cheat_sheet

December 3, 2023

1 Cheat Sheet

1.1 Week 0

1.1.1 Print function:

[1]:
```
variable_to_print = 7

print(variable_to_print)

print("string to print")

print("First line \nSecond line")
```

```
7
string to print
First line
Second line
```

1.1.2 Arithmetic operators:

[4]:
```
1+2
1-2
1/2
13*2
```

[4]:
```
26
```

1.1.3 Assigning variables:

[3]:
```
close_to_pi = 355/113
print(close_to_pi)

x = 2
y = 3
z = x * y
print(z)
```

```
3.1415929203539825
6
```

1.1.4 Data Type: Strings

A string is a series of characters bounded by 'single' or "double" quotations, used interchangeably. If you are using an apostrophe or single quote inside a string, you can bound it by double quotations to still identify it as a string.

[5]:
```
my_string = 'several characters'
my_other_string = "example"
error_string = 'grandma's recipes'
fixed_string = "grandma's recipes"
```

```
  Input In [5]
    error_string = 'grandma's recipes'
                               ^
SyntaxError: invalid syntax
```

You can use some arithmetic operators on strings:

[10]:
```
oligo = "ATG"
print(oligo*3)
print(oligo + oligo)
```

```
ATGATGATG
ATGATG
A
```

1.2 Week 1

1.2.1 Useful UNIX commands:

- pwd = print working directory (where am I now?)
- ls = list (what's in this directory?)
  - ls -lah = list all files in human-readable form
- cd (destination) = change directory to an absolute or relative destination
  - cd ~ = go to user's home directory
  - cd .. = move up one directory
  - ./ = 'here'
- cp (file to be copied) (destination) = copy file to a destination
  - cp -r (directory to be copied) (destination) = copy directory to a destination
- mkdir (name of new directory) = make a new directory inside your current directory
- mv (file to be moved) (destination) = move file to new destination
  - mv -r (directory to be moved) (destination) = move directory to a destination
  - Renaming a file or directory: mv the file or directory to its current destination

- rm (file to be removed) = delete a file
  - rm -r (directory to be removed) = delete a directory
  - THIS IS FOREVER, BE SURE YOU WANT TO rm WHATEVER YOU ARE rm-ING!!
- nano (filename) - opens nano text editor on the file specified. If file doesn't exist, nano will create it
  - Use shortcut commands listed at bottom of nano screen to save file or exit
-
  - = wildcard, represents any number of any characters
    - *.txt = any file ending with .txt
    - abc* = any file that starts with abc
    - 7 = any file that has a seven somewhere in the middle
- ? = represents any one character
  - file?.txt = any file that starts with "file", has one character of any type, and ends with ".txt"
- wc = word count
  - wc -l = count number of lines
  - check out wc -h for all available options
- grep = search a file for a patter
  - grep is very detailed, check out grep -h for usage
- = pipe, take the output of the last operation and use it as the input for the next operation - grep "lily" flowers.txt | wc -l = searches for occurrences of "lily" in the flowers.txt file and returns the number of lines

1.3 Week 2

1.3.1 Data types:

[12]:
```
my_string = 'string'
my_int = 7
my_float = 7.0
my_list = [7, "petal", "sepal", 5.8]

print(type(my_string))
print(type(my_int))
print(type(my_float))
print(type(my_list))
```

```
<class 'str'>
<class 'int'>
<class 'float'>
<class 'list'>
```

1.3.2 Numpy arrays:

[14]:
```
import numpy as np
array = np.array([1,1,2,3,5,8])
print(array)
print(type(array))
```

```
[1 1 2 3 5 8]
<class 'numpy.ndarray'>
```

You can apply operations across an array:

[15]:
```
print(array + 1)
```

```
[2 2 3 4 6 9]
```

1.3.3 Indexing:

Use square brackets [ ] after a list or array name to indicate which value in the list or array you want to indicate:

[53]:
```
array[0]
```

[53]: 1

[55]:
```
array_2D = np.array([[1,1,2,3,5,8],[4,6,6,1,9,8]])
array_2D[1,4]
```

[55]: 9

[56]:
```
my_list[2]
```

[56]: 'sepal'

Use negatives to index off the end of the list or array:

[57]:
```
array[-1]
```

[57]: 8

1.3.4 Slicing:

Use a colon `[x:y]` to indicate "from x up to but not including y" Use two colons `[x:y:z]` to indicate "from x up to but not including y, counting by z" Omit the x and/or y values to indicate the beginning or end: - `[:y]` = "from the beginning up to but not including y" - `[x:]` = "from x to the end" - `[:]` = "the whole thing" - `[::-1]` = "the whole thing in reverse (counting by -1)"

