정보교육을 위한 파이썬

정보 탐색

Version 0.0.9-d2

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Printing history:

October 2013: Major revision to Chapters 13 and 14 to switch to JSON and use OAuth. Added new chapter on Visualization.

September 2013: Published book on Amazon CreateSpace

January 2010: Published book using the University of Michigan Espresso Book machine.

December 2009: Major revision to chapters 2-10 from *Think Python: How to Think Like a Computer Scientist* and writing chapters 1 and 11-15 to produce *Python for Informatics: Exploring Information*

June 2008: Major revision, changed title to *Think Python: How to Think Like a Computer Scientist*.

August 2007: Major revision, changed title to *How to Think Like a (Python) Programmer*.

April 2002: First edition of *How to Think Like a Computer Scientist*.

The LaTeX source for the *Think Python: How to Think Like a Computer Scientist* version of this book is available from `http://www.thinkpython.com`.

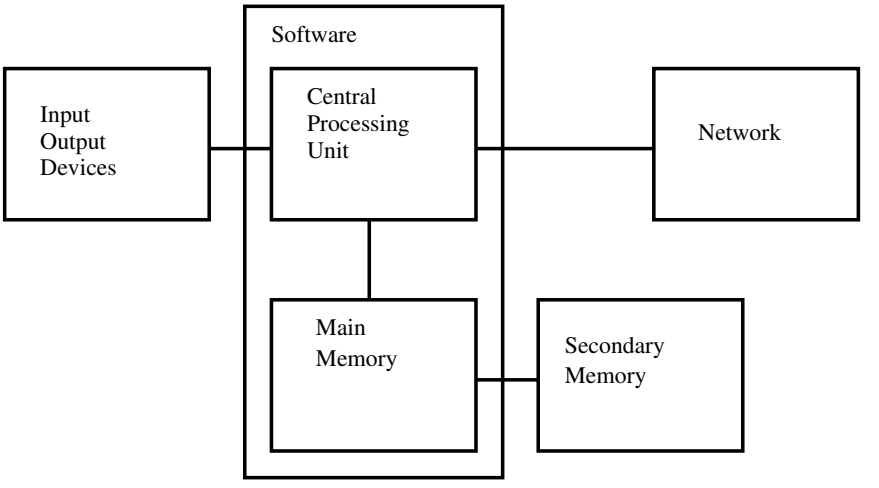
Chapter 1

파일

1.1 Persistence

지금까지, 프로그램을 어떻게 작성하고 조건문 실행, 함수, 반복을 사용하여 **중앙처리장치(CPU, Central Processing Unit)**에 프로그래머의 의도를 커뮤니케이션하는 것을 학습했다. **주기억장치(Main Memory)**에 어떻게 자료구조를 생성하고 사용하는지를 배웠다. CPU와 주기억장치는 소프트웨어가 동작하고 실행하는 곳이고 모든 ”생각(thinking)”이 일어나는 곳이다.

하지만, 하드웨어 아키텍처를 논의했던 앞의 기억을 되살린다면, 전원이 꺼지게 되면, CPU와 주기억장치에 저장된 모든 것이 지워진다. 지금까지 작성한 프로그램은 파이썬을 배우기 위한 일시적으로 재미로 연습한 것이다.



이번 장에서는 **보조 기억장치(Secondary Memory)** 혹은 파일을 가지고 작업을 시작할 것이다. 보조 기억장치는 전원이 꺼져도 지워지지 않는다. 혹은, USB 플래쉬 드라이브를 사용한 경우에는 작성한 데이터는 프로그램으로부터 시스템에서 제거되어 다른 시스템으로 전송될 수 있다.

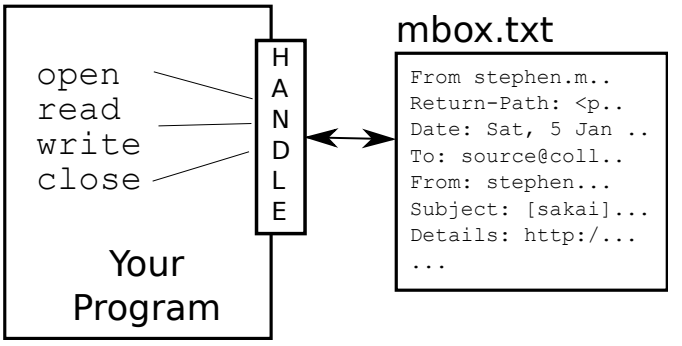
우선 텍스트 편집기로 작성한 텍스트 파일을 읽고 쓰는 것에 초점을 맞출 것이다. 나중에 데이터베이스 소프트웨어로 읽고 쓰도록 설계된 바이너리 파일인 데이터베이스와 어떻게 작업하는지를 보게 될 것이다.

