Today's Topics:

- Nested loop
- Jupyter notebook

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INTRODUCTION TO COMPUTER PROGRAMMING IN ENGINEERING AND SCIENCE

Comp Sci assignments (All tests and assignments occur Wednesdays in our lab block)

Test 1 week 7 (15%) Wednesday March 5)

Assignment 2 week 8 (10%)

Assignment 3 week 11 (10%)

Test 2 week 13 (15%)

Physics assignments

Assignments (4 x 2%) 8% Date communicated by the Physics teacher

Project 1: Solving differential equations 10% Week 11

Project 2: Applying programming in science 22% Week 15

GRADE BREAKDOWN REVIEW

```python
animals = ["lions", "tigers", "bears", "fish", "ducks", "birds", "crows"]
print(animals)
for i, animal in enumerate(animals):
    animals[i] = animal.upper()
    print(animals)
print(animals)
```

```
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
['LIONS', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
['LIONS', 'TIGERS', 'bears', 'fish', 'ducks', 'birds', 'crows']
['LIONS', 'TIGERS', 'BEARS', 'fish', 'ducks', 'birds', 'crows']
['LIONS', 'TIGERS', 'BEARS', 'FISH', 'ducks', 'birds', 'crows']
['LIONS', 'TIGERS', 'BEARS', 'FISH', 'DUCKS', 'birds', 'crows']
['LIONS', 'TIGERS', 'BEARS', 'FISH', 'DUCKS', 'BIRDS', 'crows']
['LIONS', 'TIGERS', 'BEARS', 'FISH', 'DUCKS', 'BIRDS', 'CROWS']
['LIONS', 'TIGERS', 'BEARS', 'FISH', 'DUCKS', 'BIRDS', 'CROWS']
```

SEE THE LOOP!

```python
animals = ["lions", "tigers", "bears", "fish", "ducks", "birds", "crows"]
print(animals)
for animal in animals:
    print(animal.upper())
    print(animals)
print(animals)
```

```
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
LIONS
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
TIGERS
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
BEARS
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
FISH
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
DUCKS
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
BIRDS
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
CROWS
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
['lions', 'tigers', 'bears', 'fish', 'ducks', 'birds', 'crows']
```

SEE THE LOOP!

In a nested loop, a loop run inside another loop. i and j are often used as indexes, but you can name them whatever you want.

```
for i in range(1, 11):
    print(f"Beginning loop{i}")
    for j in range(1, 11):
        print(f"We're in loop{i} on loop {j}")
    print(" ")
```

NESTED LOOP

In this example, we will loop through our list to find if any words in the list match.

```python
animals = ["lions", "tigers", "bears", "fish", "ducks", "birds", "crows"]
search_animals = ["lions", "bears"]
animals_found = 0
for animal in animals:
    print(f"Looking for matches with {animal}")
    for item in search_animals:
        print(f"is {animal} the same as {item}?")
        if item == animal:
            animals_found+=1
            print(f"yes, we now have {animals_found} animals")
```

NESTED LOOP

In this example, we will loop through a list of lists

```
numbers = [[1, 3, 5], [2, 4, 6]]
print(numbers[0][0])
print(numbers[0][1])
print(numbers[0][2])
print(numbers[1][0])
print(numbers[1][1])
print(numbers[1][2])
for i in numbers:
    print(f"looking through number set {i}")
    for j in i:
        print(f"Looking at number {j}")
```

NESTED LOOP IN LIST OF LISTS

For loop shorthand

```
first = [2, 3, 4]
second = [20, 30, 40]
final = []
for i in first:
    for j in second:
        final.append(i+j)
print(final)
```

```
Can also be
```

```
first = [2, 3, 4]
second = [20, 30, 40]
final = [i+j for i in first for j in second]
print(final)
```

FOR LOOP ONE LINER

For / in gives us the value of each element in the list

```
for animal in animals:
    print(animal, end=", “)
> lions, tigers, bears,
```

Range gives us the number within a range (here, the range is the length of the animals list, but this can be any range.

```
for animal in range(len(animals)):
    print(animal, end=", “)
# 0, 1, 2,
```

Enumerate gives us the index and value for each element in the list

```
for i, animal in enumerate(animals):
    print(f"{i} index contains {animal}”)
```

```
0 index contains lions
1 index contains tigers
2 index contains bears
```

LOOPS: FOR, RANGE, ENUMERATE

Lists need to be defined as a data type before you can perform list methods on them. For example:

```
 new_items.append("Add this to the list”)
NameError: name 'new_items' is not defined
```

✗

```
new_items = "First element”
new_items.append("Add this to the list”)
AttributeError: 'str' object has no attribute ‘append’
```

