cs229-python-review-code

April 15, 2021

0.0.1 Agenda

1. Installation
2. Basics
3. Iterables
4. Numpy (for math and matrix operations)
5. Matplotlib (for plotting)
6. Q&A

[162]:
```
# Note: This tutorial is based on Python 3.8
#       but it should apply to all Python 3.X versions
# Please note that this tutorial is NOT exhaustive
# We try to cover everything you need for class assignments
# but you should also navigate external resources
#
# More tutorials:
# NUMPY:
# https://cs231n.github.io/python-numpy-tutorial/#numpy
# https://numpy.org/doc/stable/user/quickstart.html
# MATPLOTLIB:
# https://matplotlib.org/gallery/index.html
# BASICS:
# https://www.w3schools.com/python/
# CONSULT THESE WISELY:
# The official documentation, Google, and Stack-overflow are your friends!
```


0.0.2 1. Installation

Anaconda for environment management https://www.anaconda.com/

common commands

conda env list <– list all environments

conda create -n newenv python=3.8 <– create new environment

conda enc create -f env.yml <– create environment from config file

conda activate envname <– activate a environment

conda deactivate <– exit environment

pip install packagename <– install package for current environment

jupyter notebook <– open jupyter in current environment

Package installation using conda/pip Live demo #### Recommended IDEs Spyder (in-built in Anaconda) Pycharm (the most popular choice, compatible with Anaconda)

[163]:
```
# common anaconda commands
#conda env list
#conda create -n name python=3.8
#conda env create -f env.yml
#conda activate python2.7
#conda deactivate
#install packages
#pip install <package>
```

0.0.3 2. Basics

https://www.w3schools.com/python/

[164]:
```
# input and output
name = input()
print("hello, " + name)
```

```
cs229
hello, cs229
```

[165]:
```
print("print with new line")
print("print without new line", end="")
print()
print("print multiple variables separated by a space:", name, 1, 3.0, True)
```

```
print with new line
print without new line
print multiple variables separated by a space: cs229 1 3.0 True
```

[166]:
```
# line comment
"""
block
comments
"""
```

[166]:
```
'\nblock \ncomments\n'
```

[167]:
```
# variables don't need explicit declaration
var = "hello" # string
var = 10.0    # float
```

```
var = 10      # int
var = True    # boolean
var = [1,2,3] # pointer to list
var = None    # empty pointer
```

[168]:
```
# type conversions
var = 10
print(int(var))
print(str(var))
print(float(var))
```

```
10
10
10.0
```

[169]:
```
# basic math operations
var = 10
print("var + 4 =", 10 + 4)
print("var - 4 =", 10 - 4)
print("var * 4 =", 10 * 4)
print("var ^ 4=", 10 ** 4)
print("int(var) / 4 =", 10//4)   # // for int division
print("float(var) / 4 =", 10/4)  # / for float division
# All compound assignment operators available
# including += -= *= **= /= //=
# pre/post in/decrementers not available (++ --)
```



```
var + 4 = 14
var - 4 = 6
var * 4 = 40
var ^ 4= 10000
int(var) / 4 = 2
float(var) / 4 = 2.5
```

[170]:
```
# basic boolean operations include "and", "or", "not"
print("not True is", not True)
print("True and False is", True and False)
print("True or False is", True or False)
```

```
not True is False
True and False is False
True or False is True
```

[171]:
```
# String operations
# '' and "" are equivalent
s = "String"
#s = 'Mary said "Hello" to John'
```

```
#s = "Mary said \"Hello\" to John"

# basic
print(len(s)) # get length of string and any iterable type
print(s[0]) # get char by index
print(s[1:3]) # [1,3)
print("This is a " + s + "!")

# handy tools
print(s.lower())
print(s*4)
print("ring" in s)
print(s.index("ring"))

# slice by delimiter
print("I am a sentence".split(" "))
# concatenate a list of string using a delimiter
print("...".join(['a','b','c']))

# formatting variables
print("Formatting a string like %.2f"%(0.12345))
print(f"Or like {s}!")
```



```
6
S
tr
This is a String!
string
StringStringStringString
True
2
['I', 'am', 'a', 'sentence']
a...b...c
Formatting a string like 0.12
Or like String!
```

[172]:
```
# control flows
# NOTE: No parentheses or curly braces
#       Indentation is used to identify code blocks
#       So never ever mix spaces with tabs
for i in range(0,5):
    for j in range(i, 5):
        print("inner loop")
    print("outer loop")
```

```
inner loop
inner loop
inner loop
```

```
inner loop
inner loop
outer loop
inner loop
inner loop
inner loop
inner loop
outer loop
inner loop
inner loop
inner loop
outer loop
inner loop
inner loop
outer loop
inner loop
outer loop
```

[173]:
```python
# if-else
var = 10
if var > 10:
    print(">")
elif var == 10:
    print("=")
else:
    print("<")
```



```
=
```

[174]:
```python
# use "if" to check null pointer or empty arrays
var = None
if var:
    print(var)
var = []
if var:
    print(var)
var = "object"
if var:
    print(var)
```

```
object
```

