PYTHON - ITERATORS

Ph.D. / Golden Gate Ave, San Francisco / Seoul National Univ / Carnegie Mellon / UC Berkeley / DevOps / Deep Learning / Visualization

bogotobogo.com site search:

Custom Search | Search

Iterators

In computer science, an **iterator** is an object that allows a programmer to traverse through all the elements of a collection regardless of its specific implementation.

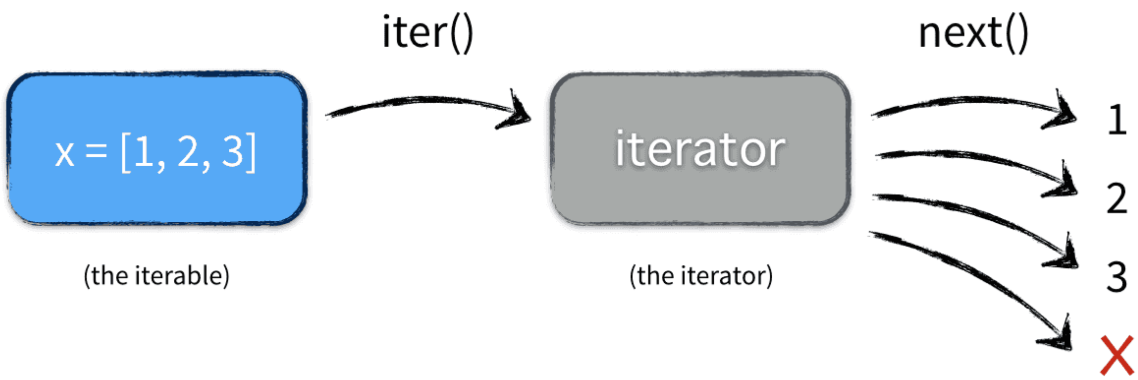
1. **iterable** produces **iterator** via **__iter__()**

```
iterator = iterable.__iter__()
```

2. **iterator** produces a stream of values via **next()**

```
value = iterator.next()
value = iterator.next()
...
```

To be more specific, we can start from an iterable, and we know a list (e.g, [1,2,3]) is iterable. **iter(iterable)** produces an **iterater**, and from this we can get stream of values.




```
>>> # Python 3
>>> iterable = [1,2,3]
>>> iterator = iterable.__iter__()     # or iterator = iter(iterable)
>>> type(iterator)
<type 'listiterator'>
>>> value = iterator.__next__()    # or value = next(iterator)
>>> print(value)
1
>>> value = next(iterator)
>>> print(value)
2
>>>
>>> # Python 2
>>> iterable = [1,2,3]
>>> iterator = iterable.__iter__()
>>> type(iterator)
<type 'listiterator'>
>>> value = iterator.next()
>>> value
1
>>> value = next(iterator)
>>> value
2
```


Python tutorial

Iterators in Python are a fundamental part of the language and in many cases go unseen as they are implicitly used in the **for** (foreach) statement, in **list comprehensions**, and in **generator expressions**.

"Iterators are the **secret sauce** of Python 3. They're everywhere, underlying everything, always just out of sight. Comprehensions are just a simple form of iterators. Generators are just a simple form of iterators. A function that yields values is a nice, compact way of building an iterator without building an iterator." - Mark Pilgrim

All of Python's standard built-in sequence types support iteration, as well as many classes which are part of the standard library.

The **for** loop can work on any sequence including lists, tuples, and strings:

```
>>> for x in [1, 2, 3, 4, 5]:
        print(x ** 3, end=' ')

1 8 27 64 125
>>>
>>> for x in (1, 2, 3, 4, 5):
        print(x ** 3, end=' ')

1 8 27 64 125
>>>
>>> for x in 'Beethoven':
        print(x * 3, end=' ')

BBB eee eee ttt hhh ooo vvv eee nnn
>>>
```


The **for** loop works on any **iterable object**. Actually, this is true of all iteration tools that scan objects from left to right in Python including **for** loops, the **list comprehensions**, and the **map** built-in function, etc.

Though the concept of **iterable objects** is relatively recent in Python, it has come to permeate the language's design. Actually, it is a generalization of the sequences. An object is **iterable** if it is either a physically stored sequence or an object that produces one result at a time in the context of an iteration tool like a **for** loop.

Note: For Python 2.x, the **print** is not a function but a statement. So, the right statement for the print is:

```
>>> for x in [1, 2, 3, 4, 5]:
...     print x ** 3,
...
1 8 27 64 125
```

File Iterators

As a way of understanding the **file iterator**, we'll look at how it works with a file. Open file objects have **readline()** method. This reads one line each time we call **readline()**, we advance to the next line. At the end of the file, an empty string is returned. We detect it to get out of the loop.

```
>>> f = open('C:\\workspace\\Masters.txt')
>>> f.readline()
'Michelangelo Buonarroti \n'
>>> f.readline()
'Pablo Picasso\n'
>>> f.readline()
'Rembrandt van Rijn \n'
>>> f.readline()
'Leonardo Da Vinci \n'
>>> f.readline()
'Claude Monet \n'
>>> f.readline()
'\n'
# Returns an empty string at end-of-file
>>> f.readline()
''
>>>
```


But files also have a **__next__()** method that has an identical effect. It returns the next line from a file each time it is called. The only difference is that **__next__()** method raises a built-in **StopIteration** exception (http://www.bogotobogo.com/python/python_modules_idle.php#python_exceptions) at end-of-file instead of returning an empty string.

argparse
(/python/python_argparse.php)

Exceptions
(/python/python_try_except_final

@static method vs class method
(/python/python_differences_bet

Private attributes and private methods
(/python/python_private_attribut

bits, bytes, bitstring, and constBitStream
(/python/python_bits_bytes_bitst

json.dump(s) and json.load(s)
(/python/python-json-dumps-loads-file-read-write.php)

Python Object Serialization - pickle and json
(/python/python_serialization_pic

Python Object Serialization - yaml and json
(/python/python_yaml_json_conv

Priority queue and heap queue data structure
(/python/python_PriorityQueue_

Graph data structure
(/python/python_graph_data_stru

Dijkstra's shortest path algorithm
(/python/python_Dijkstras_Short

Prim's spanning tree algorithm
(/python/python_Prims_Spanning

Closure
(/python/python_closure.php)

Functional programming in Python
(/python/python_functional_prog

Remote running a local file using ssh
(/python/python_ssh_remote_ru

```
>>> f = open('C:\\workspace\\Masters.txt')
>>> f.__next__()
'Michelangelo Buonarroti \n'
>>> f.__next__()
'Pablo Picasso\n'
>>> f.__next__()
'Rembrandt van Rijn \n'
>>> f.__next__()
'Leonardo Da Vinci \n'
>>> f.__next__()
'Claude Monet \n'
>>> f.__next__()
'\n'
>>> f.__next__()
Traceback (most recent call last):
  File "<pyshell#33>", line 1, in <module>
    f.__next__()
StopIteration
>>>
```

This interface is what we call the **iteration protocol** in Python. Any object with a **__next__()** method to advance to a next result is considered **iterable**. Any such object can also be stepped through with a **for** loop because all iteration tools work internally be calling **__next__()** method on each iteration.

So, the best way to read a text file line by line is not reading it at all. Instead let the **for** loop to call **__next__()** method to advance to the next line. The file object's iterator will do the work of loading lines as we go.

The example below prints each line without reading from the file at all:

```
>>> for line in open('C:\\workspace\\Masters.txt'):
        print(line.upper(), end=' ')

MICHELANGELO BUONARROTI
 PABLO PICASSO
 REMBRANDT VAN RIJN
 LEONARDO DA VINCI
 CLAUDE MONET
```


Here, we use **end=' '** in **print** to suppress adding a **\n** because line strings already have one. This is considered the best way to read text files line by line today. The reasons are:

1. It's the simplest to code.
2. It might be the quickest to run.
3. It is the best in terms of memory usage.

The older way is to call the file **readlines()** method to load the file's content into memory as a list of line strings:

```
>>> for line in open('C:\\workspace\\Masters.txt').readlines():
       print(line.upper(), end=' ')


MICHELANGELO BUONARROTI
 PABLO PICASSO
 REMBRANDT VAN RIJN
 LEONARDO DA VINCI
 CLAUDE MONET
```

This **readlines()** loads the entire file into memory all at once. So, it will not work for files too big to fit into the memory. On the contrary, the iterator-based version is immune to such memory-explosion issues and it might run quicker, too.

iter and next

We have a built-in **next()** function for manual iteration. The **next()** function automatically calls an object's **__next__()** method. For an object **X**, the call **next(X)** is the same as **X.__next__()** but simpler.

```
>>> f = open('C:\\workspace\\Masters.txt')
>>> f.__next__()
'Michelangelo Buonarroti \n'
>>> f.__next__()
'Pablo Picasso\n'
>>>
>>> f = open('C:\\workspace\\Masters.txt')
>>> next(f)
'Michelangelo Buonarroti \n'
>>> next(f)
'Pablo Picasso\n'
>>>
```


