PYTHON

FOR NETWORK ENGINEERS

Virtual Training Session
January 2023 (Day3)

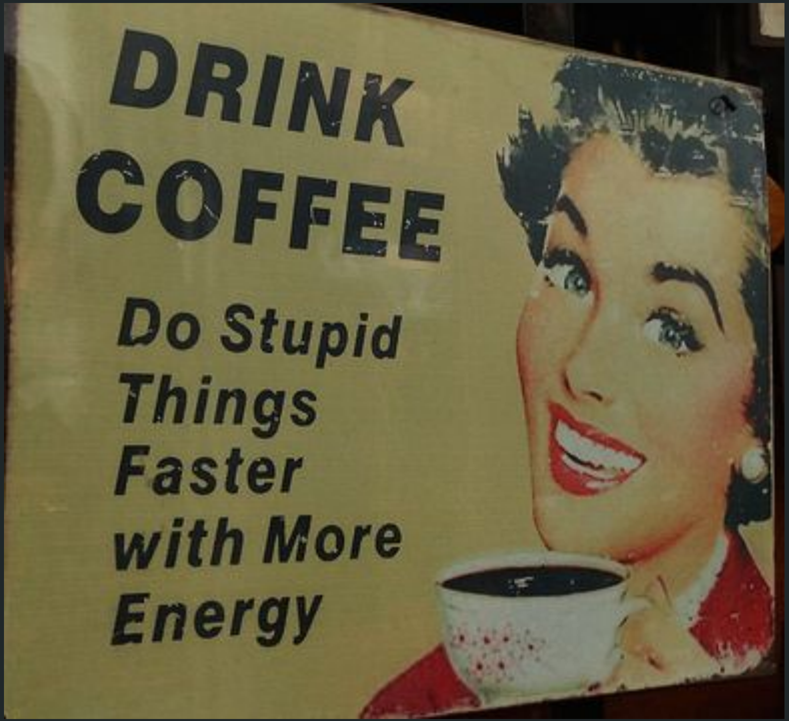
General:

Virtual-Training Day
Jan 27th, Day3 (Fri) / 9AM - 4:30PM Central

Two-Day Live Training
Mar 7th - 8th (Tues/Weds)

Focused/Minimize Distractions

The exercises are important.



Flickr: Ben Sutherland

Syllabus for Today

Review Part 1: Strings/Lists/Dictionaries
Exception Handling

On the Road to Reusable Code (Part1)
Functions
Importing Libraries
Creating your own Python Module
sys.path and $PYTHONPATH
PIP

Review Part 2: Conditionals and Loops

Handling Complex Data Structures
Regular Expressions
Linting

On the Road to Reusable Code (Part2)
Introduction to Classes and Objects

Interfacing to External Systems (Next Session)
JSON
Introduction to Requests

Environment Check

- Start VS Code
- Click "Reload Required" for any plugin upgrades.
- Source Control → More Actions → Pull, Push → Sync (to update changes to repository)
- Terminal → New Terminal (make sure virtual environment is active)

Review Part1

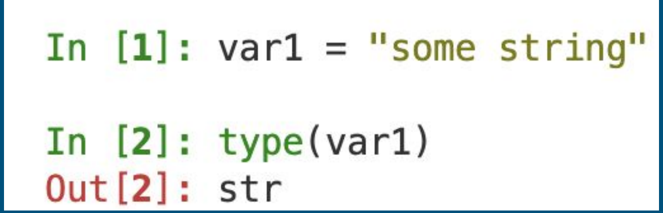
Strings

Lists

Dictionaries

python™

Strings



```
In [1]: var1 = "some string"

In [2]: type(var1)
Out[2]: str
```

String Concatenation

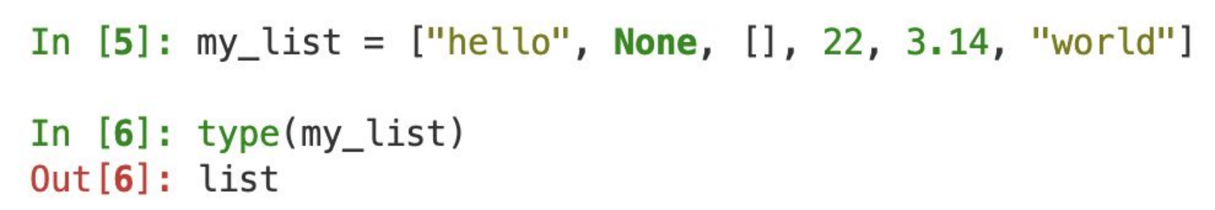
String Methods: .split(), .splitlines(), .strip(), .join()

Membership: substring in string

String Slices

F-Strings

Lists



```
In [5]: my_list = ["hello", None, [], 22, 3.14, "world"]

In [6]: type(my_list)
Out[6]: list
```

Creating a List

Accessing List Elements

Appending to a List

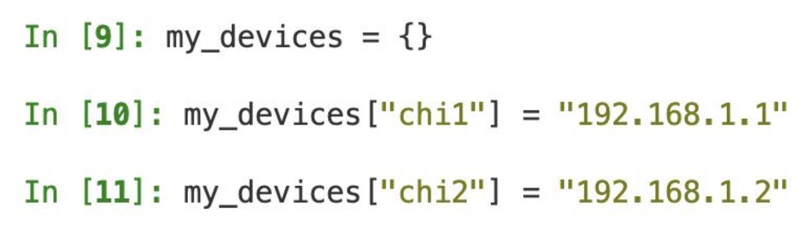
Popping elements of a List

List Concatenation

Looping over Lists

List Slices

Dictionaries

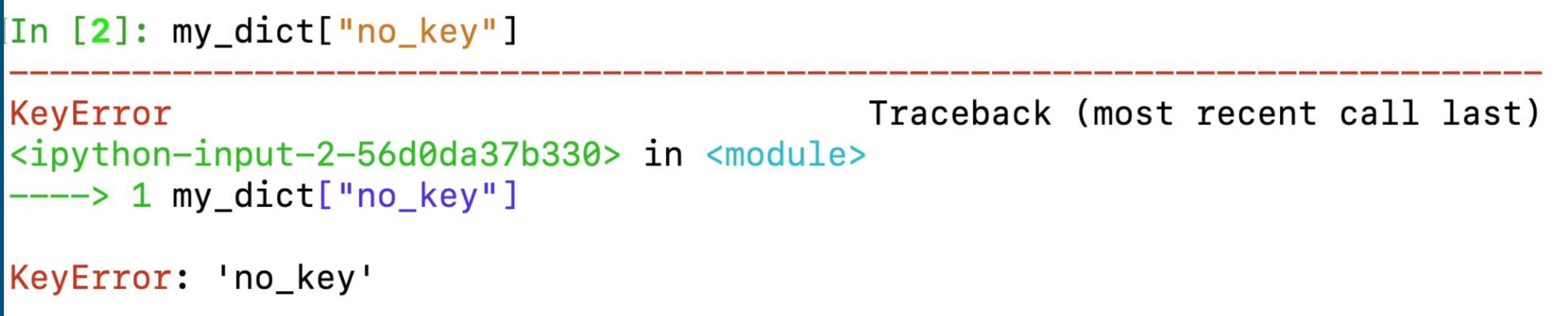


```
In [9]: my_devices = {}

In [10]: my_devices["chi1"] = "192.168.1.1"

In [11]: my_devices["chi2"] = "192.168.1.2"
```

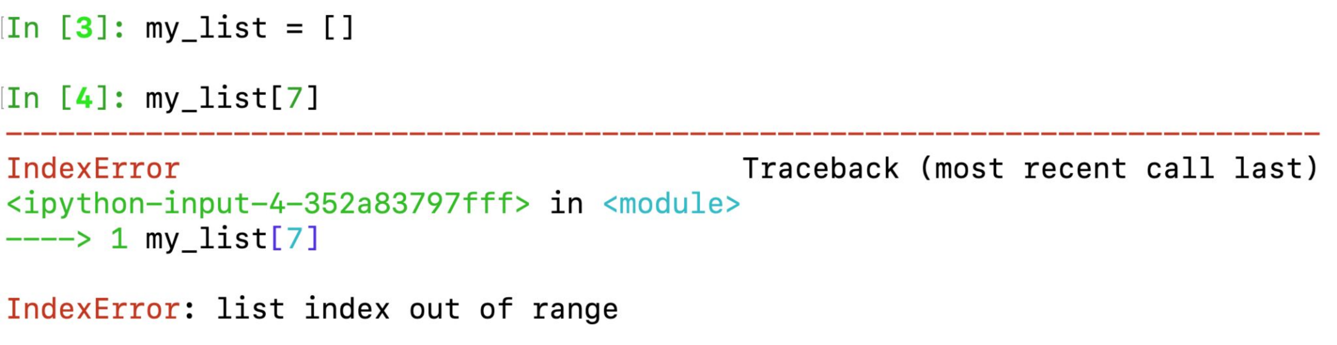
Creating a Dictionary
Accessing Keys
Adding New Keys
Looping over Dictionaries: .keys(), .values(), .items()
Popping Keys off of Dictionaries

Exception Handling

Why - Gracefully handle errors.



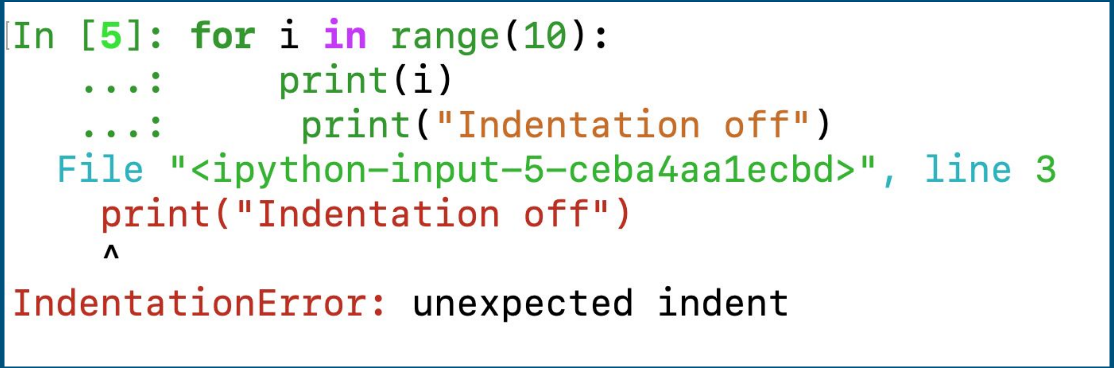
```
In [2]: my_dict["no_key"]
---------------------------------------------------------------------------
KeyError                                  Traceback (most recent call last)
<ipython-input-2-56d0da37b330> in <module>
----> 1 my_dict["no_key"]

KeyError: 'no_key'
```



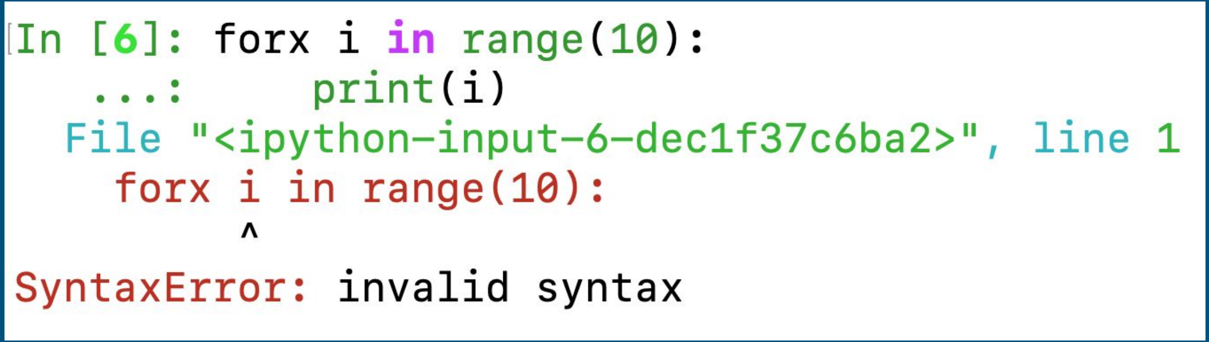
```
In [3]: my_list = []

In [4]: my_list[7]
---------------------------------------------------------------------------
IndexError                                Traceback (most recent call last)
<ipython-input-4-352a83797fff> in <module>
----> 1 my_list[7]

IndexError: list index out of range
```

Exception Handling

Why - Gracefully handle errors.



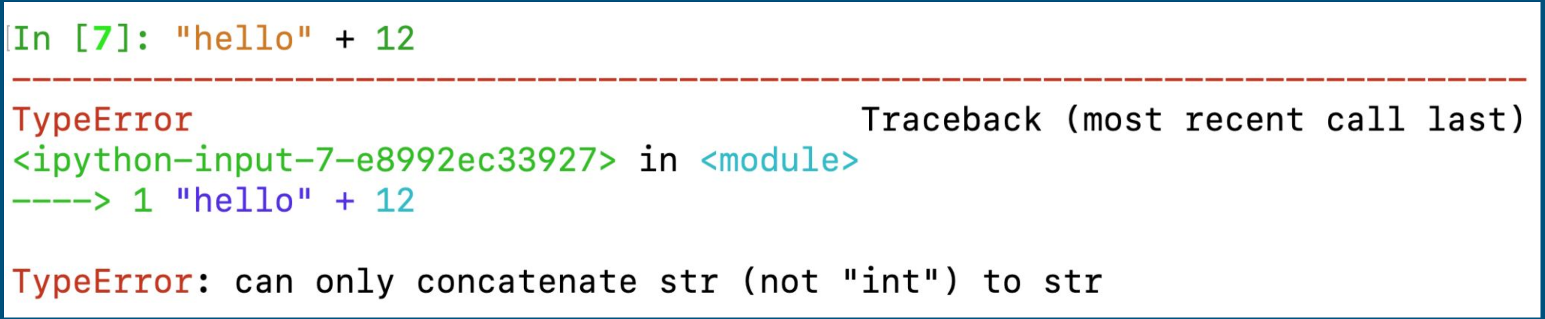
```
In [5]: for i in range(10):
   ...:     print(i)
   ...:      print("Indentation off")
  File "<ipython-input-5-ceba4aa1ecbd>", line 3
    print("Indentation off")
    ^
IndentationError: unexpected indent
```



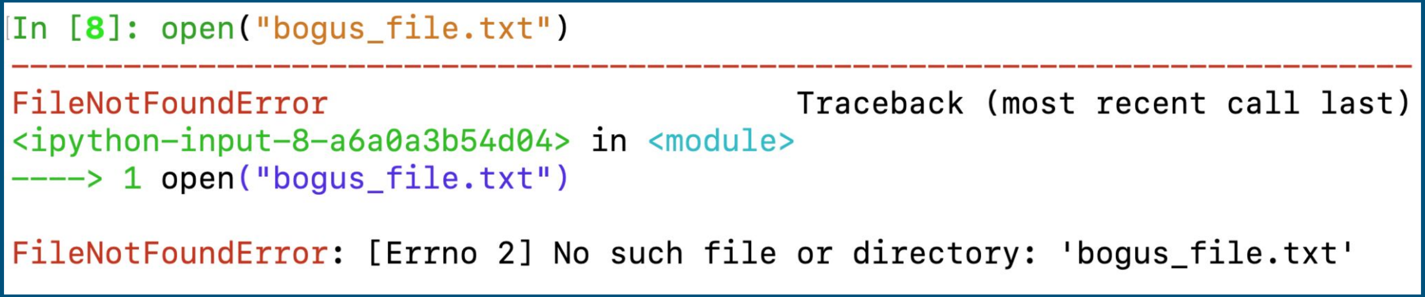
```
In [6]: forx i in range(10):
   ...:     print(i)
  File "<ipython-input-6-dec1f37c6ba2>", line 1
    forx i in range(10):
         ^
SyntaxError: invalid syntax
```

Exception Handling

Why - Gracefully handle errors.



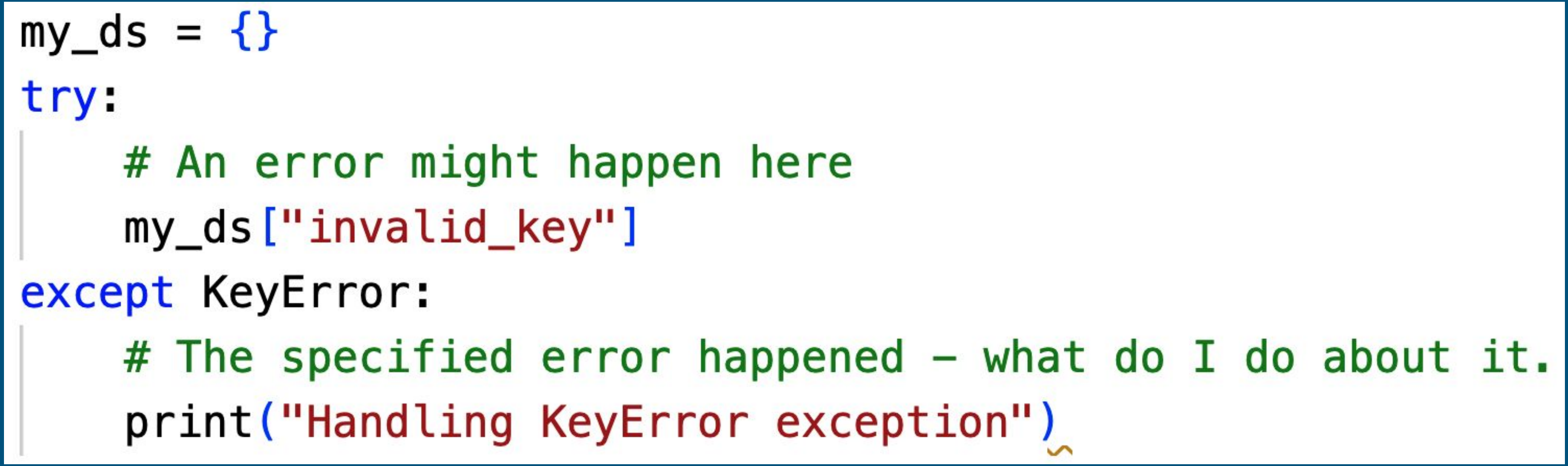
```
In [7]: "hello" + 12
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-7-e8992ec33927> in <module>
----> 1 "hello" + 12

TypeError: can only concatenate str (not "int") to str
```



```
In [8]: open("bogus_file.txt")
---------------------------------------------------------------------------
FileNotFoundError                         Traceback (most recent call last)
<ipython-input-8-a6a0a3b54d04> in <module>
----> 1 open("bogus_file.txt")

FileNotFoundError: [Errno 2] No such file or directory: 'bogus_file.txt'
```

Exception Handling

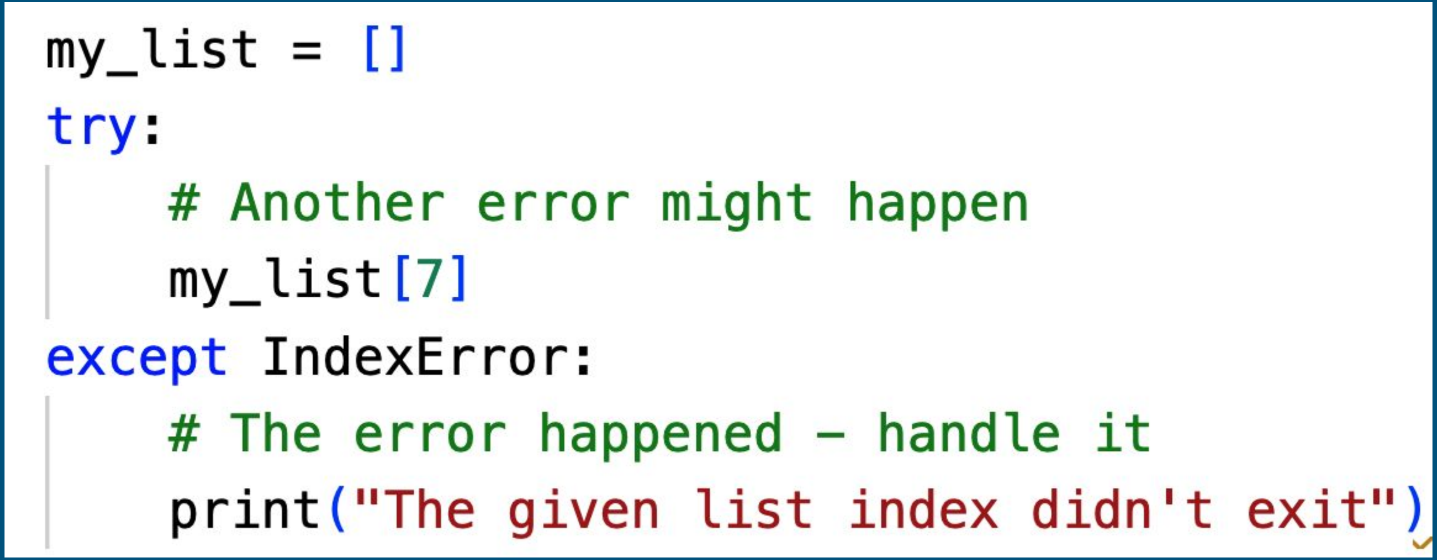
Actually handling the exception - this particular error might happen here.



```
my_ds = {}
try:
    # An error might happen here
    my_ds["invalid_key"]
except KeyError:
    # The specified error happened - what do I do about it.
    print("Handling KeyError exception")
```