[175]:
```python
# while-loop
var = 5
while var > 0:
    print(var)
    var -=1
```

```
5
4
3
2
1
```

[176]:
```
# for-loop
for i in range(3):  # prints 0 1 2
    print(i)

"""
equivalent to
for (int i = 0; i < 3; i++)
"""
print("-------")
# range (start-inclusive, stop-exclusive, step)
for i in range(2, -3, -2):
    print(i)
"""
equivalent to
for (int i = 2; i > -3; i-=2)
"""
```



```
0
1
2
-------
2
0
-2
```

[176]:
```
'\nequivalent to\nfor (int i = 2; i > -3; i-=2)\n'
```

[177]:
```
# define function
def func(a, b):
    return a + b
func(1,3)
```

[177]:
```
4
```

[178]:
```
# use default parameters and pass values by parameter name
def rangeCheck(a, min_val = 0, max_val=10):
    return min_val < a < max_val    # syntactic sugar
rangeCheck(5, max_val=4)
```

[178]:
```
False
```

[179]:
```
# define class
class Foo:

    # optinal constructor
    def __init__(self, x):
        # first parameter "self" for instance reference, like "this" in JAVA
        self.x = x

    # instance method
    def printX(self): # instance reference is required for all function␣
 ↪parameters
        print(self.x)

    # class methods, most likely you will never need this
    @classmethod
    def printHello(self):
        print("hello")

obj = Foo(6)
obj.printX()
```


6

[180]:
```
# class inheritance: inherits variables and methods
# You might need this when you learn more PyTorch
class Bar(Foo):
    pass
obj = Bar(3)
obj.printX()
```


3

0.0.4 3. Iterables

[181]:
```
alist = list()  # linear, size not fixed, not hashable
atuple = tuple() # linear, fixed size, hashable
adict = dict()  # hash table, not hashable, stores (key,value) pairs
aset = set()    # hash table, like dict but only stores keys
acopy = alist.copy() # shallow copy
print(len(alist)) # gets size of any iterable type
```

0

[182]:
```
# examplar tuple usage
# creating a dictionary to store ngram counts
d = dict()
d[("a","cat")] = 10
d[["a","cat"]] = 11
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-182-47597361a541> in <module>
      3 d = dict()
      4 d[("a","cat")] = 10
----> 5 d[["a","cat"]] = 11

TypeError: unhashable type: 'list'
```

[183]:
```
"""
List: not hashable (i.e. can't use as dictionary key)
      dynamic size
      allows duplicates and inconsistent element types
      dynamic array implementation
"""
# list creation
alist = []          # empty list, equivalent to list()
alist = [1,2,3,4,5] # initialized list
print(alist[0])
alist[0] = 5
print(alist)

print("-"*10)
# list indexing
print(alist[0]) # get first element (at index 0)
print(alist[-2]) # get last element (at index len-1)
print(alist[3:]) # get elements starting from index 3 (inclusive)
print(alist[:3]) # get elements stopping at index 3 (exclusive)
print(alist[2:4]) # get elements within index range [2,4)
print(alist[6:]) # prints nothing because index is out of range
print(alist[::-1]) # returns a reversed list

print("-"*10)
# list modification
alist.append("new item") # insert at end
alist.insert(0, "new item") # insert at index 0
alist.extend([2,3,4]) # concatenate lists
# above line is equivalent to alist += [2,3,4]
alist.index("new item") # search by content
alist.remove("new item") # remove by content
alist.pop(0) # remove by index
print(alist)

print("-"*10)
if "new item" in alist:
```

```
    print("found")
else:
    print("not found")

print("-"*10)
# list traversal
for ele in alist:
    print(ele)

print("-"*10)
# or traverse with index
for i, ele in enumerate(alist):
    print(i, ele)
```

```
1
[5, 2, 3, 4, 5]
----------
5
4
[4, 5]
[5, 2, 3]
[3, 4]
[]
[5, 4, 3, 2, 5]
----------
[2, 3, 4, 5, 'new item', 2, 3, 4]
----------
found
----------
2
3
4
5
new item
2
3
4
----------
0 2
1 3
2 4
3 5
4 new item
5 2
6 3
7 4
```

[184]:
```
"""
Tuple: hashable (i.e. can use as dictionary key)
       fixed size (no insertion or deletion)
"""
# it does not make sense to create empty tuples
atuple = (1,2,3,4,5)
 # or you can cast other iterables to tuple
atuple = tuple([1,2,3])

# indexing and traversal are same as list
```

[185]:
```
"""
Named tuples for readibility
"""
from collections import namedtuple
Point = namedtuple('Point', 'x y')
pt1 = Point(1.0, 5.0)
pt2 = Point(2.5, 1.5)
print(pt1.x, pt1.y)
```



```
1.0 5.0
```

[186]:
```
"""
Dict: not hashable
      dynamic size
      no duplicates allowed
      hash table implementation which is fast for searching
"""
# dict creation
adict = {} # empty dict, equivalent to dict()
adict = {'a':1, 'b':2, 'c':3}
print(adict)

# get all keys in dictionary
print(adict.keys())

# get value paired with key
print(adict['a'])
key = 'e'

# NOTE: accessing keys not in the dictionary leads to exception
if key in adict:
    print(adict[key])

# add or modify dictionary entries
adict['e'] = 10 # insert new key
adict['e'] = 5  # modify existing keys
```

```
print("-"*10)
# traverse keys only
for key in adict:
    print(key, adict[key])

print("-"*10)
# or traverse key-value pairs together
for key, value in adict.items():
    print(key, value)

print("-"*10)
# NOTE: Checking if a key exists
key = 'e'
if key in adict: # NO .keys() here please!
    print(adict[key])
else:
    print("Not found!")
```



```
{'a': 1, 'b': 2, 'c': 3}
dict_keys(['a', 'b', 'c'])
1
----------
a 1
b 2
c 3
e 5
----------
a 1
b 2
c 3
e 5
----------
5
```

[187]:
```
"""
Special dictionaries
"""
# set is a dictionary without values
aset = set()
aset.add('a')

# deduplication short-cut using set
alist = [1,2,3,3,3,4,3]
alist = list(set(alist))
print(alist)
```

```
# default_dictionary returns a value computed from a default function
#     for non-existent entries
from collections import defaultdict
adict = defaultdict(lambda: 'unknown')
adict['cat'] = 'feline'
print(adict['cat'])
print(adict['dog'])
```

```
[1, 2, 3, 4]
feline
unknown
```

[188]:
```
# counter is a dictionary with default value of 0
#     and provides handy iterable counting tools
from collections import Counter

# initialize and modify empty counter
counter1 = Counter()
counter1['t'] = 10
counter1['t'] += 1
counter1['e'] += 1
print(counter1)
print("-"*10)

# initialize counter from iterable
counter2 = Counter("letters to be counted")
print(counter2)
print("-"*10)

# computations using counters
print("1", counter1 + counter2)
print("2,", counter1 - counter2)
print("3", counter1 or counter2) # or for intersection, and for union
```



```
Counter({'t': 11, 'e': 1})
----------
Counter({'e': 4, 't': 4, ' ': 3, 'o': 2, 'l': 1, 'r': 1, 's': 1, 'b': 1, 'c': 1,
'u': 1, 'n': 1, 'd': 1})
----------
1 Counter({'t': 15, 'e': 5, ' ': 3, 'o': 2, 'l': 1, 'r': 1, 's': 1, 'b': 1, 'c':
1, 'u': 1, 'n': 1, 'd': 1})
2, Counter({'t': 7})
3 Counter({'t': 11, 'e': 1})
```

[189]:
```
# sorting
a = [4,6,1,7,0,5,1,8,9]
a = sorted(a)
```

```
print(a)
a = sorted(a, reverse=True)
print(a)
```

```
[0, 1, 1, 4, 5, 6, 7, 8, 9]
[9, 8, 7, 6, 5, 4, 1, 1, 0]
```

[190]:
```
# sorting
a = [("cat",1), ("dog", 3), ("bird", 2)]
a = sorted(a)
print(a)
a = sorted(a, key=lambda x:x[1])
print(a)
```

```
[('bird', 2), ('cat', 1), ('dog', 3)]
[('cat', 1), ('bird', 2), ('dog', 3)]
```

[191]:
```
# useful in dictionary sorting
adict = {'cat':3, 'bird':1}
print(sorted(adict.items(), key=lambda x:x[1]))
```



```
[('bird', 1), ('cat', 3)]
```

[192]:
```
# Syntax sugar: one-time control flow + list operation
x = [1,2,3,5,3]
"""
for i in range(len(sent)):
    sent[i] = sent[i].lower().split(" ")
"""
x1 = [xx*3 + 5 for xx in x]
print(x1)

x2 = [xx*3 + 5 for xx in x if xx < 3]
print(x2)

# Use this for deep copy!
# copy = [obj.copy() for obj in original]
```

```
[8, 11, 14, 20, 14]
[8, 11]
```

[193]:
```
# Syntax sugar: * operator for repeating iterable elements
print("-"*10)
print([1]*10)

# Note: This only repeating by value
#       So you cannot apply the trick on reference types
```

```
# To create a double list
# DONT
doublelist = [[]]*10
doublelist[0].append(1)
print(doublelist)
# DO
doublelist = [[] for _ in range(10)]
doublelist[0].append(1)
print(doublelist)
```

```
----------
[1, 1, 1, 1, 1, 1, 1, 1, 1, 1]
[[1], [1], [1], [1], [1], [1], [1], [1], [1], [1]]
[[1], [], [], [], [], [], [], [], [], []]
```

0.0.5 4. Numpy

Very powerful python tool for handling matrices and higher dimensional arrays

[194]:
```
import numpy as np
```


[200]:
```
# create arrays
a = np.array([[1,2],[3,4],[5,6]])
print(a)
print(a.shape)
# create all-zero/one arrays
b = np.ones((3,4)) # np.zeros((3,4))
print(b)
print(b.shape)
# create identity matrix
c = np.eye(5)
print(c)
print(c.shape)
# create random matrix with standard normal init
d = np.random.normal(size=(5,5))
print(d)
```



```
[[1 2]
 [3 4]
 [5 6]]
(3, 2)
[[1. 1. 1. 1.]
 [1. 1. 1. 1.]
 [1. 1. 1. 1.]]
(3, 4)
[[1. 0. 0. 0. 0.]
 [0. 1. 0. 0. 0.]
 [0. 0. 1. 0. 0.]
```

```
 [0. 0. 0. 1. 0.]
 [0. 0. 0. 0. 1.]]
(5, 5)
[[-0.16367035 -0.87855847  0.7961741   0.26598743 -1.75846406]
 [-0.09106335 -0.95040985 -0.84240584  0.5022866   0.40741974]
 [-0.6448735  -0.94000292 -0.63470733  0.3198772   0.20179754]
 [ 3.87482256 -2.01679666  1.06469451  0.75220559  0.8659874 ]
 [ 1.86533616  1.41129369  0.74469198  0.56709733  0.33023962]]
```

[201]:
```
# reshaping arrays
a = np.arange(8)          # [8,] all vectors are column by default
b = a.reshape(1,-1)       # [1,8] row vector -- -1 for auto-fill
c = a.reshape((4,2))      # shape [4,2]
d = a.reshape((2,2,-1))   # shape [2,2,2]
e = c.flatten()           # shape [8,]
f = np.expand_dims(a, 0) # [1,8]
g = np.expand_dims(a, 1) # [8,1]
h = e.squeeze()           # shape[8, ]    -- remove all unnecessary dimensions
print(a)
print(b)
```



```
[0 1 2 3 4 5 6 7]
[[0 1 2 3 4 5 6 7]]
```


[202]:
```
# be careful about vectors!
a = np.array([1,2,3]) # this is a 3-d column vector, which you cannot transpose
print(a)
print(a.shape)
print(a.T.shape)
a = a.reshape(-1, 1) # this is a 3x1 matrix, which you can transpose
print(a)
print(a.shape)
print(a.T.shape)
```



```
[1 2 3]
(3,)
(3,)
[[1]
 [2]
 [3]]
(3, 1)
(1, 3)
```

[203]:
```
# concatenating arrays
a = np.ones((4,3))
b = np.ones((4,3))
c = np.concatenate([a,b], 0)
print(c.shape)
```

```
d = np.concatenate([a,b], 1)
print(d.shape)
```

```
(8, 3)
(4, 6)
```

[204]:
```
# access array slices by index
a = np.zeros([10, 10])
a[:3] = 1
a[:, :3] = 2
a[:3, :3] = 3
rows = [4,6,7]
cols = [9,3,5]
a[rows, cols] = 4
print(a)
```

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


[205]:
```
# transposition
a = np.arange(24).reshape(2,3,4)
print(a.shape)
print(a)
a = np.transpose(a, (2,1,0)) # swap 0th and 2nd axes
print(a.shape)
print(a)
```

```
(2, 3, 4)
[[[ 0  1  2  3]
  [ 4  5  6  7]
  [ 8  9 10 11]]

 [[12 13 14 15]
  [16 17 18 19]
  [20 21 22 23]]]
(4, 3, 2)
[[[ 0 12]
  [ 4 16]
  [ 8 20]]
```

```
[[ 1 13]
 [ 5 17]
 [ 9 21]]

[[ 2 14]
 [ 6 18]
 [10 22]]

[[ 3 15]
 [ 7 19]
 [11 23]]]
```

[227]:
```
c = np.array([[1,2],[3,4]])
print(np.linalg.inv(c))
# pinv is pseudo inversion for stability
print(np.linalg.pinv(c))
# To compute c^-1 b
b = np.array([1, 1])
print(np.linalg.inv(c)@b)
print(np.linalg.solve(c,b)) # preferred
```

```
[[-2.   1. ]
 [ 1.5 -0.5]]
[[-2.   1. ]
 [ 1.5 -0.5]]
[-1.  1.]
[-1.  1.]
```


[206]:
```
# vector dot product
v1 = np.array([1,2])
v2 = np.array([3,4])
print(v1.dot(v2))
print(np.dot(v1,v2))
print(v1@v2)
```

```
11
11
11
```

[207]:
```
# vector outer product
print(np.outer(v1,v2))
print(v1.reshape(-1,1).dot(v2.reshape(1,-1)))
```

```
[[3 4]
 [6 8]]
[[3 4]
 [6 8]]
```

[208]:
```
# Matrix multiply vector (Ax)
m = np.array([1,2,3,4]).reshape(2,2)
print(m@v1)
print(m.dot(v1))
print(np.matmul(m, v1))
```

```
[ 5 11]
[ 5 11]
[ 5 11]
```

[209]:
```
# matrix multiplication
a = np.ones((4,3)) # 4,3
b = np.ones((3,2)) # 3,2 --> 4,2
print(a @ b)       # same as a.dot(b)
print(np.matmul(a,b))
```

```
[[3. 3.]
 [3. 3.]
 [3. 3.]
 [3. 3.]]
[[3. 3.]
 [3. 3.]
 [3. 3.]
 [3. 3.]]
```


[210]:
```
# broadcasting
c = np.ones([4,4])
# automatic repetition along axis
d = np.array([1,2,3,4]).reshape(4,1)
print(c.shape)
print(d.shape)
print(c + d)
```

```
(4, 4)
(4, 1)
[[2. 2. 2. 2.]
 [3. 3. 3. 3.]
 [4. 4. 4. 4.]
 [5. 5. 5. 5.]]
```

[211]:
```
# computing pairwise distance (using broadcasting)
samples = np.random.random([15, 5])
diff=samples[:,np.newaxis,:]-samples[np.newaxis]
print(samples[:,np.newaxis,:].shape)
print(samples[np.newaxis,:,:].shape)
print(diff.shape)
```

```
(15, 1, 5)
```

```
(1, 15, 5)
(15, 15, 5)
```

[212]:
```
# speed test: numpy vs list
a = np.ones((100,100))
b = np.ones((100,100))

def matrix_multiplication(X, Y):
    result = [[0]*len(Y[0]) for _ in range(len(X))]
    for i in range(len(X)):
        for j in range(len(Y[0])):
            for k in range(len(Y)):
                result[i][j] += X[i][k] * Y[k][j]
    return result

import time

# run numpy matrix multiplication for 10 times
start = time.time()
for _ in range(10):
    a @ b
end = time.time()
print("numpy spends {} seconds".format(end-start))

# run list matrix multiplication for 10 times
start = time.time()
for _ in range(10):
    matrix_multiplication(a,b)
end = time.time()
print("list operation spends {} seconds".format(end-start))

# the difference gets more significant as matrices grow in size!
```



```
numpy spends 0.003999471664428711 seconds
list operation spends 8.870983362197876 seconds
```

[213]:
```
# other common operations
a = np.ones((4,4))
print(np.linalg.norm(a, axis=0))
print(np.linalg.norm(a))
print(np.sum(a)) # sum all elements in matrix
print(np.sum(a, axis=0)) # sum along axis 0
print(np.sum(a, axis=1)) # sum along axis 1
# element-wise operations, for examples
print(np.log(a))
print(np.exp(a))
print(np.sin(a))
```

```
# operation with scalar is interpreted as element-wise
print(a * 3)
```

```
[2. 2. 2. 2.]
4.0
16.0
[4. 4. 4. 4.]
[4. 4. 4. 4.]
[[0. 0. 0. 0.]
 [0. 0. 0. 0.]
 [0. 0. 0. 0.]
 [0. 0. 0. 0.]]
[[2.71828183 2.71828183 2.71828183 2.71828183]
 [2.71828183 2.71828183 2.71828183 2.71828183]
 [2.71828183 2.71828183 2.71828183 2.71828183]
 [2.71828183 2.71828183 2.71828183 2.71828183]]
[[0.84147098 0.84147098 0.84147098 0.84147098]
 [0.84147098 0.84147098 0.84147098 0.84147098]
 [0.84147098 0.84147098 0.84147098 0.84147098]
 [0.84147098 0.84147098 0.84147098 0.84147098]]
[[3. 3. 3. 3.]
 [3. 3. 3. 3.]
 [3. 3. 3. 3.]
 [3. 3. 3. 3.]]
```


[2]:
```
# invalid operations result in an NaN
a = np.array(0)
b = np.array(0)
print(a/b)
```



```
nan

<ipython-input-2-84f2c78182a7>:4: RuntimeWarning: invalid value encountered in
true_divide
  print(a/b)
```

