SQL

Announcements

Dynamic Scope

Dynamic Scope

The way in which names are looked up in Scheme and Python is called lexical scope (or static scope) [You can see what names are in scope by inspecting the definition]

Lexical scope: The parent of a frame is the environment in which a procedure was *defined*

Dynamic scope: The parent of a frame is the environment in which a procedure was *called*

> Special form to create dynamically scoped procedures (**mu** special form only exists in Project 4 Scheme)

```
          mu
(define f (lambda (x) (+ x y)))

(define g (lambda (x y) (f (+ x x))))

(g 3 7)
```
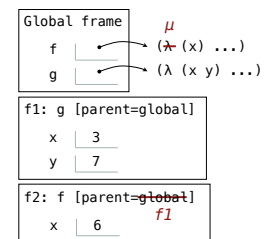
Lexical scope: The parent for f's frame is the global frame
Error: unknown identifier: y

Dynamic scope: The parent for f's frame is g's frame
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Global frame
f
g

μ
(λ (x) ...)
(λ (x y) ...)

f1: g [parent=global]
x | 3
y | 7

f2: f [parent=global]
               f1
x | 6

Databases

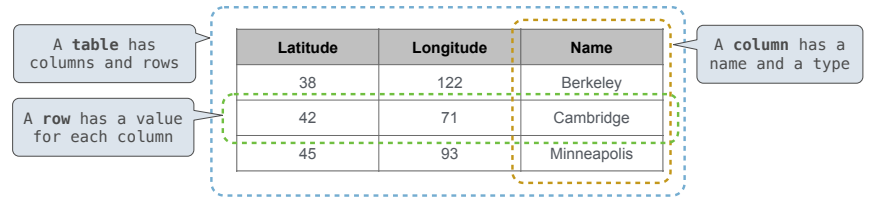## Database Management Systems

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

A **table** has columns and rows

A **row** has a value for each column

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

A **column** has a name and a type

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

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

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

Cities:

latitude	longitude	name
38	122	Berkeley
42	71	Cambridge
45	93	Minneapolis

region	name
west coast	Berkeley
other	Minneapolis
other	Cambridge

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

Today's theme:

Getting Started with SQL

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

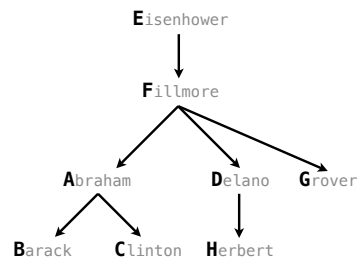Use sqlite online: code.cs61a.org/sql

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

Eisenhower

Fillmore

Abraham   **D**elano   **G**rover

Barack   **C**linton   **H**erbert

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 "delano" as parent, "herbert" as child union
select "abraham"          , "barack"          union
select "abraham"          , "clinton"         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

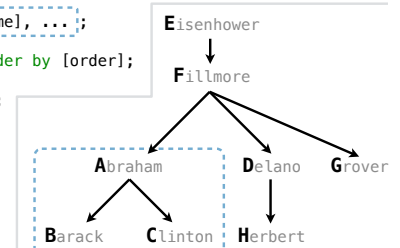An ordering over the remaining rows can be declared using an **order by** clause

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)

Eisenhower
↓
Fillmore

Abraham   **D**elano   **G**rover

Barack   **C**linton   **H**erbert

Arithmetic
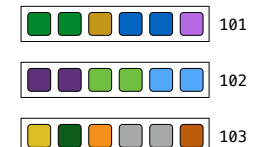

Arithmetic in Select Expressions

In a select expression, column names evaluate to row values

Arithmetic expressions can combine row values and constants

```
create table lift as
  select 101 as chair, 2 as single, 2 as couple union
  select 102         , 0          , 3             union
  select 103         , 4          , 1;

select chair, single + 2 * couple as total from lift;
```

chair	total
101	6
102	6
103	6

101

102

103

Discussion Question

Given the table **ints** that describes how to sum powers of 2 to form various integers

```
create table ints as
  select "zero" as word, 0 as one, 0 as two, 0 as four, 0 as eight union
  select "one"         , 1       , 0       , 0         , 0          union
  select "two"         , 0       , 2       , 0         , 0          union
  select "three"       , 1       , 2       , 0         , 0          union
  select "four"        , 0       , 0       , 4         , 0          union
  select "five"        , 1       , 0       , 4         , 0          union
  select "six"         , 0       , 2       , 4         , 0          union
  select "seven"       , 1       , 2       , 4         , 0          union
  select "eight"       , 0       , 0       , 0         , 8          union
  select "nine"        , 1       , 0       , 0         , 8;
```

(A) Write a select statement for a two-column table of the **word** and **value** for each integer

word	value
zero	0
one	1
two	2
three	3
...	...

(B) Write a select statement for the **word** names of the powers of two

word
one
two
four
eight

(Demo)

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