61A Lecture 29

Announcements

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

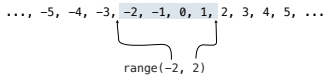
Implicit Sequences

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

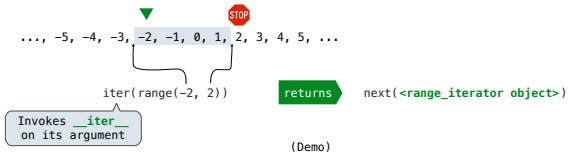
The Iterator Interface

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)