✗

```
new_items = []
new_items.append("Add this to the list”)
```

✓

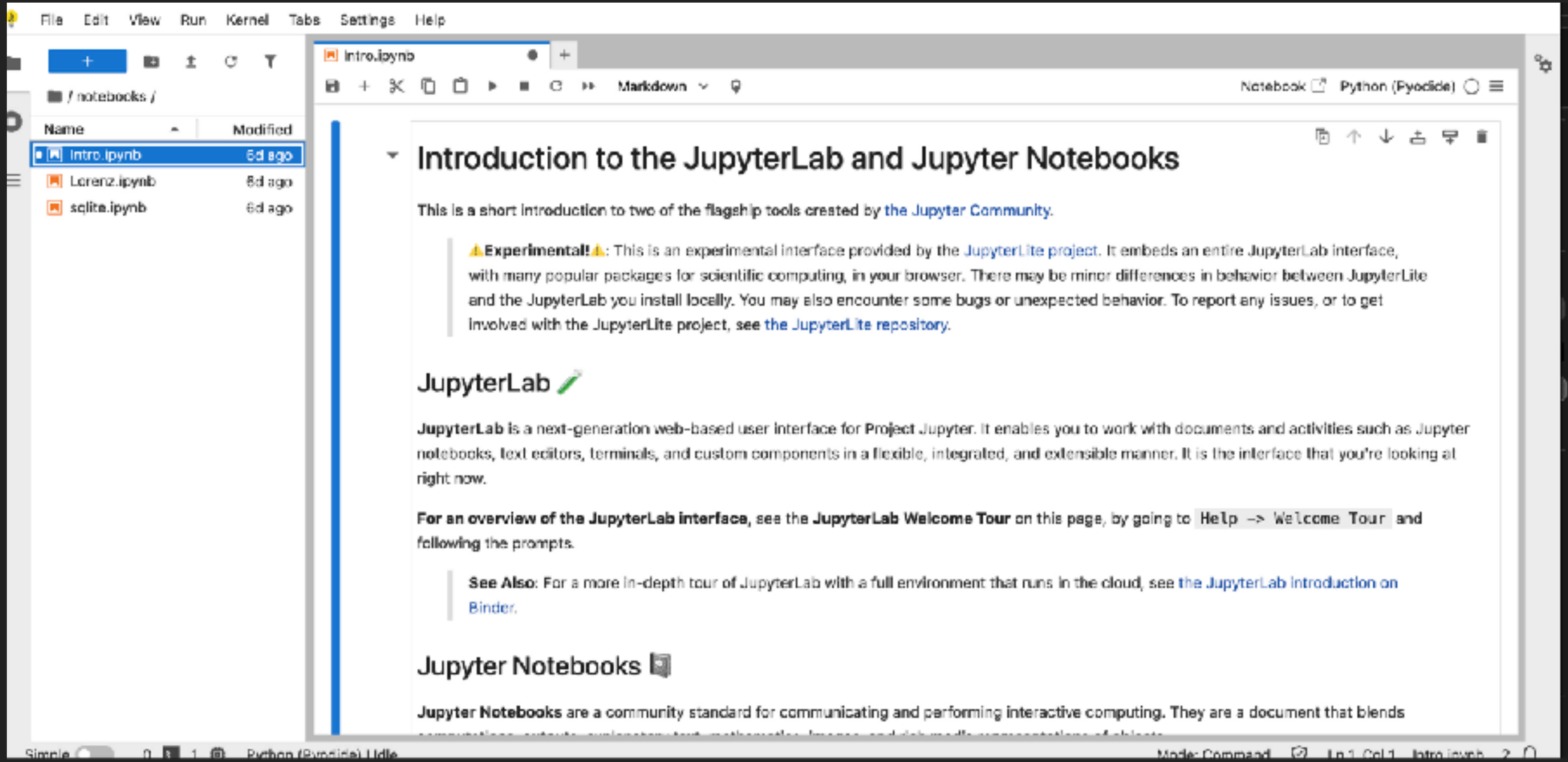
By defining an empty list, you have access to list methods. You can’t use list methods until you’ve made a variable into a list.

CREATING LISTS

https://jupyter.org/try-jupyter/lab/

https://jupyterhub.dawsoncollege.qc.ca

Jupyter notebook is a way of storing code, making visuals, and writing text in the same place on a readable page. Its great for readability when your user can interact with code online.



Introduction to the JupyterLab and Jupyter Notebooks

This is a short introduction to two of the flagship tools created by the Jupyter Community.

> ⚠**Experimental!**⚠: This is an experimental interface provided by the JupyterLite project. It embeds an entire JupyterLab interface, with many popular packages for scientific computing, in your browser. There may be minor differences in behavior between JupyterLite and the JupyterLab you install locally. You may also encounter some bugs or unexpected behavior. To report any issues, or to get involved with the JupyterLite project, see the JupyterLite repository.

JupyterLab 🧪

JupyterLab is a next-generation web-based user interface for Project Jupyter. It enables you to work with documents and activities such as Jupyter notebooks, text editors, terminals, and custom components in a flexible, integrated, and extensible manner. It is the interface that you're looking at right now.

