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For Your Eyes Only: Roles, Privileges, and Security in PostgreSQL

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FOSDEM Postgres Devroom 2024

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Agenda

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Disclaimer(s)

We won't cover everything

Content is applicable to currently supported versions of PostgreSQL (12+)

(and most of it for 9.6+)

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The Building Blocks

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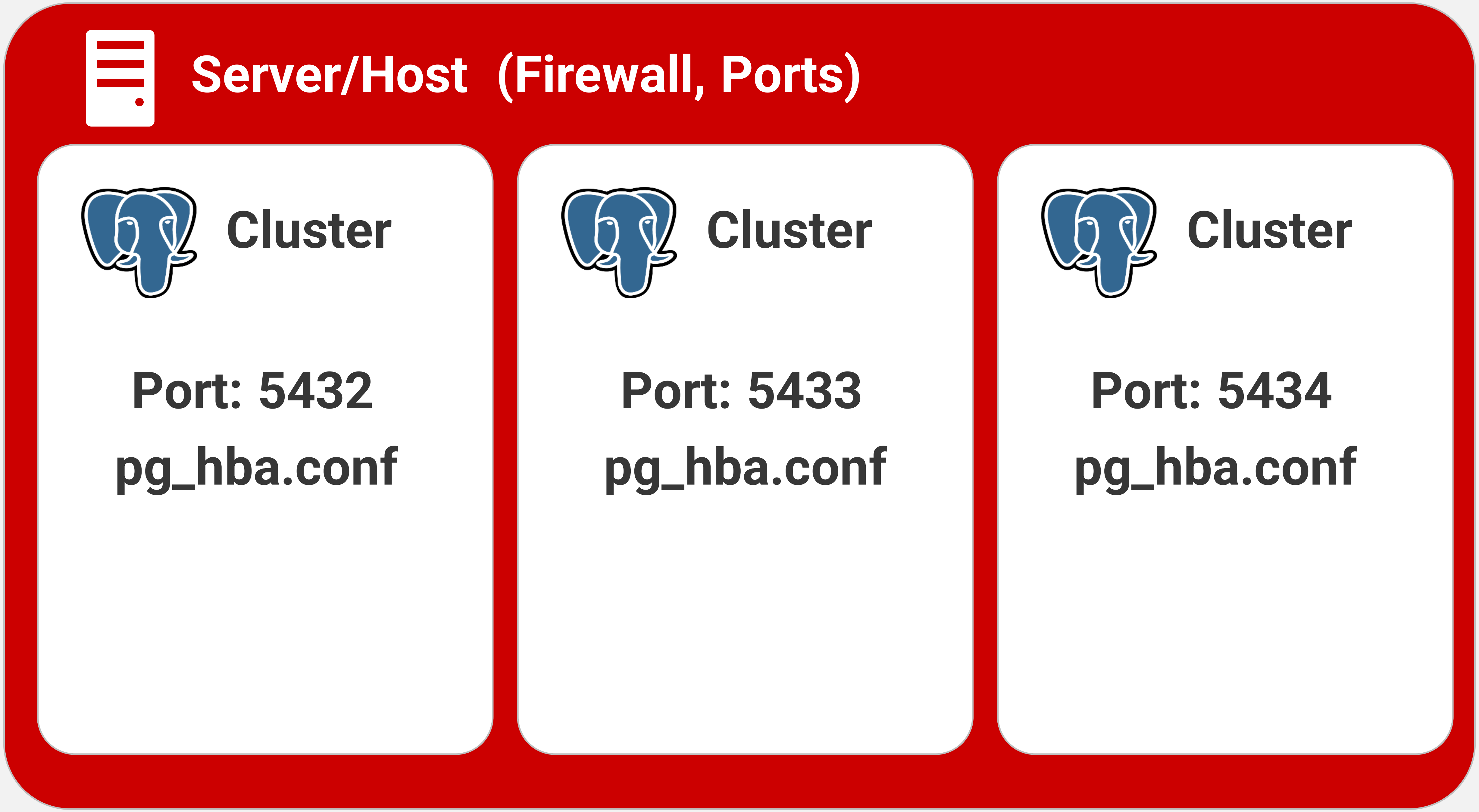
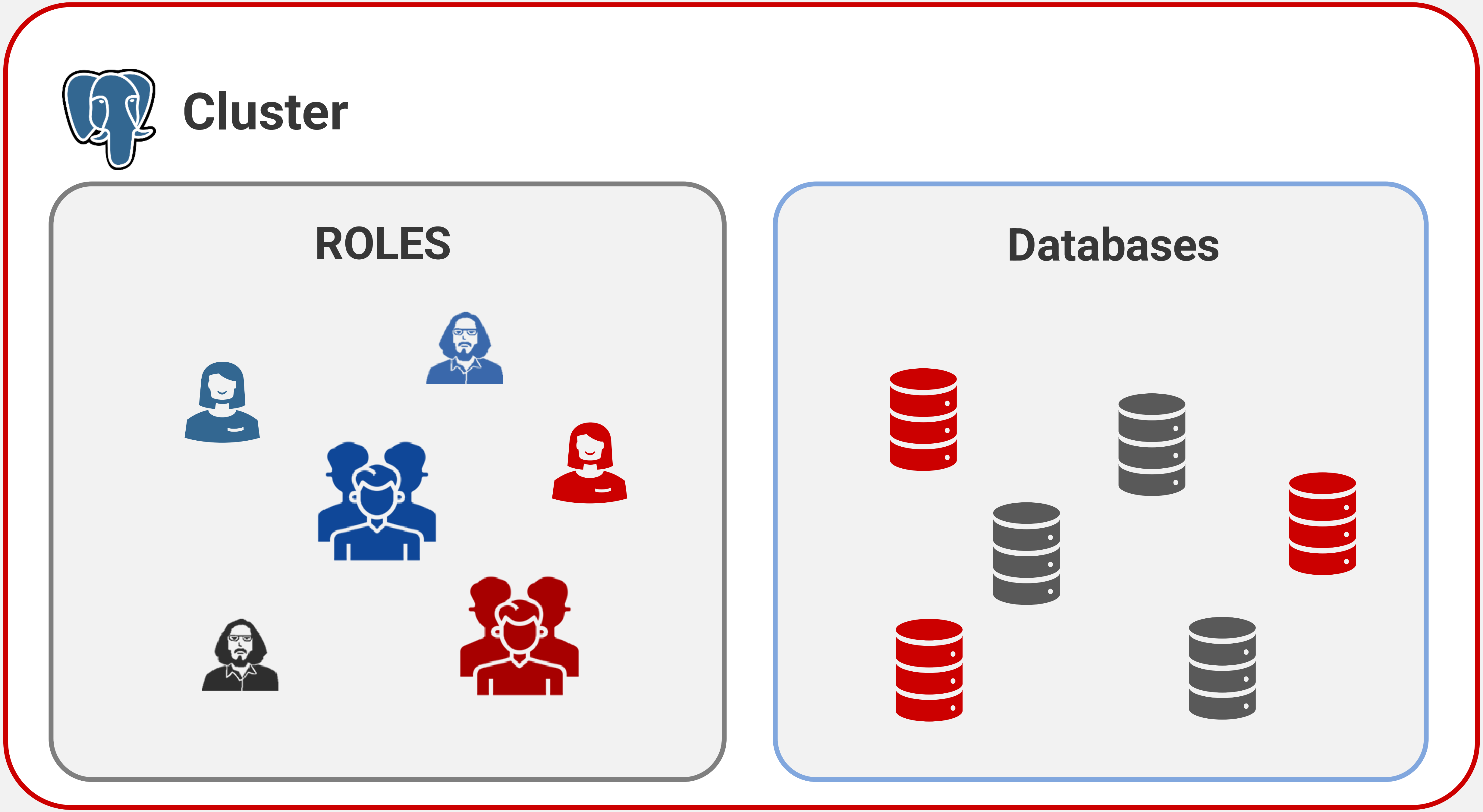
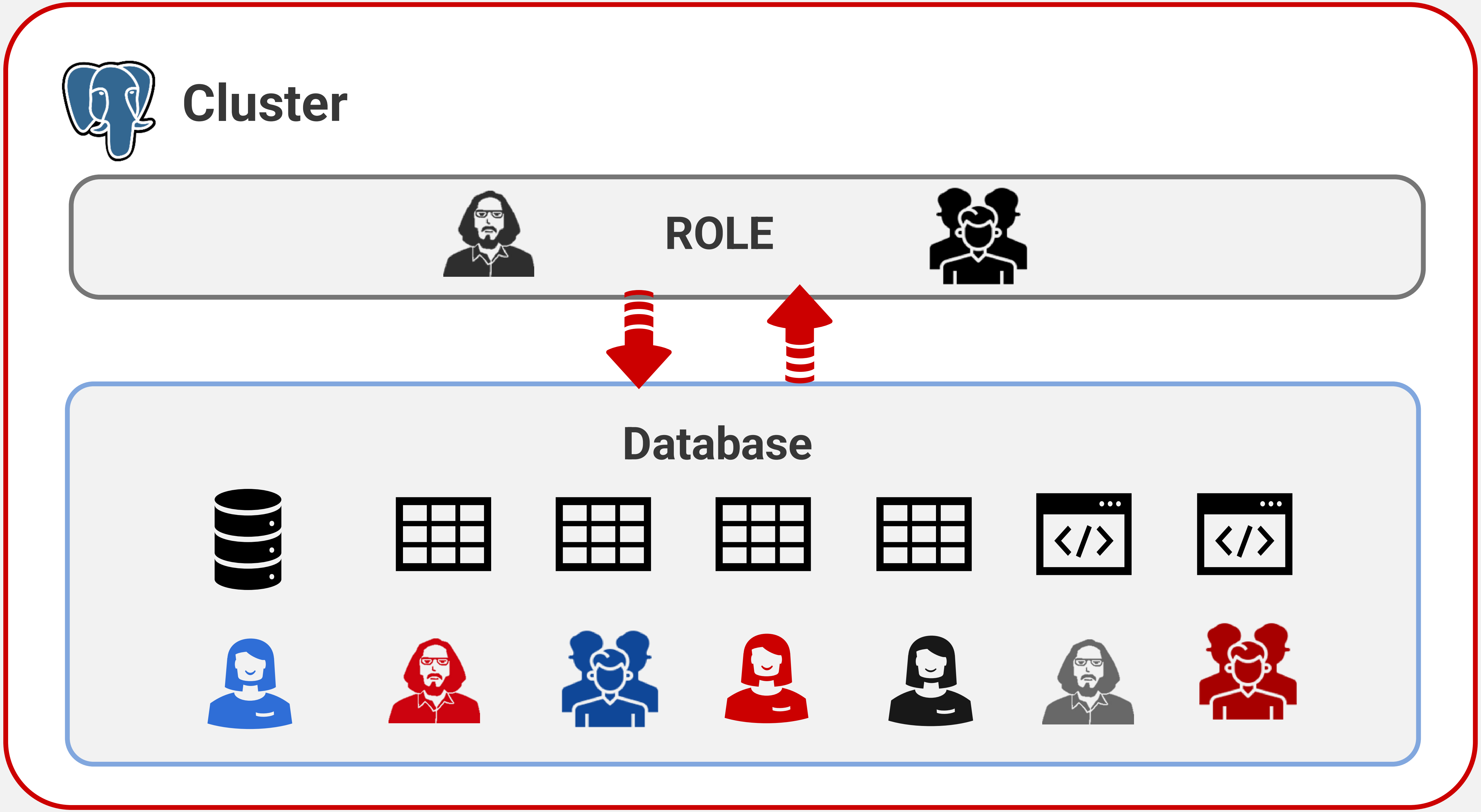

