



# PostgreSQL DBA

Step by step guide to becoming a modern PostgreSQL DBA

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The intent of this guide is to give you an idea about the DBA landscape and to help guide your learning if you are confused. The roadmap is highly opinionated — neither, knowing everything listed in the roadmap, nor the order of items given in the roadmap is required to be followed in order to be a DBA.

## Learn basic RDBMS terms and concepts

Get basic understanding of Postgres key terms and basic RDBMS concepts.

- **Object model:** data types, columns, rows, tables, schemas, databases, queries.
- **Relational model:** domains, attributes, tuples, relations, constraints, NULL.
- **Databases high-level concepts:** ACID, MVCC, transactions, write-ahead log, query processing.
- **Links:**
  - [Postgres Glossary](#)
  - SQL and Relational Theory - Christopher J. Date, 2009
  - Database Design and Relational Theory - Christopher J. Date, 2012

## Learn how to install and run PostgreSQL

Get practical skills of how to set up and run Postgres to get a working environment for further learning.

- Using package managers (APT, YUM, etc.)
- Using `docker` .
- Managing Postgres service using `systemd` (start, stop, restart, reload).
- Managing Postgres service using `pg_ctl` , or OS-specific tools (like `pg_ctlcluster` ).
- Connect to Postgres using `psql` .
- Deploy database service in cloud environment (AWS, GCE, Azure, Heroku, DigitalOcean, etc...).
- **Links:**
  - [Official download and install instructions](#)
  - [Official Docker images](#)

## Learn SQL concepts

Get practical skills of how to create and manipulate database objects and how to execute queries using `psql` client.

- Understand basic data types.
- **DML queries:** querying data, modifying data, filtering data, joining tables.
  - **Advanced topics:** transactions, CTE, subqueries, lateral join, grouping, set operators
- **DDL queries:** managing tables and schemas (create, alter, drop).
- Import and export data using `COPY` .
- **Links:**
  - [DB Fiddle](#)

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- [PostgreSQL Getting Started](#)
- [The SQL Language](#)

## Learn how to configure Postgres

Get understanding of the main aspects of how Postgres could be configured. Deep understanding of Postgres internals is not yet necessary here.

- postgresql.conf:
  - Resources usage
  - Write-ahead Log
  - Checkpoints and Background Writer
  - Cost-based vacuum and auto-vacuum
  - Replication
  - Query planner
  - Reporting, logging and statistics
  - Adding extra extensions
  - ...keep exploring other configuration options
- Links:
  - [Postgresqlco.nf](#)

## Learn Postgres security concepts

Get understanding about basic security concepts and common ways of how to deploy secure configurations.

- Authentication models, roles, pg\_hba.conf, SSL settings.
- **Objects privileges:** grant/revoke, default privileges.
- **Advanced topics** - row-level security, selinux.
- Links:
  - [Client authentication](#)
  - [Roles and users managements](#)

## Develop infrastructure DBA skills

Get practical skills of how to deploy, extend, maintain and support Postgres installations and 3rd-party Postgres ecosystem software.

- **Replication:** streaming replication, logical replication
- **Backup/recovery tools:**
  - Built-in: `pg_dump`, `pg_dumpall`, `pg_restore`, `pg_basebackup`
  - 3rd-party: `barman`, `pgbackrest`, `pg_probackup`, `WAL-G`
  - Backup validation procedures
- **Upgrading procedures**
  - Minor and major upgrades using `pg_upgrade`
  - Upgrades using logical replication
- **Connection pooling:**
  - `Pgbouncer`
  - Alternatives: `Pgpool-II`, `Odyssey`, `Pgagroal`
- **Infrastructure monitoring:** `Prometheus`, `Zabbix`, other favourite monitoring solution
- **High availability and cluster management tools:**
  - `Patroni`
  - **Alternatives:** `Repmgr`, `Stolon`, `pg_auto_failover`, `PAF`
- **Applications Load Balancing and Service Discovery:** `Haproxy`, `Keepalived`, `Consul`
- **Deploy Postgres on Kubernetes:** Simple `StatefulSet` setup, `HELM`, operators

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## Learn how to automate routines

Get practical skills, learn automation tools and automate existing routine tasks.

