Introduction to Data Management
CSE 414

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

Announcements

- Reminder: first web quiz due Sunday

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:

goes away

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

added

Multi-column Keys (2)

- Likewise for secondary keys:

goes away

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

added

Multi-column Keys (3)

- This makes manufacturer a foreign key:

```
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:

```
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:

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

- Feed those into SQLite:

```
sqlite3 foo.db < inputs.sql
```

Demo: MyTriples.java

Warning

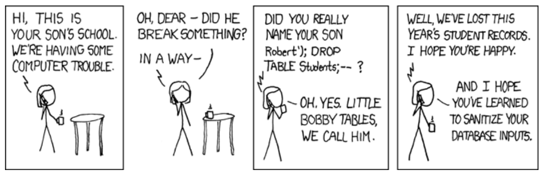
- Be very careful when doing this with strings:

```
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:

```
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

(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 BigQuery is column.)

SQLite Gotchas

- Allows NULL keys
- 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

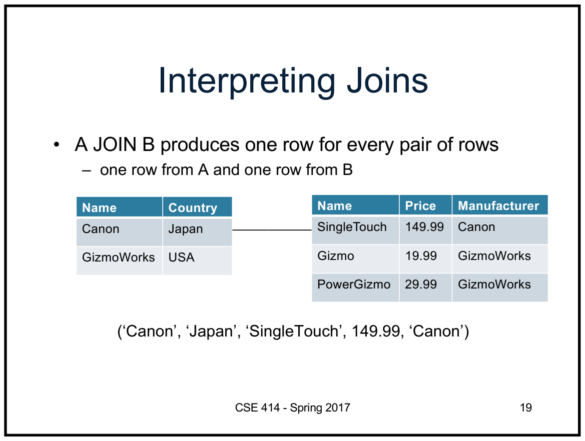
- Query results do not have to be relations
  - i.e., they can have duplicate rows
  - remove them using DISTINCT
- Result order is normally unspecified
  - choose an order using ORDER BY
  - e.g., ORDER BY country, cname
  - e.g., ORDER BY price ASC, pname DESC
- Examples in lec03-sql-basics.sql

Joins

- Can use data from multiple tables:

```
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.



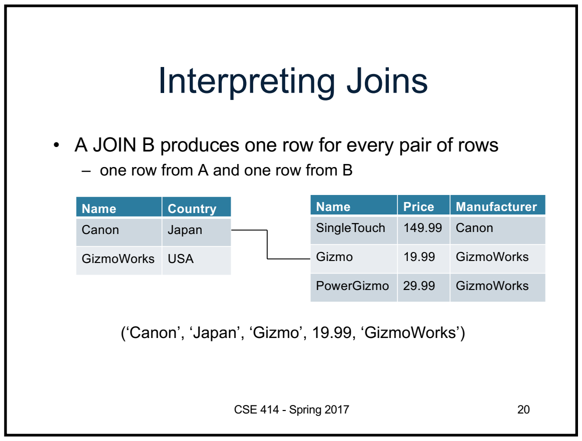
Interpreting Joins

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

Name	Country
Canon	Japan
GizmoWorks	USA

Name	Price	Manufacturer
SingleTouch	149.99	Canon
Gizmo	19.99	GizmoWorks
PowerGizmo	29.99	GizmoWorks

(‘Canon’, ‘Japan’, ‘SingleTouch’, 149.99, ‘Canon’)



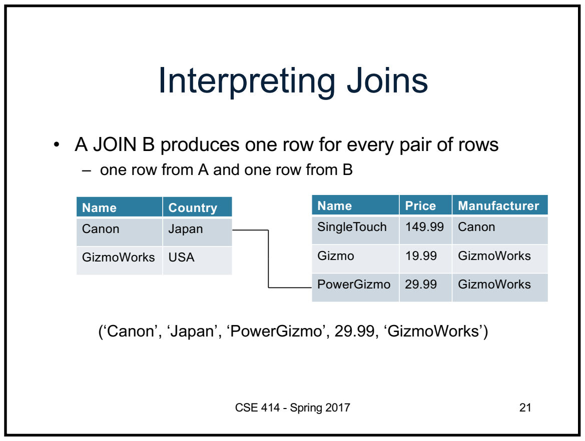
Interpreting Joins

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

Name	Country
Canon	Japan
GizmoWorks	USA

Name	Price	Manufacturer
SingleTouch	149.99	Canon
Gizmo	19.99	GizmoWorks
PowerGizmo	29.99	GizmoWorks

(‘Canon’, ‘Japan’, ‘Gizmo’, 19.99, ‘GizmoWorks’)



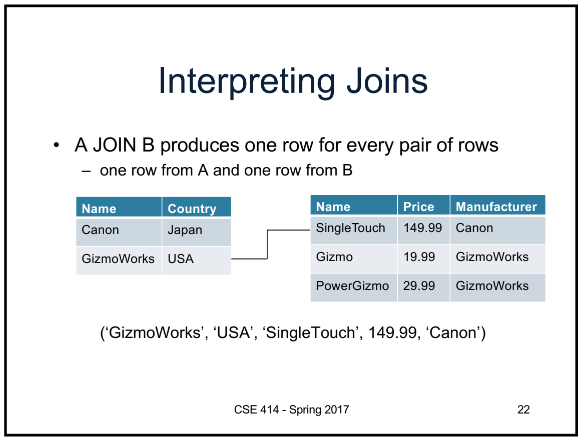
Interpreting Joins

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

Name	Country
Canon	Japan
GizmoWorks	USA

Name	Price	Manufacturer
SingleTouch	149.99	Canon
Gizmo	19.99	GizmoWorks
PowerGizmo	29.99	GizmoWorks

(‘Canon’, ‘Japan’, ‘PowerGizmo’, 29.99, ‘GizmoWorks’)



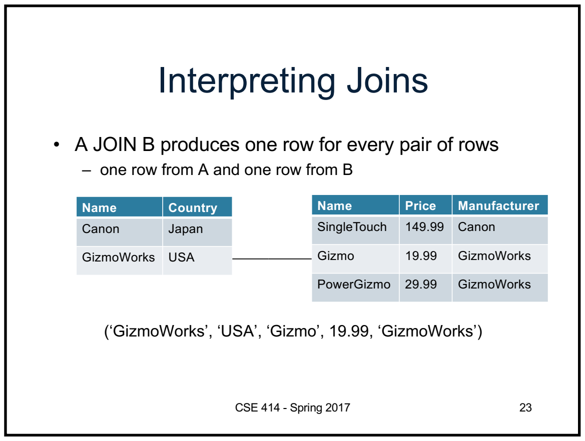
Interpreting Joins

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

Name	Country
Canon	Japan
GizmoWorks	USA

Name	Price	Manufacturer
SingleTouch	149.99	Canon
Gizmo	19.99	GizmoWorks
PowerGizmo	29.99	GizmoWorks

(‘GizmoWorks’, ‘USA’, ‘SingleTouch’, 149.99, ‘Canon’)



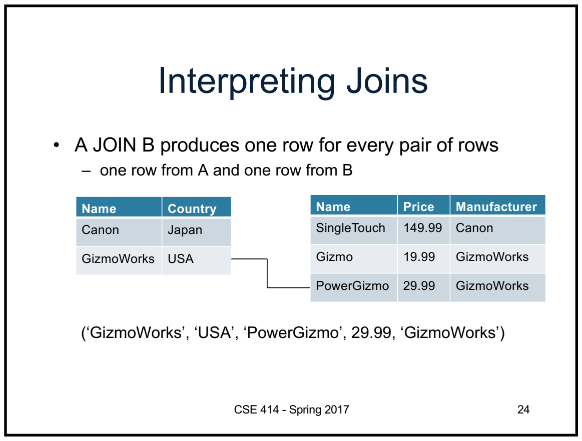
Interpreting Joins

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

Name	Country
Canon	Japan
GizmoWorks	USA

Name	Price	Manufacturer
SingleTouch	149.99	Canon
Gizmo	19.99	GizmoWorks
PowerGizmo	29.99	GizmoWorks

(‘GizmoWorks’, ‘USA’, ‘Gizmo’, 19.99, ‘GizmoWorks’)



Interpreting Joins

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

Name	Country
Canon	Japan
GizmoWorks	USA

Name	Price	Manufacturer
SingleTouch	149.99	Canon
Gizmo	19.99	GizmoWorks
PowerGizmo	29.99	GizmoWorks

(‘GizmoWorks’, ‘USA’, ‘PowerGizmo’, 29.99, ‘GizmoWorks’)

Interpreting Joins

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

Name	Country
Canon	Japan
GizmoWorks	USA

JOIN

Name	Price	Manufacturer
SingleTouch	149.99	Canon
Gizmo	19.99	GizmoWorks
PowerGizmo	29.99	GizmoWorks

- 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 it's power to not compute A JOIN B

Interpreting Joins (2)

- Can think of a join in terms of code:

```
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…