Server/Host (Firewall, Ports)
Cluster
Port: 5432
pg_hba.conf
Cluster
Port: 5433
pg_hba.conf
Cluster
Port: 5434
pg_hba.conf


Cluster
ROLES
Databases


Cluster
ROLE
Database

pg_hba.conf

- First layer of authentication
- Similar to a firewall ruleset for PostgreSQL
- Cloud vendors largely manage this for you

Which hosts & roles, can connect to what databases, using what authentication method?

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```
# Allow any user on the local system to connect to any database with
# any database user name using Unix-domain sockets (the default for local
# connections).
#
# TYPE  DATABASE        USER            ADDRESS                 METHOD
local   all             all                                     trust

# The same using local loopback TCP/IP connections.
#
# TYPE  DATABASE        USER            ADDRESS                 METHOD
host    all             all             127.0.0.1/32            trust

# Allow any user from host 192.168.12.10 to connect to database
# "postgres" if the user's password is correctly supplied.
#
# TYPE  DATABASE        USER            ADDRESS                 METHOD
host    postgres        all             192.168.12.10/32        scram-sha-256
```

https://www.postgresql.org/docs/current/auth-pg-hba-conf.html

Avoid using 'TRUST' method at all costs!*

*(can be useful for local development machines… but still…)

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Use scram-sha-256 for password authentication

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Roles

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Roles

- Own databases, schemas, and objects
  - Tables, Functions, Views, Etc.
- Have cluster-level privileges (attributes)
- Granted privileges to databases, schemas, and objects
- Can possibly grant privileges to other roles

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Users and Groups

- Semantically the same as roles
- By Convention:
  - User = `LOGIN`
  - Group = `NOLOGIN`
- PostgreSQL 8.2+ `CREATE (USER|GROUP)` is an alias

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```sql
CREATE USER user1 WITH PASSWORD 'abc123' INHERIT;
```

```sql
CREATE GROUP group1 WITH INHERIT;
```

```sql
CREATE ROLE user1 WITH LOGIN PASSWORD 'abc123' INHERIT;
```

Role Attributes

- Predefined settings that can be enabled/disabled for a given role
- Essentially cluster-level (non-database) privileges
- Map to columns in `pg_catalog.pg_roles`

PostgreSQL 15 Attributes

LOGIN

SUPERUSER

CREATEROLE

CREATEDB

REPLICATION LOGIN

PASSWORD

INHERIT

BYPASSRLS

CONNECTION LIMIT

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Unless otherwise set, new roles can <u>INHERIT privileges</u> from other roles and have <u>unlimited connections</u>

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Role Specific Session Settings

- Roles can set role-specific defaults for run-time configuration at connection time
- Any settings that can be set via SET command can be altered for a ROLE

```
ALTER ROLE user1 SET jit TO off;

ALTER ROLE user1 RESET jit;
```

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Special Roles

PostgreSQL Superuser

PostgreSQL Superuser

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PostgreSQL Superuser

- 🦸 is created by default when the cluster is initialized
- Typically named `postgres` because the system process user initiates a `initdb`
- Bypasses all security checks except `LOGIN`
- Full privilege to do "anything"
- Treat superuser with care (like `root` on Linux)

Most cloud providers do not provide superuser access

Superuser-like

Superuser-like

- Create a role with the right level of control
- Recommend adding `CREATEROLE` and `CREATEDB`
- Allows user management and database ownership
- May still limit some actions (e.g. installing extensions limited to superuser)

