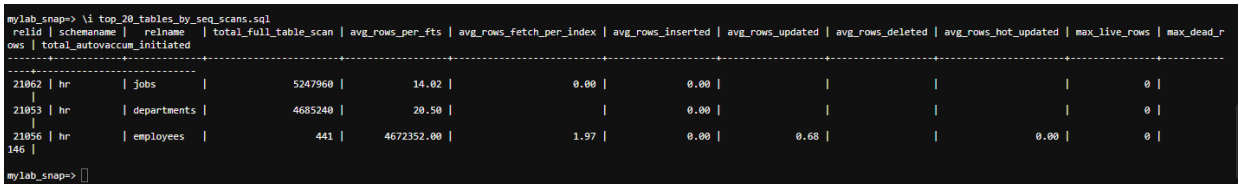


```
mylab_snap=> \i sql_stat_history.sql
Enter queryid (shown in Top x queries reports): 6455889722256851027
                query
-----------------------------------------
 select hr.update_employee_data_fname($1)

      sample_start_time       | dbid  | userid |       queryid       | snap_id | calls | delta_calls | rows/exec | elapsed_time_msec/exec | shared_blk_hit/exec | shared_blks_read/exec | shared_blks_written/exec |
 temp_blks_written/exec | blk_read_time/exec
-----------------------------+-------+--------+---------------------+---------+-------+-------------+-----------+------------------------+---------------------+-----------------------+--------------------------+
------------------------+--------------------
 2021-07-31 19:59:02.295996+00 | 16400 |  16399 | 6455889722256851027 |      18 |    39 |             |           |                        |                     |                       |                          |
                        |
 2021-07-31 20:00:01.683925+00 | 16400 |  16399 | 6455889722256851027 |      19 |    78 |          39 |         1 |               16507.31 |              312584 |                     0 |                          |
                        |
 2021-07-31 20:01:02.406562+00 | 16400 |  16399 | 6455889722256851027 |      20 |   119 |          41 |         1 |               14276.61 |              263866 |                     0 |                          |
                        |
 2021-07-31 20:02:02.401635+00 | 16400 |  16399 | 6455889722256851027 |      21 |   124 |           5 |         1 |               14194.00 |              339078 |                     0 |                          |
                        |
 2021-07-31 20:03:02.127368+00 | 16400 |  16399 | 6455889722256851027 |      22 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:04:01.777014+00 | 16400 |  16399 | 6455889722256851027 |      23 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:05:02.454367+00 | 16400 |  16399 | 6455889722256851027 |      24 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:06:02.286421+00 | 16400 |  16399 | 6455889722256851027 |      25 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:07:02.261388+00 | 16400 |  16399 | 6455889722256851027 |      26 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:08:02.446604+00 | 16400 |  16399 | 6455889722256851027 |      27 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:09:02.27943+00  | 16400 |  16399 | 6455889722256851027 |      28 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:10:01.836392+00 | 16400 |  16399 | 6455889722256851027 |      29 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:11:01.701827+00 | 16400 |  16399 | 6455889722256851027 |      30 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:12:02.365505+00 | 16400 |  16399 | 6455889722256851027 |      31 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:13:01.902551+00 | 16400 |  16399 | 6455889722256851027 |      32 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:14:02.020914+00 | 16400 |  16399 | 6455889722256851027 |      33 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:15:01.552357+00 | 16400 |  16399 | 6455889722256851027 |      34 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:16:02.369059+00 | 16400 |  16399 | 6455889722256851027 |      35 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:17:02.158305+00 | 16400 |  16399 | 6455889722256851027 |      36 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
 2021-07-31 20:18:01.880372+00 | 16400 |  16399 | 6455889722256851027 |      37 |   124 |           0 |         0 |                   0.00 |                   0 |                     0 |                          |
                        |
```

select hr.update_employee_data_fname($1) is the top query by elapsed time since it was not using index as we saw in Lab6:RDS Performance Insights.