[15]:
```
import numpy as np
array = np.array([1,1,2,3,5,8])
array_slice = array[1:5]
print(array_slice)
```

```
print(array[0:6:2]) # prints every other value
print(array[::-1]) # prints the array in reverse
```

```
[1 2 3 5]
[1 2 5]
[8 5 3 2 1 1]
```

2D arrays are sliced just as you'd indicate a Cartesian position with (x,y)

[24]:
```
import numpy as np
array_2D = np.array([[1,1,2,3,5,8],[4,6,6,1,9,8]])
print("ex1:", array_2D[1,2:5]) # Row [1], Columns [2:5]
print("ex2:", array_2D[:,:2]) # All rows, the first two columns
```

```
ex1: [6 1 9]
ex2: [[1 1]
 [4 6]]
```

1.4 Week 3

- Read in data from a .csv file (comma separated variables)

`import numpy as np data = np.loadtxt('path_to_csv/csv_name.csv', delimiter = ',')`

1.4.1 Generate heatmap:

`import matplotlib.pyplot as plt plt.imshow(data) plt.colorbar() plt.ylabel('y label') plt.xlabel('x label')`

1.4.2 np.arange(x,y,z)

Produces a range from value x up to but not including y, counting by z

[8]:
```
import numpy as np
print(np.arange(2,15))
print(np.arange(0,10,2))
print(np.arange(5,1,-1))
```

```
[ 2  3  4  5  6  7  8  9 10 11 12 13 14]
[0 2 4 6 8]
[5 4 3 2]
```

1.4.3 np.mean()

Takes the mean of an array or across the rows or column `np.mean(array)` returns the mean of all values in the array `np.mean(array, axis = 0)` takes the mean of each column `np.mean(array, axis = 1)` takes the mean of each row

Note: don't forget to check the shape of your output array to be sure you took the mean of the dimension you wanted.

np.max(), **np.min()**, and **np.sum()** function in the same way

1.4.4 np.zeros(n), np.ones(n)

Create an array of zeros or ones of length n

[25]:
```
import numpy as np

print(np.zeros(7))
print(np.ones(5))
print(np.ones(5)+3)
```

```
[0. 0. 0. 0. 0. 0. 0.]
[1. 1. 1. 1. 1.]
[4. 4. 4. 4. 4.]
```

1.4.5 Plotting: Scatter plots, etc.

- Create a scatter plot: `plt.scatter(x, y, color = , marker = , etc.)`

1.4.6 For-loops

Structure: `for <variable> in <iterable object>: do action`

Anything indented will be contained in the loop

[27]:
```
odds=[1,3,5,7]     # Define list (iterable)
for num in odds:   # For each variable (called num) in odds, do:
    print(num)     # Action (print the variable)
```

```
1
3
5
7
```

[28]:
```
odds=[1,3,5,7]
for anything in odds:  # the iterable variable can be called anything you want
    print(anything)
```

```
1
3
5
7
```

[29]:
```
odds=[1,3,5,7]
for num in odds:
    print('loop')    # The action doesn't need to necessarily use the variable.
                     # in this case, the action (print('loop')) is performed as␣
 ↪many times as there are variables in the list
```

```
loop
loop
loop
loop
```

1.4.7 Appending to lists:

[39]:
```
odds=[1,3,5,7]
more_odds = odds + [9]
print(more_odds)
```

```
[1, 3, 5, 7, 9]
```

[40]:
```
more_odds.append(11) # Note you don't have to assign more_odds.append() to a␣
 ↪new variable, more_odds is automatically updated with .append()
print(more_odds)     # In fact, if you run this cell a few more times, it will␣
 ↪continue to append
```

```
[1, 3, 5, 7, 9, 11]
```

1.4.8 Creating a counter for a for-loop:

[42]:
```
counter = 0
for i in range(0,5):
    print('loop ', counter)
    counter += 1               # This notation += is shorthand for "counter =␣
 ↪counter + 1"
```

```
loop  0
loop  1
loop  2
loop  3
loop  4
```

1.4.9 enumerate():

`enumerate()` automatically creates a counter by generating an 'enumerate object' of the format `[(0, item[0]), etc.]`