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Privileges

Privileges

- The set of access rights to databases, schemas, and objects
- Can be granted (`GRANT`) or revoked (`REVOKE`) by a role with authority
- Explicit `GRANT` or `REVOKE` only impacts **existing objects**

PostgreSQL 15 Privileges

SELECT	CREATE
INSERT	**CONNECT**
UPDATE	**TEMPORARY**
DELETE	**EXECUTE**
TRUNCATE	**USAGE**
REFERENCES	SET
TRIGGER	ALTER SYSTEM

PUBLIC Role

- All roles are granted implicit membership to `PUBLIC`
- The public role cannot be deleted
- Granted `CONNECT`, `USAGE`, `TEMPORARY`, and `EXECUTE` by default
- <=PG14: `CREATE` on the public schema by default
- >=PG15: No `CREATE` on public schema by default

Security Best Practice for PUBLIC

- Revoke all privileges on the public schema from the `PUBLIC` role
- Revoke all database privileges from the `PUBLIC` role (maybe)

```
REVOKE ALL ON SCHEMA public FROM PUBLIC;
REVOKE ALL ON DATABASE db_name FROM PUBLIC;
```

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Granting Privileges

```
-- grant the ability to create a schema
GRANT CREATE ON DATABASE app_db TO admin1;

-- see and create objects in schema
GRANT USAGE,CREATE IN SCHEMA demo_app TO dev1;

-- allow some roles only some privileges
GRANT SELECT,INSERT,UPDATE
ON ALL TABLES IN SCHEMA demo_app TO jr_dev;
```

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Granting Privileges

- Remember, explicit grants only effect existing database objects!

```
-- This will only grant to existing objects
GRANT ALL TO ALL TABLES IN SCHEMA public TO dev1;
```

More Detail on GRANT and REVOKE

What the privileges mean:

https://www.postgresql.org/docs/current/ddl-priv.html

How to GRANT privileges:

https://www.postgresql.org/docs/current/sql-grant.html

How to REVOKE privileges:

https://www.postgresql.org/docs/current/sql-revoke.html

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Inheritance

Privilege Inheritance

- Roles can be granted membership into another role
- If a role has `INHERIT` set, they automatically have usage of privileges from member roles
- The preferred method for managing group privileges

Granting Privileges

```
CREATE ROLE sr_dev WITH LOGIN password='abc' INHERIT;
CREATE ROLE rptusr WITH LOGIN password='123' INHERIT;
CREATE ROLE admin WITH NOLOGIN NOINHERIT;
CREATE ROLE ropriv WITH NOLOGIN NOINHERIT;

GRANT INSERT,UPDATE,DELETE ON ALL TABLES
     IN SCHEMA app TO admin;
GRANT SELECT ON ALL TABLES IN SCHEMA app TO ropriv;

GRANT admin,ropriv TO sr_dev;
GRANT ropriv TO rptusr;
```