Exception Handling

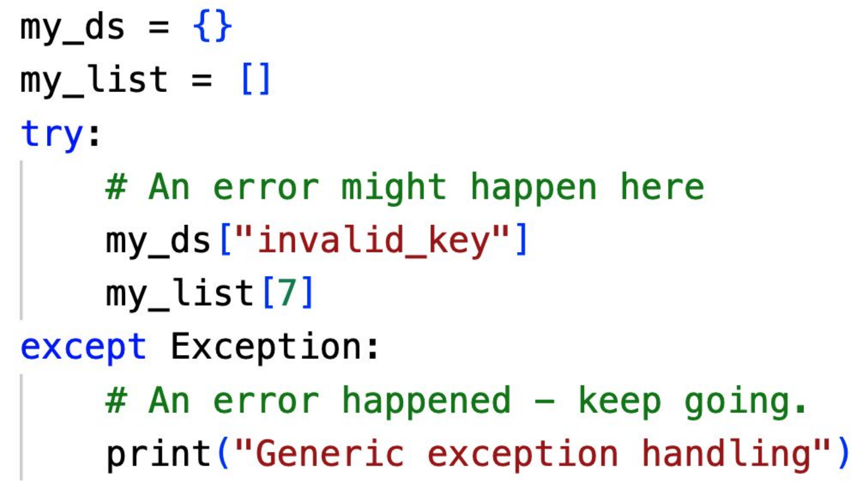
Actually handling the exception - this particular error might happen here.



```
my_list = []
try:
    # Another error might happen
    my_list[7]
except IndexError:
    # The error happened - handle it
    print("The given list index didn't exit")
```

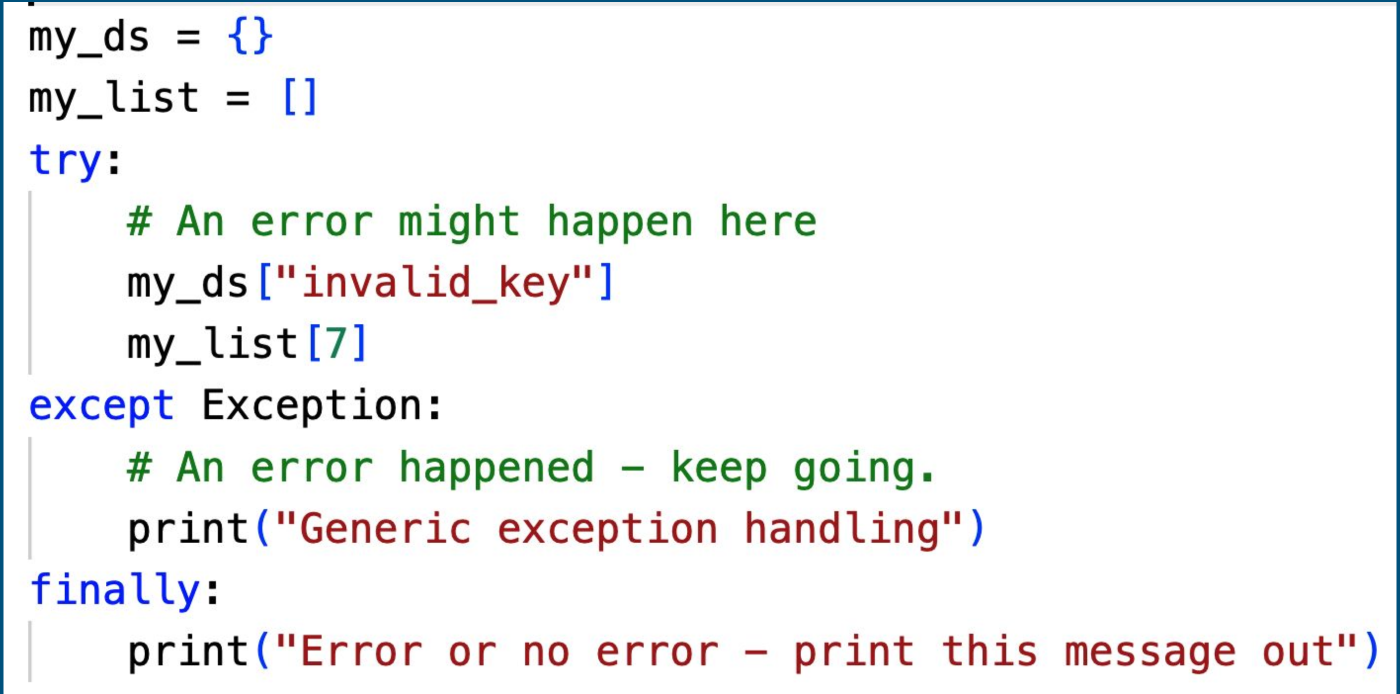
Handling Generic Exceptions

Be careful - you could be hiding errors!



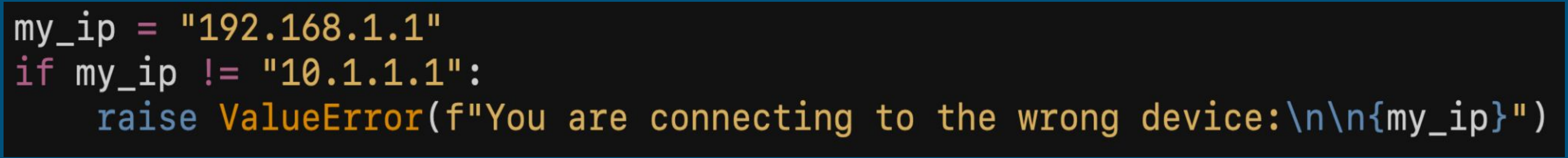
```python
my_ds = {}
my_list = []
try:
    # An error might happen here
    my_ds["invalid_key"]
    my_list[7]
except Exception:
    # An error happened - keep going.
    print("Generic exception handling")
```

Finally: Do Something in Either Case

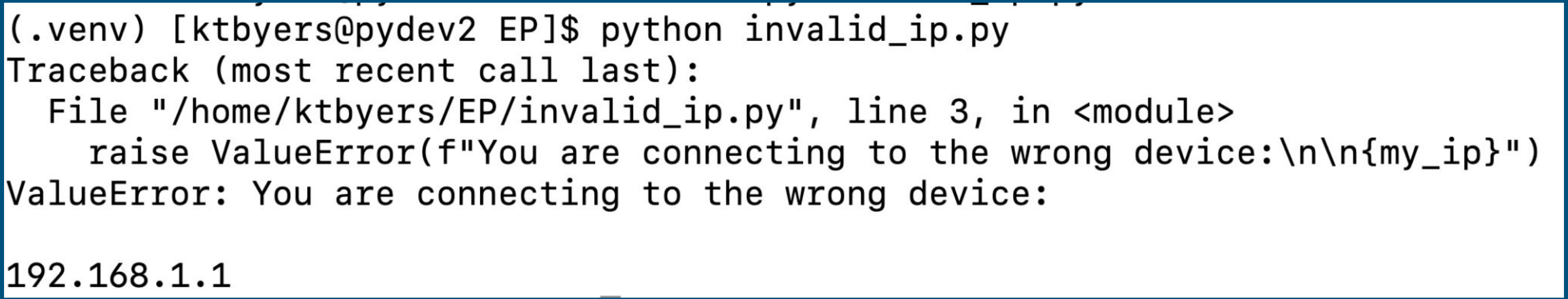


```python
my_ds = {}
my_list = []
try:
    # An error might happen here
    my_ds["invalid_key"]
    my_list[7]
except Exception:
    # An error happened - keep going.
    print("Generic exception handling")
finally:
    print("Error or no error - print this message out")
```

You can “raise” your own exceptions.



```python
my_ip = "192.168.1.1"
if my_ip != "10.1.1.1":
    raise ValueError(f"You are connecting to the wrong device:\n\n{my_ip}")
```



```
(.venv) [ktbyers@pydev2 EP]$ python invalid_ip.py
Traceback (most recent call last):
  File "/home/ktbyers/EP/invalid_ip.py", line 3, in <module>
    raise ValueError(f"You are connecting to the wrong device:\n\n{my_ip}")
ValueError: You are connecting to the wrong device:

192.168.1.1
```

Exceptions - Exercise1

Create a variable named filename.

Using a try/except block open the file referred to in the filename variable.

If the file does not exist gracefully handle the missing file using the following statement:

except FileNotFoundError:

If the file exists and is opened successfully, then print a message indicating this. If the file does not exist, then print a message that an error occurred in your exception block.

Test that your code works properly in both cases (i.e. both when the file exists and when it doesn't exist).

GitHub: {{ repo }}/day3/exceptions/exercise1.txt

On The Road to Reusable Code.

Why should we care about code reusability?

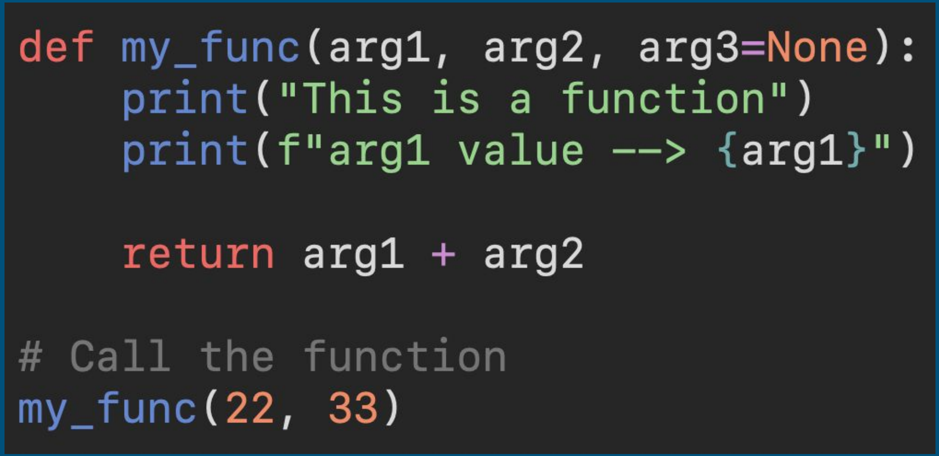
Power1: Solve a problem in code.

Power2: Create building blocks that you can reuse to solve numerous problems.

Functions - Why?

Conjunction junction,
what's your function.

Write something once, use multiple times



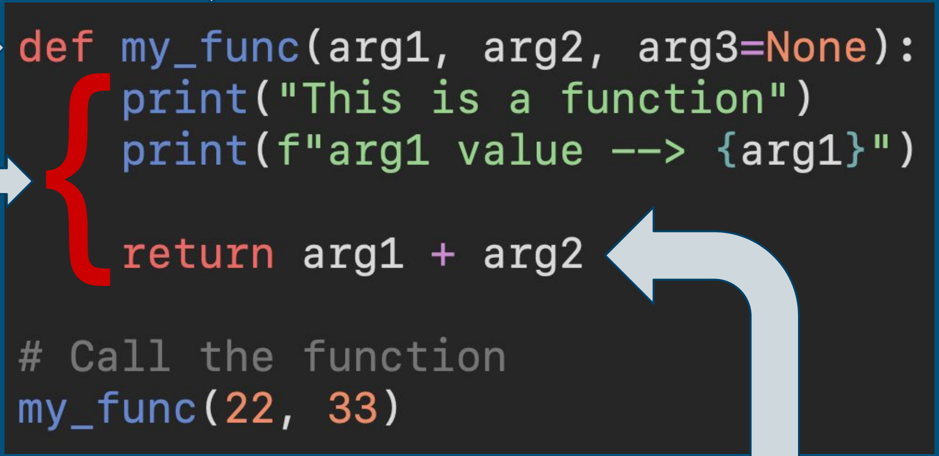
```python
def my_func(arg1, arg2, arg3=None):
    print("This is a function")
    print(f"arg1 value --> {arg1}")

    return arg1 + arg2

# Call the function
my_func(22, 33)
```

Function Syntax

'def' keyword indicates function definition

Indented code block

Function name

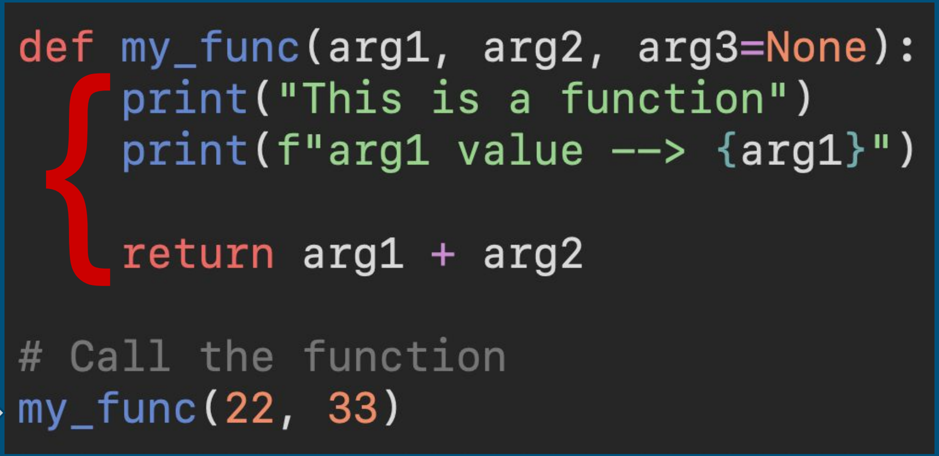


```
def my_func(arg1, arg2, arg3=None):
    print("This is a function")
    print(f"arg1 value --> {arg1}")

    return arg1 + arg2

# Call the function
my_func(22, 33)
```

Return statement (implicit return None)

Function Syntax

You have to call the function or nothing happens



```python
def my_func(arg1, arg2, arg3=None):
    print("This is a function")
    print(f"arg1 value --> {arg1}")

    return arg1 + arg2

# Call the function
my_func(22, 33)
```

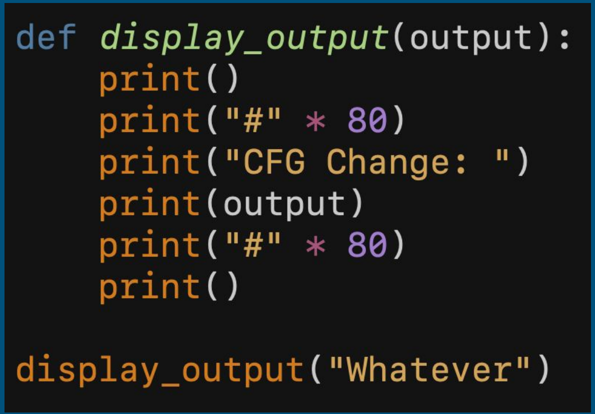
Functions - Exercise1

1. Create a function named “print_hello”.
2. It takes no arguments and prints the message “hello world” three times.
3. Have your program call this function three times in a row.
4. You should see “hello world” printed nine times in total.

GitHub: {{ repo }}/day3/functions/exercise1.txt

Function Parameters and Arguments

Function Parameter (this variable only exists in the function)



```python
def display_output(output):
    print()
    print("#" * 80)
    print("CFG Change: ")
    print(output)
    print("#" * 80)
    print()

display_output("Whatever")
```

Function Argument - what you pass-in on the function call.

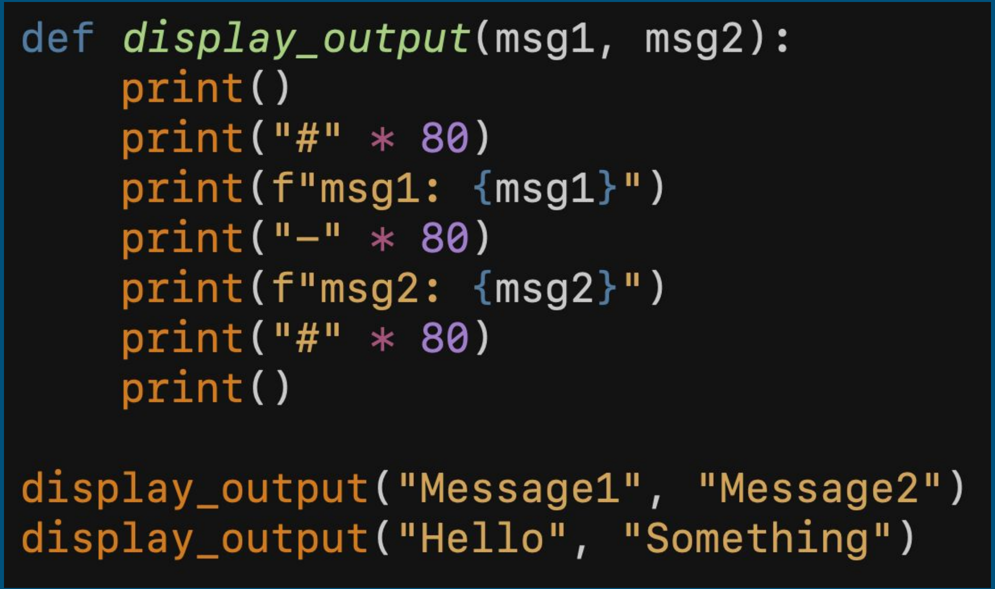
Functions - Exercise2

1. Expand on exercise 1 except the message you print out is NOT “hello world” instead it is a parameter named “msg” that is defined in the function definition.
2. Call your function, three different times and pass in three different arguments (i.e. pass in three different messages).

GitHub: {{ repo }}/day3/functions/exercise2.txt

Functions: More than one parameter.

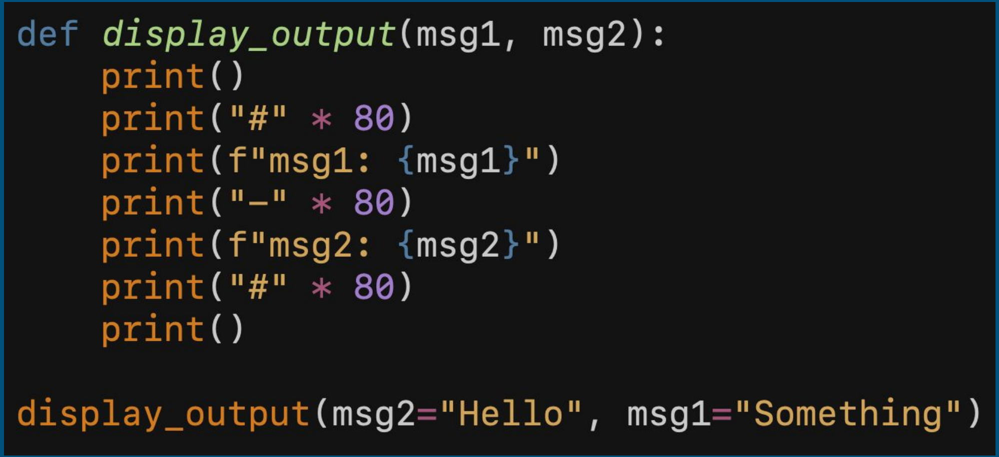
Positional arguments: first-to-first; second-to-second, etc



```python
def display_output(msg1, msg2):
    print()
    print("#" * 80)
    print(f"msg1: {msg1}")
    print("-" * 80)
    print(f"msg2: {msg2}")
    print("#" * 80)
    print()

display_output("Message1", "Message2")
display_output("Hello", "Something")
```

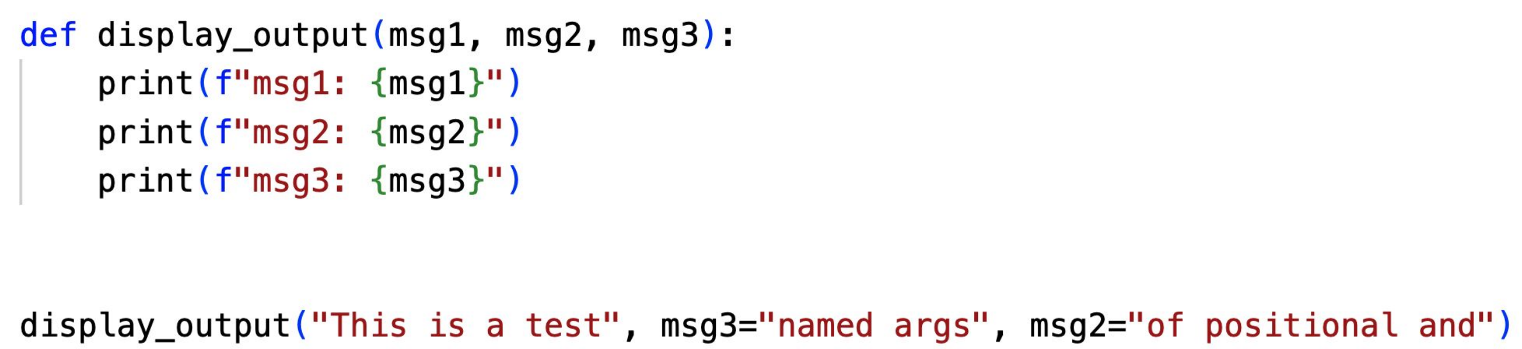
Functions: Using named arguments

Explicitly tell Python via naming the arguments.



```python
def display_output(msg1, msg2):
    print()
    print("#" * 80)
    print(f"msg1: {msg1}")
    print("-" * 80)
    print(f"msg2: {msg2}")
    print("#" * 80)
    print()

display_output(msg2="Hello", msg1="Something")
```

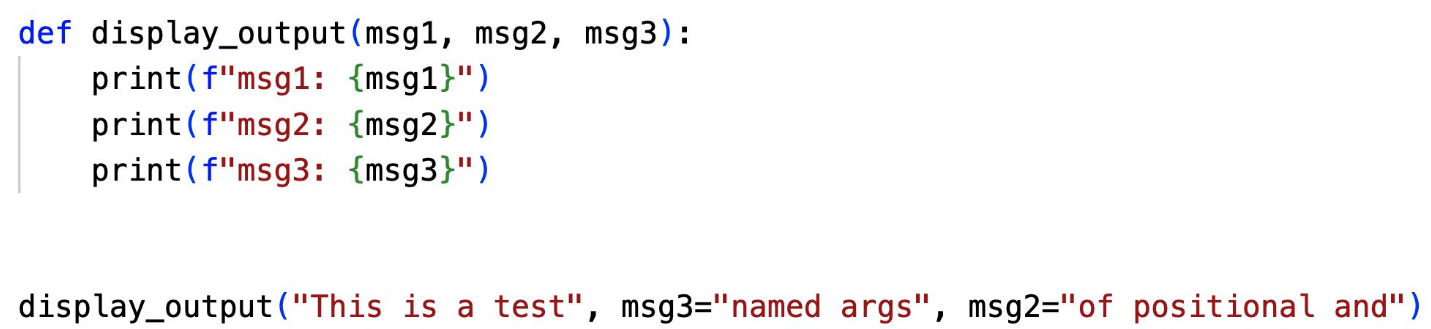
Functions: Mixing and matching positional arguments with named args



```python
def display_output(msg1, msg2, msg3):
    print(f"msg1: {msg1}")
    print(f"msg2: {msg2}")
    print(f"msg3: {msg3}")


display_output("This is a test", msg3="named args", msg2="of positional and")
```

