

Administrative Tasks Monitoring



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OS Tools

Cumulative Statistics

Server Message Log

External Monitoring Systems

Processes

ps, pgrep...

update_process_title parameter for updating the status of processes

cluster_name parameter for setting the cluster name

Resource usage

iostat, vmstat, sar, top...

Disk space

df, du, quota...

PostgreSQL runs on an operating system and to a certain extent depends on its configuration.

PostgreSQL process information is accessible via OS tools. The server parameter *update_process_title* (on by default) displays the state of each process next to its title. The *cluster_name* parameter specifies the instance name used to identify it among running processes.

Various tools are available to monitor the use of system resources (CPU, RAM, disks) in Unix: iostat, vmstat, sar, top, etc.

Disk space monitoring is also necessary. The space occupied by the database on disk can be viewed both from the database itself (see the Data Organization module) and from the OS (with the du command). The amount of disk space available is also displayed with the df command in the OS. If disk quotas are used, they must also be taken into account.

The tools and approaches to monitoring differ significantly between various OS and file systems, so we will not discuss them in detail.

<https://postgrespro.com/docs/postgresql/16/monitoring-ps>

<https://postgrespro.com/docs/postgresql/16/diskusage>

Statistics Collection

Current System Activities

Command Execution Monitoring

Extensions

There are two primary sources of information about the state of the system. The first one is statistical information collected by PostgreSQL and stored inside the cluster.

Settings of cumulative statistics

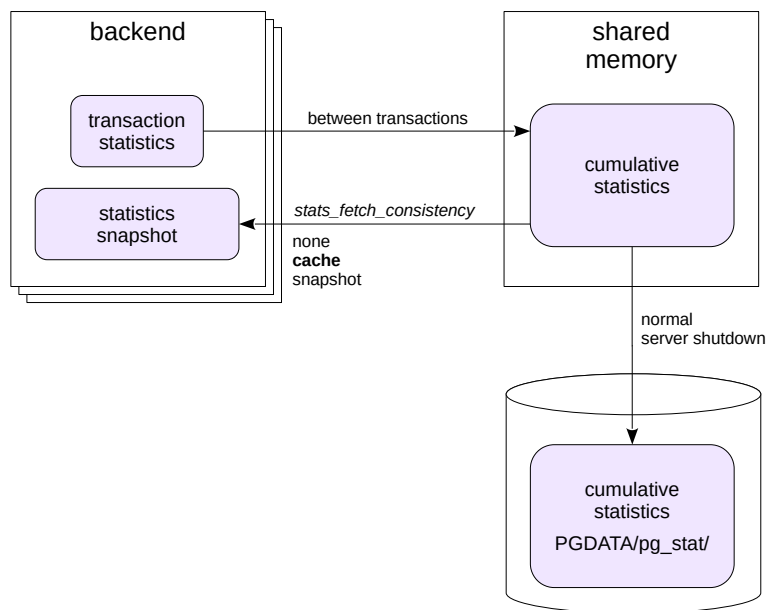
<i>parameter</i>	<i>action</i>
<i>track_activities</i>	monitor current commands
<i>track_counts</i>	collect table and index access statistics
<i>track_functions</i>	monitor user function calls off by default
<i>track_io_timing</i>	monitor block read and write timing statistics off by default
<i>track_wal_io_timing</i>	monitor write timing of WAL operations off by default

The cumulative statistics system in PostgreSQL collects and provides data on server operations. Cumulative statistics track access to tables and indexes at both the disk block and row levels. Additionally, they record details such as the number of rows, vacuum and analyze operations for each table.

It is also possible to track the number of user function calls and their execution time.

The amount of information collected is controlled by several server parameters, since the more information is collected, the greater the overhead.

<https://postgrespro.com/docs/postgresql/16/monitoring-stats>



Backends collect statistics in running transactions. The process stores this data in shared memory, updating it at most once per second (compile-time setting).

Cumulative statistics are stored in `PGDATA/pg_stat/` during a normal server shutdown and reloaded upon startup. In case of a crash shutdown, all counters are reset.

Backend may cache statistical data. The caching level is controlled by the *stats_fetch_consistency* parameter.

- **none** — no caching; statistics reside only in shared memory.
- **cache** — statistics for a single object are cached.
- **snapshot** — statistics for the entire database are cached.

Cache is the default mode, which balances consistency and performance efficiency.

Cached statistics are not refreshed and are discarded at the end of a transaction, or when `pg_stat_clear_snapshot()` is called.

Due to latency and caching, the backend will not always have the latest statistics, but it is seldom necessary.

Cumulative Statistics

```
=> CREATE DATABASE admin_monitoring;
```

```
CREATE DATABASE
```

```
=> \c admin_monitoring
```

You are now connected to database "admin_monitoring" as user "student".

Enable collection of I/O statistics first:

```
=> ALTER SYSTEM SET track_io_timing=on;
```

```
ALTER SYSTEM
```

```
=> SELECT pg_reload_conf();
```

```
pg_reload_conf
-----
t
(1 row)
```

Monitoring server activity only makes sense if there is any activity. We can imitate load with pgbench, a standard benchmarking utility.

First, it creates a number of tables and fills them with data.

```
student$ pgbench -i admin_monitoring
```

```
dropping old tables...
NOTICE: table "pgbench_accounts" does not exist, skipping
NOTICE: table "pgbench_branches" does not exist, skipping
NOTICE: table "pgbench_history" does not exist, skipping
NOTICE: table "pgbench_tellers" does not exist, skipping
creating tables...
generating data (client-side)...
100000 of 100000 tuples (100%) done (elapsed 0.25 s, remaining 0.00 s)
vacuuming...
creating primary keys...
done in 0.64 s (drop tables 0.00 s, create tables 0.03 s, client-side generate 0.29 s,
vacuum 0.12 s, primary keys 0.18 s).
```

Let's reset the previously accumulated database statistics.

```
=> SELECT pg_stat_reset();
```

```
pg_stat_reset
-----
(1 row)
```

Including instance I/O statistics:

```
=> SELECT pg_stat_reset_shared('io');
```

```
pg_stat_reset_shared
-----
(1 row)
```

Start the TPC-B test and let it run for a few seconds:

```
student$ pgbench -T 10 admin_monitoring
```

```
pgbench (16.10 (Ubuntu 16.10-1.pgdg24.04+1))
starting vacuum...end.
transaction type: <builtin: TPC-B (sort of)>
scaling factor: 1
query mode: simple
number of clients: 1
number of threads: 1
maximum number of tries: 1
duration: 10 s
number of transactions actually processed: 1132
number of failed transactions: 0 (0.000%)
```

latency average = 8.830 ms
initial connection time = 9.071 ms
tps = 113.252776 (without initial connection time)

Now, let's check the statistics on table access in terms of rows:

```
=> SELECT *
FROM pg_stat_all_tables
WHERE relid = 'pgbench_accounts'::regclass \gx

-[ RECORD 1 ]-----+-----
relid          | 16393
schemaname     | public
relname        | pgbench_accounts
seq_scan       | 0
last_seq_scan  |
seq_tup_read   | 0
idx_scan       | 2264
last_idx_scan  | 2025-09-24 17:01:10.103752+03
idx_tup_fetch  | 2264
n_tup_ins      | 0
n_tup_upd      | 1132
n_tup_del      | 0
n_tup_hot_upd  | 329
n_tup_newpage_upd | 803
n_live_tup     | 0
n_dead_tup     | 1065
n_mod_since_analyze | 1132
n_ins_since_vacuum | 0
last_vacuum    |
last_autovacuum |
last_analyze   |
last_autoanalyze |
vacuum_count   | 0
autovacuum_count | 0
analyze_count  | 0
autoanalyze_count | 0
```

And in terms of tables:

```
=> SELECT *
FROM pg_statio_all_tables
WHERE relid = 'pgbench_accounts'::regclass \gx

-[ RECORD 1 ]---+-----
relid          | 16393
schemaname     | public
relname        | pgbench_accounts
heap_blks_read | 0
heap_blks_hit  | 7775
idx_blks_read  | 269
idx_blks_hit   | 5873
toast_blks_read |
toast_blks_hit |
tidx_blks_read |
tidx_blks_hit  |
```

There are similar views for indexes:

```
=> SELECT *
FROM pg_stat_all_indexes
WHERE relid = 'pgbench_accounts'::regclass \gx

-[ RECORD 1 ]-----+-----
relid          | 16393
indexrelid     | 16407
schemaname     | public
relname        | pgbench_accounts
indexrelname    | pgbench_accounts_pkey
idx_scan       | 2264
last_idx_scan  | 2025-09-24 17:01:10.103752+03
idx_tup_read   | 3074
idx_tup_fetch  | 2264
```

```
=> SELECT *
FROM pg_statio_all_indexes
WHERE relid = 'pgbench_accounts'::regclass \gx
```



```
-[ RECORD 1 ]--+-----
reloid       | 16393
indexreloid  | 16407
schemaname   | public
relname      | pgbench_accounts
indexrelname | pgbench_accounts_pkey
idx_blks_read | 269
idx_blks_hit  | 5873
```

These views can be used to pinpoint unused indexes. Such indexes not only occupy useful space on the disk, but also waste resources on updates every time data in the table changes.

There are also views for user-defined and system objects (all, user, sys), current transaction statistics (pg_stat_xact*), and more.

You can view global statistics across the whole database:

```
=> SELECT *
FROM pg_stat_database
WHERE datname = 'admin_monitoring' \gx
```

```
-[ RECORD 1 ]-----+-----
datid          | 16386
datname        | admin_monitoring
numbackends    | 1
xact_commit    | 1151
xact_rollback  | 0
blks_read      | 271
blks_hit       | 23586
tup_returned   | 18198
tup_fetched    | 3397
tup_inserted   | 1132
tup_updated    | 3397
tup_deleted    | 0
conflicts      | 0
temp_files     | 0
temp_bytes     | 0
deadlocks      | 0
checksum_failures |
checksum_last_failure |
blk_read_time  | 9.558
blk_write_time | 1.286
session_time   | 22558.675
active_time    | 9416.434
idle_in_transaction_time | 546.994
sessions       | 2
sessions_abandoned | 0
sessions_fatal | 0
sessions_killed | 0
stats_reset    | 2025-09-24 17:00:59.741821+03
```

It provides a lot of data on the number of deadlocks occurred, committed and cancelled transactions, utilization of temporary files, and checksum errors. It also maintains total session count and statistics on sessions terminated for various reasons.

The numbackends column specifically indicates the current number of active backend processes connected to this database.

For monitoring I/O operations at the server level, administrators can query the pg_stat_io view. Let's first execute a checkpoint operation, then examine the resulting page read and write counts categorized by process type:

```
=> CHECKPOINT;
```

```
CHECKPOINT
```

```
=> SELECT backend_type, sum(hits) hits, sum(reads) reads, sum(writes) writes
FROM pg_stat_io
GROUP BY backend_type;
```

backend_type	hits	reads	writes
background worker	0	0	0
client backend	23772	271	0
walsender	0	0	0
standalone backend	0	0	0
autovacuum worker	563	0	0
autovacuum launcher	0	0	0
background writer			0
startup	0	0	0
checkpointer			2870
(9 rows)			

Configuration

statistics

current activities and waits
of backends
and background processes

parameter

track_activities
on by default

The current activities of all backends and background processes are displayed in the `pg_stat_activity` view. We will focus on it more in the demo. This view depends on the *track_activities* parameter (enabled by default).

Current Activities

Let's imitate a scenario when one process blocks another, and then figure it out using system views.

Create a table with one row:

```
=> CREATE TABLE t(n integer);
```

```
CREATE TABLE
```

```
=> INSERT INTO t VALUES(42);
```

```
INSERT 0 1
```

Start two sessions, one of which changes the table and does not complete the transaction:

```
student$ psql -d admin_monitoring
```

```
| => BEGIN;
```

```
| BEGIN
```

```
| => UPDATE t SET n = n + 1;
```

```
| UPDATE 1
```

And the other tries to change the same row and gets blocked:

```
student$ psql -d admin_monitoring
```

```
|| => UPDATE t SET n = n + 2;
```

View data about backend processes:

```
=> SELECT pid, query, state, wait_event, wait_event_type, pg_blocking_pids(pid)
FROM pg_stat_activity
WHERE backend_type = 'client backend' \gx
```

```
-[ RECORD 1
]-+-----
pid          | 20100
query        | UPDATE t SET n = n + 1;
state        | idle in transaction
wait_event   | ClientRead
wait_event_type | Client
pg_blocking_pids | {}
-[ RECORD 2
]-+-----
pid          | 19121
query        | SELECT pid, query, state, wait_event, wait_event_type,
pg_blocking_pids(pid)+
              | FROM pg_stat_activity
              +
              | WHERE backend_type = 'client backend'
state        | active
wait_event   |
wait_event_type |
pg_blocking_pids | {}
-[ RECORD 3
]-+-----
pid          | 20188
query        | UPDATE t SET n = n + 2;
state        | active
wait_event   | transactionid
wait_event_type | Lock
pg_blocking_pids | {20100}
```

The state "idle in transaction" means that the session has started a transaction, but isn't doing anything at the moment, and the transaction isn't closed. This could become a problem if the situation comes up regularly (for example, because of poor application code or driver errors), because an open transaction holds a data snapshot and prevents vacuuming.

The administrator has a parameter `idle_in_transaction_session_timeout` at their disposal to force sessions to close after their transaction is idle for a certain period of time. The `idle_session_timeout` parameter forcibly terminates sessions that remain idle beyond the specified duration.

You can also terminate a blocking session manually. First, you need the blocked process ID. The function `pg_blocking_pids` can help you with that:

```
=> SELECT pid AS blocked_pid
FROM pg_stat_activity
WHERE backend_type = 'client backend'
AND cardinality(pg_blocking_pids(pid)) > 0;

blocked_pid
-----
        20188
(1 row)
```

Instead, you can use a query on the locks table. It will return two rows in this case: one transaction has been granted the lock, while the other is waiting for it.

```
=> SELECT locktype, transactionid, pid, mode, granted
FROM pg_locks
WHERE transactionid IN (
    SELECT transactionid FROM pg_locks WHERE pid = 20188 AND NOT granted
);

locktype | transactionid | pid | mode | granted
-----+-----+-----+-----+-----
transactionid | 1884 | 20100 | ExclusiveLock | t
transactionid | 1884 | 20188 | ShareLock | f
(2 rows)
```

Generally, you have to keep the lock type in mind.

Running query can be cancelled with the `pg_cancel_backend` function. The transaction is idle in our case, so we use the `pg_terminate_backend` to terminate the session:

```
=> SELECT pg_terminate_backend(b.pid)
FROM unnest(pg_blocking_pids(20188)) AS b(pid);

pg_terminate_backend
-----
t
(1 row)
```

The `unnest` function is necessary because `pg_blocking_pids` returns an array of process IDs that block the specified process. There is only one in our examples, but there can be multiple.

Locks are discussed in more detail in the DBA2 course.

Check the backends:

```
=> SELECT pid, query, state, wait_event, wait_event_type
FROM pg_stat_activity
WHERE backend_type = 'client backend' \gx

-[ RECORD 1 ]---+-----
pid            | 19121
query          | SELECT pid, query, state, wait_event, wait_event_type+
               | FROM pg_stat_activity                                +
               | WHERE backend_type = 'client backend'
state          | active
wait_event     |
wait_event_type |
-[ RECORD 2 ]---+-----
pid            | 20188
query          | UPDATE t SET n = n + 2;
state          | idle
wait_event     | ClientRead
wait_event_type | Client
```

Only two remain, and the blocked one has completed its transaction successfully.

The `pg_stat_activity` view shows the information not only about backend processes, but also about the system background processes running on the instance:

```
=> SELECT pid, backend_type, backend_start, state
FROM pg_stat_activity;
```

pid	backend_type	backend_start	state
19026	autovacuum launcher	2025-09-24 17:00:50.561805+03	
19027	logical replication launcher	2025-09-24 17:00:50.563514+03	
19121	client backend	2025-09-24 17:00:58.475998+03	active
20188	client backend	2025-09-24 17:01:17.314073+03	idle
19023	background writer	2025-09-24 17:00:50.478885+03	
19022	checkpointer	2025-09-24 17:00:50.477168+03	
19025	walwriter	2025-09-24 17:00:50.559965+03	

(7 rows)

Compare that to what the OS reports:

```
student$ sudo head -n 1 /var/lib/postgresql/16/main/postmaster.pid
```

19021

```
student$ ps -o pid,command --ppid 19021
```

```

PID COMMAND
19022 postgres: 16/main: checkpointer
19023 postgres: 16/main: background writer
19025 postgres: 16/main: walwriter
19026 postgres: 16/main: autovacuum launcher
19027 postgres: 16/main: logical replication launcher
19121 postgres: 16/main: student admin_monitoring [local] idle
20188 postgres: 16/main: student admin_monitoring [local] idle
```

Views for monitoring command executions

<i>command</i>	<i>execution</i>
ANALYZE	pg_stat_progress_analyze
CREATE INDEX, REINDEX	pg_stat_progress_create_index
VACUUM including autovacuuming	pg_stat_progress_vacuum
CLUSTER, VACUUM FULL	pg_stat_progress_cluster
Create base backup	pg_stat_progress_basebackup
COPY	pg_stat_progress_copy

You can monitor the progress of some potentially long-running commands using the corresponding views.

The structures of the views are described in the documentation:

<https://postgrespro.com/docs/postgresql/16/progress-reporting>

Backup is discussed in the Backup module.

Additional supplied extensions

<code>pg_stat_statements</code>	query statistics
<code>pgstattuple</code>	row versions statistics
<code>pg_buffercache</code>	buffer cache status

Other extensions

<code>pg_wait_sampling</code>	statistics for waits
<code>pg_stat_kcache</code>	CPU and I/O statistics
<code>pg_qualstats</code>	predicate statistics
...	

There are extensions, both additional supplied and third-party, that enable the collection of additional statistics.

For example, the `pg_stat_statements` extension collects information about queries executed by the system, `pg_buffercache` provides tools for monitoring the buffer cache, etc.

Many key extensions are discussed in more detail in the DBA2 and DEV2 courses.

Log Record Configuration

Log File Rotation

Log Analysis

The other primary source of information about the state of the server is the message log.

Message receiver (*log_destination = list*)

stderr	error stream
csvlog	CSV format (if the collector is enabled)
jsonlog	JSON format (if the collector is enabled)
syslog	the syslog daemon
eventlog	Windows event log

Message collector (*logging_collector = on*)

- can provide additional info
- never loses messages (unlike syslog)
- writes stderr, csvlog and jsonlog to the *log_directory/log_filename*

The server log can be output in various formats and forwarded to various destinations. The format and the destination are determined primarily by the *log_destination* parameter (you can list multiple receivers separated by a comma).

The *stderr* value (on by default) sends messages to the standard error stream as plain text. The *syslog* value forwards messages to the syslog daemon (for Unix systems), and the *eventlog* value does the same for the Windows event log.

The message collector is an auxiliary process that collects additional information from all PostgreSQL processes to supplement the basic log messages. It is designed to keep track of every message, therefore it can become the bottleneck in high-load environments.

The message collector is switched on and off by the *logging_collector* parameter. When *stderr* is enabled, the messages are written into the file defined by the *log_filename* parameter, which is located in the directory defined by the *log_directory* parameter.

When the collector is on and *csvlog* is selected as a receiver, the info will also be output into a CSV file *log_filename.csv*. With the *jsonlog* output enabled, log files are written in JSON format and use the *.json* file extension.

What to Log?

Settings

information

level of messages
long command execution time
command execution time
application name
checkpoints
connections and disconnections
long lock waits
command executed
temporary file usage
...

parameter

log_min_messages
log_min_duration_statement
log_duration
application_name
log_checkpoints
log_(dis)connections
log_lock_waits
log_statement
log_temp_files


A lot of useful information can be output to the server message log. By default, almost all output is disabled so as not to turn logging into the bottleneck for the I/O subsystem. The administrator should decide what information is important, provide the necessary disk space to store it, and evaluate the impact of the log output on the overall system performance.

Log File Rotation

By the message collector

<i>setting</i>	<i>parameter</i>
file name pattern	<i>log_filename</i>
rotation time, minutes	<i>log_rotation_age</i>
rotation file size, KB	<i>log_rotation_size</i>
overwrite file	<i>log_truncate_on_rotation</i> = on
combining file name patterns and rotation times allow for different rotation schemes:	
'postgresql-%H.log', '1h'	24 files a day
'postgresql-%a.log', '1d'	7 files a week

External tools

-  logrotate system utility

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If all the log output goes into a single file, sooner or later the file will grow to an unmanageable size, making administration and analysis highly inconvenient. Therefore, a log rotation scheme is usually employed.

<https://postgrespro.com/docs/postgresql/16/logfile-maintenance>

The message collector has its own rotation tools. Some of the parameters that configure them are listed on the slide.

The *log_filename* parameter can specify not just a name, but a file name pattern using designated date and time characters.

The *log_rotation_age* parameter determines how long a file is used before the output switches to a new one (and *log_rotation_size* is the file size at which to switch to the next one).

The *log_truncate_on_rotation* flag determines if PostgreSQL should overwrite existing files or append messages to them.

Different rotation schemes can be defined by using various file name patterns and switch time combinations.

<https://postgrespro.com/docs/postgresql/16/runtime-config-logging#RUNTIME-CONFIG-LOGGING-WHERE>

Alternatively, rotation can be managed by external tools. For example, Ubuntu package uses logrotate system utility (it is configured through the `/etc/logrotate.d/postgresql-common` file).

OS tools

grep, awk...

Special analysis tools

pgBadger — requires a certain log configuration

There are different ways to analyze logs.

You can search for certain information using OS tools or specially designed scripts.

The de facto standard for log analysis is the PgBadger application <https://github.com/darold/pgbadger>, but it imposes certain restrictions on the contents of the log. In particular, only messages in English are allowed.

Log Analysis

Let's consider a simple case. For example, display all messages of the FATAL level:

```
student$ sudo grep FATAL /var/log/postgresql/postgresql-16-main.log | tail -n 10
```

```
2025-09-24 16:56:05.228 MSK [2750] student@student FATAL: terminating connection due to
administrator command
2025-09-24 17:01:19.114 MSK [20100] student@admin_monitoring FATAL: terminating
connection due to administrator command
```

The "terminating connection" message is caused by us terminating the blocking process.

Logs are usually used to analyse the queries that execute the longest. We can make the log display all executed commands and their execution times:

```
=> ALTER SYSTEM SET log_min_duration_statement=0;
```

```
ALTER SYSTEM
```

```
=> SELECT pg_reload_conf();
```

```
pg_reload_conf
-----
t
(1 row)
```

Now, run a command:

```
=> SELECT sum(random()) FROM generate_series(1,1_000_000);
```

```
sum
-----
500636.5818178172
(1 row)
```

Check the log:

```
student$ sudo tail -n 1 /var/log/postgresql/postgresql-16-main.log
```

```
2025-09-24 17:01:20.752 MSK [19121] student@admin_monitoring LOG: duration: 371.316 ms
statement: SELECT sum(random()) FROM generate_series(1,1_000_000);
```

Universal monitoring systems

Zabbix, Munin, Cacti...
cloud-based: Okmeter, NewRelic, Datadog...

PostgreSQL monitoring systems

pg_profile, pgpro_pwr
PGObserver
PostgreSQL Workload Analyzer (PoWA)
Open PostgreSQL Monitoring (OPM)
...

In practice, you need a full-fledged monitoring system that collects various metrics from both PostgreSQL and the operating system, stores the history of these metrics, displays them as readable graphs, notifies when certain metrics exceed certain limits, etc.

PostgreSQL does not come with such a system by itself, it only provides the means by which such information can be acquired. We have gone over them already. Therefore, for full-scale monitoring, an external system is required. There are quite a few such systems on the market. Some are universal and come with PostgreSQL plugins or agents. These include Zabbix, Munin, Cacti, cloud services such as Okmeter, NewRelic, Datadog, and others.

There are also systems specifically designed for PostgreSQL: PGObserver, PoWA, OPM, etc. The pg_profile extension allows you to build snapshots of static data and compare them, identifying resource-intensive operations and their dynamics. pgpro_pwr is its extended, commercially available version.

<https://postgrespro.com/docs/enterprise/16/pgpro-pwr>

An incomplete but representative list of monitoring systems can be viewed here: <https://wiki.postgresql.org/wiki/Monitoring>

Monitoring collects data on server operations both from the operating system and from the database points of view

PostgreSQL provides cumulative statistics and the server message log

Full-scale monitoring requires an external system

1. In a new database, create a table, insert several rows, and then delete all rows.
Look at the table access statistics and reference the values (n_tup_ins, n_tup_del, n_live_tup, n_dead_tup) against your activity.
Perform a vacuum, check the statistics again and compare with the previous figures.
2. Create a deadlock with two transactions.
See what information is recorded in the server message log.

2. Deadlock is a situation when two (or more) transactions are waiting for each other to complete first. Unlike a normal lock, transactions have no way to get out of deadlock, and the DBMS has to resolve it by forcibly interrupting one of the transactions.

The easiest way to reproduce a deadlock is on a table with two rows. The first transaction changes (and locks) the first row, and the second one locks the second row. Then the first transaction tries to change the second row, discovers that it is locked, and starts waiting. And then the second transaction tries to change the first row, and also waits for the lock to be released.

Table Access Statistics

Create a database and a table:

```
=> CREATE DATABASE admin_monitoring;
```

CREATE DATABASE

```
=> \c admin_monitoring
```

You are now connected to database "admin_monitoring" as user "student".

```
=> CREATE TABLE t(n numeric);
```

CREATE TABLE

```
=> INSERT INTO t SELECT 1 FROM generate_series(1,1000);
```

INSERT 0 1000

```
=> DELETE FROM t;
```

DELETE 1000

Check access statistics.

```
=> SELECT * FROM pg_stat_all_tables WHERE relid = 't'::regclass \gx
```

```
-[ RECORD 1 ]-----+-----
relid          | 16387
schemaname     | public
relname        | t
seq_scan       | 1
last_seq_scan  | 2025-09-24 17:10:17.420811+03
seq_tup_read   | 1000
idx_scan       | 
last_idx_scan  | 
idx_tup_fetch  | 
n_tup_ins      | 1000
n_tup_upd      | 0
n_tup_del      | 1000
n_tup_hot_upd  | 0
n_tup_newpage_upd | 0
n_live_tup     | 0
n_dead_tup     | 1000
n_mod_since_analyze | 2000
n_ins_since_vacuum | 1000
last_vacuum    | 
last_autovacuum | 
last_analyze   | 
last_autoanalyze | 
vacuum_count   | 0
autovacuum_count | 0
analyze_count  | 0
autoanalyze_count | 0
```

We inserted 1000 rows (n_tup_ins = 1000), then removed 1000 rows (n_tup_del = 1000).

No live row versions remain (n_live_tup = 0), all 1000 rows are dead (n_dead_tup = 1000).

Run vacuuming.

```
=> VACUUM;
```

VACUUM

```
=> SELECT * FROM pg_stat_all_tables WHERE relid = 't'::regclass \gx
```

```

-[ RECORD 1 ]-----+-----
reloid          | 16387
schemaname      | public
relname         | t
seq_scan        | 1
last_seq_scan   | 2025-09-24 17:10:17.420811+03
seq_tup_read    | 1000
idx_scan        |
last_idx_scan   |
idx_tup_fetch   |
n_tup_ins       | 1000
n_tup_upd       | 0
n_tup_del       | 1000
n_tup_hot_upd   | 0
n_tup_newpage_upd | 0
n_live_tup      | 0
n_dead_tup      | 0
n_mod_since_analyze | 2000
n_ins_since_vacuum | 0
last_vacuum     | 2025-09-24 17:10:18.878693+03
last_autovacuum |
last_analyze    |
last_autoanalyze |
vacuum_count    | 1
autovacuum_count | 0
analyze_count   | 0
autoanalyze_count | 0

```

Dead row versions vacuumed (n_dead_tup = 0), vacuuming performed one time (vacuum_count = 1).

2. Deadlocks

```
=> INSERT INTO t VALUES (1),(2);
```

```
INSERT 0 2
```

One transaction locks the first row of the table...

```
student$ psql
```

```

| => \c admin_monitoring
| You are now connected to database "admin_monitoring" as user "student".
|
| => BEGIN;
| BEGIN
|
| => UPDATE t SET n = 10 WHERE n = 1;
| UPDATE 1

```

The other locks the second row...

```
student$ psql
```

```

|| => \c admin_monitoring
|| You are now connected to database "admin_monitoring" as user "student".
||
|| => BEGIN;
|| BEGIN
||
|| => UPDATE t SET n = 200 WHERE n = 2;
|| UPDATE 1

```

Now, the first transaction tries to change the second row and waits for it to release...

```
| => UPDATE t SET n = 20 WHERE n = 2;
```

While the second transaction waits for the first row to release...

```
|| => UPDATE t SET n = 100 WHERE n = 1;
```

...and so a deadlock occurs. The server terminates one of the transactions:

```

|| ERROR:  deadlock detected
|| DETAIL:  Process 39229 waits for ShareLock on transaction 739; blocked by process 39101.
||          Process 39101 waits for ShareLock on transaction 740; blocked by process 39229.
||          HINT:  See server log for query details.
||          CONTEXT:  while updating tuple (0,1) in relation "t"

```

The other transaction gets unblocked:

```
| UPDATE 1
```

Check the message log:

```
student$ sudo tail -n 8 /var/log/postgresql/postgresql-16-main.log
```

```
2025-09-24 17:10:23.149 MSK [39229] student@admin_monitoring ERROR: deadlock detected
2025-09-24 17:10:23.149 MSK [39229] student@admin_monitoring DETAIL: Process 39229 waits
for ShareLock on transaction 739; blocked by process 39101.
    Process 39101 waits for ShareLock on transaction 740; blocked by process 39229.
    Process 39229: UPDATE t SET n = 100 WHERE n = 1;
    Process 39101: UPDATE t SET n = 20 WHERE n = 2;
2025-09-24 17:10:23.149 MSK [39229] student@admin_monitoring HINT: See server log for
query details.
2025-09-24 17:10:23.149 MSK [39229] student@admin_monitoring CONTEXT: while updating
tuple (0,1) in relation "t"
2025-09-24 17:10:23.149 MSK [39229] student@admin_monitoring STATEMENT: UPDATE t SET n =
100 WHERE n = 1;
```

1. Install the `pg_stat_statements` extension.
Execute several queries.
See what information gets into the `pg_stat_statements` view.

1. To install the extension, before executing the `CREATE EXTENSION` command, change the value of the *shared_preload_libraries* parameter, and restart the server.

<https://postgrespro.com/docs/postgresql/16/pgstatstatements>

1. The pg_stat_statements Extension

The extension collects planning and execution statistics for all queries.

For the extension to work, a module with the same name has to be loaded. To do that, add the module name to `shared_preload_libraries` and restart the server. This is usually done through `postgresql.conf`, but for the purpose of the demo we will set it using the `ALTER SYSTEM` command.

```
=> ALTER SYSTEM SET shared_preload_libraries = 'pg_stat_statements';
```

ALTER SYSTEM

```
=> \q
```

```
student$ sudo pg_ctlcluster 16 main restart
```

```
student$ psql
```

```
=> CREATE DATABASE admin_monitoring;
```

CREATE DATABASE

```
=> \c admin_monitoring
```

You are now connected to database "admin_monitoring" as user "student".

```
=> CREATE EXTENSION pg_stat_statements;
```

CREATE EXTENSION

Now, run some queries:

```
=> CREATE TABLE t(n numeric);
```

CREATE TABLE

```
=> SELECT format('INSERT INTO t VALUES (%L)', x)
FROM generate_series(1,5) AS x \gexec
```

```
INSERT 0 1
INSERT 0 1
INSERT 0 1
INSERT 0 1
INSERT 0 1
```

```
=> DELETE FROM t;
```

DELETE 5

```
=> DROP TABLE t;
```

DROP TABLE

Check the statistics for the most frequently executed query.

```
=> SELECT query, calls, total_exec_time
FROM pg_stat_statements
ORDER BY calls DESC LIMIT 1;
```

query	calls	total_exec_time
INSERT INTO t VALUES (\$1)	5	0.14766400000000002

(1 row)

The shared library is no longer required — restoring the original parameter value:

```
=> ALTER SYSTEM RESET shared_preload_libraries;
```

ALTER SYSTEM

```
=> \q
```

```
student$ sudo pg_ctlcluster 16 main restart
```