Imperial College
Business School

Imperial means
Intelligent Business

Lecture 4
Joins: bringing data together & the command line

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Reading

Video lectures:

5.2 - Basic joins.mp4
5.3.1 - Basic joins in practice.mp4
5.3.2 - Intermediate joins.mp4
5.5 - Advanced joins.mp4
5.6 - Solving an advanced join problem.mp4

Command Line Introduction.mp4
7.2.1 - Using PSQL.mp4

What's the most beautiful SQL query you ever wrote?
https://www.quora.com/Whats-the-most-complex-SQL-query-you-ever-wrote
SQL outer joins for fun and profit: https://www.slideshare.net/billkarwin/sql-outer-joins-for-fun-and-profit

Joins

Joins are the opposite of normalisation

We normalise data to make it efficient and safe to store. This mainly involves splitting up tables.

This makes data harder to view and analyse.

So we have to use the JOIN operation to bring data back together for analysis.

Joins

How do we combine information from two tables?

dog_id	name	breed
1	Rover	Great Dane
2	Fido	Dalmatian
3	Daisy	Mutt
4	Buddy	Poodle

owner_id	name	dog_name
1	Alex	Buddy
2	Brenda	Artemis
3	Charlie	Fido
4	Diana	Roger

Joins

dogs

dog_id	name	breed
1	Rover	Great Dane
2	Fido	Dalmatian
3	Daisy	Mutt
4	Buddy	Poodle

owners

owner_id	name	dog_name
1	Alex	Buddy
2	Brenda	Artemis
3	Charlie	Fido
4	Diana	Roger

```
dogs LEFT OUTER JOIN owners
ON dogs.name = owners.dog_name
```

dogs columns

owners columns

dog_id	name	breed	owner_id	name	dog_name
1	Rover	Great Dane			
2	Fido	Dalmatian	3	Charlie	Fido
3	Daisy	Mutt			
4	Buddy	Poodle	1	Alex	Buddy

Joins

owners

owner_id	name	dog_name
1	Alex	Buddy
2	Brenda	Artemis
3	Charlie	Fido
4	Diana	Roger

dogs

dog_id	name	breed
1	Rover	Great Dane
2	Fido	Dalmatian
3	Daisy	Mutt
4	Buddy	Poodle

```
owners LEFT OUTER JOIN dogs
ON owners.dog_name = dogs.name
```

owners columns

dogs columns

owner_id	name	dog_name	dog_id	name	breed
1	Alex	Buddy	4	Buddy	Poodle
2	Brenda	Artemis			
3	Charlie	Fido	2	Fido	Dalmatian
4	Diana	Roger			

Joins

owners

owner_id	name	dog_name
1	Alex	Buddy
2	Brenda	Artemis
3	Charlie	Fido
4	Diana	Roger

dogs

dog_id	name	breed
1	Rover	Great Dane
2	Fido	Dalmatian
3	Daisy	Mutt
4	Buddy	Poodle

```
owners INNER JOIN dogs
ON owners.dog_name = dogs.name
```

owners columns

dogs columns

owner_id	name	dog_name	dog_id	name	breed
1	Alex	Buddy	4	Buddy	Poodle
3	Charlie	Fido	2	Fido	Dalmatian

OUTER and INNER joins

A **JOIN** operation brings together two tables.
Rows from one table are matched with rows from another.
The **ON** line says which attributes to use to match up the rows.

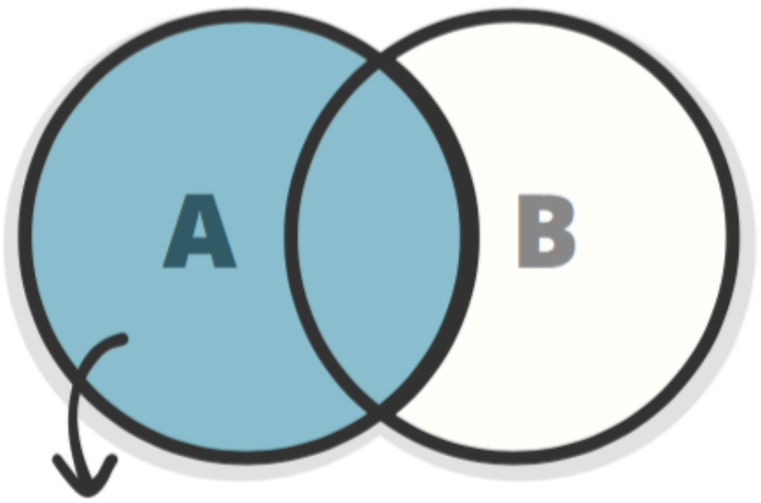
A **LEFT OUTER JOIN** B
ON A.id = B.id

Here table A is copied into the result. Then the SQL processor works down the table and inserts rows from B where they match.

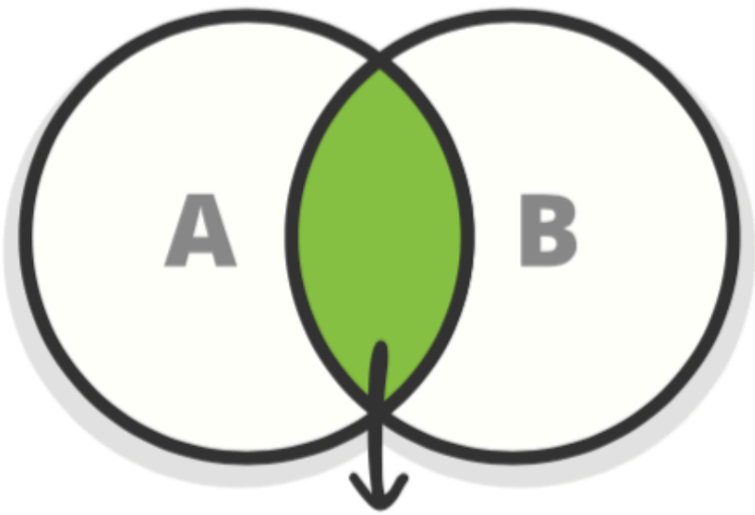
A **INNER JOIN** B
ON a.id = B.id

Here only the rows which were matched up appear in the result. Rows which were not matched up are skipped.

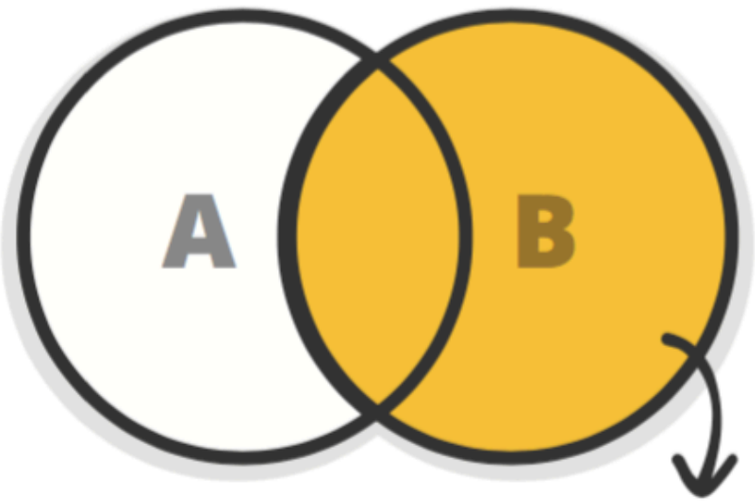
Joins



LEFT OUTER JOIN - *all rows from table A, even if they do not exist in table B*



INNER JOIN - *fetch the results that exist in both tables*



RIGHT OUTER JOIN - *all rows from table B, even if they do not exist in table A*

Joins

The inner join is symmetric!

```
owners INNER JOIN dogs
ON owners.dog_name = dogs.name
```

=

```
dogs INNER JOIN owners
ON dogs.name = owners.dog_name
```

Joins

The outer join is antisymmetric:

```
owners LEFT OUTER JOIN dogs
ON owners.dog_name = dogs.name
```

=

```
dogs RIGHT OUTER JOIN owners
ON dogs.name = owners.dog_name
```

Joins

Please note:

- No matter what kind of join you use, the columns in the result are always all the columns from the two input tables.
- As a result, we often have two columns with the same name. These can be qualified with the table name to separate them:

```
dogs.name
owners.name
```

Ambiguous columns

SELECT * from rental, staff
WHERE rental.staff_id = staff.staff_id

Notice that there are two staff_id columns, so we have to specify which table we are referring to.

You can use **SELECT** rental.* or **SELECT** staff.* to return all columns from one table.

How joins are processed

The SQL processor makes an intermediate table with **all** the columns from both joined tables.

Then, AFTER the join has been processed, the columns you asked for in the SELECT clause are extracted and sent to you.

The temporary joined table is then thrown away.

