

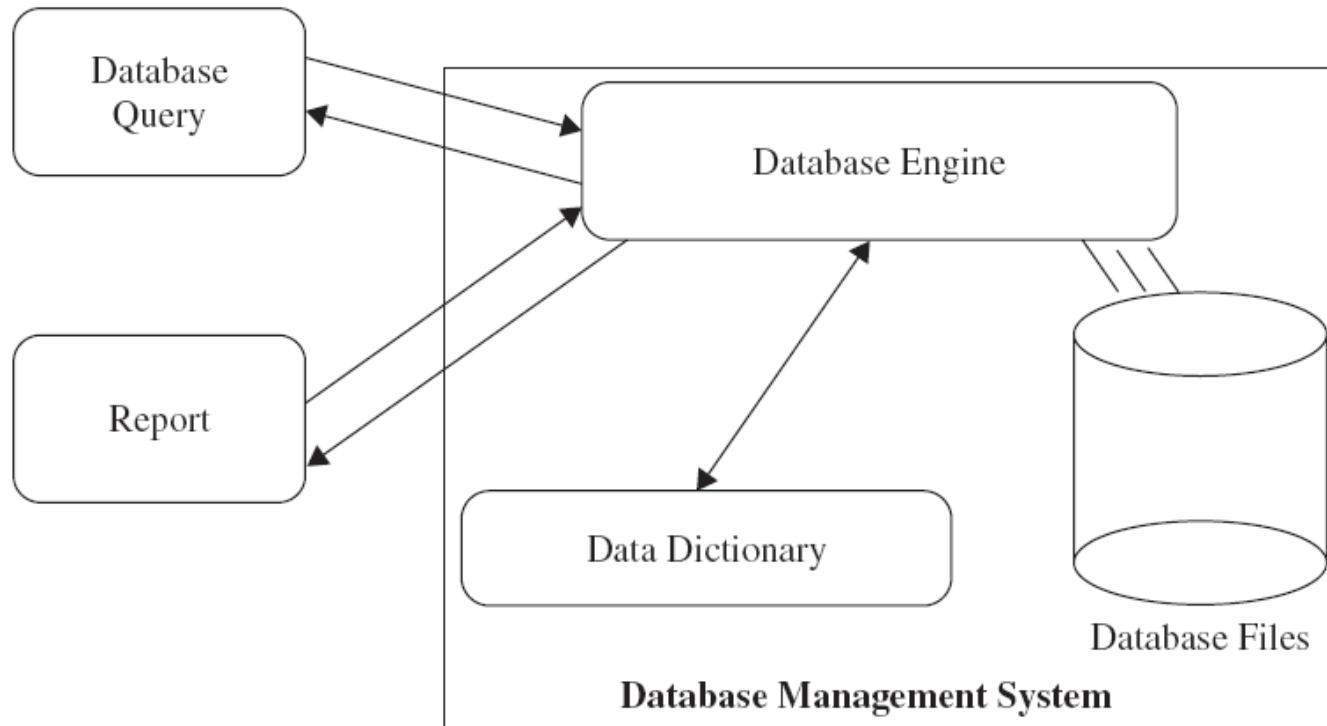
# Introduction to PostgreSQL

# Outline

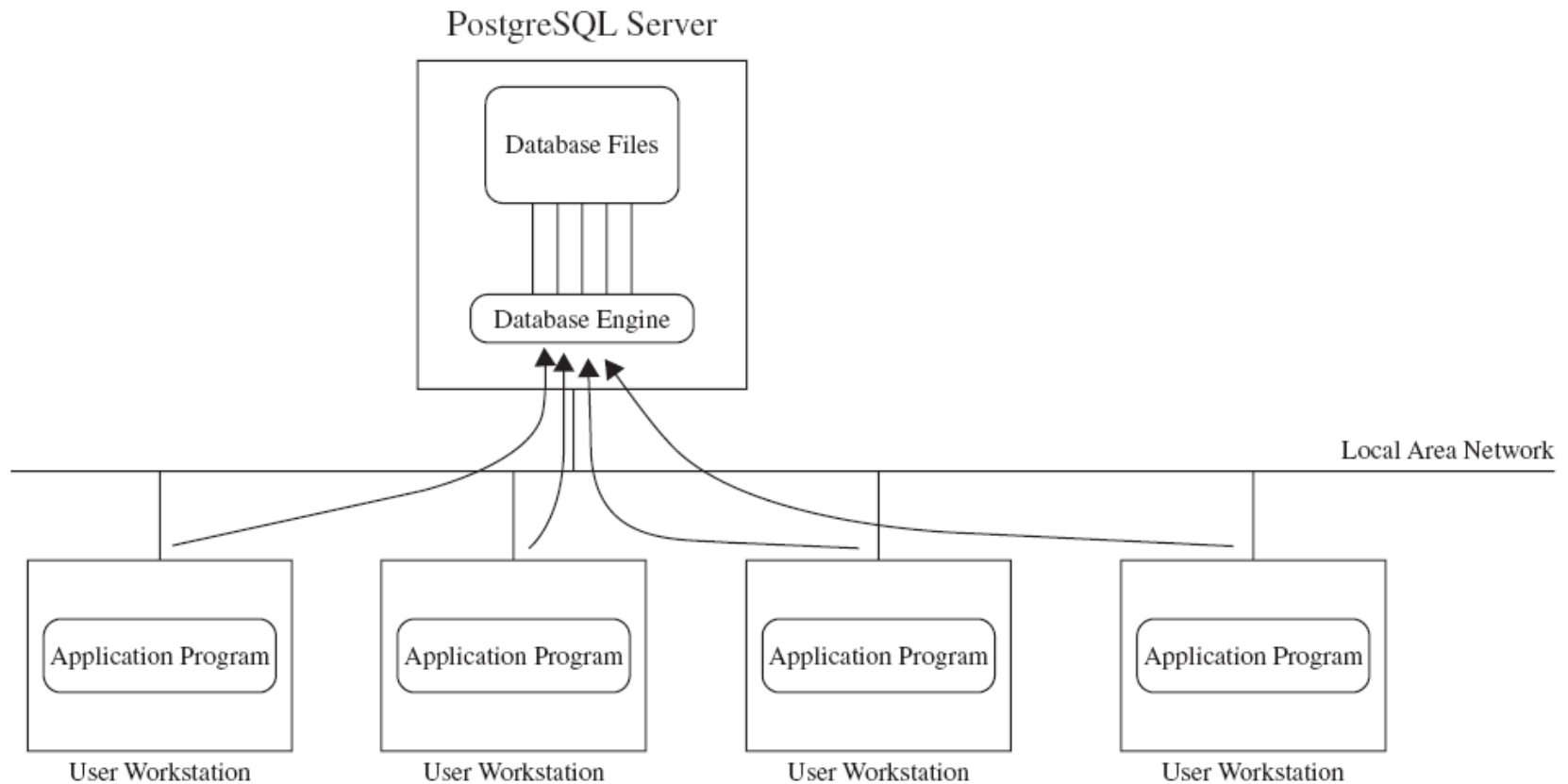
1. Database environments
2. Comparing PostgreSQL
3. Installing PostgreSQL on Windows
4. The PostgreSQL Files and Programs