[45]:
```
my_list = ['alpha', 'bravo', 'charlie', 'delta', 'echo']
print(list(enumerate(my_list)))
```

```
[(0, 'alpha'), (1, 'bravo'), (2, 'charlie'), (3, 'delta'), (4, 'echo')]
```

You can assign the counter value and the list value to two variables so that they are both callable in the for-loop:

[47]:
```
for counter, list_value in enumerate(my_list):
    print(counter)
    print(list_value)
```

```
0
alpha
1
bravo
```

```
2
charlie
3
delta
4
echo
```

1.5 Week 4

1.5.1 Defining Functions

[4]:
```
def my_function(input_string):
    print('This is the function printing:', input_string)
    return input_string + ': this is the returned value'

print(my_function('A string'))
```

```
This is the function printing: A string
A string: this is the returned value
```

The function above has these parts: - definition statement: def + the name of the function + any number of arguments/parameters taken in by the function - The arguments/parameters are the variables that will be used by the function, and make it so that you can run the function with different input values - the action: in this case it is a simple print call, but you can make the action as complex as you need - the return statement: this identifies the value that will be output by the function - any variables defined within a function will not be available outside the function - only the returned variable will be output.

Here's a more complex example:

[5]:
```
def my_other_function(x, y, list_of_ints):
    num_list = []
    for i in list_of_ints:
        num = x + y*i
        num_list.append(num)
    return num_list

output_value = my_other_function(2, 3, [4,5,6])
print(output_value)
```

```
[14, 17, 20]
```

- This function takes in three arguments: `x`, a number, `y`, another number, and `list_of_ints`, a list of integers.
- an empty list, `num_list`, is defined, which will be a place to store the values the function generates
- a for-loop takes each value in the `list_of_ints` and includes them in the equation `x + y*(current_variable_in_list_of_ints)`, and assigns that value to the variable `num`

- `num` is the added to the list `num_list`
- the function returns `num_list` so that when the function is called and assigned to `output_value`, the variable `output_value` now contains the returned `num_list` from `my_other_function`

1.5.2 Nested for-loops

If you write a for-loop within another for-loop, the interior for-loop will run fully each time the exterior for-loop iterates:

[19]:
```
my_list = ['alpha', 'bravo', 'charlie']
for list_val in my_list:
    print(list_val)
```

```
alpha
bravo
charlie
```

[20]:
```
my_list = ['alpha', 'bravo', 'charlie']
for list_val in my_list:
    print(list_val)
    for letter in list_val:
        print(letter)
```

```
alpha
a
l
p
h
a
bravo
b
r
a
v
o
charlie
c
h
a
r
l
i
e
```

1.5.3 Logical Operators

- , <, >=, <=, == (is equal), != (is not equal)
- These operators can be used to compare various objects

- The output of a logical operation is a Boolean value (`True` or `False`)

[22]:
```
print(5>3)
print(5<3)
```

```
True
False
```

[30]:
```
string1 = 'alpha'
string2 = 'kilo'
string3 = 'alpha'
string4 = 'alpaca'

print(string1 < string2) # when > or < are used to compare strings, they␣
 ↪evaluate alphabetical order

print(string3 < string4)

print(string1 == string3)

print(string1 != string2)
```

```
True
False
True
True
```

- Using a logical operator to compare two arrays will return another array of the same shape containing Boolean values.
  - Each element of the first array will be compared to the corresponding element of the second array

[32]:
```
import numpy as np
array1 = np.array([1,1,2,3,5,8])
array2 = np.array([4,6,6,1,9,8])

comparison_array = array1 > array2
comparison_array
```

[32]:
```
array([False, False, False,  True, False, False])
```

[34]:
```
array_2D_1 = np.array([[1,1,2,3,5,8],[4,6,6,1,9,8]])
array_2D_2 = np.array([[5,4,2,7,3,4],[5,3,1,2,9,8]])

comparison_array_2D =  array_2D_1 == array_2D_2
comparison_array_2D
```

[34]:
```
array([[False, False,  True, False, False, False],
       [False, False, False, False,  True,  True]])
```

By applying a Boolean array to another array, you select for True values:

[40]:
```
array_2D_1 = np.array([[1,1,2,3,5,8],[4,6,6,1,9,8]])
array_2D_2 = np.array([[5,4,2,7,3,4],[5,3,1,2,9,8]])

comparison_array_2D =  array_2D_1 == array_2D_2

output_array = array_2D_1[comparison_array_2D]

print("Original:\n",array_2D_1)
print("Comparison:\n",comparison_array_2D)
print("Output:\n",output_array) # This 'applies' the Boolean array to the␣
 ↪original array, returning only the
                                 # values that correspond to "True" in␣
 ↪comparison_array_2D
```

```
Original:
 [[1 1 2 3 5 8]
 [4 6 6 1 9 8]]
Comparison:
 [[False False  True False False False]
 [False False False False  True  True]]
Output:
 [2 9 8]
```