- Automation using shell scripts or any other favourite language ( [Bash](#) , [Python](#) , [Perl](#) , etc)
- Configuration management: [Ansible](#) , [Salt](#) , [Chef](#) , [Puppet](#)

## Develop application DBA skills

Learn theory and get practical skills of how applications should work with Postgres

- **Migrations:**
  - practical patterns and antipatterns
  - tools: [liquibase](#) , [sqitch](#) , language-specific tools
- Data import/export, bulk loading and processing
- **Queues:**
  - practical patterns and anti-patterns
  - [Skytools](#) [PGQ](#)
- Data partitioning and sharding patterns.
- Database normalization and normal forms.
- Books:
  - The Art of PostgreSQL - Dimitri Fontaine, 2020

## Learn Postgres advanced topics

Here is important to continuously extend and develop existing knowledge about Postgres.

- **Low level internals:**
  - Processes and memory architecture
  - Vacuum processing
  - Buffer management
  - Lock management
  - [Physical storage and file layout](#)
  - [System catalog](#)
- **Fine-grained tuning:**
  - Per-user, per-database settings
  - [Storage parameters](#)
  - Workload-dependant tuning: OLTP, OLAP, HTAP
- **Advanced SQL topics:**
  - PL/pgSQL, procedures and functions, triggers
  - Aggregate and window functions
  - Recursive CTE
- **Links:**
  - [The Internals of PostgreSQL](#) for database administrators and system developers
  - [PL/pgSQL Guide](#)

## Learn Postgres troubleshooting techniques

Get basic understanding about troubleshooting tools and get practical skills of how to detect and resolve problems.

- **Operating system tools**
  - [top](#) ( [htop](#) , [atop](#) )
  - [sysstat](#)
  - [iotop](#)

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- `pg_stat_statements`
- **Postgres tools**
  - `pgcenter` - *personal recommendation*
- **Query analyzing:**
  - [EXPLAIN](#)
  - [Depesz](#) online EXPLAIN visualization tool
  - [PEV](#) online EXPLAIN visualization tool
  - [Tensor](#) online EXPLAIN visualization tool, RU language only
- **Log analyzing:**
  - `pgBadger`
  - Ad-hoc analyzing using `grep`, `awk`, `sed`, etc.
- **External tracing/profiling tools:** `gdb`, `strace`, `perf-tools`, `ebpf`, core dumps
- **Troubleshooting methods:** USE, RED, Golden signals
- **Links:**
  - [Linux Performance](#) by Brendan Gregg
  - [USE Method](#)

## Learn SQL optimization technics

Get understanding and practical skills of how to optimize SQL queries.

- **Indexes, and their use cases:** B-tree, Hash, GiST, SP-GiST, GIN, BRIN
- SQL queries patterns and anti-patterns
- SQL schema design patterns and anti-patterns
- **Links:**
  - [Use the Index, Luke](#) - a Guide to Database Performance for Developers
- **Books:**
  - SQL Antipatterns: Avoiding the Pitfalls of Database Programming - Bill Karwin, 2010

## Develop architect skills

Get deeper understanding of Postgres use cases and where Postgres is suitable and where is not.

- **Postgres forks and extensions:** `Greenplum`, `Timescaledb`, `Citus`, `Postgres-XL`, etc.
- RDBMS in general, benefits and limitations
- Differences between Postgres and other RDBMS and NoSQL databases


## Develop Postgres hacker skills

Get involved to Postgres community and contribute to Postgres; be a useful member of Postgres, and the open source community; use personal experience to help other people.

- Daily reading and answering in [mailing lists](#)
  - `pgsql-general`
  - `pgsql-admin`
  - `pgsql-performance`
  - `pgsql-hackers`
  - `pgsql-bugs`
- Reviewing patches
- Writing patches, attending in [Commitfests](#)

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