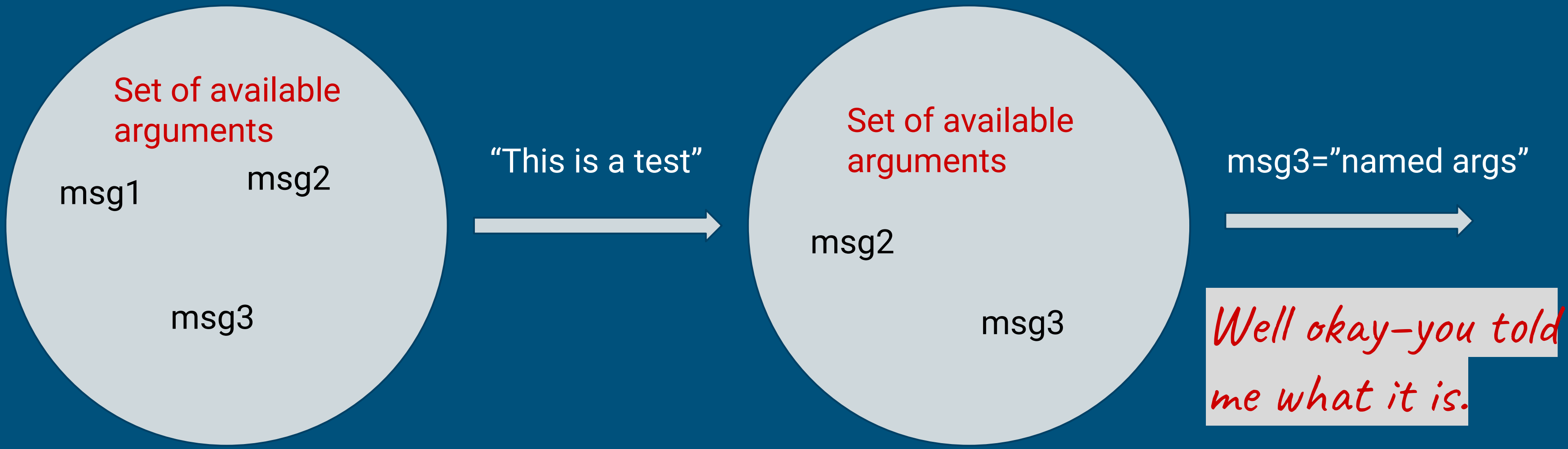
Named arguments last

Positional arguments first



```python
def display_output(msg1, msg2, msg3):
    print(f"msg1: {msg1}")
    print(f"msg2: {msg2}")
    print(f"msg3: {msg3}")


display_output("This is a test", msg3="named args", msg2="of positional and")
```

PYTHON FOR NETWORK ENGINEERS



Well okay–you told me what it is.

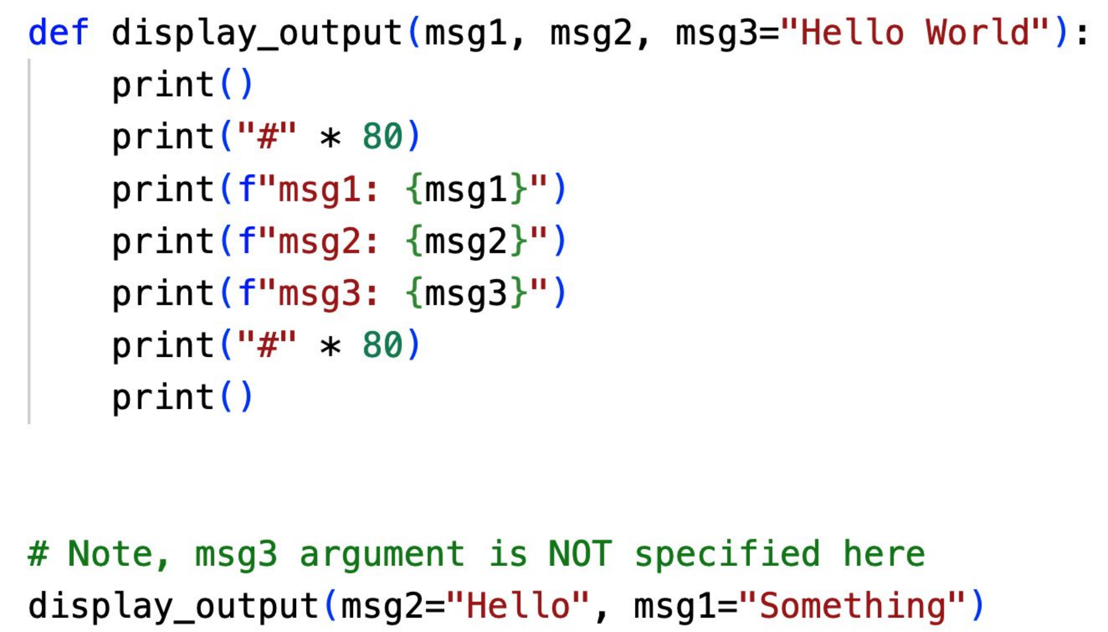
Functions - Exercise3

1. Create a function that has four parameters named var1, var2, var3, var4.
2. In the function print out each variable and indicate which variable it is.
3. Call the function using entirely positional arguments.
4. Call the function using entirely named arguments.
5. Call the function with var1 as a positional argument and var2 through var4 as named arguments.
6. Try to call the function with var1 specified first and using a named argument (and var2 through var4 as positional arguments, but specified after var1). This will generate an error.

GitHub: {{ repo }}/day3/functions/exercise3.txt

Functions: Default Values

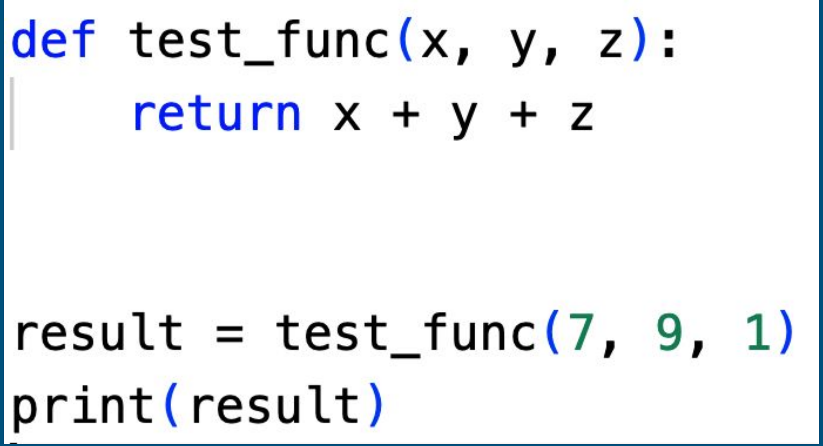
msg3 parameter has a default value



```
def display_output(msg1, msg2, msg3="Hello World"):
    print()
    print("#" * 80)
    print(f"msg1: {msg1}")
    print(f"msg2: {msg2}")
    print(f"msg3: {msg3}")
    print("#" * 80)
    print()


# Note, msg3 argument is NOT specified here
display_output(msg2="Hello", msg1="Something")
```

Note: Very useful for expanding functions across time.

Functions: ReturnValues

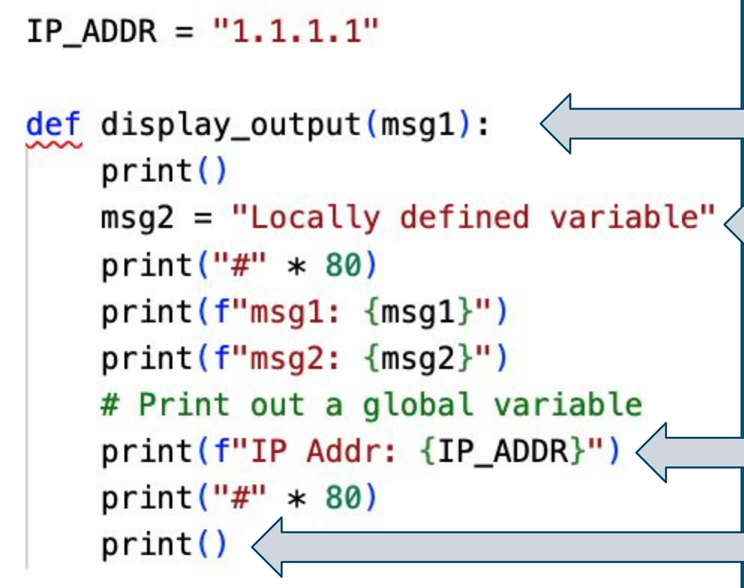


```python
def test_func(x, y, z):
    return x + y + z


result = test_func(7, 9, 1)
print(result)
```

Functions can return results which can then be used outside of the function.

Functions: Where do functions look for variables (LEGB Rule)

LEGB:
L = Local
E = Enclosed (nested functions)
G = Global
B = Builtins



```
IP_ADDR = "1.1.1.1"

def display_output(msg1):
    print()
    msg2 = "Locally defined variable"
    print("#" * 80)
    print(f"msg1: {msg1}")
    print(f"msg2: {msg2}")
    # Print out a global variable
    print(f"IP Addr: {IP_ADDR}")
    print("#" * 80)
    print()
```

msg1 = Local variable

msg2 = Local variable

IP_ADDR = Global variable

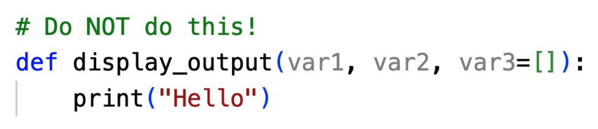
print() = Builtin

Functions: Things that might not be obvious.

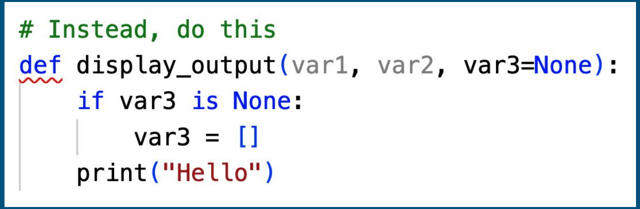
Function parameters/arguments don't have to be strings. They can be other data types including numbers and potentially lists & dictionaries.

Functions always return something (there is a default return None).

Do not directly use lists or dictionaries with default values. Instead do:



```python
# Do NOT do this!
def display_output(var1, var2, var3=[]):
    print("Hello")
```



```python
# Instead, do this
def display_output(var1, var2, var3=None):
    if var3 is None:
        var3 = []
    print("Hello")
```

Functions: Additional topics you can explore.

1. Passing arguments using *args.
2. Passing arguments using **kwargs.
3. Defining parameters using **kwargs.
4. Python’s Lambda function.

Functions - Exercise4

Based on your earlier exercise where you parsed the serial number from “show version” output (or use ex4_reference_base.py)

a. Create two functions

b. Function1 opens the file and returns all of the data in the file as a text string. This function should take one argument (the filename).

c. Function2 parses the show_version output and returns the serial number.

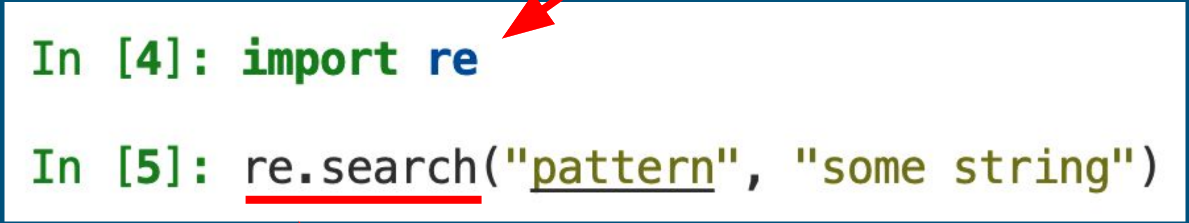
GitHub: {{ repo }}/day3/functions/exercise4.txt

GitHub: {{ repo }}/day3/functions/ex4_reference_base.py

How do we use third-party libraries?

Find the "re" library

Libraries: Two Different Import Formats

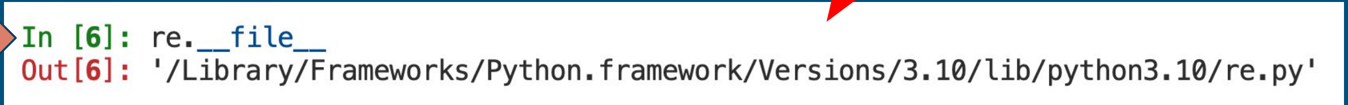


```
In [4]: import re

In [5]: re.search("pattern", "some string")
```

Names must be prefixed with "re."

Process this entire file–line by line.

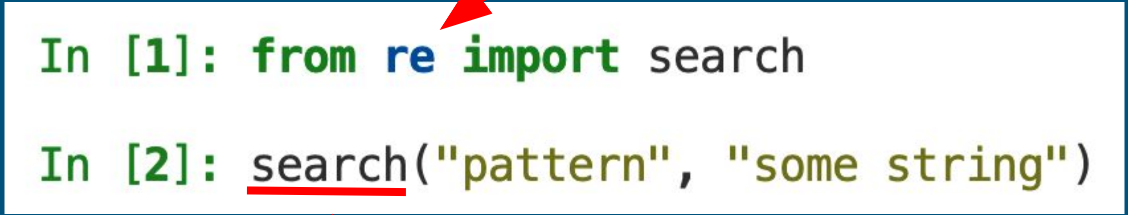
Here is where Python found "re"



```
In [6]: re.__file__
Out[6]: '/Library/Frameworks/Python.framework/Versions/3.10/lib/python3.10/re.py'
```

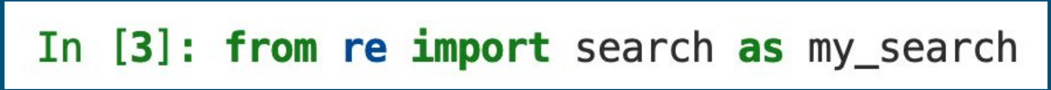
Libraries: Two Different Import Formats

Still finds the "re" library



```
In [1]: from re import search

In [2]: search("pattern", "some string")
```

But this form does not require prefixing the name with "re.".



```
In [3]: from re import search as my_search
```

Still processes the entire file–line by line.

Import in this form processes the file in the same way; it just changes the name references in your program.

Modules – Creating your Own Python Library

1. Create a file ending in .py
2. Add two functions to this.
3. Import this file and use the functions.

A Python file that you can import is a termed a "module"

Modules – What if you have both executable code and importable code in your Python file?

Dunder-name: __name__ == "__main__" .

Why does this work?

Modules Exercise1

In a new Python file do the following:

* Create a function that takes a number as input and returns the number squared.
* Create a second function that takes two numbers and returns the product of those numbers.
* Use the "if __name__ == "__main__":" technique and separate the functions from the executable code.
* For the executable code, test your two functions using a couple of test cases. You can use assert statements to verify your test cases work.

For example, as a simple test you can do something like the following:

```
result = squared(2)
assert result == 4
```

Introduce a simple error in your testing (i.e. something that results in the test statements being False) and observe that your testing catches this error.

GitHub: {{ repo }}/day3/modules/exercise1.txt

Modules Exercise2

In a new Python file, import the two functions that you created in exercise1.

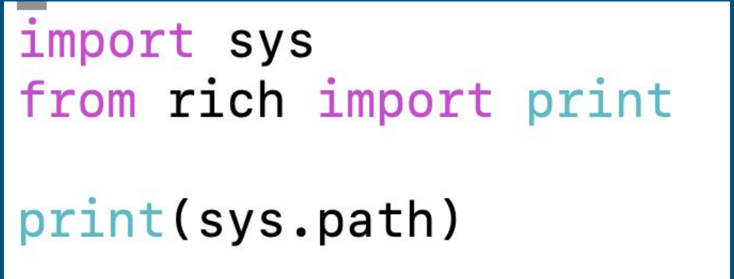
Ensure that none of the test code executes during the import process (probably add print statements to the test code section so you can better determine this section is not executing)

Invoke each of the two functions and print the result to standard output.

python™

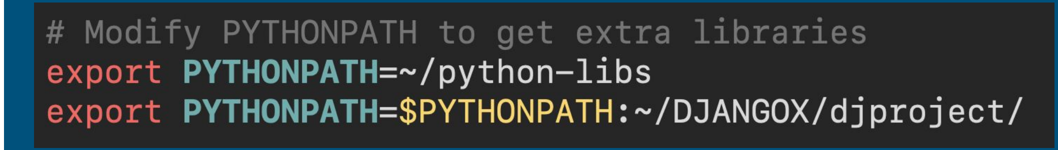
GitHub: {{ repo }}/day3/modules/exercise2.txt

How does Python find things?

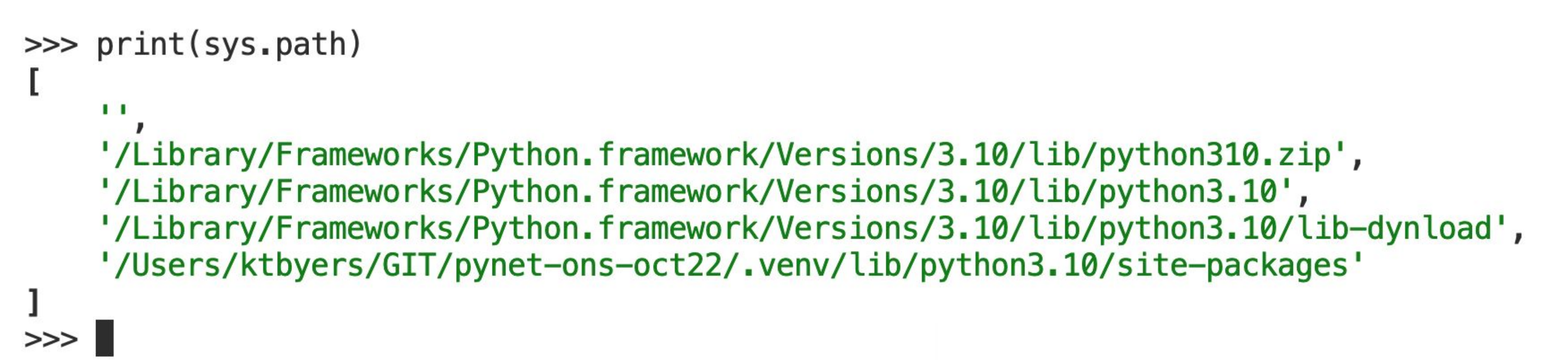


```
import sys
from rich import print

print(sys.path)
```

sys.path and $PYTHONPATH



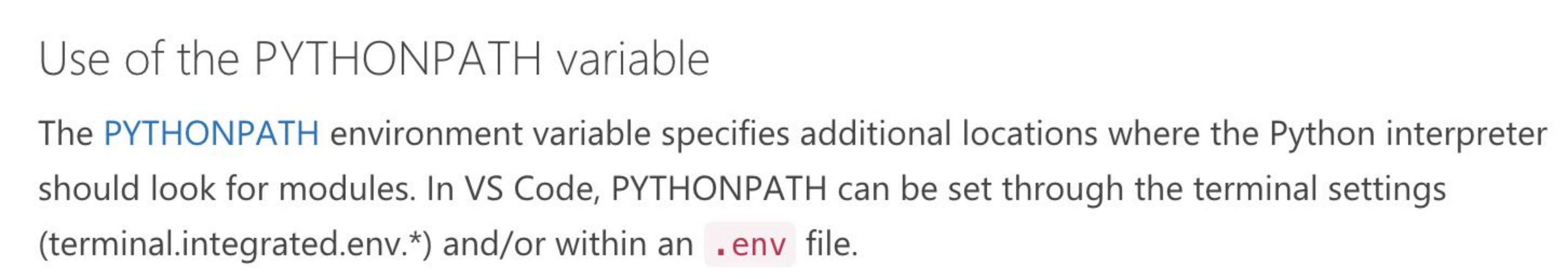
```
# Modify PYTHONPATH to get extra libraries
export PYTHONPATH=~/python-libs
export PYTHONPATH=$PYTHONPATH:~/DJANGOX/djproject/
```



```
>>> print(sys.path)
[
    '',
    '/Library/Frameworks/Python.framework/Versions/3.10/lib/python310.zip',
    '/Library/Frameworks/Python.framework/Versions/3.10/lib/python3.10',
    '/Library/Frameworks/Python.framework/Versions/3.10/lib/python3.10/lib-dynload',
    '/Users/ktbyers/GIT/pynet-ons-oct22/.venv/lib/python3.10/site-packages'
]
>>> 
```

$PYTHONPATH and VS Code

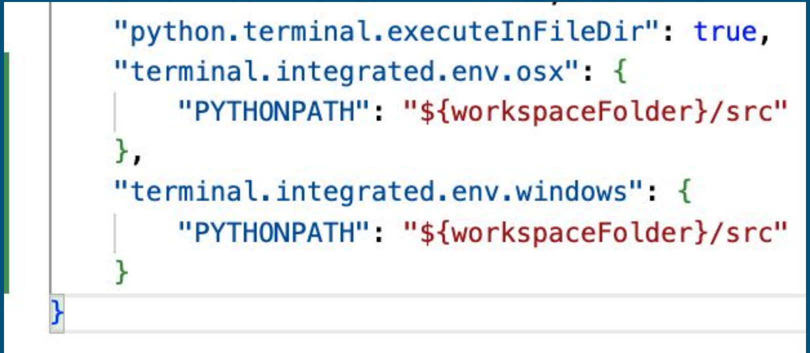
https://code.visualstudio.com/docs/python/environments#_use-of-the-pythonpath-variable



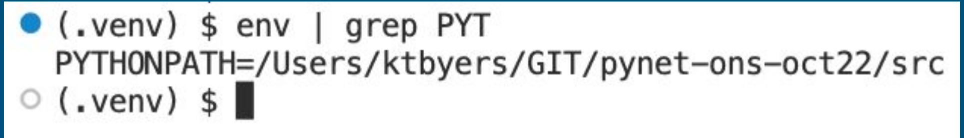
Use of the PYTHONPATH variable

The PYTHONPATH environment variable specifies additional locations where the Python interpreter should look for modules. In VS Code, PYTHONPATH can be set through the terminal settings (terminal.integrated.env.*) and/or within an `.env` file.