Table access on 'app' schema

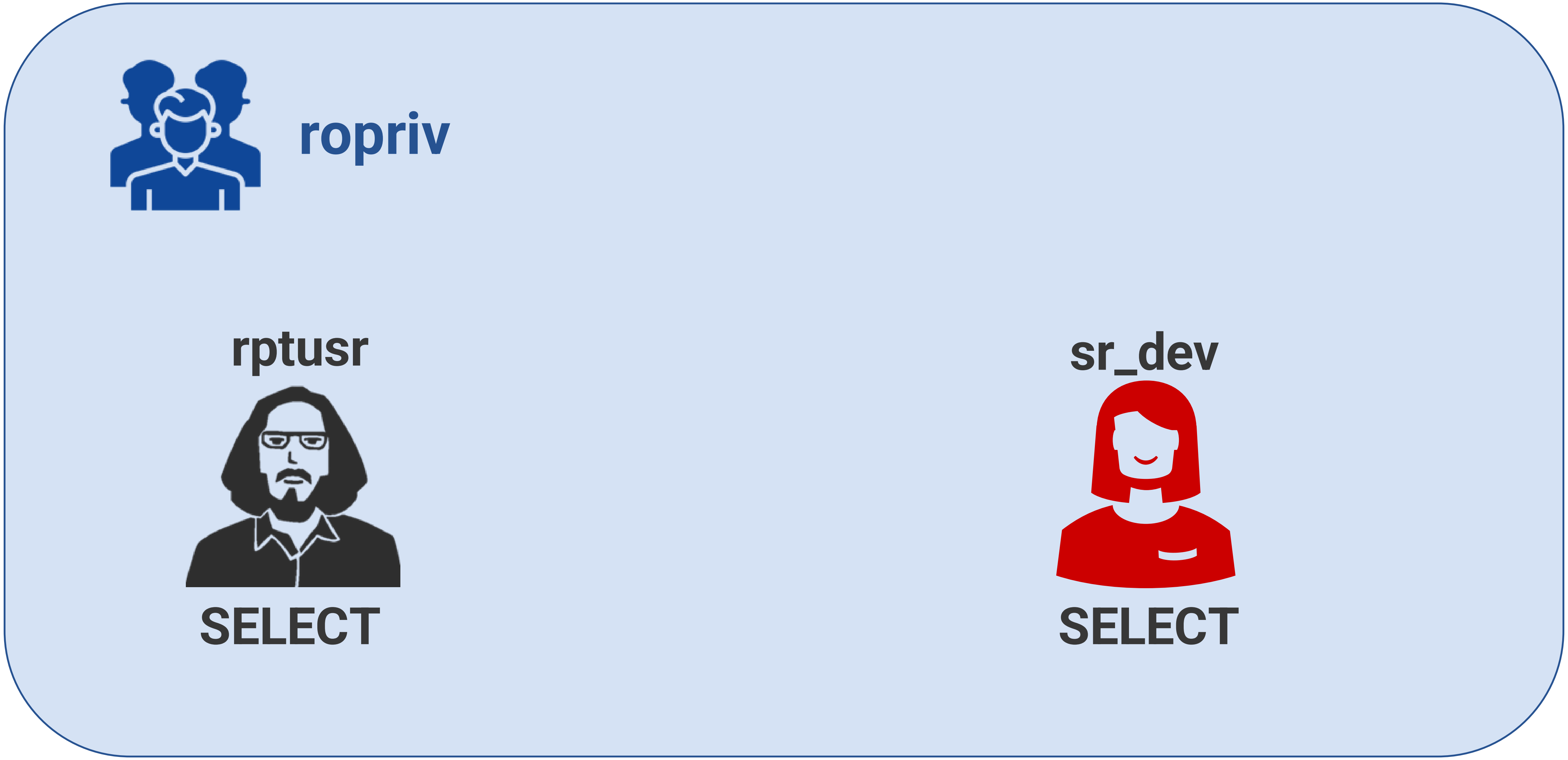
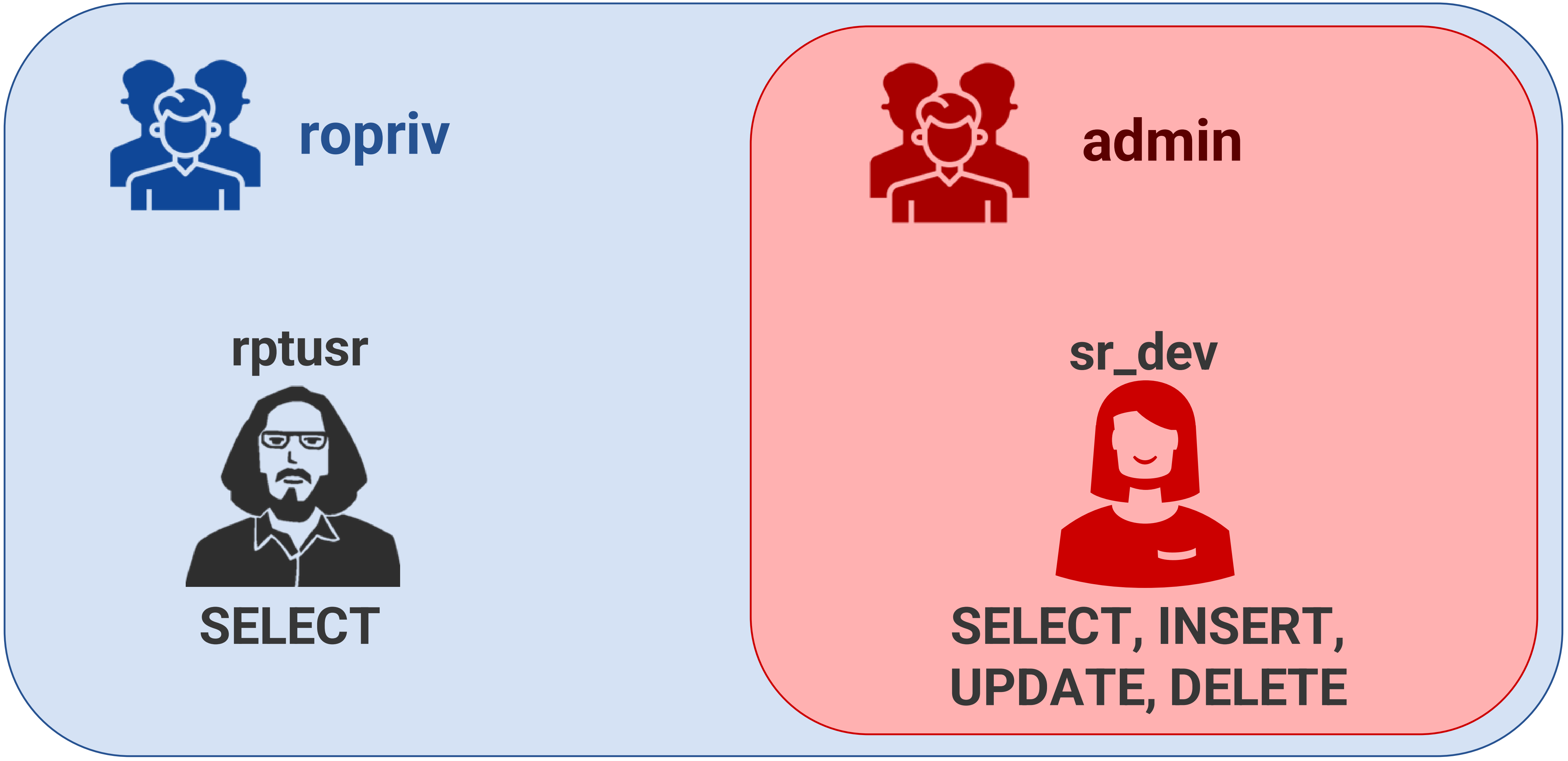


Table access on 'app' schema



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Object Ownership

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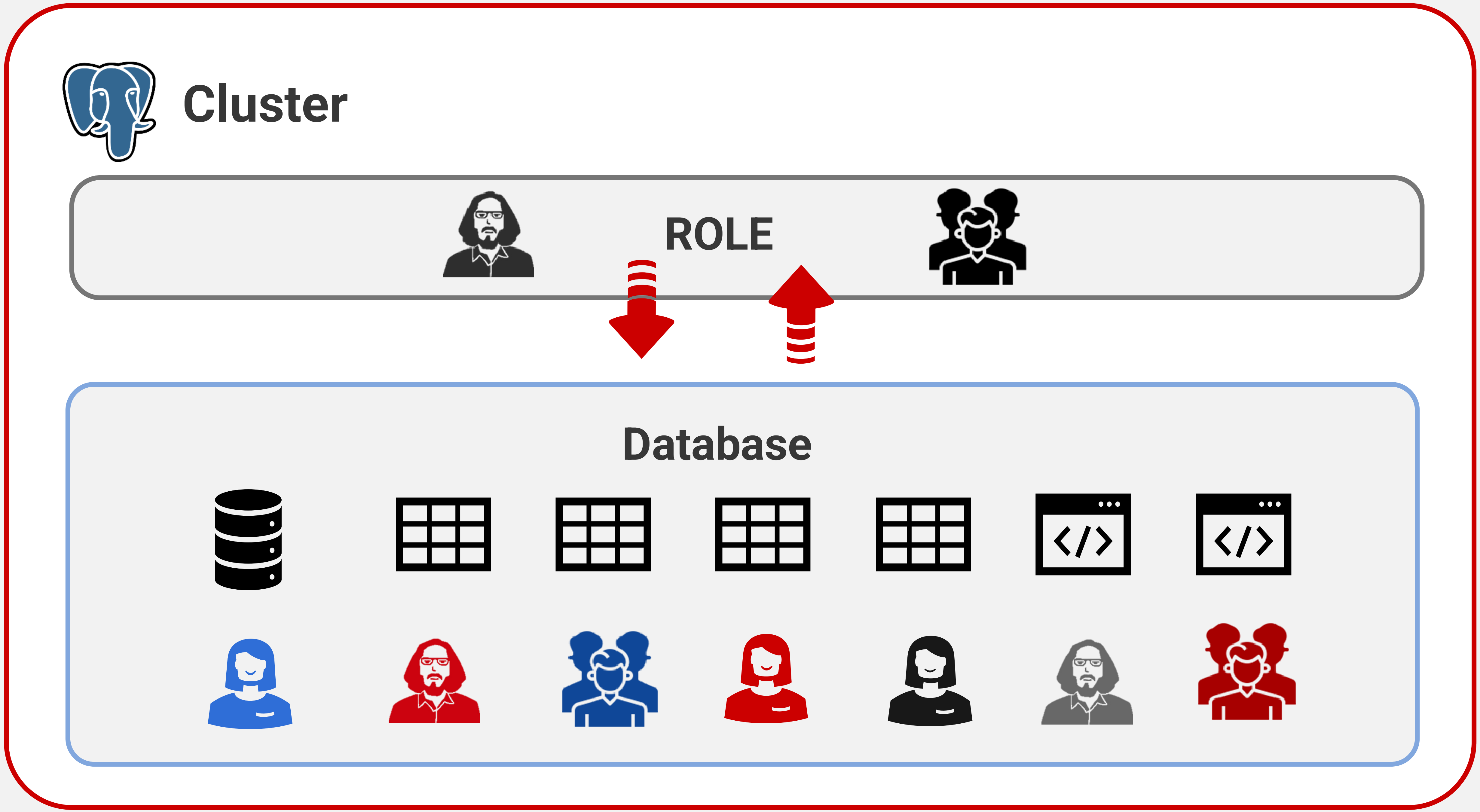
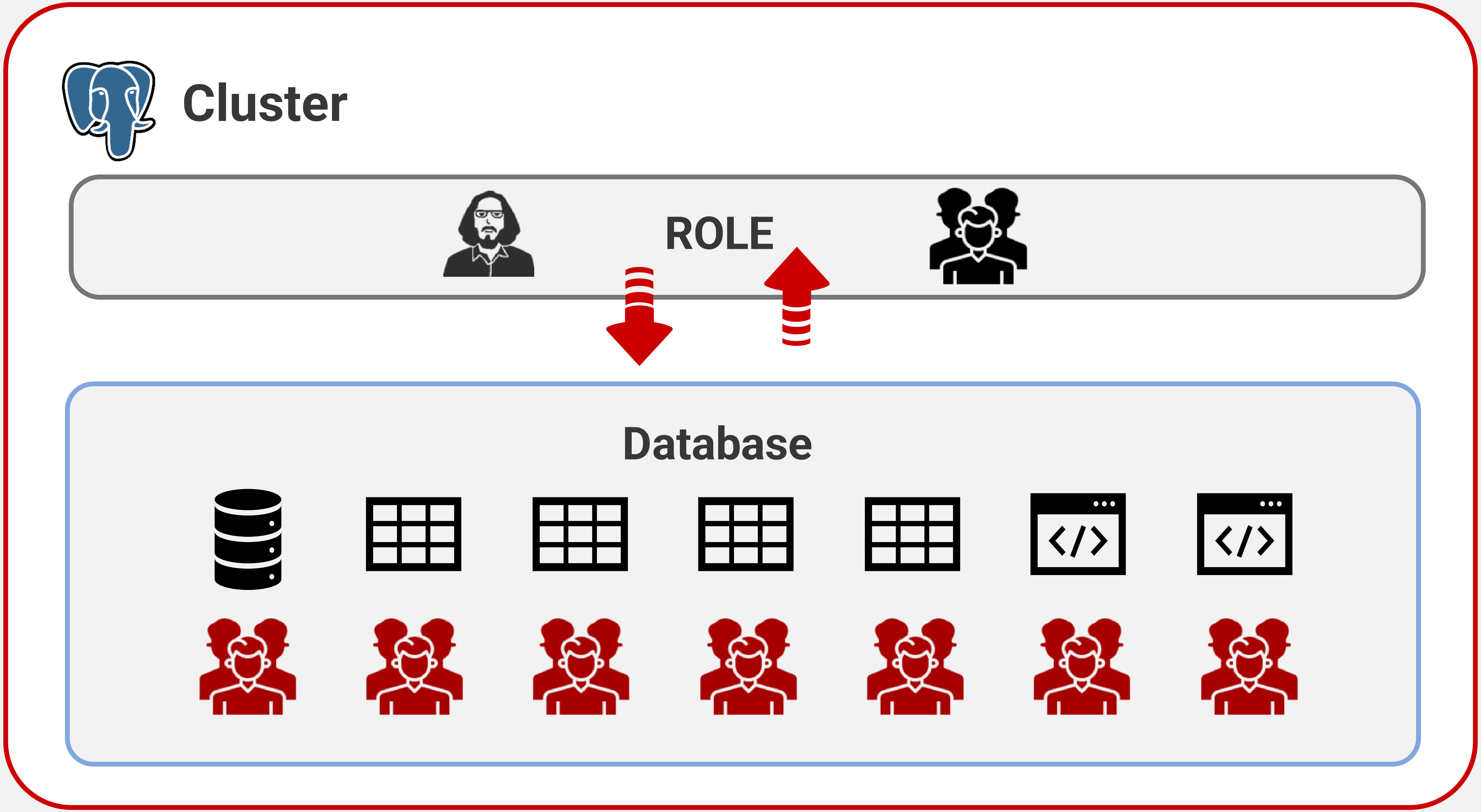
Object Ownership

