

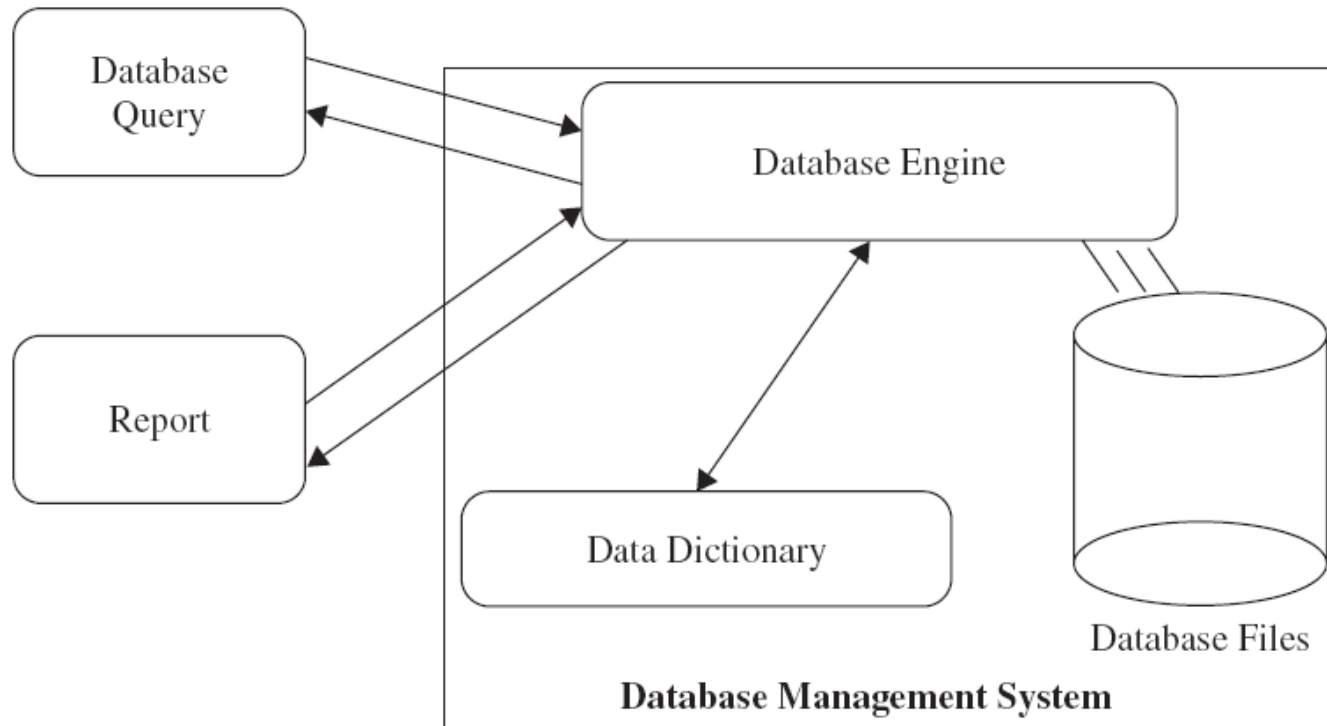
# Introduction to PostgreSQL

# Outline

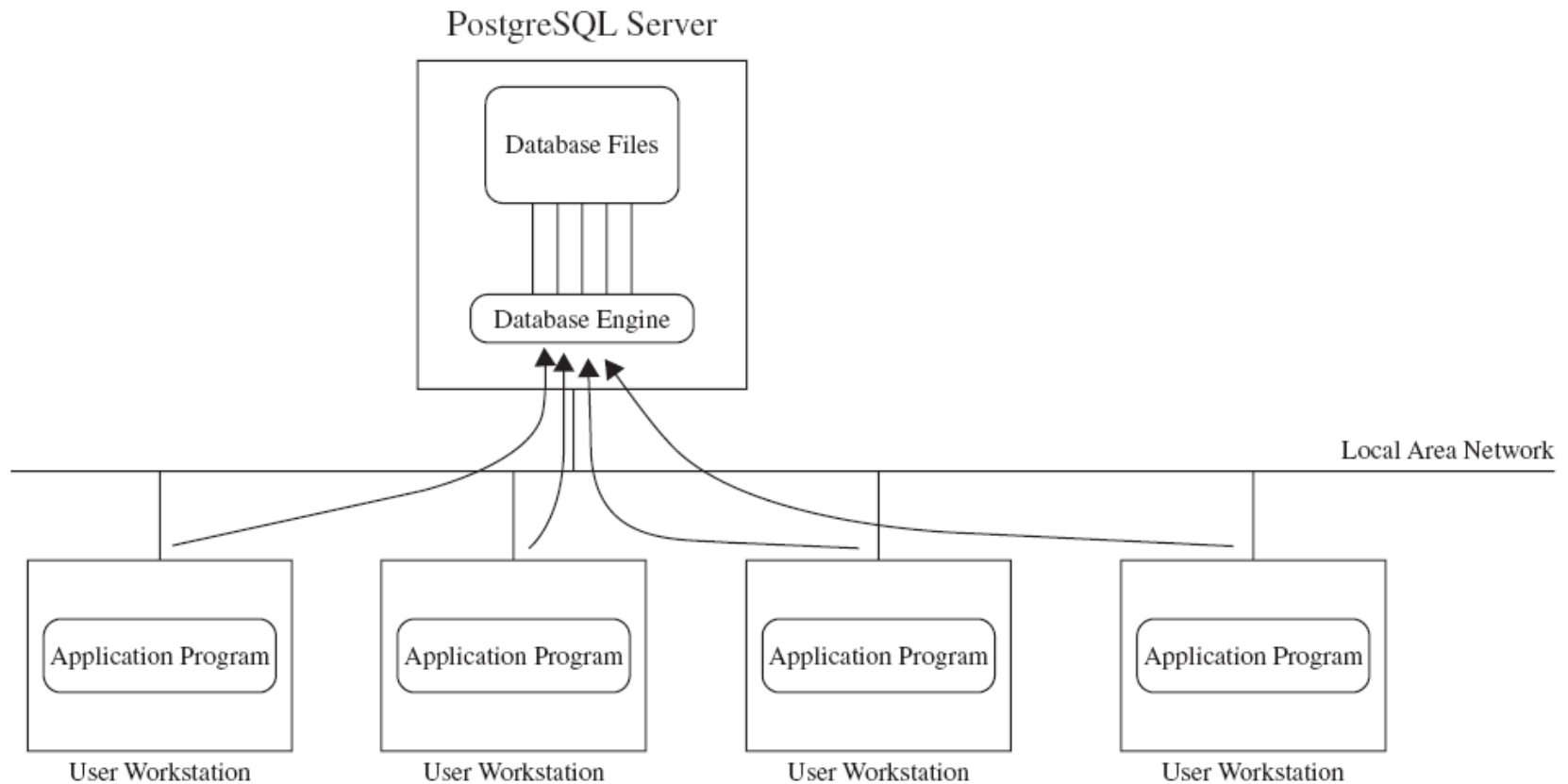
1. Database environments
2. Comparing PostgreSQL
3. Installing PostgreSQL on Windows
4. The PostgreSQL Files and Programs