1.2 파일 열기

하드 디스크의 파일을 읽거나 쓸려고 할 때, 파일을 **열여야** 한다. 파일을 여는 것은 운영체제와 커뮤니케이션하는데 운영체제는 각 파일의 데이터가 어디에 저장되었는지를 알고 있다. 여러분이 파일을 열 때, 운영체제는 파일이 존재하는 확인하고 이름으로 파일을 찾을 수 있게 요청한다. 이번 예제에서, 파이썬을 시작한 동일한 폴더에 저장된 `mbox.txt` 파일을 열 것이다. `www.py4inf.com/code/mbox.txt` 에서 파일은 다운로드할 수 있다.

```
>>> fhand = open('mbox.txt')
>>> print fhand
<open file 'mbox.txt', mode 'r' at 0x1005088b0>
```

`open`이 성공하면, 운영체제는 **파일 핸들러(file handle)**을 반환한다. **파일 핸들러(file handle)**은 파일에 담겨있는 실제 데이터가 아니고, 대신에 데이터를 읽을 수 있도록 "핸들(handle)"을 사용할 수 있도록 한다. 요청한 파일이 존재하고, 파일을 읽을 수 있는 적절한 권한이 있다면 이제 핸들이 여러분에게 주어졌다.



파일이 존재하지 않는다면, `open`은 트레이스백(traceback) 오류로 파일 열기를 실패하고, 파일에 존재하는 핸들도 얻지 못한다.

```
>>> fhand = open('stuff.txt')
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
IOError: [Errno 2] No such file or directory: 'stuff.txt'
```

나중에 `try`와 `except`를 가지고, 존재하지 않는 파일을 열려고 하는 상황을 좀더 우아하게 처리할 것이다.

1.3 Text files and lines

A text file can be thought of as a sequence of lines, much like a Python string can be thought of as a sequence of characters. For example, this is a sample of a text

file which records mail activity from various individuals in an open source project development team:

```
From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008
Return-Path: <postmaster@collab.sakaiproject.org>
Date: Sat, 5 Jan 2008 09:12:18 -0500
To: source@collab.sakaiproject.org
From: stephen.marquard@uct.ac.za
Subject: [sakai] svn commit: r39772 - content/branches/
Details: http://source.sakaiproject.org/viewsvn/?view=rev&rev=39772
...
```

The entire file of mail interactions is available from `www.py4inf.com/code/mbox.txt` and a shortened version of the file is available from `www.py4inf.com/code/mbox-short.txt`. These files are in a standard format for a file containing multiple mail messages. The lines which start with "From " separate the messages and the lines which start with "From:" are part of the messages. For more information, see `en.wikipedia.org/wiki/Mbox`.

To break the file into lines, there is a special character that represents the "end of the line" called the **newline** character.

In Python, we represent the **newline** character as a backslash-n in string constants. Even though this looks like two characters, it is actually a single character. When we look at the variable by entering "stuff" in the interpreter, it shows us the `\n` in the string, but when we use `print` to show the string, we see the string broken into two lines by the newline character.

```
>>> stuff = 'Hello\nWorld!'
>>> stuff
'Hello\nWorld!'
>>> print stuff
Hello
World!
>>> stuff = 'X\nY'
>>> print stuff
X
Y
>>> len(stuff)
3
```

You can also see that the length of the string `'X\nY'` is *three* characters because the newline character is a single character.

So when we look at the lines in a file, we need to *imagine* that there is a special invisible character at the end of each line that marks the end of the line called the newline.

So the newline character separates the characters in the file into lines.

1.4 Reading files

While the **file handle** does not contain the data for the file, it is quite easy to construct a `for` loop to read through and count each of the lines in a file:

```
fhand = open('mbox.txt')
count = 0
for line in fhand:
    count = count + 1
print 'Line Count:', count

python open.py
Line Count: 132045
```

We can use the file handle as the sequence in our `for` loop. Our `for` loop simply counts the number of lines in the file and prints them out. The rough translation of the `for` loop into English is, "for each line in the file represented by the file handle, add one to the `count` variable."

The reason that the `open` function does not read the entire file is that the file might be quite large with many gigabytes of data. The `open` statement takes the same amount of time regardless of the size of the file. The `for` loop actually causes the data to be read from the file.

When the file is read using a `for` loop in this manner, Python takes care of splitting the data in the file into separate lines using the newline character. Python reads each line through the newline and includes the newline as the last character in the `line` variable for each iteration of the `for` loop.

Because the for loop reads the data one line at a time, it can efficiently read and count the lines in very large files without running out of main memory to store the data. The above program can count the lines in any size file using very little memory since each line is read, counted, and then discarded.

If you know the file is relatively small compared to the size of your main memory, you can read the whole file into one string using the `read` method on the file handle.

```
>>> fhand = open('mbox-short.txt')
>>> inp = fhand.read()
>>> print len(inp)
94626
>>> print inp[:20]
From stephen.marquar
```

In this example, the entire contents (all 94,626 characters) of the file `mbox-short.txt` are read directly into the variable `inp`. We use string slicing to print out the first 20 characters of the string data stored in `inp`.

When the file is read in this manner, all the characters including all of the lines and newline characters are one big string in the variable **inp**. Remember that this

form of the `open` function should only be used if the file data will fit comfortably in the main memory of your computer.

If the file is too large to fit in main memory, you should write your program to read the file in chunks using a `for` or `while` loop.

1.5 Searching through a file

When you are searching through data in a file, it is a very common pattern to read through a file, ignoring most of the lines and only processing lines which meet a particular criteria. We can combine the pattern for reading a file with string **methods** to build simple search mechanisms.

For example, if we wanted to read a file and only print out lines which started with the prefix "From:", we could use the string method **startswith** to select only those lines with the desired prefix:

```
fhand = open('mbox-short.txt')
for line in fhand:
    if line.startswith('From:') :
        print line
```

When this program runs, we get the following output:

```
From: stephen.marquard@uct.ac.za

From: louis@media.berkeley.edu

From: zqian@umich.edu

From: rjlowe@iupui.edu
...
```

The output looks great since the only lines we are seeing are those which start with "From:", but why are we seeing the extra blank lines? This is due to that invisible **newline** character. Each of the lines ends with a newline, so the `print` statement prints the string in the variable **line** which includes a newline and then `print` adds *another* newline, resulting in the double spacing effect we see.

We could use line slicing to print all but the last character, but a simpler approach is to use the **rstrip** method which strips whitespace from the right side of a string as follows:

```
fhand = open('mbox-short.txt')
for line in fhand:
    line = line.rstrip()
    if line.startswith('From:') :
        print line
```

When this program runs, we get the following output:

```
From: stephen.marquard@uct.ac.za
From: louis@media.berkeley.edu
From: zqian@umich.edu
From: rjlowe@iupui.edu
From: zqian@umich.edu
From: rjlowe@iupui.edu
From: cwen@iupui.edu
...
```

As your file processing programs get more complicated, you may want to structure your search loops using `continue`. The basic idea of the search loop is that you are looking for "interesting" lines and effectively skipping "uninteresting" lines. And then when we find an interesting line, we do something with that line.

We can structure the loop to follow the pattern of skipping uninteresting lines as follows:

```
fhand = open('mbox-short.txt')
for line in fhand:
    line = line.rstrip()
    # Skip 'uninteresting lines'
    if not line.startswith('From:') :
        continue
    # Process our 'interesting' line
    print line
```

The output of the program is the same. In English, the uninteresting lines are those which do not start with "From:", which we skip using `continue`. For the "interesting" lines (i.e. those that start with "From:") we perform the processing on those lines.

We can use the `find` string method to simulate a text editor search which finds lines where the search string is anywhere in the line. Since `find` looks for an occurrence of a string within another string and either returns the position of the string or -1 if the string was not found, we can write the following loop to show lines which contain the string "@uct.ac.za" (i.e. they come from the University of Cape Town in South Africa):

```
fhand = open('mbox-short.txt')
for line in fhand:
    line = line.rstrip()
    if line.find('@uct.ac.za') == -1 :
        continue
    print line
```

Which produces the following output:

```
From stephen.marquard@uct.ac.za Sat Jan  5 09:14:16 2008
X-Authentication-Warning: set sender to stephen.marquard@uct.ac.za using -f
From: stephen.marquard@uct.ac.za
Author: stephen.marquard@uct.ac.za
From david.horwitz@uct.ac.za Fri Jan  4 07:02:32 2008
X-Authentication-Warning: set sender to david.horwitz@uct.ac.za using -f
```

```
From: david.horwitz@uct.ac.za
Author: david.horwitz@uct.ac.za
...
```

1.6 Letting the user choose the file name

We really do not want to have to edit our Python code every time we want to process a different file. It would be more usable to ask the user to enter the file name string each time the program runs so they can use our program on different files without changing the Python code.

This is quite simple to do by reading the file name from the user using `raw_input` as follows:

```
fname = raw_input('Enter the file name: ')
fhand = open(fname)
count = 0
for line in fhand:
    if line.startswith('Subject:') :
        count = count + 1
print 'There were', count, 'subject lines in', fname
```

We read the file name from the user and place it in a variable named `fname` and open that file. Now we can run the program repeatedly on different files.

```
python search6.py
Enter the file name: mbox.txt
There were 1797 subject lines in mbox.txt

python search6.py
Enter the file name: mbox-short.txt
There were 27 subject lines in mbox-short.txt
```

Before peeking at the next section, take a look at the above program and ask yourself, "What could go possibly wrong here?" or "What might our friendly user do that would cause our nice little program to ungracefully exit with a traceback, making us look not-so-cool in the eyes of our users?".

1.7 Using `try, except,` and `open`

I told you not to peek. This is your last chance.

What if our user types something that is not a file name?

```
python search6.py
Enter the file name: missing.txt
Traceback (most recent call last):
  File "search6.py", line 2, in <module>
    fhand = open(fname)
IOError: [Errno 2] No such file or directory: 'missing.txt'
```

```
python search6.py
Enter the file name: na na boo boo
Traceback (most recent call last):
  File "search6.py", line 2, in <module>
    fhand = open(fname)
IOError: [Errno 2] No such file or directory: 'na na boo boo'
```

Do not laugh, users will eventually do every possible thing they can do to break your programs — either on purpose or with malicious intent. As a matter of fact, an important part of any software development team is a person or group called **Quality Assurance** (or QA for short) whose very job it is to do the craziest things possible in an attempt to break the software that the programmer has created.

The QA team is responsible for finding the flaws in programs before we have delivered the program to the end-users who may be purchasing the software or paying our salary to write the software. So the QA team is the programmer's best friend.

So now that we see the flaw in the program, we can elegantly fix it using the `try`/`except` structure. We need to assume that the `open` call might fail and add recovery code when the `open` fails as follows:

```
fname = raw_input('Enter the file name: ')
try:
    fhand = open(fname)
except:
    print 'File cannot be opened:', fname
    exit()

count = 0
for line in fhand:
    if line.startswith('Subject:') :
        count = count + 1
print 'There were', count, 'subject lines in', fname
```

The `exit` function terminates the program. It is a function that we call that never returns. Now when our user (or QA team) types in silliness or bad file names, we "catch" them and recover gracefully:

```
python search7.py
Enter the file name: mbox.txt
There were 1797 subject lines in mbox.txt

python search7.py
Enter the file name: na na boo boo
File cannot be opened: na na boo boo
```

Protecting the `open` call is a good example of the proper use of `try` and `except` in a Python program. We use the term "Pythonic" when we are doing something the "Python way". We might say that the above example is the Pythonic way to open a file.

Once you become more skilled in Python, you can engage in repartee' with other Python programmers to decide which of two equivalent solutions to a problem is "more Pythonic". The goal to be "more Pythonic" captures the notion that programming is part engineering and part art. We are not always interested in just making something work, we also want our solution to be elegant and to be appreciated as elegant by our peers.

1.8 Writing files

To write a file, you have to open it with mode `'w'` as a second parameter:

```
>>> fout = open('output.txt', 'w')
>>> print fout
<open file 'output.txt', mode 'w' at 0xb7eb2410>
```

If the file already exists, opening it in write mode clears out the old data and starts fresh, so be careful! If the file doesn't exist, a new one is created.

The `write` method of the file handle object puts data into the file.

```
>>> line1 = 'This here's the wattle,\n'
>>> fout.write(line1)
```

Again, the file object keeps track of where it is, so if you call `write` again, it adds the new data to the end.

We must make sure to manage the ends of lines as we write to the file by explicitly inserting the newline character when we want to end a line. The `print` statement automatically appends a newline, but the `write` method does not add the newline automatically.

```
>>> line2 = 'the emblem of our land.\n'
>>> fout.write(line2)
```

When you are done writing, you have to close the file to make sure that the last bit of data is physically written to the disk so it will not be lost if the power goes off.

```
>>> fout.close()
```

We could close the files which we open for read as well, but we can be a little sloppy if we are only opening a few files since Python makes sure that all open files are closed when the program ends. When we are writing files, we want to explicitly close the files so as to leave nothing to chance.

1.9 Debugging

When you are reading and writing files, you might run into problems with whitespace. These errors can be hard to debug because spaces, tabs and newlines are normally invisible:

```
>>> s = '1 2\t 3\n 4'
>>> print s
1 2  3
 4
```

The built-in function `repr` can help. It takes any object as an argument and returns a string representation of the object. For strings, it represents whitespace characters with backslash sequences:

```
>>> print repr(s)
'1 2\t 3\n 4'
```

This can be helpful for debugging.

One other problem you might run into is that different systems use different characters to indicate the end of a line. Some systems use a newline, represented `\n`. Others use a return character, represented `\r`. Some use both. If you move files between different systems, these inconsistencies might cause problems.

For most systems, there are applications to convert from one format to another. You can find them (and read more about this issue) at `wikipedia.org/wiki/Newline`. Or, of course, you could write one yourself.

1.10 Glossary

catch: To prevent an exception from terminating a program using the `try` and `except` statements.

newline: A special character used in files and strings to indicate the end of a line.

Pythonic: A technique that works elegantly in Python. “Using try and except is the *Pythonic* way to recover from missing files.”.

Quality Assurance: A person or team focused on insuring the overall quality of a software product. QA is often involved in testing a product and identifying problems before the product is released.

text file: A sequence of characters stored in permanent storage like a hard drive.

1.11 Exercises

Exercise 1.1 Write a program to read through a file and print the contents of the file (line by line) all in upper case. Executing the program will look as follows:

```
python shout.py
Enter a file name: mbox-short.txt
FROM STEPHEN.MARQUARD@UCT.AC.ZA SAT JAN  5 09:14:16 2008
RETURN-PATH: <POSTMASTER@COLLAB.SAKAIPROJECT.ORG>
```

```
RECEIVED: FROM MURDER (MAIL.UMICH.EDU [141.211.14.90])
 BY FRANKENSTEIN.MAIL.UMICH.EDU (CYRUS V2.3.8) WITH LMTPA;
 SAT, 05 JAN 2008 09:14:16 -0500
```

You can download the file from `www.py4inf.com/code/mbox-short.txt`

Exercise 1.2 Write a program to prompt for a file name, and then read through the file and look for lines of the form:

```
X-DSPAM-Confidence: 0.8475
```

When you encounter a line that starts with "X-DSPAM-Confidence:" pull apart the line to extract the floating point number on the line. Count these lines and the compute the total of the spam confidence values from these lines. When you reach the end of the file, print out the average spam confidence.

```
Enter the file name: mbox.txt
Average spam confidence: 0.894128046745

Enter the file name: mbox-short.txt
Average spam confidence: 0.750718518519
```

Test your file on the `mbox.txt` and `mbox-short.txt` files.

Exercise 1.3 Sometimes when programmers get bored or want to have a bit of fun, they add a harmless **Easter Egg** to their program (`en.wikipedia.org/wiki/Easter_egg_(media)`). Modify the program that prompts the user for the file name so that it prints a funny message when the user types in the exact file name 'na na boo boo'. The program should behave normally for all other files which exist and don't exist. Here is a sample execution of the program:

```
python egg.py
Enter the file name: mbox.txt
There were 1797 subject lines in mbox.txt

python egg.py
Enter the file name: missing.tyxt
File cannot be opened: missing.tyxt

python egg.py
Enter the file name: na na boo boo
NA NA BOO BOO TO YOU - You have been punk'd!
```

We are not encouraging you to put Easter Eggs in your programs - this is just an exercise.