File I/O

- Objectives
  - See how to read and write multiple file types
  - Use deterministic cleanup for files correctly
  - Work with in-memory streaming APIs
  - Work with paths and directories cross-platform

File I/O in Python

- Common types of file operations
  - Text
    - Read / write text of any format
    - String-based IO
  - Binary
    - Read / write binary of any format
    - Stream bytes and bytearray in and out
  - XML
    - Load XML documents
    - Parse / query documents using XPath
  - JSON
    - Convert JSON to / from dictionaries

Text I/O [modes]

- Opening and creating text files
  - Uses `open(filename, mode)` built-in

Mode	Meaning
r	Open text file for **reading**. Stream is positioned at the **beginning** of the file.
r+	Open for **reading** and **writing**. The stream is positioned at the **beginning** of the file.
w	**Truncate** file to zero length or create text file for writing. The stream is positioned at the **beginning** of the file.
w+	Open for **reading** and **writing**. The file is **created** if it does not exist, otherwise it is **truncated**. The stream is positioned at the **beginning** of the file.
a	Open for **writing**. The file is **created** if it does not exist. The stream is positioned at the **end** of the file.
a+	Open for **reading** and **writing**. The file is **created** if it does not exist. The stream is positioned at the **end** of the file.

Text I/O [reading examples]

Open file with built-in open method.

Utility methods make text files easy.

```
csvFileName = "SomeData.csv"

fin = open(csvFileName, 'r', encoding="utf-8")
lines = fin.readlines()
```

Loads all data at once

Text file handles are iterable (line by line)

```
csvFileName = "SomeData.csv"

fin = open(csvFileName, 'r', encoding="utf-8")
for line in fin:
    print(line, end='')
```

Uses deferred iteration

Text I/O [cleaning up]

Files should be closed ASAP.

```
csvFileName = "SomeData.csv"

fin = open(csvFileName, 'r', encoding="utf-8")
lines = fin.readlines()
fin.close()
```

```
csvFileName = "SomeData.csv"

with open(csvFileName, 'r', encoding="utf-8") as fin:
    for line in fin:
        print(line, end='')
```

The **with** statement makes this trivial, even in the case of exceptions or early returns.

Text I/O [writing text files]

Create or open text file for appending with **a+** mode

```
with open("app.log", 'a+', encoding="utf-8") as fout:
    fout.write("The application is starting up...\n")
    fout.write("Everything looks good.\n")
```

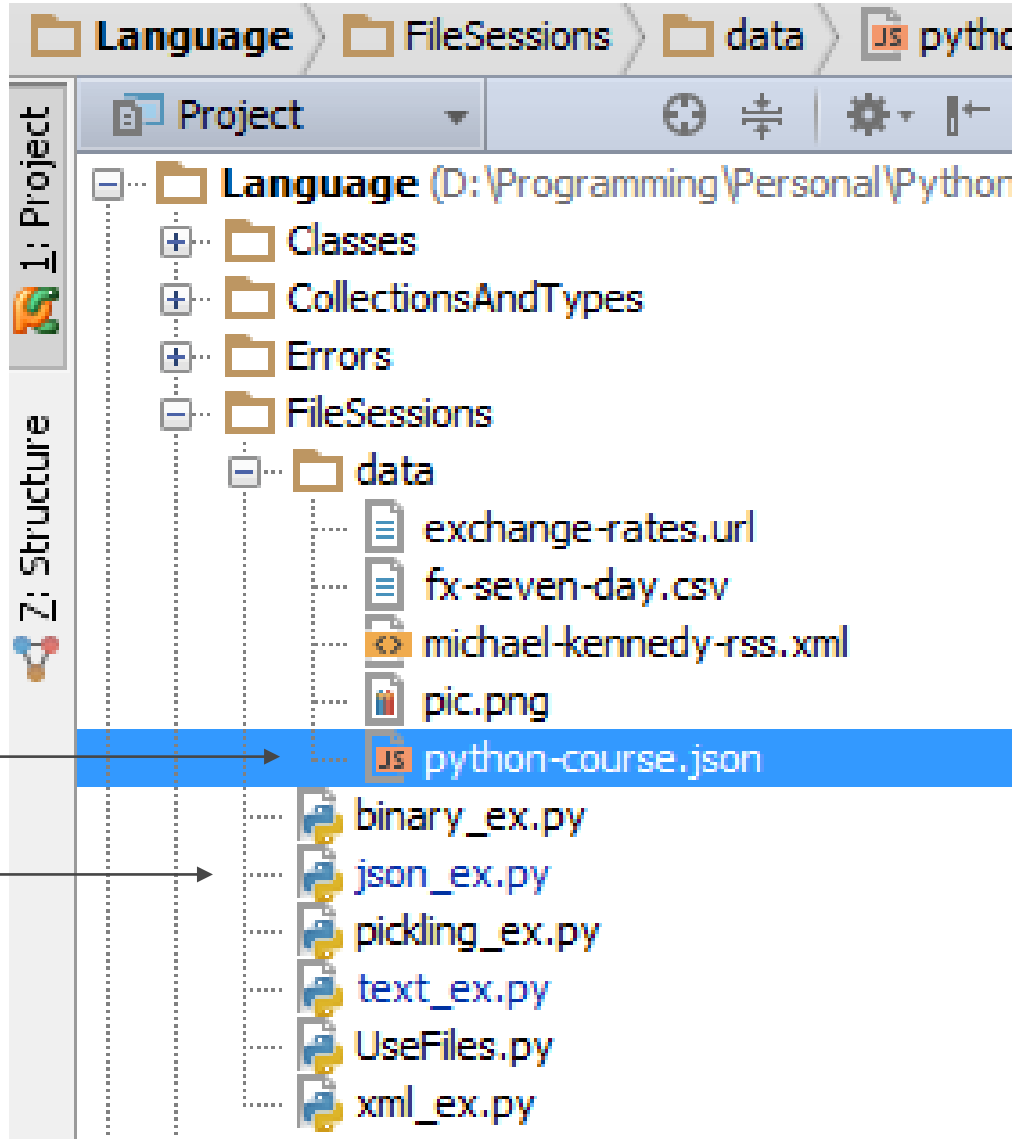
Write method takes a string, appends it to the file

There is no ‘writeline’ but you can make one.

Working with file paths (cross-platform)

How do I locate this file

From this file?



Note: this must be cross-platform safe.

Working with file paths (cross-platform)

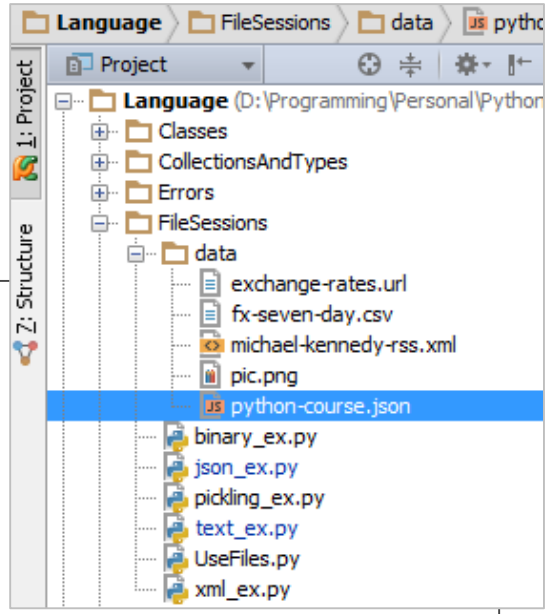
OS module has path and file tools

os.path.dirname() gets the folder

__file__ is the script

os.path.join() creates the new file path

```
import os

srcFile = __file__
srcDir = os.path.dirname(srcFile)
file = 'python-course.json'

targetFile = os.path.join(srcDir, 'data', file)

print(targetFile)

# prints this on OS X
#/Users/mkennedy/epython/Language/FileSessions/data/python-course.json

# prints this on Windows
#D:\Python_Course\Language\FileSessions\data\python-course.json
```



Binary I/O [reading files]

Incoming data can be stored in **bytearray** or directly processed.

Must specify **binary mode** (**rb**)

```
bytes = bytearray()

with open(srcFile, 'rb') as fin:
    chunkSize = 1024
    buffer = fin.read(chunkSize)
    while buffer:
        bytes.extend(buffer)
        buffer = fin.read(chunkSize)
```

Read buffer sized chunks and store or process them.

XML Files

- XML file support is built-in to Python
  - Import the `xml.etree` module
  - The **ElementTree** XML API provides simple DOM-based API

Import **xml.etree** module

Load xml via files

Load xml via strings

```
from xml.etree import ElementTree

xmlFile = "blog.rss.xml"
dom = ElementTree.parse(xmlFile)

xmlContent = "<rss><channel>...</channel></rss>"
dom = ElementTree.fromstring(xmlContent)
```

https://docs.python.org/3/library/xml.etree.elementtree.html

XML Files [querying data]

- Given this RSS data, find all titles and related links.

```
<?xml version="1.0" encoding="UTF-8"?>
<rss version="2.0">
    <channel>
        <title>Michael Kennedy on Technology</title>
        <link>http://blog.michaelckennedy.net</link>
        <item>
            <title>Watch Building beautiful web...</title>
            <link>http://blog.michaelckennedy.net/...</link>
        </item>
        <item>
            <title>MongoDB for .NET developers</title>
            <link>http://blog.michaelckennedy.net/...</link>
        </item>
        <item>...</item>
     </channel>
</rss>
```

XML Files [querying data]

Search for elements using dom.**findall**()

Extract the data from each item

```
from xml.etree import ElementTree
dom = ElementTree.parse("blog.rss.xml")

items = dom.findall('channel/item')
print("Found {0} blog entries.".format(len(items)))

entries = []
for item in items:
    title = item.find('title').text
    link  = item.find('link').text
    entries.append( (title, link) )
```

```
Found 50 blog entries.
entries[:3] =>
[
   ('title1', 'link1'),
   ('title2', 'link2'),
   ('title3', 'link3),
]
```

JSON data

- JSON support comes built-in to Python
  - import the **`json`** module
  - serialize dictionaries

JSON data [parsing JSON]

- Python dictionaries' and JSON string representations are extremely similar.
  - Converting between them should be easy

Python dictionary

```
{
   'hobbies': [
      'biking',
      'motocross',
      'hiking'],
    'name': 'Michael',
    'email': '...'
}
```

JSON string

```
{
  "hobbies": [
       "biking",
       "motocross",
       "hiking"],
   "email": "...",
   "name": "Michael"
}
```

JSON data [JSON to dictionaries]

Access JSON classes by importing **json**

Start with JSON text as a string

```
import json

jsonTxt = '{"name": "Jeff", "age": 24}'

d = json.loads(jsonTxt)
print( type(d) )
print( d )

# prints:
# <class 'dict'>
# {'age': 24, 'name': 'Jeff'}
```

json.loads converts a string to a dictionary

Note: **json.load** converts a file to a dictionary (pass a file **stream** as the parameter).

JSON data [dictionaries to JSON]

Access JSON classes by importing **json**

Start with a dictionary

```
import json

d = dict(name="Jeff", age=24)

jsonTxt = json.dumps(d)
print( jsonTxt )

# prints: '{"age": 24, "name": "Jeff"}'
```

json.dumps converts a dictionary to a string

Note: **json.dump** converts a dictionary to a file.

Summary

- Python has built-in support for text, binary, JSON, XML, and serialization files
- File handles should generally be used within with blocks
- The io module gives a file API to in-memory objects
- The os module enables cross-platform file operations