61A Lecture 30

Wednesday, November 12

Announcements

- Homework 8 due Wednesday 11/12 @ 11:59pm
- Project 4 due ~~Thursday~~ Friday 11/21 @ 11:59pm
  - Early submission point #1: Questions 1–6 by Friday 11/14 @ 11:59pm
  - Early submission point #2: Questions 1–16 by Tuesday 11/18 @ 11:59pm
  - Early submission point #3: Submit by Thursday 11/20 @ 11:59pm
- Homework 9 combined with Homework 10 (6 pts), due Wednesday 11/26 @ 11:59pm
- Guest lecture Friday 11/14 by Andrew Huang

Survey Results

Midterm 2 was difficult and discouraging

Too many adjacent deadlines

Too hard to get help in office hours and homework/project parties

Better guidance on how to solve problems

Pace, information overload, and extra credit

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 and parallel computing

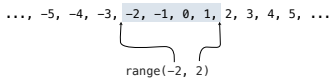
Implicit Sequences

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

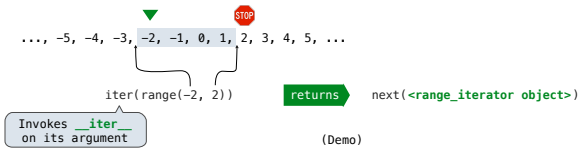
The Iterator Interface

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

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

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

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

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

>>> for letter in letters_generator('a', 'e'):
        print(letter)
a
b
c
d
```

(Demo)