

PostgreSQL Instance Configuration and System Catalog

Estimated time needed: 30 minutes

In this lab, you will obtain hands-on experience in customizing the configuration of a PostgreSQL server instance, both through the command line interface (CLI) and by editing the configuration files. Furthermore, you will learn to navigate and query the PostgreSQL system catalog, which is a series of tables that store metadata about objects in the database.

Objectives

After completing this lab, you will be able to:

- Customize the configuration parameters of your PostgreSQL server instance
- Query the system catalog to retrieve metadata about database objects

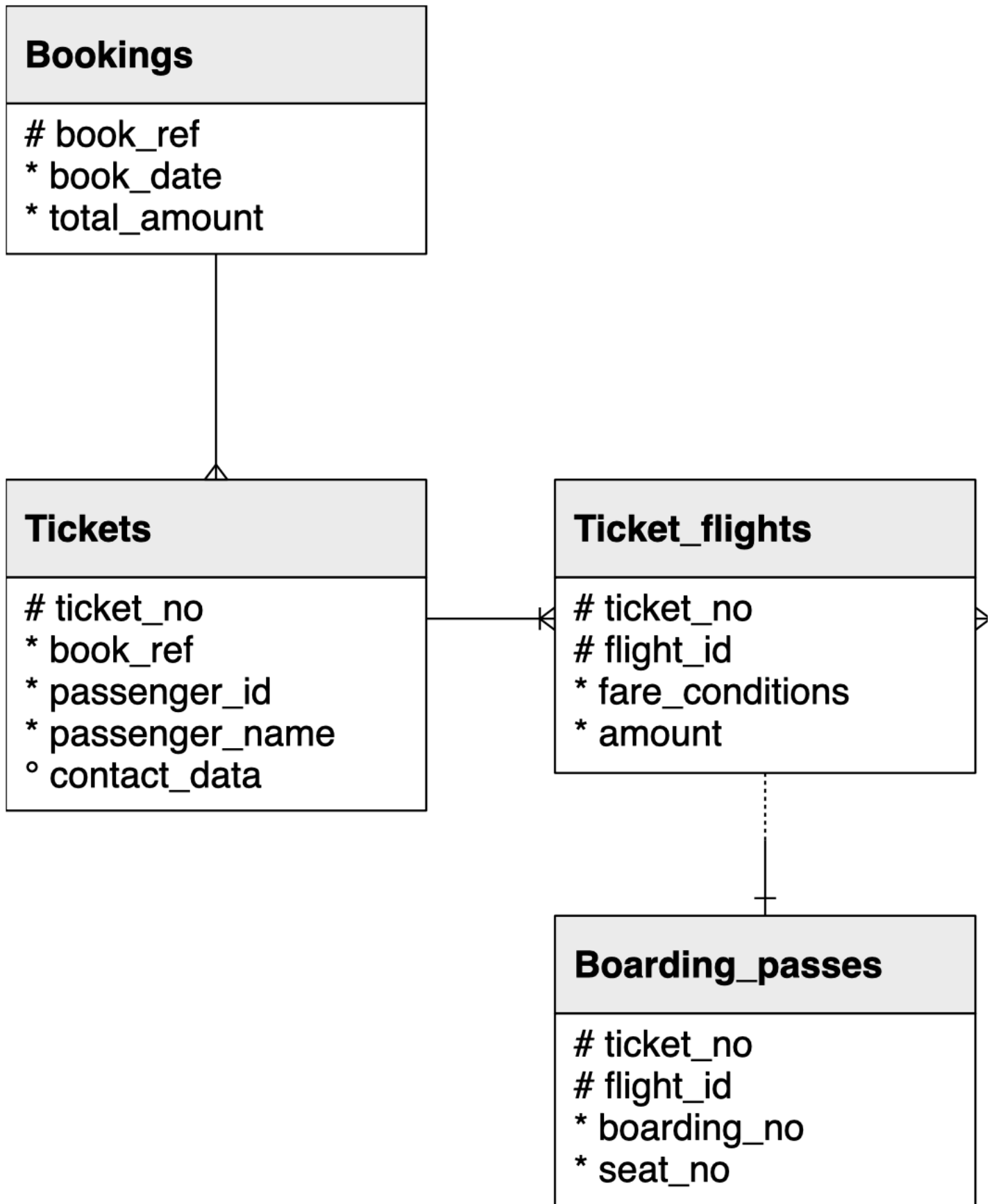
Software Used in This Lab

In this lab, you will be using PostgreSQL. It is a popular open-source object relational database management system (RDBMS) capable of performing a wealth of database administration tasks such as storing, manipulating, retrieving, and archiving data.