$PYTHONPATH and VS Code



```
    "python.terminal.executeInFileDir": true,
    "terminal.integrated.env.osx": {
        "PYTHONPATH": "${workspaceFolder}/src"
    },
    "terminal.integrated.env.windows": {
        "PYTHONPATH": "${workspaceFolder}/src"
    }
}
```

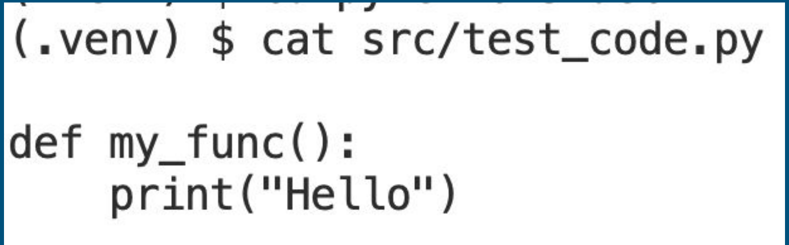


```
● (.venv) $ env | grep PYT
  PYTHONPATH=/Users/ktbyers/GIT/pynet-ons-oct22/src
○ (.venv) $ █
```

$PYTHONPATH and VS Code

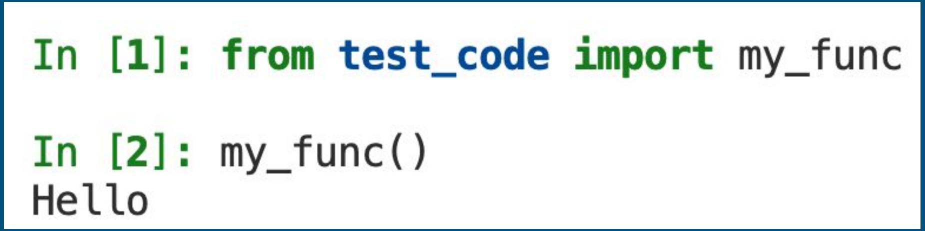
On the road to reusable code.

We can create a Python file and locate it in {workspace}/src



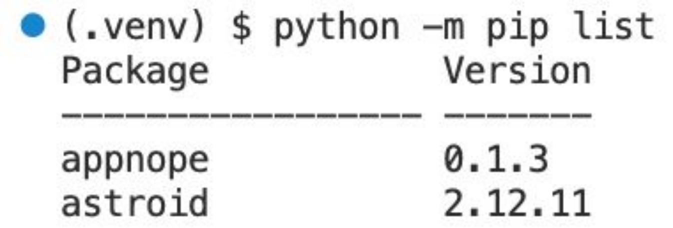
```
(.venv) $ cat src/test_code.py

def my_func():
    print("Hello")
```

We can import and use it (from anywhere on our system).



```
In [1]: from test_code import my_func

In [2]: my_func()
Hello
```

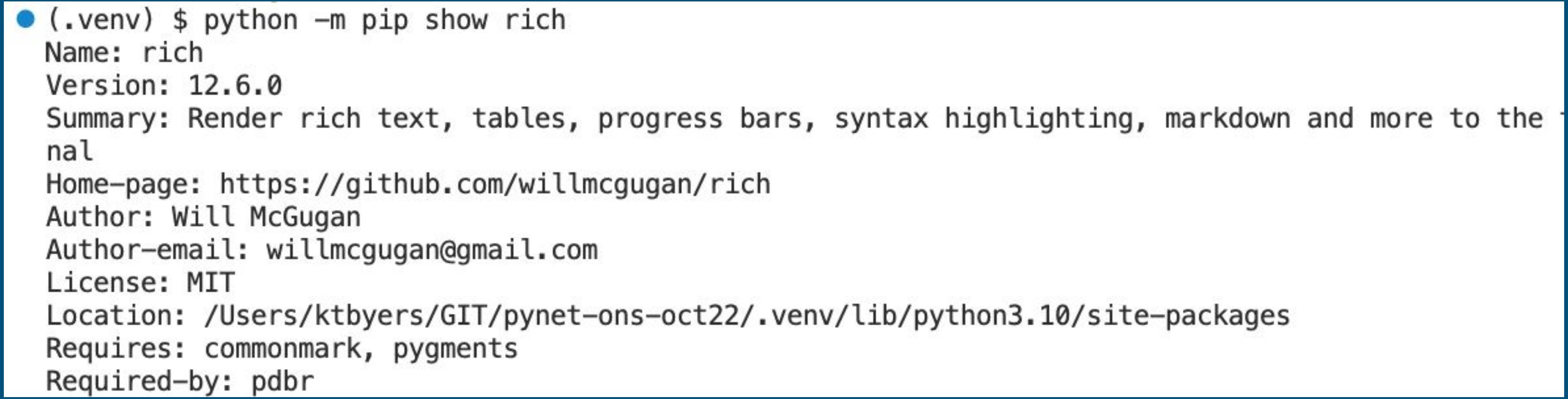
PIP - How to Install Third-Party Libraries.



```
● (.venv) $ python -m pip list
  Package            Version
  ------------------ --------
  appnope            0.1.3
  astroid            2.12.11
```

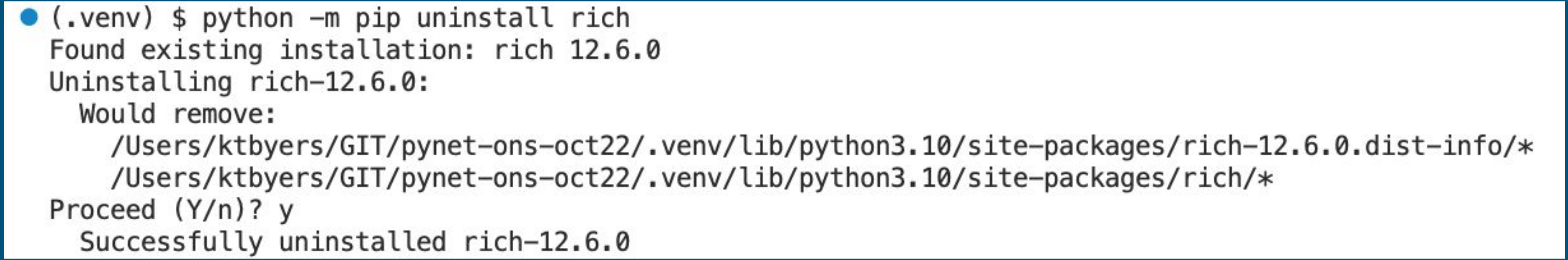
pypi = Python Package Index

PIP - Package Installer for Python.

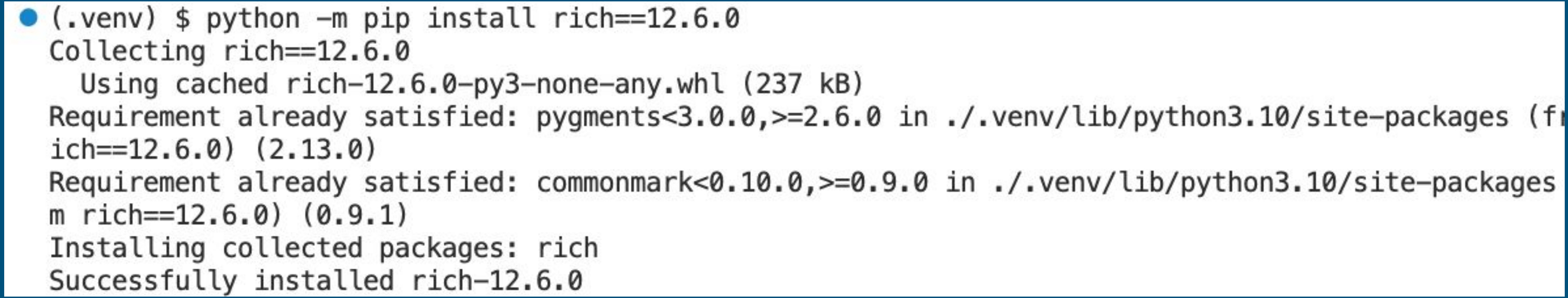


```
● (.venv) $ python -m pip show rich
  Name: rich
  Version: 12.6.0
  Summary: Render rich text, tables, progress bars, syntax highlighting, markdown and more to the
  nal
  Home-page: https://github.com/willmcgugan/rich
  Author: Will McGugan
  Author-email: willmcgugan@gmail.com
  License: MIT
  Location: /Users/ktbyers/GIT/pynet-ons-oct22/.venv/lib/python3.10/site-packages
  Requires: commonmark, pygments
  Required-by: pdbr
```

PIP - Package Installer for Python.

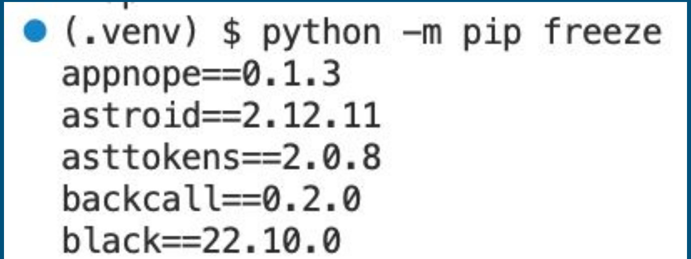


```
● (.venv) $ python -m pip uninstall rich
  Found existing installation: rich 12.6.0
  Uninstalling rich-12.6.0:
    Would remove:
      /Users/ktbyers/GIT/pynet-ons-oct22/.venv/lib/python3.10/site-packages/rich-12.6.0.dist-info/*
      /Users/ktbyers/GIT/pynet-ons-oct22/.venv/lib/python3.10/site-packages/rich/*
  Proceed (Y/n)? y
    Successfully uninstalled rich-12.6.0
```



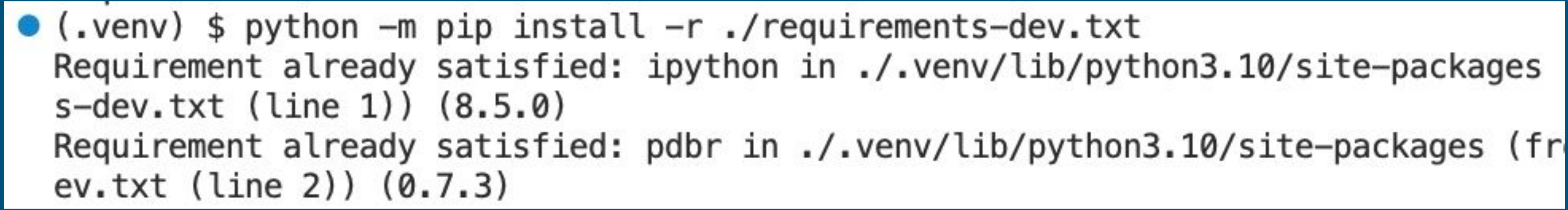
```
● (.venv) $ python -m pip install rich==12.6.0
  Collecting rich==12.6.0
    Using cached rich-12.6.0-py3-none-any.whl (237 kB)
  Requirement already satisfied: pygments<3.0.0,>=2.6.0 in ./.venv/lib/python3.10/site-packages (f
  ich==12.6.0) (2.13.0)
  Requirement already satisfied: commonmark<0.10.0,>=0.9.0 in ./.venv/lib/python3.10/site-packages
  m rich==12.6.0) (0.9.1)
  Installing collected packages: rich
  Successfully installed rich-12.6.0
```

PIP - Package Installer for Python.

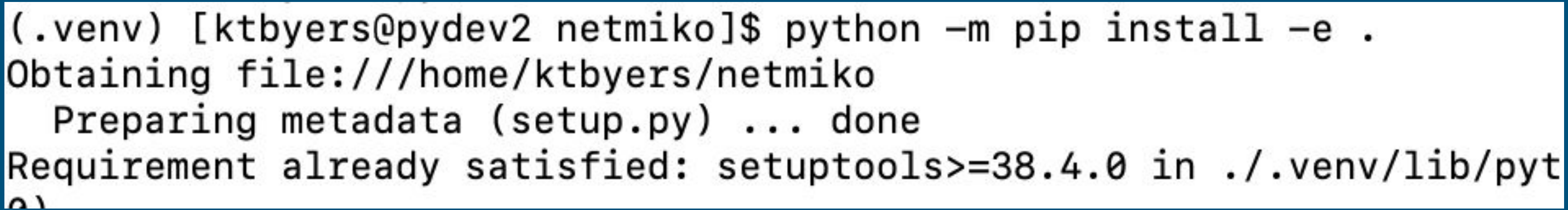


```
● (.venv) $ python -m pip freeze
  appnope==0.1.3
  astroid==2.12.11
  asttokens==2.0.8
  backcall==0.2.0
  black==22.10.0
```

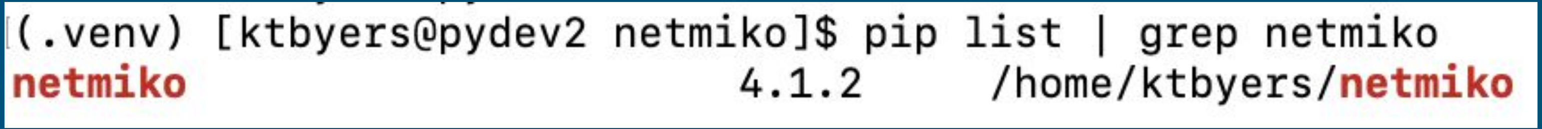
PIP - Package Installer for Python.



```
● (.venv) $ python -m pip install -r ./requirements-dev.txt
  Requirement already satisfied: ipython in ./.venv/lib/python3.10/site-packages
  s-dev.txt (line 1)) (8.5.0)
  Requirement already satisfied: pdbr in ./.venv/lib/python3.10/site-packages (fr
  ev.txt (line 2)) (0.7.3)
```



```
(.venv) [ktbyers@pydev2 netmiko]$ python -m pip install -e .
Obtaining file:///home/ktbyers/netmiko
  Preparing metadata (setup.py) ... done
Requirement already satisfied: setuptools>=38.4.0 in ./.venv/lib/pyt
0)
```



```
(.venv) [ktbyers@pydev2 netmiko]$ pip list | grep netmiko
netmiko                               4.1.2     /home/ktbyers/netmiko
```

Review Part2

Conditionals

Loops

python™

Conditionals

Syntax

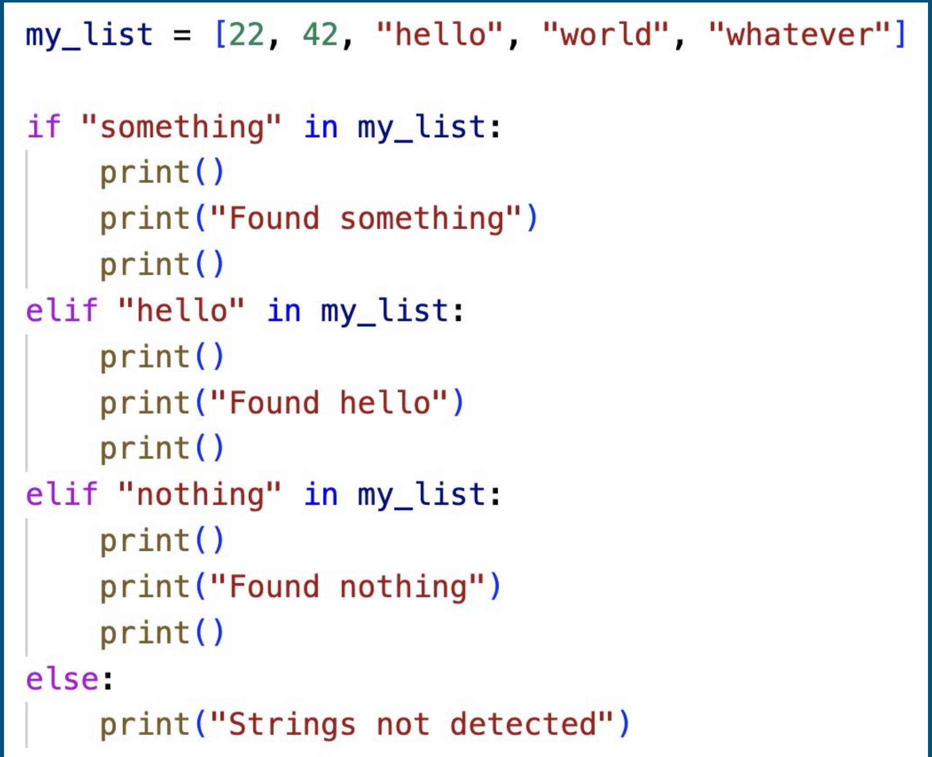
Expression Evaluation

Comparison Operators

Truish

Logical-or / Logical-and

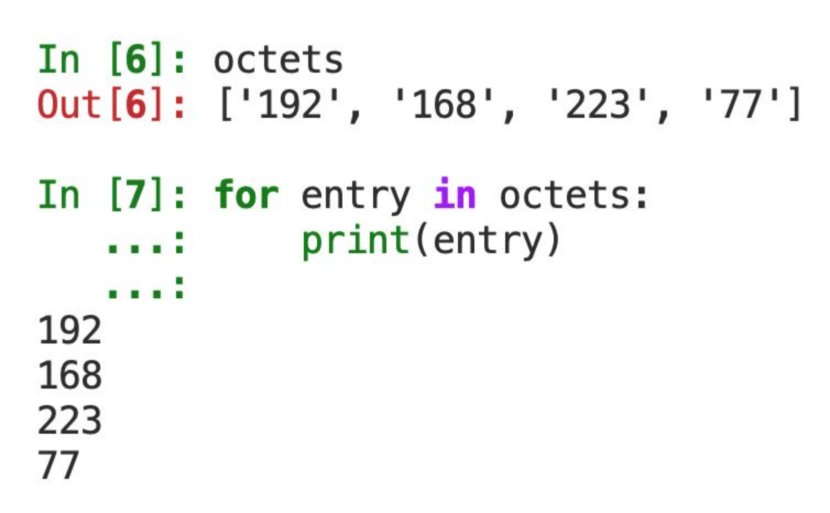
Nested Ifs



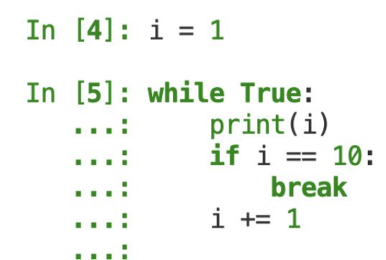
```python
my_list = [22, 42, "hello", "world", "whatever"]

if "something" in my_list:
    print()
    print("Found something")
    print()
elif "hello" in my_list:
    print()
    print("Found hello")
    print()
elif "nothing" in my_list:
    print()
    print("Found nothing")
    print()
else:
    print("Strings not detected")
```

Loops

- Syntax
- Break Statement
- Continue Statement
- Enumerate (lists)
- .items() (dictionaries)

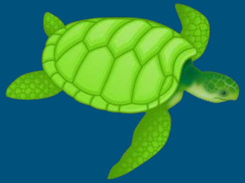


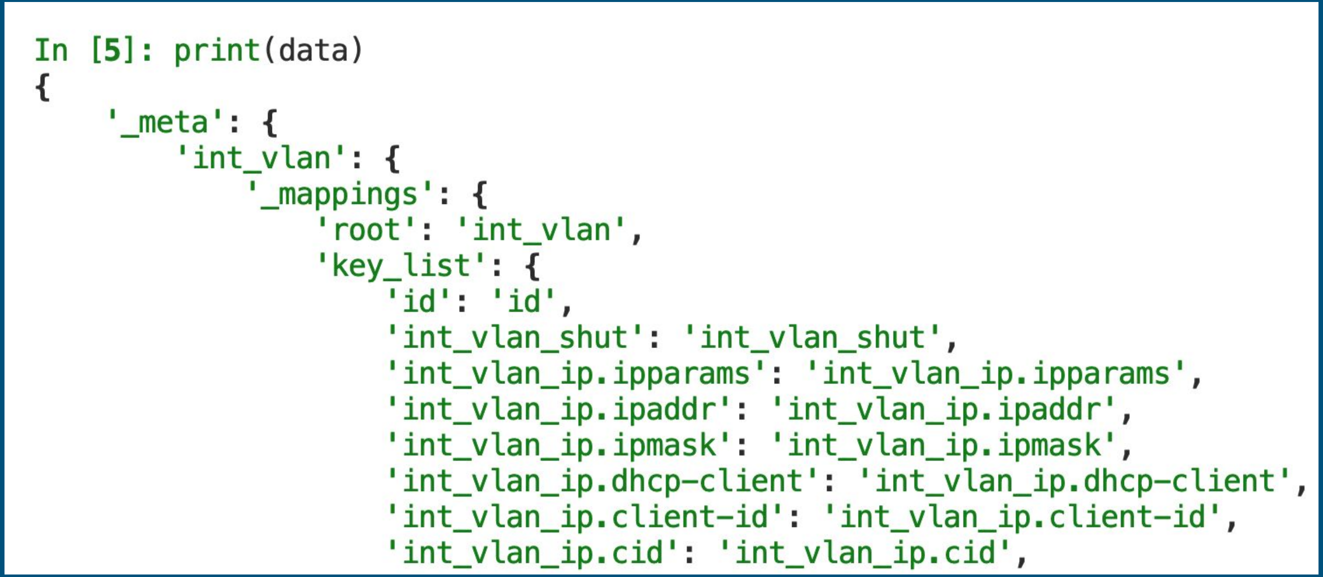
```
In [6]: octets
Out[6]: ['192', '168', '223', '77']

In [7]: for entry in octets:
   ...:     print(entry)
   ...:
192
168
223
77
```



```
In [4]: i = 1

In [5]: while True:
   ...:     print(i)
   ...:     if i == 10:
   ...:         break
   ...:     i += 1
   ...:
```

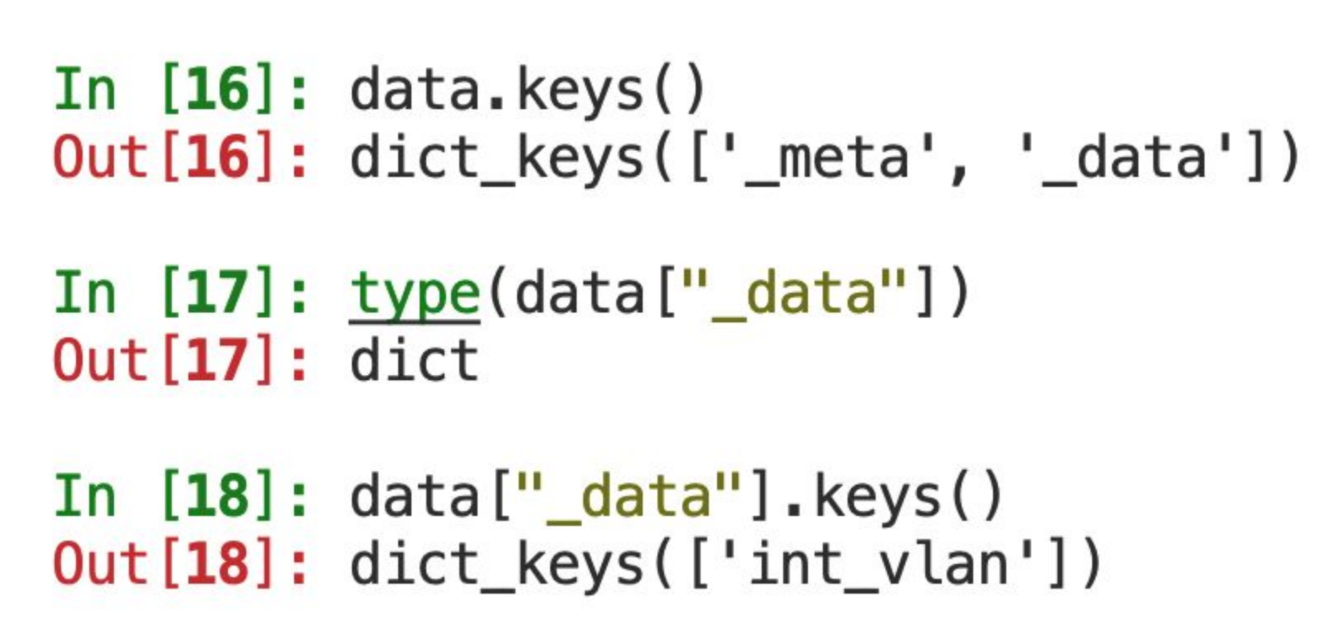
Handling Complex Data Structures
Data structures all the way down





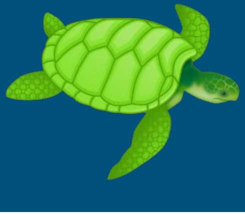
```
In [5]: print(data)
{
    '_meta': {
        'int_vlan': {
            '_mappings': {
                'root': 'int_vlan',
                'key_list': {
                    'id': 'id',
                    'int_vlan_shut': 'int_vlan_shut',
                    'int_vlan_ip.ipparams': 'int_vlan_ip.ipparams',
                    'int_vlan_ip.ipaddr': 'int_vlan_ip.ipaddr',
                    'int_vlan_ip.ipmask': 'int_vlan_ip.ipmask',
                    'int_vlan_ip.dhcp-client': 'int_vlan_ip.dhcp-client',
                    'int_vlan_ip.client-id': 'int_vlan_ip.client-id',
                    'int_vlan_ip.cid': 'int_vlan_ip.cid',
```

Step down into the data structure: Layer-by-layer



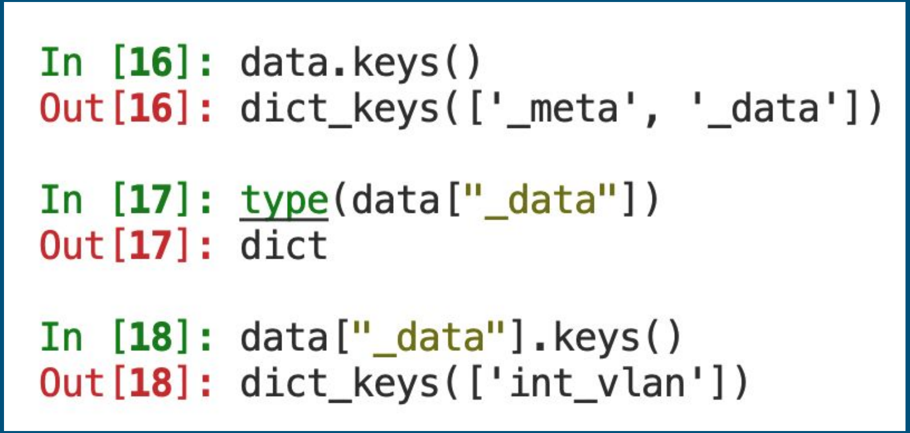
```
In [16]: data.keys()
Out[16]: dict_keys(['_meta', '_data'])

In [17]: type(data["_data"])
Out[17]: dict

In [18]: data["_data"].keys()
Out[18]: dict_keys(['int_vlan'])
```

Step down into the data structure: Layer-by-layer

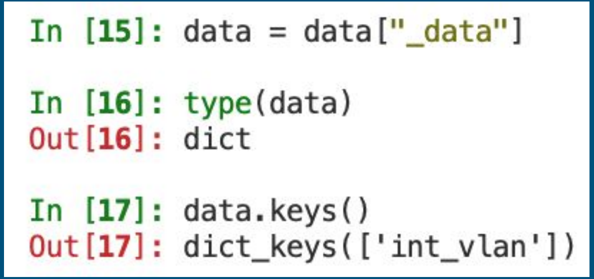


Dictionaries: Look at the Keys

Lists: Look at the List length and potentially a single element.

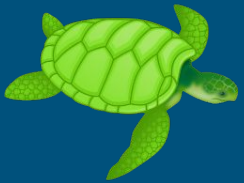


```
In [16]: data.keys()
Out[16]: dict_keys(['_meta', '_data'])

In [17]: type(data["_data"])
Out[17]: dict

In [18]: data["_data"].keys()
Out[18]: dict_keys(['int_vlan'])
```



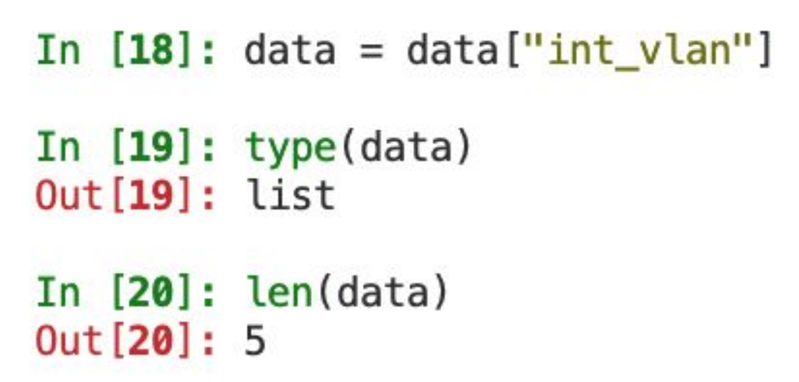
```
In [15]: data = data["_data"]

In [16]: type(data)
Out[16]: dict

In [17]: data.keys()
Out[17]: dict_keys(['int_vlan'])
```

Step down into the data structure: Layer-by-layer

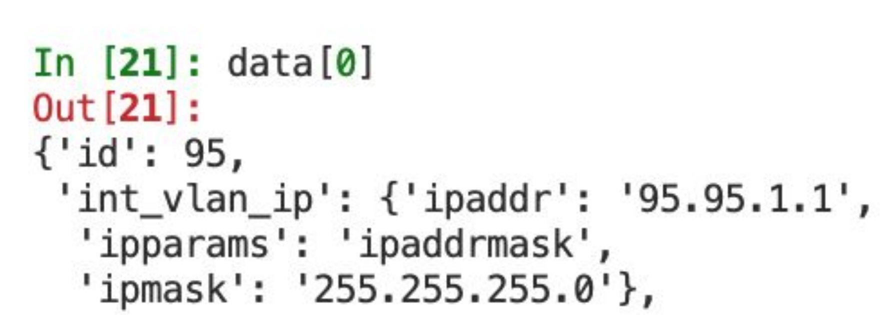


Dictionaries: Look at the Keys

Lists: Look at the List length and potentially a single element.

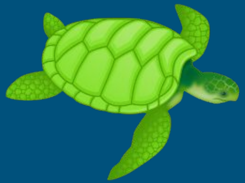


```
In [18]: data = data["int_vlan"]

In [19]: type(data)
Out[19]: list

In [20]: len(data)
Out[20]: 5
```



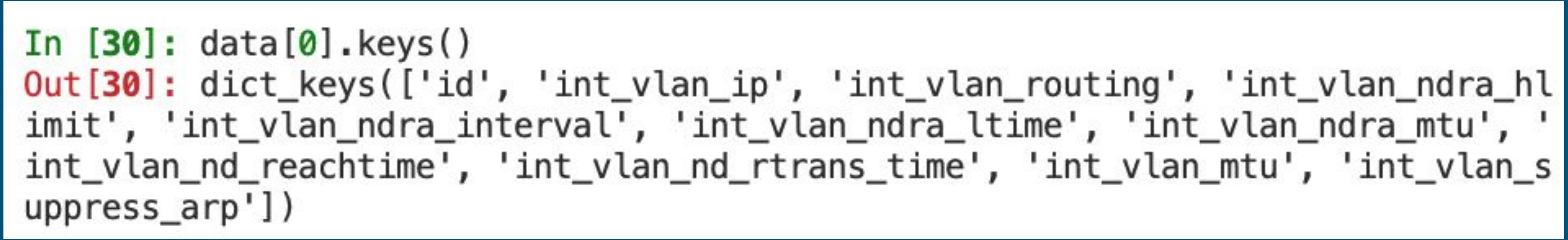
```
In [21]: data[0]
Out[21]:
{'id': 95,
 'int_vlan_ip': {'ipaddr': '95.95.1.1',
  'ipparams': 'ipaddrmask',
  'ipmask': '255.255.255.0'},
```

Step down into the data structure: Layer-by-layer



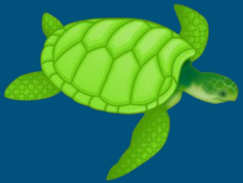
Dictionaries: Look at the Keys

Lists: Look at the List length and potentially a single element.



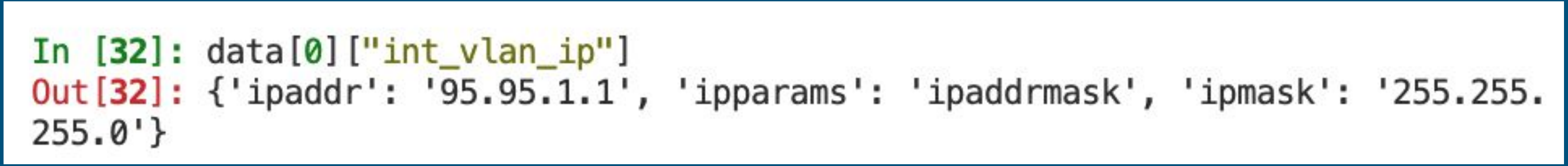
```
In [30]: data[0].keys()
Out[30]: dict_keys(['id', 'int_vlan_ip', 'int_vlan_routing', 'int_vlan_ndra_hl
imit', 'int_vlan_ndra_interval', 'int_vlan_ndra_ltime', 'int_vlan_ndra_mtu', '
int_vlan_nd_reachtime', 'int_vlan_nd_rtrans_time', 'int_vlan_mtu', 'int_vlan_s
uppress_arp'])
```

Step down into the data structure: Layer-by-layer

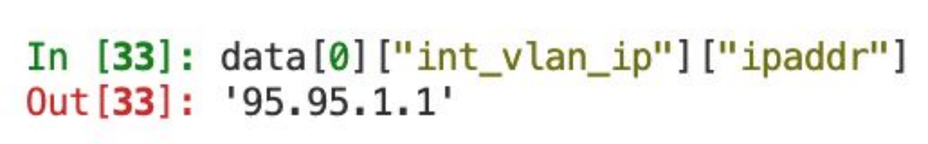


Dictionaries: Look at the Keys

Lists: Look at the List length and potentially a single element.

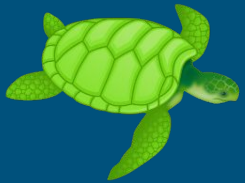


```
In [32]: data[0]["int_vlan_ip"]
Out[32]: {'ipaddr': '95.95.1.1', 'ipparams': 'ipaddrmask', 'ipmask': '255.255.
255.0'}
```

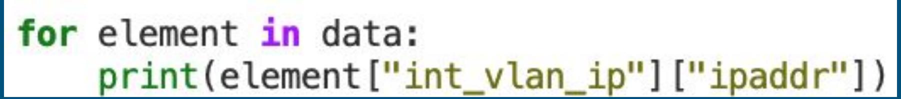


```
In [33]: data[0]["int_vlan_ip"]["ipaddr"]
Out[33]: '95.95.1.1'
```

Step down into the data structure: Layer-by-layer

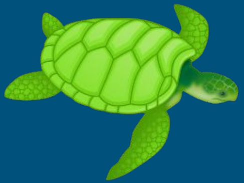


But we are still only looking at one element of this list. How to handle ALL of the elements?

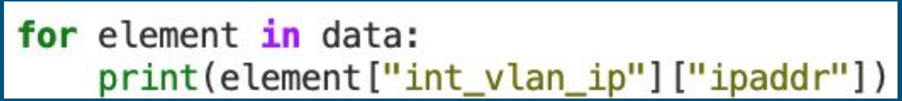


```
for element in data:
    print(element["int_vlan_ip"]["ipaddr"])
```

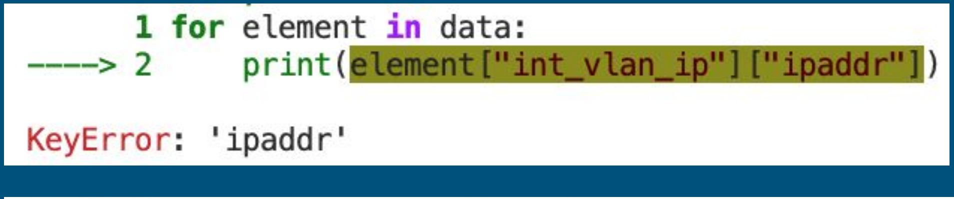
Step down into the data structure: Layer-by-layer



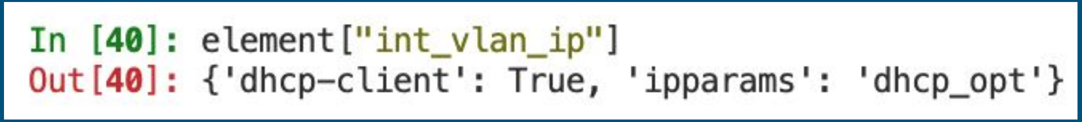
This didn't work–why not?



```
for element in data:
    print(element["int_vlan_ip"]["ipaddr"])
```

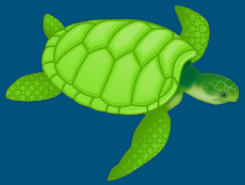


```
      1 for element in data:
----> 2     print(element["int_vlan_ip"]["ipaddr"])

KeyError: 'ipaddr'
```

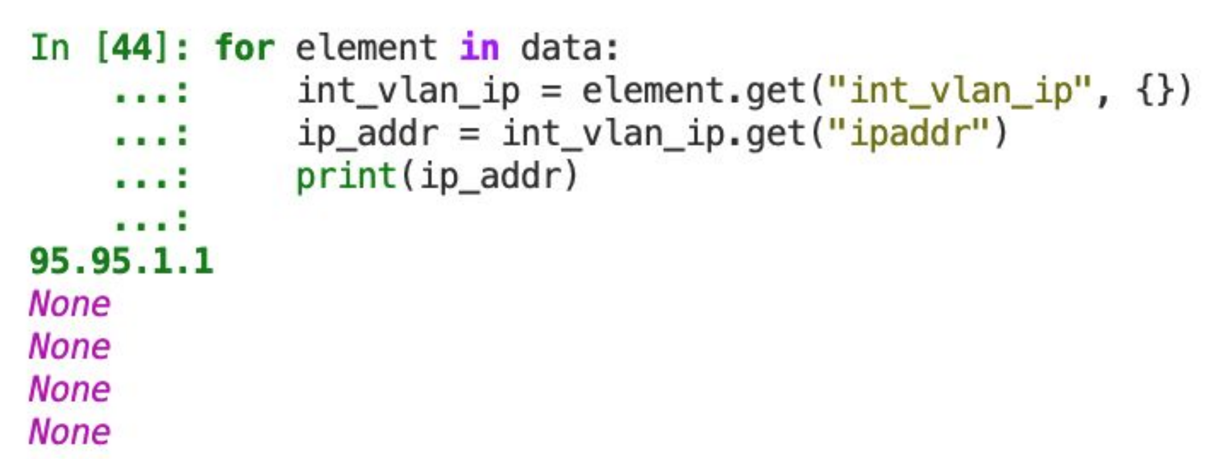


```
In [40]: element["int_vlan_ip"]
Out[40]: {'dhcp-client': True, 'ipparams': 'dhcp_opt'}
```

Step down into the data structure: Layer-by-layer



What do we do about it?



```
In [44]: for element in data:
    ...:     int_vlan_ip = element.get("int_vlan_ip", {})
    ...:     ip_addr = int_vlan_ip.get("ipaddr")
    ...:     print(ip_addr)
    ...:
95.95.1.1
None
None
None
None
```

Remember Your Process

Peel the data structure back layer-by-layer

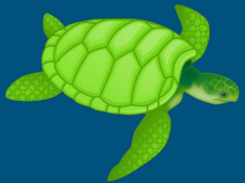
1. Determine the type of the data structure (probably either a list or a dictionary).

2. If dictionary, look at the keys (hopefully, you can pick one that you want).

3. If a list, look at the length of the list. If length is one, just unwrap the list and repeat this process.

4. If the list is longer than one, look at one single element and see if you can determine what to do from there.

5. With lists, it is possible you need to use a loop to handle all of the elements uniformly.



Complex Data Structures - Exercise2

Load the JSON file "struct_data1.json" in a Python script as a Python data structure. This text represents the routing table on a Cisco switch.

To read a JSON file, you can do the following:

```
import json
with open("my_file.json") as f:
    data = json.load(f)
```

Use rich.print to print this object to stdout so you can get a good idea what you're dealing with.

Print the type and length of the object. In this scenario, we know that all of the elements of this object are of the same type and length, but this is not always the case.

Print the type and length of the zeroith element of the object to be sure what data types you are working with.

Exercises:
./day3/complex_data_struct/struct_ex2.txt

Complex Data Structures - Exercise2

Create a new dictionary variable called "parsed_data".

Iterate through the structured data, creating a key in the "parsed_data" dictionary for every network that is NOT of "protocol" "L" (local routes).

Add the "nexthop_if" and "nexthop_ip" values to this dictionary.

rich.print your output when complete, it should look similar to this:

```
{
    '0.0.0.0': {'nexthop_interface': 'Vlan3967', 'nexthop_ip': '172.31.255.254'},
    '172.31.254.0': {'nexthop_interface': 'Vlan254', 'nexthop_ip': ''},
    '172.31.255.5': {'nexthop_interface': 'Loopback0', 'nexthop_ip': ''},
    '172.31.255.254': {'nexthop_interface': 'Vlan3967', 'nexthop_ip': ''}
}
```

Exercises:
./day3/complex_data_struct/struct_ex2.txt

Regular Expressions

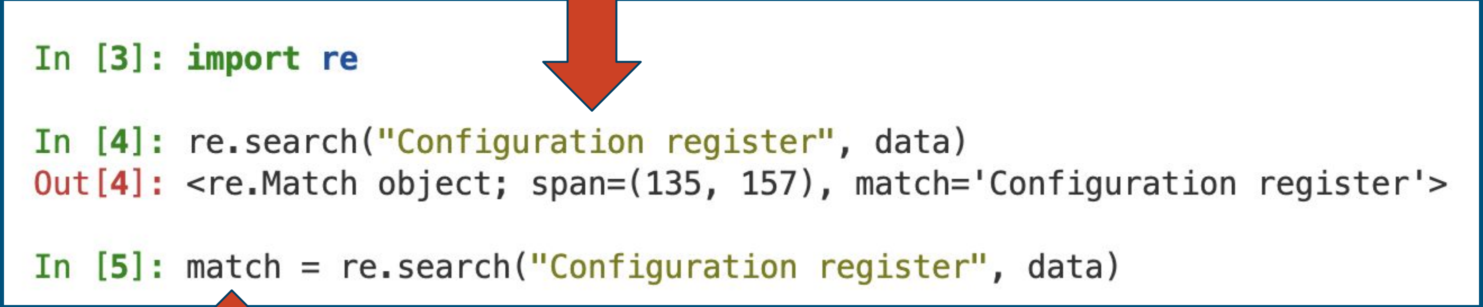
What problem are we trying to solve?