# 1. Database environments

# A Simple Database engine



# A multiuser PostgreSQL environment



# PostgreSQL

- **Scalable.** Vertical scalability is a hallmark of PostgreSQL. Considering that almost any custom software solution tends to grow, resulting in database extension, this particular option certainly supports business growth and development.
- **Support for custom data types.** PostgreSQL natively supports a large number of data types by default, such as JSON, XML, H-Store, and others. PostgreSQL takes advantage of it, being one of the few relational databases with strong support for NoSQL features. Additionally, it allows users to define their own data types.
- **Easily-integrated third-party tools.**
- **Free, Open-source and community-driven.** Postgres is completely open-source and supported by its community, which strengthens it as a complete ecosystem. Additionally, developers can always expect free and prompt community assistance

# 3. Installing PostgreSQL on Windows

# Download

<http://www.postgresql.org/download/windows>

➔ **Download the installer** certified by EDB for all supported PostgreSQL versions

(Latest version 15)

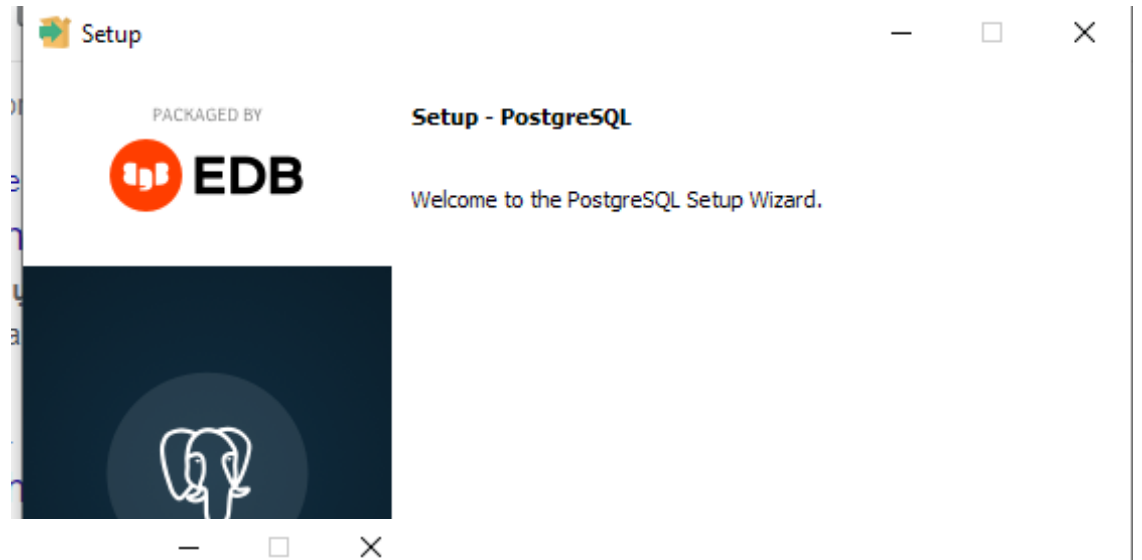
- The graphical installer for PostgreSQL includes
  - the ***PostgreSQL server***
  - ***pgAdmin IV***: a graphical tool for managing and developing your databases
  - and ***StackBuilder***: a package manager that can be used to download and install additional PostgreSQL applications and drivers



# Install and test

- Install
- Stop/start server (run as administrator)
- Connect to server from pgAdmin4

# Install



Setup

## Installation Directory



Please specify the directory where PostgreSQL will be installed.

Installation Directory



< Back

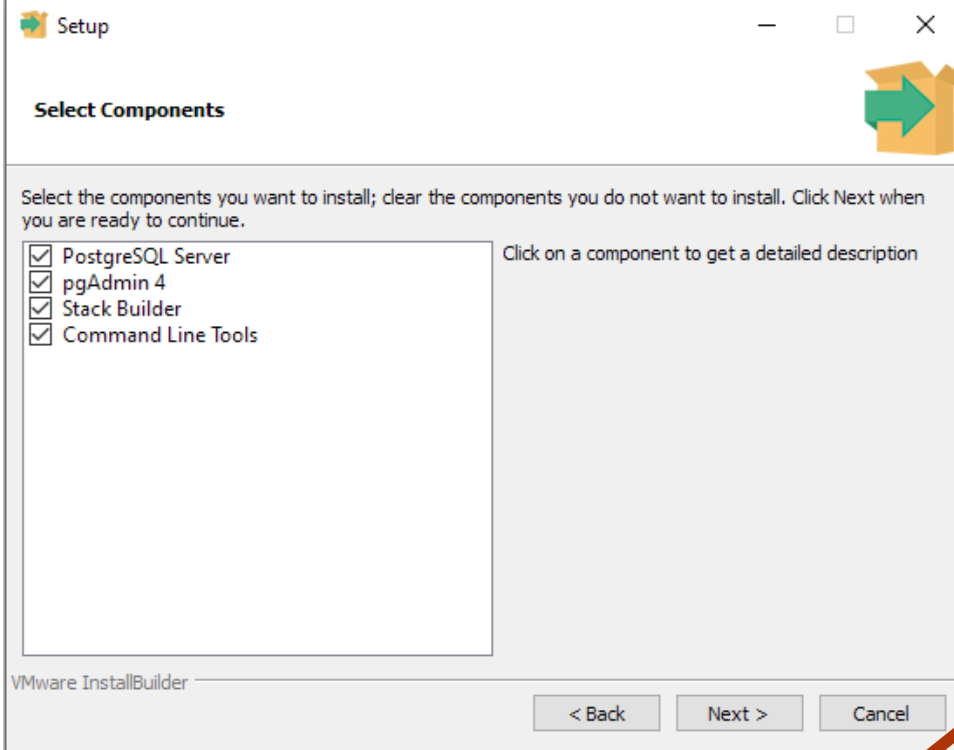
Next >

Cancel

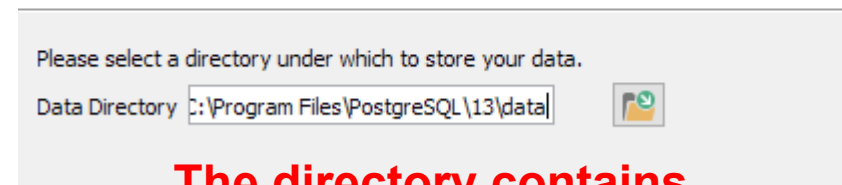
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Next >

