HOW CONSTRAINING

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ANNOUNCEMENTS

- Homework 4 due on Thursday!
  - Everything relating to joins, so you have everything you need to do all the problems
- Exam 1 back to you!
  - Mean: 35.2, Median: 36.75, StDev: 5.03
- I had a typo in the `hw4.sql` file where the `INSERT INTO` statement for the superheroes table was missing the last `e`. I have fixed that on the official side, but if you were having issues, it should be an easy manual fix as well.
- Polling today: **polling.jedrembold.prof**

REVIEW!

Given the table (named `employees`) to the right and the query immediately below, what would the output table look like?

```
SELECT p1.name, p2.name
FROM employees as p1
LEFT JOIN employees as p2
  ON p1.superior id > p2.id
ORDER BY p1.name LIMIT 2;
```

id	name	superior_id
1	Bob	NULL
2	Frank	1
3	Kelly	1
4	Anne	3
5	Tiffany	2
6	Henry	4

A)

name	name
Anne	Kelly
Bob	NULL

B)

name	name
Anne	Kelly
Frank	Bob

C)

name	name
Frank	Bob
Kelly	Bob

D)

name	name
Anne	Bob
Anne	Frank

THE ART OF NAMING

IDENTIFIERS

- We've been naming tables and columns for a while now, and sometimes you've seen double quotes around them and other times you have not
- Double quotes around an identifier (table or column name) achieves several things:
  - The name becomes *case sensitive*. Otherwise, all names in SQL are case insensitive.
  - The name can include special characters that otherwise are not allowed
    - Without double quotes, only letters, underscores, or digits are allowed, and the identifier must start with a letter or underscore
  - The name could be the same as an SQL keyword
    - If the keyword clearly would not apply where the identifier exists, SQL can figure it out, but otherwise it MUST be double quoted
    - Try to limit naming identifiers after common keywords, as it just gets confusing

GUIDELINES

- Recommendations for good identifier naming:
  - Use snake case: Using all lowercase characters and underscores to separate words
  - Keep names easy to understand: As the complexity of the database increases, it might start having 100's of tables. Given them names that actually help you immediately know what they contain!
  - Use plurals for table names: Tables hold many rows worth of data, so it makes sense to refer to them in the plural.
  - Keep them fairly short: Postgres limits you to 63 characters, but other systems are even less. So keep them short and sweet.
  - When copying tables, use new names that assist later management: Often you may want to copy a table to run some calculations or alter it in a way that does not affect the original. Consider appending the date in `YYYY-MM-DD` to the table name to make it easier to find later what your latest version is.

CHAINS THAT CONSTRAIN

WHY CONSTRAIN YOURSELF?

- Data is only useful if we can easily access it in the form we'd expect
- Specific column types already are one step in this direction
  - Entering in data in another format either gets converted or an error gets output
- We can also implement a variety of other *constraints* on the columns or rows of our table
  - All are with the idea of further ensuring that the data in our table is of the form that we expect
  - If we try to enter or change any data that would violate these constraints, SQL will return an error instead.

CONSTRAINING DETAILS

- Postgres gives you two main locations where you can apply constraints:
  - At the column level, immediately after specifying a column type
  - At the table level, after all columns have been specified
- For the most part, all the different types of contraints can be applied in either location
  - Only exception is constraints that refer to multiple columns, which should be applied as table constraints
- The anatomy of a constraint syntax looks like:

```
CONSTRAINT constraint name CONSTRAINT_TYPE
CONSTRAINT_CONDITIONS
```

CHECK

- The `CHECK` constraint is perhaps the most straightforward, in that it just checks to see if a certain condition is true
- If the condition is untrue, then an error will be raised
- Can be written in either form, but must be a table constraint if referencing multiple columns

```
CREATE TABLE example (
  col1 INT CHECK (col1 > 0),
  col2 INT,
  col3 INT,
  CONSTRAINT second_constraint CHECK (col2 > col3)
);
```

NOT NULL

- Often, you may want to enforce a particular column to *always* have data
- To do so, you can set up a contraint on a column to not contain any null values
- The `NOT NULL` constraint is only applied to columns, not to the entire table!

```
CREATE TABLE example (
  col1 INT NOT NULL,
  col2 INT
);
```

UNIQUENESS

- Similarly to forcing a column to always contain data, you can also force it to have only *unique* data
- Requires that every row in that column have a distinct value. Any duplicates will be rejected.
- If done as a table constraint, can also require pairs of columns to be unique

```
CREATE TABLE example (
  col1 INT UNIQUE,
  col2 INT,
  col3 INT,
  CONSTRAINT uniq_pair UNIQUE (col2, col3)
);
```

UNDERSTANDING CHECK

Given the table created as seen below, which insertion command would complete successfully?

```
CREATE TABLE uc (
  id_num INT UNIQUE NOT NULL,
  prod_name TEXT UNIQUE,
  price NUMERIC(5,2)
  wholesale NUMERIC(5,2),
  CHECK (price > wholesale),
  CHECK (price >= 0)
);
```

Option A

```
INSERT INTO uc VALUES
 (1, 'Steak', 3.22, 5.00),
 (2, 'Beans', 4.12, 2.50));
```

Option A

```
INSERT INTO uc VALUES
 (1, 'Steak', 3.22, 1.23),
 (2, NULL, 2.65, 1.26));
```

Option A

```
INSERT INTO uc VALUES
 (1, 'Steak', 3.22, 2.78),
 (NULL, 'Beans', 4.12, 2.50));
```

Option A

```
INSERT INTO uc VALUES
 (1, 'Steak', -3.22, -5.00),
 (2, 'Steak', 4.12, 2.50));
```

THE PRIMARY DIRECTIVE

- Combining `UNIQUE` and `NOT NULL` is extremely useful in having a column that gives an unambiguous way to selection a specific row from a table
- Can define a **single** *primary key* for a table, that reflects this joint constraint
- If you already have a table column doing this, why declare as a primary key?
  - It enforces that entries in your column need to maintain this unique and present constraint going forward
  - It can simplify joins, as the default column to join on is the primary key
  - It will speed of queries, as SQL uses the primary key to better optimize its searches
- Sometimes desirable to create a *composite primary key* based off multiple columns

NATURAL VS SURROGATE

- Where possible, using a *natural* primary key is often preferred
  - Requires that a column already in your data meets the criteria of containing purely unique, non-null values
  - Can sometimes combine a few columns to arrive at this requirement
  - Using the existing data for the key helps give the primary key some actual meaning
- In other situations, a *surrogate* primary key may be necessary
  - Adds an artificial column to your table that contains purely unique, non-null values
    - The `SERIAL` data types are great for this, or some people prefer to use UUIDs
  - The drawback is that your tables may lose some meaning without performing a bunch of joins

CREATING PRIMARY KEYS

- You can create a primary key constraint on a single column using either syntax
- Composite primary keys must be done as a table constraint

```
CREATE TABLE example (
  col1 TEXT PRIMARY KEY,
  col2 INT
  );
```

```
CREATE TABLE example (
  col1 TEXT,
  col2 INT,
  col3 INT,
  CONSTRAINT comp_key PRIMARY KEY (col1, col2)
);
```

FOREIGN KEYS

- Columns in tables can be related to columns in other tables: *foreign key constraints* are a way to formalize these relationships
- Says: "the values in this column also appear in this other column in this other table"
  - Almost always refers to another primary key, though it could technically be any uniquely constrained column
- Could have many foreign key constraints in one table, as opposed to having only a single primary key constraint
- Uses the keyword `REFERENCES`

```
CREATE TABLE example2 (
  col1 TEXT PRIMARY KEY,
  col2 INT REFERENCES example (col1)
);
```

TABLE FOREIGN CONSTRAINTS

- Declaring foreign constraints in the table syntax is more cumbersome, and I'd only do it if you had a composite primary key that you needed to match

```
CREATE TABLE example2 (
  col1 TEXT PRIMARY KEY,
  col2 INT,
  col3 INT,
  CONSTRAINT fkey_pair FOREIGN KEY (col2,col3)
    REFERENCES example (col1,col2)
);
```

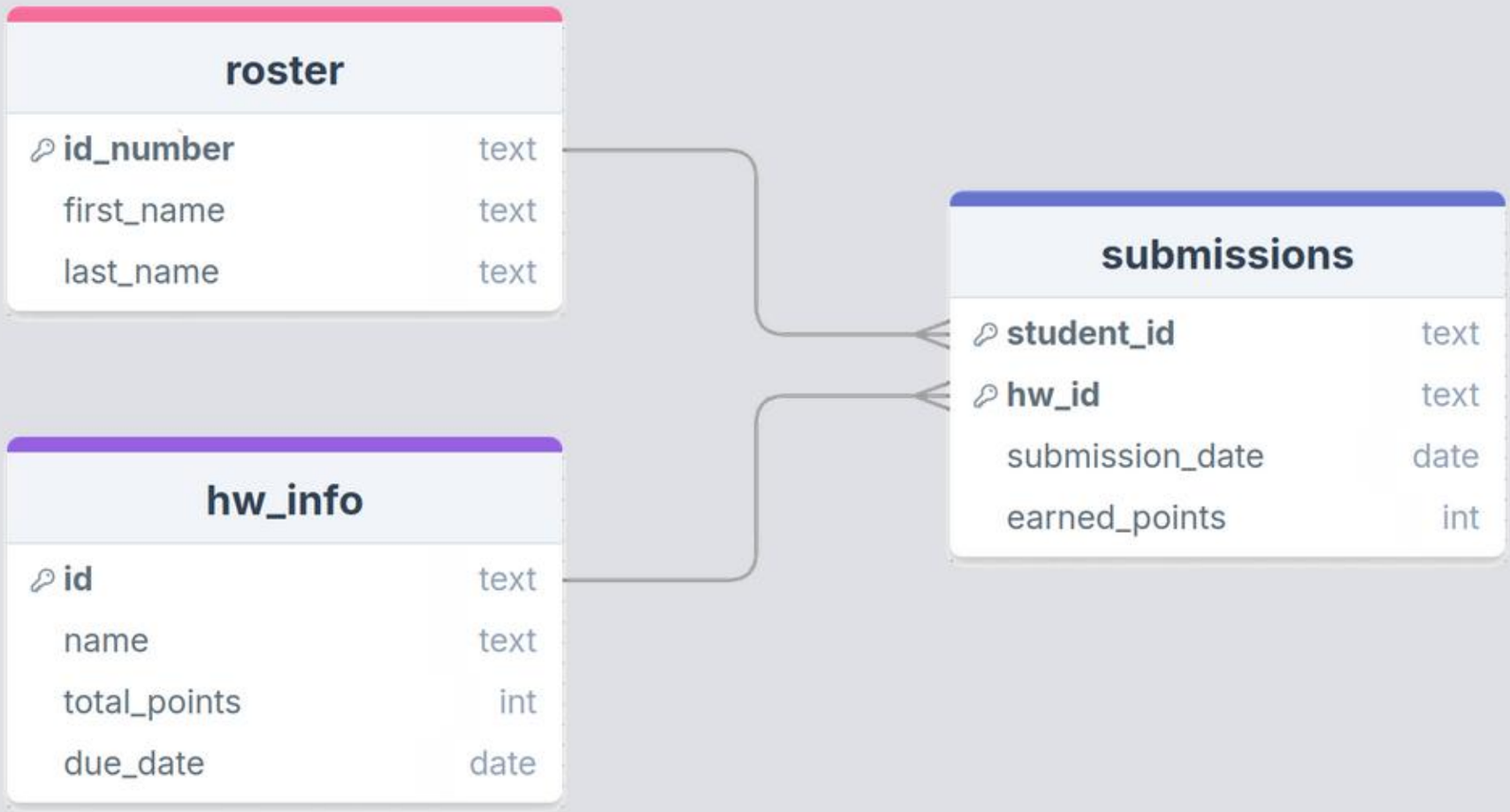
FOREIGN CONSIDERATIONS

- Foreign keys are meant to enforce the relations between tables, so they raise some other considerations
  - You can not add a row to a table that refers to another until that other table contains the necessary primary key
  - You can not delete a table that has another depending on it
  - By default, you can not delete or change an individual row in a table that is being referenced by another
    - Can alter this so that any referencing rows are ALSO deleted
    - Could also tweak to set those row foreign keys to be `NULL` or the column default

```
...
col2 INT REFERENCES example ON DELETE CASCADE
col3 INT REFERENCES example ON DELETE SET NULL
...
```

EXAMPLE

- We previously looked at joins with the roster, hw_info, and submissions tables. How would we create these with full constraints?



YOUR TURN

Suppose you wanted to track your Spotify playlist information in your own database. Questions you may want to be able to answer might include:

- What is the total playtime of this playlist?
- What is the most common band in a particular playlist?
- Of all the artists who perform songs in any playlist, which artists collaborate with others the most?
- Songs from how many different albums are in a particular playlist?

In groups of two or three, sketch out table diagrams similar to what we just saw in the previous example (commonly called ERD or Entity Relationship Diagrams), that would allow all these questions to be answered. Your tables should include primary keys and foreign keys where appropriate.

Online sketching resources include: drawsql, visual-paradigm, or DrawIO