61A Lecture 29

Friday, April 10

Announcements

- Homework 8 due Wednesday 4/15 @ 11:59pm (small)
- Project 4 due Thursday 4/23 @ 11:59pm (BIG!)
  - 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

Data Processing

Processing Sequential Data

Many data sets can be processed sequentially:
- The set of all Twitter posts
- Votes cast in an election
- Sensor readings of an airplane
- The positive integers: 1, 2, 3, ...

However, the **sequence interface** we used before does not always apply
- A sequence has a finite, known length
- A sequence allows element selection for any element

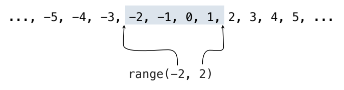
Some important ideas in **big data processing:**
- Implicit representations of streams of sequential data
- Declarative programming languages to manipulate and transform data
- Distributed computing

Implicit Sequences

Implicit Sequences

An implicit sequence is a representation of sequential data that does not explicitly store each element

Example: The built-in **range** class represents consecutive integers
- The range is represented by two values: start and end
- The length and elements are computed on demand
- Constant space for arbitrarily long sequences



(Demo)

Iterators

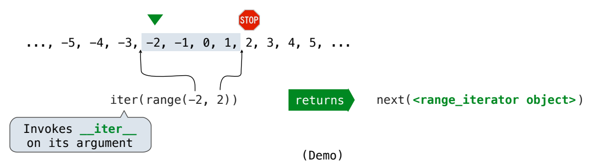
The Iterator Interface

An iterator is an object that can provide the next element of a sequence

The **__next__** method of an iterator returns the next element

The built-in **next** function invokes the **__next__** method on its argument

If there is no next element, then the **__next__** method of an iterator should raise a **StopIteration** exception



(Demo)

Iterable Objects

Iterables and Iterators

Iterator: Mutable object that tracks a position in a sequence, advancing on **__next__**

Iterable: Represents a sequence and returns a new iterator on **__iter__**

```
LetterIter is an iterator:     LetterIter('a', 'e')     ▼
                               LetterIter('a', 'e')     ▼

Letters is iterable:             Letters('a', 'e')       'a'    'b'    'c'    'd'
```

(Demo)

Built-in Iterators

Iterators from Built-in Functions

Many built-in Python sequence operations return iterators that compute results lazily

map(func, iterable):	Iterate over func(x) for x in iterable
filter(func, iterable):	Iterate over x in iterable if func(x)
zip(first_iter, second_iter):	Iterate over co-indexed (x, y) pairs
reversed(sequence):	Iterate over x in a sequence in reverse order

To view the results, place the resulting elements in a sequence

list(iterable):	Create a list containing all x in iterable
tuple(iterable):	Create a tuple containing all x in iterable
sorted(iterable):	Create a sorted list containing x in iterable

(Demo)

For Statements

The For Statement

```
for <name> in <expression>:
    <suite>
```

1. Evaluate the header <expression>, which must evaluate to an iterable object
2. For each element in that sequence, in order:
   A. Bind <name> to that element in the first frame of the current environment
   B. Execute the <suite>

When executing a **for** statement, __iter__ returns an iterator and __next__ provides each item:

```
>>> counts = [1, 2, 3]
>>> for item in counts:
        print(item)
1
2
3
```

```
>>> counts = [1, 2, 3]
>>> items = counts.__iter__()
>>> try:
        while True:
            item = items.__next__()
            print(item)
    except StopIteration:
        pass # Do nothing
1
2
3
```

Generator Functions

Generators and Generator Functions

A generator function is a function that yields values instead of returning them

A normal function returns once; a generator function yields multiple times

A generator is an iterator, created by a *generator function*

When a generator function is called, it returns a generator that iterates over yields

```
>>> def letter_generator(next_letter, end):
        while next_letter < end:
            yield next_letter
            next_letter = chr(ord(next_letter)+1)

>>> s = letter_generator('a', 'z')
>>> next(s)
'a'
>>> next(s)
'b'
```

(Demo)