Announcements
Information Hiding
Attributes for Internal Use

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

```bash
>>> fibs = fib_generator()
>>> [next(fibs) for _ in range(10)]
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"""
```
Names in Local Scope

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    """A generator function for Fibonacci numbers."
    yield 0
    previous, current = 0, 1
    while True:
        yield current
        previous, current = current, previous + current

>>> fibs = fib_generator()
>>> [next(fibs) for _ in range(10)]
[0, 1, 1, 2, 3, 5, 8, 13, 21, 34]
"""
```

There is no way to access values bound to "previous" and "current" externally.
Singleton Objects
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NoneType, the class of None, is a singleton class; None is its only instance
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    """An iterator over no values."""
    def __next__(self):
        raise StopIteration
empty_iterator = empty_iterator()
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The class
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The instance The class
Declarative Languages
Database Management Systems
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The Structured Query Language (SQL) is perhaps the most widely used programming language.
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SQL is a declarative programming language.
Declarative Programming
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```sql
create table cities as
select 38 as latitude, 122 as longitude, "Berkeley" as name union
```

<table>
<thead>
<tr>
<th>Cities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Latitude</td>
</tr>
<tr>
<td>----------</td>
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```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";

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

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Structured Query Language (SQL)
The SQL language is an ANSI and ISO standard, but DBMS's implement custom variants.
SQL Overview

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

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- 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
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```sql
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```
select "delano" as parent, "herbert" as child;
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```
Delano
  ↓
Herbert
```
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select "delano" as parent, "herbert" as child union
select "abraham", "barack" union
```

```
Abraham
| Barack
```

```
Delano
| Herbert
```
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```sql
select "delano" as parent, "herbert" as child union
select "abraham", "barack" union
select "abraham", "clinton" union
```

![Diagram](https://via.placeholder.com/150)

Abraham → Barack

Delano → Clinton → Herbert
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```
select "delano" as parent, "herbert" as child union
select "abraham", "barack" union
select "abraham", "clinton" union
select "fillmore", "abraham" union
```
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select "fillmore", "delano" union
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select "abraham", "clinton" union
select "fillmore", "abraham" union
select "fillmore", "delano" union
select "fillmore", "grover" union
```
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select "abraham", "clinton" union
select "fillmore", "abraham" union
select "fillmore", "delano" union
select "fillmore", "grover" union
select "eisenhower", "fillmore";
```
Naming Tables

```
select "delano" as parent, "herbert" as child
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

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select "delano" as parent, "herbert" as child
select "abraham", "barack" union
select "abraham", "clinton" union
select "fillmore", "abraham" union
select "fillmore", "delano" union
select "fillmore", "grover" union
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SQL is often used as an interactive language
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A `create table` statement gives the result a name.

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A \texttt{create table} statement gives the result a name

\begin{verbatim}
create table [name] as [select statement];
\end{verbatim}

\begin{verbatim}
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select "abraham", "clinton" union
select "fillmore", "abraham" union
select "fillmore", "delano" union
select "fillmore", "grover" union
select "eisenhower", "fillmore";
\end{verbatim}
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

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

```sql
create table parents as
select "delano" as parent, "herbert" as child
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

A `create table` statement gives the result a name

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

create table parents as
  select "delano" as parent, "herbert" as child
  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. 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:

<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
Select Statements Project Existing Tables

A `select` statement can specify an input table using a `from` clause.
Select Statements Project Existing Tables

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

```sql
select [expression] as [name], [expression] as [name], ... ;
```
Select Statements Project Existing Tables

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

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

```sql
select [columns]  ;
```
Select Statements Project Existing Tables

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

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

select [columns] from [table];
```
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.

```
select [expression] as [name], [expression] as [name], ...;
select [columns] from [table];
```
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.

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

select [columns] from [table] where [condition] ;
```
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.

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

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

```
select [expression] as [name], [expression] as [name], ...;
select [columns] from [table] where [condition] order by [order];
```
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

\[
\text{select} \ [\text{expression}] \ as \ [\text{name}], \ [\text{expression}] \ as \ [\text{name}], \ ...
\]

\[
\text{select} \ [\text{columns}] \ from \ [\text{table}] \ where \ [\text{condition}] \ order by \ [\text{order}];
\]
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

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```sql
select [expression] as [name], [expression] as [name], ...;
select [columns] from [table] where [condition] order by [order];
```
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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";
```
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- `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;`
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.

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

<table>
<thead>
<tr>
<th>Child</th>
<th>Parent</th>
</tr>
</thead>
<tbody>
<tr>
<td>barack</td>
<td>fillmore</td>
</tr>
<tr>
<td>clinton</td>
<td>fillmore</td>
</tr>
</tbody>
</table>
Select Statements Project Existing Tables

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

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

```plaintext
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;
```

<table>
<thead>
<tr>
<th>Child</th>
<th>Parent</th>
</tr>
</thead>
<tbody>
<tr>
<td>barack</td>
<td>fillmore</td>
</tr>
<tr>
<td>clinton</td>
<td>fillmore</td>
</tr>
</tbody>
</table>

(Demo)