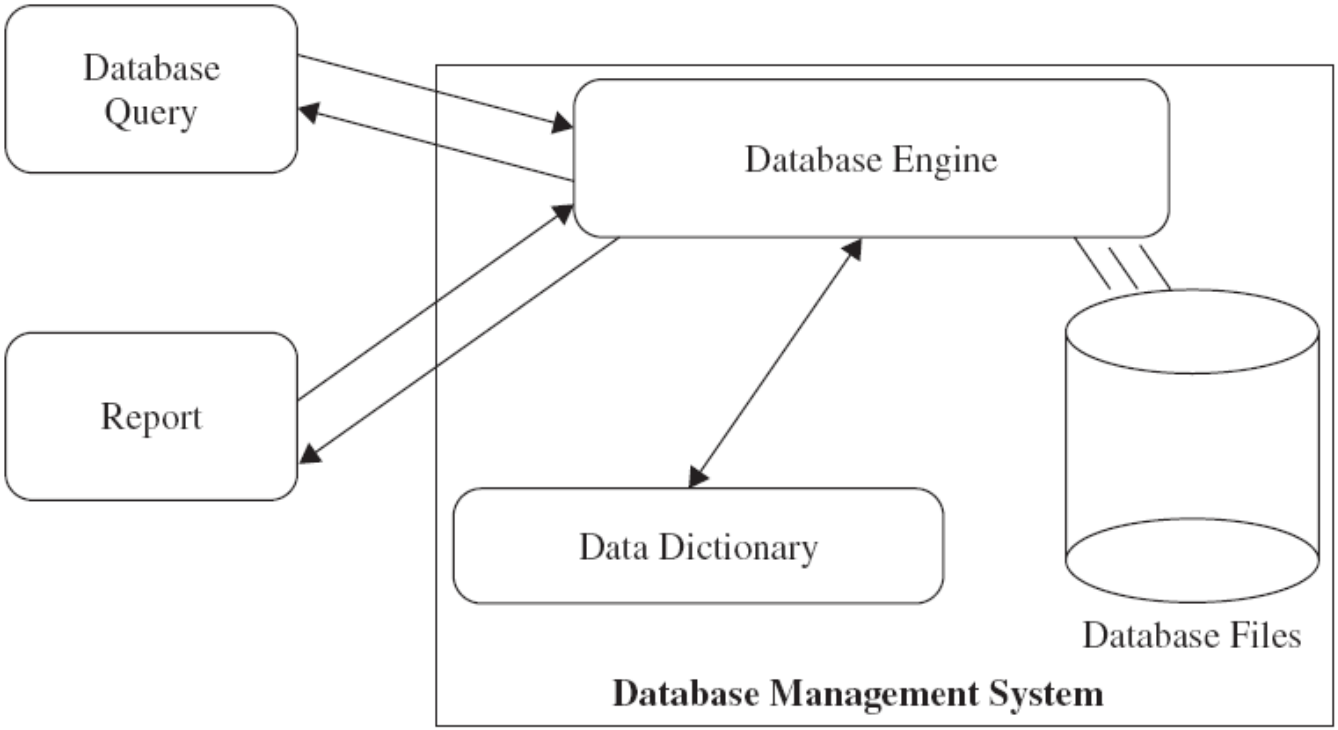
Introduction to PostgreSQL

Outline

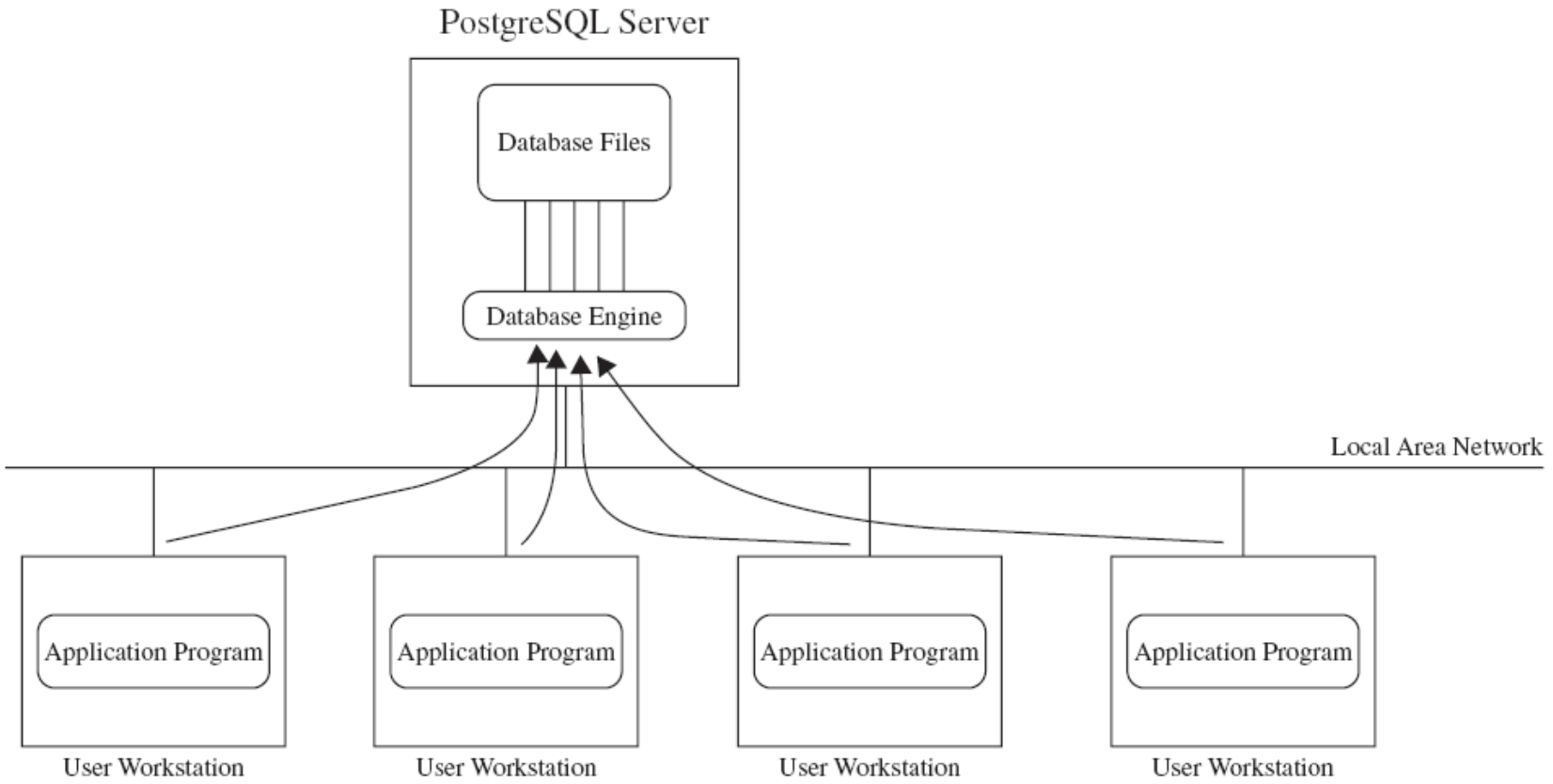
1. Database environments
2. Comparing PostgreSQL
3. Installing PostgreSQL on Windows
4. The PostgreSQL Files and Programs

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 10*g* 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

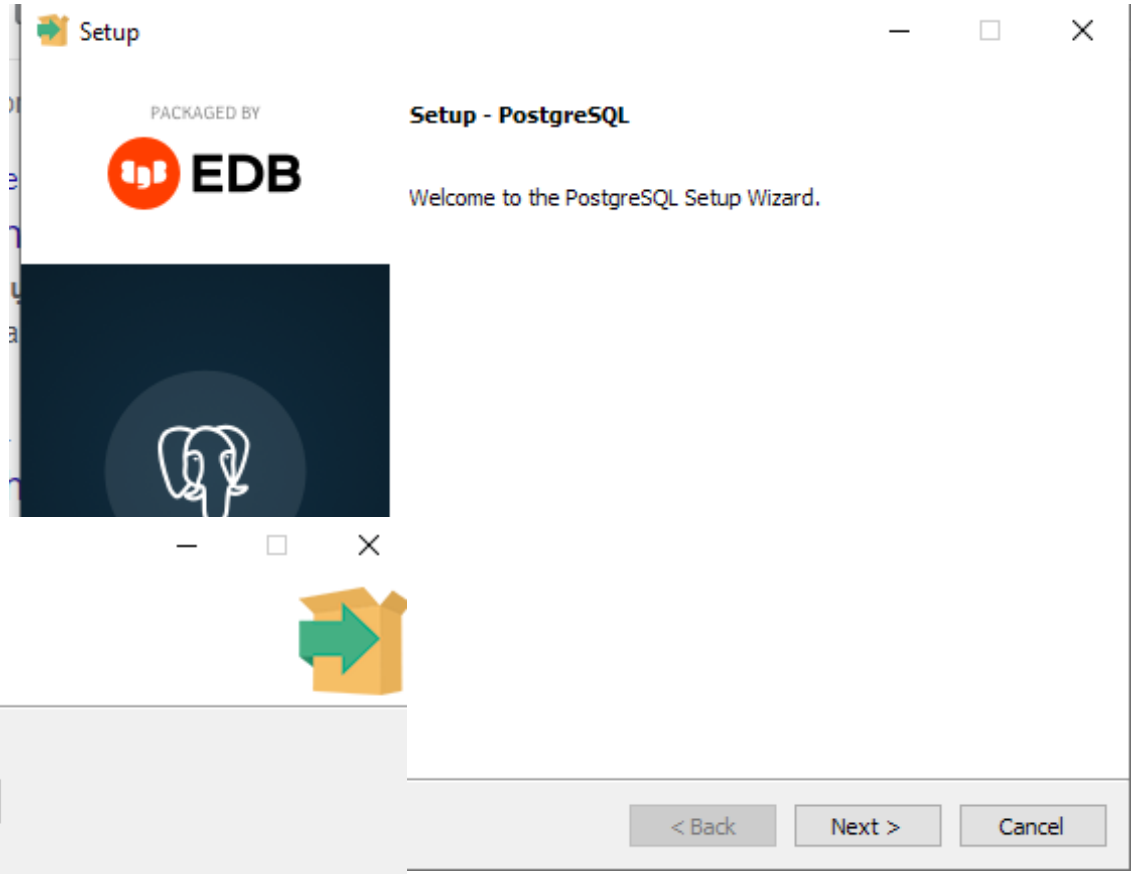
(Lastest version 13)

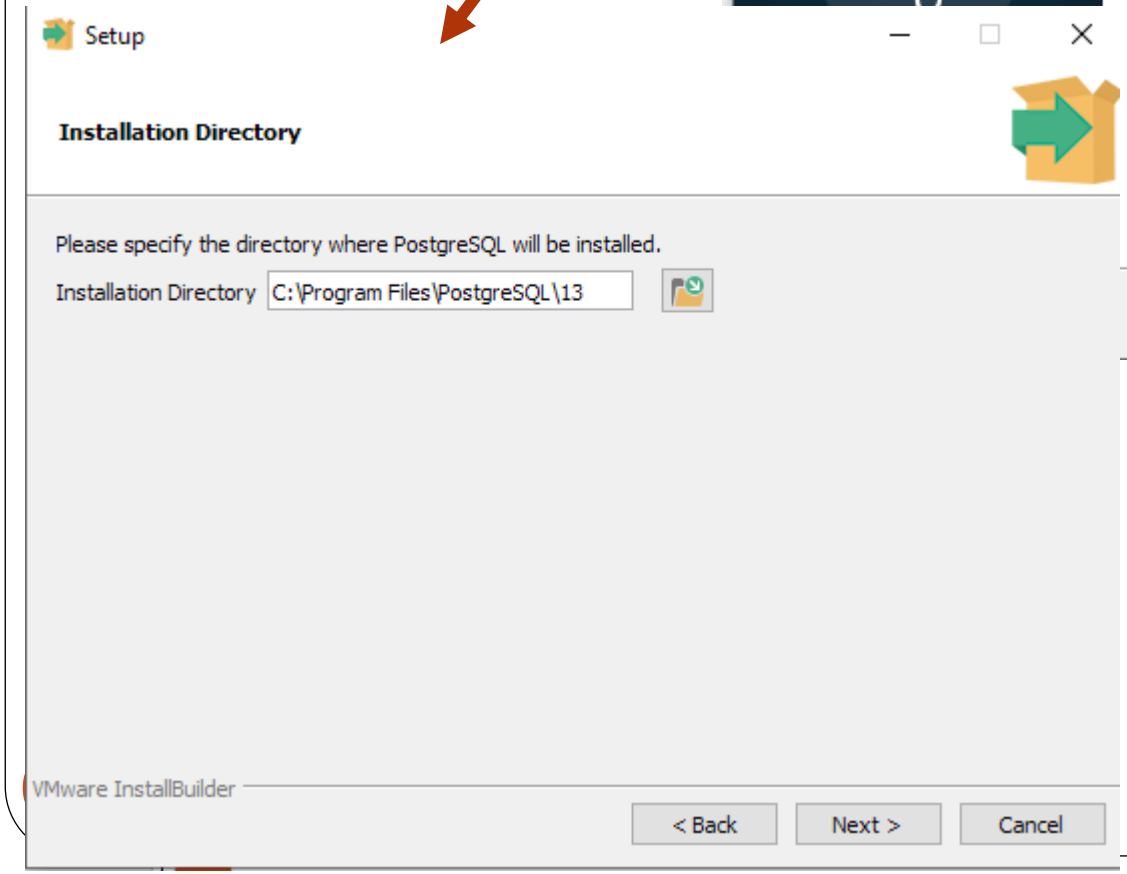
- The graphical installer for PostgreSQL includes
  - the ***PostgreSQL server***
  - ***pgAdmin IV***: a graphical tool for managing and developing your databases
  - and ***StackBuilder***: a package manager that can be used to download and install additional PostgreSQL applications and drivers

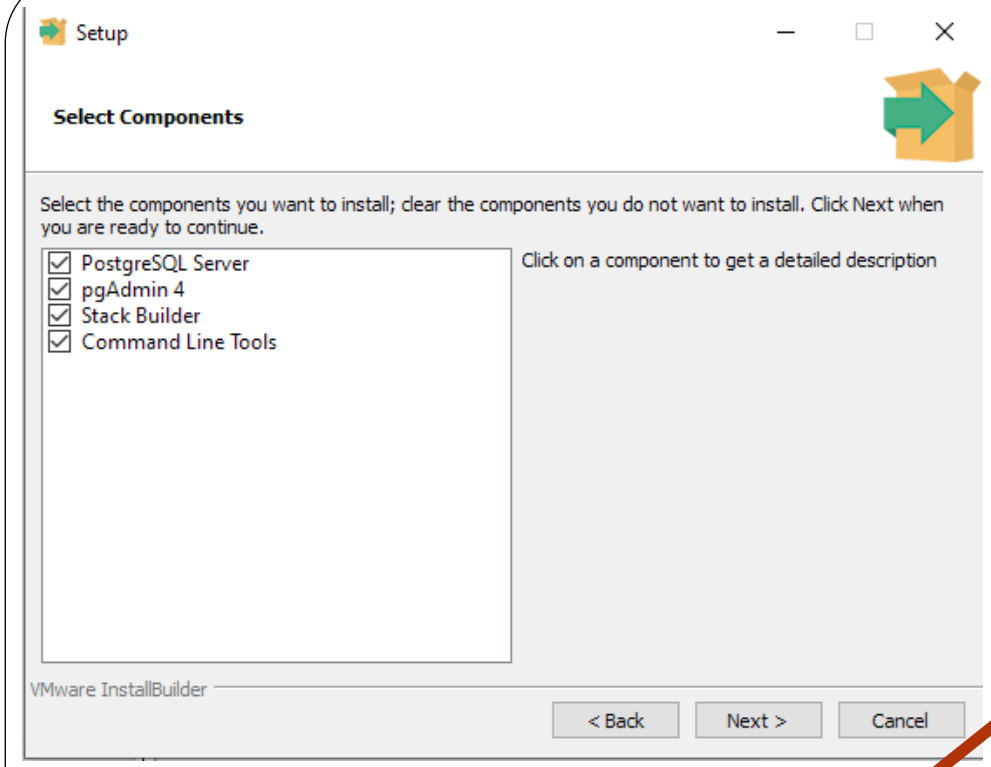
Install and test

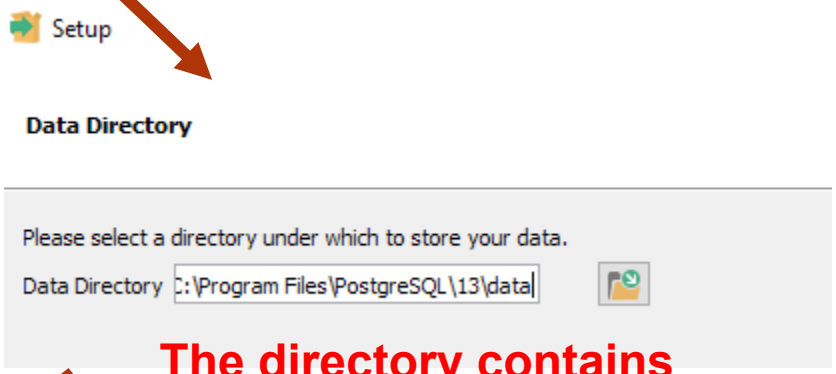
- Install
- Stop/start server (run as administrator)
- Connect to server from pgAdmin4

Install

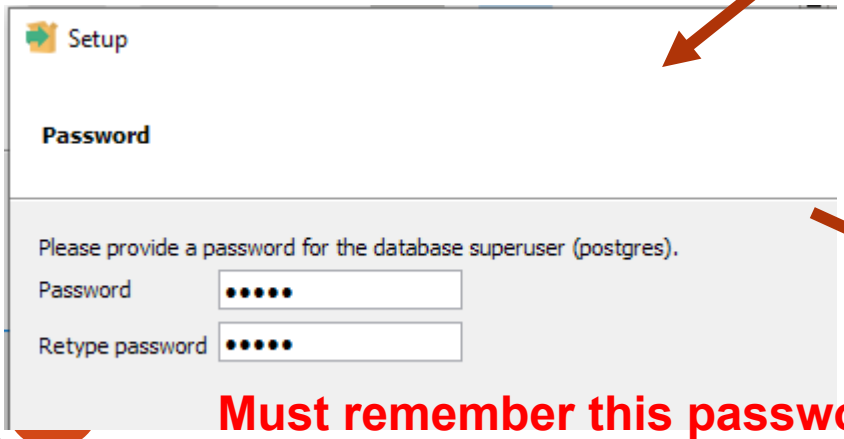

Setup
PACKAGED BY
EDB
Setup - PostgreSQL
Welcome to the PostgreSQL Setup Wizard.
< Back
Next >
Cancel


Setup
Installation Directory
Please specify the directory where PostgreSQL will be installed.
Installation Directory
C:\Program Files\PostgreSQL\13
VMware InstallBuilder
< Back
Next >
Cancel



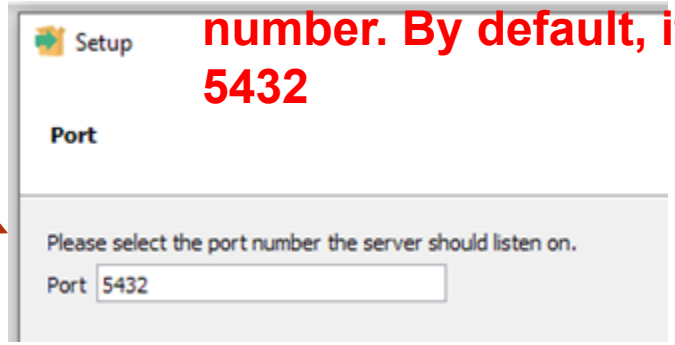


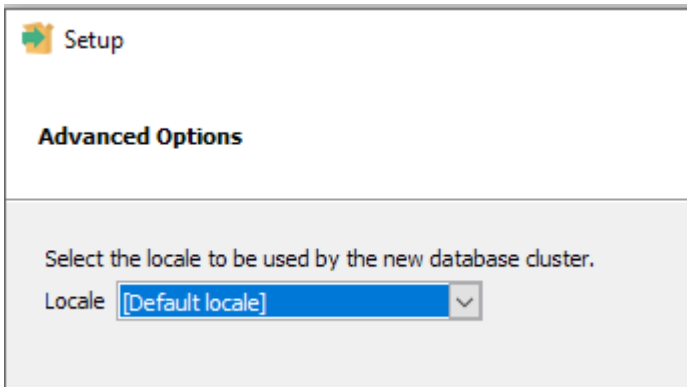
The directory contains all data files

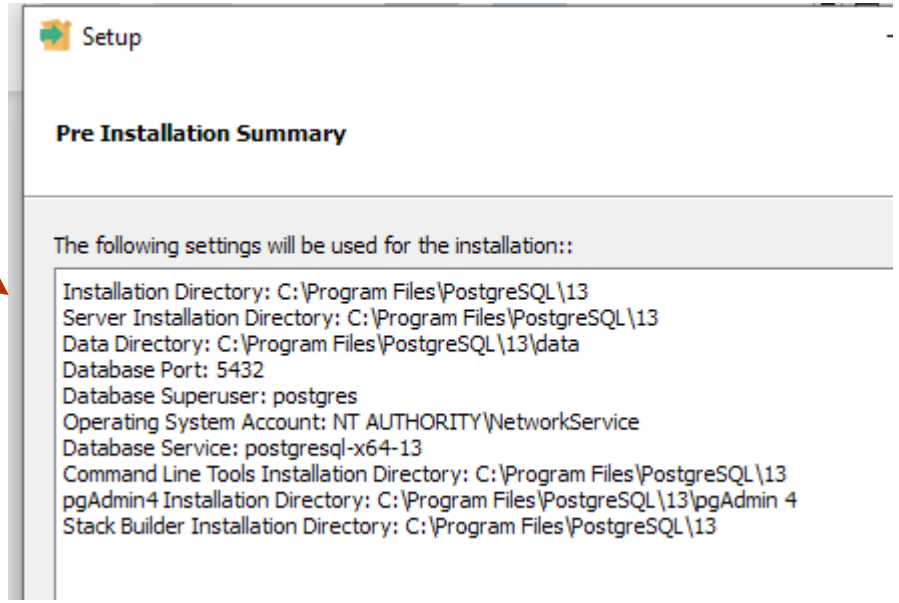


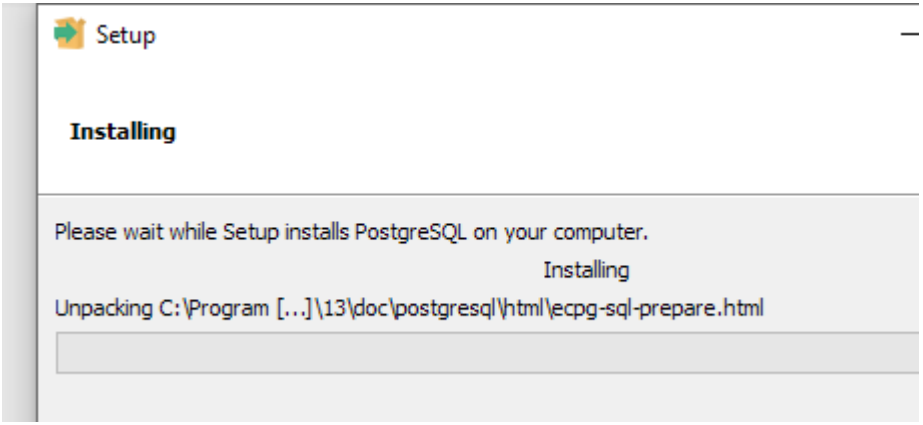
Must remember this password

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

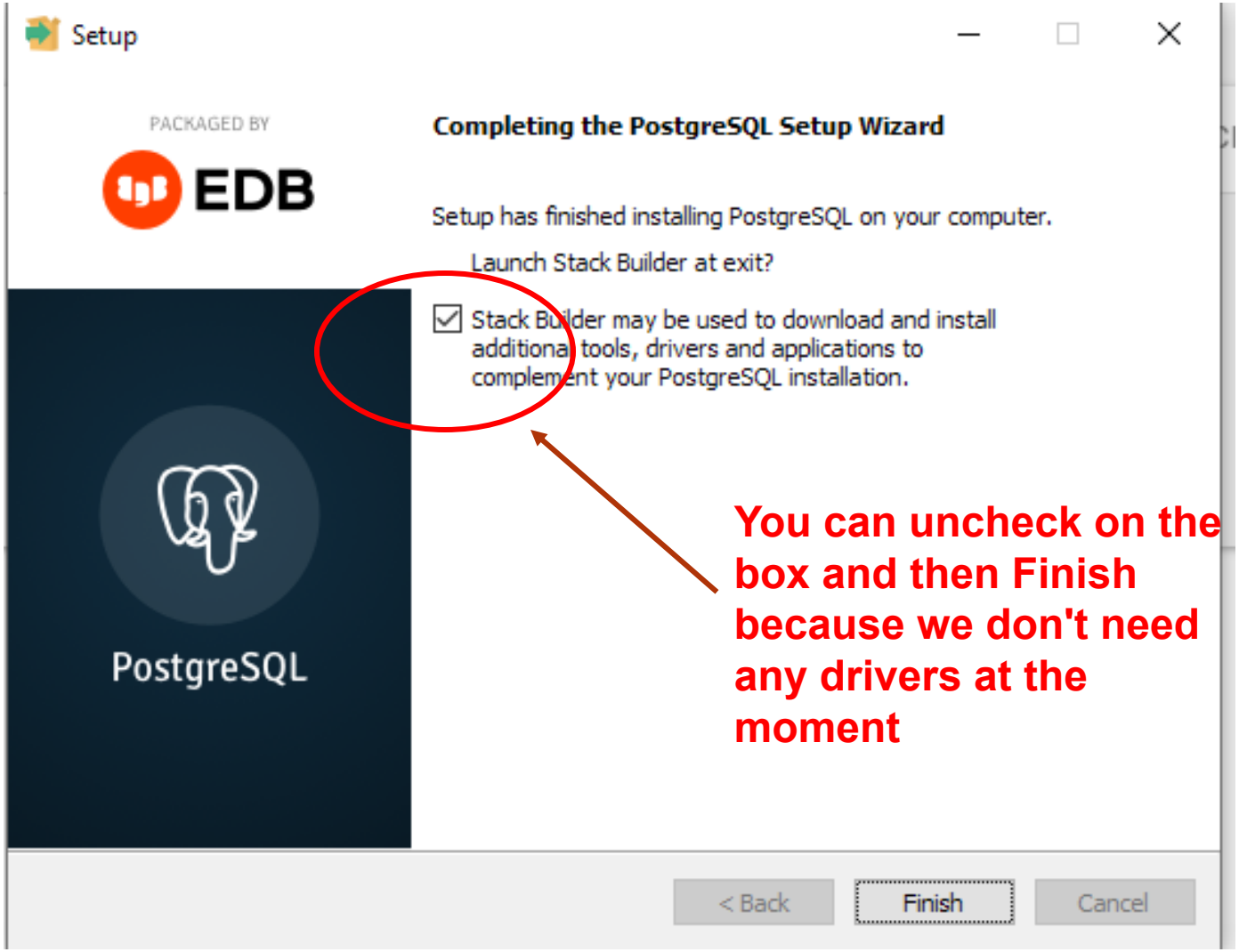



Setup
Advanced Options
Select the locale to be used by the new database cluster.
Locale
[Default locale]

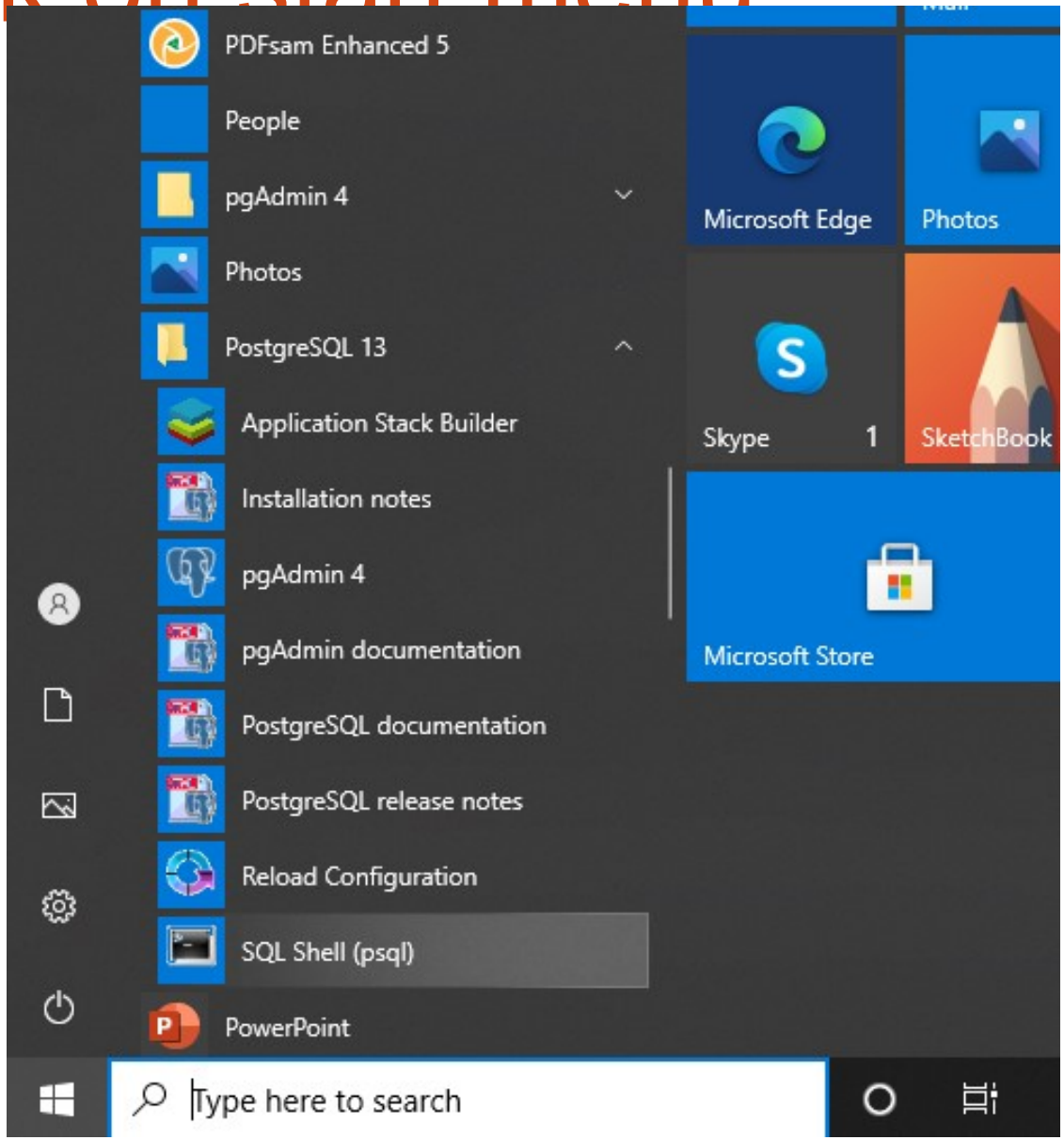

Setup
Pre Installation Summary
The following settings will be used for the installation::
Installation Directory: C:\Program Files\PostgreSQL\13
Server Installation Directory: C:\Program Files\PostgreSQL\13
Data Directory: C:\Program Files\PostgreSQL\13\data
Database Port: 5432
Database Superuser: postgres
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


Setup
PACKAGED BY
EDB
Completing the PostgreSQL Setup Wizard
Setup has finished installing PostgreSQL on your computer.
Launch Stack Builder at exit?
Stack Builder may be used to download and install additional tools, drivers and applications to complement your PostgreSQL installation.
PostgreSQL
< Back
Finish
Cancel
You can uncheck on the box and then Finish because we don't need any drivers at the moment

Check on start menu

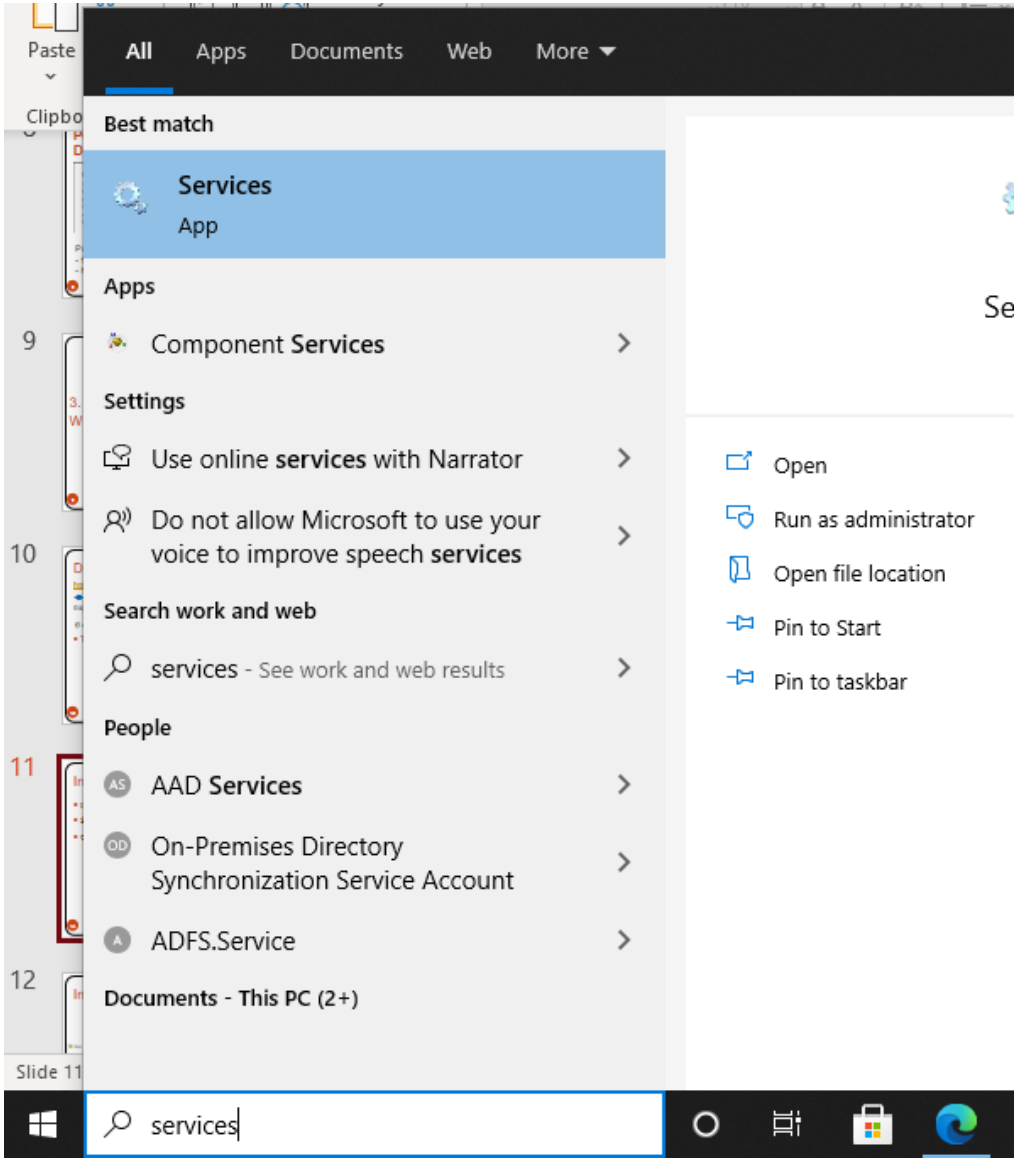


Notes: Uninstall postgreSQL

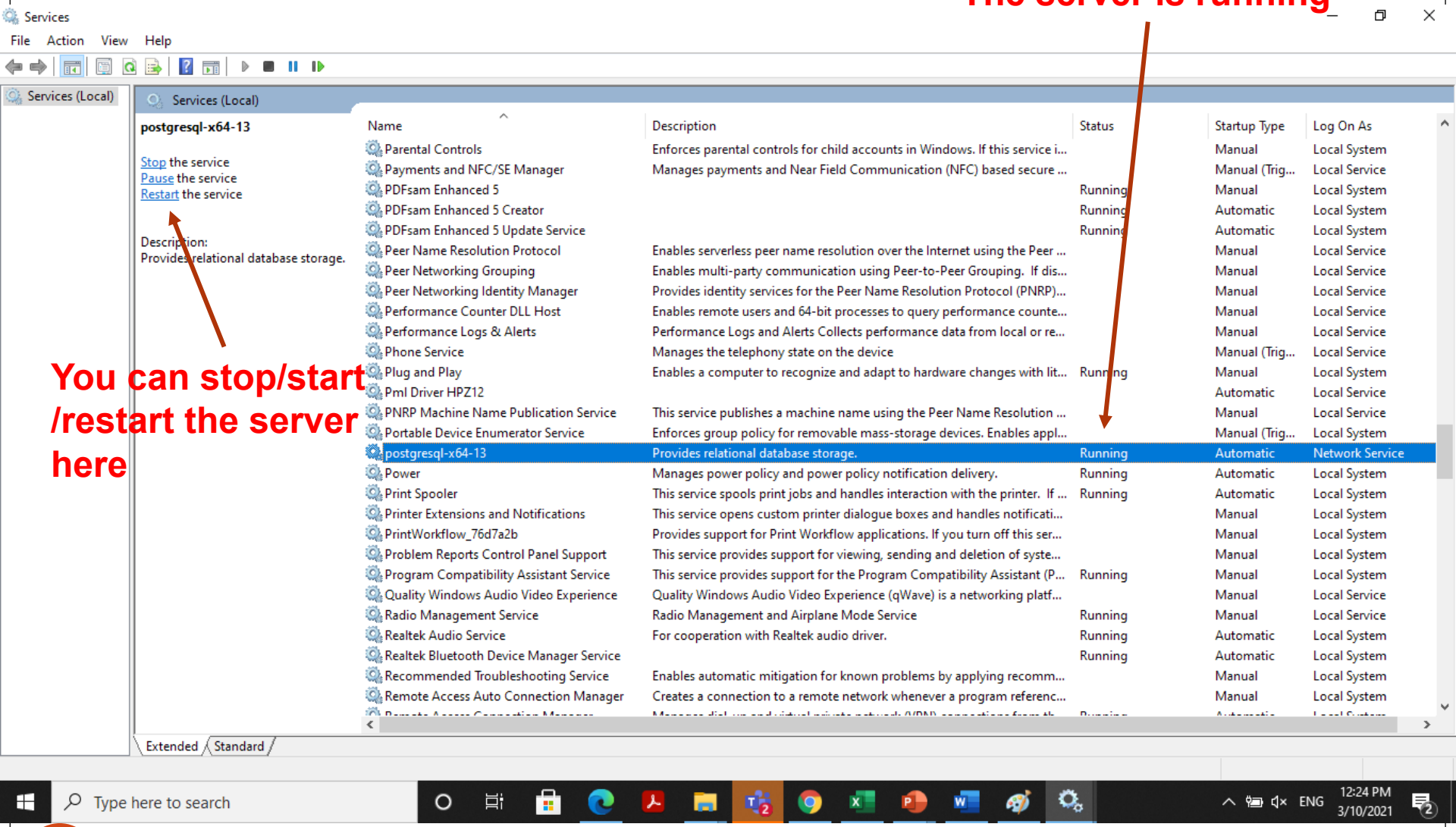
- Uninstall
- Remove data directory

  C:\Program Files\PostgreSQL

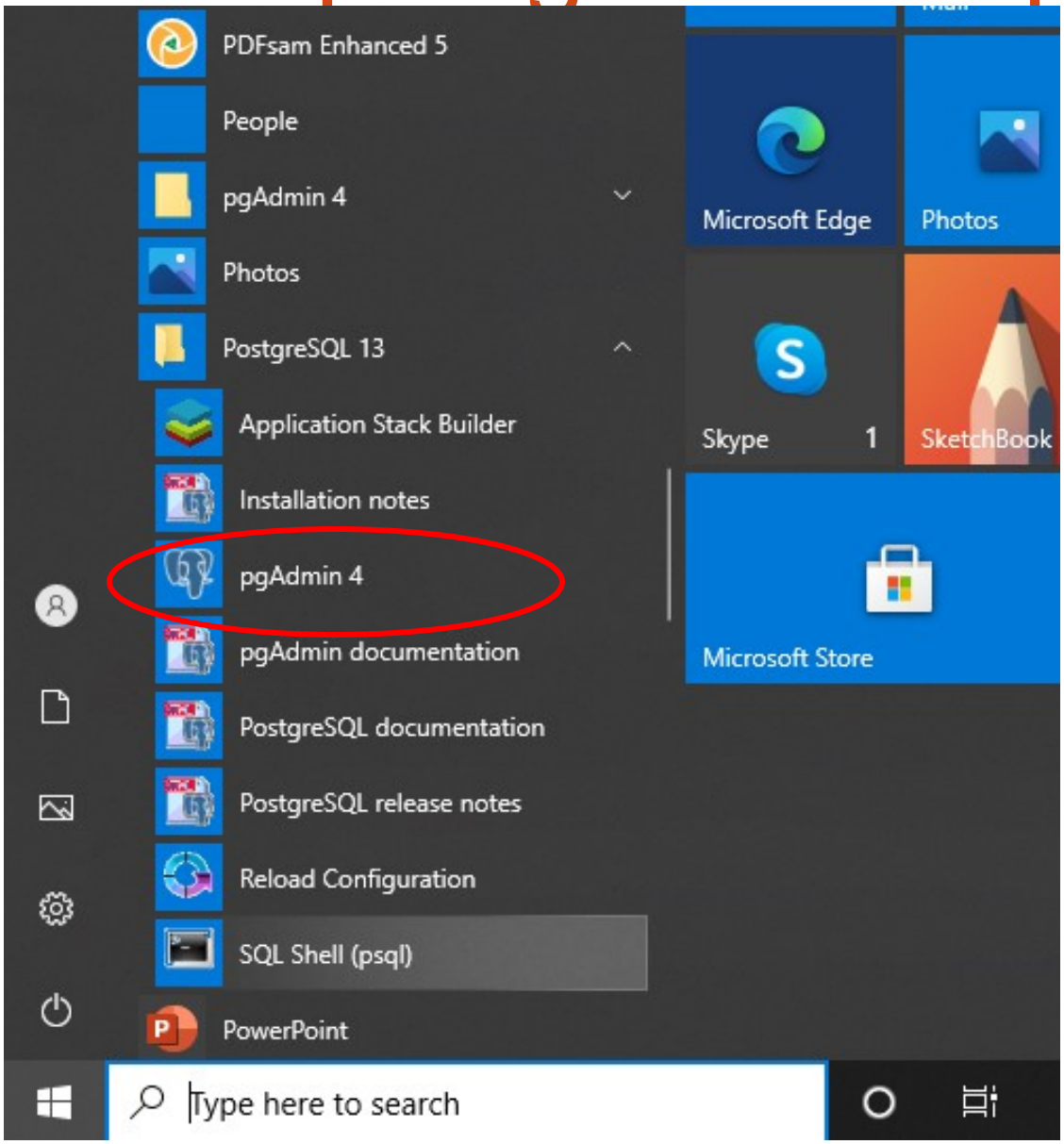
Server services



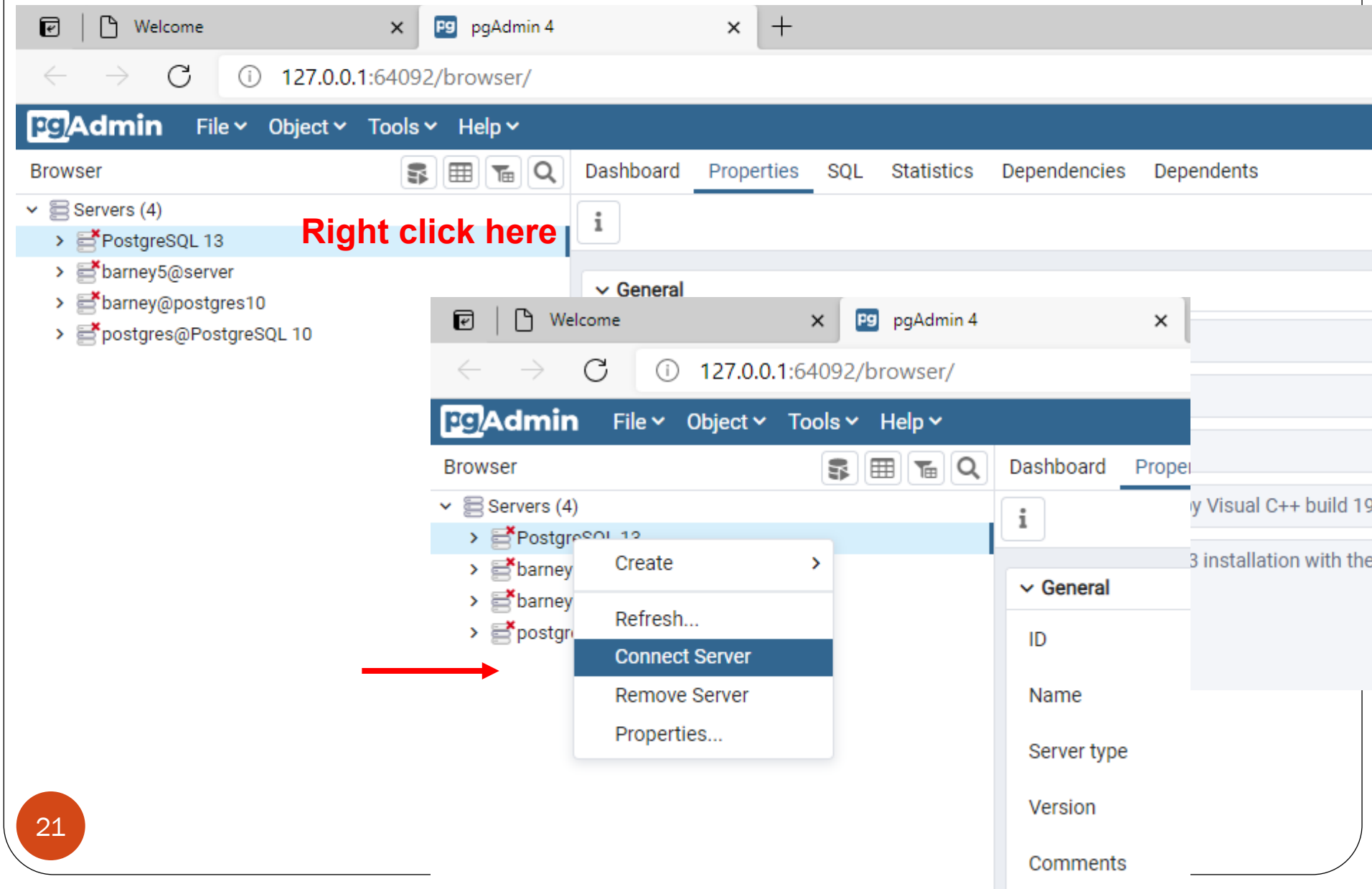
Server services