When the **for** loop begins, it obtains an iterator from the iterable object by passing it to the **iter** built-in function. This object returned by **iter** has the required the **__next__()** method. Let's look at the internals of this through **for** loop with lists. For Python versions < 3, we may want to use **next(iterObj)** instead of **iterobj.__next__()**.

```
>>> # works only for v.3+

>>> L = [1, 2, 3]

>>> iter(L) is L     # L itself is not an iterator object
False

>>> iterObj = iter(L)
>>> iterObj.__next__ ()
1
>>> iterObj.__next__ ()
2
>>> iterObj.__next__ ()
3
>>> iterObj.__next__ ()
Traceback (most recent call last):
  File .....
    iterObj.__next__ ()
StopIteration
>>>
```

The step:

```
iterObj = iter(L)
```

is not required for files because a file object is its own iterator. In other words, files have their own **__next__()** method. So, for file object, we do not need to get a returned iterator.

```
>>> f = open('C:\\workspace\\Masters.txt')
>>> iter(f) is f
True
>>> f.__next__ ()
'Michelangelo Buonarroti \n'
>>>
```

But list and other built-in object are not their own iterators because they support multiple open iterations. For an object like that, we must call **iter** to start iteration:

```
>>> L = [1, 2, 3]
>>> iter(L) is L
False
>>> L.__next__()
Traceback (most recent call last):
  File ...
    L.__next__()
AttributeError: 'list' object has no attribute '__next__'
>>>
>>>
>>> iterObj = iter(L)
>>> iterObj.__next__()
1
>>> next(iterObj)
2
>>>
```

(/python/python_cellular_automa

Batch gradient descent algorithm (/python/python_numpy_batch_g

Longest Common Substring Algorithm (/python/python_longest_commo

Python Unit Test - TDD using unittest.TestCase class (/python/python_unit_testing.php

Simple tool - Google page ranking by keywords (/python/python_site_page_ranki

Google App Hello World (/python/GoogleApp/python_Goo

Google App webapp2 and WSGI (/python/GoogleApp/python_Goo

Uploading Google App Hello World (/python/GoogleApp/python_Goo

Python 2 vs Python 3 (/python/python_differences_Pyt

virtualenv and virtualenvwrapper (/python/python_virtualenv_virtu

Uploading a big file to AWS S3 using boto module (/DevOps/AWS/aws_S3_uploading

Scheduled stopping and starting an AWS instance (/DevOps/AWS/aws_stopping_sta

Cloudera CDH5 - Scheduled stopping and starting services (/Hadoop/BigData_hadoop_CDH5

Removing Cloud Files - Rackspace API with curl and subprocess (/python/python_Rackspace_API_

Checking if a process is running/hanging and stop/run

Though Python iteration tools call these functions automatically, we can use them to apply the iteration protocol **manually**, too.

```
>>> L = [1, 2, 3]
>>>
>>> for x in L:                # Automatic iteration
        print(x ** 3, end=' ') # Obtains iter, calls __next__
                               # and catches exceptions


1 8 27
>>> iterObj = iter(L)          # Manual iteration which is
>>>                            # for loops usually do
```

Other Iterators

We've looked at the iterators for files and lists. How about the others such as dictionaries?

To step through the keys of a **dictionary** is to request its keys list explicitly:

```
>>> D = {'a':97, 'b':98, 'c':99}
>>> for k in D.keys():
        print(k, D[k])


a 97
c 99
b 98
```

Dictionaries have an iterator that automatically returns one key at a time in an iteration context:

```
>>> iterObj = iter(D)
>>> next(iterObj)
'a'
>>> next(iterObj)
'c'
>>> next(iterObj)
'b'
>>> next(iterObj)
Traceback (most recent call last):
  File ...
    next(iterObj)
StopIteration
>>>
```

a scheduled task on Windows (/python/python-Windows-Check-if-a-Process-is-Running-Hanging-Schtasks-Run-Stop.php)

Apache Spark 1.3 with PySpark (Spark Python API) Shell (/Hadoop/BigData_hadoop_Apac

Apache Spark 1.2 Streaming (/Hadoop/BigData_hadoop_Apac

bottle 0.12.7 - Fast and simple WSGI-micro framework for small web-applications ... (/python/Bottle/Python_Bottle_Fr

Flask app with Apache WSGI on Ubuntu14/CentOS7 ... (/python/Flask/Python_Flask_Blog

Selenium WebDriver (/python/python_Selenium_WebD

Fabric - streamlining the use of SSH for application deployment (/python/Fabric/python_Fabric.ph

Ansible Quick Preview - Setting up web servers with Nginx, configure enviroments, and deploy an App (/DevOps/Ansible/Ansible_Setting

Neural Networks with backpropagation for XOR using one hidden layer (/python/python_Neural_Networ

NLP - NLTK (Natural Language Toolkit) ... (/python/NLTK/NLTK_install.php)

RabbitMQ(Message broker server) and Celery(Task queue) ... (/python/RabbitMQ_Celery/pytho

OpenCV3 and Matplotlib ... (/python/OpenCV_Python/python

Simple tool - Concatenating slides using FFmpeg ...

So, we no longer need to call the **keys()** method to step through dictionary keys. The **for** loop will use the iteration protocol to grab one key at a time through:

```
>>> for k in D:
        print(k, D[k])


a 97
c 99
b 98
```

Other Python object types also support the iterator protocol and thus may be used in **for** loops too. For example, **shelves** which is an access-by-key file system for Python objects and the results from **os.popen** which is a tool for reading the output of shell commands are iterable as well:

```
>>> import os
>>> P = os.popen('dir')
>>> P.__next__()
' Volume in drive C has no label.\n'
>>> P.__next__()
' Volume Serial Number is 0C60-AED5\n'
>>> next(P)
Traceback (most recent call last):
  File ...
    next(P)
TypeError: _wrap_close object is not an iterator
>>>
```

Note that **popen** object support a **P.next()** method, they support the **P.__next__()** method, but not the **next(P)** built-in.

The iteration protocol also is the reason that we've had to wrap some results in a **list** call to see their values all at once (Python ver. 3.x). Object that are iterable returns results one at a time, not in a physical list:

```
>>> R = range(5)
>>> # Ranges are iterables in 3.0
>>> R
range(0, 5)
>>> # Use iteration protocol to produce results
>>> iterObj = iter(R)
>>> next(iterObj)
0
>>> next(iterObj)
1
>>> # Use list to collect all results at once
>>> list(range(5))
[0, 1, 2, 3, 4]
>>>
```

Note on **range()**:
For Python 3.x, **range** just returns an iterator, and generates items in the range **on demand** instead of building the list results in memory (Python 2.x does this). So, if we want to display result, we must use **list(range(...))**:

```
>>> L = range(5)

>>> L
range(0, 5)        # Python 3.x
>>> list(L)
[0, 1, 2, 3, 4]

>>> L
[0, 1, 2, 3, 4]    # Python 2.x
```

Now we should be able to see how it explains why the **enumerate** tool works the way it does:

```
>>> E = enumerate('Python')
>>> E
<enumerate object at 0x0000000003234678>
>>> iterObj = iter(E)
>>> # Generate results with iteration protocol
>>> next(iterObj)
(0, 'P')
>>> next(iterObj)
(1, 'y')
>>> list(enumerate('Python'))
[(0, 'P'), (1, 'y'), (2, 't'), (3, 'h'), (4, 'o'), (5, 'n')]
```


OpenCV 3 image and video processing with Python

OpenCV 3 with Python (/python/OpenCV_Python/pythor

Image - OpenCV BGR : Matplotlib RGB (/python/OpenCV_Python/pythor

Basic image operations - pixel access (/python/OpenCV_Python/pythor

iPython - Signal Processing with NumPy (/python/OpenCV_Python/pythor

Signal Processing with NumPy I - FFT and DFT for sine, square waves, unitpulse, and random signal (/python/OpenCV_Python/pythor

Signal Processing with NumPy II - Image Fourier Transform : FFT & DFT (/python/OpenCV_Python/pythor

Inverse Fourier Transform of an Image with low pass filter: cv2.idft() (/python/OpenCV_Python/pythor

Image Histogram (/python/OpenCV_Python/pythor

Video Capture and Switching colorspaces - RGB / HSV (/python/OpenCV_Python/pythor

Adaptive Thresholding - Otsu's clustering-based image thresholding (/python/OpenCV_Python/pythor

Edge Detection - Sobel and Laplacian Kernels (/python/OpenCV_Python/pythor

Canny Edge Detection (/python/OpenCV_Python/pythor

Hough Transform - Circles (/python/OpenCV_Python/pythor

Watershed Algorithm : Marker-based Segmentation I (/python/OpenCV_Python/pythor

Watershed Algorithm : Marker-based Segmentation II (/python/OpenCV_Python/pythor

Image noise reduction : Non-local Means denoising algorithm (/python/OpenCV_Python/pythor local_Means_Denoising_Algorithr

Image object detection : Face

Machine Learning with scikit-learn

scikit-learn : Machine Learning Quick Preview (/python/scikit-learn/scikit_machine_learning_qu

scikit-learn : Data Preprocessing I - Missing / Categorical data (/python/scikit-learn/scikit_machine_learning_Da Missing-Data-Categorical-Data.php)

scikit-learn : Data Preprocessing II - Partitioning a dataset / Feature scaling / Feature Selection / Regularization (/python/scikit-learn/scikit_machine_learning_Da II-Datasets-Partitioning-Feature-scaling-Feature-Selection-Regularization.php)

scikit-learn : Data Preprocessing III - Dimensionality reduction vis Sequential feature selection / Assessing feature importance via random forests (/python/scikit-learn/scikit_machine_learning_Da III-Dimensionality-reduction-via-Sequential-feature-selection-Assessing-feature-importance-via-random-forests.php)

Data Compression via Dimensionality Reduction I - Principal component analysis (PCA) (/python/scikit-learn/scikit_machine_learning_Da _PCA.php)

scikit-learn : Data Compression via Dimensionality Reduction II - Linear Discriminant Analysis (LDA) (/python/scikit-learn/scikit_machine_learning_Da

scikit-learn : Data Compression via Dimensionality Reduction III - Nonlinear mappings via kernel principal component (KPCA) analysis (/python/scikit-

learn/scikit_machine_learning_Da nonlinear-mappings-via-kernel-principal-component-analysis.php)

scikit-learn : Logistic Regression, Overfitting & regularization (/python/scikit-learn/scikit-learn_logistic_regression.php)

scikit-learn : Supervised Learning & Unsupervised Learning - e.g. Unsupervised PCA dimensionality reduction with iris dataset (/python/scikit-learn/scikit_machine_learning_Su

scikit-learn : Unsupervised_Learning - KMeans clustering with iris dataset (/python/scikit-learn/scikit_machine_learning_Ur

scikit-learn : Linearly Separable Data - Linear Model & (Gaussian) radial basis function kernel (RBF kernel) (/python/scikit-learn/scikit_machine_learning_Lir

scikit-learn : Decision Tree Learning I - Entropy, Gini, and Information Gain (/python/scikit-learn/scikt_machine_learning_De

scikit-learn : Decision Tree Learning II - Constructing the Decision Tree (/python/scikit-learn/scikit_machine_learning_Cc

scikit-learn : Random Decision Forests Classification (/python/scikit-learn/scikit_machine_learning_Ra

scikit-learn : Support Vector Machines (SVM) (/python/scikit-learn/scikit_machine_learning_Su

scikit-learn : Support Vector Machines (SVM) II (/python/scikit-

MACHINE LEARNING ALGORITHMS AND CONCEPTS

learn_batch-gradient-descent-versus-stochastic-gradient-descent.php)

Single Layer Neural Network - Adaptive Linear Neuron using linear (identity) activation function with batch gradient descent method (/python/scikit-learn/Single-Layer-Neural-Network-Adaptive-Linear-Neuron.php)

Single Layer Neural Network : Adaptive Linear Neuron using linear (identity) activation function with stochastic gradient descent (SGD) (/python/scikit-learn/Single-Layer-Neural-Network-Adaptive-Linear-Neuron-with-Stochastic-Gradient-Descent.php)

Logistic Regression (/python/scikit-learn/logistic_regression.php)

VC (Vapnik-Chervonenkis) Dimension and Shatter (/python/scikit-learn/scikit_machine_learning_VC

Bias-variance tradeoff (/python/scikit-learn/scikit_machine_learning_Bi variance-Tradeoff.php)

Maximum Likelihood Estimation (MLE) (/python/scikit-learn/Maximum-Likelyhood-Estimation-MLE.php)

Neural Networks with backpropagation for XOR using one hidden layer (/python/python_Neural_Networ

minHash (/Algorithms/minHash_Jaccard_Si

tf-idf weight (/Algorithms/tf_idf_term_frequen

ARTIFICIAL NEURAL NETWORKS (ANN)

[Note] Sources are available at Github - Jupyter notebook files (https://github.com/Einsteinish/A Neural-Networks-with-Jupyter.git)

CONTACT

BogoToBogo
contactus@bogotobogo.com (mailto:#)

FOLLOW BOGOTOBOGO

(https://www.facebook.com/KHongSanFrancisco) (https://twitter.com/KHongTwit) (https://plus.google.com/u/0/+KHongSanFrancisco/posts)

ABOUT US (/ABOUT_US.PHP)

contactus@bogotobogo.com (mailto:contactus@bogotobogo.co)

Golden Gate Ave, San Francisco, CA 94115

Golden Gate Ave, San Francisco, CA 94115