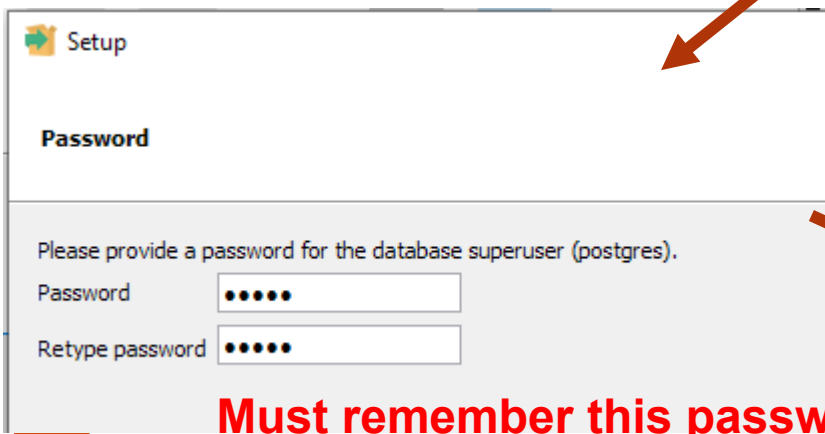
Cancel



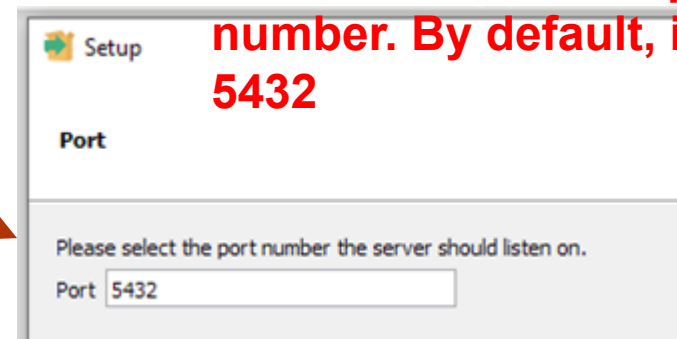
### Data Directory



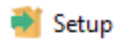
**The directory contains all data files**



**Must remember this password**



**Must remember the port number. By default, it is 5432**

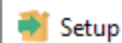


Setup

### Advanced Options

Select the locale to be used by the new database cluster.

Locale [Default locale] ▼



Setup

### Pre Installation Summary

The following settings will be used for the installation::

Installation Directory: C:\Program Files\PostgreSQL\13  
Server Installation Directory: C:\Program Files\PostgreSQL\13  
Data Directory: C:\Program Files\PostgreSQL\13\data  
Database Port: 5432  
Database Superuser: postgres  
Operating System Account: NT AUTHORITY\NetworkService  
Database Service: postgresql-x64-13  
Command Line Tools Installation Directory: C:\Program Files\PostgreSQL\13  
pgAdmin4 Installation Directory: C:\Program Files\PostgreSQL\13\pgAdmin 4  
Stack Builder Installation Directory: C:\Program Files\PostgreSQL\13



Setup

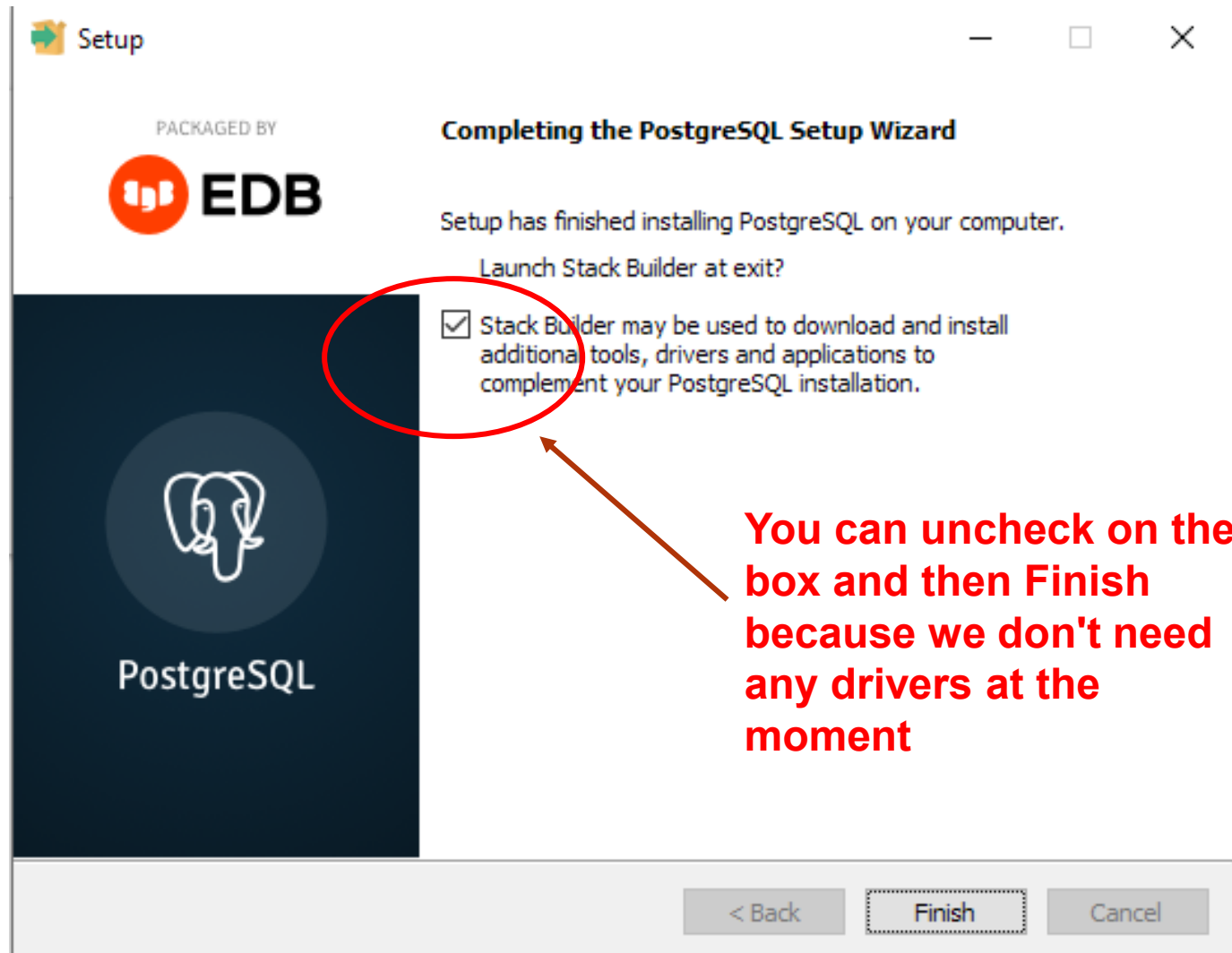
### Installing

Please wait while Setup installs PostgreSQL on your computer.