1.5.4 If/else-statements:

Use logical operators inside an if-statement to perform an action if a condition is met:

[41]:
```
x = 7
if x > 5:
    print("X is greater than five")
```

```
X is greater than five
```

Add an `else` condition to specify what happens if the condition is not met:

[42]:
```
x = 3
if x > 5:
    print("X is greater than five")
else:
    print("X is not greater than five")
```

```
X is not greater than five
```

1.5.5 in statements:

- Evaluate whether an element is in an object

[46]:
```
letter = 'a'
string_list = ['alpha', 'kilo']

for string in string_list:
    if letter in string:
        print(string,"contains an",letter)
    else:
        print(string,"has no",letter)
```

```
alpha contains an a
kilo has no a
```

[48]:
```
num_list = [0,4,6,1,2]
print(4 in num_list)
print(3 in num_list)
```

```
True
False
```

1.6 Week 5

- Define a figure and axes variables: `my_fig = plt.figure()` `ax = plt.axes()` `ax.plot(x,y)` `ax.set_xlabel('horizontal label')` `ax.set_ylabel('vertical label')` `ax.set_title('my title')` `ax.set_xlim(0, 100)` `ax.axvline(2)` `ax.axhline(6,color='r')`

Defining a figure with plt.figure() allows you to work on multiple figures at one time, each assigned to a different variable, i.e.:

[21]:
```
import matplotlib.pyplot as plt


fig1 = plt.figure()
fig2 = plt.figure()
fig3 = plt.figure()
```

```
<Figure size 640x480 with 0 Axes>
```

```
<Figure size 640x480 with 0 Axes>
```

```
<Figure size 640x480 with 0 Axes>
```

1.6.1 np.diff()

`np.diff` calculates the differences between adjacent values in an array:

[18]:
```
output = np.diff(np.array([1,1,2,3,5,8,13]))
output
```

[18]:
```
array([0, 1, 1, 2, 3, 5])
```

(1-1 = 0, 2-1 = 1, 3-2 = 1, etc.)

Notice how many values are in each array above.

1.6.2 Plotting labels & legends:

When you call a plotting function, if you define a label for your line, bar, etc., and call the plt.legend() function, the legend will automatically populate with the labels for each line:

`plt.plot(x,y, label = "my_line") plt.legend()`

This is particularly useful when plotting many lines. If you have a list of your line names, you can iterate through them with a for-loop:

`line_names = ["line1", "line2" ,"line3"] for i in lines: plt.plot(lines[i], label = line_names[i])`

1.6.3 While Loops:

Format: `while <condition is met>: do function`

[30]:
```
i = 0
while i < 7:
    i = i+1
    print(i)
```

```
1
2
3
4
5
6
7
```

1.7 Week 6:

Subsetting arrays with conditionals:

[38]:
```
#Define an array
arr = np.array([[2,4,1,7],[9,4,7,6],[1,2,1,5],[4,8,8,1]])
print(arr, "\n")

#Make a selection based on a conditional (values greater than 5)
conditional_selection = arr > 5
print(conditional_selection, "\n")

#Subset the original array with the selection array
subset_arr = arr[conditional_selection]
print(subset_arr) # This returns an array of all the values from the original␣
 ↪array that are greater than 5
```

```
[[2 4 1 7]
 [9 4 7 6]
```

```
 [1 2 1 5]
 [4 8 8 1]]

[[False False False  True]
 [ True False  True  True]
 [False False False False]
 [False  True  True False]]

[7 9 7 6 8 8]
```

1.7.1 np.argmax(), np.argmin(), np.argsort()

[47]:
```
np.argmax(arr) # Returns the index of the max value in an array (reads a 2D array like 1D),
               #i.e. the 4th index is the first value of the second row
```

[47]:
```
4
```

[58]:
```
np.argmax(arr, axis = 1) # gives the index of the max value for each row
```

[58]:
```
array([3, 0, 3, 1])
```

[42]:
```
np.argmax(arr, axis = 0) # gives the index of the max value for each column
```

[42]:
```
array([1, 3, 3, 0])
```

np.argmin() behaves the same, but finds the index of the min

np.argsort() returns the indexes of the array if it were to be sorted:

[50]:
```
print(arr[0])
print(np.argsort(arr[0]))
```

```
[2 4 1 7]
[2 0 1 3]
```

Read this as: the sorted order of the first row is the `[2]` value, then the `[0]` value, then the `[1]` value, then the `[3]` value.

A for-loop to demonstrate:

[52]:
```
for i in np.argsort(arr[0]):
    print(arr[0,i])
```

```
1
2
4
7
```

1.7.2 Creating subplots:

- Defining figure and figuresize `fig=plt.figure(figsize=(10,3))`
- Making subplots:

```
fig,ax=plt.subplots()
fig, (ax1,ax2)=plt.subplots(1,2)
fig.savefig('myfig.pdf')
```

- Methods of the axis class:

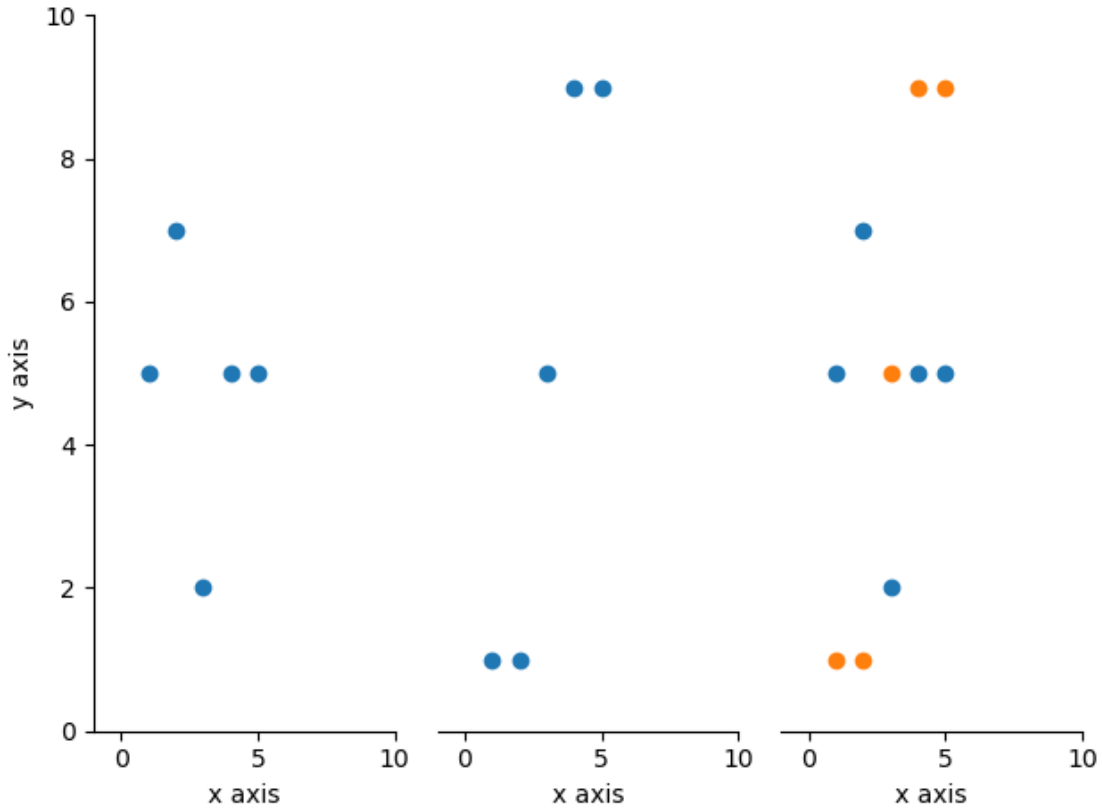
```
ax.xticks
ax.yticks
ax.set_ylim
ax.set_xlim
ax.xticklabels
ax.yticklabels
ax.text
ax.spines
ax.set_aspect
```

- Useful reference: Matplotlib Gallery examples For instance, subplots example

[53]:
```
import numpy as np
import matplotlib.pyplot as plt

arr1 = np.array([[1,2,3,4,5],[5,7,2,5,5]])
arr2 = np.array([[1,2,3,4,5],[1,1,5,9,9]])


fig, ax = plt.subplots(1,3) # Defines a new figure and axes, gives dimensions␣
 ↪for subplot grid: 1 row, 2 columns
ax[0].scatter(arr1[0],arr1[1])
ax[1].scatter(arr2[0],arr2[1])
ax[2].scatter(arr1[0],arr1[1])
ax[2].scatter(arr2[0],arr2[1])
ax[0].set_ylabel('y axis')
for axis in ax:
    axis.set_xlim(-1,10)
    axis.set_ylim(0,10)
    axis.set_xlabel('x axis')
    axis.spines['top'].set_visible(False)
    axis.spines['right'].set_visible(False)
for i in range(1,3):
    ax[i].spines['top'].set_visible(False)
    ax[i].spines['right'].set_visible(False)
    ax[i].spines['left'].set_visible(False)
    ax[i].set_yticks([])
fig.tight_layout() # Generic statement for keeping labels and axes from␣
 ↪overlapping
```



1.7.3 Dictionaries:

Creating a dictionary

[8]:
```
new_dict = {} # Start with an empty dict and add key-value pairs to it
new_dict['key1'] = 'value1' # Call a value by 'indexing' the dictionary by its␣
↪key

new_dict
```

[8]:
```
{'key1': 'value1'}
```

[10]:
```
# Read in a dict from lists
key_list = ['key1', 'key2']
value_list = ['value1', 'value2']

new_dict = {}
for i in range(0,len(key_list)):
    new_dict[key_list[i]] = value_list[i]

new_dict
```

[10]:
```
{'key1': 'value1', 'key2': 'value2'}
```

[13]:
```
# Zip two lists into a dict:
key_list = ['key1', 'key2']
value_list = ['value1', 'value2']

new_dict = dict(zip(key_list, value_list))
print(new_dict)

# Return a dictionary's keys
print(new_dict.keys())

# Return a dictionary's values

print(new_dict.values())
```

```
{'key1': 'value1', 'key2': 'value2'}
dict_keys(['key1', 'key2'])
dict_values(['value1', 'value2'])
```

1.7.4 Complex dictionaries:

Dictionary values can be complex objects:

[51]:
```
# Dictionary of lists
my_dict = {'plants': ['maple', 'pine', 'snowberry'], 'fungi': ['amanita',␣
 ↪'morel']}
print(my_dict)
print(my_dict['plants'][2]) # Index a complex dictionary with a series of [ ]␣
 ↪brackets
```

```
{'plants': ['maple', 'pine', 'snowberry'], 'fungi': ['amanita', 'morel']}
snowberry
```

[30]:
```
# Dictionary of dictionaries
my_dict = {'plants': {'angiosperm':'maple', 'confier':'pine'}, 'fungi':␣
 ↪{'basidio': 'amanita', 'asco': 'morchella'}}
print(my_dict)
print(my_dict['fungi']['asco'])
```

```
{'plants': {'angiosperm': 'maple', 'confier': 'pine'}, 'fungi': {'basidio':
'amanita', 'asco': 'morchella'}}
morchella
```

[52]:
```
# Iterate through a dictionary
my_dict = {'plants': {'angiosperm':'maple', 'confier':'pine'}, 'fungi':␣
 ↪{'basidio': 'amanita', 'asco': 'morchella'}}

for key in my_dict:
```

```
    print("Level 1:", key)
    for x in my_dict[key]:
        print("Level 2:", x)
        print("Level 3:", my_dict[key][x])
```

```
Level 1: plants
Level 2: angiosperm
Level 3: maple
Level 2: confier
Level 3: pine
Level 1: fungi
Level 2: basidio
Level 3: amanita
Level 2: asco
Level 3: morchella
```

1.8 Week 8

- Python shell script
  - Create a python file in JupyterLab: Launcher > Other > Python file
  - Write your script and save it as a .py file
  - Run your file from the shell with `python my_script_name.py`
- ipython
  - Opens a python environment in the command line
  - Code in python directly on the command line
  - Run a python script file with `run my_script_name.py`

1.9 Week 9

- Read a file in as text: `file_object = open('file_name', 'r')  #'r' indicates 'read'`
- Close file: `file_object.close()`
- Idiomatic syntax, which automatically closes the file:

```
with open('file_name') as file_object:
    for each_line in file_object:
        print(each_line)
```

- Open a file for writing: `output_file = open('file_name', 'w')   #'w' indicates 'write'`

```
with open('output_file_name', 'w') as output_file:
    output_file.write(each_line)
    output_file.write(each_line + '\n')  #Writes out a line with a 'newline' character at the
```

- Strip unwanted characters off a line

```
line.strip()
line.strip('\n')
```

- Split lines into components, returns a list of words:

```
line.split()
line.split(' ') #Split on spaces
```

[ ]: