61A Lecture 31

Wednesday, April 15

Announcements

- Homework 8 due Wednesday 4/17 @ 11:59pm
- Please complete the course survey on resources! **http://goo.gl/ajEBkT**
- 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

Information Hiding

Attributes for Internal Use

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

```
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
```

"Please don't reference these directly. They may change."

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

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

```
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

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

The instance

The class

Stream Implementation

Stream Implementation

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

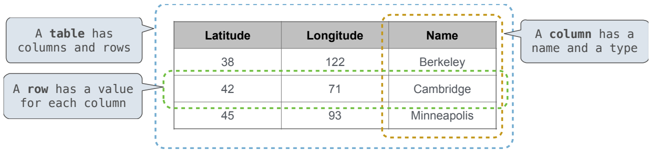
```
class Stream:
    """A lazily computed linked list."""
    class empty:
        def __repr__(self):
            return 'Stream.empty'
    empty = empty()

    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
```

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



A **table** has columns and rows

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

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

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

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

Cities:

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

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

Region	Name
west coast	Berkeley
other	Minneapolis
other	Cambridge

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

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
- The code for executing **select** statements fits on a single sheet of paper (next lecture)

Today's theme:

http://awhimsicalbohemian.typepad.com/.a/6a00e5538b84f3883301538dfa8f19970b-800wi

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/

Use the SQL example from the textbook: http://composingprograms.com/examples/sql/sql.zip

Selecting Value Literals

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

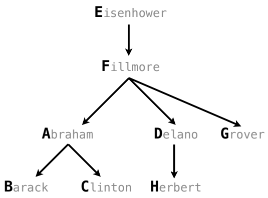
A column description is an expression, optionally followed by **as** and a column name

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

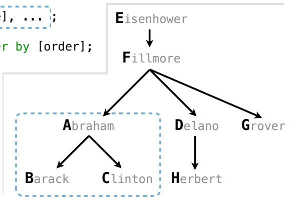
Column descriptions determine how each input row is projected to a result row

```
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
Delano
Grover
Barack
Clinton
Herbert