Introduction to Relational Databases and SQL

What is a Relational Database?

- Relational databases store related data in **tabular form**
- Relationships between tables are defined with **keys** (primary and foreign)
- Most relational databases are created for use by applications and optimized for **CRUD *transactions***
  - Create
  - Read
  - Update
  - Delete
- Data Analysts/Data Scientists mostly focused on **Read** - querying the data. They want to look at the data and perform calculations without making any permanent changes.

What is SQL

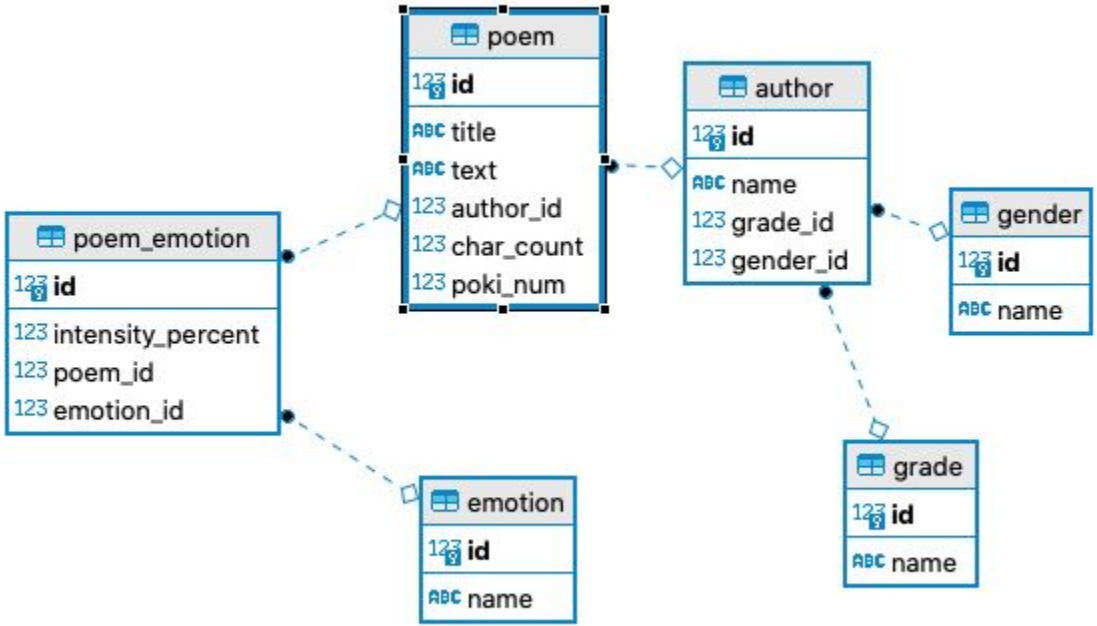
SQL stands **S**tructured **Q**uery **L**anguage. It is the language you use to interact with a database. It allows you to write out what you want to search for, goes to a database that you specify, then returns those results to you.

The Structured part of SQL means queries are written in a specific format using specific keywords.

Keywords

- **SELECT**
- **FROM**
- AS
- **LIMIT**
- **DISTINCT**
- **COUNT**
- **WHERE**
- AND
- OR
- BETWEEN
- IN
- **(NOT) NULL**
- **LIKE**
- **AVG()**, SUM(), **MAX()**, **MIN()**, etc.
- **ORDER BY**
- **GROUP BY**
- HAVING

For our learning examples, we will be using the PoetryKids database. Below is an Entity Relationship Diagram (ERD) that shows the tables in the database and the relationships between tables.



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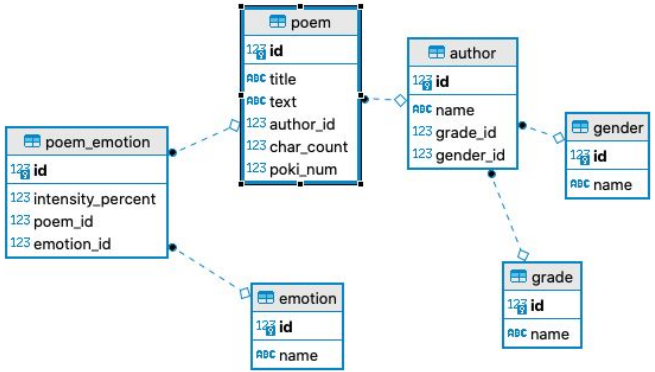
Format of a Query

Keywords all caps

```
SELECT text
FROM poem;
```

End with semicolon



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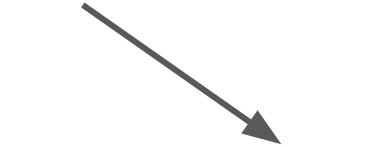
Format of a Query

the column(s)
to retrieve



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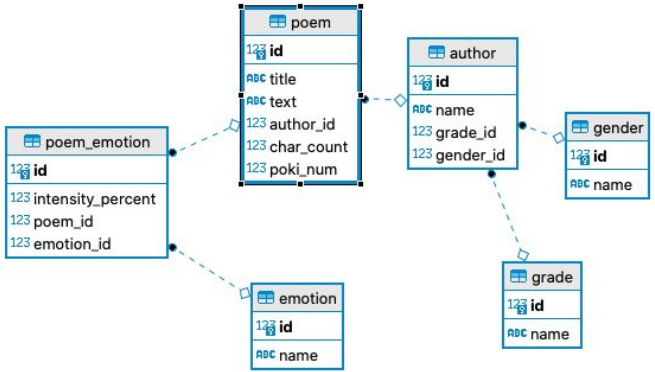
```



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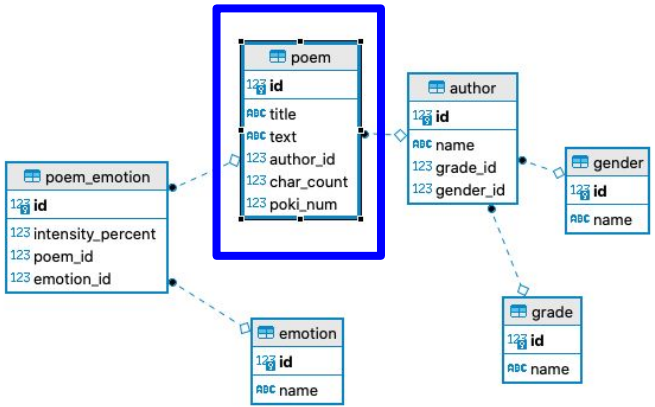


