Announcements
Information Hiding
**Attributes for Internal Use**

An attribute name that starts with one underscore is not meant to be referenced externally.

```python
class FibIter:
    """An iterator over Fibonacci numbers."""
    def __init__(self):
        self._next = 0
        self._addend = 1
    def __next__(self):
        result = self._next
        self._addend, self._next = self._next, self._addend + self._next
        return result
```

This naming convention is not enforced, but is typically respected

A programmer who designs and maintains a public module may change internal-use names

Starting a name with two underscores enforces restricted access from outside the class
Names in Local Scope

A name bound in a local frame is not accessible to other environments, except those that extend the frame

```python
def fib_generator():
    """A generator function for Fibonacci numbers.
    >>> fibs = fib_generator()
    >>> [next(fibs) for _ in range(10)]
    [0, 1, 1, 2, 3, 5, 8, 13, 21, 34]
    """
    yield 0
    previous, current = 0, 1
    while True:
        yield current
        previous, current = current, previous + current
```

There is no way to access values bound to "previous" and "current" externally.
Singleton Objects

A singleton class is a class that only ever has one instance.

NoneType, the class of None, is a singleton class; None is its only instance.

For user-defined singletons, some programmers re-bind the class name to the instance.

```python
class empty_iterator:
    """An iterator over no values."""
    def __next__(self):
        raise StopIteration

empty_iterator = empty_iterator()

```

The instance

The class
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

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

```sql
cities:
<table>
<thead>
<tr>
<th>Latitude</th>
<th>Longitude</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>122</td>
<td>Berkeley</td>
</tr>
<tr>
<td>42</td>
<td>71</td>
<td>Cambridge</td>
</tr>
<tr>
<td>45</td>
<td>93</td>
<td>Minneapolis</td>
</tr>
</tbody>
</table>
```

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

```sql
cities:
<table>
<thead>
<tr>
<th>Region</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>west coast</td>
<td>Berkeley</td>
</tr>
<tr>
<td>other</td>
<td>Minneapolis</td>
</tr>
<tr>
<td>other</td>
<td>Cambridge</td>
</tr>
</tbody>
</table>
```
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: http://kripken.github.io/sql.js/GUI/
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";
```
Naming Tables

SQL is often used as an interactive language

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

An `create table` statement gives the result a name:

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

create table parents as

<table>
<thead>
<tr>
<th>Parent</th>
<th>Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>abraham</td>
<td>barack</td>
</tr>
<tr>
<td>abraham</td>
<td>clinton</td>
</tr>
<tr>
<td>delano</td>
<td>herbert</td>
</tr>
<tr>
<td>fillmore</td>
<td>abraham</td>
</tr>
<tr>
<td>fillmore</td>
<td>delano</td>
</tr>
<tr>
<td>fillmore</td>
<td>grover</td>
</tr>
<tr>
<td>eisenhower</td>
<td>fillmore</td>
</tr>
</tbody>
</table>
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;
```