61A Lecture 32

Monday, November 17

Announcements

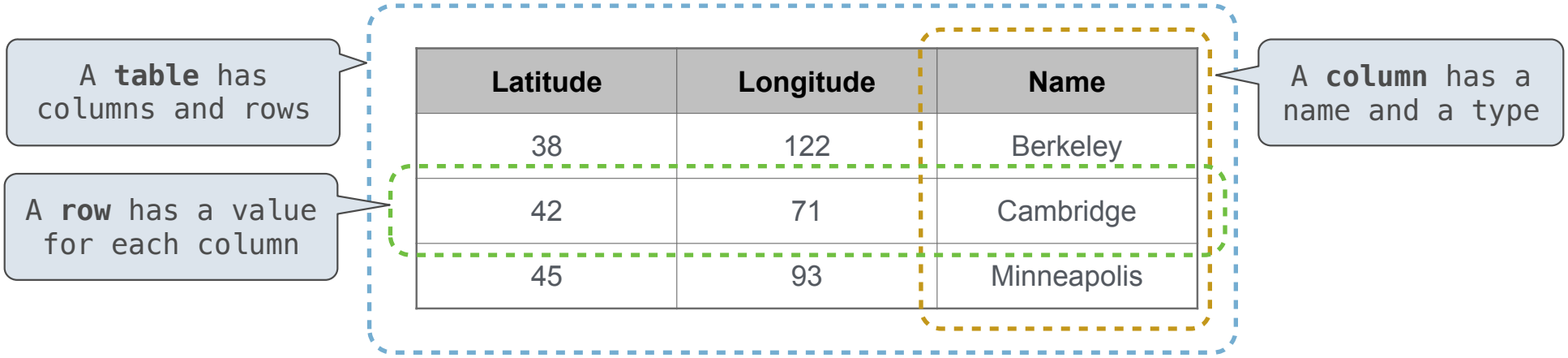
- Project 4 due Friday 11/21 @ 11:59pm
  - Project party Monday 11/17 6:30pm – 8:30pm in 10 Evans
  - Early submission point #2: Questions 1–16 by Tuesday 11/18 @ 11:59pm
  - Early submission point #3: Submit by Thursday 11/20 @ 11:59pm
- Homework 9 (6 pts) due Wednesday 11/26 @ 11:59pm

Declarative Languages

Database Management Systems

Database management systems (DBMS) are important, heavily used, and interesting!

A table is a collection of records, which are rows that have a value for each column



The Structured Query Language (SQL) is perhaps the most widely used programming language

SQL is a *declarative* programming language

Declarative Programming

In **declarative languages** such as SQL & Prolog:

- A "program" is a description of the desired result
- The interpreter figures out how to generate the result

In **imperative languages** such as Python & Scheme:

- A "program" is a description of computational processes
- The interpreter carries out execution/evaluation rules

Cities:

Latitude	Longitude	Name
38	122	Berkeley
42	71	Cambridge
45	93	Minneapolis

```
create table cities as
  select 38 as latitude, 122 as longitude, "Berkeley" as name union
  select 42,             71,               "Cambridge"       union
  select 45,             93,               "Minneapolis";
```

Region	Name
west coast	Berkeley
other	Minneapolis
other	Cambridge

```
select "west coast" as region, name from cities where longitude >= 115 union
select "other",                name from cities where longitude <  115;
```

Structured Query Language (SQL)

SQL Overview

The SQL language is an ANSI and ISO standard, but DBMS's implement custom variants

- A **select** statement creates a new table, either from scratch or by projecting a table
- A **create table** statement gives a global name to a table
- Lots of other statements exist: **analyze**, **delete**, **explain**, **insert**, **replace**, **update**, etc.
- Most of the important action is in the **select** statement
- The code for executing **select** statements fits on a single sheet of paper (next lecture)

Today's theme:

http://awhimsicalbohemian.typepad.com/.a/6a00e5538b84f3883301538dfa8f19970b-800wi

Getting Started with SQL

Install sqlite (version 3.8.3 or later): http://sqlite.org/download.html

Use sqlite online: http://kripken.github.io/sql.js/GUI/

Use the SQL example from the textbook: http://composingprograms.com/examples/sql/sql.zip

Selecting Value Literals

A **select** statement always includes a comma-separated list of column descriptions

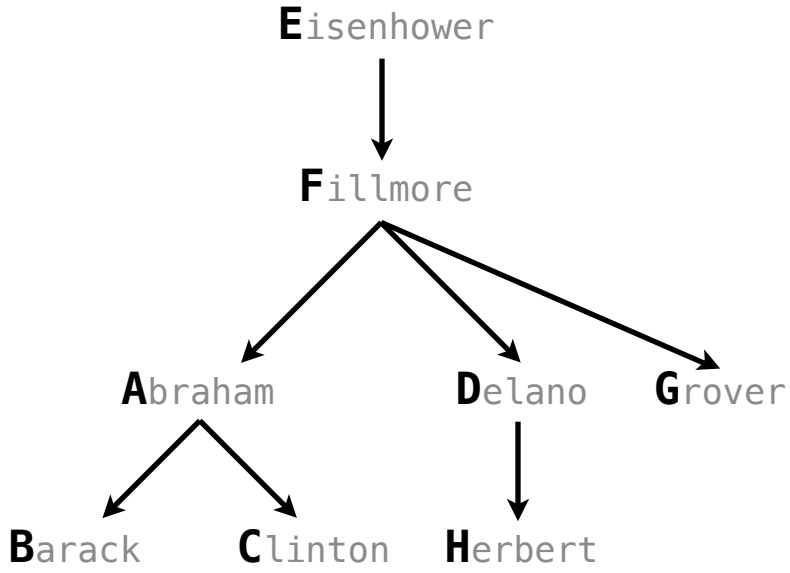
A column description is an expression, optionally followed by **as** and a column name

```
select [expression] as [name], [expression] as [name]; ...
```

Selecting literals creates a one-row table

The union of two select statements is a table containing the rows of both of their results

```
select "abraham" as parent, "barack" as child;union
select "abraham"          , "clinton"         union
select "delano"           , "herbert"         union
select "fillmore"         , "abraham"         union
select "fillmore"         , "delano"          union
select "fillmore"         , "grover"          union
select "eisenhower"       , "fillmore";
```



Naming Tables

SQL is often used as an interactive language

The result of a **select** statement is displayed to the user, but not stored

A **create table** statement gives the result a name

```
create table [name] as [select statement];
```

```
create table parents as
select "abraham" as parent, "barack" as child union
select "abraham"          , "clinton"         union
select "delano"           , "herbert"         union
select "fillmore"         , "abraham"         union
select "fillmore"         , "delano"          union
select "fillmore"         , "grover"          union
select "eisenhower"       , "fillmore";
```

Parents:

Parent	Child
abraham	barack
abraham	clinton
delano	herbert
fillmore	abraham
fillmore	delano
fillmore	grover
eisenhower	fillmore

Projecting Tables

Select Statements Project Existing Tables

A **select** statement can specify an input table using a **from** clause

A subset of the rows of the input table can be selected using a **where** clause

An ordering over the remaining rows can be declared using an **order by** clause

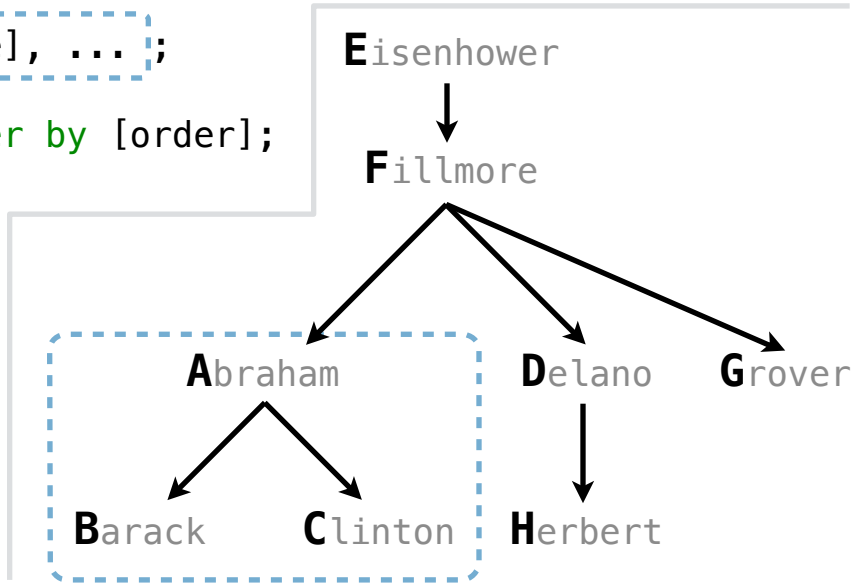
Column descriptions determine how each input row is projected to a result row

```
select [expression] as [name], [expression] as [name], ... ;
select [columns] from [table] where [condition] order by [order];
select child from parents where parent = "abraham";
select parent from parents where parent > child;
```

Child
barack
clinton

Parent
fillmore
fillmore

(Demo)



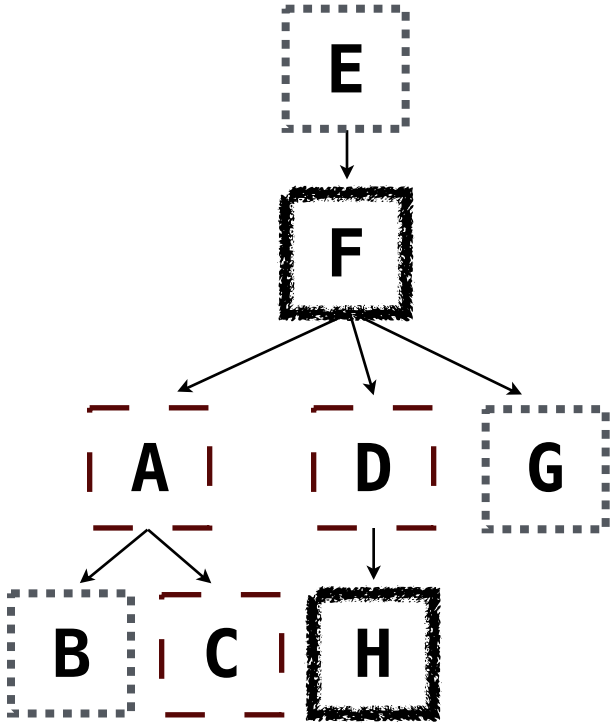
Joining Tables

Joining Two Tables

Two tables **A** & **B** are joined by a comma to yield all combos of a row from **A** & a row from **B**

```
create table dogs as
  select "abraham" as name, "long" as fur union
  select "barack"         , "short"       union
  select "clinton"        , "long"        union
  select "delano"         , "long"        union
  select "eisenhower"     , "short"       union
  select "fillmore"       , "curly"       union
  select "grover"         , "short"       union
  select "herbert"        , "curly";

create table parents as
  select "abraham" as parent, "barack" as child union
  select "abraham"          , "clinton"         union
  ...;
```



Select the parents of curly-furred dogs

```
select parent from parents, dogs
              where child = name and fur = "curly";
```

(Demo)

Aliases and Dot Expressions

Joining a Table with Itself

Two tables may share a column name; dot expressions and aliases disambiguate column values

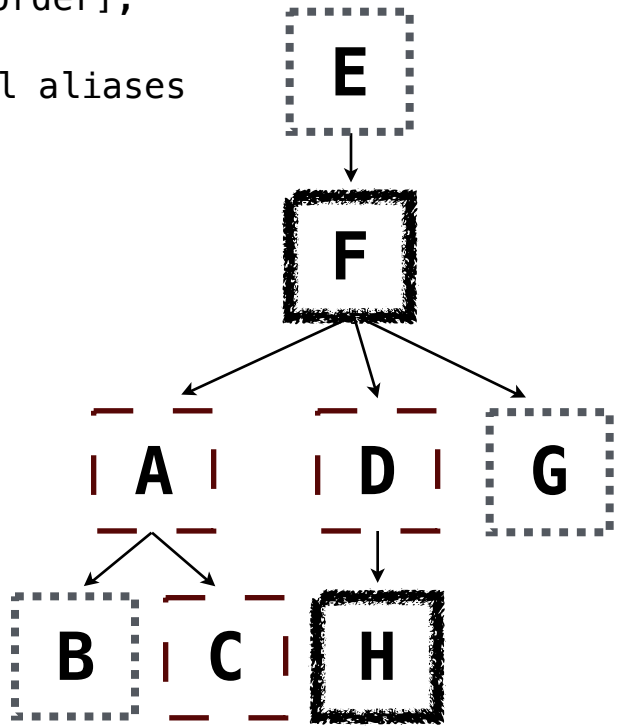
```
select [columns] from [table] where [condition] order by [order];
```

[table] is a comma-separated list of table names with optional aliases

Select all pairs of siblings

```
select a.child as first, b.child as second
  from parents as a, parents as b
  where a.parent = b.parent and a.child < b.child;
```

First	Second
barack	clinton
abraham	delano
abraham	grover
delano	grover



Joining Multiple Tables

Multiple tables can be joined to yield all combinations of rows from each

```
create table grandparents as
  select a.parent as grandog, b.child as granpup
    from parents as a, parents as b
    where b.parent = a.child;
```

Select all grandparents with the same fur as their grandchildren

Which tables need to be joined together?

```
select grandog from grandparents, dogs as c, dogs as d
                where grandog = c.name  and
                      granpup = d.name and
                      c.fur = d.fur;
```