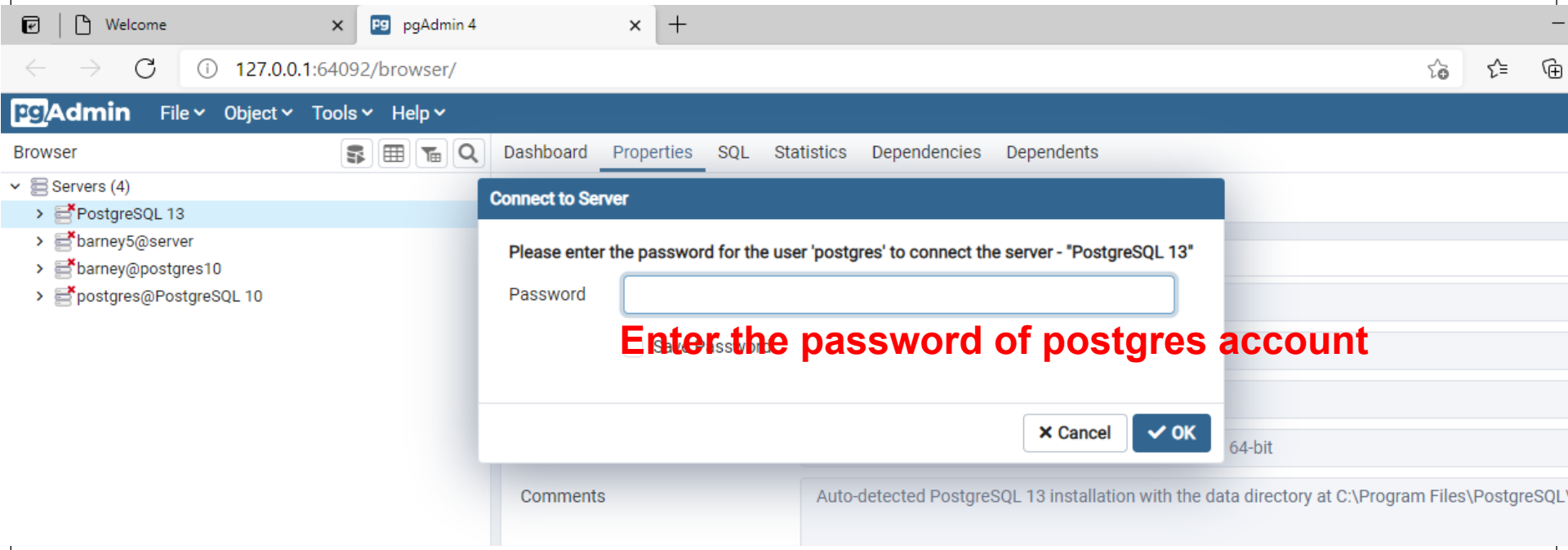
Connect to postgres from pgAdmin 4



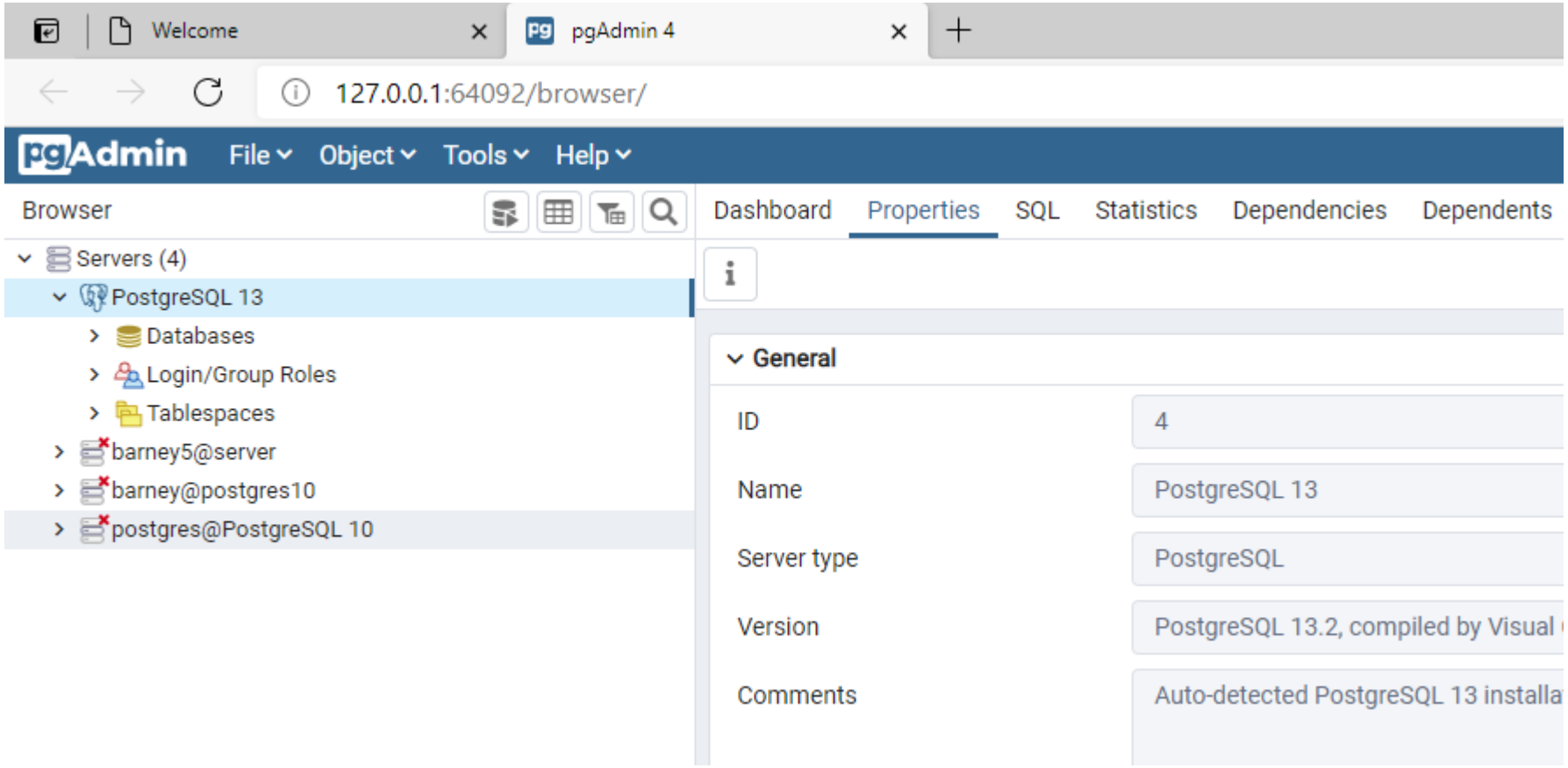
Connect to postgres from pgAdmin 4



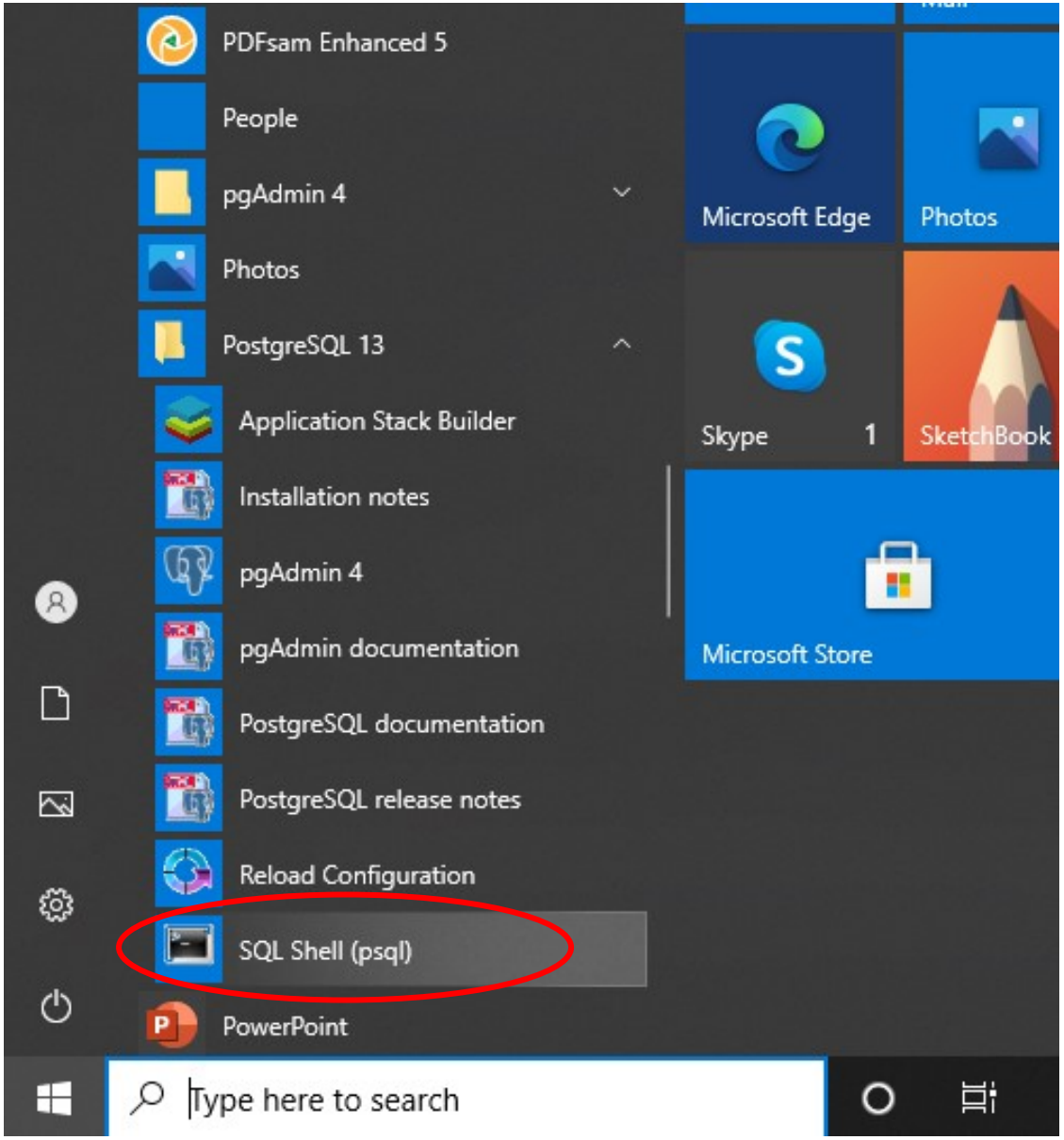
Connect to postgres from pgAdmin 4



Connect to postgres from pgAdmin 4



Connect to postgres using psql



Connect to postgres using psql

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 PostgreSQLthe 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: *postgresl-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 = puting 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

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