# 1. Database environments

# A Simple Database engine



# A multiuser PostgreSQL environment



## 2. Comparing PostgreSQL

# PostgreSQL Versus Commercial DBMS Products

Database Product	CPU Limitation	Memory Limitation	Database Limitation
Microsoft SQL Server Express	1 CPU	1GB RAM	4GB
IBM DB2 Universal Database Express-C	2 CPUs	4GB RAM	Unlimited
Oracle Database 10g Express Edition	1 CPU	1GB RAM	4GB

## Free Commercial Database Limitations

### PostgreSQL:

- free open source
- No limitations: CPU, Memory, Database

# 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

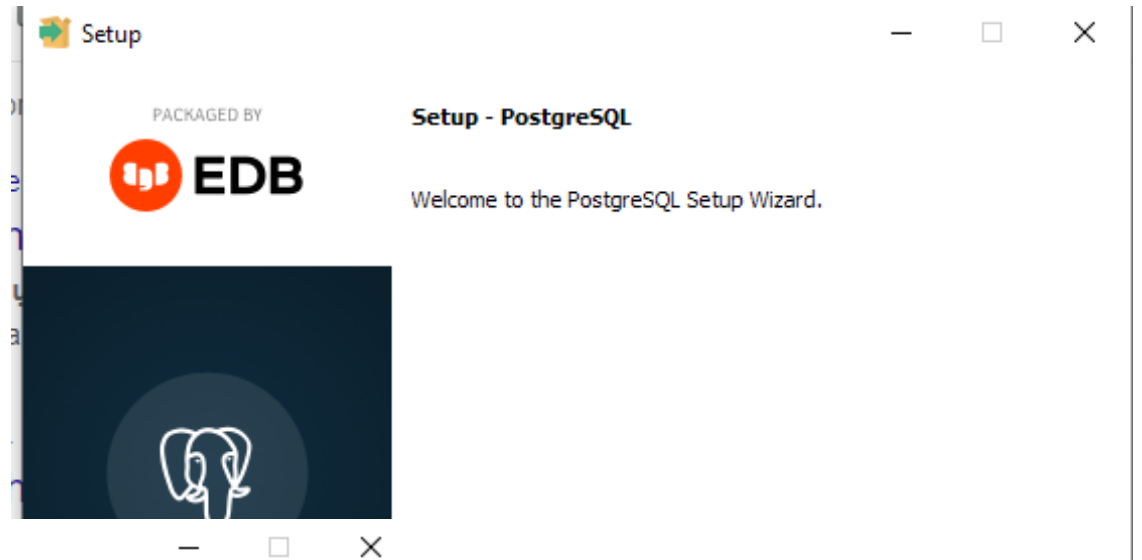
(Latest version 13)

- 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.

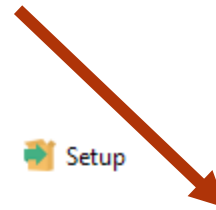
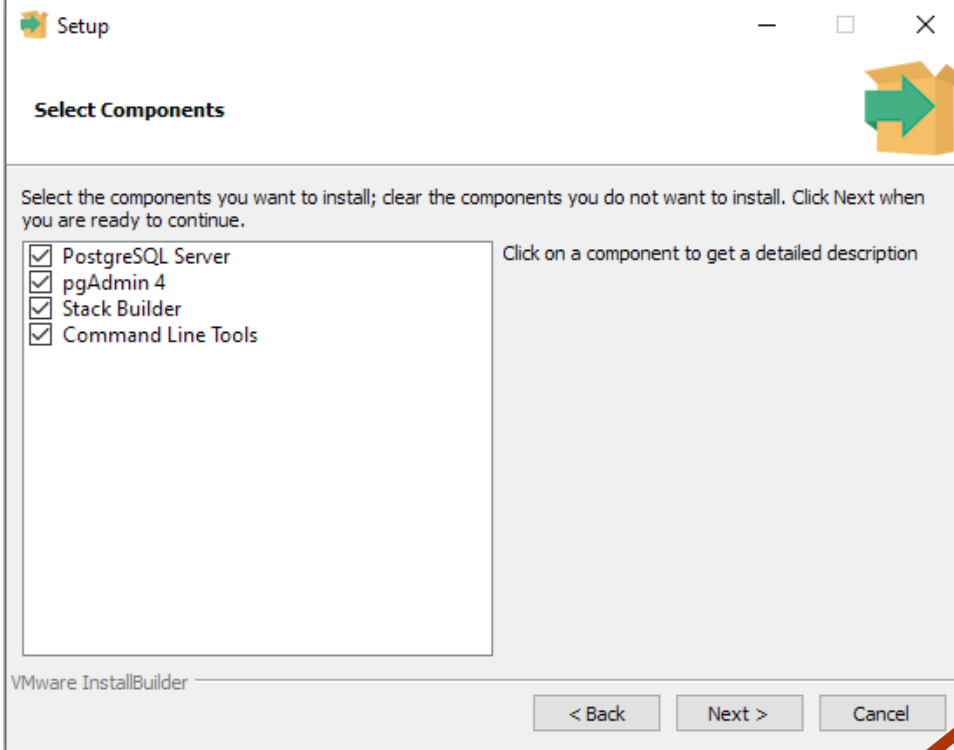
Installation Directory



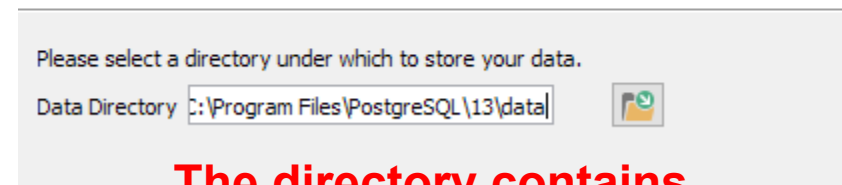
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Next >

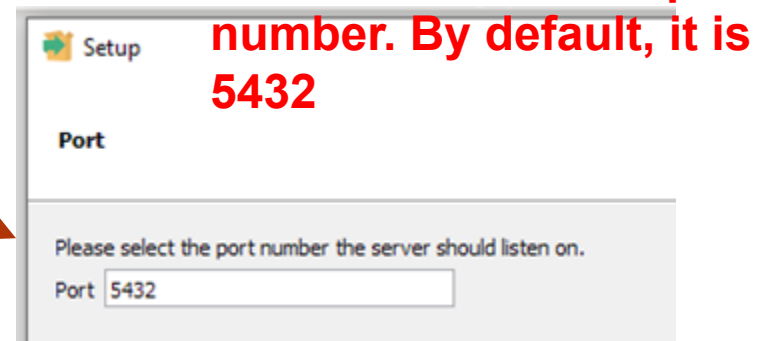
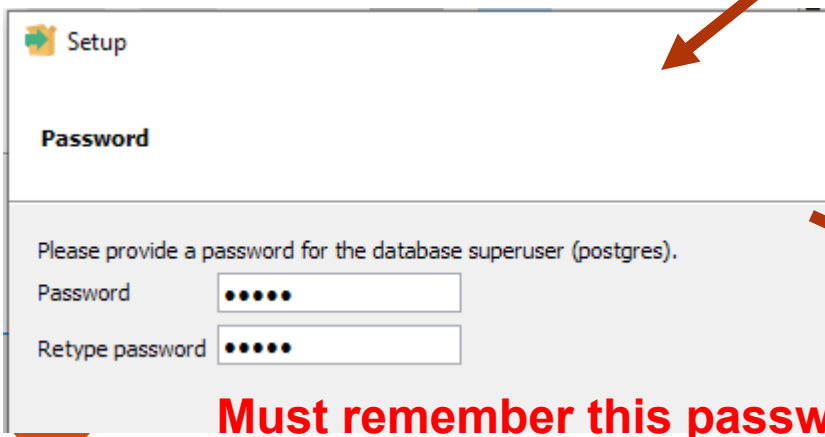
Cancel