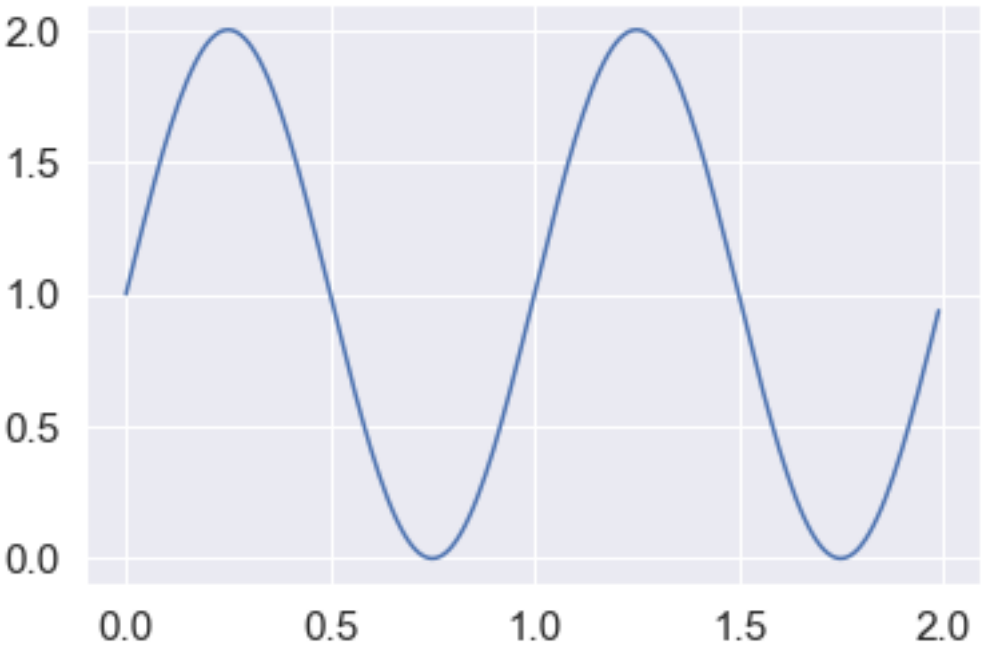
0.0.6 5. Matplotlib

Powerful tool for visualization Many tutorials online. We only go over the basics here

[214]:
```
import matplotlib.pyplot as plt
```

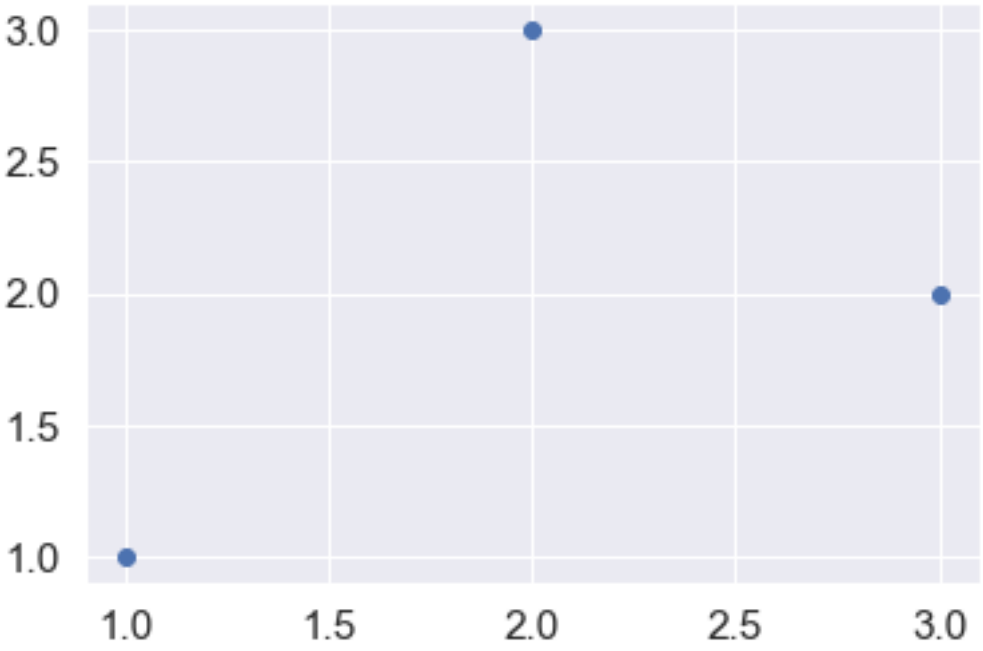
[215]:
```
# line plot
x = np.arange(0, 2, 0.01)
y = 1+np.sin(2*np.pi*x)
plt.plot(x,y)
```

[215]:
```
[<matplotlib.lines.Line2D at 0x1c1bb9fbee0>]
```



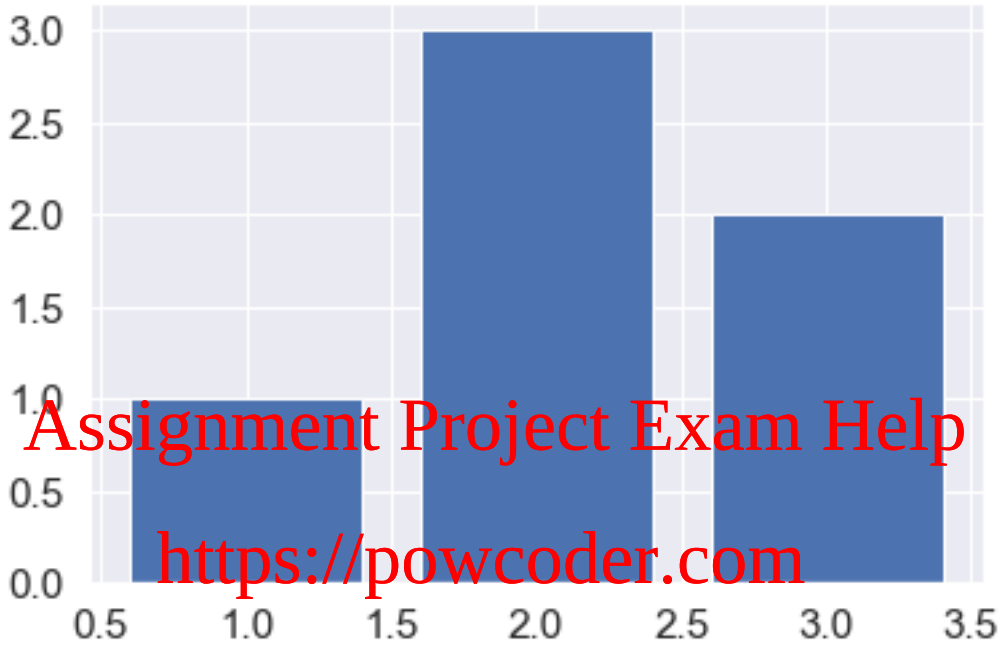
[216]:
```
# scatter plot
x = [1,3,2]
y = [1,2,3]
plt.scatter(x,y)
```


