File I/O

BBM 101 - Introduction to Programming I

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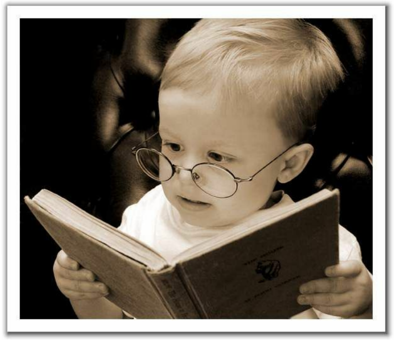
File Input and Output

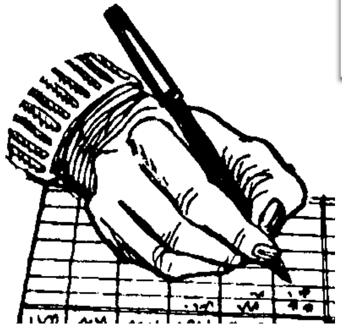
- As a programmer, when would one use a file?
- As a programmer, what does one do with a file?

Files Store Information When a Program is not Running

Important operations:

- open a file
- close a file
- read data
- write data





Files and Filenames

- A file object represents data on your disk drive
  - Can read from it and write to it

- A filename (usually a string) states where to find the data on your disk drive
  - Can be used to find/create a file
  - Examples:
    - Linux/Mac:"`/home/rea/class/140/lectures/file_io.pptx`"
    - Windows:"`C:\Users\rea\My Documents\cute_dog.jpg`"
    - Linux/Mac: "`homework3/images/Husky.png`"
    - "`Husky.png`"

Two Types of Filenames

- An Absolute filename gives a specific location on disk:
  `"/home/rea/class/140/14wi/lectures/file_io.pptx"` or
  `"C:\Users\rea\My Documents\homework3\images\Husky.png"`
  – Starts with "/" (Unix) or "C:\" (Windows)
  – Warning: code will fail to find the file if you move/rename files or run your program on a different computer

- A Relative filename gives a location relative to the *current working directory*:
  `"lectures/file_io.pptx"` or `" images\Husky.png"`
  – Warning: code will fail to find the file unless you run your program from a directory that contains the given contents

- *A relative filename is usually a better choice*

Examples

Linux/Mac: These *could* all refer to the same file:

```
"/home/rea/class/140/homework3/images/Husky.png"
"homework3/images/Husky.png"
"images/Husky.png"
"Husky.png"
```

Windows: These *could* all refer to the same file:

```
"C:\Users\rea\My Documents\class\140\homework3\images\Husky.png'
"homework3\images\Husky.png"
"images\Husky.png"
"Husky.png"
```

“Current Working Directory” in Python

The directory from which you ran Python

To determine it from a Python program:

```
>>> import os    # "os" stands for "operating system"
>>> os.getcwd()
'/Users/johndoe/Documents'
```

Can be the source of confusion: where are my files?

Reading a File in Python

```
# Open takes a filename and returns a file.
# This fails if the file cannot be found & opened.
myfile = open("datafile.dat")

# Approach 1:
for line_of_text in myfile:
  … process line_of_text

# Approach 2:
all_data_as_a_big_string = myfile.read()

myfile.close() # close the file when done reading
```

Assumption: file is a sequence of lines
Where does Python expect to find this file (note the relative pathname)?

Reading a File Example

```
# Count the number of words in a text file
in_file = "thesis.txt"
myfile = open(in_file)
num_words = 0
for line_of_text in myfile:
    word_list = line_of_text.split()
    num_words += len(word_list)

myfile.close()
print("Total words in file: ", num_words)
```

Reading a File Multiple Times

You can iterate over a **list** as many times as you like:

```
mylist = [ 3, 1, 4, 1, 5, 9 ]
for elt in mylist:
  … process elt
for elt in mylist:
  … process elt
```

Iterating over a **file** uses it up:

```
myfile = open("datafile.dat")
for line_of_text in myfile:
   … process line_of_text
for line_of_text in myfile:
   … process line_of_text
```

This loop body will never be executed!

How to read a file multiple times?

Solution 1: Read into a list, then iterate over it

```
myfile = open("datafile.dat")
mylines = []
for line_of_text in myfile:
  mylines.append(line_of_text)
… use mylines
```

Solution 2: Re-create the file object
(slower, but a better choice if the file does not fit in memory)

```
myfile = open("datafile.dat")
for line_of_text in myfile:
   … process line_of_text
myfile = open("datafile.dat")
for line_of_text in myfile:
   … process line_of_text
```

Writing to a File in Python

```
#  Replaces any existing file of this name
myfile = open("output.dat", "w")
```

open for **W**riting (no argument, or **"r"**, for **R**eading)

```
#  Just like printing output
myfile.write("a bunch of data")
myfile.write("a line of text\n")
```

"\n" means end of line (**N**ewline)

```
myfile.write(4)
```

Wrong; results in:

```
TypeError: expected a character buffer object
```

```
myfile.write(str(4))
```

Right. Argument must be a string

```
myfile.close()
```

close when done with all writing

File Access Modes

Mode	Description
`"r"`	Read from a file. If the file doesn't exist, Python will complain with an error.
`"w"`	Write to a file. If the file exists, its contents are overwritten. If the file doesn't exist, it's created.
`"a"`	Append a file. If the file exists, new data is appended to it. If the file doesn't exist, it's created.
`"r+"`	Read from and write to a file. If the file doesn't exist, Python will complain with an error.
`"w+"`	Write to and read from a file. If the file exists, its contents are overwritten. If the file doesn't exist, it's created.
`"a+"`	Append and read from a file. If the file exists, new data is appended to it. If the file doesn't exist, it's created.

Direct (Random) Access Files

- Allows direct access to any piece of data in a file without reading the data that comes before it.

```
>>> f = open('workfile', 'rb+')
>>> f.write(b'0123456789abcdef')
16

>>> f.seek(5) # Go to the 6th byte in the file 5
>>> f.read(1)
b'5'

>>> f.seek(-3, 2) # Go to the 3rd byte before the end
13

>>> f.read(1)
b'd'
```

The *second* argument of fseek () is optional and defaults to 0 (absolute file positioning); other values are 1 (seek relative to the current position) and 2 (seek relative to the file's end).