We are trying to extract information from strings and we have a special way of creating patterns to do this.

Basically we have a special "language" that we can use to construct patterns and from these patterns we can extract certain information.

Regular Expressions: The Simple Case (literal characters)

Search for the string "Configuration Register" in the variable named data.

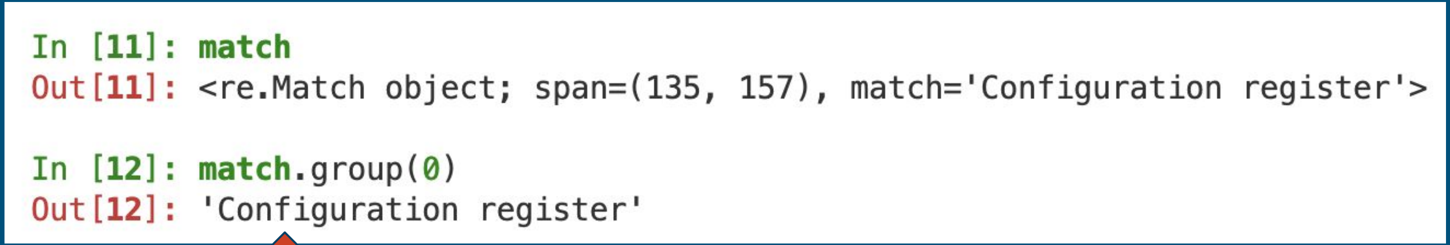


```
In [3]: import re

In [4]: re.search("Configuration register", data)
Out[4]: <re.Match object; span=(135, 157), match='Configuration register'>

In [5]: match = re.search("Configuration register", data)
```

Do we have a "match" or not.

Regular Expressions: The Simple Case (literal characters)

We can also use matching for making decisions.



```
In [11]: match
Out[11]: <re.Match object; span=(135, 157), match='Configuration register'>

In [12]: match.group(0)
Out[12]: 'Configuration register'
```

If we match, then we can use .group(0) to see the text that we matched.

But Literal Strings are not too interesting...

Regular Expressions: Special Characters

.	Any single character
.*	Any character repeated zero or more times.
.+	Any character repeated one or more times.
.?	Any character zero or one time.
\s	Whitespace character class
\S	Non-white space character class
\w	Any word character
\d	Any digit character

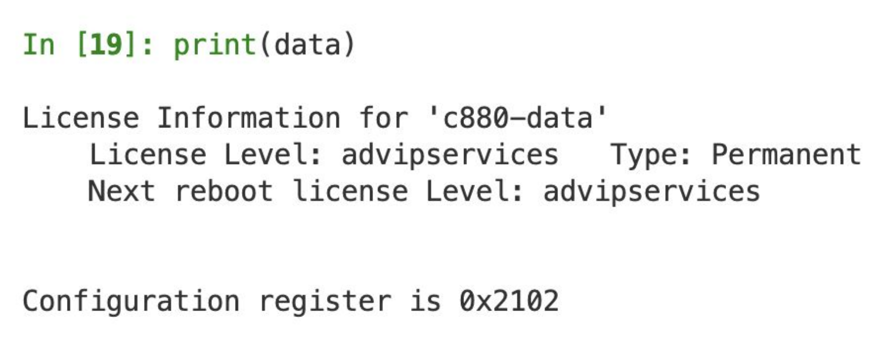
Anchors

^	Beginning of the line
$	End of the line

[ ]	Constructing your own character class

( )	Parenthesis for remembering things
(|)	Parenthesis can also be logical-or
*?	Convert to non-greedy
+?	Convert to non-greedy
\	Escape sequence

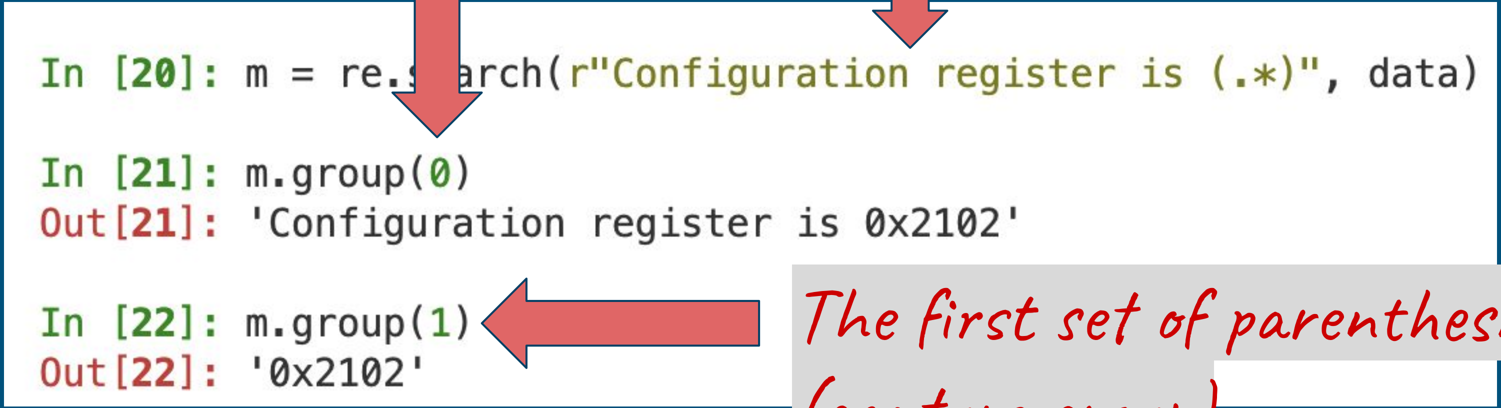
Special Character Examples



```
In [19]: print(data)

License Information for 'c880-data'
    License Level: advipservices   Type: Permanent
    Next reboot license Level: advipservices


Configuration register is 0x2102
```

group(0) = The entire match

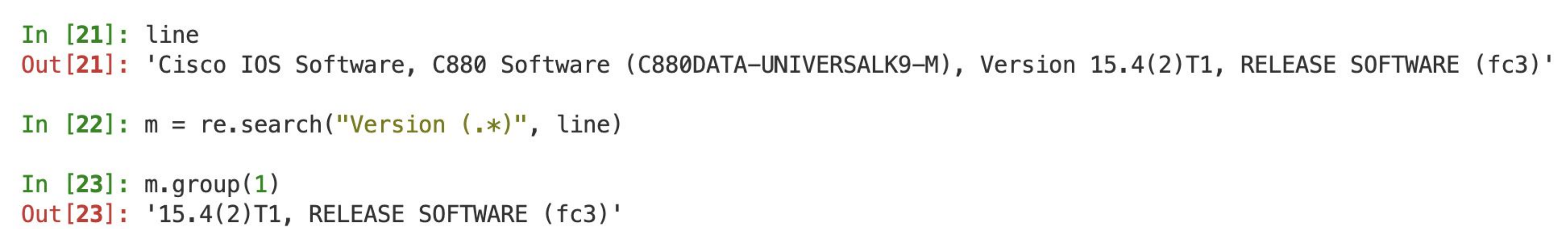
Our Pattern



```
In [20]: m = re.search(r"Configuration register is (.*)", data)

In [21]: m.group(0)
Out[21]: 'Configuration register is 0x2102'

In [22]: m.group(1)
Out[22]: '0x2102'
```

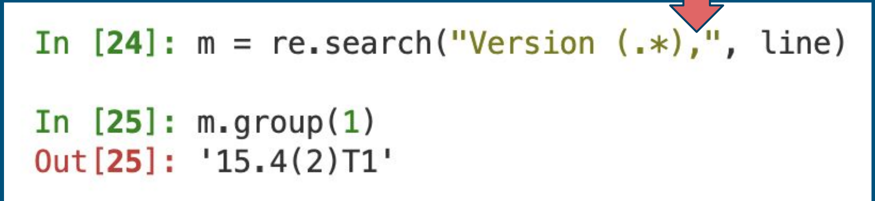
The first set of parenthesis (capture group)

Special Character Examples



```
In [21]: line
Out[21]: 'Cisco IOS Software, C880 Software (C880DATA-UNIVERSALK9-M), Version 15.4(2)T1, RELEASE SOFTWARE (fc3)'

In [22]: m = re.search("Version (.*)", line)

In [23]: m.group(1)
Out[23]: '15.4(2)T1, RELEASE SOFTWARE (fc3)'
```

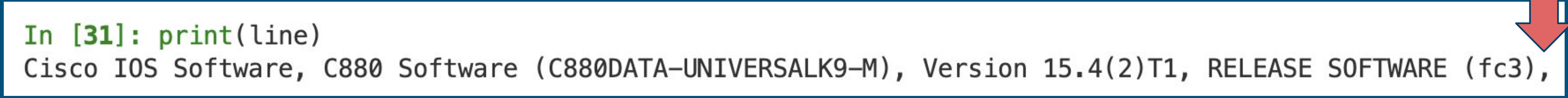
Add the comma (to stop the capturing)



```
In [24]: m = re.search("Version (.*),", line)

In [25]: m.group(1)
Out[25]: '15.4(2)T1'
```

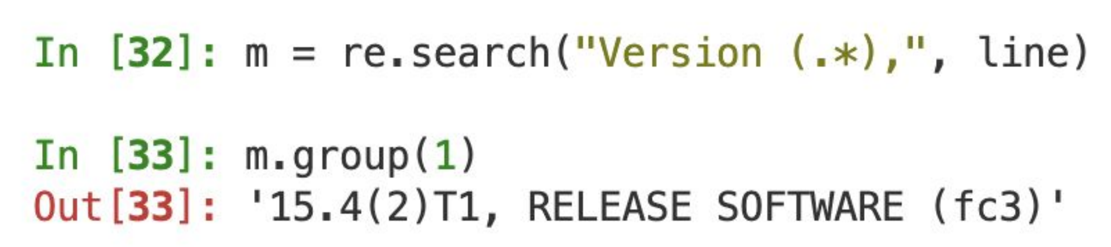
Special Character Examples

But what if line had an additional comma somewhere?



```
In [31]: print(line)
Cisco IOS Software, C880 Software (C880DATA-UNIVERSALK9-M), Version 15.4(2)T1, RELEASE SOFTWARE (fc3),
```

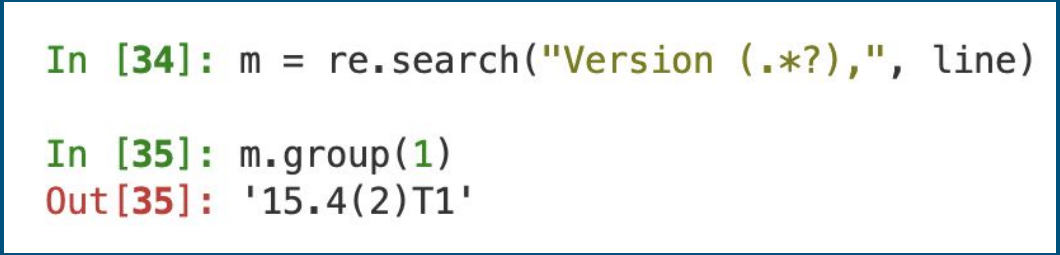
Back to our previous issue–we are capturing more than we want to.



```
In [32]: m = re.search("Version (.*),", line)

In [33]: m.group(1)
Out[33]: '15.4(2)T1, RELEASE SOFTWARE (fc3)'
```

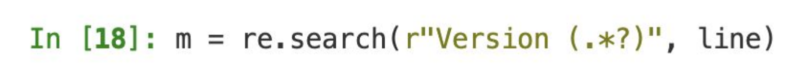
Special Character Examples

Make the wildcard be non-greedy



```
In [34]: m = re.search("Version (.*?),", line)

In [35]: m.group(1)
Out[35]: '15.4(2)T1'
```

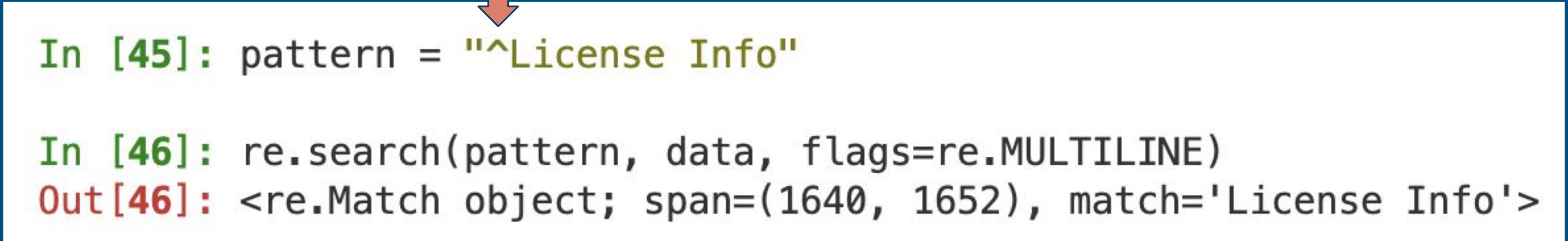
What happens if we drop the comma from the pattern?



```
In [18]: m = re.search(r"Version (.*?)", line)
```

Using Anchors

Beginning of the Line Anchor



```
In [45]: pattern = "^License Info"

In [46]: re.search(pattern, data, flags=re.MULTILINE)
Out[46]: <re.Match object; span=(1640, 1652), match='License Info'>
```

By default anchors operate on the basis of the entire string so "^" means the beginning of the entire string.

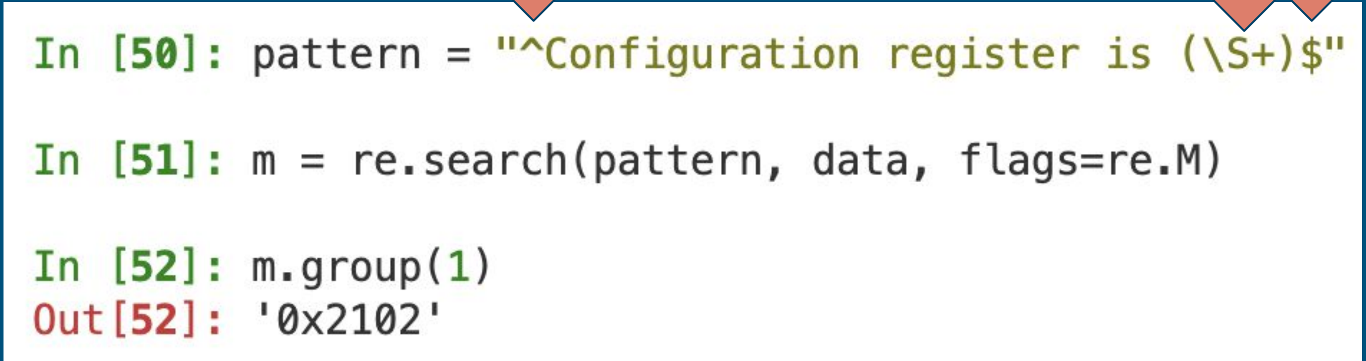
We can change this behavior by setting re.MULTILINE i.e. operate on a line-by-line basis (does this show up at the beginning of a line).

Using Anchors

Non-whitespace character class.

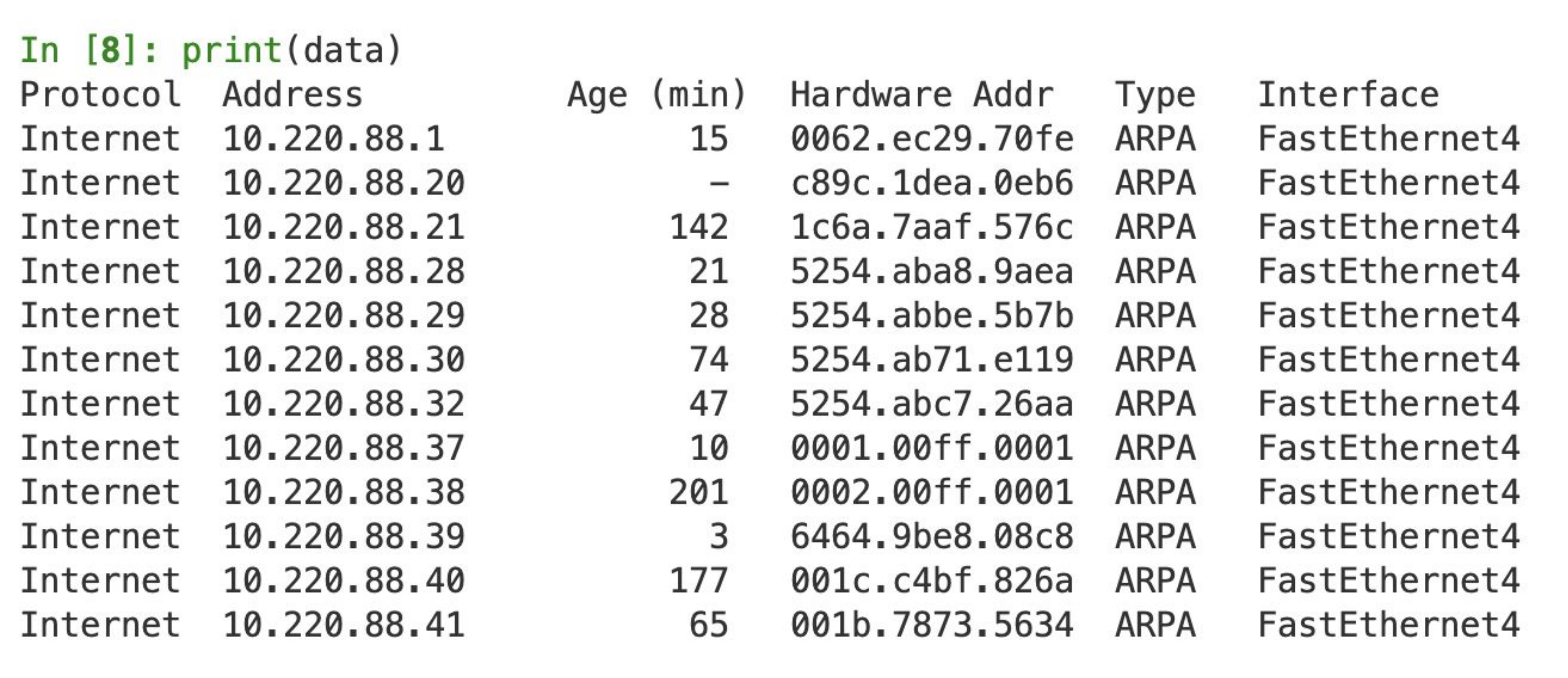
Beginning of the line

End of the line



```
In [50]: pattern = "^Configuration register is (\S+)$"

In [51]: m = re.search(pattern, data, flags=re.M)

In [52]: m.group(1)
Out[52]: '0x2102'
```

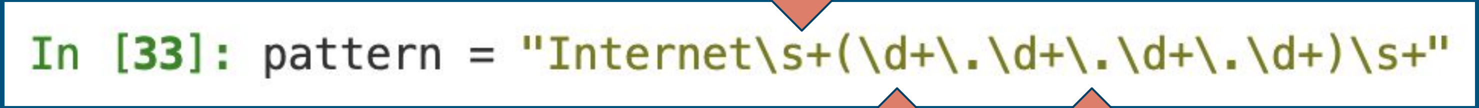
Extracting patterns that repeat



```
In [8]: print(data)
Protocol  Address                 Age (min)  Hardware Addr   Type   Interface
Internet  10.220.88.1                    15  0062.ec29.70fe  ARPA   FastEthernet4
Internet  10.220.88.20                    -  c89c.1dea.0eb6  ARPA   FastEthernet4
Internet  10.220.88.21                  142  1c6a.7aaf.576c  ARPA   FastEthernet4
Internet  10.220.88.28                   21  5254.aba8.9aea  ARPA   FastEthernet4
Internet  10.220.88.29                   28  5254.abbe.5b7b  ARPA   FastEthernet4
Internet  10.220.88.30                   74  5254.ab71.e119  ARPA   FastEthernet4
Internet  10.220.88.32                   47  5254.abc7.26aa  ARPA   FastEthernet4
Internet  10.220.88.37                   10  0001.00ff.0001  ARPA   FastEthernet4
Internet  10.220.88.38                  201  0002.00ff.0001  ARPA   FastEthernet4
Internet  10.220.88.39                    3  6464.9be8.08c8  ARPA   FastEthernet4
Internet  10.220.88.40                  177  001c.c4bf.826a  ARPA   FastEthernet4
Internet  10.220.88.41                   65  001b.7873.5634  ARPA   FastEthernet4
```

Extracting patterns that repeat

Consecutive whitespace



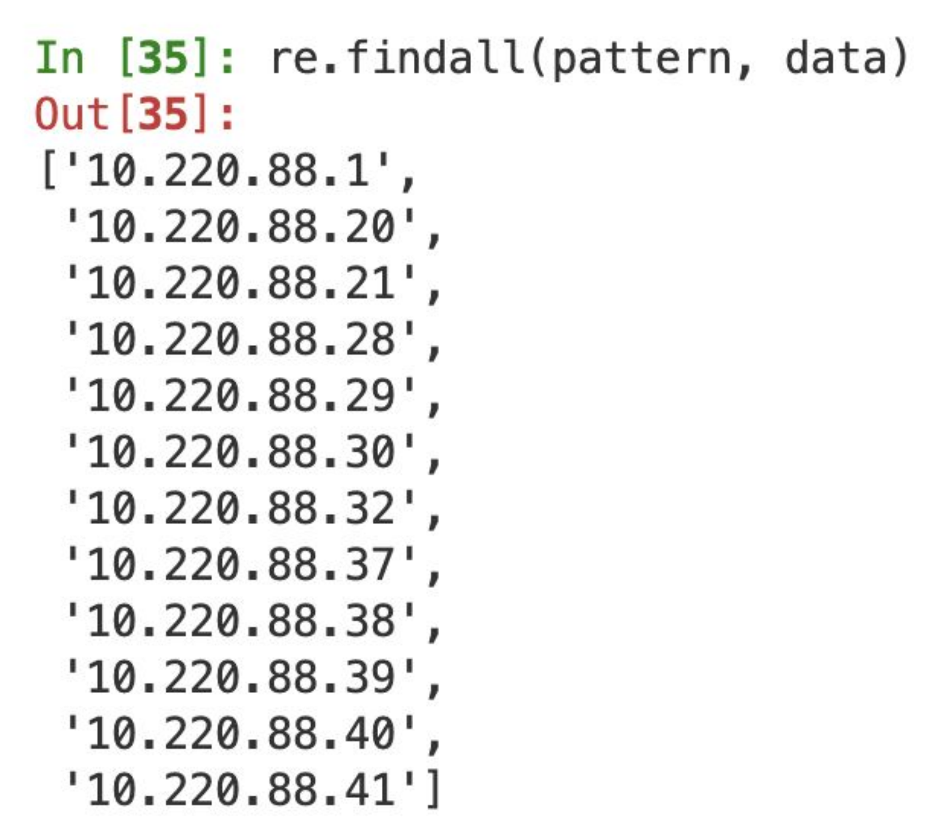
```
In [33]: pattern = "Internet\s+(\d+\.\d+\.\d+\.\d+)\s+"
```

Consecutive digits

Literal Period (backslash escape)

Retain what is in the parenthesis.

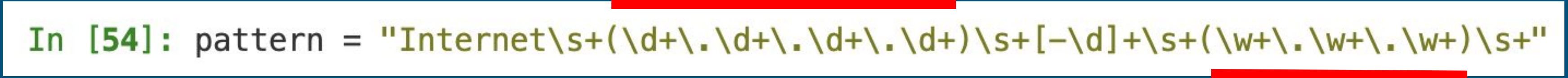
Find ALL occurrences of pattern in data (return a list)



```
In [35]: re.findall(pattern, data)
Out[35]:
['10.220.88.1',
 '10.220.88.20',
 '10.220.88.21',
 '10.220.88.28',
 '10.220.88.29',
 '10.220.88.30',
 '10.220.88.32',
 '10.220.88.37',
 '10.220.88.38',
 '10.220.88.39',
 '10.220.88.40',
 '10.220.88.41']
```

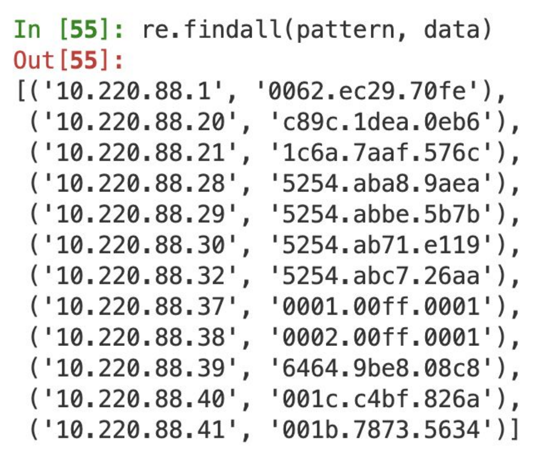
Expand on the pattern

IP Address
(capture group1)



```
In [54]: pattern = "Internet\s+(\d+\.\d+\.\d+\.\d+)\s+[-\d]+\s+(\w+\.\w+\.\w+)\s+"
```

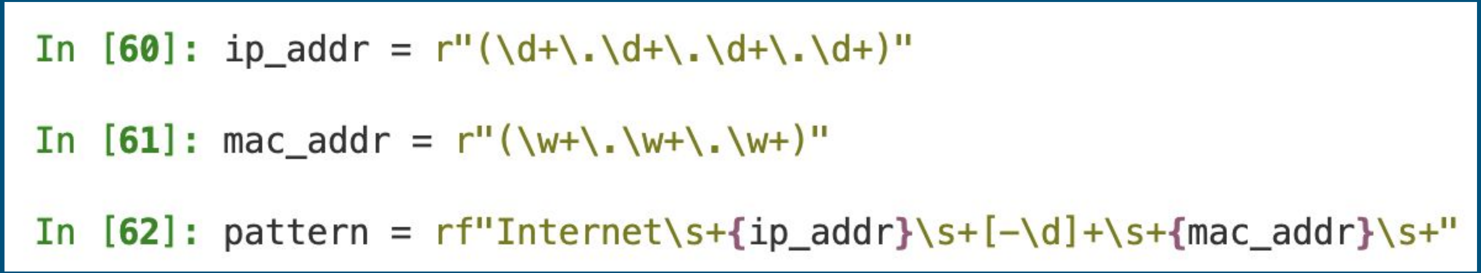
MAC Address
(capture group2)



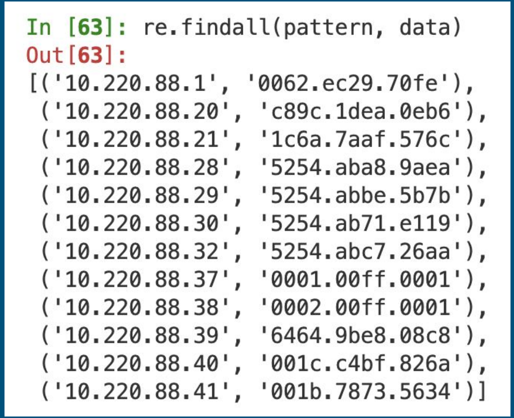
```
In [55]: re.findall(pattern, data)
Out[55]:
[('10.220.88.1', '0062.ec29.70fe'),
 ('10.220.88.20', 'c89c.1dea.0eb6'),
 ('10.220.88.21', '1c6a.7aaf.576c'),
 ('10.220.88.28', '5254.aba8.9aea'),
 ('10.220.88.29', '5254.abbe.5b7b'),
 ('10.220.88.30', '5254.ab71.e119'),
 ('10.220.88.32', '5254.abc7.26aa'),
 ('10.220.88.37', '0001.00ff.0001'),
 ('10.220.88.38', '0002.00ff.0001'),
 ('10.220.88.39', '6464.9be8.08c8'),
 ('10.220.88.40', '001c.c4bf.826a'),
 ('10.220.88.41', '001b.7873.5634')]
```

Capture both the IP Address and MAC Address in one operation.

Making things more readable



```
In [60]: ip_addr = r"(\d+\.\d+\.\d+\.\d+)"

In [61]: mac_addr = r"(\w+\.\w+\.\w+)"

In [62]: pattern = rf"Internet\s+{ip_addr}\s+[-\d]+\s+{mac_addr}\s+"
```



```
In [63]: re.findall(pattern, data)
Out[63]:
[('10.220.88.1', '0062.ec29.70fe'),
 ('10.220.88.20', 'c89c.1dea.0eb6'),
 ('10.220.88.21', '1c6a.7aaf.576c'),
 ('10.220.88.28', '5254.aba8.9aea'),
 ('10.220.88.29', '5254.abbe.5b7b'),
 ('10.220.88.30', '5254.ab71.e119'),
 ('10.220.88.32', '5254.abc7.26aa'),
 ('10.220.88.37', '0001.00ff.0001'),
 ('10.220.88.38', '0002.00ff.0001'),
 ('10.220.88.39', '6464.9be8.08c8'),
 ('10.220.88.40', '001c.c4bf.826a'),
 ('10.220.88.41', '001b.7873.5634')]
```

Resources and Where to Go Next

Python Regular Expression Documentation

https://docs.python.org/3/library/re.html

Regular Expression Utility Website

https://regex101.com/

Exercise: Regular Expressions

1. Read in the file named "aruba_show_version.txt".

2. Using regular expressions extract the Model, OS Version, and Uptime.

3. Print these items to standard output.

Exercises:
./day3/regex/exercise1.txt

Python Linters

Pylint or pycodestyle

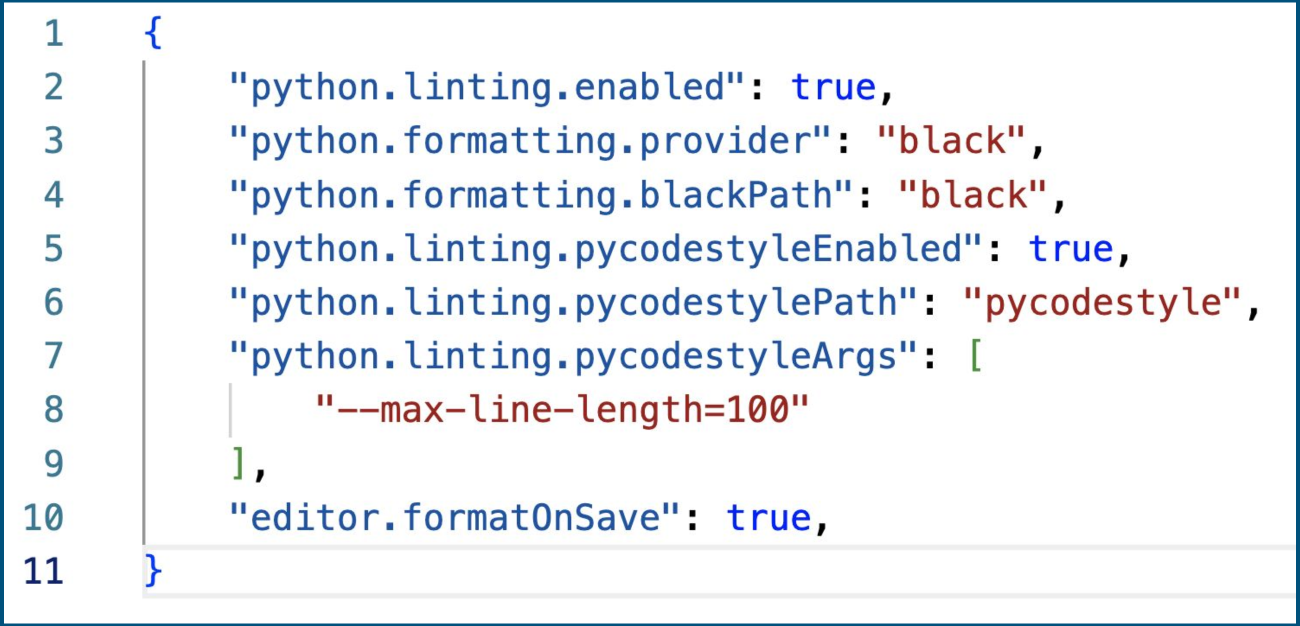
Consistency and conventions make your life easier.

Finds obvious errors. Finds problems you might not be aware of.

pylint my_file.py
pycodestyle my_file.py
pylama my_file.py

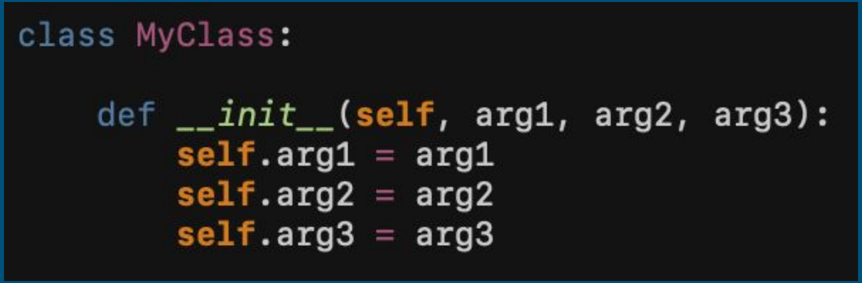
Auto formatting with Python Black

Python Linters and VS Code



```json
{
    "python.linting.enabled": true,
    "python.formatting.provider": "black",
    "python.formatting.blackPath": "black",
    "python.linting.pycodestyleEnabled": true,
    "python.linting.pycodestylePath": "pycodestyle",
    "python.linting.pycodestyleArgs": [
        "--max-line-length=100"
    ],
    "editor.formatOnSave": true,
}
```

Classes and Objects - Why?



```
class MyClass:

    def __init__(self, arg1, arg2, arg3):
        self.arg1 = arg1
        self.arg2 = arg2
        self.arg3 = arg3
```

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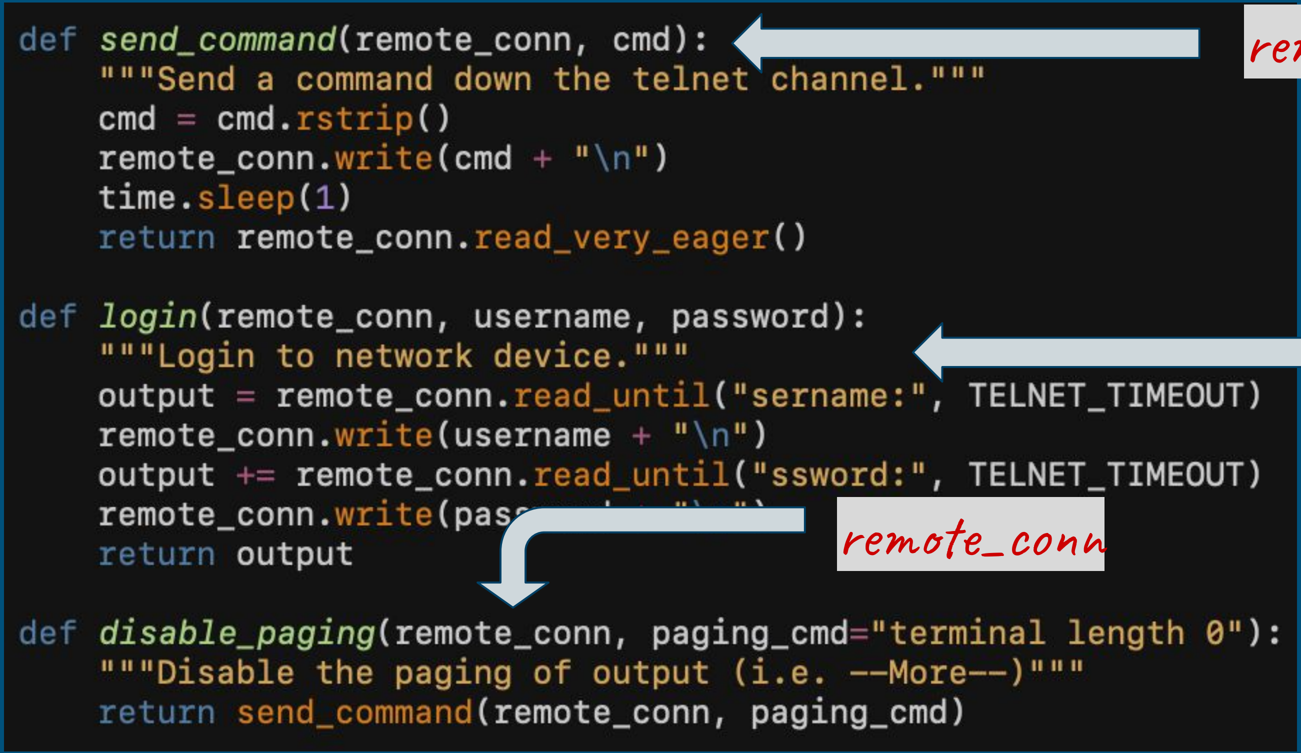
Classes and Objects - Why? Why? Why?

Code Reuse - But Why Aren't Functions Enough (or are they)?



```
def send_command(remote_conn, cmd):
    """Send a command down the telnet channel."""
    cmd = cmd.rstrip()
    remote_conn.write(cmd + "\n")
    time.sleep(1)
    return remote_conn.read_very_eager()

def login(remote_conn, username, password):
    """Login to network device."""
    output = remote_conn.read_until("sername:", TELNET_TIMEOUT)
    remote_conn.write(username + "\n")
    output += remote_conn.read_until("ssword:", TELNET_TIMEOUT)
    remote_conn.write(pas
    return output

def disable_paging(remote_conn, paging_cmd="terminal length 0"):
    """Disable the paging of output (i.e. --More--)"""
    return send_command(remote_conn, paging_cmd)
```

remote_conn

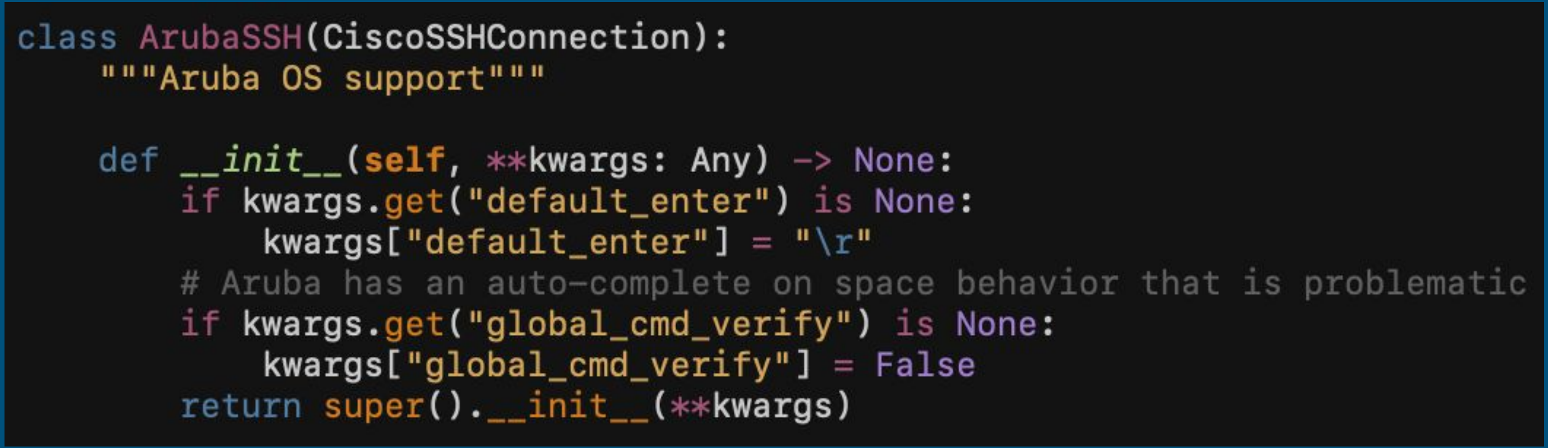
remote_conn

remote_conn

Classes and Objects - Why? Why? Why?

Code Reuse - But Why Aren't Functions Enough (or are they)?

Situations where you have a lot of common code, but you want to overwrite/replace some subset of behaviors.



```python
class ArubaSSH(CiscoSSHConnection):
    """Aruba OS support"""

    def __init__(self, **kwargs: Any) -> None:
        if kwargs.get("default_enter") is None:
            kwargs["default_enter"] = "\r"
        # Aruba has an auto-complete on space behavior that is problematic
        if kwargs.get("global_cmd_verify") is None:
            kwargs["global_cmd_verify"] = False
        return super().__init__(**kwargs)
```

Classes and Objects - Don't Miss the Forest for all the Trees!

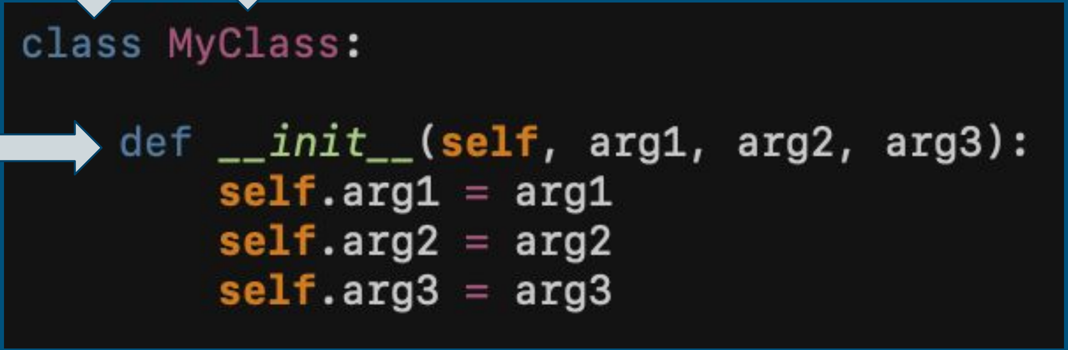
Code Reuse - But Why Aren't Functions Enough (or are they)?

Classes and Objects - Syntax

class keyword

ClassName (PascalCase)

The "init" method

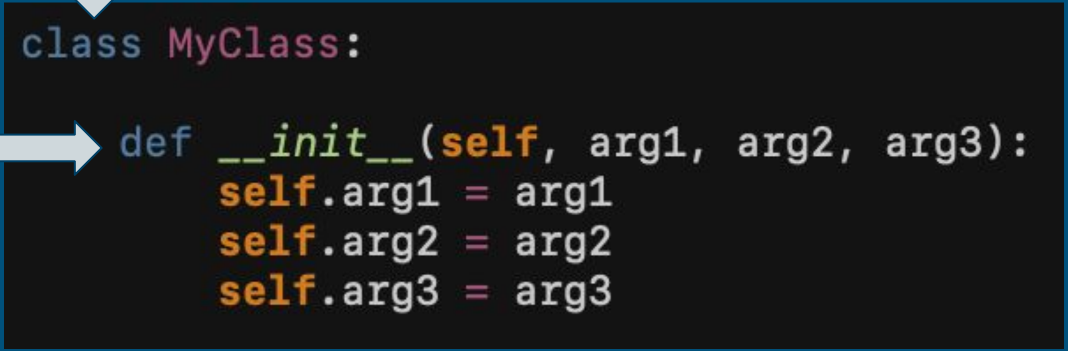


```
class MyClass:

    def __init__(self, arg1, arg2, arg3):
        self.arg1 = arg1
        self.arg2 = arg2
        self.arg3 = arg3
```

Classed and Objects - What the heck is going on with "init"

class keyword

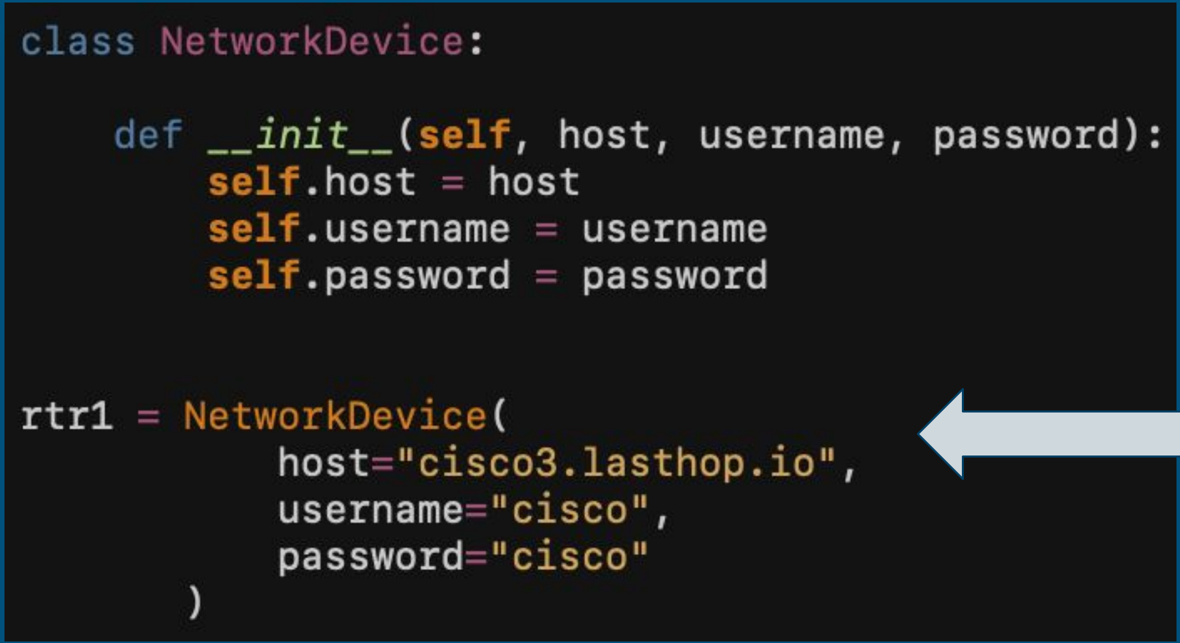
The "init" method



```
class MyClass:

    def __init__(self, arg1, arg2, arg3):
        self.arg1 = arg1
        self.arg2 = arg2
        self.arg3 = arg3
```

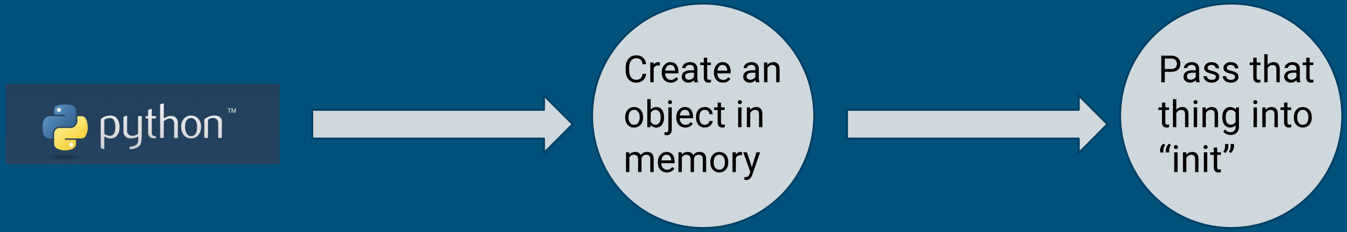
Think of it as a blueprint for what happens when you create instances of these things.

Our Blueprint



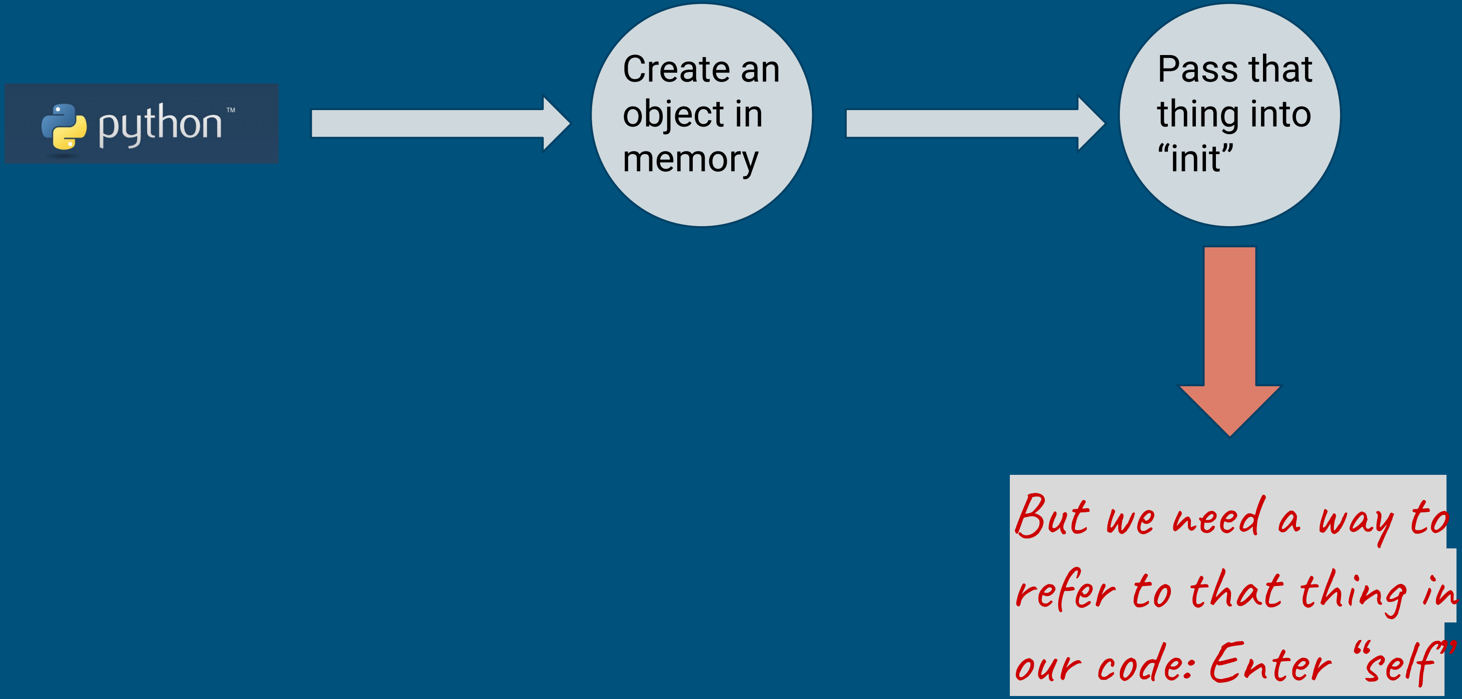
```
class NetworkDevice:

    def __init__(self, host, username, password):
        self.host = host
        self.username = username
        self.password = password


rtr1 = NetworkDevice(
            host="cisco3.lasthop.io",
            username="cisco",
            password="cisco"
    )
```

Create one of these NetworkDevice things.



Create an object in memory

Pass that thing into “init”



Create an object in memory

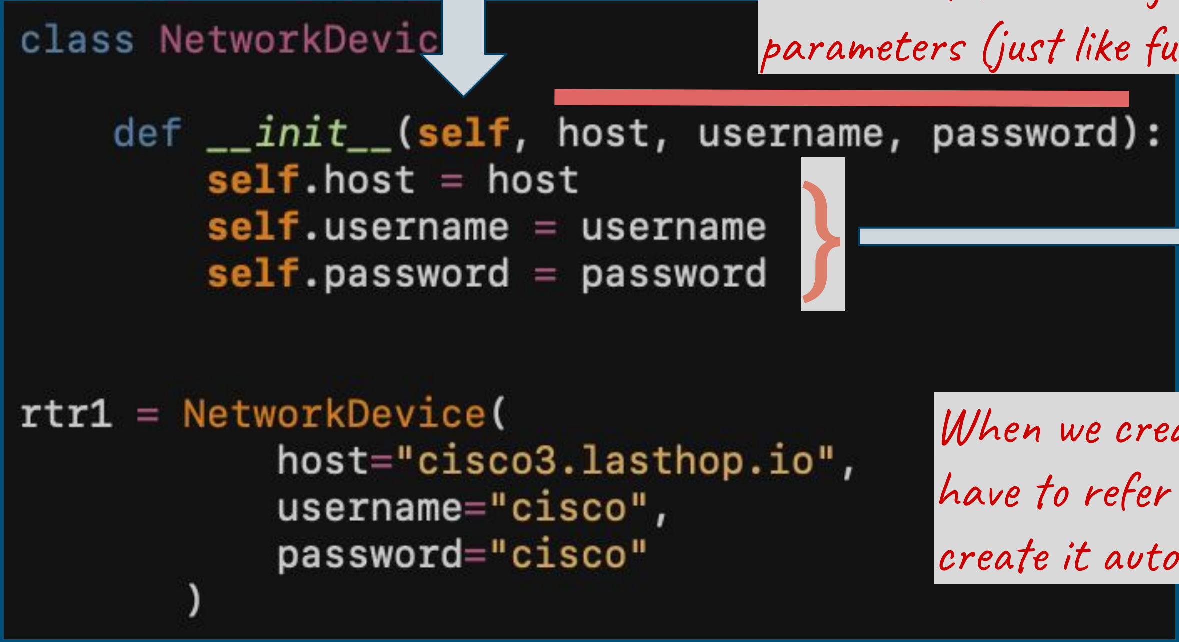
Pass that thing into "init"

But we need a way to refer to that thing in our code: Enter "self"

python™

That thing in memory

The rest of these are just normal parameters (just like functions)



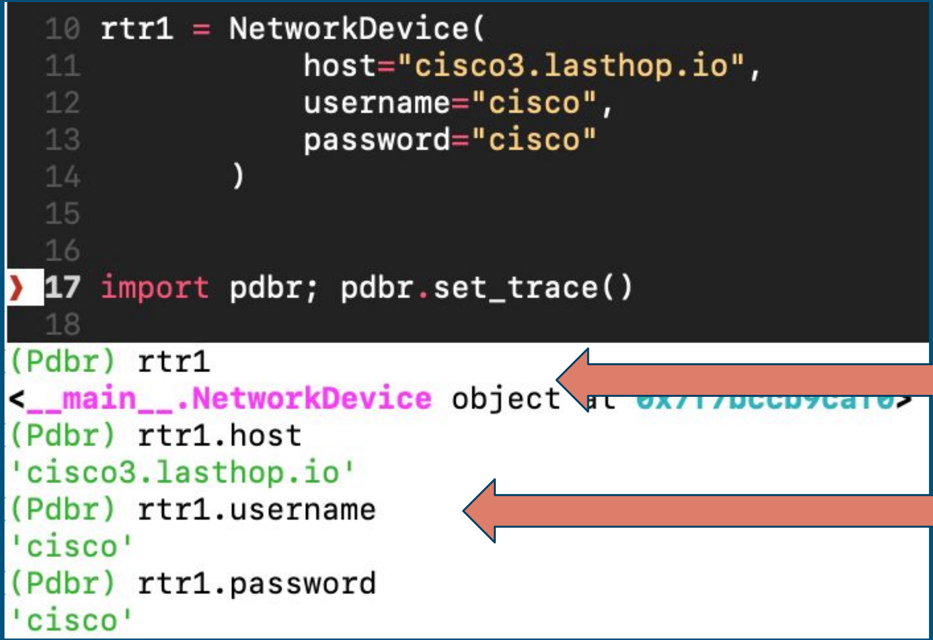
```
class NetworkDevic

    def __init__(self, host, username, password):
        self.host = host
        self.username = username
        self.password = password


rtr1 = NetworkDevice(
           host="cisco3.lasthop.io",
           username="cisco",
           password="cisco"
       )
```

A very common pattern is to assign the things you pass in to the object

When we create the object, we don't have to refer to the object (Python will create it automatically).

Why?

A very common pattern is to assign the things you pass in to the object.



```
rtr1 = NetworkDevice(
            host="cisco3.lasthop.io",
            username="cisco",
            password="cisco"
        )


import pdbr; pdbr.set_trace()

(Pdbr) rtr1
<__main__.NetworkDevice object at 0x7f7bccb9caf0>
(Pdbr) rtr1.host
'cisco3.lasthop.io'
(Pdbr) rtr1.username
'cisco'
(Pdbr) rtr1.password
'cisco'
```

We created an instance of this thing.

The thing now knows the attributes that we bound to it (in __init__).

Classes - Exercise1

Create a NetworkDevice class. The class should have fields for ip_addr, username, and password.

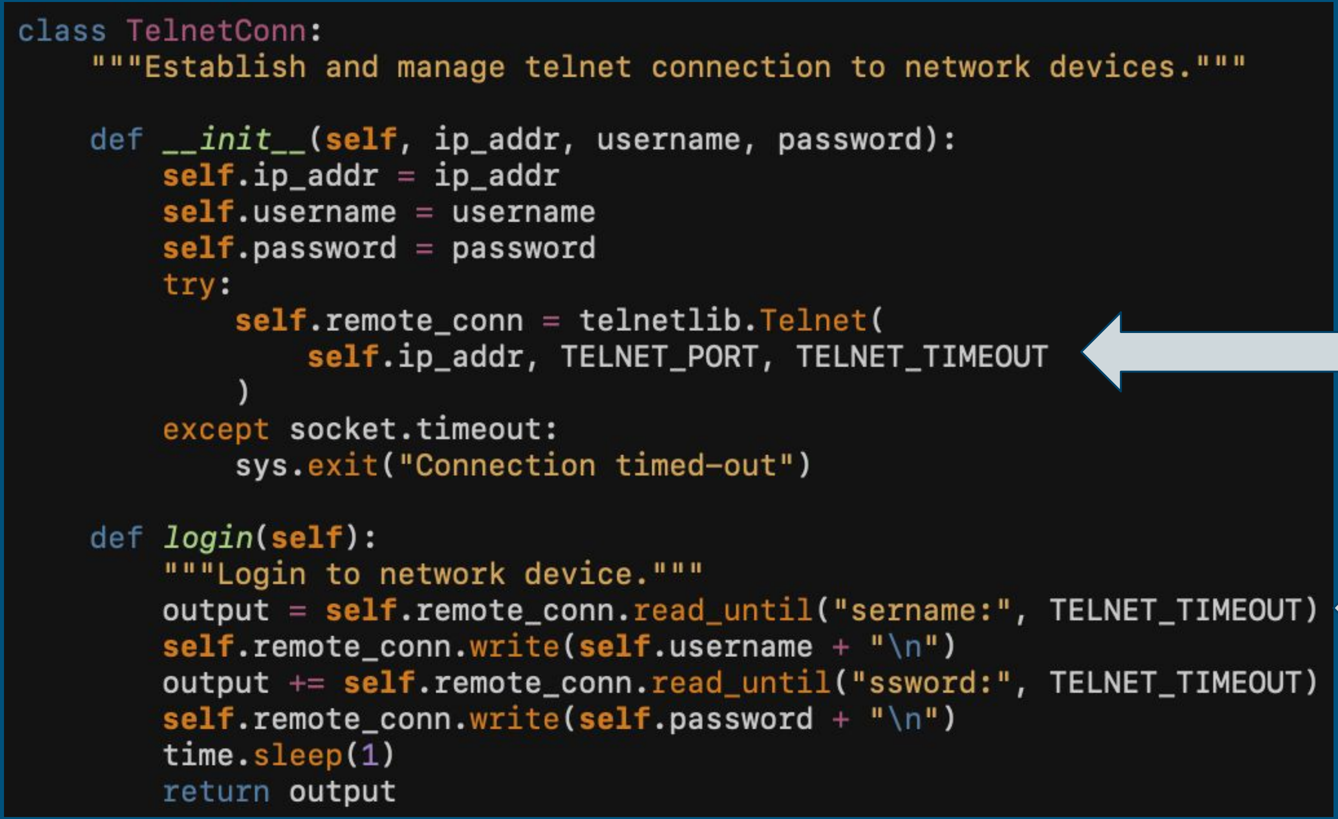
Assign the ip_addr, username, and password field to the object in the “init” method.

Create four different network device objects using this class.

For one of these objects print out the ip_addr, username, and password attributes of the object.

Exercises:
./day3/py_classes/classes_ex1.txt

Sure, okay, but what does this allow us to do?



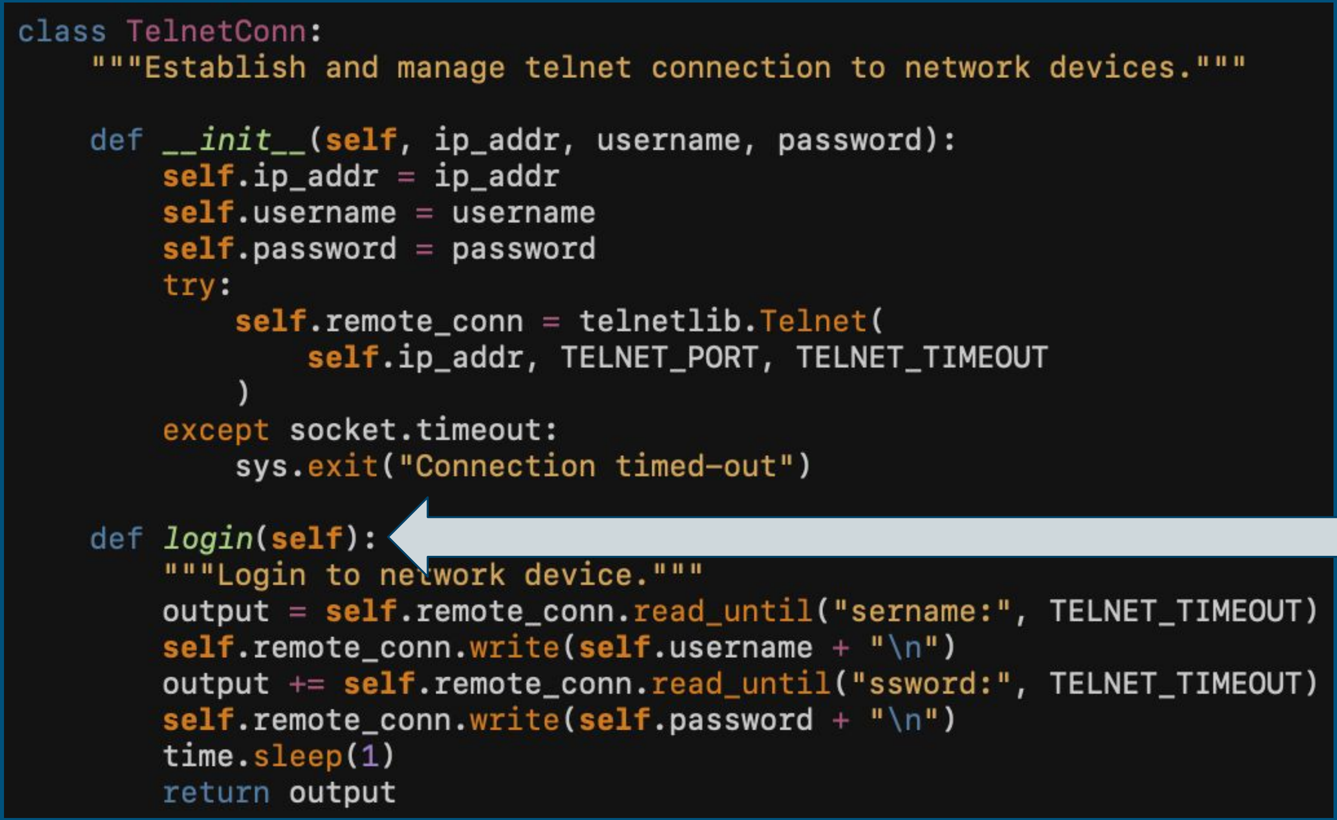
```
class TelnetConn:
    """Establish and manage telnet connection to network devices."""

    def __init__(self, ip_addr, username, password):
        self.ip_addr = ip_addr
        self.username = username
        self.password = password
        try:
            self.remote_conn = telnetlib.Telnet(
                self.ip_addr, TELNET_PORT, TELNET_TIMEOUT
            )
        except socket.timeout:
            sys.exit("Connection timed-out")

    def login(self):
        """Login to network device."""
        output = self.remote_conn.read_until("sername:", TELNET_TIMEOUT)
        self.remote_conn.write(self.username + "\n")
        output += self.remote_conn.read_until("ssword:", TELNET_TIMEOUT)
        self.remote_conn.write(self.password + "\n")
        time.sleep(1)
        return output
```

We don't need to pass the arguments any longer (they are bound to the object)

The telnet connection is bound to the object.

We can then reuse it later.

One Last Thing



```python
class TelnetConn:
    """Establish and manage telnet connection to network devices."""

    def __init__(self, ip_addr, username, password):
        self.ip_addr = ip_addr
        self.username = username
        self.password = password
        try:
            self.remote_conn = telnetlib.Telnet(
                self.ip_addr, TELNET_PORT, TELNET_TIMEOUT
            )
        except socket.timeout:
            sys.exit("Connection timed-out")

    def login(self):
        """Login to network device."""
        output = self.remote_conn.read_until("sername:", TELNET_TIMEOUT)
        self.remote_conn.write(self.username + "\n")
        output += self.remote_conn.read_until("ssword:", TELNET_TIMEOUT)
        self.remote_conn.write(self.password + "\n")
        time.sleep(1)
        return output
```

This is a method. It is just a fancy name for a function inside of an object.

One Other Last Thing

Functions work pretty well.

We are all trying to learn and apply new things.

Try to get a toehold.

Classes - Exercise2

Expand on exercise 1 and create two new methods for your NetworkDevice class.

Method1 should be named “print_ip” and should print the IP address of the device.

Method2 should be named “print_creds” and should print the username and password of the device.

Both methods should have only a single parameter “self”. No other parameters should be used.

Create an instance of this class and call your two methods.

Exercises:
./day3/py_classes/classes_ex2.txt