- Object creator = owner
- Owner is a "superuser" of the objects they own
- Initial object access = **Principle of Least Privilege**
  - Unless specifically granted ahead of time, objects are owned and "accessible" by the creator/superuser only
- Roles can specify default privileges to `GRANT` for each object type that they create


Cluster
ROLE
Database


Cluster
ROLE
Database

Default Privileges

```
ALTER DEFAULT PRIVILEGES
GRANT SELECT ON TABLES TO public;


citusconn=> \ddp
                Default access privileges
  Owner    | Schema | Type  |     Access privileges
----------+---------+-------+---------------------------
 postgres |         | table | =r/postgres              +
          |         |       | postgres=arwdDxt/postgres
```

Providing Object Access

Option 1: (owner)

Explicitly `GRANT` access after object creation

Option 2: (owner)

`ALTER DEFAULT PRIVILEGES`

Option 3:

`SET ROLE` to **app role** before creation with correct **default privileges**

Option 4: (PG14+)

Use `pg_read_all_data` or `pg_write_all_data` predefined roles

Object Ownership Security

- `CREATE OR REPLACE` doesn't change ownership
- Security issue with users that have create permissions (particularly the `public` schema)
- PostgreSQL 15 removes default create permissions from PUBLIC on the public schema

DEMO

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Predefined Roles

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Predefined Roles

- Cluster-level roles that can be granted
- Work starting in PostgreSQL 14+ to simplify privilege management
- `pg_read_all_data` (for example)
  - If a role that has `CONNECT` to a database, they can `SELECT` from all tables