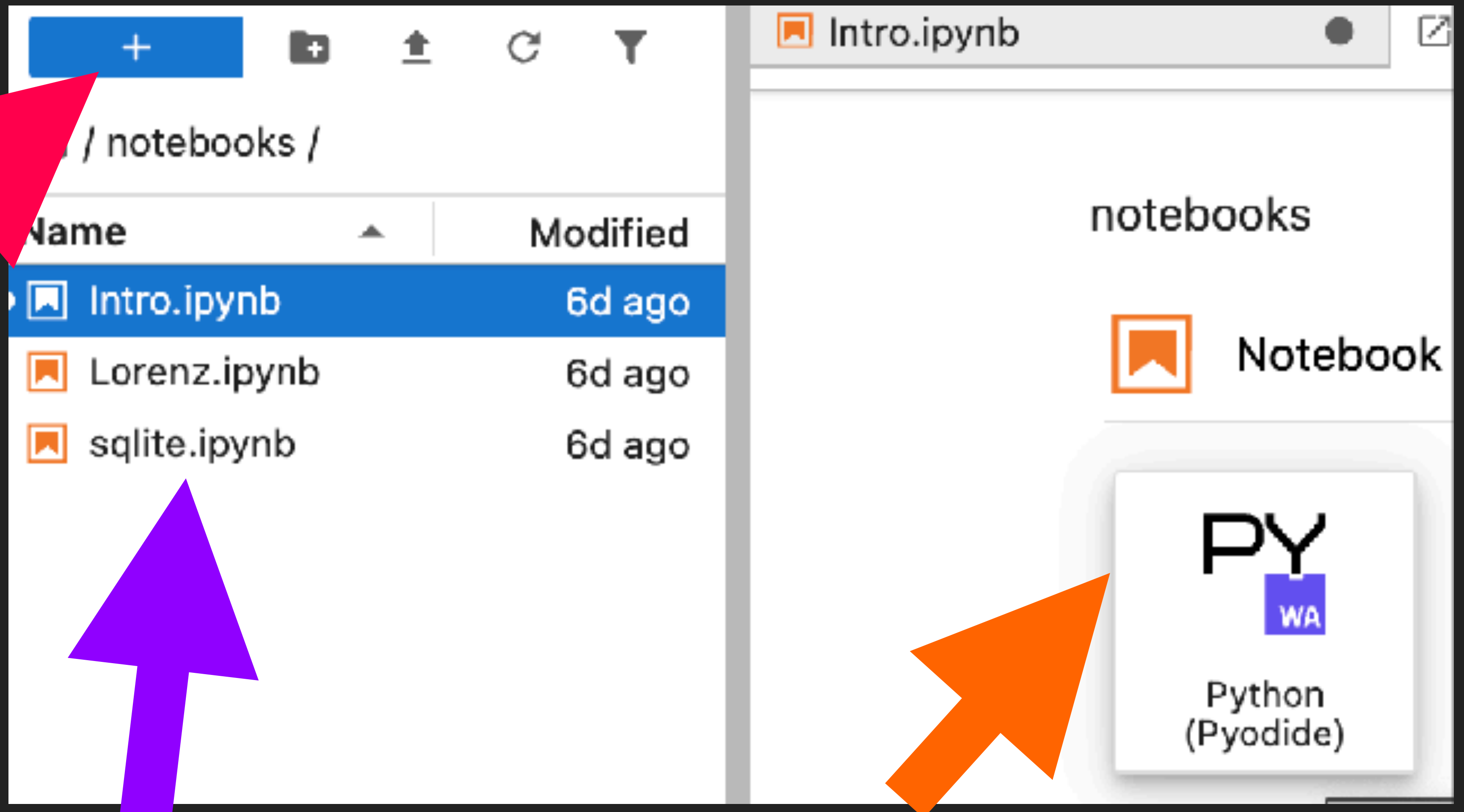
For an overview of the JupyterLab interface, see the **JupyterLab Welcome Tour** on this page, by going to `Help -> Welcome Tour` and following the prompts.

> **See Also**: For a more in-depth tour of JupyterLab with a full environment that runs in the cloud, see the JupyterLab introduction on Binder.

Jupyter Notebooks 📓

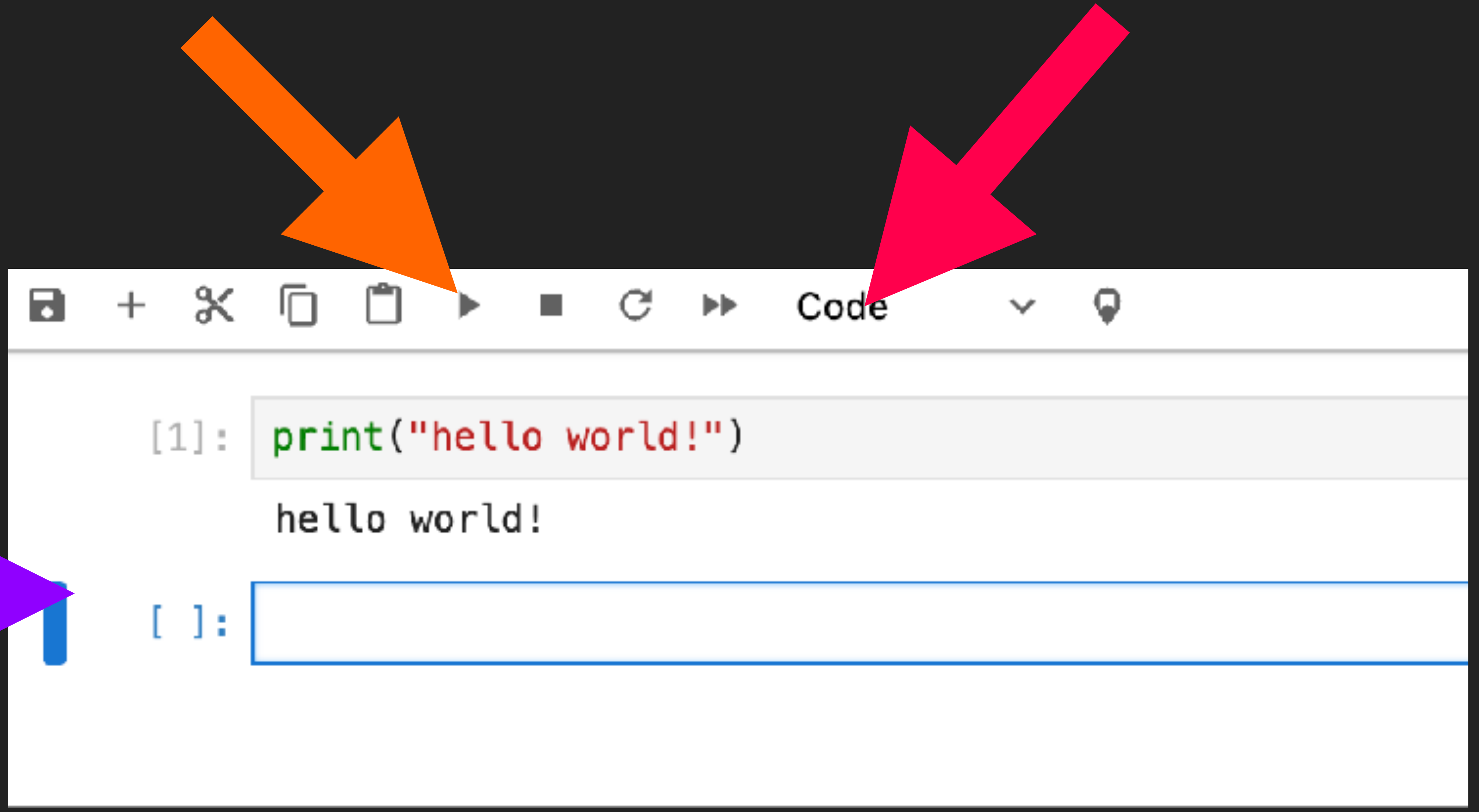
Jupyter Notebooks are a community standard for communicating and performing interactive computing. They are a document that blends

JUPYTER NOTEBOOK



You can create new files that are stored in your account as .jpynb. These files are specific to Jupyter notebook. Make sure to create a python file.

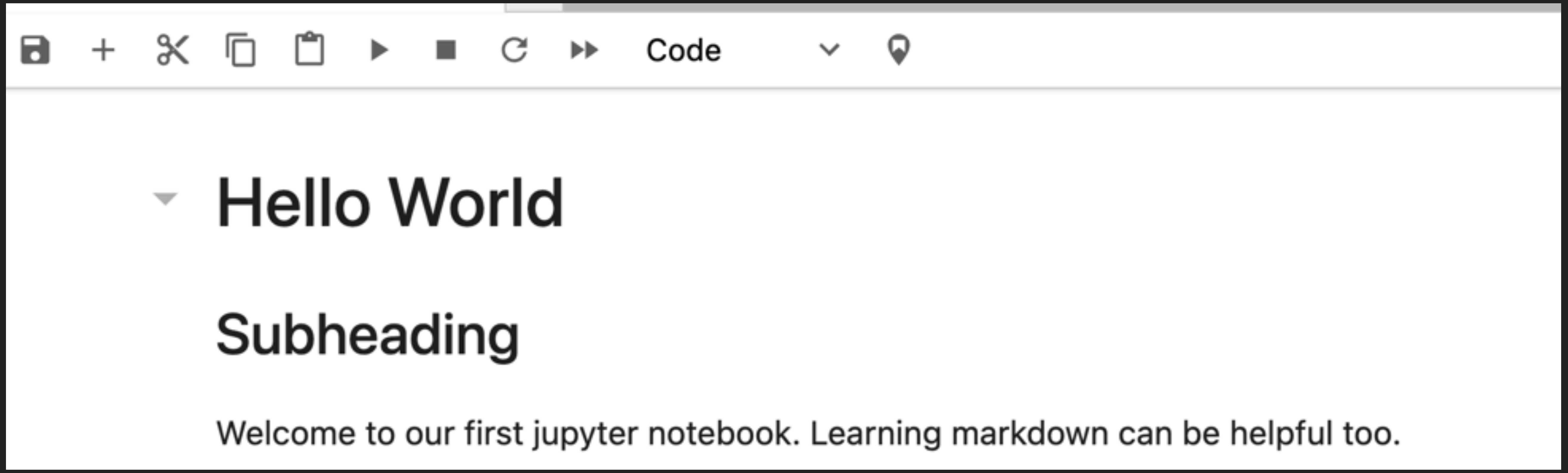
JUPYTER NOTEBOOK



```
[1]: print("hello world!")
     hello world!
[ ]:
```

Jupyter notebook uses “cells” to write code, text, or markdown. Each cell can contain something different. Make your cell “code” and then run the code to see the output.

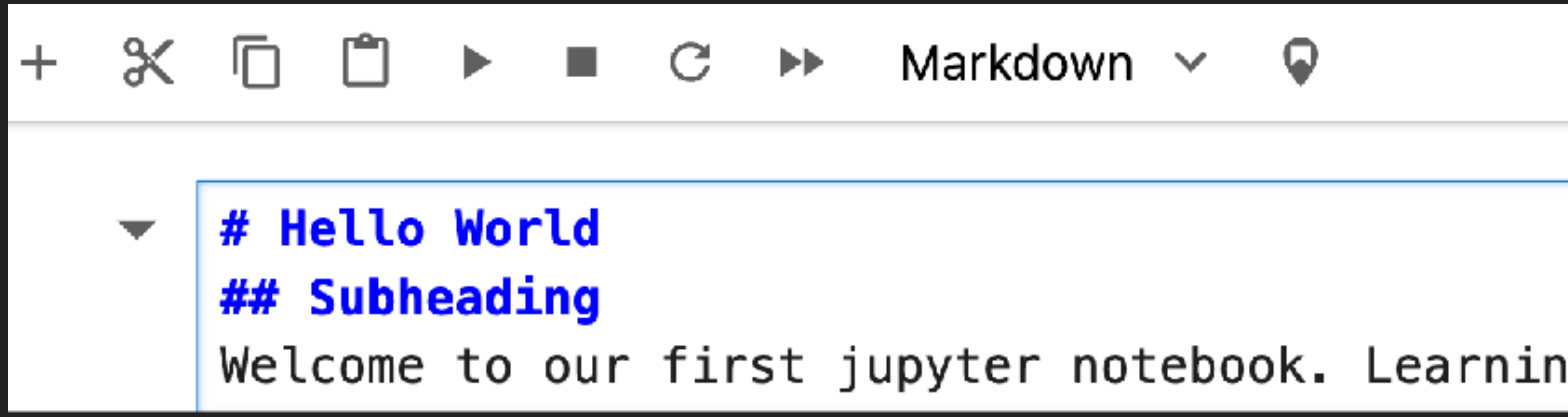
JUPYTER NOTEBOOK



Hello World

Subheading

Welcome to our first jupyter notebook. Learning markdown can be helpful too.



```
# Hello World
## Subheading
Welcome to our first jupyter notebook. Learnin
```

Markdown is a way of writing and formatting text that is common for code docuentation. Here is a sheet of markdown notations

https://jupyter-notebook.readthedocs.io/en/stable/examples/Notebook/Working%20With%20Markdown%20Cells.html

Markdown is helpful for making your document more readable

MARKDOWN

Matplotlib is a python module used to create plots and graphs.

https://matplotlib.org/stable/

Numpy is a module used to work with arrays and lists of data.

https://numpy.org/

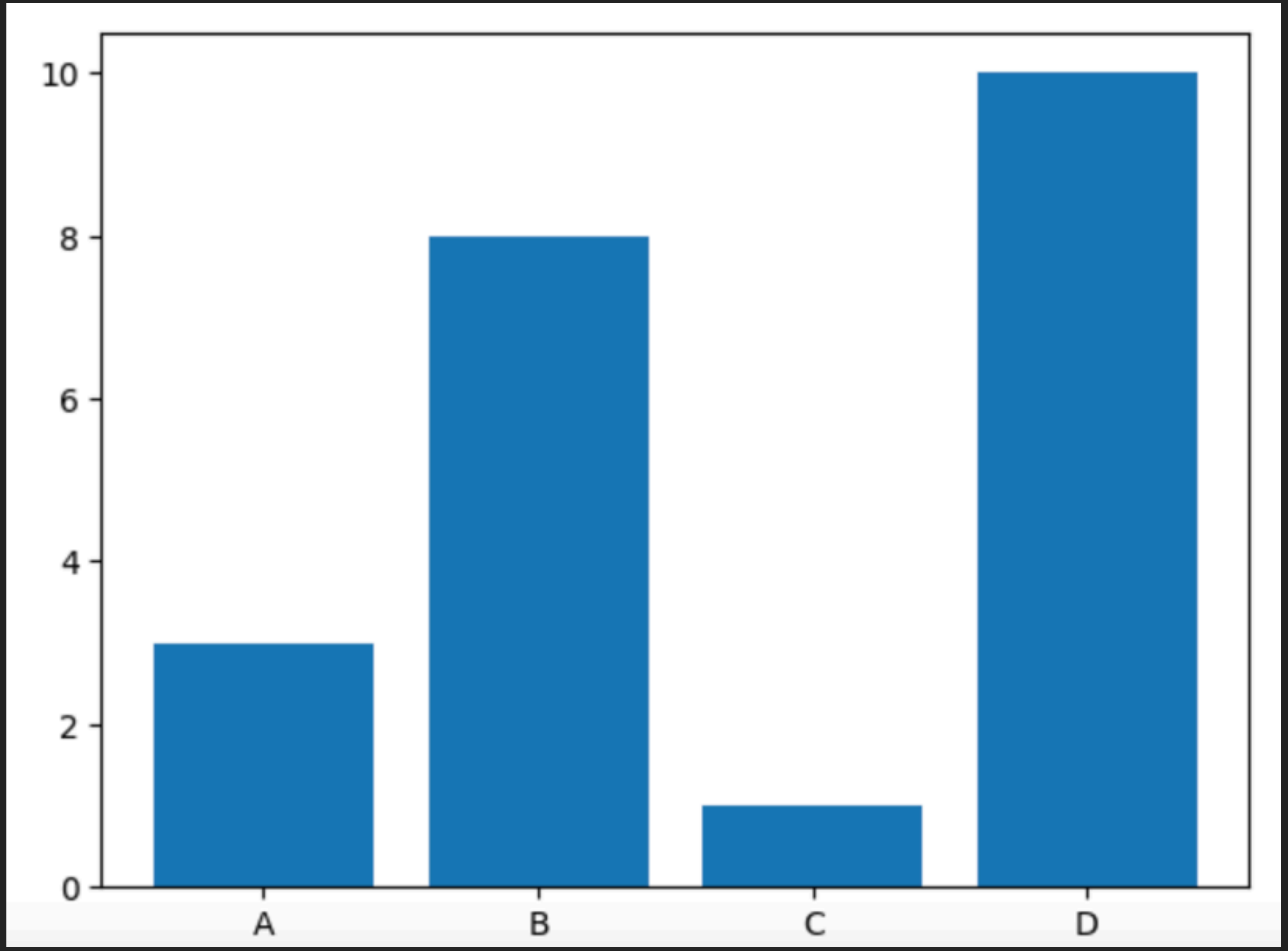
By using them in jupyter notebook, we can create complex visualizations. You can install this modules on your own computer as well, follow instructions on the page. They are already installed on jupyter hub.

MATPLOTLIB AND NUMPY

Lets make a basic plot in jupyter notebook. Import matplotlib and numpy. We create two numpy arrays with np.array and use put.bar with x and y. Matplotlib assumes the value of Y axis based on the input and adds default colours.

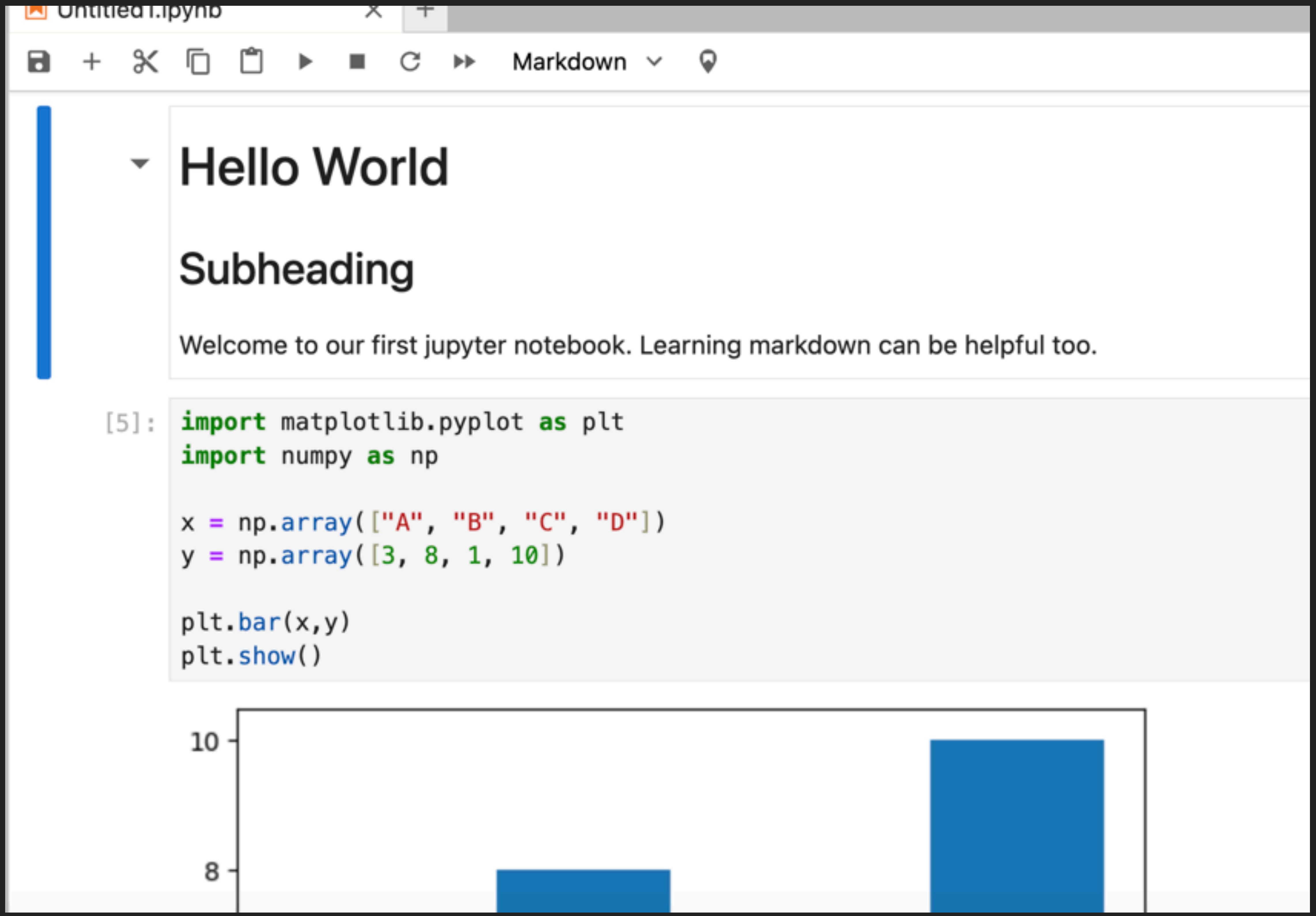
```
import matplotlib.pyplot as plt
import numpy as np

x = np.array(["A", "B", "C", "D"])
y = np.array([3, 8, 1, 10])

plt.bar(x,y)
plt.show()
```

MATPLOTLIB



Your jupyter notebook file can contain many code, markdown, and raw text in combination.

Try some examples https://matplotlib.org/stable/gallery/index.html



Hello World

Subheading

Welcome to our first jupyter notebook. Learning markdown can be helpful too.

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

     x = np.array(["A", "B", "C", "D"])
     y = np.array([3, 8, 1, 10])

     plt.bar(x,y)
     plt.show()
```

.JPNB

LAB TIME

```
num_list = ["339", "362", “859"]
```

Add an element at a specific index

```
num_list.insert(2, “test")
print(num_list)
# ['339', '362', 'test', '859']
```

Remove an element at a specific index

```
num_list.pop(2)
print(num_list)
# ['339', '362', 'test', '859']
```

Reverse the list

```
num_list.reverse()
print(num_list)
# ['859', '362', ‘339']
```

Add to the end of the list

```
num_list.append("TESTING!")
print(num_list)
# ['859', '362', '339', 'TESTING!']
```

MODIFYING A LIST WITH A LIST METHOD

- List is a collection which is ordered and changeable. Allows duplicate members.\

```
my_list = ["this", "is", "my", "list" ]
print(my_list[1])
```

- Tuple is a collection which is ordered and unchangeable. Allows duplicate members.

```
my_tuple = ("check", "out", "this", “tuple")
print(my_tuple[1])
```

- Set is a collection which is unordered, unchangeable*, and unindexed. No duplicate members.

```
my_set = {"apple", "duck", "cookie"}
print(my_set)
```

- Dictionary is a collection which is ordered** and changeable. No duplicate members.

```
my_dict = {'key': "value",
           'fruit': "orange",
           'seat': 4}
print(my_dict["key"])
```

PYTHON COLLECTIONS

Enumerate is used to access both the index and value of each element. This is useful if we need to know the exact position within a list, not only the value. T

```
animals = ["lions", "tigers", "bears"]
for i, animal in enumerate(animals):
    print(f"{i} index contains {animal}")
```

You can use enumerate with an index in the for loop, or without. Without you will need to access each element individually.

```
for animal in enumerate(animals):
    print(animal)
    print(animal[0])
    print(animal[1])
```

```
(0, 'lions') 0 lions
(1, 'tigers') 1 tigers
(2, 'bears') 2 bears
```

LOOPS: FOR ENUMERATE

When modifying a list in a loop, you must call it by the list index and not the variable in the for loop.

```
for animal in animals:
    animal.upper()
print(animals)
#['lions', 'tigers', 'bears']
```

You can display or assign elements in a list like this, but you can't use this to modify the list because animals is a a different variable

```
for index, animal in enumerate(animals):
    animals[index] = animals[index].upper()
print(animals)
# ['LIONS', 'TIGERS', 'BEARS']
```

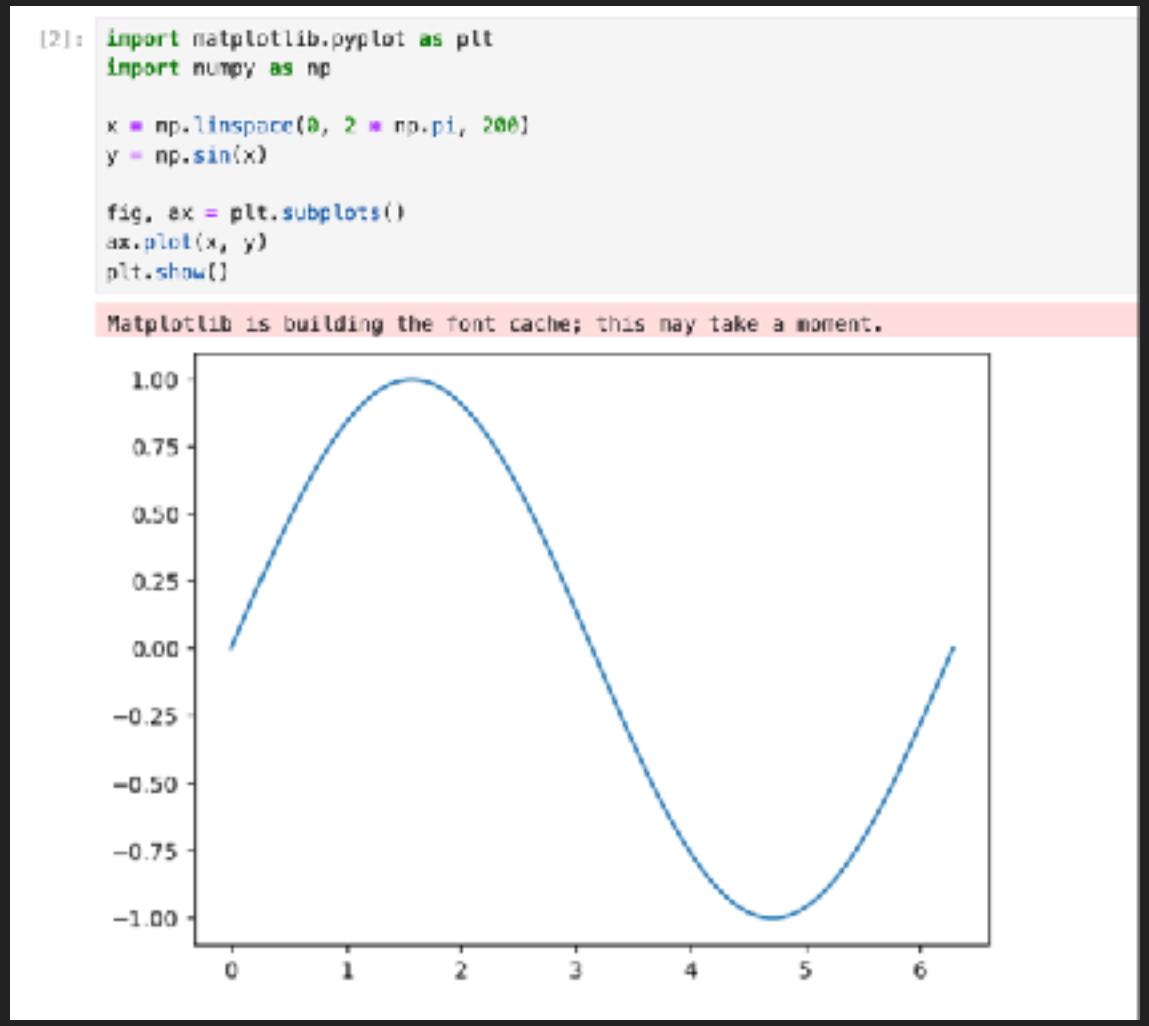
Here we are using the index of the list to modify the element

MODIFYING A LIST IN A LOOP

It may be a good idea to create two lists and store each if you are sorting elements

```
numbers_to_sort = [34,36,1,77,352,485]
even_nums = []
odd_nums = []
for nums in numbers_to_sort:
    if nums%2:
        odd_nums.append(nums)
    else:
        even_nums.append(nums)
print(f"Even nums are {even_nums} and odd nums are {odd_nums}")
```

CREATING LIST IN A LOOP



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

     x = np.linspace(0, 2 * np.pi, 200)
     y = np.sin(x)

     fig, ax = plt.subplots()
     ax.plot(x, y)
     plt.show()
```

```
Matplotlib is building the font cache; this may take a moment.
```

https://matplotlib.org/

Use in Jupyter Notebook Or install on your own computer

MATPLOTLIB

There are any ways to search lists and strings, depending what you are looking for and at what level you want to understand your data. Here are some examples.

```python
animals = ["lions", "tigers", "bears", "lions", "ducks"]
find = "lions"

if find in animals: print("its there")
# Checks if the item is present anywhere in the list
print(animals.index(find))
#Returns the exact location of the first instance

find_counter = 0
for animal in animals:
    if animal == find:
        find_counter+=1
print(find_counter)
# Find how many times it appears

find_locations = []
for index, animal in enumerate(animals):
    if animal == find:
        find_locations.append(index)
print(f"The word {find} appears {len(find_locations)} times at {find_locations}")
# Find how many times and where it appears in the list
```

EXAMPLE: WAYS TO FIND

Range returns a value that can be used to move through a set number of iterations

Here range is 0 - 6 (non inclusive)

```
for x in range(6):
  print(x)
# 0 1 2 3 4 5
```

Here range is 3 - 6 (non inclusive)

```
for x in range(3, 6):
  print(x)
# 3 4 5
```

LOOPS: FOR IN RANGE

With three values we can set the increment per loop, here I'm setting it to 2. So it will count by 2 (non inclusively)

```
for x in range(0, 6, 2):
  print(x, end=“ ")
# 0 2 4
```

Note: you can use end=“, “ to indicate how the line ends instead of a new line. Ex; here we put a “, “ instead of a line break. This Is useful when debugging loops!

```
for i in range(-1, 5, 2):
    print(i, end=", ") # prints: -1, 1, 3,
```

LOOPS: FOR IN RANGE

```python
# Find a range in a string
my_string = "A string to iterate through, lets find some letters"
start_position = my_string.find("string")
end_position = my_string.find("find")
# r = range(start_position, end_position)
for i in range(start_position, end_position):
    print(my_string[i], end= "  “)
```

This example uses range and for loop in a string.

We are using range to find the indexes in a string between two words and listing each letter between them. We can also start at the end of string by adding the length of the index of the word.

```python
start_position = my_string.find("string")+len("string")
```

LOOPS: FOR IN RANGE

Fruit represents a single item in the list. It changes as we iterate through the list. Every loop, we’re looking at the next item of fruit inside fruits.

```
fruits = ['apple', 'banana',
‘cherry']
```

Fruits references the specific list

```
for fruit in fruits:
    print(len(fruit))
```

Fruit can be named anything, but this is typical naming convention.

FOR / IN LOOPS

Before we can really see the power of for loops, we need to talk about lists.

Lists are a way of storing many things in a single variable. You can access them like we do with string indexes, remembering 0 is the first item in a list. A list can be many o

```
my_string_list = ["apple", "oranges", "bananas"]
print(my_string_list[0]) # apples
my_int_list = [2, 3, 10]
print(my_int_list[1]) #3
my_float_list = [2.4, 502.4, 2.5]
print(my_float_list[2]) #2.5
my_list_list = [ [1,4,5], [3,5,4], [4,2,5]]
print(my_list_list[1][1]) #5
```

LISTS

Lists can contain multiple data types. List is the entire structure (with its own methods) and each item can be accessed and on its own. Its important to pay attention to data types if your list is like this!

```
my_mixed_list = [2.4, "502.4", 2]
print(type(my_mixed_list)) # <class 'list'>
print(type(my_mixed_list[1])) # <class ‘str'>
```

LISTS

Similar to strings, there are list methods. You can find them here https://www.w3schools.com/python/python_ref_list.asp

List methods can only be performed on variables that have the data type list.

```
fruits = ['apple', 'banana', 'cherry']
print(fruits) # ['apple', 'banana', 'cherry']
fruits.reverse()
print(fruits)# ['cherry', 'banana', 'apple']
```

LISTS METHODS

Append will add a new item to the list (to the end)

```
new_fruit = input("What is another fruit?")
fruits.append(new_fruit)
print(fruits)
```

LISTS: APPEND

We can turn a string into a list if it has a delineator (something to separate the items of a list.

```
# Convert a string into a list
my_string_to_convert = "apples, oranges, bananas"
print(my_string_to_convert) # apples, oranges, bananas
my_string_to_convert = my_string_to_convert.split(“,") # ['apples', '
oranges', ' bananas’]
print(my_string_to_convert)
```

This string is split by the comma, but it has spaces! We can handle this two ways:

- Make a string that has no spaces (“apples, oranges, bananas”) or trip the white space with replace

```
my_string_to_convert = my_string_to_convert.replace(" ", "")
print(my_string_to_convert)
```

STRING TO LIST

Delineators can be anything! “this|is|my|string” or even “this is my string” where the delineator is a space.

This can be useful when getting data from a larger file that ou need to clean up. For example, data from a study or collection!

STRING TO LIST

Coming up: Nested loops, matplotlib and Jupyter notebook

NEXT CLASS: