Database Systems
CSE 414

Lecture 7: SQL Wrap-up

Announcements

- WQ3 is out, due Sunday 11pm
- HW2 is due tomorrow (Tue) 11pm
  - H3 will be posted later this week
  - you will be using Microsoft Azure
  - we will send out codes for free student use
    - good for 6 months and up to $600

Recap from last lecture

- Subqueries can occur in many clauses:
  - SELECT
  - FROM
  - WHERE
- Monotone queries: SELECT-FROM-WHERE
  - Existential quantifier
- Non-monotone queries
  - Universal quantifier
  - Aggregation

Examples of Complex Queries

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

1. Find drinkers that frequent <u>some</u> bar that serves <u>some</u> beer they like.
2. Find drinkers that frequent <u>some</u> bar that serves <u>only</u> beers they don’t like.
3. Find drinkers that frequent <u>only</u> bars that serves <u>some</u> beer they like.

```
Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)
```

Example 1

Find drinkers that frequent some bar that serves some beer they like.

```
SELECT DISTINCT X.drinker
FROM Frequents X, Serves Y, Likes Z
WHERE X.bar = Y.bar AND
    Y.beer = Z.beer AND
    X.drinker = Z.drinker
```

drinker + bar they frequent + beer served that they like
=> drinker is an answer

(even though we only want the drinker,
we need the rest to know it's an answer.)

```
Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)
```

Example 1

Find drinkers that frequent some bar that serves some beer they like.

```
SELECT DISTINCT X.drinker
FROM Frequents X, Serves Y, Likes Z
WHERE X.bar = Y.bar AND
    Y.beer = Z.beer AND
    X.drinker = Z.drinker
```

What happens if we didn’t write DISTINCT?

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 2

Find drinkers that frequent some bar that serves only beers they don't like

Existential

Universal

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 2

Find drinkers that frequent some bar that serves only beers they don't like

bar serves only beers that X does not like =
bar that does NOT serve some beer that X does like

Let's find the others (drop the NOT):
Drinkers that frequent some bars that serves some beer they like.

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 2

Find drinkers that frequent <u>some</u> bar that serves <u>only</u> beers they don’t like

Let’s find the others (drop the NOT):
Drinkers that frequent <u>some</u> bars that serves <u>some</u> beer they like.

That’s the previous query…

```
SELECT DISTINCT X.drinker
FROM Frequents X, Serves Y, Likes Z
WHERE X.bar = Y.bar AND
    Y.beer = Z.beer AND
    X.drinker = Z.drinker
```

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 2

Find drinkers that frequent some bar that serves only beers they don't like

Let's find the others (drop the NOT):
Drinkers that frequent some bars that serves some beer they like.

That's the previous query… Let's write it with a subquery:

```
SELECT DISTINCT X.drinker
FROM Frequents X
WHERE EXISTS (SELECT *
              FROM Serves Y, Likes Z
              WHERE X.bar=Y.bar AND
                    X.drinker=Z.drinker AND
                    Y.beer = Z.beer)
```

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 2

Find drinkers that frequent some bar that serves only beers they don't like

Let's find the others (drop the NOT):
Drinkers that frequent some bars that serves some beer they like.

That's the previous query… Let's write it with a subquery:

Now negate!

```
SELECT DISTINCT X.drinker
FROM Frequents X
WHERE NOT EXISTS (SELECT *
                  FROM Serves Y, Likes Z
                  WHERE X.bar=Y.bar AND
                      X.drinker=Z.drinker AND
                      Y.beer = Z.beer)
```

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 3

Find drinkers that frequent only bars that serves some beer they like.

Universal

Existential

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 3

Find drinkers that frequent <u>only</u> bars that serves <u>some</u> beer they like.

X frequents <u>only</u> bars that serve <u>some</u> beer X likes =
X does NOT frequent <u>some</u> bar that serves <u>only</u> beer X doesn’t like

Let’s find the others (drop the NOT):
Drinkers that frequent <u>some</u> bar that serves <u>only</u> beer they don’t like.

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 3

Find drinkers that frequent <u>only</u> bars that serves <u>some</u> beer they like.

Let's find the others (drop the NOT):
Drinkers that frequent <u>some</u> bar that serves <u>only</u> beer they don't like.

That's the previous query!

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 3

Find drinkers that frequent only bars that serves some beer they like.

Let's find the others (drop the NOT):
Drinkers that frequent some bar that serves only beer they don't like.

That's the previous query!

```
SELECT DISTINCT X.drinker
FROM Frequents X
WHERE NOT EXISTS (SELECT *
                  FROM Serves Y, Likes Z
                  WHERE X.bar=Y.bar AND
                      X.drinker=Z.drinker AND
                      Y.beer = Z.beer)
```

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 3

Find drinkers that frequent only bars that serves some beer they like.

Let's find the others (drop the NOT):
Drinkers that frequent some bar that serves only beer they don't like.

That's the previous query! But write it as a nested query:

```
SELECT DISTINCT U.drinker
FROM Frequents U
WHERE U.drinker IN
    (SELECT DISTINCT X.drinker
     FROM Frequents X
     WHERE NOT EXISTS (SELECT *
                       FROM Serves Y, Likes Z
                       WHERE X.bar=Y.bar AND
                           X.drinker=Z.drinker AND
                           Y.beer = Z.beer))
```

Likes(drinker, beer)
Frequents(drinker, bar)
Serves(bar, beer)

Example 3

Find drinkers that frequent only bars that serves some beer they like.

Let’s find the others (drop the NOT):
Drinkers that frequent some bar that serves only beer they don’t like.

That’s the previous query!

Now negate!

Now need three nested queries

```
SELECT DISTINCT U.drinker
FROM Frequents U
WHERE U.drinker NOT IN
    (SELECT DISTINCT X.drinker
     FROM Frequents X
     WHERE NOT EXISTS (SELECT *
                            FROM Serves Y, Likes Z
                            WHERE X.bar=Y.bar AND
                                X.drinker=Z.drinker AND
                                Y.beer = Z.beer))
```

Product (pname, price, cid)
Company(cid, cname, city)

Unnesting Aggregates

Find the number of companies in each city

```
SELECT DISTINCT X.city, (SELECT count(*)
                         FROM Company Y
                         WHERE X.city = Y.city)
FROM  Company X
```

```
SELECT city,  count(*)
FROM   Company
GROUP BY city
```

Note: no need for DISTINCT
(DISTINCT *is the same* as GROUP BY)

Product (pname, price, cid)
Company(cid, cname, city)

Unnesting Aggregates

Find the number of companies in each city

```
SELECT DISTINCT X.city, (SELECT count(*)
                         FROM Company Y
                         WHERE X.city = Y.city)
FROM  Company X
```

```
SELECT city,  count(*)
FROM   Company
GROUP BY city
```

Equivalent queries

Product (pname, price, cid)
Company(cid, cname, city)

Unnesting Aggregates

Find the number of companies in each city

```
SELECT DISTINCT X.city, (SELECT count(*)
                         FROM Company Y
                         WHERE X.city = Y.city)
FROM  Company X
```

```
SELECT city,  count(*)
FROM   Company
GROUP BY city
```

Wait… **are** they equivalent?

Purchase(pid, product, quantity, price)

Grouping vs Nested Queries

```
SELECT      product, Sum(quantity) AS TotalSales
FROM        Purchase
WHERE       price > 1
GROUP BY    product
```

```
SELECT DISTINCT  x.product, (SELECT Sum(y.quantity)
                             FROM    Purchase y
                             WHERE x.product = y.product
                             AND y.price > 1)
                             AS TotalSales
FROM        Purchase x
WHERE       x.price > 1
```

Why twice ?

Author(<u>login</u>,name)
Wrote(login,url)

More Unnesting

Find authors who wrote ≥ 10 documents:

Attempt 1: with nested queries

This is SQL by a novice

```
SELECT DISTINCT Author.name
FROM     Author
WHERE 10 <= (SELECT count(url)
             FROM    Wrote
             WHERE Author.login=Wrote.login)
```

Author(<u>login</u>,name)
Wrote(login,url)

More Unnesting

Find authors who wrote ≥ 10 documents:

Attempt 1: with nested queries

Attempt 2: using GROUP BY and HAVING

```
SELECT     name
FROM       Author, Wrote
WHERE      Author.login=Wrote.login
GROUP BY name
HAVING     count(url) >= 10
```

This is SQL by an expert

Product (pname, price, cid)
Company(cid, cname, city)

Finding Witnesses

For each city, find the most expensive product made in that city

Finding the maximum price is easy…

```
SELECT x.city, max(y.price)
FROM Company x, Product y
WHERE x.cid = y.cid
GROUP BY x.city;
```

But we need the *witnesses*, i.e. the products with max price

Product (pname, price, cid)
Company(cid, cname, city)

Finding Witnesses

To find the witnesses:
compute the maximum price in a subquery

```
SELECT DISTINCT u.city, v.pname, v.price
FROM Company u, Product v,
    (SELECT x.city, max(y.price) as maxprice
     FROM Company x, Product y
     WHERE x.cid = y.cid
     GROUP BY x.city) w
WHERE u.cid = v.cid
      and u.city = w.city
      and v.price=w.maxprice;
```

Not a bad solution…

Product (pname, price, cid)
Company(cid, cname, city)

Finding Witnesses

Or we can use a subquery in where clause

```
SELECT u.city, v.pname, v.price
FROM Company u, Product v
WHERE u.cid = v.cid AND
        v.price >= ALL (SELECT y.price
                        FROM Company x, Product y
                        WHERE u.city=x.city
                              and x.cid=y.cid);
```

Product (<u>pname</u>, price, cid)
Company(<u>cid</u>, cname, city)

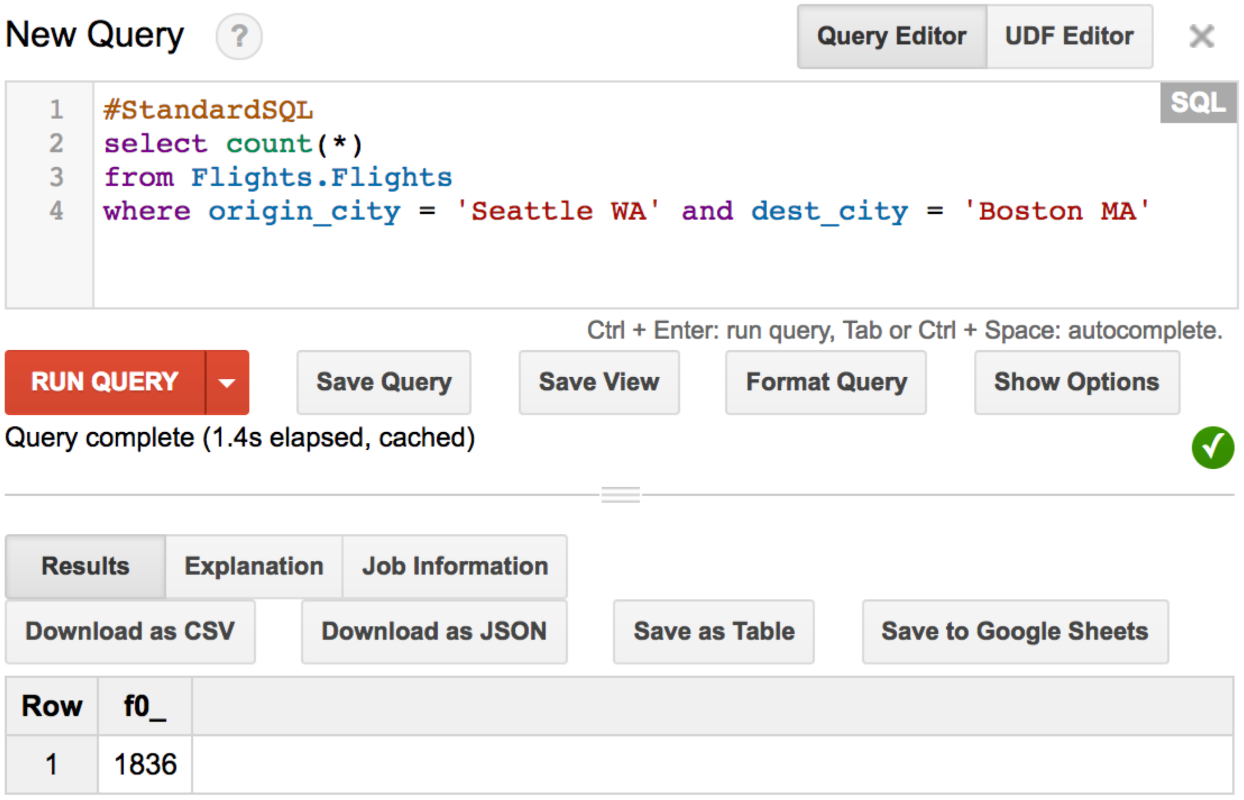
Finding Witnesses

There is a more concise solution here:

Idea: Product JOIN Product ON “made in the same city”
Then group by first product.
Then check that first product is more expensive than all of the second products in the group.

```
SELECT u.city, v.pname, v.price
FROM Company u, Product v, Company x, Product y
WHERE u.cid = v.cid and u.city = x.city and x.cid = y.cid
GROUP BY u.city, v.pname, v.price
HAVING v.price = max(y.price);
```

BigQuery Demo



```
#StandardSQL
select count(*)
from Flights.Flights
where origin_city = 'Seattle WA' and dest_city = 'Boston MA'
```

Ctrl + Enter: run query, Tab or Ctrl + Space: autocomplete.

Query complete (1.4s elapsed, cached)

Row	f0_
1	1836

Supports SQL queries on TB of data

(we won't use it in this class, but useful to know about)