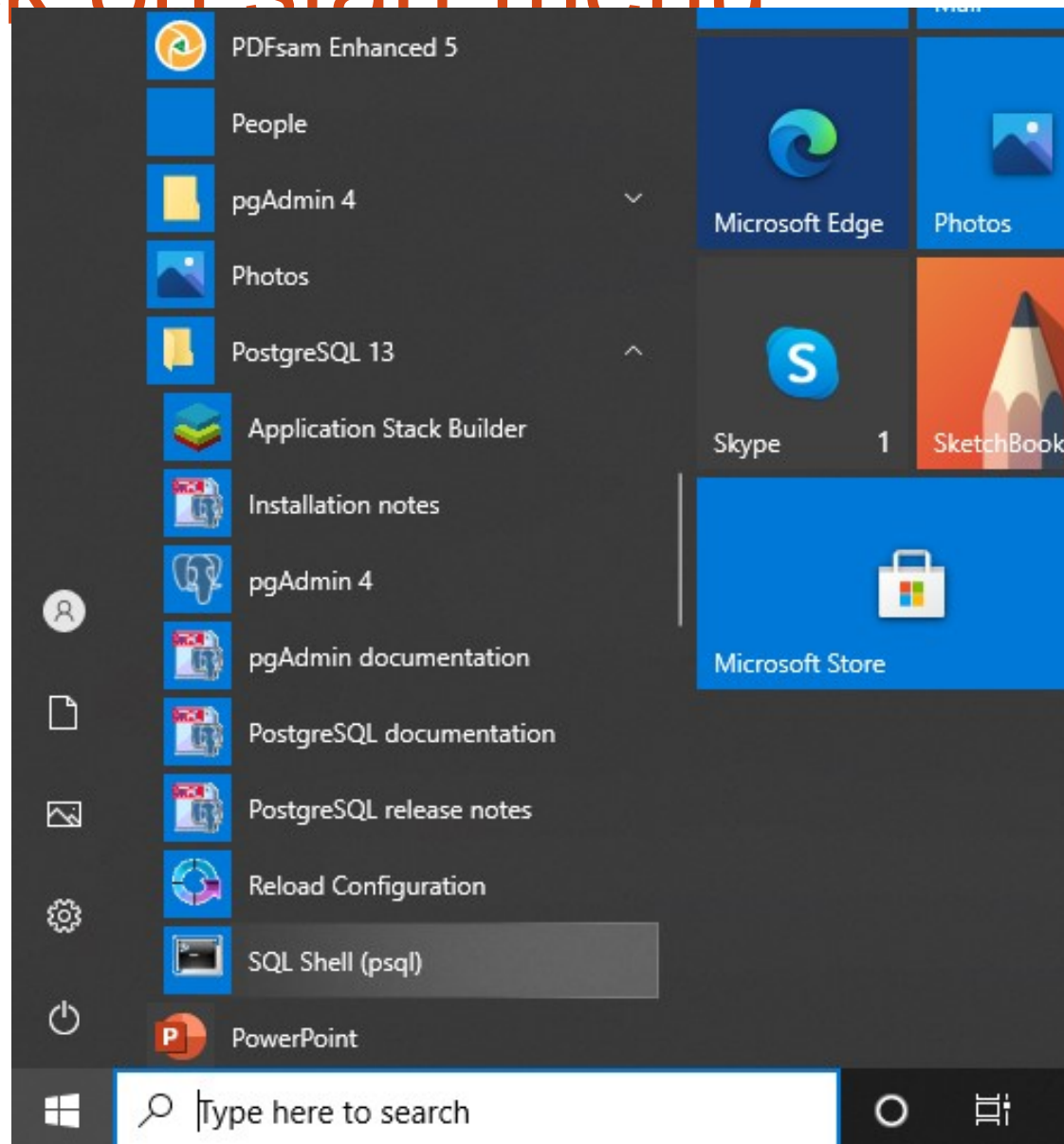
Installing

Unpacking C:\Program [...]\13\doc\postgresql\html\ecpg-sql-prepare.html

# Install



# Check on start menu

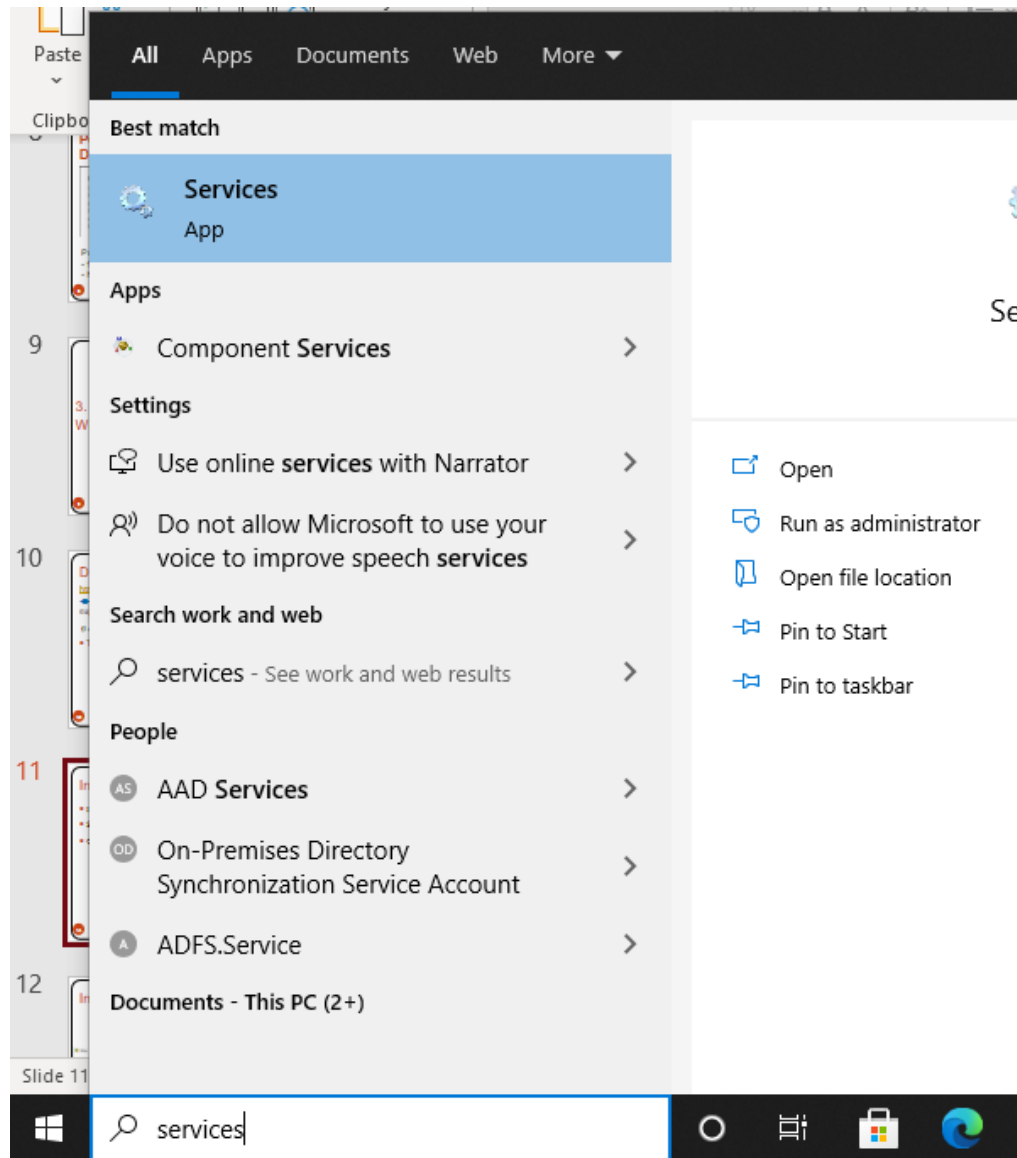


# Notes: Uninstall postgresQL

- Uninstall
- Remove data directory

***C:\Program Files\PostgreSQL***

# Server services





# Server services

The server is running

The screenshot shows the Windows Services console. The 'Services (Local)' window is open, displaying a list of services. The 'postgresql-x64-13' service is selected and highlighted in blue. Its status is 'Running', and its startup type is 'Automatic'. The description for this service is 'Provides relational database storage.'.