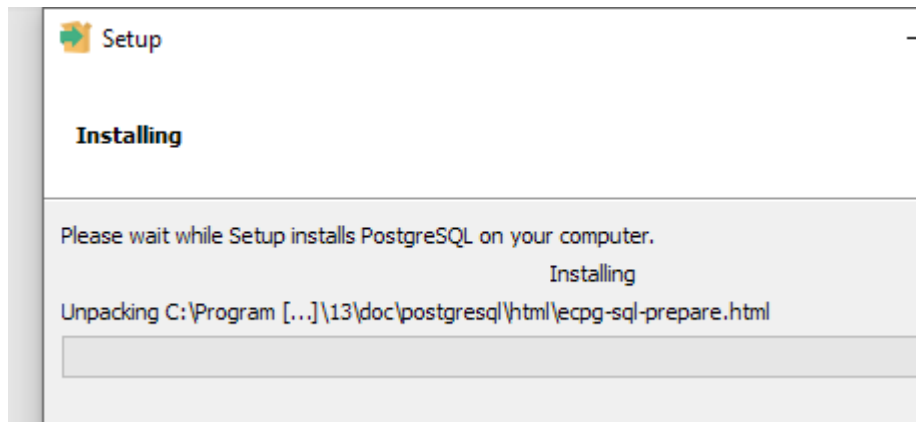
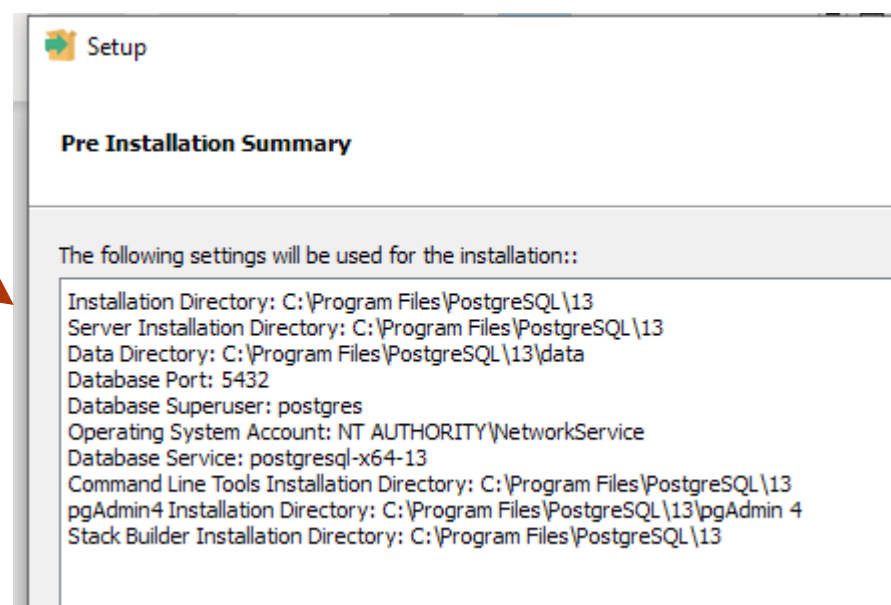
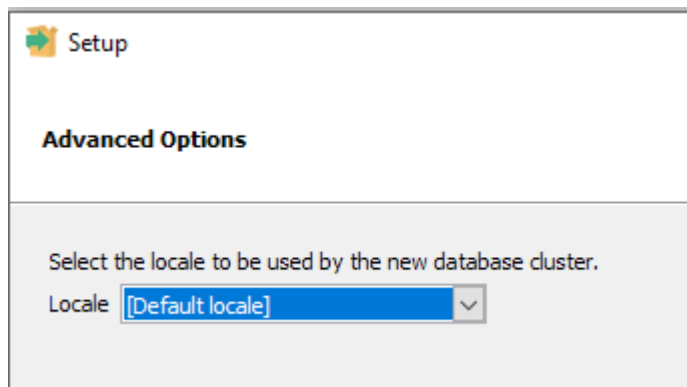


### Data Directory

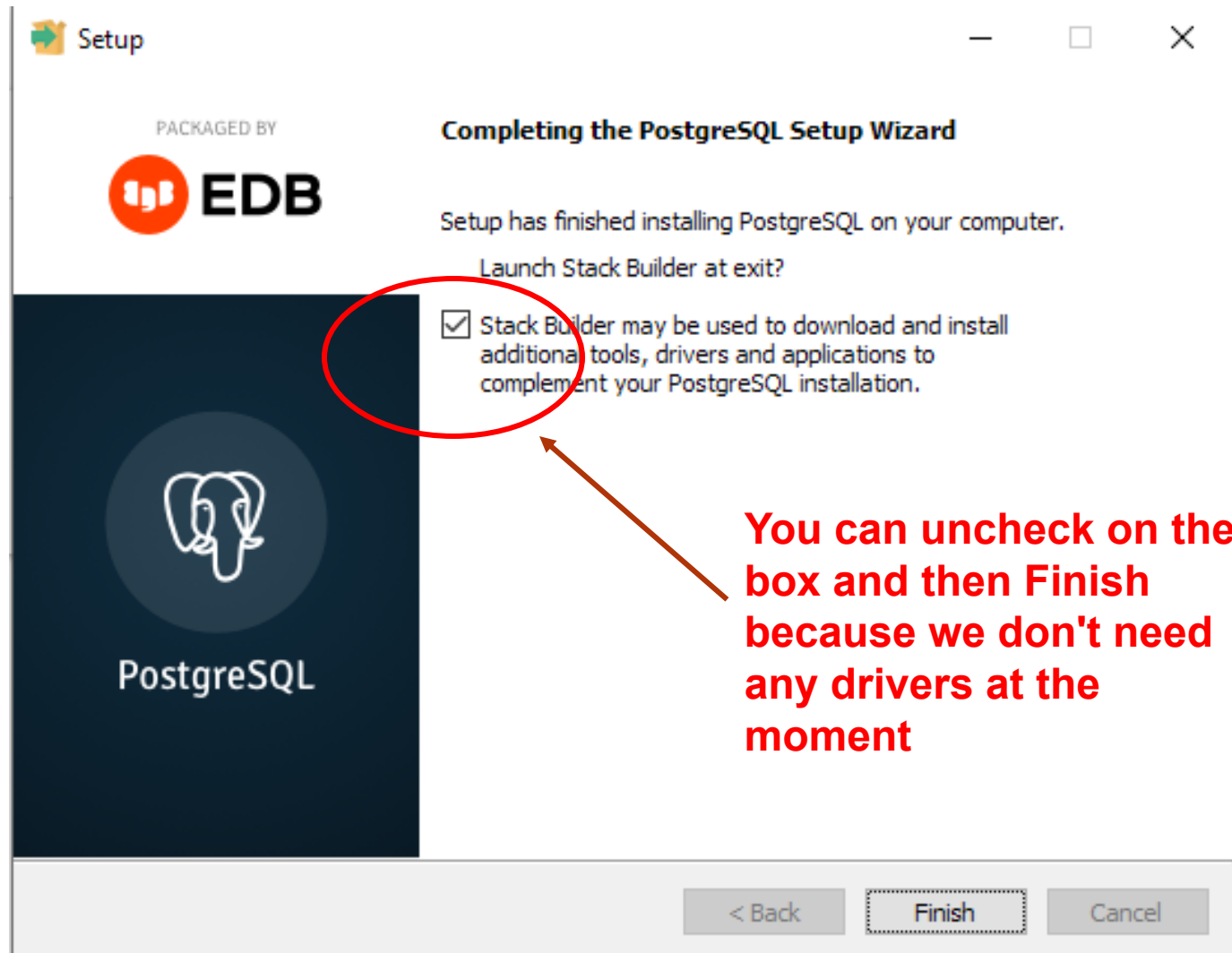


**The directory contains all data files**

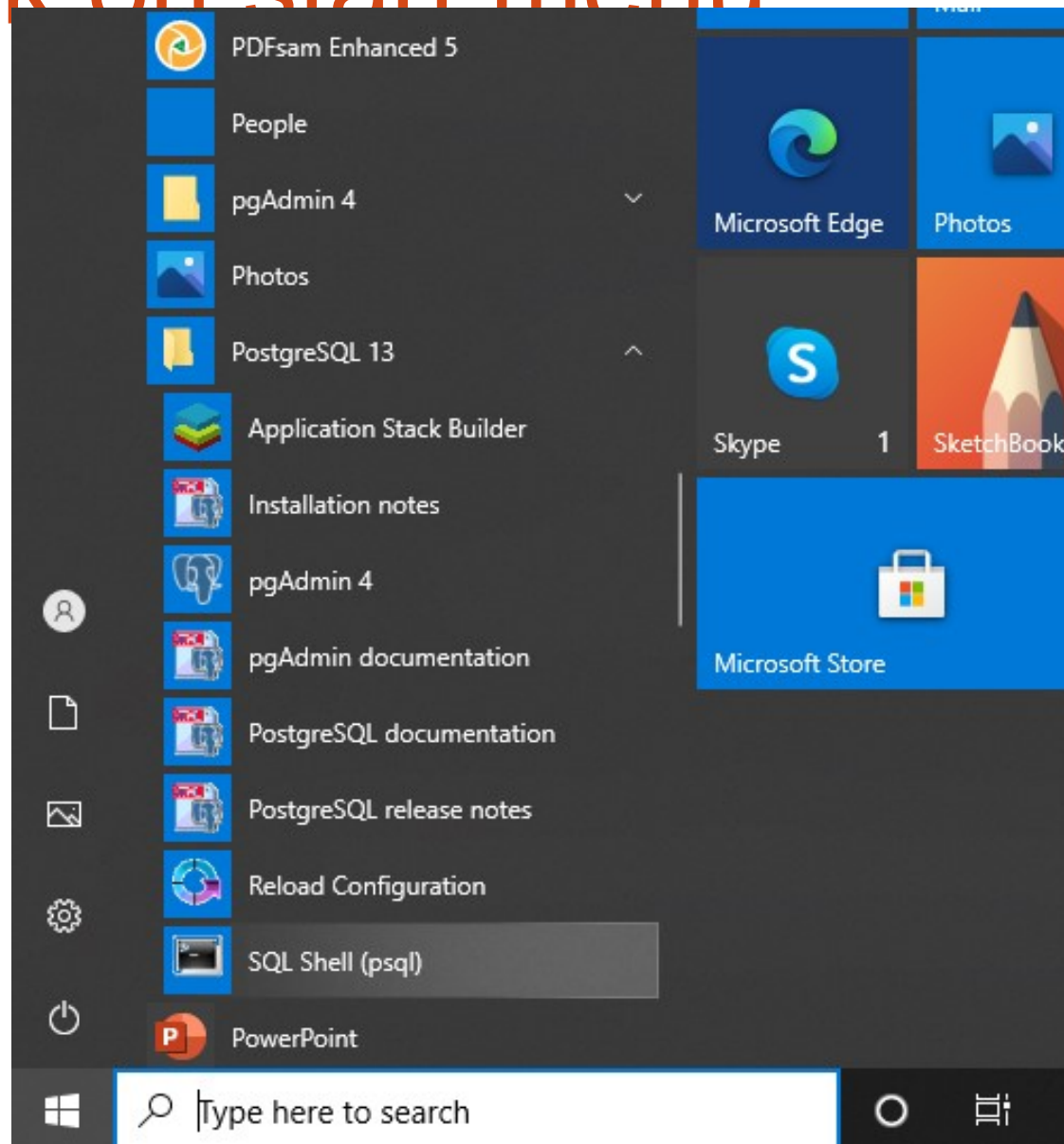




# Install



# Check on start menu



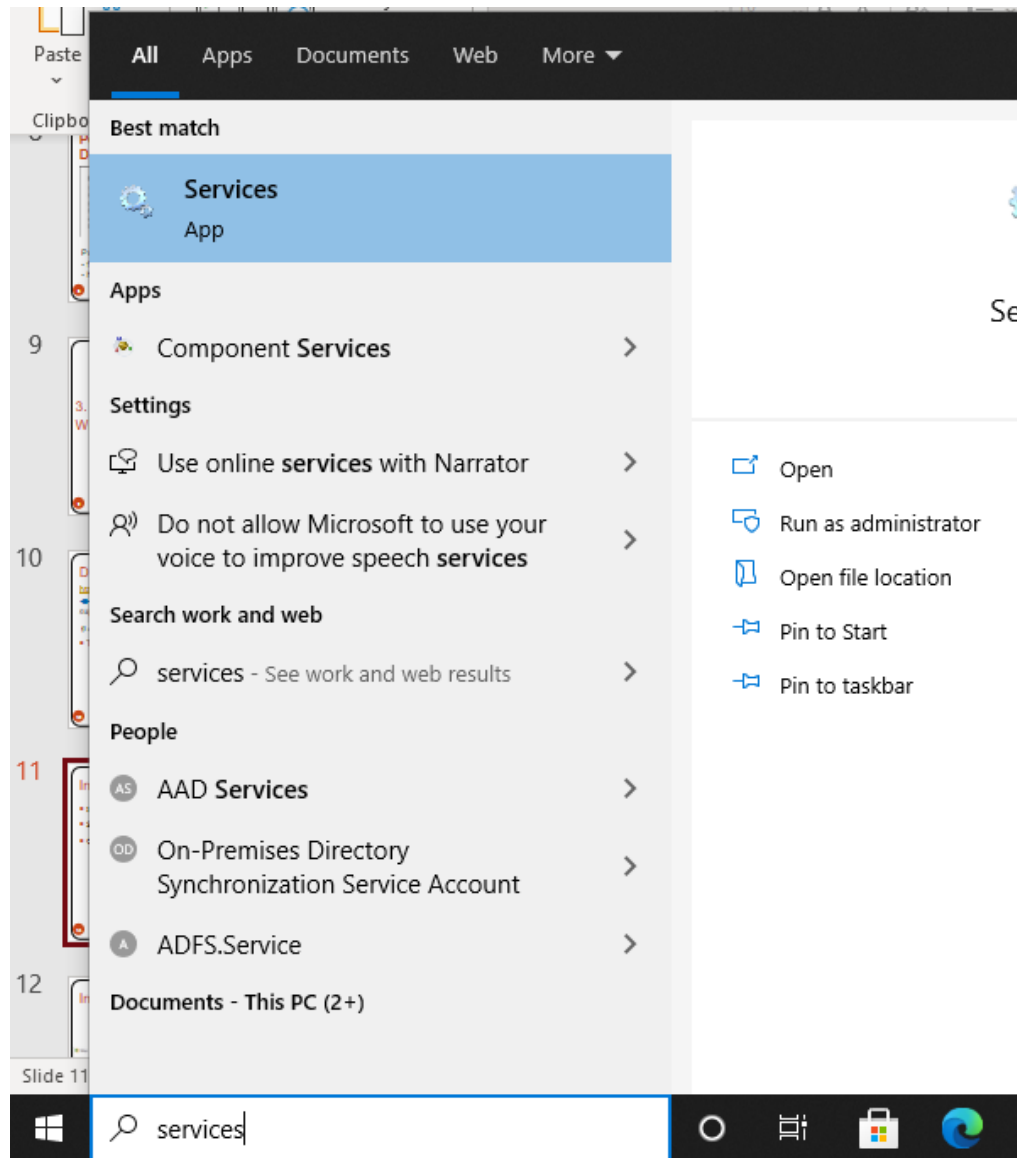


# Notes: Uninstall postgresQL

- 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'. A red arrow points from the text 'The server is running' to the 'Running' status. Another red arrow points from the text 'You can stop/start/restart the server here' to the 'Stop', 'Pause', and 'Restart' links in the left-hand pane.

**Services (Local)**

**postgresql-x64-13**

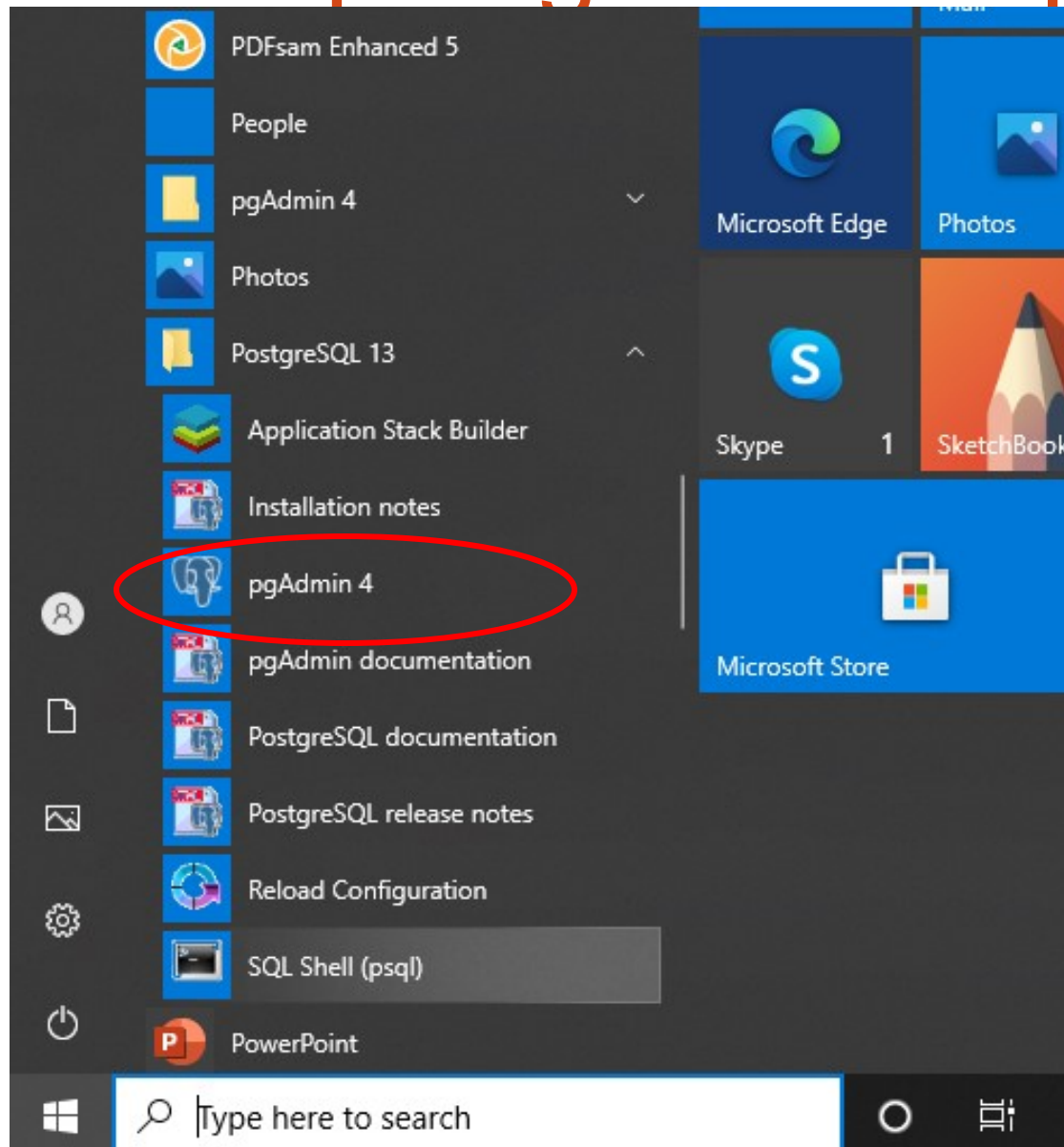
[Stop](#) the service  
[Pause](#) the service  
[Restart](#) the service

Description:  
Provides relational database storage.

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 virtual 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 has a top navigation bar with 'pgAdmin' and menus for 'File', 'Object', 'Tools', and 'Help'. 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'. The 'PostgreSQL 13' server is selected and highlighted in blue. A red arrow points to the 'PostgreSQL 13' server entry, and a red text label 'Right click here' is placed next to it. A context menu is open over the 'PostgreSQL 13' server, showing options: 'Create', 'Refresh...', 'Connect Server', '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)

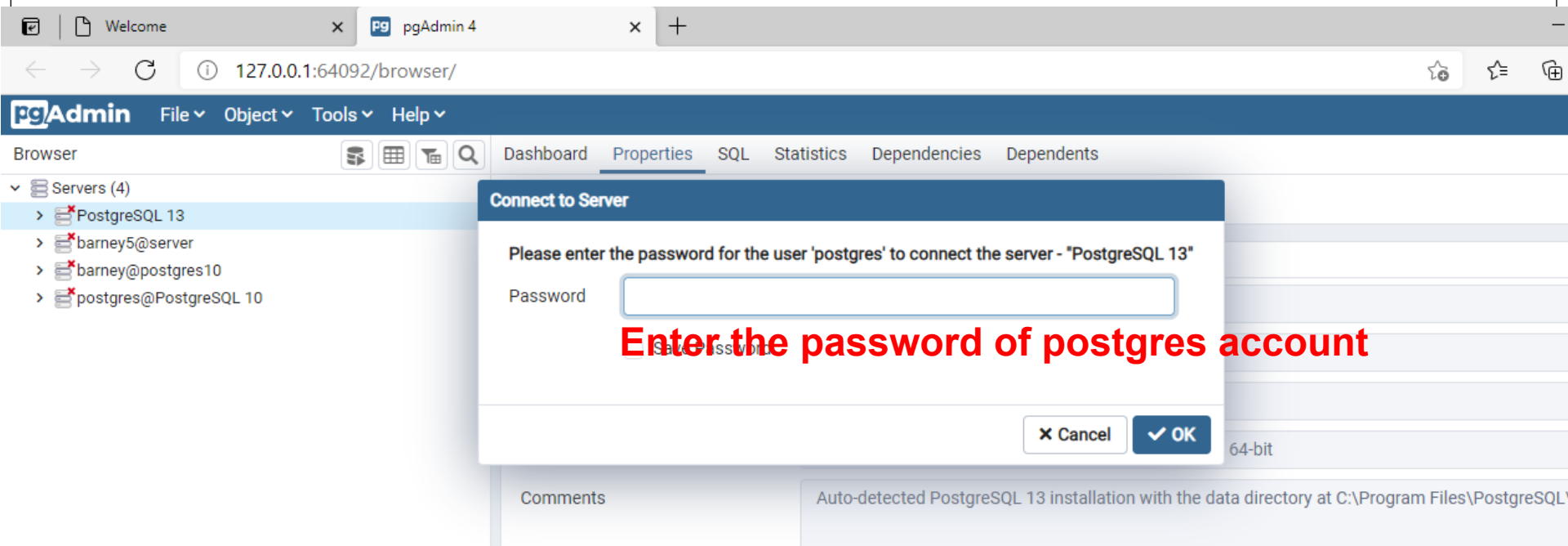
- > PostgreSQL 13
- > barney5@server
- > barney@postgres10
- > postgres@PostgreSQL 10

Right click here

Connect Server

21

# Connect to postgres from pgAdmin 4

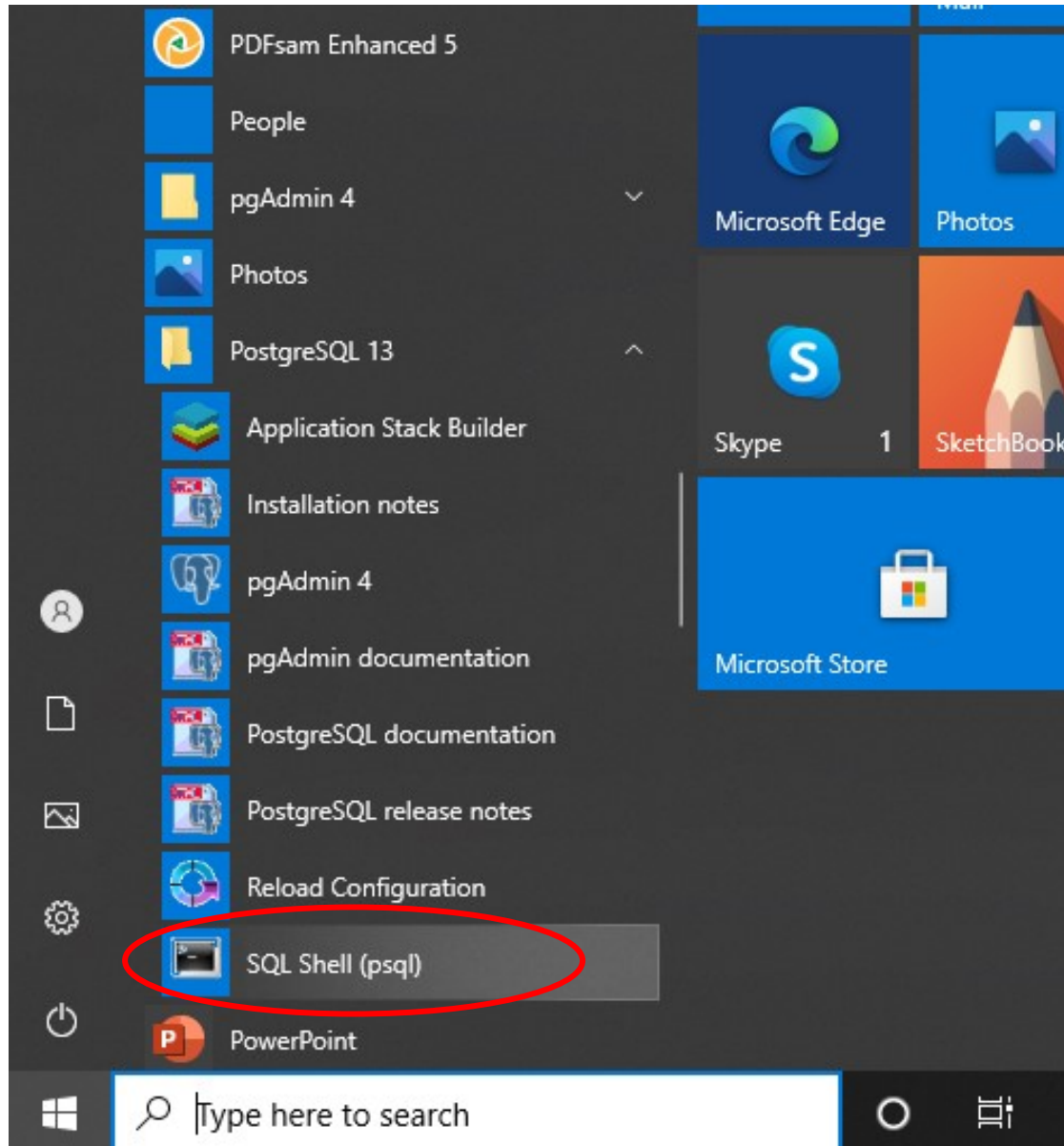


# Connect to postgres from pgAdmin 4

The screenshot shows the pgAdmin 4 web interface in a browser. The address bar displays `127.0.0.1:64092/browser/`. The interface 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. The 'PostgreSQL 13' server is selected, and its 'Properties' tab is active. The 'General' section of the properties shows the following details:

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:

# 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
```

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

# 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:

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

