Introduction to Data Management
CSE 414

Lecture 3: More SQL
(including most of Ch. 6.1-6.2)

Overload: https://goo.gl/forms/2pFBteeXg5L7wdC12
Announcements

• WQ2 will be posted tomorrow and due on Oct. 17, 11pm

• HW2 will be posted tomorrow and due on Oct. 16, 11pm
Multi-column Keys

• This makes name a key:

```
CREATE TABLE Company(
    name VARCHAR(20) PRIMARY KEY,
    country VARCHAR(20),
    employees INT,
    for_profit BOOLEAN);
```

• How can we make a key on name & country?
Multi-column Keys

- Syntax change if a primary key has multiple columns:

```sql
CREATE TABLE Company(
    name VARCHAR(20) PRIMARY KEY,
    country VARCHAR(20),
    employees INT,
    for_profit BOOLEAN,
    PRIMARY KEY (name, country));
```
Multi-column Keys (2)

• Likewise for secondary keys:

```sql
CREATE TABLE Company(
    name VARCHAR(20) UNIQUE,
    country VARCHAR(20),
    employees INT,
    for_profit BOOLEAN,
    UNIQUE (name, country));
```
Multi-column Keys (3)

• This makes manufacturer a foreign key:

```sql
CREATE TABLE Product(
    name VARCHAR(20),
    price DECIMAL(10,2),
    manufacturer VARCHAR(20)
    REFERENCES Company(name));
```

good idea to include target column name
Multi-column Keys (3)

• Similar syntax for foreign keys:

```sql
CREATE TABLE Product(
    name VARCHAR(20),
    price DECIMAL(10,2),
    manu_name VARCHAR(20),
    manu_co VARCHAR(20),
    FOREIGN KEY (manu_name, manu_co)
    REFERENCES Company(name, country));
```

now need both name & country

added
One Way to Input Data

• Write a program that outputs SQL statements:

```java
for (int a = 1; a <= 50; a++)
    for (int b = 1; b <= 50; b++)
        System.out.format("INSERT INTO T VALUES (%d,%d);
                        ", a, b);
```

• Feed those into SQLite:

```
sqlite3 foo.db < inputs.sql
```
Demo: MakeTriples.java
Warning

• Be very careful when doing this with strings:

    System.out.format(
        "INSERT INTO T2 VALUES (%d, '%s');",
        3, "O'Shaughnessy");

Becomes:

    INSERT INTO T2 VALUES (3, 'O’Shaughnessy');

which is a syntax error in this case
Hi, this is your son's school. We're having some computer trouble.

Oh, dear - did he break something? In a way -

Did you really name your son Robert'); DROP TABLE Students;--?

Oh, yes. Little Bobby Tables, we call him.

Well, we've lost this year's student records. I hope you're happy.

And I hope you've learned to sanitize your database inputs.

https://xkcd.com/327/
Warning (cont)

• Be very careful when doing this with strings:

```java
System.out.format(
    "INSERT INTO T VALUES (%d, '%s');", 
    3, "O'Shaughnessy");
```

• This allows a SQL injection attack!
  – Must check for quotes and escape (or disallow) them.
  – We’ll see safer ways to do this using JDBC

• DBMSs usually have faster ways to input data
  – SQLite has .import (try with .mode csv)
SQLite Uses

• SQLite is just a library

• Can be used as part of any C/C++/Java program
  – ex: could be used in an iPhone app

• Can be used in Chrome & Safari
  – no support in Firefox or IE
Demo: websql.html in **Chrome**  
(Note: this HTML/JS code is out of class scope)

Also selection & projection examples  
(see lec03-sql-basics.sql)
Physical Data Independence

• SQL doesn’t specify how data is stored on disk

• No need to think about encodings of data types
  – ex: DECIMAL(10,2)
  – ex: VARCHAR(255)
    • does this need to use 255 bytes to store ‘hello’?

• No need to think about how tuples are arranged
  – ex: could be row- or column-major ordered
  – (Most DBMSs are row-ordered, but Google’s BigQuery is column-oriented.)
SQLite Gotchas

• Allows NULL keys
  – At most one tuple can have NULL in the key
  – According to the SQL standard, PRIMARY KEY should always imply NOT NULL, but this is not the case in SQLite

• Does not support boolean or date/time columns

• Doesn’t always enforce domain constraints!
  – will let you insert a string where an INT is expected

• Doesn’t enforce foreign key constraints by default

• Etc…
DISTINCT and ORDER BY

• Query results do not have to be relations
  – i.e., they can have duplicate rows
  – remove them using DISTINCT

• Result order is normally unspecified
  – choose an order using ORDER BY
  – e.g., ORDER BY country, cname
  – e.g., ORDER BY price ASC, pname DESC

• Examples in lec03-sql-basics.sql
Joins

• Can use data from multiple tables:

```sql
SELECT pname, price
FROM Product, Company
WHERE manufacturer = cname AND
       country = 'Japan' AND
       price < 150;
```

• This is a selection and projection of the “join” of the Product and Company relations.
Interpreting Joins

• A JOIN B produces one row for every pair of rows
  – one row from A and one row from B

<table>
<thead>
<tr>
<th>Cname</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canon</td>
<td>Japan</td>
</tr>
<tr>
<td>GizmoWorks</td>
<td>USA</td>
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<tr>
<th>Pname</th>
<th>Price</th>
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• This join produces 6 different rows
  – in general, # rows in join is (# rows in A) * (# rows in B)
  – number of rows often much smaller after selection…
  – DBMS will do everything in its power to not compute A JOIN B
Interpreting Joins (2)

• Can think of a join in terms of code:

```java
for every row C in Company {
    for every row P in Product {
        if (P.manufacturer = C.cname and
            C.country = ‘Japan’ and
            P.price < 150.00)
            output (C.cname, C.country,
                    P.pname, P.price, P.category,
                    P.manufacturer);
    }
}
```
Types of Joins

- We usually think of the selection as part of the join
  - e.g., manufacturer = cname and country = ‘Japan’ and …
  - called the “join predicate”

- Join without a predicate is cross product / cross join

- Special names depending on predicate
  - natural join if “=“ between pairs of columns with same name
  - with well chosen col names, many joins become natural

- These are “inner” joins. We will discuss outer later…
Join Examples

• See lec03-sql-basics.sql…