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Lecture 27
Iterators

FIT 1008
Introduction to Computer Science

Objectives for today's lecture

- To understand the importance of **iterators**
- To learn how to implement and use them
- To learn to make our classes iterable by creating iterators on them

For loops

```
for c in "abc":
    print(c)

for item in ["apple", "pear", "plum"]:
    print(item)

infile = open("example.txt")
for line in infile:
    print(line, end=' ')
```

Can we iterate over our own objects?

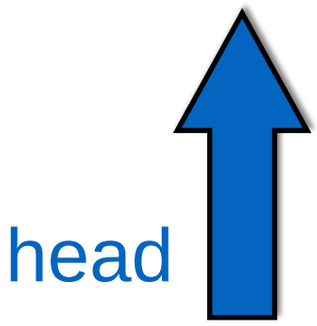
```
for c in "abc":
    print(c)
```

```
a
b
c
```

```
>>> s = 'abc'
>>> itr = iter(s)
>>> itr
<str_iterator object at 0x10382f250>
>>> c = next(itr)
>>> c
'a'
>>> c = next(itr)
>>> c
'b'
>>> c = next(itr)
>>> c
'c'
>>> c = next(itr)
Traceback (most recent call last):
  File "<pyshell#12>", line 1, in <module>
    c = next(itr)
StopIteration
```

We would like to be able to write code like:

```
for item in my_linked_list:
print(item)
```

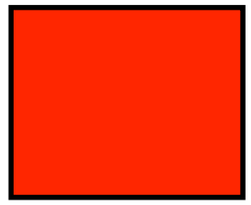


Next!

Next!

Next!

Next! No more



Handled differently in different languages.

Python: raise `StopIteration`

List iterator

- We need to create an **iterator class** for the list.
  A class with the methods:

```
__init__
__iter__
__next__
```

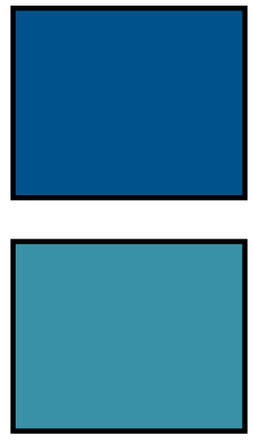
current

None

head

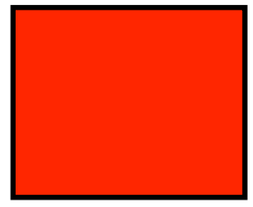
Our iterator class needs a **current** instance variable. Initially referencing the head

Next!



Next!

Next!



```
class ListIterator:
    def __init__(self,head):
        self.current = head

    def __iter__(self):
        return self

    def __next__(self):
        if self.current is None:
            raise StopIteration
        else:
            item_required = self.current.item
            self.current = self.current.next
            return item_required
```

Alternative definition of __next__

```
def __next__(self):
    try:
        item_required = self.current.item
        self.current = self.current.next
        return item_required
except AttributeError:
    raise StopIteration
```

How is my Iterator connected to the List class?

- The List class needs to have an **`__iter__`** method too
- Which returns a list iterator object initialised to the head of the list