```
SELECT text
FROM poem;
```

the table to retrieve from

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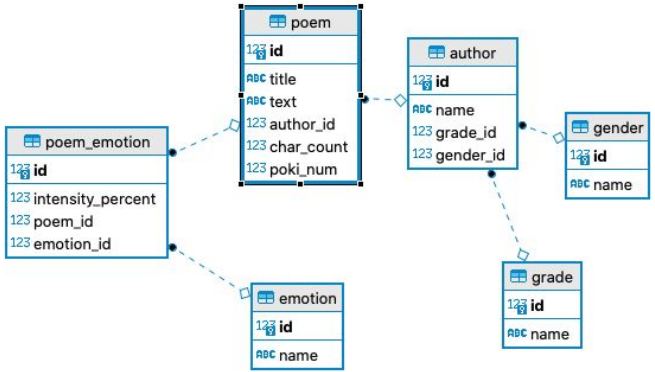
Format of a Query




```
SELECT text
FROM poem
WHERE char_count < 20;
```

Only return rows satisfying this condition.

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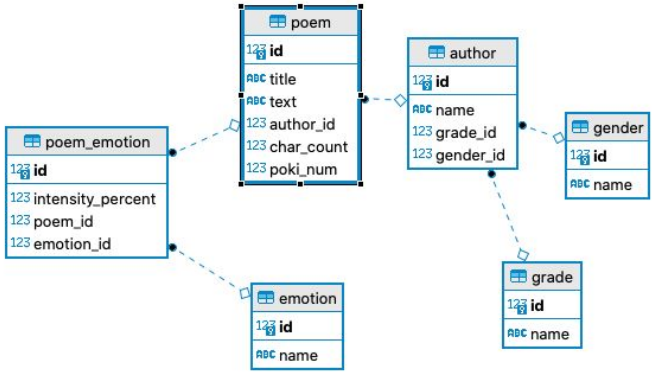
Format of a Query




```
SELECT text
FROM poem
WHERE char_count < 20
LIMIT 5;
```

Just return the first 5 results.

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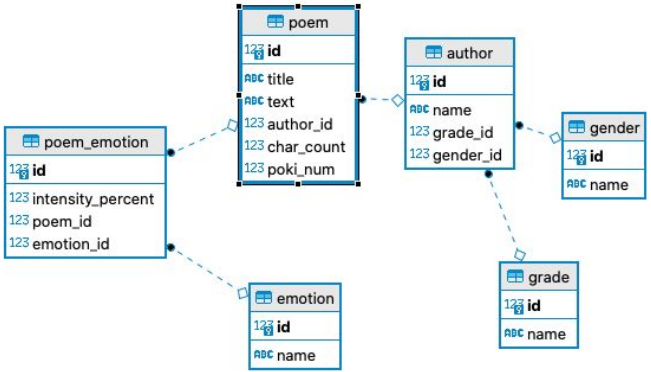
Selecting single columns from a table

You can also specify individual columns to return, each separated by a ‘,’:

```
SELECT name, grade_id
FROM author
LIMIT 5;
```

	name character varying	grade_id integer
1	a	1
2	aab	1
3	aadhya	1
4	aaliyah	1
5	aanna	1

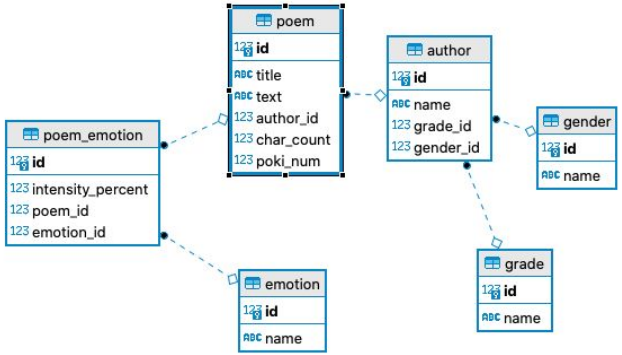


Selecting all columns from a table

A shorthand to **SELECT ALL** is to use a *:

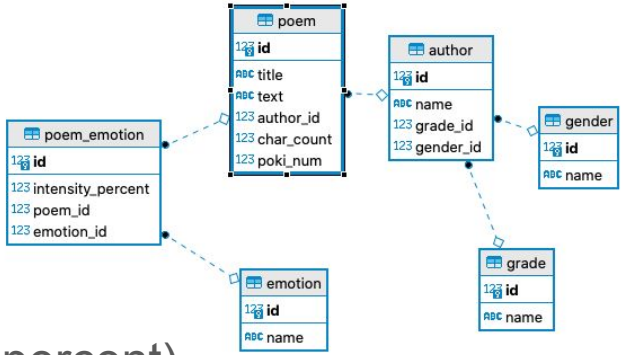
```
SELECT *
FROM emotion;
```

	id [PK] integer	name character varying
1	1	Anger
2	2	Fear
3	3	Sadness
4	4	Joy



Aggregating Data

You may want to summarize your data in different ways. For example you could **COUNT**, **SUM**, **AVERAGE**, or find the **MAX** or **MIN**:




```
SELECT COUNT(id)
FROM author
WHERE grade_id = 4;
```

count bigint
3288

```
SELECT AVG(intensity_percent)
FROM poem_emotion
WHERE emotion_id = 2;
```

avg numeric
45.4740880030086499

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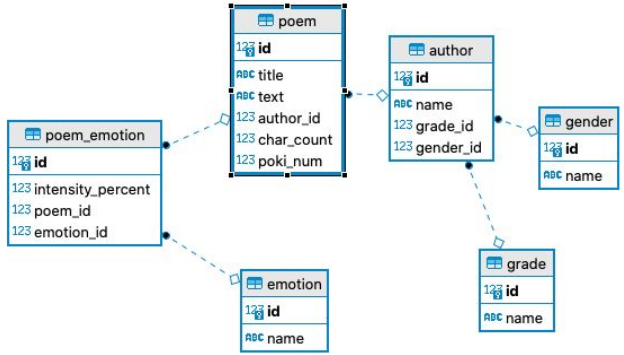
Aggregating Data with GROUP BY

The **GROUP BY** keyword will subdivide the table based on the specified columns. You can then perform aggregations on the subgroups:




```
SELECT COUNT(id)
FROM author
GROUP BY grade_id;
```

	count bigint
1	623
2	2344
3	3464
4	3288
5	1437

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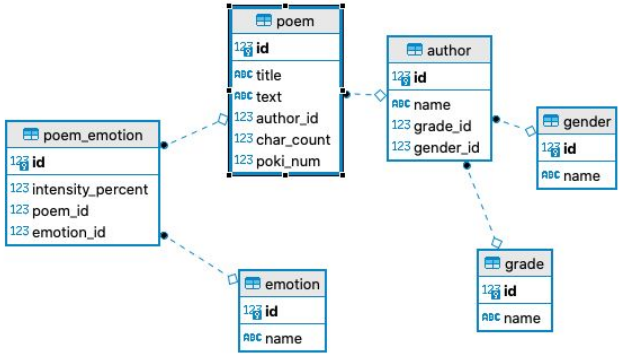


```
SELECT grade_id, COUNT(id)
FROM author
GROUP BY grade_id;
```

	grade_id integer	count bigint
1	1	623
2	3	2344
3	5	3464
4	4	3288
5	2	1437

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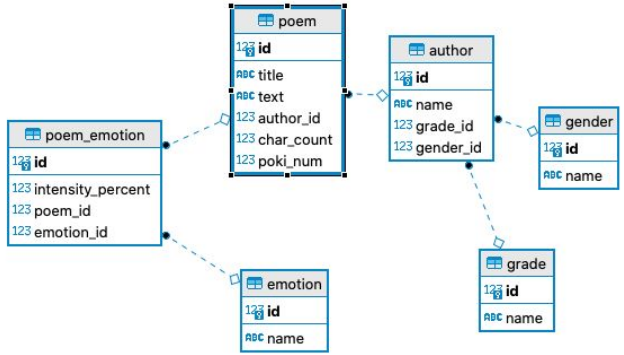


```
SELECT grade_id, COUNT(id)
FROM author
GROUP BY grade_id
ORDER BY grade_id;
```

	grade_id integer	count bigint
1	1	623
2	2	1437
3	3	2344
4	4	3288
5	5	3464

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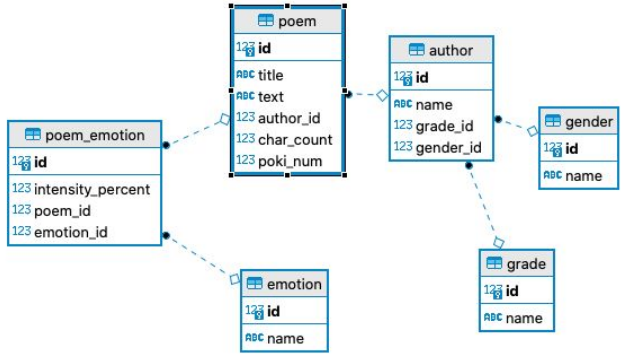
Aggregating Data with GROUP BY



The **GROUP BY** keyword will subdivide the table based on the specified columns. You can then perform aggregations on the subgroups:

```
SELECT grade_id, COUNT(id)
FROM author
GROUP BY grade_id
ORDER BY count DESC;
```

	grade_id integer	count bigint
1	5	3464
2	4	3288
3	3	2344
4	2	1437
5	1	623

By default, ORDER BY sorts in ascending order, but we can change it with DESC.

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Queries are written following this basic format:

SELECT *columns*
FROM *table*
WHERE *condition*
GROUP BY *columns*
HAVING *condition*
ORDER BY *columns*

It's helpful to know that the query ***executes*** in a different **order**:
FROM
WHERE
GROUP BY
HAVING
SELECT

https://jvns.ca/blog/2019/10/03/sql-queries-don-t-start-with-select/

Finding unique values

Sometimes a particular column or a calculation will result in duplicate values. To get just unique values:

```
SELECT COUNT (DISTINCT name)
FROM author;
```

	count bigint
1	7403

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Selecting/avoiding null values

Null values will likely exist in any data set you work with. It will be useful to identify or exclude records with null values:

```
SELECT title, char_count
FROM poem
WHERE title IS NOT NULL
LIMIT 5;
```

	title character varying	char_count integer
1	Computer	106
2	Angel	164
3	Nature Nature and Nat...	491
4	Jack	74
5	When I awoke one mor...	325

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Joining Data

Often data will be spread across **multiple tables**. In order to perform an analysis you may need to **combine the data from two or more tables**.

Table A		
id	col_1	col_2
1	23-B	12
2	435	45
3	AB145	23
4	BB	56
5	435	123

Table B		
id	lookup_id	col_a
a1	1	a
a2	2	a
b1	3	b
b2	4	b
a3	5	a

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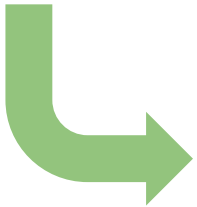

Table B

id	lookup_id	col_a
a1	1	a
a2	2	a
b1	3	b
b2	4	b
a3	5	a

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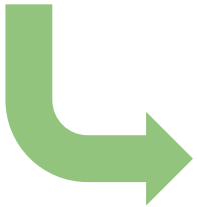

Table B

id	lookup_id	col_a
a1	1	a
a2	2	a
b1	3	b
b2	4	b
a3	5	a

merge_table

id	col_1	col_2	col_a
1	23-B	12	a
2	435	45	a
3	AB145	23	b
4	BB	56	b
5	435	123	a

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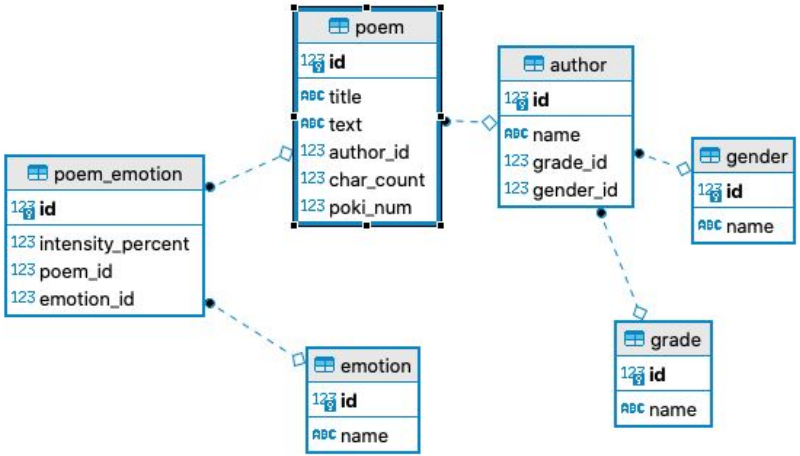
Joining Data - example

Goal: Retrieve the title of each poem along with the poem author's name.



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Joining Data - example

Goal: Retrieve the title of each poem along with the poem author's name.

Process:

a. decide what tables you need
b. decide how to connect your tables
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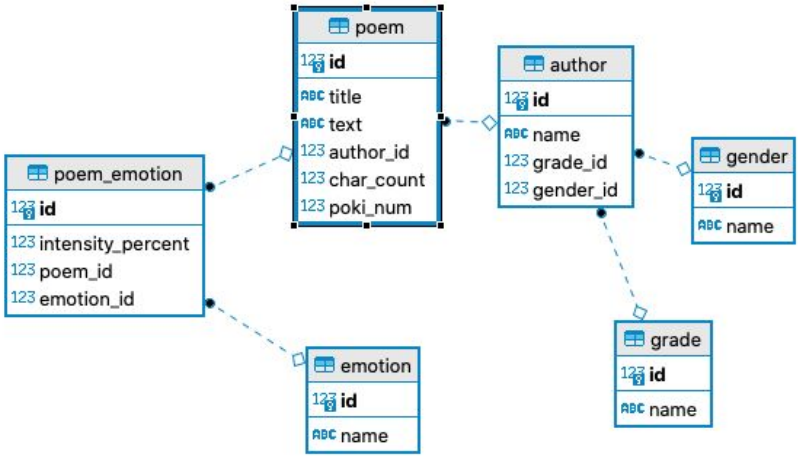

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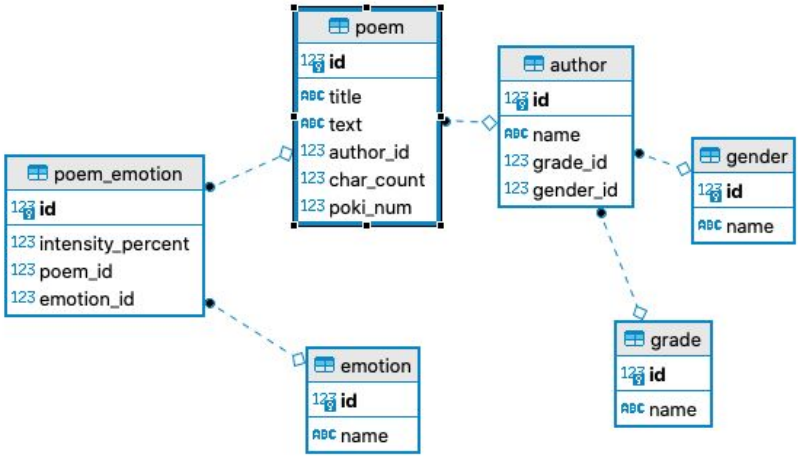


```
SELECT
FROM
JOIN
ON
```

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Joining Data - example

Goal: Retrieve the title of each poem along with the poem author's name.

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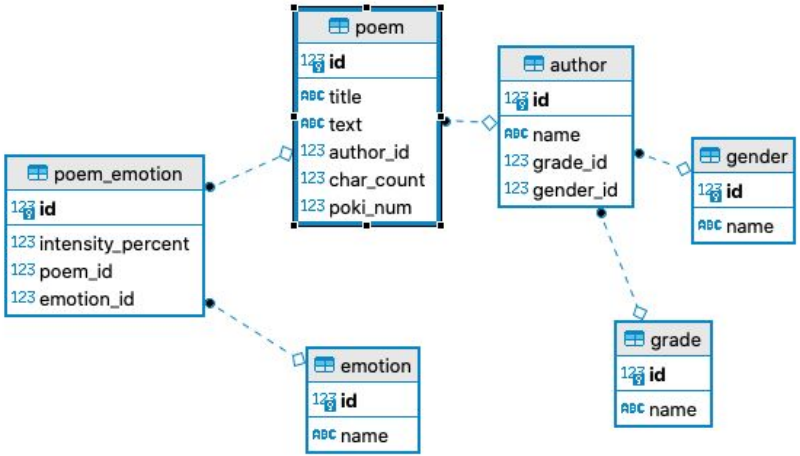


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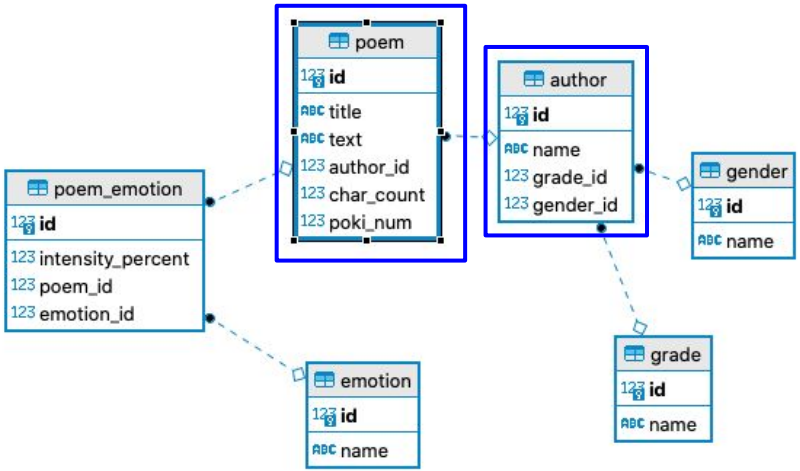


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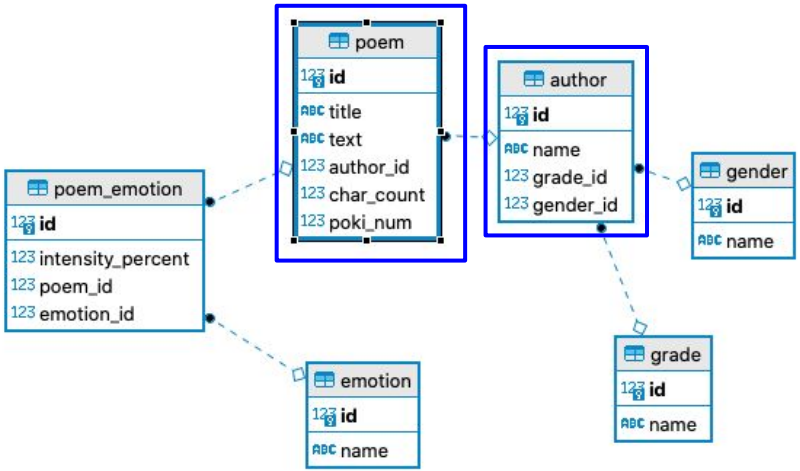


```
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FROM poem
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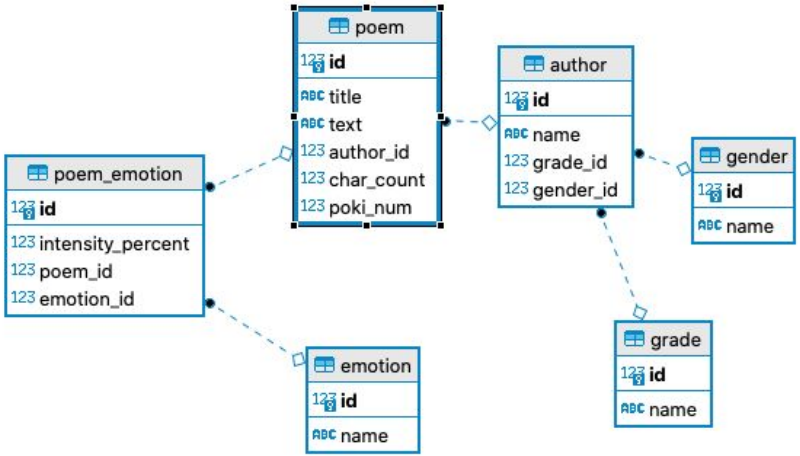


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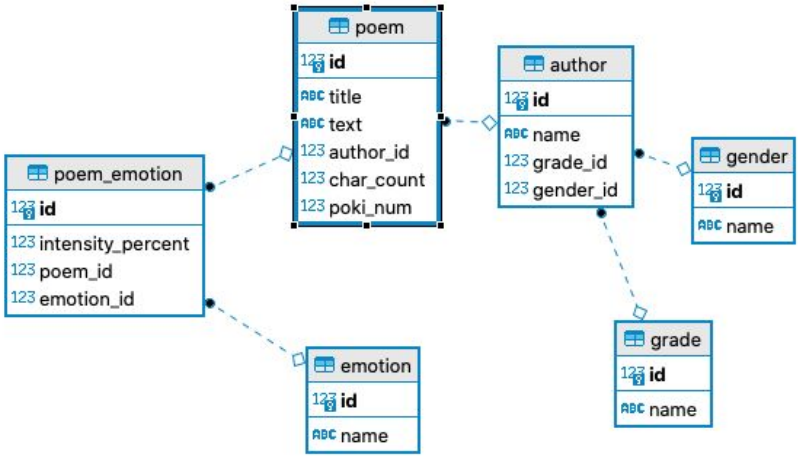


```
SELECT
FROM poem
JOIN author
ON poem.author_id = author.id;
```

Specify columns using *table.column*

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Joining Data - example

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Process:

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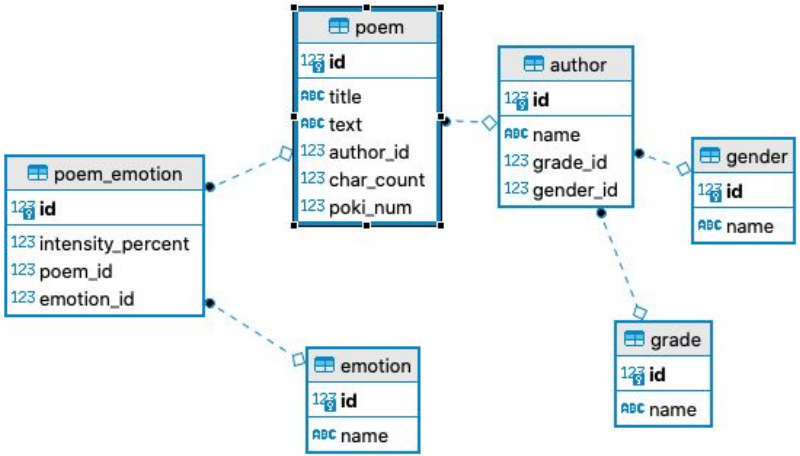


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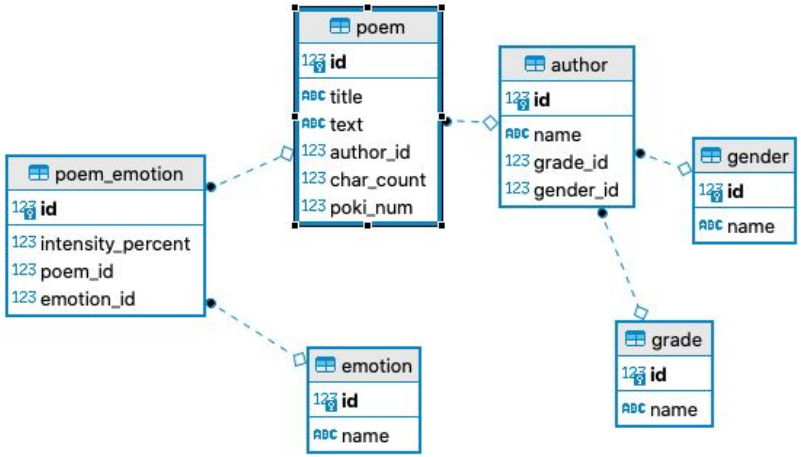


```
SELECT poem.title, author.name
FROM poem
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```

Specify columns using *table.column*

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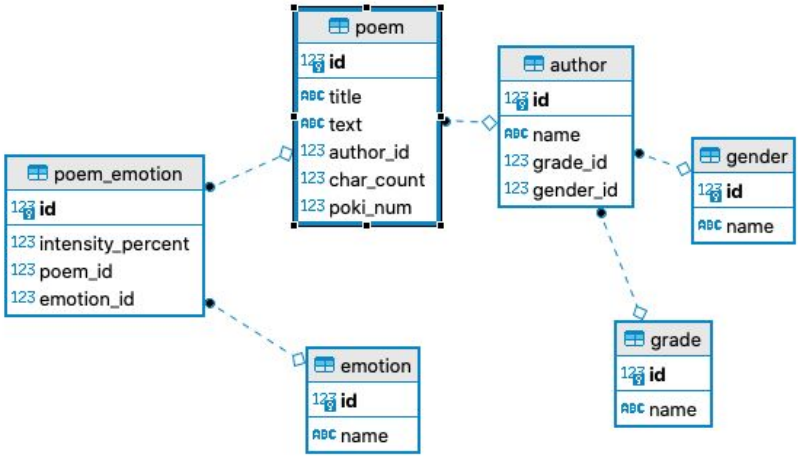


```
SELECT poem.title, author.name
FROM poem
JOIN author
ON poem.author_id = author.id;
```

	title character varying	name character varying
1	Computer	a
2	Angel	aab
3	Nature Nature and Nature	aadhya
4	Jack	aaliyah
5	When I awoke one morning	aanna
6	My Blue Berries and My Cherries	aarathi

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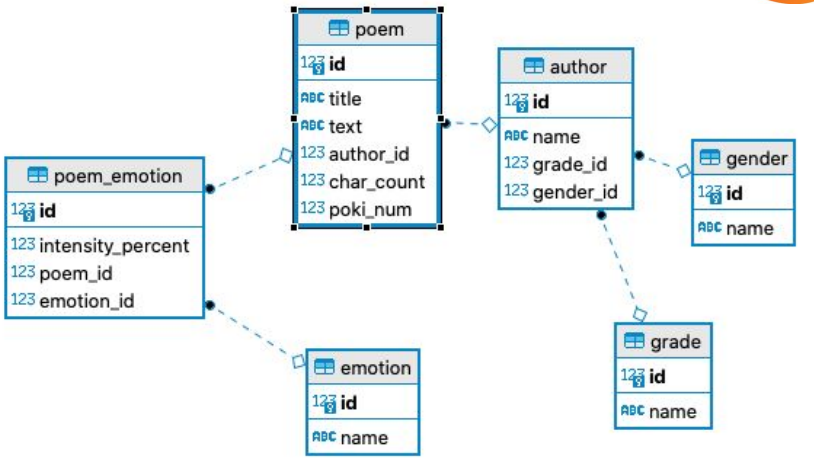
Joining Data - Joining 3 Tables

Goal: Retrieve the title of each poem along with the author's name and grade name.

Process:

a. decide what tables you need
b. decide how to connect your tables
c. decide which columns to select



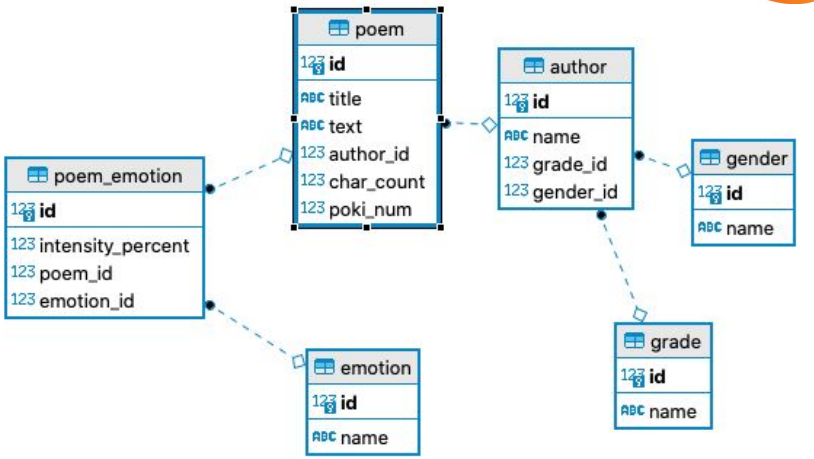

```
SELECT
FROM
JOIN
ON
JOIN
ON
```

Joining Data - Joining 3 Tables

Goal: Retrieve the title of each poem along with the author's name and grade name.

Process:

a. **decide what tables you need**
b. decide how to connect your tables
c. decide which columns to select



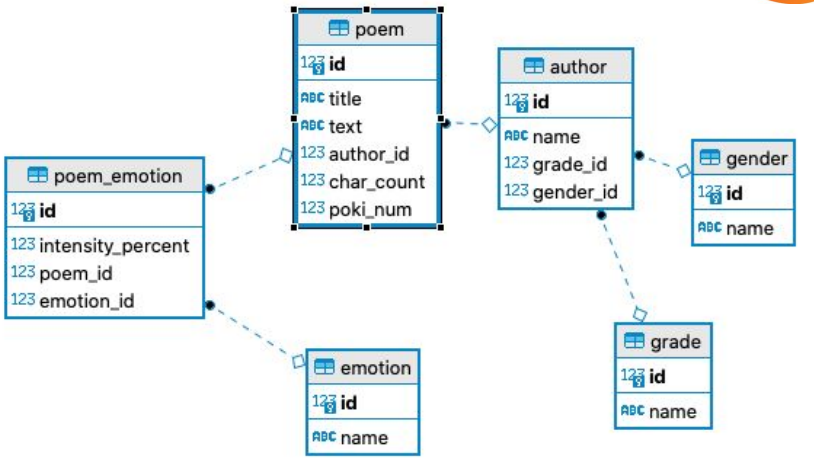

```
SELECT
FROM poem
JOIN author
ON
JOIN grade
ON
```

Joining Data - Joining 3 Tables

Goal: Retrieve the title of each poem along with the author's name and grade name.

Process:

a. decide what tables you need
b. decide how to connect your tables
c. decide which columns to select



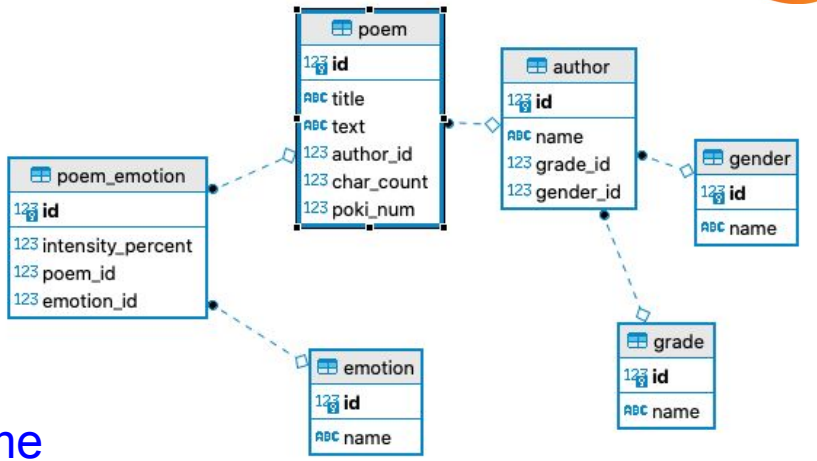

```
SELECT
FROM poem
JOIN author
ON poem.author_id = author.id
JOIN grade
ON author.grade_id = grade.id;
```

Joining Data - Joining 3 Tables

Goal: Retrieve the title of each poem along with the author's name and grade name.

Process:

a. decide what tables you need
b. decide how to connect your tables
c. decide which columns to select



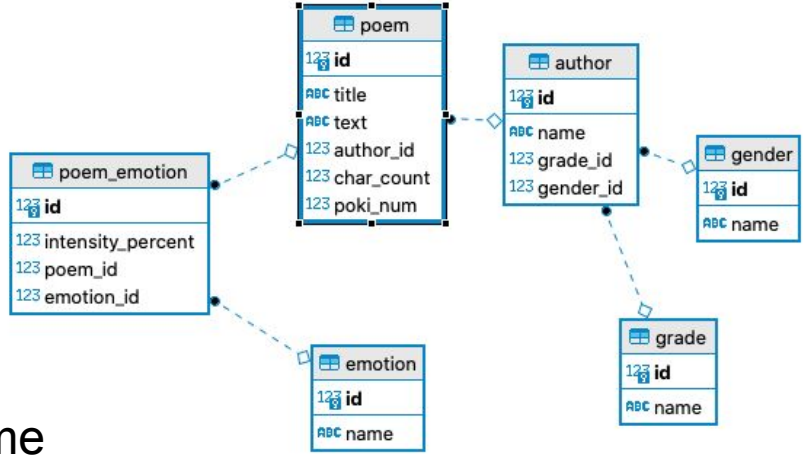

```
SELECT poem.title, author.name, grade.name
FROM poem
JOIN author
ON poem.author_id = author.id
JOIN grade
ON author.grade_id = grade.id;
```

Joining Data - Joining 3 Tables

Goal: Retrieve the title of each poem along with the author's name and grade name.

Process:

a. decide what tables you need
b. decide how to connect your tables
c. decide which columns to select




```
SELECT poem.title, author.name, grade.name
FROM poem
JOIN author
ON poem.author_id = author.id
JOIN grade
ON author.grade_id = grade.id;
```

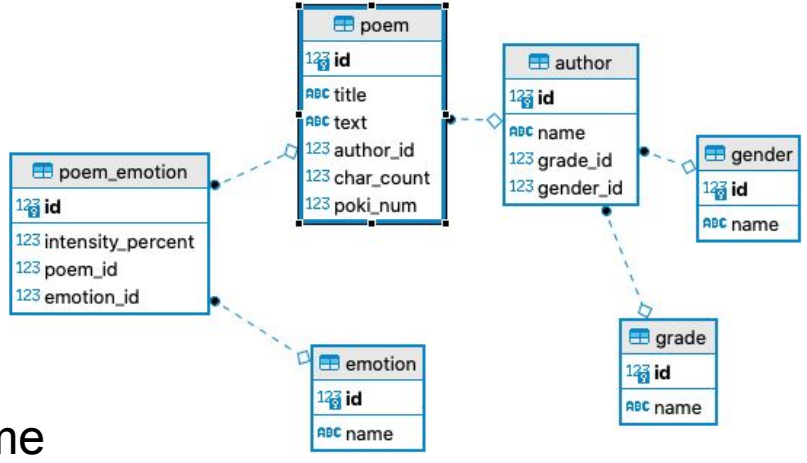
	title character varying	name character varying	name character varying
1	Computer	a	1st Grade
2	Angel	aab	1st Grade
3	Nature Nature and Nature	aadhya	1st Grade
4	Jack	aaliyah	1st Grade
5	When I awoke one morning	aanna	1st Grade
6	My Blue Berries and My Cherries	aarathi	1st Grade

Joining Data - Joining 3 Tables

Goal: Retrieve the title of each poem along with the author's name and grade name.

Process:

a. decide what tables you need
b. decide how to connect your tables
c. decide which columns to select




```
SELECT poem.title, author.name, grade.name
FROM poem
JOIN author
ON poem.author_id = author.id
JOIN grade
ON author.grade_id = grade.id;
```

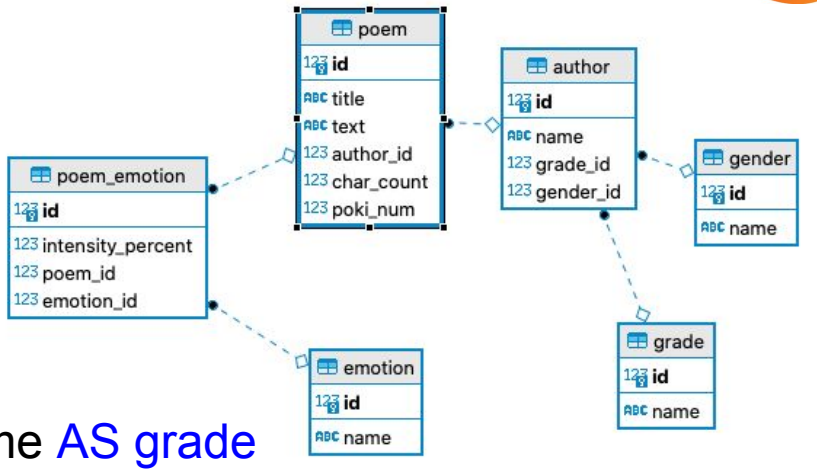
	title character varying	name character varying	name character varying
1	Computer	a	1st Grade
2	Angel	aab	1st Grade
3	Nature Nature and Nature	aadhya	1st Grade
4	Jack	aaliyah	1st Grade
5	When I awoke one morning	aanna	1st Grade
6	My Blue Berries and My Cherries	aarathi	1st Grade

Joining Data - Joining 3 Tables

Goal: Retrieve the title of each poem along with the author's name and grade name.

Process:

a. decide what tables you need
b. decide how to connect your tables
c. decide which columns to select



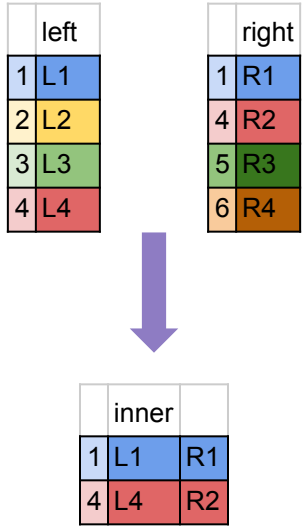

```
SELECT poem.title, author.name, grade.name AS grade
FROM poem
JOIN author
ON poem.author_id = author.id
JOIN grade
ON author.grade_id = grade.id;
```

	title character varying	name character varying	grade character varying
1	Computer	a	1st Grade
2	Angel	aab	1st Grade
3	Nature Nature and Nature	aadhya	1st Grade
4	Jack	aaliyah	1st Grade
5	When I awoke one morning	aanna	1st Grade
6	My Blue Berries and My Cherries	aarathi	1st Grade

INNER JOIN

Combining data from a **left** and **right** table is called **JOIN**ing. There are multiple kinds of joins and each one combines the data in a different way.

An **INNER JOIN** keeps **only the rows that have matching values in both tables**. This is the default type of join if you just use the **JOIN** keyword in your query.



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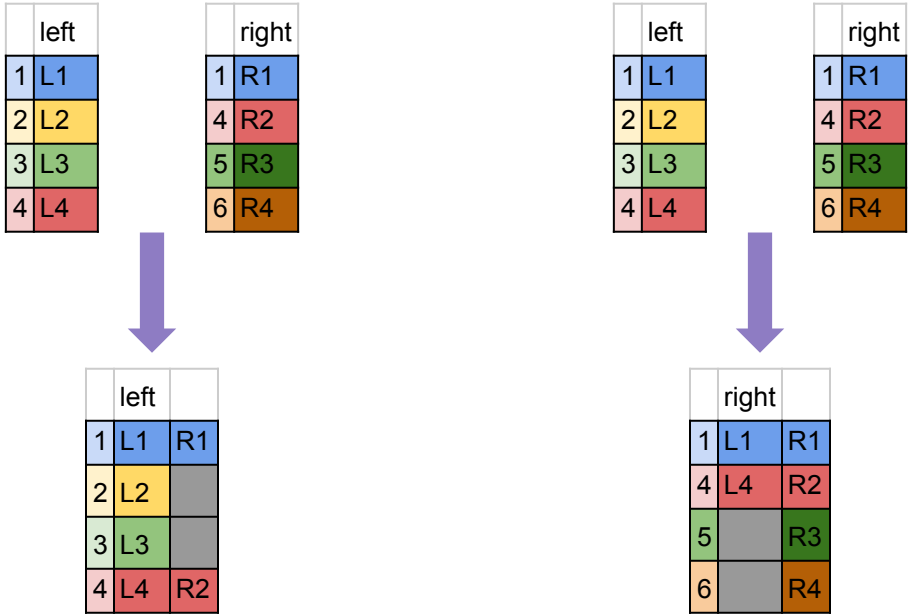
LEFT JOIN and RIGHT JOIN

A **LEFT JOIN** keeps **all** rows from the left table and all **matching** rows from the right table. A **RIGHT JOIN** works similarly, except all rows from the right table are kept.



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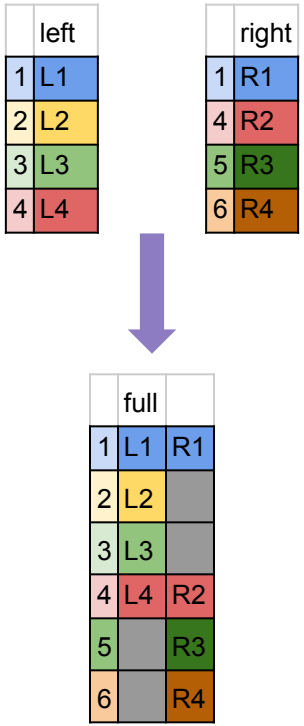
FULL JOIN (Sometimes called An OUTER JOIN depending on the SQL dialect)

A **FULL JOIN** keeps **all rows from both tables**:



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Additional Practice

W3Schools SQL Tutorial - https://www.w3schools.com/sql/default.asp

Khan Academy - https://www.khanacademy.org/computing/computer-programming/sql

DataCamp - https://learn.datacamp.com/skill-tracks/sql-fundamentals