Sequential joins

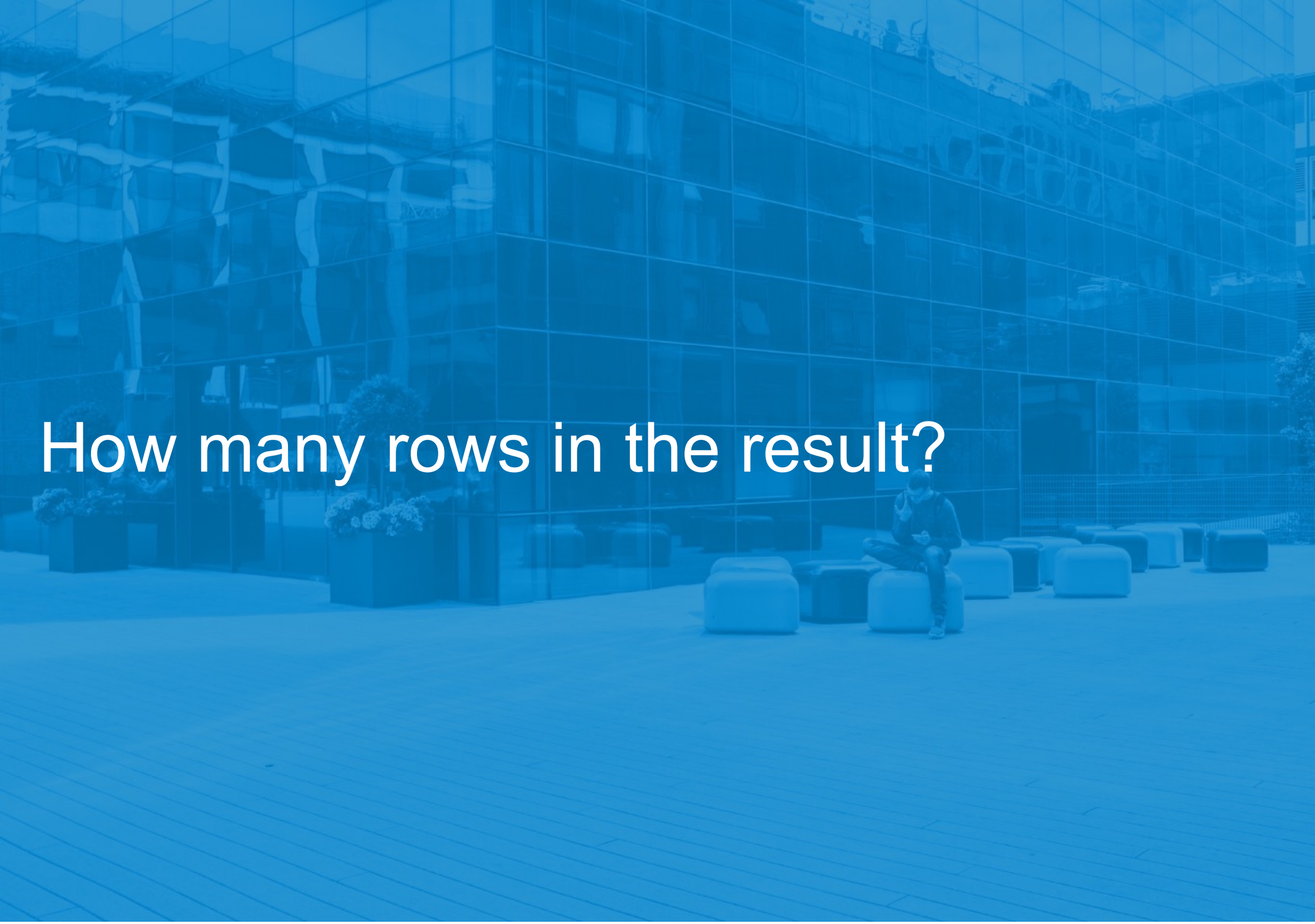
You can chain joins:

A INNER JOIN B
INNER JOIN C
INNER JOIN D

etc
(each with an ON line)

The SQL processor does the joins sequentially, adding to the joined result table as it goes along.

Doing a JOIN is like following a relationship line on the ER diagram.



How many rows in the result?

When do joins increase the row count?

owners

owner_id	name
1	Alex
2	Brenda

dogs

dog_id	owner_id	name	breed
1	1	Rover	Great Dane
2	1	Fido	Dalmatian
3	1	Daisy	Mutt
4	2	Buddy	Poodle

```
owners LEFT OUTER JOIN dogs
ON dogs.owner_id = owners.owner_id
```

owners columns

dogs columns

owner_id	name	dog_id	owner_id	name	breed
1	Alex	1	1	Rover	Great Dane
1	Alex	2	1	Fido	Dalmatian
1	Alex	3	1	Daisy	Mutt
2	Brenda	4	2	Buddy	Poodle

When do joins increase the row count?

When we do

table_1 INNER JOIN table_2

or

table_1 LEFT OUTER JOIN table_2

and some rows in table_1 are matched up with more than one row in table_2,
the row count will increase
(joined table will have more rows than table_1).

When do joins decrease the row count?

owners

owner_id	name
1	Alex
2	Brenda
3	Charlie
4	Daisy

dogs

dog_id	owner_id	name	breed
1	3	Rover	Great Dane

```
owners LEFT OUTER JOIN dogs
ON dogs.owner_id = owners.owner_id
```

owners columns

dogs columns

owner_id	name	dog_id	owner_id	name	breed
1	Alex				
2	Brenda				
3	Charlie	1	3	Rover	Great Dane
4	Daisy				

When do joins decrease the row count?

owners

owner_id	name
1	Alex
2	Brenda
3	Charlie
4	Daisy

dogs

dog_id	owner_id	name	breed
1	3	Rover	Great Dane

```
owners INNER JOIN dogs
ON dogs.owner_id = owners.owner_id
```

owners columns

dogs columns

owner_id	name	dog_id	owner_id	name	breed
3	Charlie	1	3	Rover	Great Dane

When do joins decrease the row count?

When we do

table_1 INNER JOIN table_2

and some rows in table_1 do not get matched up with rows in table_2

(or the other way around, since the inner join is symmetric),

the row count is decreased
(joined table does not have all of the rows from table 1).

When we do

table_1 LEFT JOIN table_2

we will always see all the rows from table_1, since the left join includes them all.

Both effects combined

owners

owner_id	name
1	Alex
2	Brenda
3	Charlie

dogs

dog_id	owner_id	name	breed
1	3	Rover	Great Dane
2	3	Spot	Dalmatian
3	3	Fido	Terrier

```
owners INNER JOIN dogs
ON dogs.owner_id = owners.owner_id
```

owners columns

dogs columns

owner_id	name	dog_id	owner_id	name	breed
3	Charlie	1	3	Rover	Great Dane
3	Charlie	2	3	Spot	Dalmatian
3	Charlie	3	3	Fido	Terrier

Two owners rows lost; one owners row copied three times: still three rows in the final table.

JOIN USING

Where two tables share a column, instead of writing:

```
select * FROM
orders INNER JOIN order_details
ON orders.orderid = order_details.orderid
```

...one can write:

```
select * FROM
orders INNER JOIN order_details
USING (orderid)
```

USING works with lists of columns too (joins on all).

Outer joins

LEFT JOIN

is the same thing as

LEFT OUTER JOIN

(same for right joins)

Outer joins

A INNER JOIN B LEFT OUTER JOIN C

can be written

(A INNER JOIN B) LEFT OUTER JOIN C

or

A INNER JOIN B
LEFT OUTER JOIN C

and is not the same as

A INNER JOIN (B LEFT OUTER JOIN C)

The cross join

- The cross join produces a table with each row associated with each other row.

- There are no join conditions – all rows are joined to all other rows. This operation is also called the **Cartesian product**.

- If table A has x rows and table B has y rows, A cross join B will have x * y rows.

SELECT * FROM
rental **CROSS JOIN** staff

This can be abbreviated with the comma (this is equivalent):
SELECT * FROM rental, staff

Cross joins and WITH vs. normal joins and ON

Notice that

```
SELECT * from rental, staff
WHERE rental.staff_id = staff.staff_id
```

returns the same rows as

```
SELECT * FROM
rental INNER JOIN staff
ON rental.staff_id = staff.staff_id
```

Checking the matching staff_id can be done by either WHERE or ON.
Is there any difference in speed?

The command line

The command line

The command line is a vital everyday tool for data scientists.

It allows the computer to be controlled by issuing text commands, without a GUI (graphical user interface).

The command line has not changed much since the 1970s.

Common commands

	OS X/Linux/Unix	**Windows**
Show current folder	pwd *print working directory*	cd *by itself*
Change directory	cd *change directory*	cd
List files in current folder	ls	dir
Make new directory	mkdir	mkdir
Show the file in which a command is stored	which	*N/A*
Set environment variable (just in current command line session)	export var=val	SET var=val (or control panel)

PSQL

PSQL

PSQL is a command line utility allowing you to

- Make queries, just like pgAdmin;
- Control the Postgres server using special PSQL commands.

PSQL

-h host
-p port
-U user

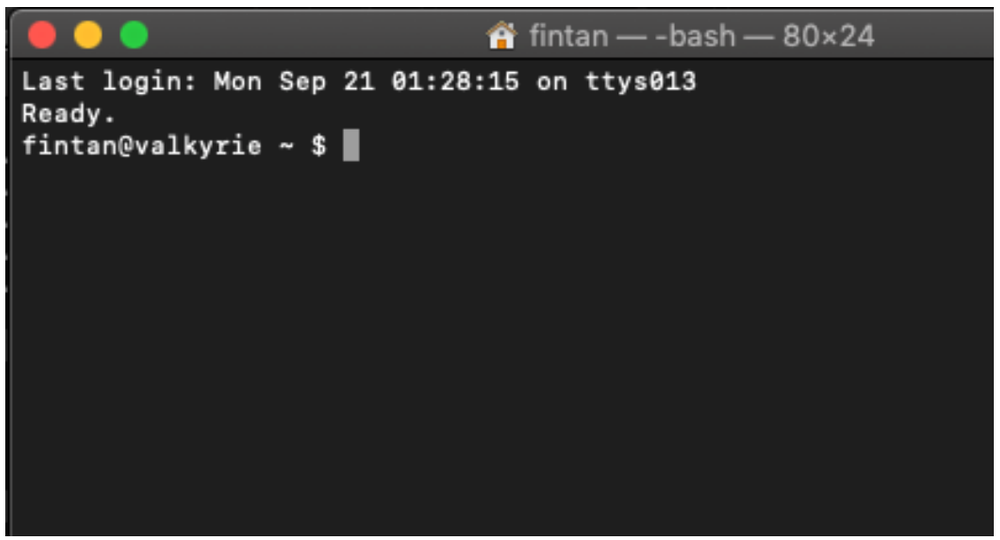
-f run a particular SQL file

-E report on what you're doing

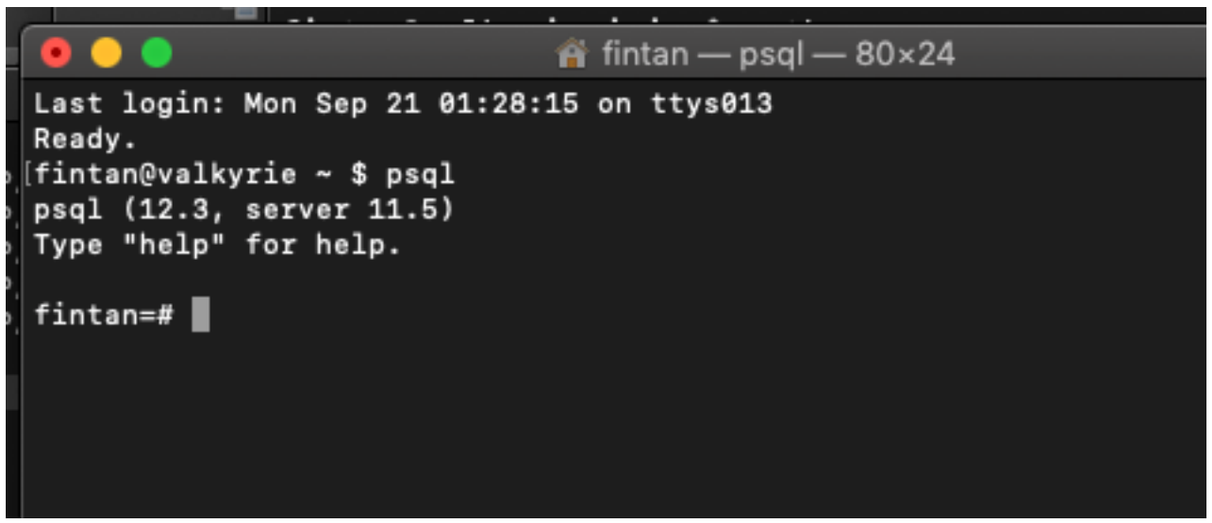
Which environment are you in?

Be aware whether you are in PSQL or the normal command line.

Notice that the prompt is different in psql:



Command line



PSQL

Note that PSQL **requires** a closing semicolon and closed quotes, etc.

Restart PSQL if you get stuck.

PSQL

EXPLAIN __query__: see the query plan for the given query

EXPLAIN ANALYZE __query__: see and execute the query plan for the given query

ANALYZE [__table__]: collect statistics

PSQL

\c my_database connect to database
\l list databases
\lv list views

\copy (SELECT * FROM __table_name__) TO 'file_path_and_name.csv'
WITH CSV

export as CSV

\du

list users

pg_dump

PSQL

```
sudo service postgresql stop
sudo service postgresql start
sudo service postgresql restart
```