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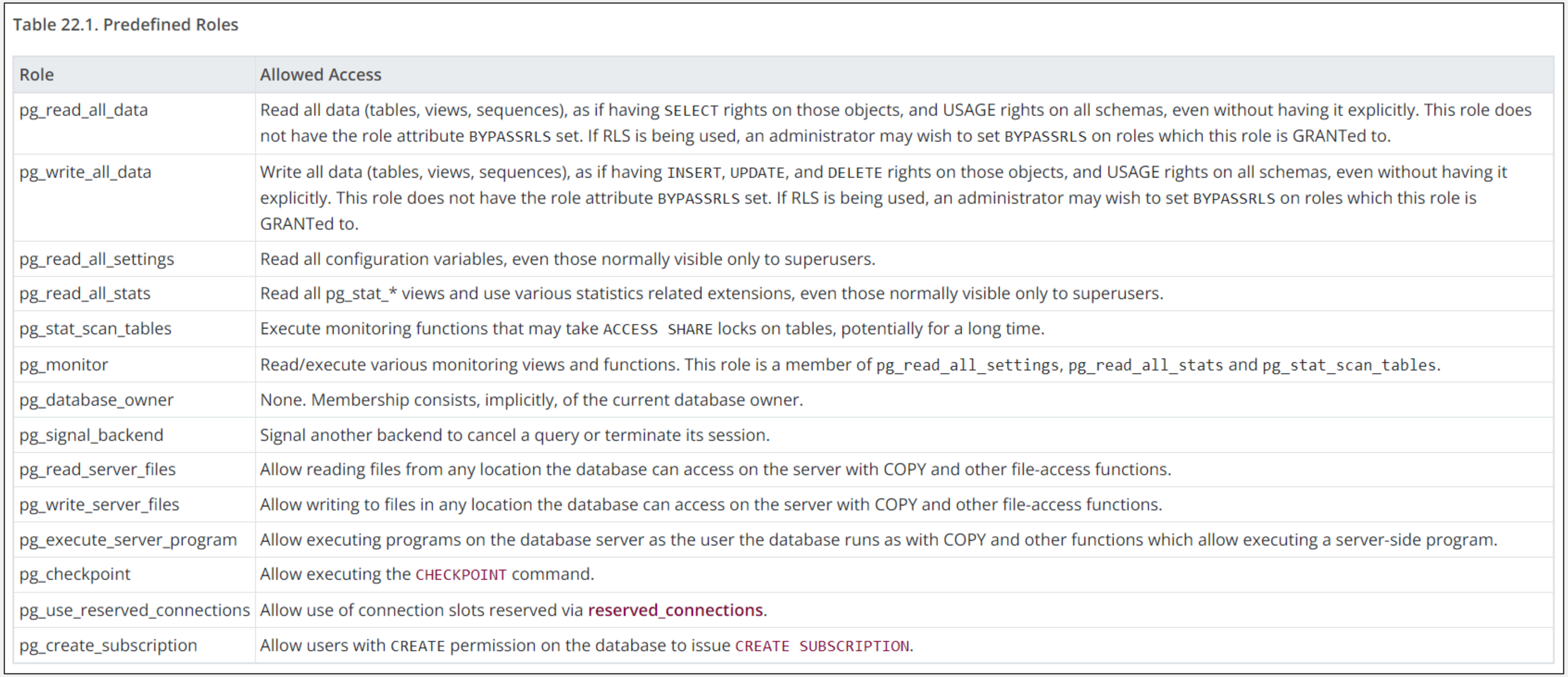

Table 22.1. Predefined Roles

Role	Allowed Access
pg_read_all_data	Read all data (tables, views, sequences), as if having `SELECT` rights on those objects, and USAGE rights on all schemas, even without having it explicitly. This role does not have the role attribute `BYPASSRLS` set. If RLS is being used, an administrator may wish to set `BYPASSRLS` on roles which this role is GRANTed to.
pg_write_all_data	Write all data (tables, views, sequences), as if having `INSERT`, `UPDATE`, and `DELETE` rights on those objects, and USAGE rights on all schemas, even without having it explicitly. This role does not have the role attribute `BYPASSRLS` set. If RLS is being used, an administrator may wish to set `BYPASSRLS` on roles which this role is GRANTed to.
pg_read_all_settings	Read all configuration variables, even those normally visible only to superusers.
pg_read_all_stats	Read all pg_stat_* views and use various statistics related extensions, even those normally visible only to superusers.
pg_stat_scan_tables	Execute monitoring functions that may take `ACCESS SHARE` locks on tables, potentially for a long time.
pg_monitor	Read/execute various monitoring views and functions. This role is a member of `pg_read_all_settings`, `pg_read_all_stats` and `pg_stat_scan_tables`.
pg_database_owner	None. Membership consists, implicitly, of the current database owner.
pg_signal_backend	Signal another backend to cancel a query or terminate its session.
pg_read_server_files	Allow reading files from any location the database can access on the server with COPY and other file-access functions.
pg_write_server_files	Allow writing to files in any location the database can access on the server with COPY and other file-access functions.
pg_execute_server_program	Allow executing programs on the database server as the user the database runs as with COPY and other functions which allow executing a server-side program.
pg_checkpoint	Allow executing the `CHECKPOINT` command.
pg_use_reserved_connections	Allow use of connection slots reserved via **reserved_connections**.
pg_create_subscription	Allow users with `CREATE` permission on the database to issue `CREATE SUBSCRIPTION`.

https://www.postgresql.org/docs/current/predefined-roles.html

What Questions do you have?

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🎉 THANK YOU! 🎉

github.com/ryanbooz/presentations

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