[216]: <matplotlib.collections.PathCollection at 0x1e1ba390670>



[217]:
```
# bar plots
plt.bar(x,y)
```

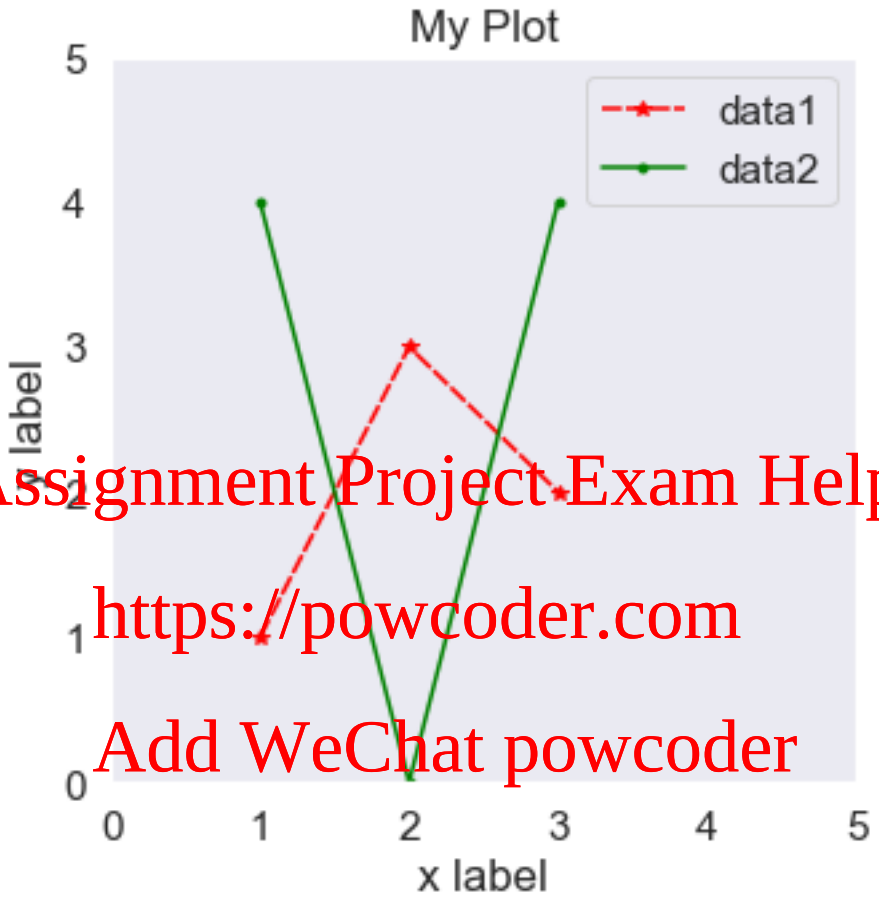
[217]:
```
<BarContainer object of 3 artists>
```



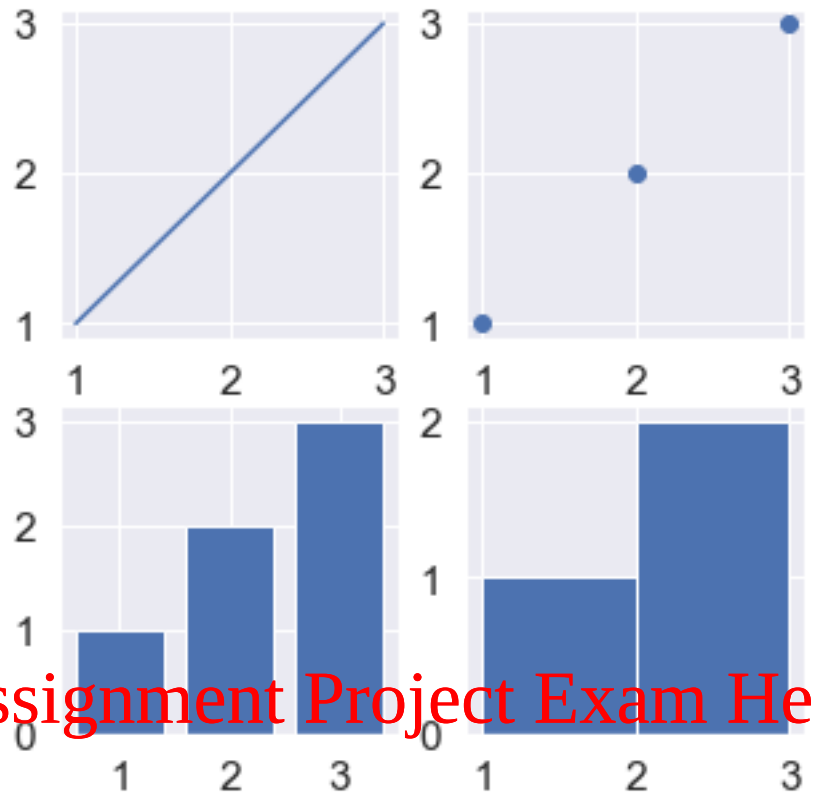
[218]:
```
# plot configurations
x = [1,2,3]
y1 = [1,3,2]
y2 = [4,0,4]

# set figure size
plt.figure(figsize=(5,5))

# set axes
plt.xlim(0,5)
plt.ylim(0,5)
plt.xlabel("x label")
plt.ylabel("y label")

# add title
plt.title("My Plot")

plt.plot(x,y1, label="data1", color="red", marker="*", dashes=[5,1])
```

```
plt.plot(x,y2, label="data2", color="green", marker=".")
plt.grid()
plt.legend()
```

[218]: <matplotlib.legend.Legend at 0x1c1ba021fa0>

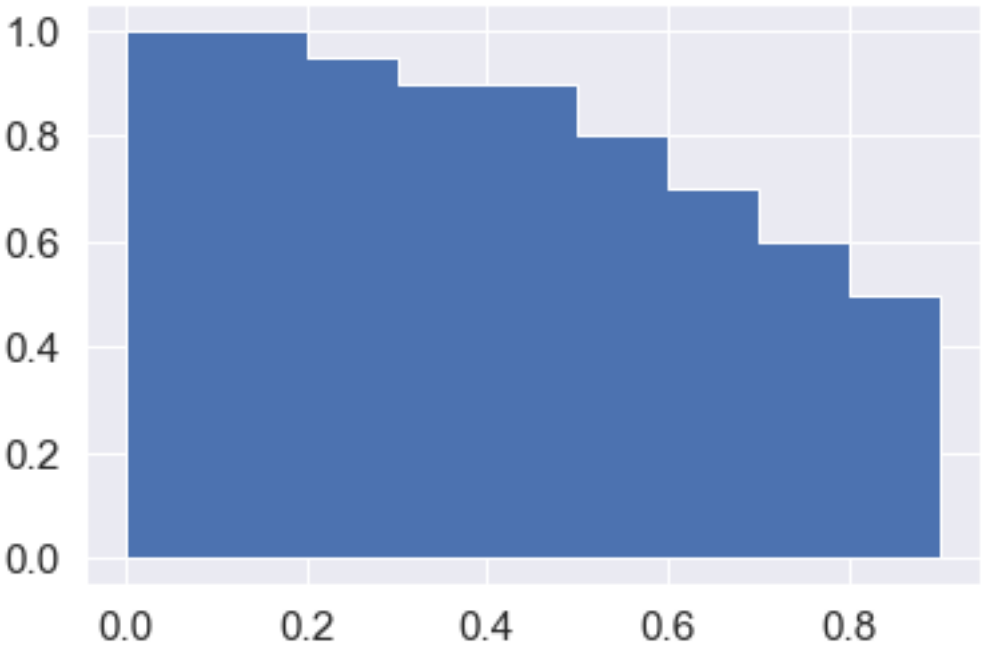


[219]:
```
# subplots
f, ax = plt.subplots(2,2,figsize=(5,5))
ax[0][0].plot(x,y)
ax[0][1].scatter(x,y)
ax[1][0].bar(x,y)
ax[1][1].hist(x,y)
plt.show()
```



[220]:
```
# plot area under curve
probs = [1, 1, 0.95, 0.9, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4]
thres = np.arange(0,1,0.1)
plt.fill_between(x=thres, y1=probs, y2=0, step='post')
```

[220]: <matplotlib.collections.PolyCollection at 0x1c1ba20d400>



[221]:
```
import seaborn as sn
import matplotlib.pyplot as plt

array = [[13,1,1,0,2,0],
         [3,9,6,0,1,0],
         [0,0,16,2,0,0],
         [0,0,0,13,0,0],
         [0,0,0,0,15,0],
         [0,0,1,0,0,15]]
labels = 'A B C D E F'.split(' ')
sn.heatmap(array, annot=True, annot_kws={"size": 16}, cmap="rocket_r")
plt.xticks(ticks=np.arange(len(labels))+0.5,labels=labels)
plt.yticks(ticks=np.arange(len(labels))+0.5,labels=labels,rotation=0)
plt.show()
```

[ ]: