

# Declarative Programming

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## Announcements

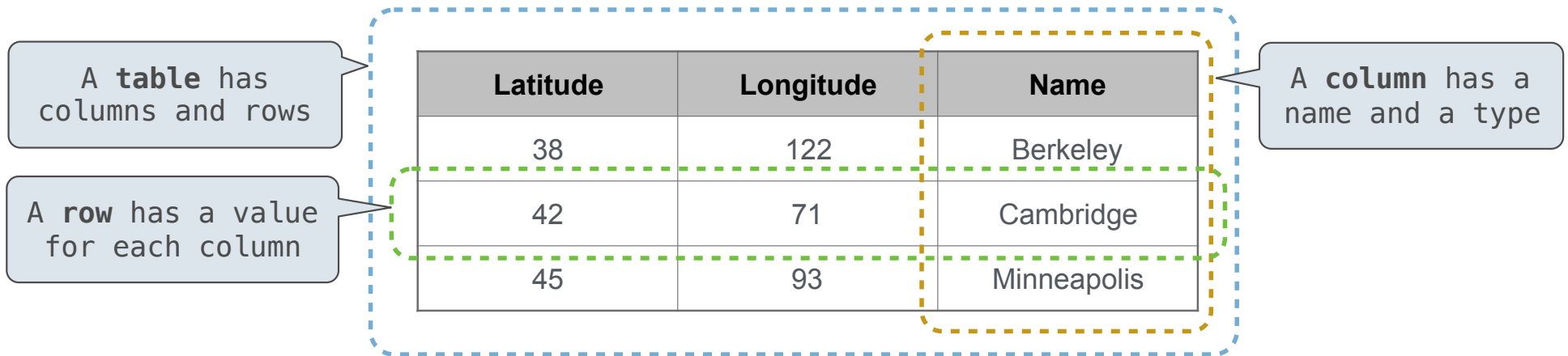
# Declarative Languages

## Database Management Systems

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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

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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

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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

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

Use sqlite online: [code.cs61a.org/sql](http://code.cs61a.org/sql)



## Selecting Value Literals

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

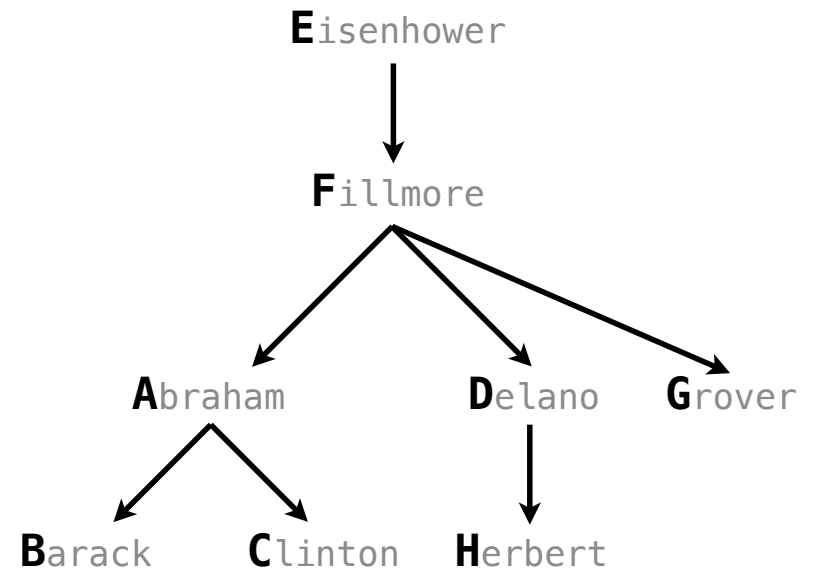
A column description is an expression, optionally followed by **as** and a column name

```
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";
```



## Naming Tables

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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];
```

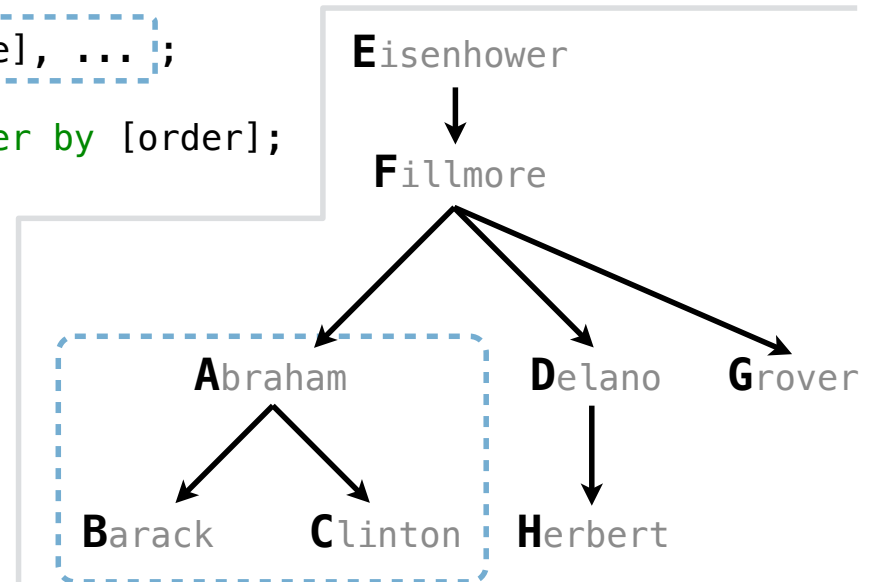
```
select child from parents where parent = "abraham";
```

```
select parent from parents where parent > child;
```

Child
barack
clinton

Parent
fillmore
fillmore

(Demo)



Arithmetic

## Arithmetic in Select Expressions

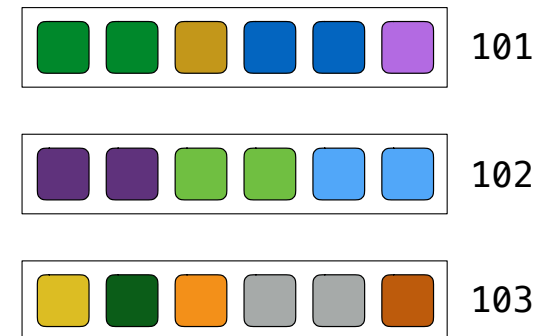
In a select expression, column names evaluate to row values

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



## 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

...

...

(Demo)

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

word
one
two
four
eight