Announcements

- Homework 8 due Wednesday 4/17 @ 11:59pm
- Project 4 due Thursday 4/23 @ 11:59pm
- Early point #1: Questions 1-12 submitted (correctly) by Friday 4/17 @ 11:59pm
- Early point #2: All questions (including Extra Credit) by Wednesday 4/22 @ 11:59pm

http://goo.gl/ajEBkT

Information Hiding

Attributes for Internal Use

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

```python
>>> def _last_(self):
...     self._next = self
...     self._addend = 0
...     return

>>> 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."
    previous, current = 0, 1
    while True:
        yield current
        previous, current = current, previous + current
```

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()
```

Stream Implementation

A stream is a linked list with an explicit first element and a rest-of-the-list that is computed lazily

```python
class Stream:
    """A lazily computed linked list."
    def __repr__(self):
        return 'Stream.empty'
    def __init__(self, first, compute_rest=lambda: Stream.empty):
        assert callable(compute_rest), 'compute_rest must be callable.'
        self.first = first
        self._compute_rest = compute_rest

    @property
    def rest(self):
        """Return the rest of the stream, computing it if necessary.""
        if self._compute_rest is not None:
            self._rest = self._compute_rest()
            self._compute_rest = None
        return self._rest
```

Stream Implementation
Declarative Languages

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;

SQL Overview

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

SQL is a declarative language.

Database Management Systems

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

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

A table has columns and rows

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

A column has a name and a type

The Structured Query Language (SQL) is often used as an interactive language.

SQL is a declarative programming language.

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 [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

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];

Parents:

<table>
<thead>
<tr>
<th>Parent</th>
<th>Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>abraham</td>
<td>barack</td>
</tr>
<tr>
<td>delano</td>
<td>herbert</td>
</tr>
<tr>
<td>grover</td>
<td>fillmore</td>
</tr>
</tbody>
</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.

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;