To complete this lab, you will be accessing the PostgreSQL service through the IBM Skills Network (SN) Cloud IDE, which is a virtual development environment you will use throughout this course.

Database Used in This Lab

In this lab, you will use a database from <https://postgrespro.com/education/demodb> distributed under the [PostgreSQL licence](#). It stores a month of data about airline flights in Russia and is organized according to the following schema:



Launching PostgreSQL in Cloud IDE

To get started with this lab, launch PostgreSQL using the Cloud IDE. You can do this by following these steps:

1. Click the Skills Network extension button in the left pane.
2. Open the “DATABASES” drop-down menu and click “PostgreSQL”
3. Click the “Start” button. PostgreSQL may take a few moments to start.

The screenshot shows the IBM Skills Network interface for launching a PostgreSQL application. The interface is dark-themed with a sidebar on the left and a main content area on the right.

Callout 1: Points to the PostgreSQL icon in the sidebar under the 'DATABASES' section.

Callout 2: Points to the PostgreSQL button in the 'DATABASES' list.

Callout 3: Points to the 'Start' button in the PostgreSQL details panel.

The main content area displays the PostgreSQL application details, including the version (v13.2) and a status indicator (INACTIVE). The 'Start' button is highlighted in blue.

The sidebar contains various icons for different categories: Databases (MySQL, PostgreSQL, MongoDB, Cassandra), Cloud, Big Data, and a bottom section with a flask icon.

The top of the interface shows tabs for 'Lab', 'IBMCLOUD', and 'Launch Application', along with a menu bar with options like 'File', 'Edit', 'Selection', 'View', 'Go', 'Run', 'Terminal', and 'Help'.

Downloading and Creating the Database

First, you will need to download the database.

1. Open a new terminal by clicking the “New Terminal” button near the bottom of the interface.

Lab IBMCloud Launch Application

File Edit Selection View Go Run Terminal Help

SKILLS NETWO... PostgreSQL ×

▼ DATABASES

- MySQL
- PostgreSQL
- MongoDB
- Cassandra

> CLOUD

> BIG DATA

> OTHER

PostgreSQL

ACTIVE

v13.2 | v5.0 | v13.2

Connect to PostgreSQL and pgAdmin directly in your Skills

Start

Summary Connection Information Details

Your database and pgAdmin server are now ready to use and you can connect using the provided credentials. For more details on how to navigate PostgreSQL, please refer to the documentation.

Username:

Password:

You can manage Postgres via:

pgAdmin [↗](#)

Or to interact with the database in the terminal, select one of the following options:

Postgres CLI **New Terminal**

0 0

2. Run the following command in the terminal:

```
1. 1
```

```
1. wget https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/example-guided-project/flights_RUSSIA_small.sql
```

Copied!

The file you downloaded is a full database backup of a month of flight data in Russia. Now, you can perform a full restoration of the data set by first opening the PostgreSQL CLI.


3. Near the bottom of the window, click the “Postgres CLI” button to launch the command line interface.

Lab


IBMCLOUD

Launch Application

FileEditSelectionViewGoRunTerminalHelp



SKILLS NETWORK




DATABASES

MySQL


PostgreSQL

MongoDB


Cassandra




CLOUD



BIG DATA



OTHER



PostgreSQL ×

PostgreSQL

ACTIVE

v13.2 | v5.0 | v13.2

Connect to PostgreSQL and pgAdmin directly in your Skills

Start

Summary

Connection Information

Details

Your database and pgAdmin server are now ready to use and

credentials. For more details on how to navigate Postgres, p

Username:

Password:

You can manage Postgres via:

pgAdmin

Or to interact with the database in the terminal, select one of

Postgres CLI

New Terminal

0

0

4. In the PostgreSQL CLI, enter the command `\i <file_name>`. In your case, the file name will be the name of the file you downloaded, `flights_RUSSIA_small.sql`. This will restore the data into a new database called `demo`.

```
1. 1
1. \i flights_RUSSIA_small.sql
```

Copied!

The restorations may take a few moments to complete.

5. Verify that the database was properly created by entering the following command:

```
1. 1
1. \dt
```

Copied!

You should see the following output showing all the tables that are part of the bookings schema in the `demo` database.

```
theia@theiadocker-davidpastern: /home/project theia@theiadocker-davidpastern: /ho

demo=# \dt

      List of relations
Schema | Name          | Type  | Owner
-----+-----+-----+-----
bookings | aircrafts_data | table | postgres
bookings | airports_data  | table | postgres
bookings | boarding_passes | table | postgres
bookings | bookings       | table | postgres
bookings | flights        | table | postgres
bookings | seats          | table | postgres
bookings | ticket_flights | table | postgres
bookings | tickets        | table | postgres
(8 rows)

demo=#
```

Exercise 1: Configure Your PostgreSQL Server Instance

A PostgreSQL server instance has a corresponding file named `postgresql.conf` that contains the configuration parameters for the server. By modifying this file, you can enable, disable, or otherwise customize the settings of your PostgreSQL server instance to best suit your needs as a database administrator. While you can manually modify this `postgresql.conf` file and restart the server for the changes to take effect, you can also edit some configuration parameters directly from the command line interface (CLI).

In this exercise, you will customize the configuration settings for the PostgreSQL instance using the CLI.

1. First, let's take a look at the current setting of the `wal_level` parameter. You can do so by entering the following command into the CLI:

```
1. 1
1. SHOW wal_level;
```

Copied!

Without going into too much detail, the `wal_level` parameter dictates how much information is written to the write-ahead log (WAL), which can be used for continuous archiving. If you're interested, you can find further information in the [PostgreSQL official documentation](#).

2. The `ALTER SYSTEM` command is a way to modify the global defaults of a PostgreSQL instance without having to manually edit the configuration file. Let's give it a try and change the `wal_level` parameter to `logical`. To change the parameter, enter the following command into the CLI:

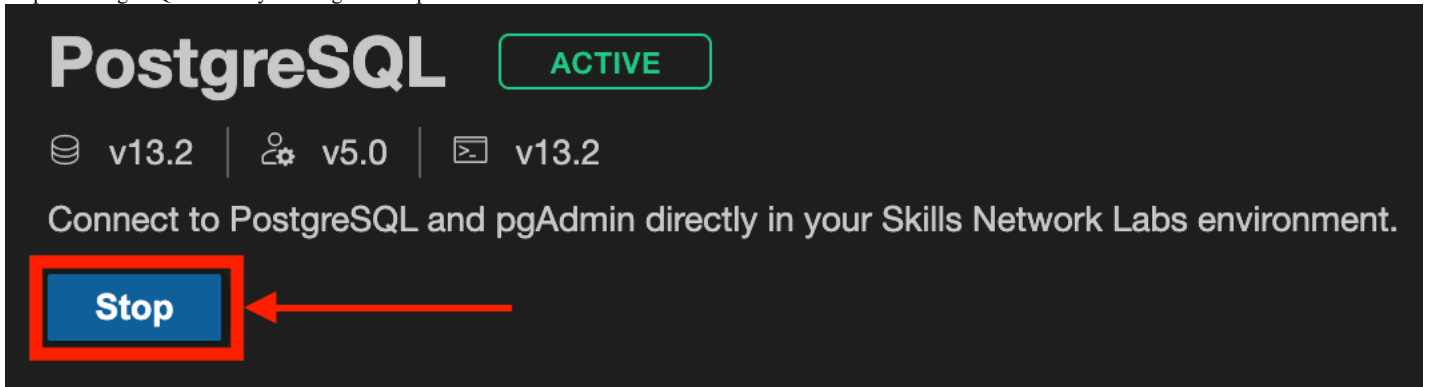
```
1. 1
1. ALTER SYSTEM SET wal_level = 'logical';
```

Copied!

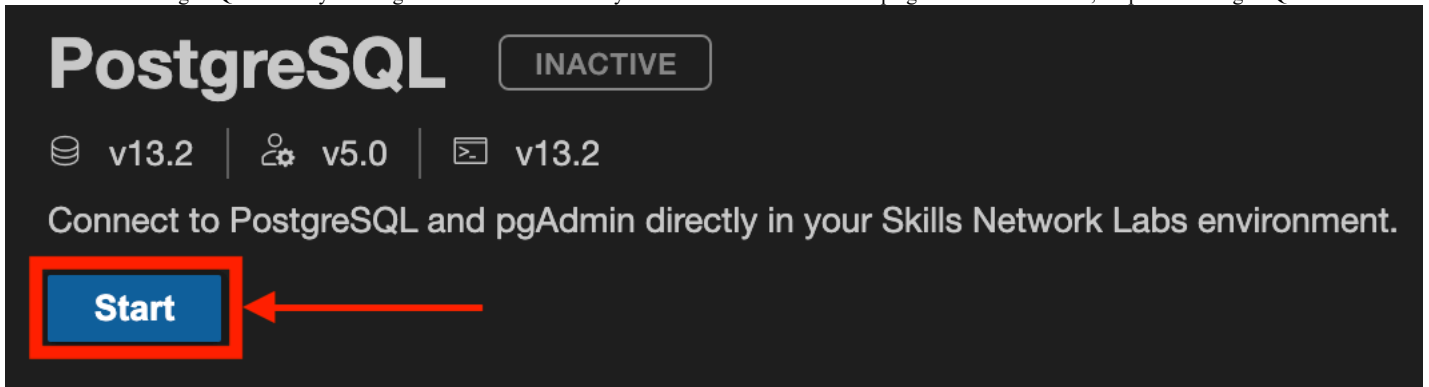
3. **Try it yourself:** Use the CLI to check the current setting of `wal_level`.

- **Hint** (Click Here)
- **Solution** (Click Here)

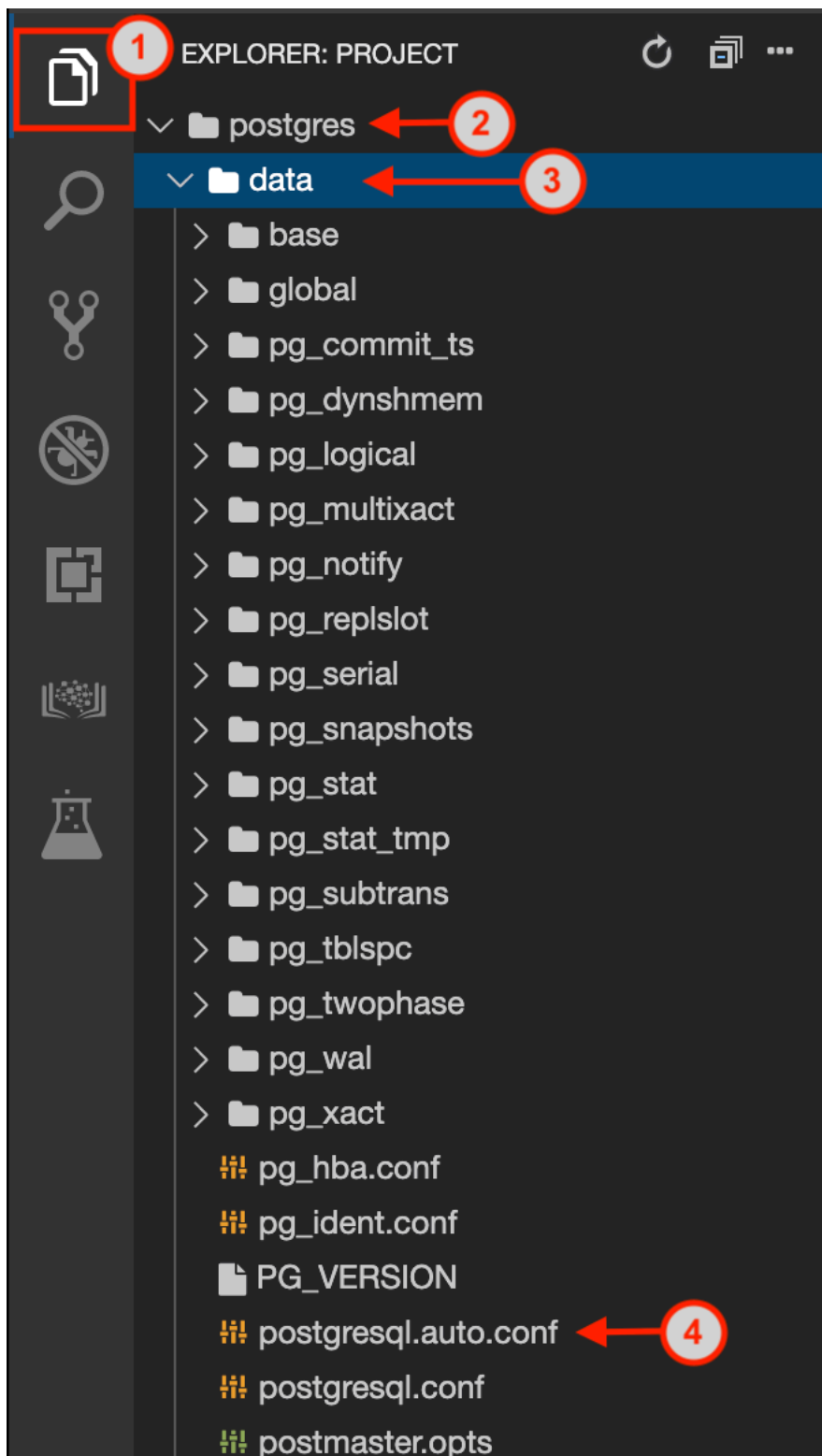
4. Stop the PostgreSQL server by clicking the “Stop” button and close all CLI and terminal tabs.



5. Now restart the PostgreSQL server by clicking the “Start” button. It may take a few moments to start up again. When does it so, reopen the PostgreSQL CLI.



6. When you executed the `ALTER SYSTEM` command in Step 2 of this exercise, a new file named `postgres.auto.conf` was created. You can open the file by first opening the file explorer on Cloud IDE then clicking `postgres > data > postgresql.auto.conf`.



```
PostgreSQL postgresql.auto.conf x
1 # Do not edit this file manually!
2 # It will be overwritten by the ALTER SYSTEM command.
3 wal_level = 'logical'
4
```

This file was automatically modified to contain the new parameter you set using the ALTER SYSTEM command in Step 2. When you started up the PostgreSQL server again, it will read this file and set the wal_level parameter to logical.

7. Finally, and for the last time in this lab, let's confirm the current setting of the `wal_level` parameter. Enter the following into the CLI:

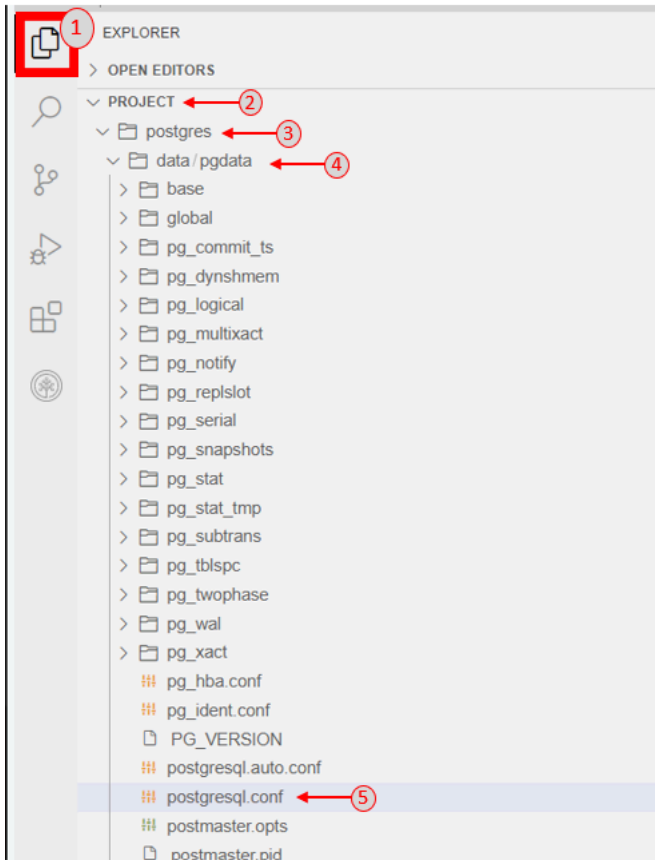
```
1. 1
1. SHOW wal_level;
```

Copied!

```
postgres=# SHOW wal_level;
wal_level
-----
logical
(1 row)
```

You can see that the parameter was changed successfully after the restart.

8. For more advanced instance configuration where many parameter changes are required, using a series of `ALTER SYSTEM` commands may be cumbersome. Instead, you can edit the `postgresql.conf` file directly. You can once again use the Cloud IDE file explorer to open `postgres > data > postgresql.conf`.



You can edit the configuration file right in the Cloud IDE file explorer.

PostgreSQL postgresql.conf ×

```

1  # -----
2  # PostgreSQL configuration file
3  # -----
4  #
5  # This file consists of lines of the form:
6  #
7  #   name = value
8  #
9  # (The "=" is optional.)  Whitespace may be used.  Comments are intro
10 # "#" anywhere on a line.  The complete list of parameter names and
11 # values can be found in the PostgreSQL documentation.
12 #
13 # The commented-out settings shown in this file represent the default
14 # Re-commenting a setting is NOT sufficient to revert it to the default
15 # you need to reload the server.
16 #
17 # This file is read on server startup and when the server receives a
18 # signal.  If you edit the file on a running system, you have to SIGHUP
19 # server for the changes to take effect, run "pg_ctl reload", or execute
20 # "SELECT pg_reload_conf()".  Some parameters, which are marked below
21 # require a server shutdown and restart to take effect.
22 #
23 # Any parameter can also be given as a command-line option to the server
24 # "postgres -c log_connections=on".  Some parameters can be changed
25 # with the "SET" SQL command.

```

Exercise 2: Navigate the System Catalog

The system catalog stores schema metadata, such as information about tables and columns and internal bookkeeping information. In PostgreSQL, the system catalogs are regular tables in which you can add columns and insert and update values. In directly modifying the system catalogs, you can cause severe problems in your system, so it is generally recommended to avoid doing so. Instead, the system catalogs are updated automatically when performing other SQL commands. For example, if you run a `CREATE DATABASE` command, a new database is created on the disk and a new row is automatically inserted into the `pg_database` system catalog table, storing metadata about that database.

First, you need to connect to the database by entering the following command:

1. 1
1. \connect demo

Copied!

Let's explore some of the system catalog tables in PostgreSQL.

1. Start with a simple query of `pg_tables`, which is a system catalog containing metadata about each table in the database. Let's query it to display metadata about all the tables belonging to the `bookings` schema in the `demo` database by entering the following command into the CLI:

1. 1
1. SELECT * FROM pg_tables WHERE schemaname = 'bookings';

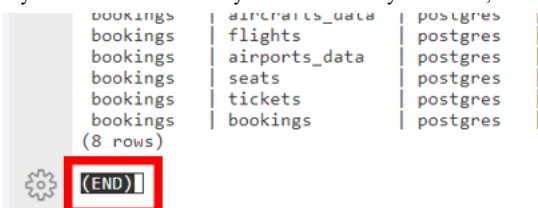
Copied!

```
demo=# SELECT * FROM pg_tables WHERE schemaname = 'bookings';
schemaname | tablename | tableowner | tablespace | hasindexes |
-----+-----+-----+-----+-----+
bookings | ticket_flights | postgres | | t |
bookings | boarding_passes | postgres | | t |
bookings | aircrafts_data | postgres | | t |
bookings | flights | postgres | | t |
bookings | airports_data | postgres | | t |
bookings | seats | postgres | | t |
bookings | tickets | postgres | | t |
bookings | bookings | postgres | | t |
(8 rows)
```

As you can see, the 8 tables belonging to the bookings schema are displayed with various pieces of metadata, such as the table owner and other parameters.

Note:

If you encounter a black keyword "END" on your screen, as shown in the image below



```
bookings | aircrafts_data | postgres |
bookings | flights | postgres |
bookings | airports_data | postgres |
bookings | seats | postgres |
bookings | tickets | postgres |
bookings | bookings | postgres |
(8 rows)
(END)
```

This indicates you've reached the end of the current session.

To exit the session:

- Simply type `:/q` in the command prompt. This will exit the current session and return you to the "demo=#" prompt.

2. Suppose as the database administrator, you would like to enable row-level security for the `boarding_passes` table in the `demo` database. When row security is enabled on a table, all normal access to the table for selecting or modifying rows must be specified by a row security policy. Since row security policies are not the focus of this lab, we will not go in depth about specifying a policy but will simply enable it for demonstration purposes. However, if you wish to learn more about this topic, you can check out the [PostgreSQL documentation](#). To enable row security on the `boarding_passes` table, enter the following command in the CLI:

```
1. 1
```

```
1. ALTER TABLE boarding_passes ENABLE ROW LEVEL SECURITY;
```

Copied!

3. **Try it yourself:** Use the CLI to query the `pg_tables` to display metadata about the tables belonging to the `bookings` schema and confirm that the row security for the `boarding_passes` was successfully enabled.

► **Hint** (Click Here)

► **Solution** (Click Here)

4. Let's connect your work in the previous section about PostgreSQL instance configuration to the system catalogs. Earlier, you used `SHOW` statements to display configuration parameters. There's also a system catalog called `pg_settings` that stores data about configuration parameters of the PostgreSQL server. Let's query with the following command:

```
1. 1
```

```
1. SELECT name, setting, short_desc FROM pg_settings WHERE name = 'wal_level';
```

Copied!

```
postgres=# SELECT name, setting, short_desc FROM pg_settings WHERE name =
name | setting | short_desc
-----+-----+-----
wal_level | logical | Set the level of information written to the WAL.
(1 row)
```

From the query, you see the same results from the `SHOW` statement in Exercise 1 and more. In fact, `pg_tables` contains much more data about a given parameter than is available from the `SHOW` statement (a full list can be found in the [documentation](#)) so, the somewhat more complicated SQL query has its benefits.

Exercise 3: Try it yourself!

Now that you have seen some examples of configuring a PostgreSQL instance and navigating the system catalogs, it's time to put what you learned to use and give it a go yourself.

In this practice exercise, suppose you wanted to change the name of the `aircrafts_data` to `aircraft_fleet`.

1. **Try it yourself:** First, try changing the name of the table by directly editing the `pg_tables` table from the system catalogs.

- ▶ **Hint** (Click Here)
- ▶ **Solution** (Click Here)

2. To properly change the name of the `aircrafts_data`, enter the following command in the CLI:

```
1. 1
1. ALTER TABLE aircrafts_data RENAME TO aircraft_fleet;
```

Copied!

3. **Try it yourself:** To confirm that the table was successfully renamed, query `pg_tables` from the system catalog by schemaname 'bookings' to display the tablename column.

- ▶ **Hint** (Click Here)
- ▶ **Solution** (Click Here)

Conclusion

Congratulations on completing this lab on database administration with PostgreSQL! You now have some foundational knowledge on how to configure a PostgreSQL instance and customize it for your specific use cases. In addition, you now have the ability to query the system catalog to retrieve metadata on database objects and you are ready to move on to the next lesson.

Author

[David Pasternak](#)

Other Contributors

Sandip Saha Joy, Rav Ahuja

Changelog

Date	Version	Changed by	Change Description
2021-09-20	0.1	David Pasternak	Initial version created
2022-07-27	0.2	Lakshmi Holla	Updated html tag
2023-05-05	0.3	Jaskomal Natt	Updated copyright date and removed empty cells

© IBM Corporation 2023. All rights reserved.