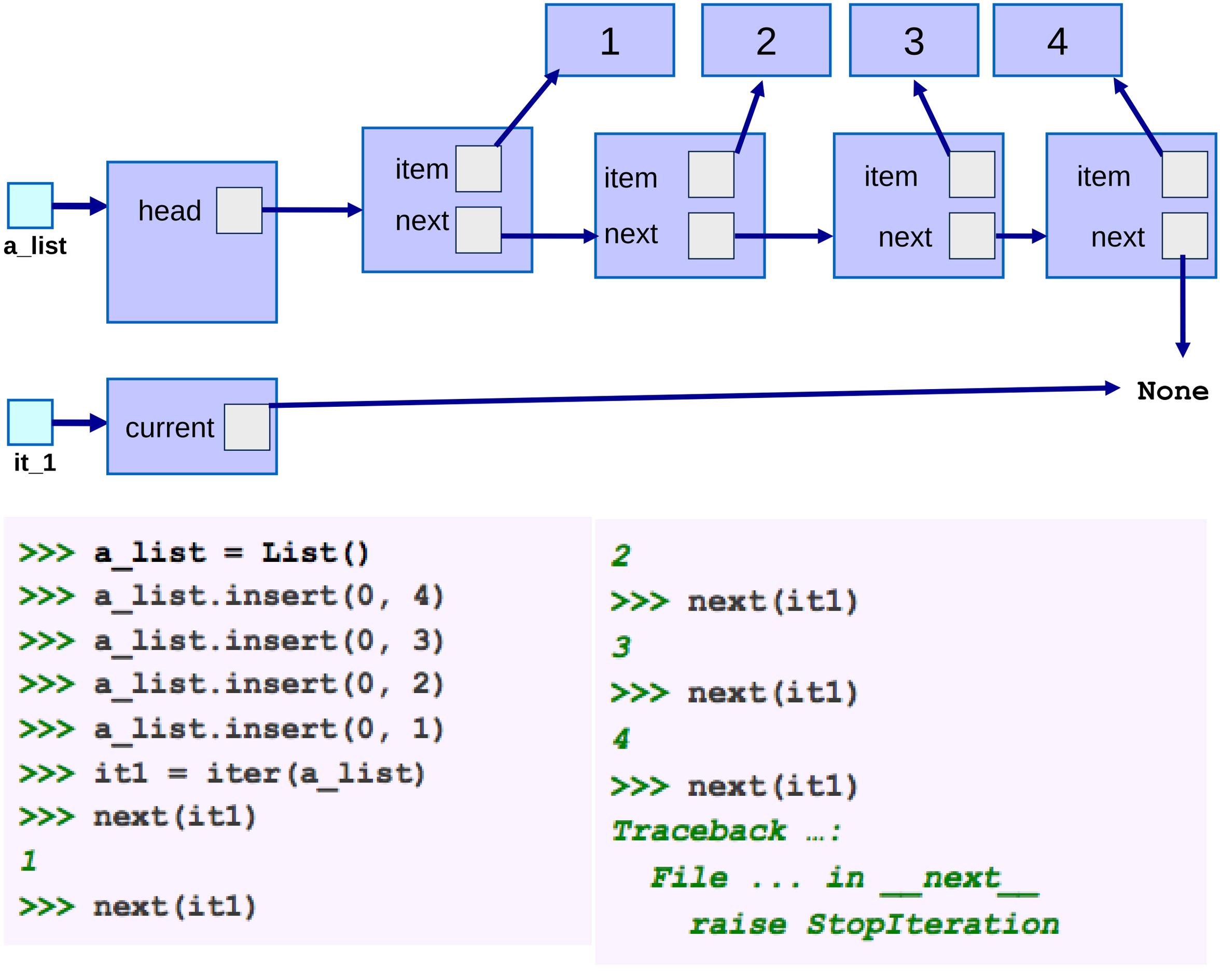
```
class List:
    def __init__(self):
        self.head = None
        self.count = 0

    def __iter__(self):
        return ListIterator(self.head)
```

```
class ListIterator:
    def __init__(self,head):
        self.current = head

    def __iter__(self):
        return self

    def __next__(self):
        if self.current is None:
            raise StopIteration
        else:
            item_required = self.current.item
            self.current = self.current.next
            return item_required
```




```
>>> a_list = List()
>>> a_list.insert(0, 4)
>>> a_list.insert(0, 3)
>>> a_list.insert(0, 2)
>>> a_list.insert(0, 1)
>>> it1 = iter(a_list)
>>> next(it1)
1
>>> next(it1)
2
>>> next(it1)
3
>>> next(it1)
4
>>> next(it1)
Traceback …:
  File ... in __next__
    raise StopIteration
```

Iterables and Iterators

- We have made our List class **iterable**: it implements an **`__iter__`** method that returns an Iterator on the list

- Objects of the ListIterator class are **iterators**: they implement **`__iter__`** and **`__next__`** methods

```
>>> my_list = List()
>>> my_list.insert(0, 3)
>>> my_list.insert(0, 2)
>>> my_list.insert(0, 1)
>>>
>>> for i in my_list:
...     print(i)
...
1
2
3
```

So let’s use it

- Define all_positive(a_list) which returns **True** if all items are > 0.
- You are a user: **outside** the class, no access to internals

```
def all_positive(a_list):
    for item in a_list:
        if item < 0:
            return False
    return True
```

List comprehensions

```
>>> A = [3*x for x in range(10)]
>>> A
[0, 3, 6, 9, 12, 15, 18, 21, 24, 27]
>>> B = [x for x in A if x % 2 == 0]
>>> B
[0, 6, 12, 18, 24]
```

List comprehensions allow you to:

- Performing some operation for every element
- Selecting a subset of elements that meet a condition
- AND return a list

```
def all_positive(a_list):
    for item in a_list:
        if item < 0:
            return False
    return True
```

```
def all_positive(a_list):
    return [] == [e for e in a_list if e <= 0]
```

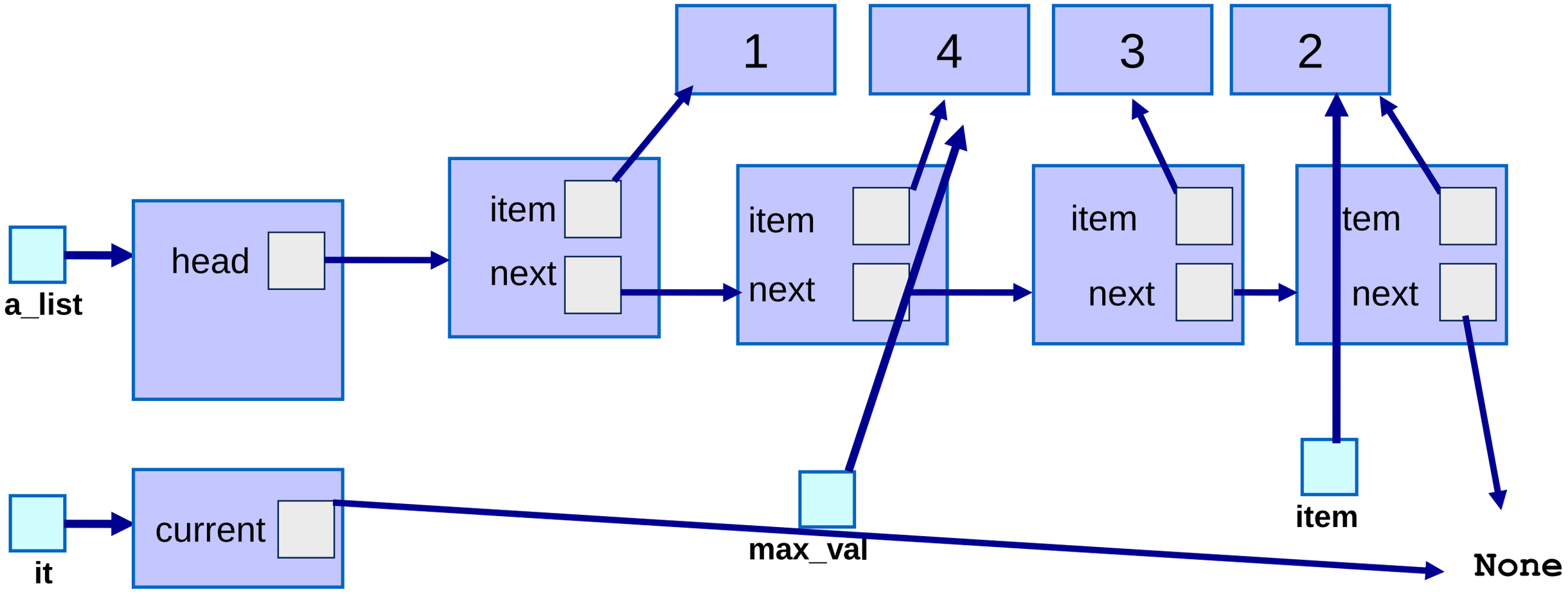
maximum_item

- Define **`maximum_item(a_list)`** to find maximum of the items in a list

- Assume you are a **user**: outside the class, no access to internals

- Need to use an iterator.

```
def max(a_list):
    try:
        it = iter(a_list)  # construct an iterator
        max_val = next(it) # get the first element
        for item in it:    # traverse the rest of the list
            if max_val < item:
                max_val = item
        return max_val
    except StopIteration:
        raise Exception("The list is empty")
```




```
def max(a_list):
    try:
        it = iter(a_list)  # construct an iterator
        max_val = next(it) # get the first element
        for item in it:    # traverse the rest of the list
            if max_val < item:
                max_val = item
        return max_val
    except StopIteration:
        raise Exception("The list is empty")
```

Fibonacci Numbers

0, 1, 1, 2, 3, 5, 8, 13, ...

```
class Fibonacci:
    def __init__(self, maximum):
        self.maximum = maximum
        self.count = 0
        self.a = 0
        self.b = 1

    def __iter__(self):
        return self

    def __next__(self):
        next_fib = self.a
        self.count +=1
        if self.count > self.maximum:
            raise StopIteration
        self.a = self.b
        self.b = next_fib + self.b
        return next_fib
```

```
>>> for i in Fibonacci(10):
...     print(i, end=" ")
...
0 1 1 2 3 5 8 13 21 34 >>>
```

Summary

- How to make lists iterable by implementing an iterator for them
- How to construct a simple traversal iterator
- How to use iterators to define functions
- How to use iterators to generate sequences of items