from zero to query

a sql primer

oskar 2023-02-16

sql - a fundamental tool for the data professional

- database management
- data pipeline engineering
- data modeling
- data designing
- big data (parallel, distributed)
- data querying
- data analytics

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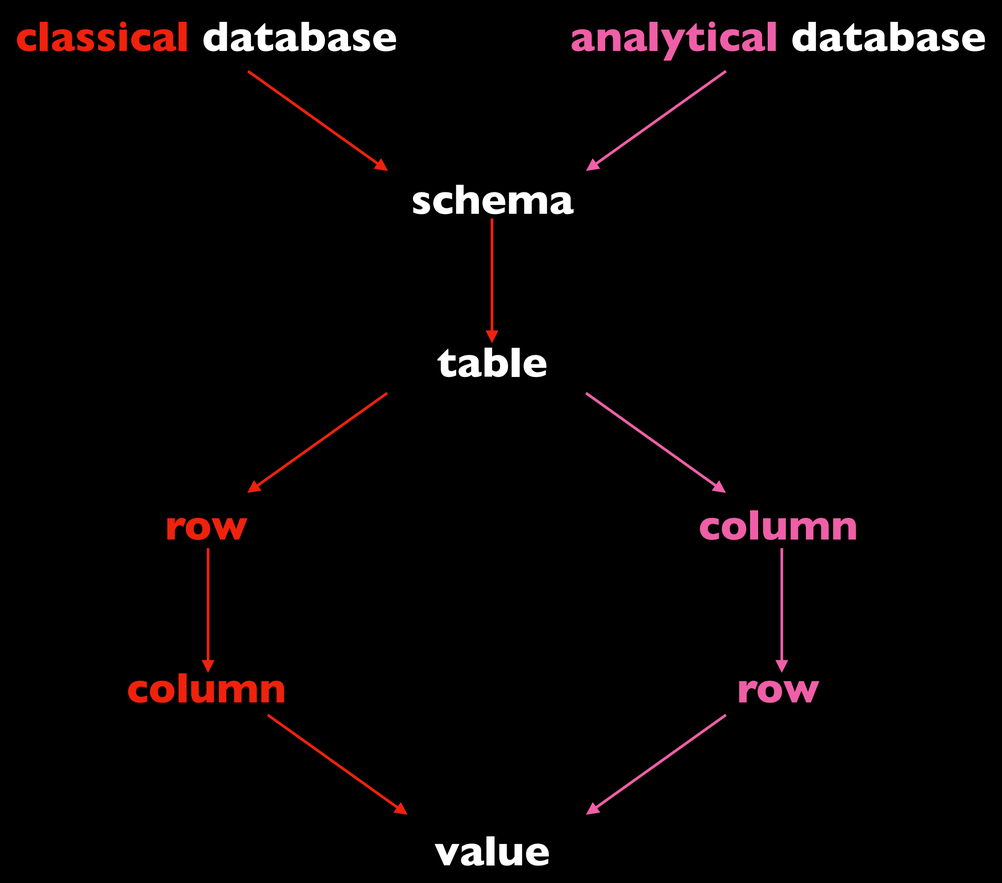
classical database
analytical database
schema
table
row
column
column
row
value

data definition	data management	data querying	data control	transaction control
to operate on entire tables	to operate on table cells, rows, columns	to fetch data from tables	to control access to schemas + tables	for transactional atomicity, dev
CREATE	INSERT	SELECT	GRANT	COMMIT
DROP	UPDATE		REVOKE	ROLLBACK
ALTER	DELETE			SAVE POINT
TRUNCATE				

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a note on sqlite

- small (<2mb)
- open source
- serverless
- self-contained
- fast
- complete
- in-memory
- cross-platform
- ubiquitous

sqlite commands

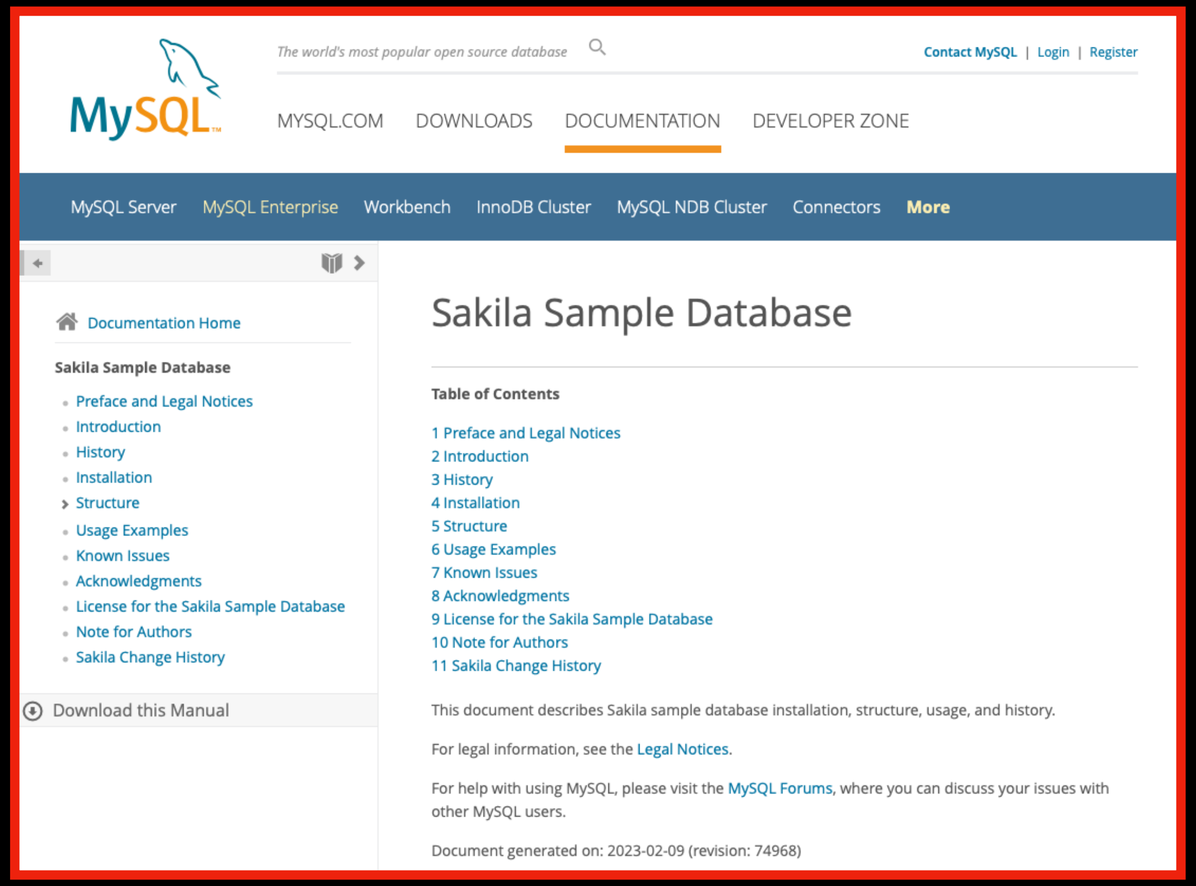
- these are not sql commands!
- they start with a '.'
- they operate on the environment, not the data
- examples:
  - .quit
  - .open <path-to-database>
  - .show
  - .help
  - .cd <directory>
  - .shell CMD ARGS…

sql commands

- these run on the database
- they end with a ‘;’
- you can add comments with ‘-- a comment’
- they operate on the data tables
- example:
  - SELECT {columns} FROM table; -- a&b

the sakila training data

- classic, fictional data
- dvd rental company
- 20 relational tables:
  - normalised: no repetition
  - stores
  - inventory
  - films
  - film casting
  - actors
  - film ratings



```
.open data/sqlite-sakila.db

.header ON
.mode qbox
.show

.tables
```

.tables

```
sqlite> .tables
actor                film                payment
address              film_actor          rental
category             film_category       sales_by_film_category
city                 film_list           sales_by_store
country              film_text           staff
customer             inventory           staff_list
customer_list        language            store
sqlite>
```

the sakila training data

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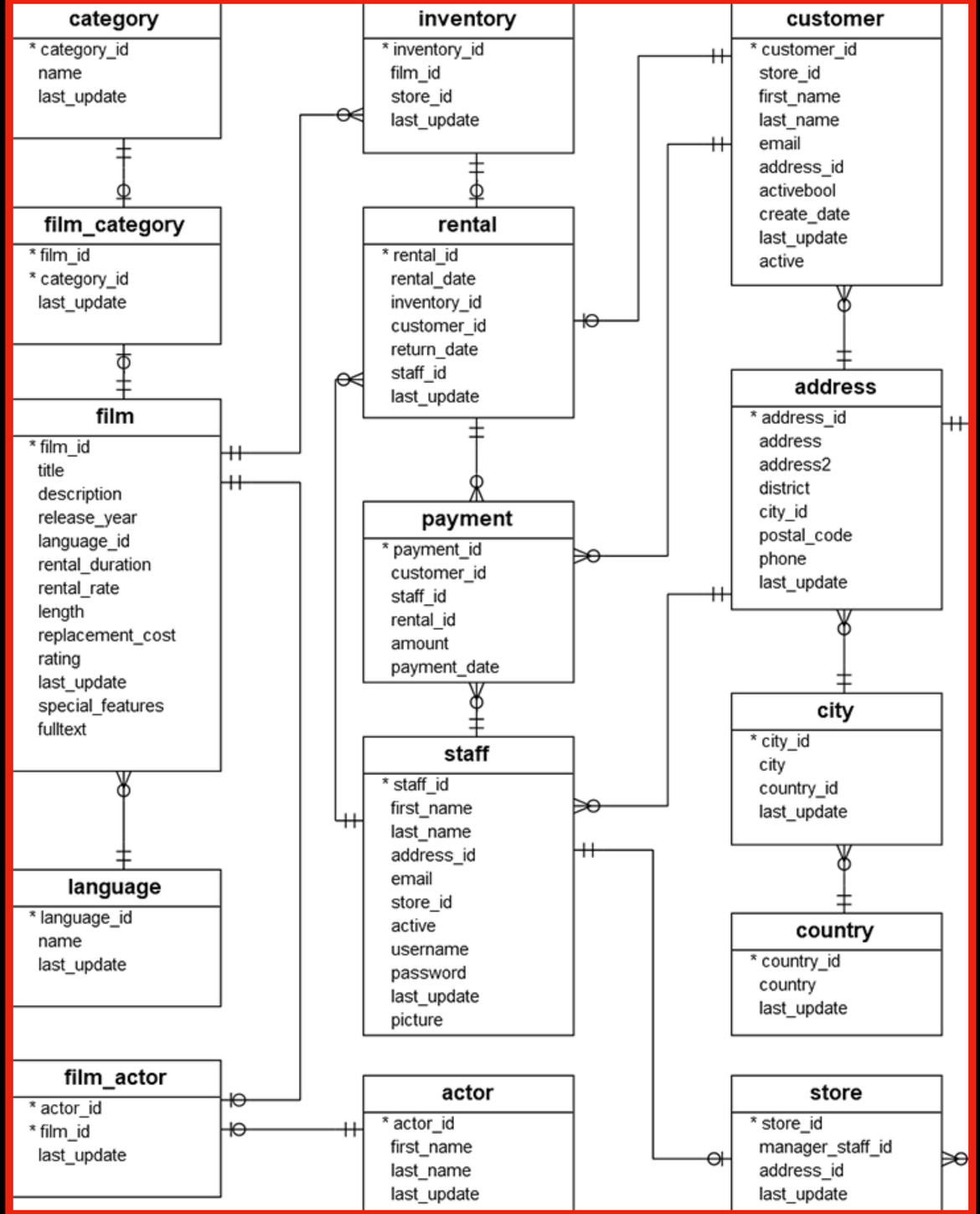
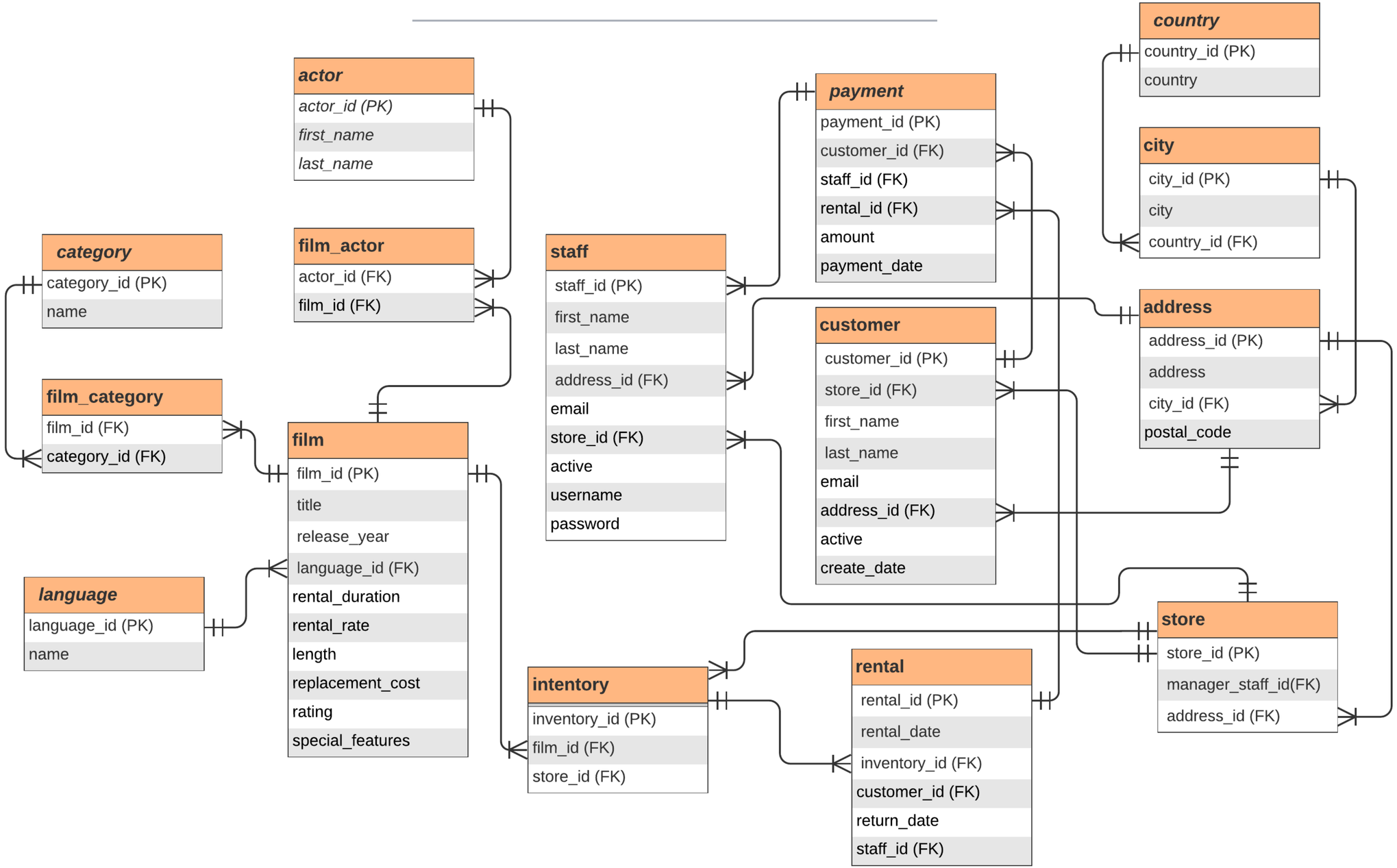
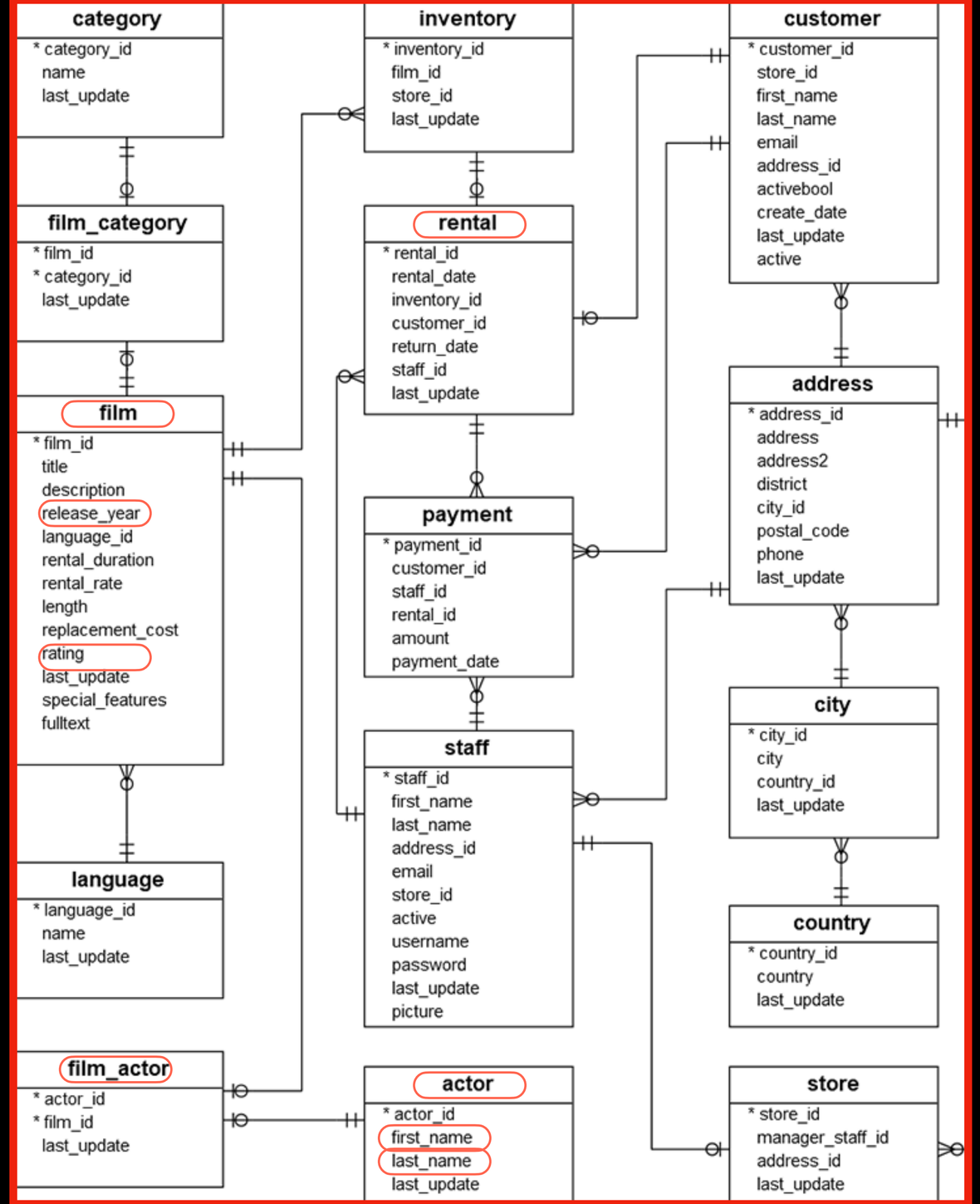


SQLite3 Sakila Sample Database ERD



today's objective:

"which **top 10** *actors* were *rented* out the greatest number of times, counting only '**R**' *rated films* made in **2006**?"



today's plan:

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

```
- SELECT {columns} FROM {table};
- + LIMIT num
- + WHERE {a_condition}
- + ORDER BY {columns}
- + GROUP BY {columns}
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

what do the tables contain?

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

```
- SELECT {columns} FROM {table};
- + LIMIT num
- + WHERE {a_condition}
- + ORDER BY {columns}
- + GROUP BY {columns}
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

SELECT … FROM …;

```
- SELECT * FROM {table};
  -- returns all columns and all rows from {table}

- SELECT name, category_id AS id FROM category;
  -- returns columns name and id (in that order) from table category

- SELECT a.first_name FROM actor a;
  -- creates an alias for table actor, refers to its column, first_name

- SELECT price + tax AS total_cost FROM sales;
  -- returns the sum of price+tax, calls the output ‘total_cost’

- SELECT DISTINCT first_name FROM staff;
  -- returns all the first names in the staff table, no duplicates
```

SELECT (aggregate function) FROM … ;

- SELECT COUNT(*) AS num_records FROM actor;
  -- returns the number of rows in table actor, names the output ‘num_records’

- COUNT(DISTINCT rating) FROM film;
  -- returns a count of distinct values in the rating column

- SELECT AVG(replacement_cost) AS avg_cost FROM film;
  -- returns the average replacement cost of a film

- SELECT AVG(rental_rate) AS average_rate FROM film;
  -- returns the average rate of rental from film table

- SELECT MAX(s.sale_cost) AS highest_value_sale FROM sales s;
  -- returns the highest value sale from sales

- SELECT MIN(length) AS shortest_length FROM film;
  -- returns the length of the shortest film

that's too many rows!

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

```
- SELECT {columns} FROM {table}
- + LIMIT num;
- + WHERE {a_condition}
- + ORDER BY {columns}
- + GROUP BY {columns}
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

SELECT … FROM … LIMIT …;

```
- SELECT * FROM {table} LIMIT {n};
  -- returns all columns of {n} unspecified rows from {table}

- SELECT * FROM sales LIMIT 5;
  -- returns 5 unspecified rows of all columns from sales

- SELECT sale_date, sale_cost FROM sales LIMIT 15;
  -- returns 15 unspecified rows of two columns from sales table

- SELECT id AS region_id, name AS region_name FROM regions LIMIT 10;
  -- returns region id and region name for 10 unspecified rows
```

but i only want specific rows!

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

```
- SELECT {columns} FROM {table}
- + LIMIT num
- + WHERE {a_condition};
- + ORDER BY {columns}
- + GROUP BY {columns}
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

SELECT … FROM … WHERE … [LIMIT n];

```
- SELECT * FROM {table} WHERE {column}={expression};
  -- returns only rows where the value in {column} equals {expression}

- SELECT * FROM table_name WHERE column1<>{expression};
  -- returns only rows where the value in column1 is not {expression}

- SELECT name AS item_name FROM items WHERE item_price>=10;
  -- returns names of items whose price is greater than or equal to £10

- SELECT name FROM items WHERE item_price>=10 LIMIT 8;
  -- returns 8 of the items whose price is greater or equal to £10
```

comparison operators

operator syntax	meaning
`{column} = {expression}`	column value is equal to expression value
`{column} <> {expression}`	column value is not equal to expression value
`{column} != {expression}`	column value is not equal to expression value
`{column} < {expression}`	column value is less than expression value
`{column} <= {expression}`	column value is less than or equal to expression value
`{column} > {expression}`	column value is greater than expression value
`{column} >= {expression}`	column value is greater than or equal to expression value
`{column} IN ({exp1}, {exp2}, …)`	column value is one of ‘exp1’, ‘exp2’, …
`{column} LIKE ‘%expr%’`	(string) column contains substring ‘expr’
`{column} BETWEEN {exp1} AND {exp2}`	{exp1} <= column value <= {exp2}

comparison operators

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`{column} = {expression}`	column value is equal to expression value
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`{column} LIKE ‘%expr%’`	(string) column contains substring ‘expr’
`{column} BETWEEN {exp1} AND {exp2}`	{exp1} <= column value <= {exp2}

SELECT … FROM … WHERE …;

- SELECT * FROM sales WHERE sale_date BETWEEN ‘2023–02-01’ AND ‘2023-02-04’;
  -- returns only sales occurring between feb 1st and feb 4th, inclusive

- SELECT * FROM sales WHERE region_id IN (14,56,43) ;
  -- returns only sales in regions with id 14, 56, or 43

- SELECT * FROM region WHERE region_name LIKE ‘%new%’;
  -- returns only regions whose name contains ‘new’

- SELECT DISTINCT postal_code FROM address WHERE postal_code LIKE ’97%';
  -- show all the postal codes that start with ’97’

but i only want the most extreme rows!

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

```
- SELECT {columns} FROM {table}
- + LIMIT num;
- + WHERE {a_condition}
- + ORDER BY {columns}
- + GROUP BY {columns}
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

SELECT … FROM … ORDER BY … LIMIT …;

```
- SELECT * FROM items ORDER BY item_cost LIMIT 10;
  -- return only the top 10 least expensive items in the catalog

- SELECT * FROM items ORDER BY item_cost DESC LIMIT 10;
  -- return only the top 10 most expensive items in the catalog
```

how can i aggregate select rows into a single row?

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

```
- SELECT {columns} FROM {table}
- + LIMIT num
- + WHERE {a_condition}
- + ORDER BY {columns}
- + GROUP BY {columns};
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

SELECT {col}, … FROM … GROUP BY {col};

```
- SELECT region_id, COUNT(*) FROM sales GROUP BY region_id;
  -- return each region’s number of records from the sales table

- SELECT region_id, AVG(item_price) FROM items GROUP BY item_type;
  -- return the average price of items of each type from the items table

- SELECT item_type, MAX(item_price) FROM items GROUP BY item_type;
  -- returns the price of the priciest item of each type from the item table
```

how do i report only some aggregated groups?

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

```
- SELECT {columns} FROM {table};
- + LIMIT num
- + WHERE {a_condition}
- + ORDER BY {columns}
- + GROUP BY {columns}
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

SELECT {col}, … FROM … GROUP BY {col};

- SELECT col1, COUNT(*) AS num FROM table GROUP BY col1 HAVING num>10;
  -- count instances of each value of col1, but only output rows with count>10

- SELECT rating, AVG(length) AS len FROM film GROUP BY rating HAVING len<115;
  -- the film rating categories with average length of film under 115 minutes

- SELECT actor_id, COUNT(*) AS n FROM film_actor GROUP BY actor_id HAVING n<15;
  -- which actor ids have appeared in fewer than 15 films?

but my information is spread over two tables!

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

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- SELECT {columns} FROM {table};
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- + ORDER BY {columns}
- + GROUP BY {columns}
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

SELECT … FROM a INNER JOIN b ON …;

```
- SELECT a.city, b.country
  FROM city a
    INNER JOIN country b ON a.country_id=b.country_id
  ; -- output a table with city-country names

- SELECT f.title, f.length, l.name
  FROM film f
    INNER JOIN language l ON f.language_id=l.language_id
  WHERE rating='R'
  LIMIT 10; -- output a sample of films and the name of the language it is in
```

JOIN

city

city_id	city	country_id	last_update
1	A Corua (La Corua)	87	2021-03-06 15:51:49
2	Abha	82	2021-03-06 15:51:49
3	Abu Dhabi	101	2021-03-06 15:51:49
4	Acua	60	2021-03-06 15:51:49
5	Adana	97	2021-03-06 15:51:49
6	Addis Abeba	31	2021-03-06 15:51:49
7	Aden	107	2021-03-06 15:51:49
8	Adoni	44	2021-03-06 15:51:49

country

country_id	country	last_update
1	Afghanistan	2021-03-06 15:51:49
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3	American Samoa	2021-03-06 15:51:49
4	Angola	2021-03-06 15:51:49
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6	Argentina	2021-03-06 15:51:49
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we want this

city-and-country

city_id	city	country
1	?	?
2	?	?
3	?	?
4	?	?
5	?	?
6	?	?
7	?	?
8	?	?

we want this

city-and-country

city_id	city	country
1	A Corua (La Corua)	Spain
2	Abha	Saudi Arabia
3	Abu Dhabi	United Arab Emirates
4	Acua	Mexico
5	Adana	Turkey
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7	Aden	Yemen
8	Adoni	India

so we add a JOIN to the WHERE clause

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+

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```
SELECT
    city_id, city.city, country.country
FROM
    city
    INNER JOIN country ON city.country_id=country.country_id
;
```

so we add a JOIN to the WHERE clause

=

city-and-country

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1	A Corua (La Corua)	Spain
2	Abha	Saudi Arabia
3	Abu Dhabi	United Arab Emirates
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```
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    city
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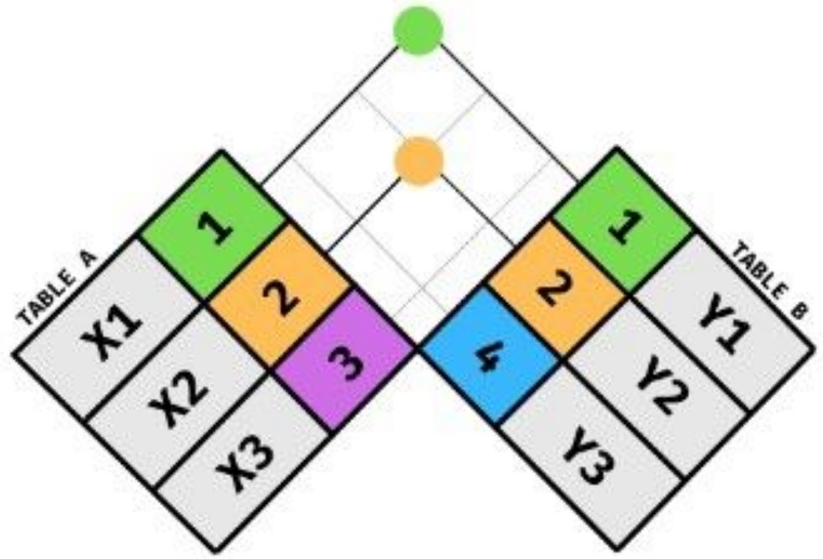
```

FROM a INNER JOIN b

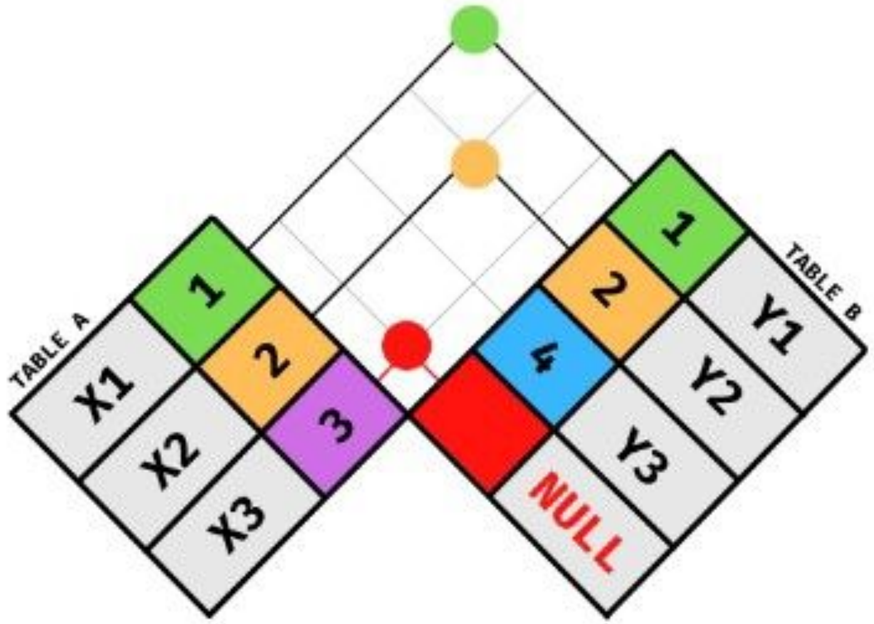


INNER JOIN

```
SELECT
    <SELECT LIST>
FROM        TABLE_A A
INNER JOIN TABLE_B B
    ON A.KEY = B.KEY
```

KEY	VAL_X	VAL_Y
1	X1	Y1
2	X2	Y2

LEFT OUTER JOIN



LEFT JOIN

```
SELECT
    <SELECT LIST>
FROM      TABLE_A A
LEFT JOIN TABLE_B B
    ON A.KEY = B.KEY
```

KEY	VAL_X	VAL_Y
1	X1	Y1
2	X2	Y2
3	X3	NULL


All data professionals need to understand table joins
@DATAWITHDANNY

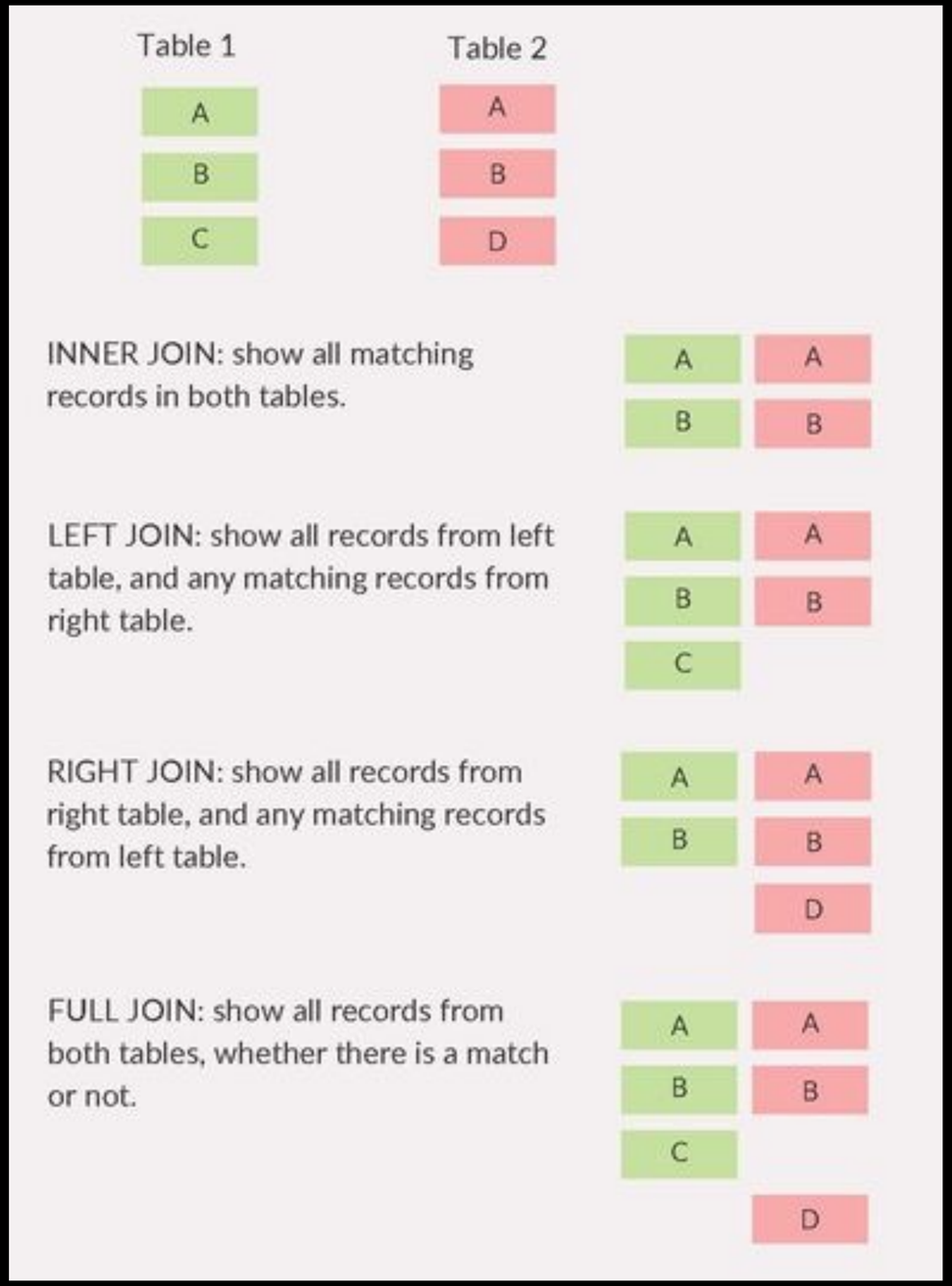
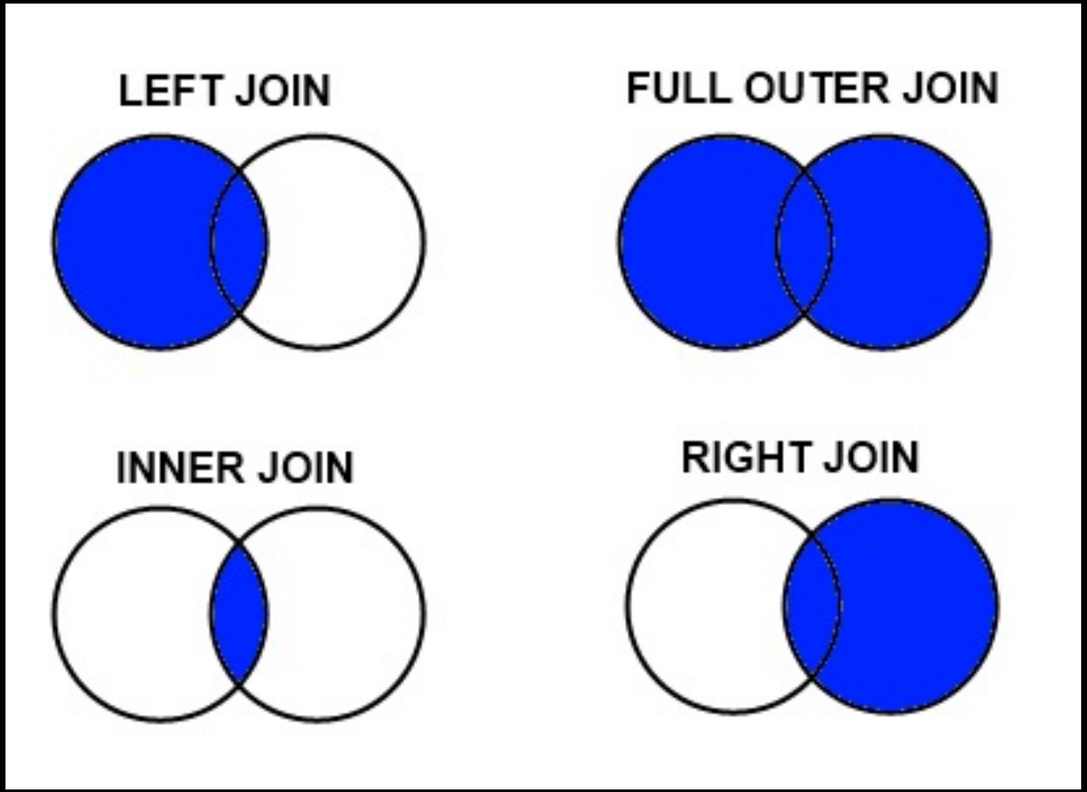


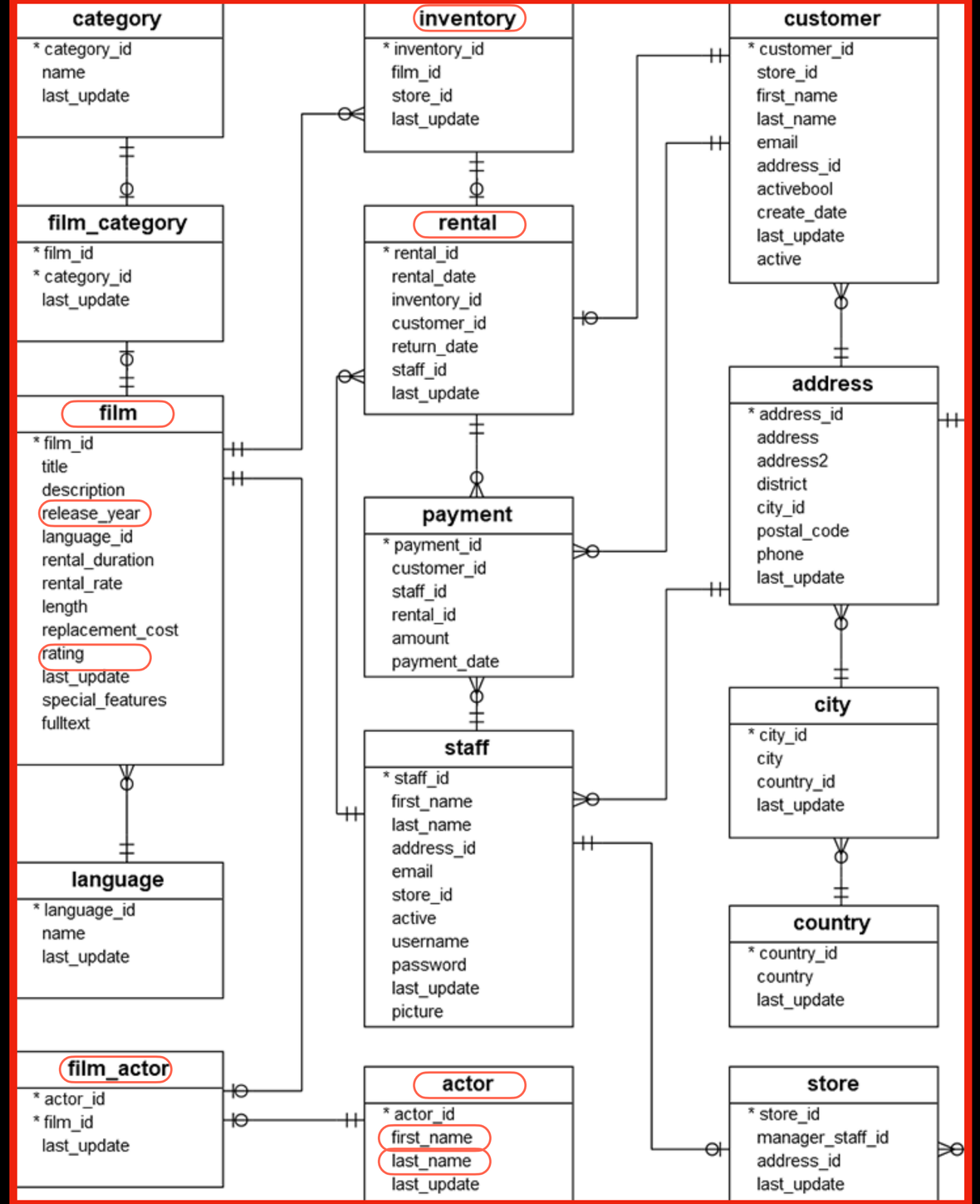
Table 1
A
B
C
Table 2
A
B
D
INNER JOIN: show all matching records in both tables.
LEFT JOIN: show all records from left table, and any matching records from right table.
RIGHT JOIN: show all records from right table, and any matching records from left table.
FULL JOIN: show all records from both tables, whether there is a match or not.


All data professionals need to understand table joins
@DATAWITHDANNY


LEFT JOIN
FULL OUTER JOIN
INNER JOIN
RIGHT JOIN

today's objective:

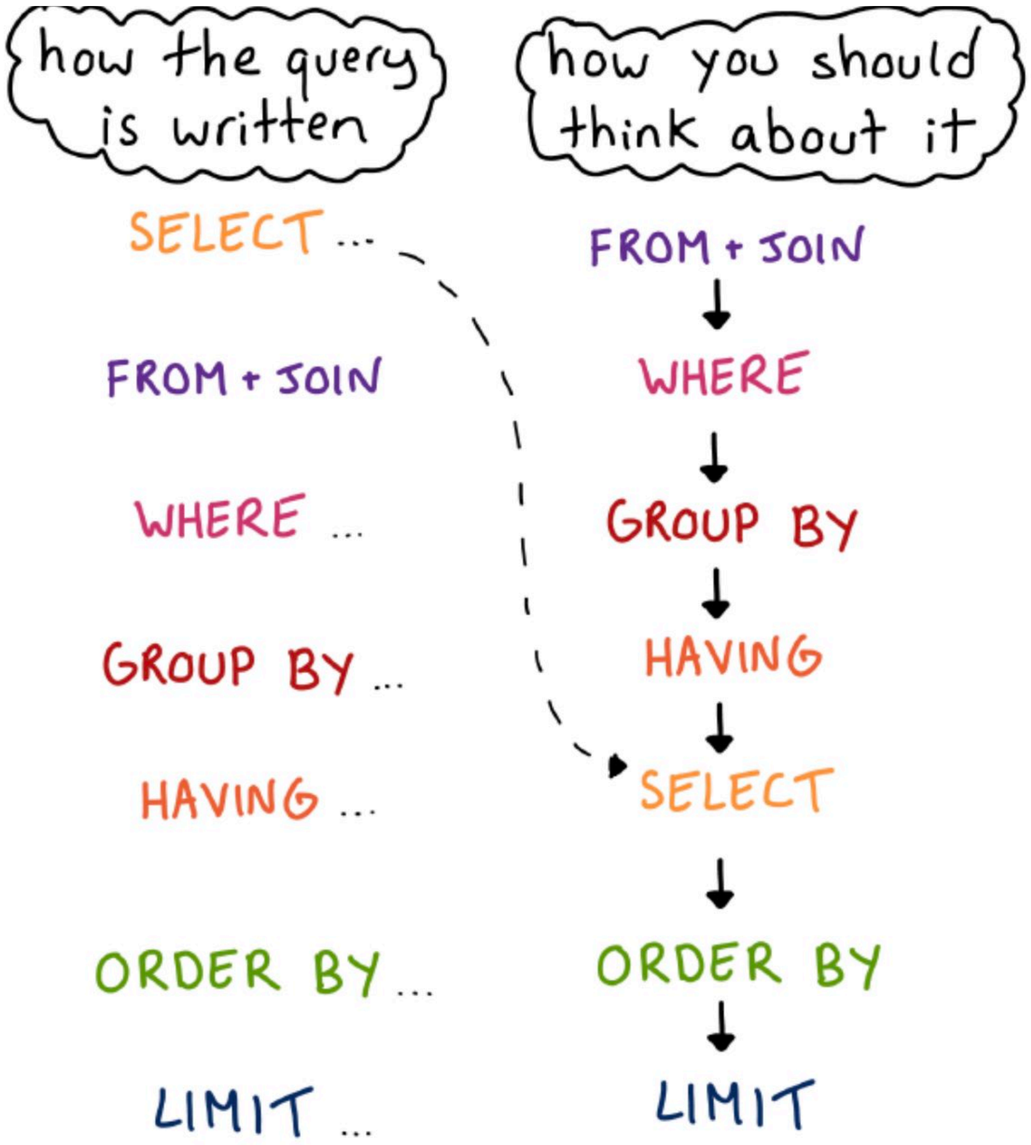
"which **top 10** *actors* were *rented* out the greatest number of times, counting only '**R**' *rated films* made in **2006**?"



how do i combine the components of a SELECT?

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

```
- SELECT {columns} FROM {table};
- + LIMIT num
- + WHERE {a_condition}
- + ORDER BY {columns}
- + GROUP BY {columns}
- + HAVING {a_condition}
- + INNER JOIN {table_2} ON {col1}={col2}
```

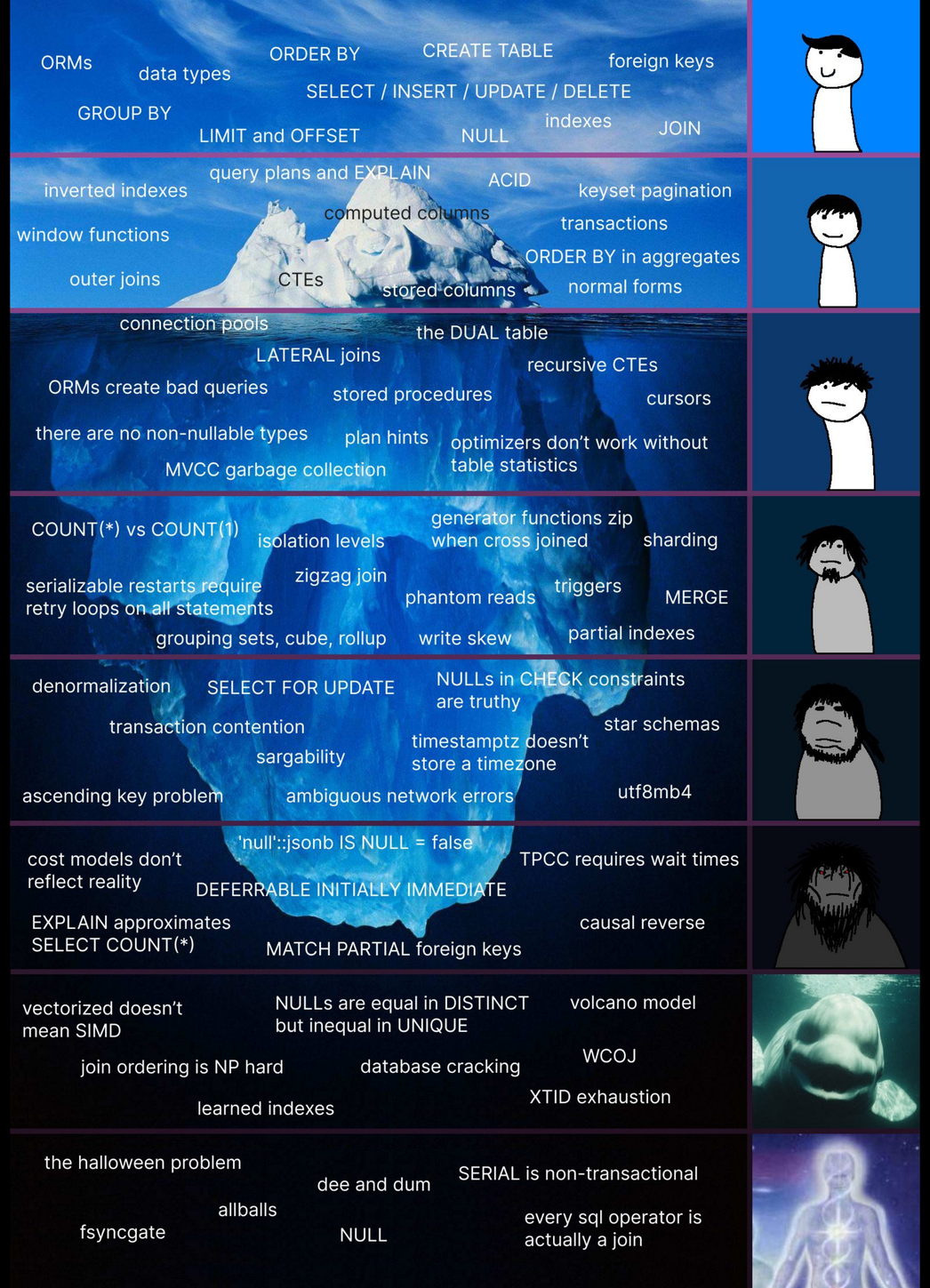

how the query is written
how you should think about it
SELECT ...
FROM + JOIN
WHERE ...
GROUP BY ...
HAVING ...
ORDER BY ...
LIMIT ...
FROM + JOIN
WHERE
GROUP BY
HAVING
SELECT
ORDER BY
LIMIT

your turn! compose a query to answer:

"which top 10 actors were rented out the greatest number of times, counting only 'R' rated films made in 2006?"

hint: structure of the solution

```
SELECT
   {}         AS actor_name,
   COUNT({}) AS num_rentals
FROM {table1}
    INNER JOIN {table2} ON {join-condition}
    INNER JOIN {table3} ON {join-condition}
    INNER JOIN {table4} ON {join-condition}
    INNER JOIN {table5} ON {join-condition}
WHERE {row condition1}
    AND {row condition2}
GROUP BY {column1}
ORDER BY {column} DESC
LIMIT {num}
```


ORMs
data types
ORDER BY
CREATE TABLE
foreign keys
SELECT / INSERT / UPDATE / DELETE
GROUP BY
LIMIT and OFFSET
NULL
indexes
JOIN
inverted indexes
query plans and EXPLAIN
ACID
keyset pagination
computed columns
transactions
window functions
ORDER BY in aggregates
outer joins
CTEs
stored columns
normal forms
connection pools
the DUAL table
LATERAL joins
recursive CTEs
ORMs create bad queries
stored procedures
cursors
there are no non-nullable types
plan hints
optimizers don't work without table statistics
MVCC garbage collection
COUNT(*) vs COUNT(1)
isolation levels
generator functions zip when cross joined
sharding
zigzag join
serializable restarts require retry loops on all statements
phantom reads
triggers
MERGE
grouping sets, cube, rollup
write skew
partial indexes
denormalization
SELECT FOR UPDATE
NULLs in CHECK constraints are truthy
transaction contention
star schemas
timestamptz doesn't store a timezone
sargability
ascending key problem
ambiguous network errors
utf8mb4
'null'::jsonb IS NULL = false
cost models don't reflect reality
TPCC requires wait times
DEFERRABLE INITIALLY IMMEDIATE
EXPLAIN approximates SELECT COUNT(*)
causal reverse
MATCH PARTIAL foreign keys
vectorized doesn't mean SIMD
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WCOJ
join ordering is NP hard
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XTID exhaustion
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allballs
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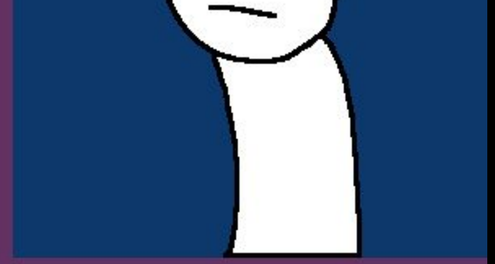

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further learning

- refresher: https://www.youtube.com/watch?v=kbKty5ZVKMY
- pandas experts note: https://www.youtube.com/watch?v=fmrmwFPMMaM
- more discussion: https://www.youtube.com/watch?v=OV6Mh2Jl9zQ
- deeper learning: https://app.datacamp.com/learn/career-tracks/data-analyst-in-sql
- two week free course online starting 2023-02-20: https://corise.com/course/sql-crash-course