7. To see the top tables by sequential scan (or Full table scan), run the following query:

```
\i top_20_tables_by_seq_scans.sql
```

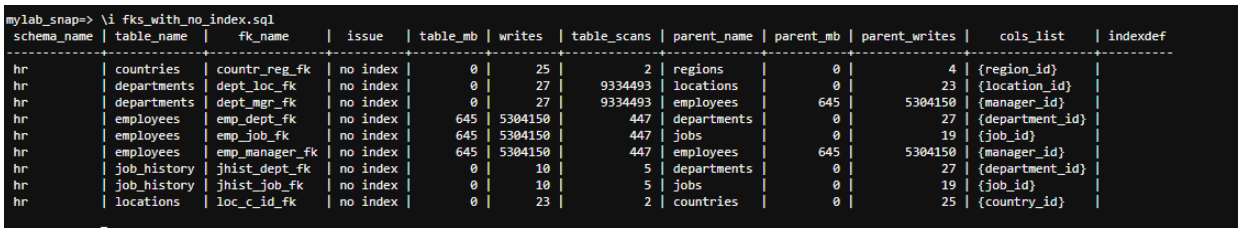


```
mylab_snap=> \i top_20_tables_by_seq_scans.sql
 relid | schemaname |   relname   | total_full_table_scan | avg_rows_per_fts | avg_rows_fetch_per_index | avg_rows_inserted | avg_rows_updated | avg_rows_deleted | avg_rows_hot_updated | max_live_rows | max_dead_r
ows | total_autovaccum_initiated
-------+------------+-------------+-----------------------+------------------+--------------------------+-------------------+------------------+------------------+----------------------+---------------+----------
----+----------------------------
 21062 | hr         | jobs        |               5247960 |            14.02 |                     0.00 |              0.00 |                  |                  |                      |             0 |
    |
 21053 | hr         | departments |               4685240 |            20.50 |                          |              0.00 |                  |                  |                      |             0 |
    |
 21056 | hr         | employees   |                   441 |       4672352.00 |                     1.97 |              0.00 |             0.68 |                  |                 0.00 |             0 |
146 |

mylab_snap=>
```

The output shows some indexing opportunities for employees tables where we had 441 full table scans with average 4672352 rows returning in each scan.

8. To see the foreign keys which doesn't have an index on them (as per schema design best practice), run the following query:

```
\i fks_with_no_index.sql
```

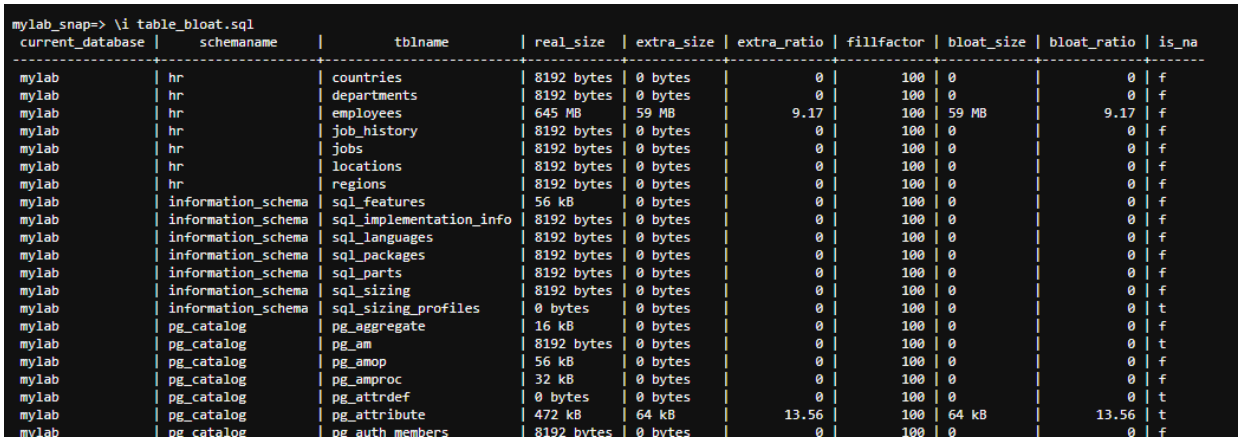


```
mylab_snap=> \i fks_with_no_index.sql
 schema_name | table_name  |     fk_name     |  issue   | table_mb | writes  | table_scans | parent_name | parent_mb | parent_writes |    cols_list    | indexdef
-------------+-------------+-----------------+----------+----------+---------+-------------+-------------+-----------+---------------+-----------------+----------
 hr          | countries   | countr_reg_fk   | no index |        0 |      25 |           2 | regions     |         0 |             4 | {region_id}     |
 hr          | departments | dept_loc_fk     | no index |        0 |      27 |     9334493 | locations   |         0 |            23 | {location_id}   |
 hr          | departments | dept_mgr_fk     | no index |        0 |      27 |     9334493 | employees   |       645 |       5304150 | {manager_id}    |
 hr          | employees   | emp_dept_fk     | no index |      645 | 5304150 |         447 | departments |         0 |            27 | {department_id} |
 hr          | employees   | emp_job_fk      | no index |      645 | 5304150 |         447 | jobs        |         0 |            19 | {job_id}        |
 hr          | employees   | emp_manager_fk  | no index |      645 | 5304150 |         447 | employees   |       645 |       5304150 | {manager_id}    |
 hr          | job_history | jhist_dept_fk   | no index |        0 |      10 |           5 | departments |         0 |            27 | {department_id} |
 hr          | job_history | jhist_job_fk    | no index |        0 |      10 |           5 | jobs        |         0 |            19 | {job_id}        |
 hr          | locations   | loc_c_id_fk     | no index |        0 |      23 |           2 | countries   |         0 |            25 | {country_id}    |
```

The output above shows that there are some tables in **hr** schema with missing foreign key indexes. Depending on the number of queries accessing those tables and their execution frequency, indexing those columns will reduce full table (sequential) scans and pressure on the IO subsystem.

9. To see the table bloat across all tables, run the following query:

```
\i table_bloat.sql
```



```
mylab_snap=> \i table_bloat.sql
 current_database |     schemaname     |         tblname          | real_size  | extra_size | extra_ratio | fillfactor | bloat_size | bloat_ratio | is_na
------------------+--------------------+--------------------------+------------+------------+-------------+------------+------------+-------------+------
 mylab            | hr                 | countries                | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | hr                 | departments              | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | hr                 | employees                | 645 MB     | 59 MB      |        9.17 |        100 | 59 MB      |        9.17 | f
 mylab            | hr                 | job_history              | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | hr                 | jobs                     | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | hr                 | locations                | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | hr                 | regions                  | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | information_schema | sql_features             | 56 kB      | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | information_schema | sql_implementation_info  | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | information_schema | sql_languages            | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | information_schema | sql_packages             | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | information_schema | sql_parts                | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | information_schema | sql_sizing               | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | information_schema | sql_sizing_profiles      | 0 bytes    | 0 bytes    |           0 |        100 | 0          |           0 | t
 mylab            | pg_catalog         | pg_aggregate             | 16 kB      | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | pg_catalog         | pg_am                    | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | t
 mylab            | pg_catalog         | pg_amop                  | 56 kB      | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | pg_catalog         | pg_amproc                | 32 kB      | 0 bytes    |           0 |        100 | 0          |           0 | f
 mylab            | pg_catalog         | pg_attrdef               | 0 bytes    | 0 bytes    |           0 |        100 | 0          |           0 | t
 mylab            | pg_catalog         | pg_attribute             | 472 kB     | 64 kB      |       13.56 |        100 | 64 kB      |       13.56 | t
 mylab            | pg_catalog         | pg_auth_members          | 8192 bytes | 0 bytes    |           0 |        100 | 0          |           0 | f
```

The above output shows that hr.employees table has 9% bloat which can be freed up using a Full Vacuum or pg_repack.

This concludes the lab!

In this lab, we saw how we can derive insights using PostgreSQL dictionary stats with the help of Snapper tool. Feel free to explore other sample SQLs provided by Snapper as time permits.