# 61A Lecture 30

# Announcements

# Data Processing

## Data Processing

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

# Iterators

## Iterators

A container can provide an iterator that provides access to its elements in some order

`iter(iterable)`: Return an iterator over the elements of an iterable value

`next(iterator)`: Return the next element in an iterator

```
>>> s = [3, 4, 5]
>>> t = iter(s)
>>> next(t)
3
>>> next(t)
4
```

```
>>> u = iter(s)
>>> next(u)
3
>>> next(t)
5
>>> next(u)
4
```

Iterators are always ordered, even if the container that produced them is not

```
>>> d = {'one': 1, 'two': 2, 'three': 3}
>>> k = iter(d)
>>> next(k)
'one'
>>> next(k)
'three'
>>> next(k)
'two'
```

```
>>> v = iter(d.values())
>>> next(v)
1
>>> next(v)
3
>>> next(v)
2
```

Keys and values are iterated over in an arbitrary order which is non-random, varies across Python implementations, and depends on the dictionary's history of insertions and deletions. If keys, values and items views are iterated over with no intervening modifications to the dictionary, the order of items will directly correspond.

(Demo)

https://docs.python.org/3/library/stdtypes.html#dictionary-view-objects

# 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 = iter(counts)
>>> try:
        while True:
            item = next(items)
            print(item)
    except StopIteration:
        pass # Do nothing
1
2
3
```

## Processing Iterators

A **StopIteration** exception is raised whenever **next** is called on an empty iterator

```
>>> contains('strength', 'stent')
True
>>> contains('strength', 'rest')
False
>>> contains('strength', 'tenth')
True
```

```
def contains(a, b):
    ai = iter(a)
    for x in b:
        try:
            while next(ai) != x:
                pass # do nothing
        except StopIteration:
            return False
    return True
```



## Built-In Iterator Functions

## Built-in Functions for Iteration

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 contents of an iterator, place the resulting elements into a container

| | |
|---|---|
| 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)



## Generators

## Generators and Generator Functions

```
>>> def plus_minus(x):
...     yield x
...     yield -x

>>> t = plus_minus(3)
>>> next(t)
3
>>> next(t)
-3
>>> t
<generator object plus_minus ...>
```

A *generator function* is a function that **yield**s values instead of **return**ing them

A normal function **return**s once; a *generator function* can **yield** multiple times

A *generator* is an iterator created automatically by calling a *generator function*

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

(Demo)



## Iterable User-Defined Classes

The special method **__iter__** is called by the built-in **iter()** & should return an iterator

```
>>> list(Countdown(5))
[5, 4, 3, 2, 1]
>>> for x in Countdown(3):
...     print(x)
3
2
1
```

```
class Countdown:
    def __init__(self, start):
        self.start = start

    def __iter__(self):
        v = self.start
        while v > 0:
            yield v
            v -= 1
```



## Generators & Iterators

## Generators can Yield from Iterators

A **yield from** statement yields all values from an iterator or iterable (Python 3.3)

```
>>> list(a_then_b([3, 4], [5, 6]))
[3, 4, 5, 6]
```

```
def a_then_b(a, b):
    for x in a:
        yield x
    for x in b:
        yield x
```

```
def a_then_b(a, b):
    yield from a
    yield from b
```

---

```
>>> list(countdown(5))
[5, 4, 3, 2, 1]
```

```
def countdown(k):
    if k > 0:
        yield k
        yield from countdown(k-1)
```

(Demo)