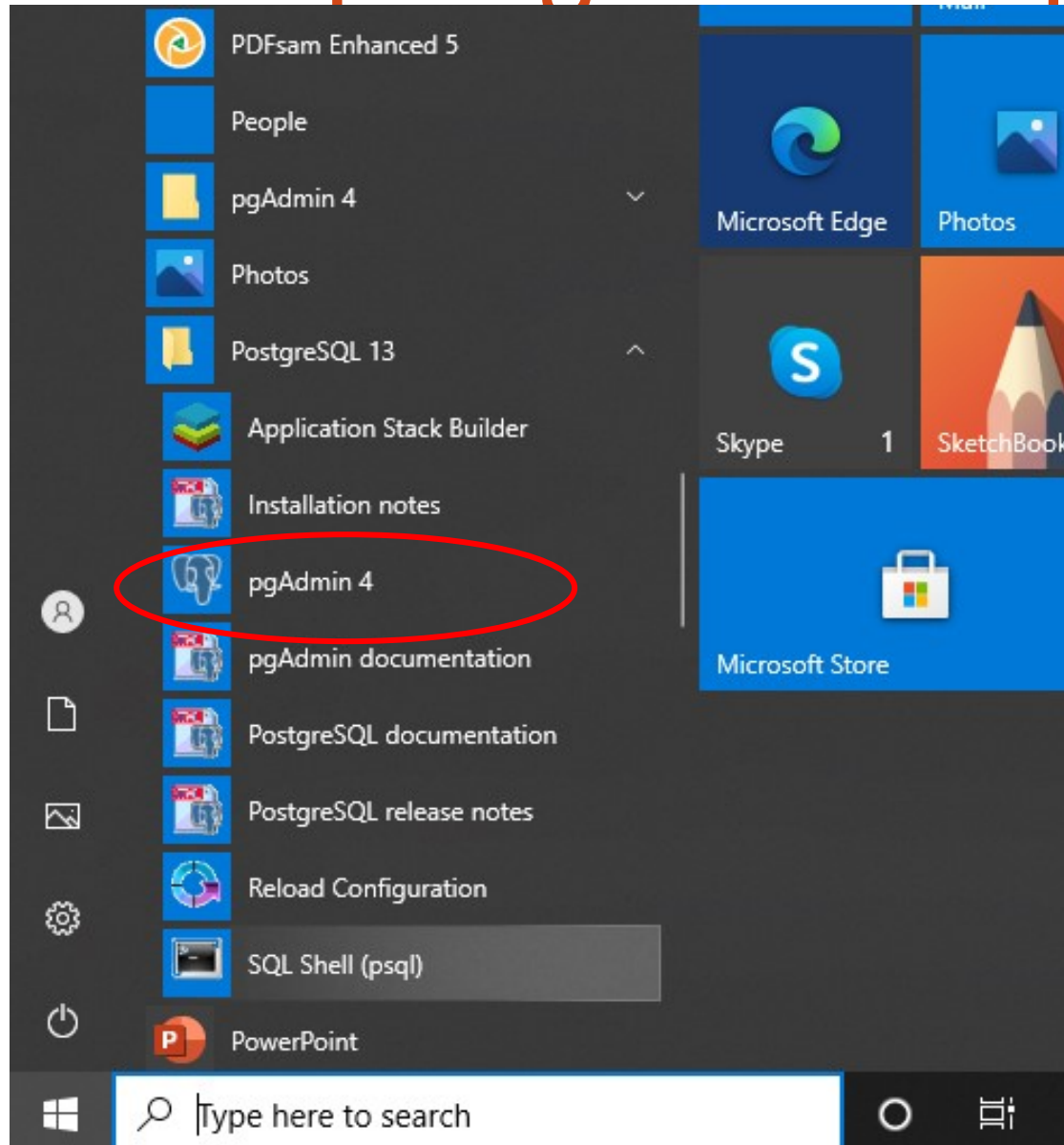
On the left side of the console, there are links to 'Stop the service', 'Pause the service', and 'Restart the service'. A red arrow points from the text 'You can stop/start/restart the server here' to these links.

Another red arrow points from the text 'The server is running' to the 'Running' status of the 'postgresql-x64-13' service.

| Name                                     | Description   | Status  | Startup Type    | Log On As       |
|--|---|---------|-----------------|-----------------|
| Parental Controls                        | Enforces parental controls for child accounts in Windows. If this service i...  |         | Manual          | Local System    |
| Payments and NFC/SE Manager              | Manages payments and Near Field Communication (NFC) based secure ...            |         | Manual (Trig... | Local Service   |
| PDFsam Enhanced 5                        |   | Running | Manual          | Local System    |
| PDFsam Enhanced 5 Creator                |   | Running | Automatic       | Local System    |
| PDFsam Enhanced 5 Update Service         |   | Running | Automatic       | Local System    |
| Peer Name Resolution Protocol            | Enables serverless peer name resolution over the Internet using the Peer ...    |         | Manual          | Local Service   |
| Peer Networking Grouping                 | Enables multi-party communication using Peer-to-Peer Grouping. If dis...        |         | Manual          | Local Service   |
| Peer Networking Identity Manager         | Provides identity services for the Peer Name Resolution Protocol (PNRP)...      |         | Manual          | Local Service   |
| Performance Counter DLL Host             | Enables remote users and 64-bit processes to query performance counte...        |         | Manual          | Local Service   |
| Performance Logs & Alerts                | Performance Logs and Alerts Collects performance data from local or re...       |         | Manual          | Local Service   |
| Phone Service                            | Manages the telephony state on the device                                       |         | Manual (Trig... | Local Service   |
| Plug and Play                            | Enables a computer to recognize and adapt to hardware changes with lit...       | Running | Manual          | Local System    |
| Pml Driver HPZ12                         |   |         | Automatic       | Local Service   |
| PNRP Machine Name Publication Service    | This service publishes a machine name using the Peer Name Resolution ...        |         | Manual          | Local Service   |
| Portable Device Enumerator Service       | Enforces group policy for removable mass-storage devices. Enables appl...       |         | Manual (Trig... | Local System    |
| postgresql-x64-13                        | Provides relational database storage.   | Running | Automatic       | Network Service |
| Power                                    | Manages power policy and power policy notification delivery.                    | Running | Automatic       | Local System    |
| Print Spooler                            | This service spools print jobs and handles interaction with the printer. If ... | Running | Automatic       | Local System    |
| Printer Extensions and Notifications     | This service opens custom printer dialogue boxes and handles notificati...      |         | Manual          | Local System    |
| PrintWorkflow_76d7a2b                    | Provides support for Print Workflow applications. If you turn off this ser...   |         | Manual          | Local System    |
| Problem Reports Control Panel Support    | This service provides support for viewing, sending and deletion of syste...     |         | Manual          | Local System    |
| Program Compatibility Assistant Service  | This service provides support for the Program Compatibility Assistant (P...     | Running | Manual          | Local System    |
| Quality Windows Audio Video Experience   | Quality Windows Audio Video Experience (qWave) is a networking platf...         |         | Manual          | Local Service   |
| Radio Management Service                 | Radio Management and Airplane Mode Service                                      | Running | Manual          | Local Service   |
| Realtek Audio Service                    | For cooperation with Realtek audio driver.                                      | Running | Automatic       | Local System    |
| Realtek Bluetooth Device Manager Service |   | Running | Automatic       | Local System    |
| Recommended Troubleshooting Service      | Enables automatic mitigation for known problems by applying recomm...           |         | Manual          | Local System    |
| Remote Access Auto Connection Manager    | Creates a connection to a remote network whenever a program referenc...         |         | Manual          | Local System    |
| Remote Access Connection Manager         | Manages dial-up and individual private network (VPN) connections from th...     | Running | Automatic       | Local System    |

You can stop/start/restart the server here

# Connect to postgres from pgAdmin 4



# Connect to postgres from pgAdmin 4

The image shows the pgAdmin 4 web interface in a browser window. The address bar shows the URL `127.0.0.1:64092/browser/`. The interface includes a top navigation bar with 'File', 'Object', 'Tools', and 'Help' menus. Below this is a 'Browser' pane on the left showing a tree of servers under 'Servers (4)'. The servers listed are 'PostgreSQL 13', 'barney5@server', 'barney@postgres10', and 'postgres@PostgreSQL 10'. A red arrow points to the 'PostgreSQL 13' entry, and a red text label 'Right click here' is placed next to it. A right-click context menu is open over 'PostgreSQL 13', showing options: 'Create', 'Refresh...', 'Connect Server' (highlighted), 'Remove Server', and 'Properties...'. A red arrow points to the 'Connect Server' option. The right pane shows the 'General' tab for the selected server, displaying fields like 'ID', 'Name', 'Server type', 'Version', and 'Comments'.

Browser

Servers (4)

- PostgreSQL 13
- barney5@server
- barney@postgres10
- postgres@PostgreSQL 10

Right click here

Connect Server

General

ID

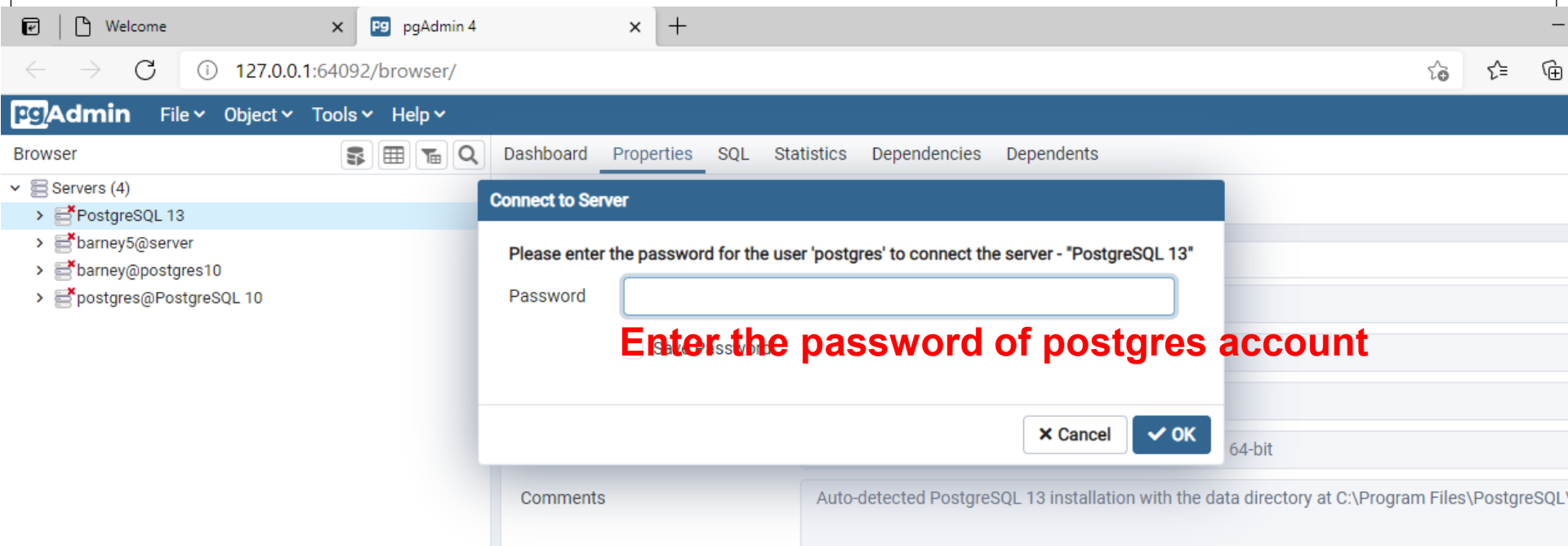
Name

Server type

Version

Comments

# Connect to postgres from pgAdmin 4

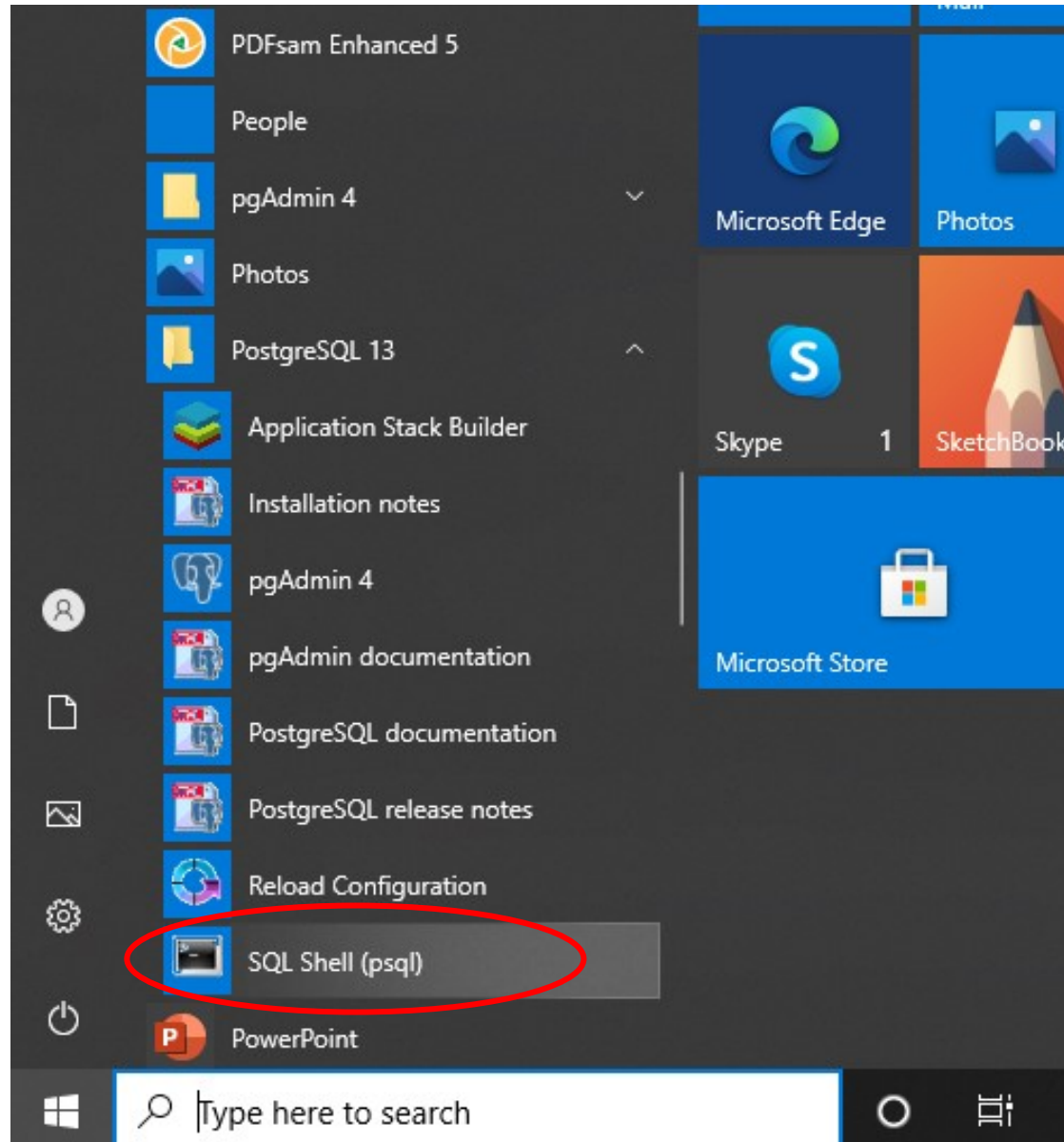


# Connect to postgres from pgAdmin 4

The screenshot shows the pgAdmin 4 web interface in a browser. The address bar displays `127.0.0.1:64092/browser/`. The interface has a dark blue header with the pgAdmin logo and navigation menus: File, Object, Tools, and Help. Below the header is a 'Browser' section with a tree view on the left and a 'Properties' panel on the right. The tree view shows a hierarchy: Servers (4) > PostgreSQL 13 > Databases, Login/Group Roles, Tablespaces, barney5@server, barney@postgres10, and postgres@PostgreSQL 10. The 'Properties' panel is currently showing the 'General' tab for the selected 'PostgreSQL 13' server. The 'General' tab displays the following information:

| General     |                                      |
|-------------|--------------------------------------|
| ID          | 4                                    |
| Name        | PostgreSQL 13                        |
| Server type | PostgreSQL                           |
| Version     | PostgreSQL 13.2, compiled by Visual  |
| Comments    | Auto-detected PostgreSQL 13 installa |

# Connect to postgres using psql



# Connect to postgres using psql

```
SQL Shell (psql)
Server [localhost]:
Database [postgres]:
Port [5432]:
Username [postgres]:
Password for user postgres:
psql (13.2)
WARNING: Console code page (850) differs from Windows code page (1252)
        8-bit characters might not work correctly. See psql reference
        page "Notes for Windows users" for details.
Type "help" for help.

postgres=# \l

               List of databases
  Name          | Owner   | Encoding | Collate          | Ctype          | Access privileges
-----+-----+-----+-----+-----+-----
 postgres       | postgres | UTF8      | English_United States.1252 | English_United States.1252 | =c/postgres +
 template0      | postgres | UTF8      | English_United States.1252 | English_United States.1252 | postgres=CTc/postgres
 template1      | postgres | UTF8      | English_United States.1252 | English_United States.1252 | =c/postgres +
                                     postgres=CTc/postgres
(3 rows)

postgres=# \q
```

## 4. Install PostgreSQL on Ubuntu



# Install

## Postgresql APT Repository:

(<https://www.postgresql.org/download/linux/ubuntu/>)

# Create the file repository configuration:

```
sudo sh -c 'echo "deb http://apt.postgresql.org/pub/repos/apt $(lsb_release -cs)-  
pgdg main" > /etc/apt/sources.list.d/pgdg.list'
```

# Import the repository signing key:

```
wget --quiet -O - https://www.postgresql.org/media/keys/ACCC4CF8.asc | sudo  
apt-key add -
```

# Update the package lists:

```
sudo apt-get update
```

# Install the latest version of PostgreSQL.

# If you want a specific version, use 'postgresql-12' or similar instead of 'postgresql':

```
sudo apt-get -y install postgresql
```

# Install

- After installing PostgreSQL the following packages are also installed:  
(Installed packages: postgresql, postgresql-client, postgresql-client-common, postgresql-common, sysstat , ...)
- If pgadmin4 (a graphical administration utility) is not installed, use the apt-get command:

```
sudo apt-get install pgadmin4
```

# Client installation

- If you only wish to connect to an external PostgreSQL server, install only the PostgreSQL client package:

- Client installation

```
sudo apt-get install postgresql-client
```

- Connect to the server:

```
psql -h server.domain.org database user
```

Example: `psql -h 192.168.100.5 postgres postgres`

```
psql -h localhost postgres postgres
```

# Basic Server Setup

- Set the password of the PostgreSQL user (role) called "postgres"
  - Connect as a role with the same name as the local user (i.e. postgres) to the database "postgres"  
`sudo -u postgres psql postgres`
  - Set a password for the "postgres" database role:  
`\password postgres` and then give your password when prompted
  - Exit the psql prompt: `\q`
- You can try to create the first database with the command  
`sudo -u postgres createdb mydb`

# Basic Server Setup

- **Allowing local connections**

- By default, local connections are not allowed for the postgres user
- As a super user, open `/etc/postgresql/x.x/main/pg_hba.conf` (Ubuntu) in a text editor:

- `sudo gedit /etc/postgresql/9.6/main/pg_hba.conf`

- Scroll down to the line that describes local socket connections like this:

```
local    all             postgres            peer
local    all             all                 peer
```

- Change the "`peer`" method to "`md5`"
- To allow connections using pgAdmin, find the line that describes local loopback connections over IPv6:

```
host     all             all                 ::1/128  ident
```

- Change the "`ident`" method to "`md5`"
- Save and close the file

# Basic Server Setup

- Restart postgresql : `sudo service postgresql restart`
  - To test your connection using **psql**: `psql -U postgres -W`
  - To test your connection using **pgAdmin**, connect to the database at localhost:**5432** using the user name **postgres** and the password supplied

# Stop/start/reload PostgreSQL server – on Ubuntu

```
sudo service postgresql  
{start|stop|restart|reload|force-reload|status}
```

# Create superuser

- Create a database superuser, same name as login name:

# Create a new superuser

```
sudo -u postgres createuser --superuser $USER
```

# Set password for the new user

```
sudo -u postgres psql
```

```
postgres=# \password $USER
```



# 5. The PostgreSQL Files and Programs

# PostgreSQL Files – on Windows

- Default: `C:\Program Files\PostgreSQL\x.x`

| Directory   | Description  |
|-------------|--|
| bin         | The PostgreSQL main programs, utilities, and library files   |
| data        | PostgreSQL Data Dictionary, log files, and the transaction log   |
| doc         | Documentation on contrib modules, PgOleDb, and psqlODBC  |
| include     | C program header files for developing C programs for PostgreSQL (if the Development package was installed)     |
| jdbc        | Java JDBC library files for developing Java programs for PostgreSQL (if the JDBC package was installed)        |
| lib         | PostgreSQL library files for the executable programs   |
| npgsql      | Microsoft .NET library files for developing .NET programs for PostgreSQL (if the npgsql package was installed) |
| PgAdmin III | The pgAdmin III program documentation  |
| share       | Contrib modules and timezone information for PostgreSQL  |

# Database cluster Directory

- Default: `C:\Program Files\PostgreSQL\x.x\data`

| Directory    | Description   |
|--------------|---|
| base         | Contains a directory for each database                            |
| global       | Contains system tables for the Data Dictionary                    |
| pg_clog      | Contains status files on transaction commits                      |
| pg_log       | Contains PostgreSQL system log files                              |
| pg_multixact | Contains multitransaction status information used for row locking |
| pg_subtrans  | Contains subtransaction status information                        |
| pg_tblspc    | Contains links to database tables                                 |
| pg_twophase  | Contains phase files for the two-phase transaction commit process |
| pg_xlog      | Contains the transaction log files                                |

# PostgreSQL Files - on Ubuntu

- **Configuration files:**

`/etc/postgresql/x.x/main/`

- **Data directory:**

`/var/lib/postgresql/x.x/main/`

- **Log files:**

`/var/log/postgres/`

# pg\_log directory for Administrators

- Each started time, a new log file: *postgres-year-month-day-time.log*
- Each row: a timestamp + the event

```
2006-06-29 20:13:45 FATAL:  database "test" does not exist
2006-06-29 20:24:01 LOG:   transaction ID wrap limit is 2147484148,
                           limited by database "postgres"
2006-06-29 20:25:05 LOG:   autovacuum: processing database "Test"
2006-06-29 20:26:05 LOG:   autovacuum: processing database "template1"
2006-06-29 20:27:05 LOG:   autovacuum: processing database "postgres"
2006-06-29 20:28:18 NOTICE:  ALTER TABLE / ADD PRIMARY KEY will create
                              implicit index "ItemID" for table "test"
```

# PostgreSQL Log Message Levels

| Message Severity | Description   |
|------------------|---|
| DEBUG            | Program information for developers  |
| INFO             | Information requested by a database user from a database command                  |
| NOTICE           | Information that may be useful to the database user regarding a submitted command |
| WARNING          | Information about possible problems in a user session                             |
| ERROR            | A minor error that caused a user command to abort                                 |
| LOG              | Information of interest for the administrator related to the PostgreSQL system    |
| FATAL            | A major error that caused a user session to abort                                 |
| PANIC            | A major error that caused the PostgreSQL system to abort                          |

# Configuration Files

- How PostgreSQL behaves is controlled by three separate configuration files
  - *postgresql.conf* (C:\Program Files\PostgreSQL\x.x\data)
  - *pg\_hba.conf*
  - *pg\_ident.conf*
- Text files:
  - can be changed at any time
  - will not take effect until either the system is restarted or reloaded
  - Each entry in the configuration files is on a separate line
  - #: comment

# Changing configuration files

- Use text editor: **notepad++**, **gedit**, ...
- Default values = standard values
- If a **configuration line is commented out**, PostgreSQL **uses the default value** for that entry
- Changing the default value = removing the comment symbol from the line, reloading or restarting system
- Reverting to the default value for an entry = putting the comment symbol back, stopping and restarting the PostgreSQL system (**NOT reloading**)



# The postgresql.conf File

- Format: *featurename = value*
- Example: **port = 5432**
- The main configuration file
  - File Locations Section
  - Connections and Authentication Section
  - Resource Usage Section
  - Write Ahead Log Section
  - Query Tuning Section
  - Error Reporting and Logging Section
  - Runtime Statistics Section
  - Autovacuum Parameters Section
  - Client Connection Defaults Section
  - Lock Management Section
  - Version/Platform Compatibility Section
  - Customized Options Section

# The pg\_hba.conf File

- Configure:
  - Which network hosts are allowed to connect to PostgreSQL
  - Which PostgreSQL usernames can be used to connect from the network
  - What authentication method users must use to log into the system
  - Which PostgreSQL databases an authenticated client can connect to
- Format: *connection-type database user network-address login-method [options]*
- Example: **host all all 127.0.0.1/32 md5**

# The pg\_hba.conf File

- Format: connection-type database user network-address login-method [options ]
- Examples:
  - `host all all 127.0.0.1/32 md5` : allows any client on the localhost to connect as any user to any database using md5 authentication
  - `host all postgres 192.168.1.0/24 md5` : allows the *postgres* user account to connect any database from the local 192.168.1.0 subnetwork (192.168.1.0 to 192.168.1.255)

# The pg\_ident.conf File

- Provides a method for you to map remote client user accounts to PostgreSQL user accounts
- Format: *map-name ident-name PostgreSQL-user-account*
- Example:
  - `host all all 192.168.0.10/32 ident map=testhost`: All users from the host 192.168.0.10 will have access to all PostgreSQL databases. User accounts from this host are mapped to PostgreSQL user accounts using the testhost ident mapping.
  - `testhost rich richard`
  - `testhost mike michael`
  - `testhost dan daniel`

# Programs

- Most Unix administrators live and die by simple command-line programs : **psql**
- Windows administrators will want to use the graphical tools available in the **pgAdmin** application. **pgAdmin** is also available on Ubuntu.

# PostgreSQL Server Commands – on Windows

- Location: C:\Program Files\PostgreSQL\x.x\bin
- **postgres:** the PostgreSQL database server
  - The utility command pg\_ctl can be used to ***start and shut down the postgres server*** safely and comfortably

# PostgreSQL Server Commands – on Windows

- **pg\_ctl**: control the PostgreSQL system (stop, start, or reload the configuration files, kill a specified process)
  - using the -D commandline option
  - Example: **C:\>pg\_ctl stop -D "c:\ProgramFiles\PostgreSQL\x.x\data"**

## Document:

<file:///C:/Program%20Files/PostgreSQL/x.x/doc/postgresql/html/app-pg-ctl.html>

<http://www.postgresql.org/docs/x.x/static/app-pg-ctl.html>

# Stop/start/reload PostgreSQL server – on Ubuntu

- Easy way:

```
sudo service postgresql  
{start|stop|restart|reload|force-reload|status}
```

- Can use `pg_ctl`

```
cd /usr/lib/postgresql/x.x/bin/
```

```
pg_ctl -D /var/lib/postgresql/x.x/main -l logfile start
```



# PostgreSQL Client Applications

## Table of Contents

`clusterdb` — cluster a PostgreSQL database  
`createdb` — create a new PostgreSQL database  
`createuser` — define a new PostgreSQL user account  
`dropdb` — remove a PostgreSQL database  
`dropuser` — remove a PostgreSQL user account  
`ecpg` — embedded SQL C preprocessor  
`pg_basebackup` — take a base backup of a PostgreSQL cluster  
`pgbench` — run a benchmark test on PostgreSQL  
`pg_config` — retrieve information about the installed version of PostgreSQL  
`pg_dump` — extract a PostgreSQL database into a script file or other archive file  
`pg_dumpall` — extract a PostgreSQL database cluster into a script file  
`pg_isready` — check the connection status of a PostgreSQL server  
`pg_receivewal` — stream write-ahead logs from a PostgreSQL server  
`pg_recvlogical` — control PostgreSQL logical decoding streams  
`pg_restore` — restore a PostgreSQL database from an archive file created by `pg_dump`  
`pg_verifybackup` — verify the integrity of a base backup of a PostgreSQL cluster  
`psql` — PostgreSQL interactive terminal  
`reindexdb` — reindex a PostgreSQL database  
`vacuumdb` — garbage-collect and analyze a PostgreSQL database

# PostgreSQL Client Applications

- **psql**: a command-line interface to the PostgreSQL system
- **pg\_config**: see the current configuration values used to compile and install the PostgreSQL package
- **pg\_dump**: dump (or back up) the contents of a database on the PostgreSQL system to a file
  - Script: SQL files
  - Archived: compressed binary files (using **pg\_restore** to restore)

# PostgreSQL Client Applications

- **pg\_dumpall**: similar to the pg\_dump program, except it dumps all of the databases to a file
- **pg\_restore**: restore a PostgreSQL database from an archive file created by pg\_dump

**pgAdmin III / pgAdmin IV**: a fancy graphical interface for administering a PostgreSQL system

- Open Source: [www.pgadmin.org](http://www.pgadmin.org)

