Python 3 Notes

Data Type	Integer: 0,2,7 Float: 1.3, 6.23 String: 'hello', "123" Booleans: True, False Set: {unique elements} Dictionary: {key: values} List: [ ] Tuples: ( ) └▶Immutable(cannot change value inside)	('a',1,) ('a',) ('a') t = (1,2,3,4) (1,2) + (3,4) ((1,2),) + (3,4)	-> tuple -> tuple -> str t[10:] => () t[:10] => (1,2,3,4) (1,2,3,4) ((1,2), 3, 4)
Arithmetic Operations	1. Bracket () 2. Exponent: ** 3. (Multiply: *) | (Divide: /) | (Quotient: //) | (Modulus/: %)	4. (Plus: +) | (Minus: -) 5. (Greater: >) | (Less or equal: <=) | (Equals to: ==) | (Not equal to: !=)	
Commentating	# Comment	""" Long Comment """ -when long comment used in function, help(fn) will output the comment inside	
Variable name = 'Sam' num = 12 l = ['a', 'b', 'c']	print('My name is {} and my age is {}'.format(name, num)) print('My name is {} and my age is {}'.format(Sam, 12)) print('My name is %s and my age is %s' %(name, num)) print('My name is ' + Name + 'my age is ' + str(num)) print('My name is %r and my age is %s' %(name, num)) print(f'My name is {name!r} and my age is {num:1.0f}') print('Floating point numbers: %5.2f' %(13.144)) print('a', 'b') print(*l, sep =' & ')	My name is Sam and my age is 12 My name is 'Sam' and my age is 12 Floating point numbers: 13.14 # 5 is min no. of char including whitespace; 2 is no. of dp a b #Using , automatically adds space a & b & c #* print out all items, sep = separator	
Indexing	s = 'abcdef'	s[0] = 'a' s[-1] = 'f' s[:2] = 'ab' s[:-1:2] = 'ace'	s = [a,b,[c[d,e]]] d = {'k1':[1,2,3]}	s[2][1][0] = 'd' d['k1] = [1,2,3]
AND OR	and – both conditions true (evaluate all conditions) or – at least 1 condition true (evaluate 1st condition first) not 0, not None, not '' are all true	(1>2) and (2>3) (1<2) and (2<3) (1<2) or (2>3) or (1==1) 20 or True True or 20 20 and True True and 20 False==0 and False == ''	False True True 20 True True 20 False (True and False)	

	if 1<2:
	  print('hello')
	elif ___:
	  ___
	else ___:
	  ___
		#short form
		print('hello') if 1<2 else: ...
			seq = [1,2,3,4,5]
			for item in seq:
			  print(item)
			OR
			for x in range (0,6):
			  print(x)
				1
				2
				3
				4
				5

	i = 1 while i<4: print('i is: ' + str(i))	i is :1 i is :2 i is :3	1 > 1, 000 3,2,1>0,1,2 (1,2,3) + (1,2,3)	(False, 0) (3,2,True,1,2) (1,2,3,1,2,3)

x = 'Sam'	break	break out of current loop
	continue	goes to top of nearest loop
	pass	does nothing (to not get error when loop is empty)

	for item in x:
	  if item == 'a':
	  continue
	  print('item')
		S
		m

	for item in x:
	  if item == 'a':
	  break
	  print('item')
		S

list1 = [1,2,3]
list2 = ['a', 'b', 'c']
	for item in enumerate(x):
	  print(item)
	
	for item in zip(list1, list2):
	  print(item)
		(0, 'S')
		(1, 'a')
		(2, 'm')
		(1, 'a')
		(2, 'b')
		(3, 'c')

	list1.extend(list2) list1	[1, 2, 3, 'a', 'b', 'c']

x = [1,2,3,4] out = []	for num in x: out.append(num**2) print(out)	x = [1,2,3,4] out = [num**2 for num in x] print(out)	[1,4,9,16]

Function	def my_func(parameter):
	  print(parameter)
	def say_hello(name='Default')
	  print(f'Hello {name}')
	say_hello()
		print --> value not stored/remembered
		return --> can store in variable
		--> default value if no arg passed
		
		Hello Default

	def times2(var):
	  return var*2
	def myfunc(*args):
	  return sum(args) * 0.05
	def myfunc(**kwargs):
	  print(kwargs)
	  if 'fruit' in kwargs:
	  print('My fruit is {}'.format(kwargs['fruit']))
	  else:
	  print('I do not like fruit')
	myfunc(fruit = 'apple', veggie = 'lettuce')
		t = lambda var: var*2
		
		--> can insert multiple numbers ('args' is dummy variable and in form of tuple)
		--> only keywords
		
		{'fruit': 'apple', 'veggie': 'lettuce')
		My fruit is apple

Built-in Functions seq = [1,2,3,4,5] lst = [True, False, True] # All iterables(can only print out items once)	list(map(lambda num: num*2, seq)) list(filter(lambda num: num%2 ==0, seq) reduce(lambda x,y:10*x+y, seq) all(lst) any(lst)	[2,4,6,8,10] [2,4] --> filter will ensure condition is true 12345 ((((1*10+2)*10+3)*10+4)*10+5) False True

	list(zip([1,2,3], ['a', 'b', 'c'], ['+','-','*']))	[(1, 'a', '+'), (2, 'b', '-'), (3, 'c', '*')]
Higher Order Fn	foo = lambda x: lambda a,b: a*x+b bar = foo(5) bar(2,3) def thrice(f): return lambda x: f(f(f(x))) add1 = lambda x: x + 1 thrice(thrice(add1))(0) thrice(thrice)(add1)(0)	 13 (2*5+3) 9 27
Methods name= 'sAm', x='s a m'	name.upper() name.lower() name.title() x.split()	SAM sam Sam ['s', 'a', 'm']
lst = [1,2,3] lst2 = [1,2,4]	d.keys() --> return keys d.items() --> return key and values d.values() --> return values t.count('a') --> count no. of times 'a' is in tuple t.index('a') --> smallest index of 'a' in tuple # List and dictionary are mutable => their original global values will be changed if passed into a function lst2 > lst --> True # Compare first element and so on until unequal element is found. If first N elements equal, but one list longer, longer list is greater	list.pop() --> remove and return last value list.pop(0) --> remove 1st value list.append(('a', 'b')) --> add 'new' to end of list # [1,2,3, ('a', 'b')] list.extend(('a','b')) --> add iterable to end of list # [1,2,3, 'a', 'b'] list.insert(obj, index) --> insert object at index list.reverse() --> reverse elements in list list.copy() --> copy list if dont want original list to be affected
Sorting	Inplace Stable {-2, 4, 5, -11, 9, -10} {-2, -11, -10, 4, 5, 9} bubble sort (stable, inplace) selection sort (inplace) insertion sort (stable, inplace) merge sort	- No additional space required, elements are reindexed - Relative index remain the same Before sorting by negative integers first After sorting, relative index same - for i in range, compare i and i+1 (each iteration will decrease by 1 as largest value to end) - find min value in unsorted list, place min value at end of sorted list, repeat - for each i, find index to insert in sorted list -
	'x' in [1,2,3] '1' in [1,2,3] ord('o') ord('1') '12345' < '2345' isinstance(obj, data type)	False True 111 (Unicode code point, alphanumeric character 49 have a number assigned to them) True (only look at first alphanumeric value of str) # Better than checking type as considers inheritance as well (subclass will be same as class in isinstance but not for type())

x = [(1,2), (3,4)]	for items in x:
	  print(item)
	
	for (a,b) in x:
	  print(a)
		(1,2)
		(3,4)
		
		1
		3

	for (a,b) in x:
	  print(a)
	  print(b)
		1
		2
		3
		4

Truthy/Falsey value - values which evaluate to true / false	False: [], '', (), {}, range(0), 0, 0.0, None, False Truth: non-empty list, dict..., non-zero numbers, Truth	However, 1 == True (True) 5 == True (False) And 0 == False (True) [] == False (False)
Equivalence & Identity	Equivalence refers to same content Identity refers to same memory space x = (1,2) y = (1,2) x is y x == y z = x z is x a = (1,2,3) a == (1,2,3) a is (1,2,3)	== is (Equivalence subset of identity) False True True True False (Not stored in same space)

Function in a function	def a(x,y):
	  def b(i):
	  return i*x*y
	  return b
		h = (3,5)
		h(2) => 30
		
		a(3,5)(2) =>30

Big O Notation	O(1) O(log n) O(n) O(n*log n) O(n**2) O(n**3) O(2**n)	Time proportional to no. of operations (Time to execute once * no. of times fn is called) Space proportional to no. of pending operations
Files	pwd input = open('filename.txt', 'r') input.read() input.readlines() input.seek(0) input.write('Hello World') input.close() import os os.getcwd() os.listdir(param) import shutil shutil.move('file', 'new_dir') import sendtotrash sendtotrash.sendtotrash('file')	present working directory r: read | w: write | a: append | r+: reading & writing | w+: writing & reading (overwrite existing file or create new file) | wb: write binary # output everything in 1 line & cursor goes to end of file # output lines as separate obj in list # to get cursor back to start of file # same as pwd # param can be any directory, default is pwd # move file to another directory

```
import zipfile
comp_file = zipfile.ZipFile('comp_file.txt', 'w')                    # creating a new empty zip file
comp_file.write('filename.txt', compress_type =
zipfile.ZIP_DEFLATED)
comp_file.close()
zip_obj = zipfile.ZipFile('comp_file.txt', 'r')                      # unzip file
zip_obj.extractall('extracted_content')
shutil.make_archive('newfile', 'zip', dir_to_zip)
shutil.unpack_archive('filetounpack', 'newfile2', 'zip')
```

Object Oriented Programming

Superclass : base class where other object inherit from

```
class NameOfClass():

    #Class object attribute
    num = 0
    def __init__(self, param1, param2):
        self.param1 = param1
        self.param2 = param2
        self.area = self.param2 *2
        NameOfClass.num += 1
    def some_mtd(self):
        # perform some action
        print(f'Hello {self.param1}')

x = NameOfClass('Sam', 20)
x.attri OR NameOfClass.attri
x.param1
x.param2
x.area
x.some_mtd()
```

--> naming convention follows camel casing: each word is capitalized
--> same attribute for all instance of this class
#NameOfClass.num --> 'random'
--> attribute of the class

--> track how many instances of class created
--> methods that can be called with this class

```
'random'
'Sam'
20
40
Hello Sam
```

Inheritance
Subclass

```
class Name2(NameOfClass):

    def __init__(self):
        NameOfClass.__init__(self)
OR.     super().__init__(self)
        print('Attribute of Name2')
    def some_mtd(self):
        print('Hi')
```

--> Name2 inherit base class (NameOfClass)
- Name2 will inherit all mtd in NameOfClass

--> Name2 inherit all attribute of NameOfClass in addition to the print statement

--> overwrite method in base class for class Name2

Polymorphism
- different classes use the same mtd name

```
Niko = Dog('Niko')
Felix = Cat('Felix')
pet_speak(Niko) => Niko say woof!
pet_speak(Felix) => Felix say meow!

fido = Dog('Fido')
isis = Cat('Isis')
```

```
class Dog():
    def __init__(self, name):
        self.name = name
    def speak(self):
        return self.name + ' say woof!'

class Cat():
    def __init__(self, name):
        self.name = name
    def speak(self):
        return self.name + ' say meow!'

def pet_speak(pet):
```

```
class Animal():
    def __init__(self, name):
        self.name = name
    def speak(self):
        raise NotImplementedError('Subclass
        must implement this abstract method')

class Dog(Animal):
    def speak(self):
        return self.name + ' say woof!'

class Cat(Animal):
    def speak(self):
```

print(fido.speak()) => Fido say woof! print(isis.speak()) => Isis say meow!	print(pet.speak())	return self.name + ' say meow!'

Special Methods / Dunder Mtds	class Book():
	def __init__(self, title, author, pages):
	self.title = title
	self.author = author
	self.pages = pages
	def __str__(self):
	return f'{self.title} by {author}'
	def __len__(self):
	return self.pages
		b = Book(Python rocks, Jose, 200)
		print(b) => Python rocks by Jose
		str(b) => 'Python rocks by Jose'
		len(b) => 200
		
		--> return this whenever str of b required
		- __(function name)__ allows predefined methods to be called on your class
		- __equals__ for ==

Errors	try:
	# Want to run this code that may have an error
	result = 10 + '10'
	except:
	# Runs if code in try fails
	print('You aren't adding correctly')
	raise MyError("...")
	else:
	# Runs if code in try runs correctly
	print('Added')
	finally:
	# Code here always run
	print('I always run')
	
	class MyError(Exception):
	def __init__(self, msg):
	super().__init__(msg)
		You aren't adding correctly
		I always run
		
		--> To target a specific error, (e.g. except TypeError:)
		- can have multiple except statements
		- can raise own error but must define class
		
		--> Code will always run even there is a break in code above. (Usually used to close or save a file)
		
		- default would be subclass of Exception
		
		- msg to be printed out beside error

Decorators
- fn that can change / extend behavior of other fn without permanently modifying the other fn
	def decorator(original_func):
	def wrap_func():
	print('Before original function')
	original_func()
	print('After original function')
	return wrap_func
	
	def new_func():
	print('I want to be decorated')
		decorated_func = decorator(new_func)
		decorated_func() => Before original function
		I want to be decorated
		After original function
		@decorator
		def new_func():
		print('I want to be decorated')
		
		new_func()
		--> same output as decorated func
		--> comment out @decorator to remove if not needed

Generator Fn
- instead of computing an entire sequence of values and hold in memory, it only generate 1 value and wait until next value is needed
	def gencubes(n):
	for num in range(n):
	yield num**3
	for x in gencubes(3):
	print(x)
	
	def simple_gen():
	for x in range(3):
	print(x)
		-one example in range(), which just keeps track of last number and add the step size
		- more memory efficient as no need to create entire list and iterate through it
		0
		1
		8

	g = simple_gen()
	print(next(g))
	print(next(g))
	print(next(g))
	print(next(g))
	
	s = 'ord'
	
	next(s)
	s_iter = iter(s)
	next(iter(s))
	next(iter(s))
	next(iter(s))
	
	gencom = (i/2 for i in ... if ...)
	for i in ...:
	  if ...:
	  yield i/2
		--> will rmb the last called value
		0
		1
		2
		--> StopIteration error
		
		works with for x in s:
		  print(x)
		--> TypeError as str not iterable
		o
		r
		d
		
		--> generator comeprehension
		--> equivalent to

Built-In Modules	from collections import Counter lst = [1,1,1,2,2,2,2,2,3,3,3,3] Counter(lst) Counter(lst).most_common(n=..) sum(c.values()) c.clear() list(c) set(c) dict(c) c.items() Counter(dict(list_of_pairs)) c.most_common()[:-n-1:-1] c += Counter() from collections import defaultdict d = defaultdict(lambda: 0) from collections import namedtuple Dog = namedtuple('Dog',['age','breed','name']) sam = Dog(age=2,breed='Lab',name='Sammy') sam.age || sam[0] import datetime t = datetime.time(4,20,1) print(t) t.hour...t.microsecond t.tzinfo print(datetime.date.today()) from datetime import datetime, date print(datetime(2021,2,5,10,47,05) t.replace(hour = 10) date1 = date(2021,2,5)	-works with string as well - technically a dict so normal dict mtds can be used Counter({1: 3, 2: 5, 3: 4) [(2: 5), (3: 4), (1: 3)] # n = no. of most common items # total of all counts # reset all counts # list unique elements # convert to a set # convert to a regular dictionary # convert to a list of (elem, cnt) pairs # convert from a list of (elem, cnt) pairs # n least common elements # remove zero and negative counts # assign default value to a key that is called even though not present in dict # assign named indices to tuple values (almost likea creating a class) 2 04:20:01 4...0 None (timezone info) 2021-MM-DD 2021-02-05 10:47:05 datetime.time(10,20,1)

lst = list(range(0,20))	date2 = date(2020,2,5) date1-date2 import random random.randint(0,100) random.seed(101) random.choice(lst) random.choice(population = lst, k = 5) random.sample(population = lst, k = 5) random.shuffle(lst) import pdb pdb.set_trace() q	 datetime.timedelta(365) 74 (0 and 100 inclusive) # ensure following calls of randint will generate same output but not same int 16 [4,4,5,20,14] (k = no. of items picked with replacement) [4,1,13,16,7] (without replacement) # shuffle position of values in list # python debugger # find out value of variable at that pt of trace # to quit trace

Timing code	import time, timeit
	start_time = time.time()
	# code here
	end_time = time.time()
	elapsed_time = end_time - start_time
	
	stmt = '''func_one(100)'''
	setup = '''#code for func_one'''
	timeit.timeit(stmt, setup, number = 100000)
		
		# statement to be called
		
		# number: number of time func_one is called

Regex (regular expression) match = re.search(pattern, text)	import re r"(\d\d\d)-\d\d\d-\d\d\d\d" r"(\d{3})-\d{3}-\d{4}" re.search(pattern, text) match.span() match.start() match.end() re.findall(pattern, text) match.group() re.compile(r'(\d{3})-(...)-(...)')	- r (to inform python value inside string are identifiers) # \d: digit || \w: alphanumeric || \s: white space || \D: non-digit || \W: non-alphanumeric || \S: non-whitespace - () and - are exact identifiers that we are looking for # +: >=1 || {3}: exactly 3 times || {2,4}: 2-4 times || (3,}: >= 3 || * : >= 0 || ? : 1 or 0 - text: where to search , pattern|pattern2: search for pattern or pattern2 , .pattern: search for _pattern (e.g. .at: => cat, hat, sat) ^: start with, $: end with, [^]: exclude things in bracket [^]+ : exclude things and combine back to string (12,17) #index of matches (only return first match) 12 17 # return pattern that you are searching for # group the values and can call group(n)
Web-Scrapping	Html CSS Javascript CSS syntax soup.select('div') soup.select('#some_id') soup.select('.notice')	Basic structure and content Design and Style Interactive elements of webpage All elements with the tag The HTML element containing the id attribute of some_id All the HTML elements with the CSS class named notice # if class = some class -> soup.select('.some.class')

	soup.select('div span') soup.select('div > span') import requests res = requests.get('url') import bs4 soup = bs4.BeautifulSoup(res.text, 'lxml') search = soup.select(...) search.text url = search[0]['src'] link = requests.get('url') file.write(link.content) base_url = 'http://abcde/page-{}.html' base_url.format('i')	Elements named within an element named Any elements named that are directly within an element named , with no other element in between #General steps to getting text off website # To download image to computer # acts like a dict object. src: source url # link.content will be in binary form, so open file with 'wb' # Going through different page of website # http://abcde/page-i.html
Images	from PIL import Image img = Image.open('example.jpg') img.show() img.size img.filename img.format_description i2 = img.crop(x,y,w,h) img.paste(im = i2, box = (x,y)) img.resize(h,w) img.rotate(90, expand = True) img.putalpha(val) img.save('new.jpg')	# pillow # No need .show() for jupyter notebook (1993,1257) 'example.jpg' 'JPEG (ISO 10918)' # top left is (0,0) and (w,h) is coordinates of end pt # Paste i2 over img, box is top left coord of i2 # resize image # first arg is degree to rotate, # without expand, new img will have old dimensions and # empty space will be filled black # Make image transparent # Save image

Numpy	import numpy as np my_list = [1,2,3] arr = np.array(my_list) arr x = ([1,2,3]), [4,5,6]) x	 array([1,2,3]) array([[1,2,3], [4,5,6]])
	np.arange(0,10,2) np.zeros(3) np.ones(2) np.zeros((2,3))	array([0,2,4,6,8]) array([0,0,0]) array([1,1]) array([[0,0,0], [0,0,0]])
	np.linspace(0,5,11) -->(start, stop, no. of values) np.eye(3) -->identity matrix	array([0. , 0.5, 1. , 1.5, 2. , 2.5, 3. , 3.5, 4. , 4.5, 5.]) array([[1,0,0], [0,1,0] [0,0,1]])
	np.random.rand(1,2) -->(row, column) np.random.randn(1,2) np.random.randint(1,100,10) -->(start inclusive, end exclusive, no. of values)	-->random no. in uniform dist. -->random no. in normal dist. -->random int. in range

	arr.reshape(5,5) arr.max() arr.min() arr.argmax() arr.shape() arr.dtype() arr_copy = arr.copy()	-->reshape array into type of matrix -->max value in array -->min value -->index of max value -->tells you shape/dimension of matrix -->tells you data type -->when you dont want original data to be affected
arr = np.array([[5,10,15], [20,25,30], [35,40,45]])	arr[1,2] OR arr[1][2] arr[:2, 1:] -->[row, column] arr>10 arr[arr>10]	30 array([[10,15], [25,30]]) array([[False, False, True], [True, True, True], [True, True, True]]) array([15,20,25,30,35,40,45])
	np.sqrt(arr) np.exp(arr) np.sin(arr) np.log(arr) np.sum(arr) np.isnan(var)	√ ** sine logarithm sum array return boolean of var is null
Pandas labels = ['a', 'b', 'c'] x = [10, 20, 30] d = {'a':10, 'b':20, 'c':30}	import pandas as pd pd.Series(np.array(x)) OR pd.Series(x) pd.Series(data = x, index = labels) OR pd.Series(d)	0 10 1 20 2 30 dtype: int64 a 10 b 20 c 30 dtype:int64
	ser1 = pd.Series([1,2,3], ['US', 'Germany', 'USSR'] ser2 = pd.series([1,2,5], ['US', 'Germany', 'Italy'] ser1 + ser2	Germany 4.0 Italy NaN US 2.0 USSR NaN dtype: int64
DataFrame	df = pd.DataFrame(randn(3,2), ['A', 'B','C'], ['X', 'Y'] -->(data, index, column)	X Y A 2.7 0.6 B. 0.7 1.9 C -2.0 0.1
	df['X'] df['X'] > 0 df[df['X'] > 0] df['new'] = df['X'] + df['Y'] df.reset_index() df.set_index('List') df.idxmin()	--> get X column --> get boolean for condition --> get data which satisfy condition --> insert new column in dataframe --> change index to 0,1,2 | default is not permanent --> change index --> gives index of min value for each column
X Y A 2.7 0.6 B. 0.7 1.9 C -2.0 0.1	df.loc['A'] OR df.iloc[0] df.loc['B', 'Y']	X 2.7 Y 0.6 --> index of row 1.9 --> [row, column]
	df[(df['X'] > 0) & (df['Y' > 1)]	--> and condition

	df[(df['X'] > 0) | (df['Y' > 1)]	--> or condition

Multilevel Index

```
arr = [np.array(['G1', 'G1', 'G1', 'G2', 'G2', 'G2']),
       np.array(['1', '2', '3', '1', '2', '3'])]
df=pd.DataFrame(np.random.randn(6,2), index=arr,
columns=['A', 'B'])
df.index.names=['Groups', 'Num']
df
```

Groups	Name	A	B
G1	1	0.30	1.69
	2	-1.70	-1.15
	3	-0.13	0.39
G2	1	0.16	-1.20
	2	0.80	1.10
	3	0.63	0.75

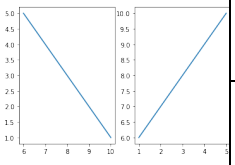
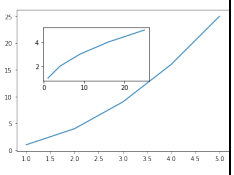
```
df.loc['G1'].loc['1']
```

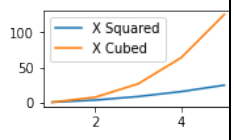
```
A. 0.30
B 1.69
Name: 1, dtype:float64
```

```
df.xs('1', level='Num')
```

Groups	A	B
G1	0.30	1.69
G2	0.16	-1.20

	df.drop('R')	--> drop row E, default is row drop not permanent
	df.drop('C', inplace=True, axis=1) OR df = df.drop('C', axis=1)df.dropna()	--> permanently drop column C
	df.dropna(axis=1)	--> remove columns with null value
	df.dropna(thresh=2)	--> remove rows with >=2 null values
	df.fillna(value='...')	--> fill null values
	df['A'].fillna(value=df['A'].mean())	--> for column A, fill null values with mean of column A
	df.groupby('Groups')	--> compile into groups by column
	df.groupby(by=['List'])	--> compile into multiple groups by column
	df['A'].mean() sum, std, count	--> get average, sum, std deviation, count
	df.describe()	--> get stats of df
	df.info()	--> get data type and null values
	df.head(5)	--> get first 5 rows of df
	df.transpose()	--> transpose df
	pd.concat([df1, df2, df3], axis = .., join =)	concat to stack data --> axis = 0: concat along rows (default) --> axis = 1: concat along columns --> join = outer: union (default) --> join = inner: intersection
	pd.merge(df1, df2, how = 'left', on = 'col')	merge to combine dataframes according to column --> how = inner (default), outer, left, right --> on = column name: combine according to this column
	df1.join(df2, how = 'outer')	join same as merge but column = index only --> how = left (default), inner, outer, right
	df['A'].unique()	--> array of unique values in column A
	len(df['A'].unique()])	--> no. of unique values in array
	OR df['A'].nunique()	
	sorted(df['A'].unique())	--> sort unique value in array

	df['A'].value_counts() df['A'].apply(lambda x: x*2) df.columns() df.index() df.sort_values('A') df.isnull() df.pivot_table(values = ['..'], index = ['..'], columns = ['..']	--> display no. of times value occurs --> map own function onto df['A'] --> column names --> shows index --> sort df according to values in column A (index remain the same according to orginal) --> boolean of null values --> pivot unstructured data into dataframe according to index and column specified
	pd.read_csv('file_name.csv') df.to_csv('filename', index = False) pd.read_excel('..', sheetname = 'Sheet1') df.to_excel('..', sheetname = '..') pd.read_html('..html') pd.read_sql('..', con = ..)	--> read csv file --> change df to csv file (default index not saved) --> read excel file --> read html file --> read sql file (con = connection)
	df.select_dtypes(int) pd.to_datetime(df['A']) df.corr() df.corrwith(df2) df.replace(inplace = '..', value = '..')	--> subset of df with datatype according to specified (int, float, obj, bool) --> convert str to datetime obj --> correlation btw columns --> correlation btw dataframes --> replace data in inplace (can be list) with data in value
Matplotlib	import matplotlib.pyplot as plt %matplotlib inline plt.show() plt.plot(x,y) plt.xlabel('X axis') plt.ylabel('Y axis') plt.title('Title')	 --> for jupyter notebook --> last line if not jupyter notebook --> label x axis --> label y axos --> label title
Multiple graphs in 1 canvas 	plt.subplot(1,2,1) plt.plot(x,y,'r') plt.subplot(1,2,2) plt.plot(y,x,'b')	--> dimensions of graph (height, width, plot no.) --> (x,y, color(red)) --> (x,y, color(bluez))
	fig, axes = plt.subplots(nrows = 1, ncols = 2) axes[0].plot(x,y, label='..') axes[1].plot(y,x)	--> (1 row by 2 columns of graph) --> can label graph
2 diagram overlay each other 	fig = plt.figure() axes1 = fig.add_axes([0.1,0.2,0.8,0.8]) axes2 = fig.add_axes([0.2,0.5,0.4,0.3]) axes1.plot(x,y, color = '..', linewidth = .., linestyle = '..', alpha = 0.5, marker = '..', markersize = .., markerfacecolor = 'yellow' markeredgewidth = .., markeredgecolor = ..) axes2.plot(y,x)	--> creating a canvass --> [10% from left, 20% from bot, 80% width, 80% height] --> color (#RGB Hex code for more colors), linewidth: default 1, increase for thicker line linestyle: '- -' (dashed), '-' (solid), '-.' (dashed dot) ':' (dotted) alpha: transparency marker: point marker. 'o', '+', '*', '1', 'x' markersize: size of marker

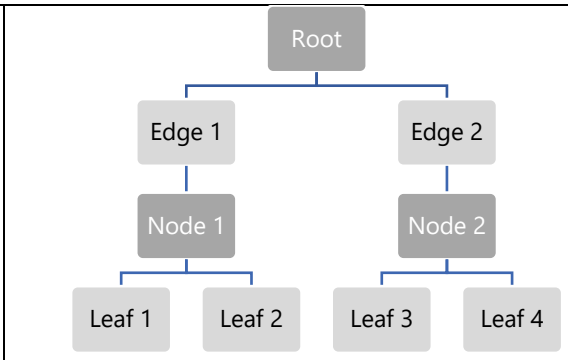
		markerfacecolor: color of markers markeredgewidth: width of marker edge markeredgecolor: color of marker edge
2 graph on 1 diagram 	fig = plt.figure() ax = fig.add_axes([0,0,1,1]) ax.plot(x, x**2, label = 'X Squared') ax.plot(x, x**3, label = 'X Cubed') ax.legend(loc=0) ax.set_xlimit([0,2]) ax.set_ylimit([0,1])	--> loc=location 0:best, 1:upper right, 2:upp left, 3:low left, 4:low right, 5:right, 6:center left, 7:center right 8:low center, 9: upp center, 10:center --> OR loc = (0.1,0.1) : 10% left, 10% bot --> set x limit(lower limit, upper limit)
	plt.tight_layout() plt.figure(figsize=(12,5), dpi = 100) fig.savefig('file_name')	--> to spread out graph --> figsize in inches (width, height) --> save figure
	plt.scatter(x,y) plt.hist() plt.boxplot()	
Seaborn S = x = 'A', y = 'B', data = df	import seaborn as sns sns.displot(df['A']) sns.jointplot(S, kind = '..') sns.pairplot(df, hue = 'C', palette = 'coolwarm') sns.rugplot(df['A']) sns.barplot(S, estimator = np.std) sns.countplot(x = '..', data = df) sns.boxplot(S) sns.violinplot(S, split = True) sns.stripplot(S, jitter = True) sns.swarmplot(S) sns.factorplot(S, kind = 'bar') sns.lmplot(S, col = 'C', aspect = 0.6, size = 8) sns.heatmap(df, annot = True, cmap = 'coolwarm', linecolor = 'red', linewidth = 3) sns.clustermap(df, standard_scale = 1)	--> default kind='hist', kind:type of plot --> scatterplot, kind = hex, reg: regression line, kde --> jointplot for all variables; hue: separate data using color; palette: type of color (matplotlib colormap) --> horizontal dash plot: shows density of data --> default is bar plot with estimator mean --> bar plot with y = count --> box and whisker plot --> boxplot but for all data, split = True: split values according to category along center line --> scatterplot when one variable is categorical, jitter = True: used when point overlap --> combine strip & violin plot(not for large data) --> general plot --> linear fit; col: split into 2 graphs unlike hue where both plots in 1 diagram; aspect: ratio of width to height; size: absolute size of diagram --> annot: annotate and label values; cmap: color --> cluster rows & columns according to similarity, standard_scale: normalise data
	g = sns.PairGrid(df) g.map(plt.scatter) g.map_diag(sns.displot) g.map_upper(plt.scatter) g.map_lower(sns.kdeplot)	--> provides more control than pairplot --> diagonal graphs shows dist plot --> upper of diagonal shows scatter plot --> lower of diagonal shows kde plot
	g = sns.Facetgrid(data = df, col = 'A', row = 'B') g.map(sns.displot, 'C', 'D')	--> similar to Pairgrid but shows multiple graphs segregated according to rows and cols --> 'D' if graphs required for more variables

	plt.figure(figsize=(12,3)) sns.set_style('white') sns.despine(left = True, bottom = True) sns.set_context('poster'), font_scale = 3 df.plot(x = '..', y = '..'kind = '..', figsize = (.,.), cmap = '..', color = '..')	--> will override seaborn --> style of background(ticks, blackgrid, whitegrid) --> default remove top and right spine --> sns has built in format(paper, notebook) --> use matplotlib to plot
Plotly & Cufflinks	import cufflinks as cf import chart_studio.plotly as py import plotly.graph_objs as go from plotly.offline import download_plotlyjs, init_notebook_mode, plot, iplot init_notebook_mode(connected=True) cf.go_offline()	--> interactive plot
	df.iplot(kind = 'scatter', x = 'A', y = 'B', mode = 'markers', size = 20, colorscale = 'rdylbu', bins = 50) df.scatter_matrix()	--> kind: scatter, bar, box, surface, hist, spread, bubble mode = markers: so that data pts are not connected by lines size: size of markers (can be another column so that plot has additional variable) colorscale: redyellowblue --> similar to pairplot
Chororpleth Maps	data = dict(type = 'choropleth', locations = [..], locationmode = 'USA-states', colorscale = '..', reversescale = True, text = [..], z = [..], colorbar = {'title': 'Colorbar title goes here'}, marker = dict(line = dict(color = 'rgb(255,255,255), width = 1)) layout = dict(geo = (scope': 'usa', showlakes = True, lakecolor = Ygbl(85,173,240))), choromap = go.Figure(data = [data], layout = layout) iplot(choromap) OR layout = dict(title = '..', geo = dict(showframe = False, projection = {'type': 'Mercator'}	--> type: type of map locations: name of countries/states locationmode: ISO-3(for short form of country name in location), USA-states, country names colorscale: Greys, YlGnBu, Greens, YlOrRd, Bluered, RdBu, Reds, Blues, Picnic, Rainbow, Portland, Jet, Hot, Blackbody, Earth, Electric, Viridis, Cividis reversescale = True: reverse colorscale text: info displayed when hovering z = "y-values" colorbar: customise colorbar: title, len, lenmode geo: map layout: world | usa | europe | asia | africa | north america | south america showlakes: whether lakes are shown lakecolor: customise color of lakes marker: customise markers --> showframe: whether frame is drawn --> projection: how map is displayed equirectangular | mercator | orthographic | natural earth | kavrayskiy7 | miller | robinson | eckert4 | azi muthal equal area | azimuthal equidistant | conic equal area | conic conformal | conic equidistant | gnomonic | stereographic | mollweide | hammer | transverse mercator | albers usa | winkel tripel | aitoff | sinusoidal
Machine Learning	Accurracy = correct predictions / total predictions Recall = True +ve / (True +ve + False -ve) Precision = True +ve / (True +ve + False +ve) F1 score = $2 * \frac{\text{Precision} * \text{Recall}}{\text{Precision} + \text{Recall}}$ F1 score best = 1	Confusion Matrix

			Predictions	
			+	-
	Actual	+	True +ve	False -ve Type II error
		-	False +ve Type I error	True -ve

	Mean Absolute Error(MAE) = $\frac{1}{n}\sum_{i=1}^{n}\lvert y_i - \hat{y_i}\rvert$ Mean Squared Error(MSE) = $\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y_i})^2$ Root Mean Squared Error(RMSE) = $\sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y_i})^2}$	Bias Variance Trade-Off : by constantly adding complexity to model / model overfit, could lead to training data accuracy to increase, while test data accuracy to decrease
	General: Supervised Estimator from sklearn.family import model model.fit() model.predict() model.predict_proba() model.score()	General: Unsupervised Estimator from sklearn.family import model model.fit() model.transform() model.fit_transform() model.predict() model.score()

Linear Regression	X = df[['A', 'B', 'C',...]] y = df['Y'] from sklearn.model_selection import train_test_split X_train, X_test, y_train, y_test = train_test_split(X, y, test size = 0.3) from sklearn.linear_model import LinearRegression lm = LinearRegression() lm.fit(X_train, y_train) coeff_df = pd.DataFrame(lm.coef_, X.columns, columns = [''Coefficient'] predictions = lm.predict(X_test) plt.scatter(y_test, predictions) sns.displot((y_test - predicitions), bins = 50) from sklearn import metrics metrics.mean_absolute_error(y_test, predictions) metrics.mean_squared_error(y_test, predictions) np.sqrt(metrics.mean_squared_error(y_test, predictions))	--> test size: how much data to set aside for test --> create instance of model --> fit data to model --> produce dataframe of coefficient for each x value --> use test data to predict y value --> ideally a straight line --> ideally normal distribution
Logistics Regression uses logistic function to classify binary variable	aa = pd.get_dummies(df['A'], drop_first = True) df = df.drop(['A'], axis = 1) df = pd.concat([df, aa], axis = 1) OR nameofcol = ['A'] df = pd.get_dummies(df, columns = nameofcol, drop_first = True) from sklearn.linear_model import LogisticRegression logmodel = LogisticRegression() train test split...fit...predict... from sklearn.metrics import classification_report, confusion_matrix print(classification_report(y_test, predictions)) print(confusion_matrix(y_test, predictions))	--> dtype 'object' and 'category' will be converted to binary values drop_first: remove 1 column as the other column can tell result (if female = 0.0, male confirm = 1.0), so no need for 2 columns --> drop column with classes and combine column with binary value with df --> to create list of the column --> columns only accept list objects; change column A to dummies and drop column A --> Precision, Recall, F1 score, Support support is the number of occurence of the given class in your dataset

K Nearest Neighbour classify variable according to data around it K = no. of nearest neighbour you want to take into account	from sklearn.preprocessing import StandardScaler scaler = StandardScaler() scaled_features = scaler.fit_transform(df.drop('Target Class', axis = 1) df_feat = pd.DataFrame(scaled_features, columns = df.columns[:-1]) train test split with (X = df_feat, y = df['Target Class']) from sklearn.neighbors import KNeighborsClassifier error_rate = [] for i in range(1,40): knn = KNeighborsClassifier(n_neighbors = i) knn.fit(X_train, y_train) pred_i = knn.predict(X_test) error_rate.append(np.mean(pred_i != y_test)) plt.plot(range(1,40), error_rate) knn = KNeighborsClassifier(N_neighbors = ...) fit...predict...error report...	--> fit and standardise data (less "y" column) --> dataframe of "X" value less "y" column --> to find the best K value get mean of False (0) and True (1), where predictions != y_test (higher value = higher --> error rate) --> choose value near min & surroundings don't fluctuate much --> sub best K value in --> can compare report with K=1
Decision Trees & Random Forests Root = 1st Condition Edge = Different outcome Node = Condition Leaf = Final Outcome Random Forest combine output of multiple decision tree to generate final output	train test split... from sklearn.tree import DecisionTreeClassifier dtree = DecisionTreeClassifier fit...predict...error report... from sklearn.ensemble import RandomForestClassifier rfe = RandomForestClassifier(n_estimators = 200) fit...predict...error report...	
Support Vector Machines - non-probabilistic binary linear classifier recognise pattern, - used for classification & regression analysis	Support vector = vector pts that margin line touches can expand to non linear data using 'kernel trick'	--> choose best line to categorise data (if data on left side of line: class A; if data on right side of line: class B)
	train test split... from sklearn.svm import SVC model = SVC() fit...predict...error report from sklearn.model_selection import GridSearchCV param_grid = {'C': [0.1, 1, 10, 100, 1000], 'gamma': [1, 0.1, 0.01, 0.001, 0.0001], 'kernel': ['rbf']} grid = GridSearchCV(SVC(), param_grid, refit = True, verbose = 3) grid.fit(X_train, y_train) grid.best_params_ predict...error report...	--> dict of paramters to try --> refit: use the best paramter found; verbose: messages to see what it is doing
K Means Clustering - unsupervised learning; - divide data into distinct grps such that observations within each grp is similar; - assign data to cluster for which centroid is closest - K = no. of clusters - sum of squared error(SSE) = sum of squared dist. btw data in cluster & centroid - 'elbow method': k value = when SSE drastically	from sklearn.cluster import KMeans kmeans = KMeans(n_clusters = ..) kmeans.fit(df) kmeans.cluster_centers_ kmeans.labels_	--> coordinates of centroid --> predicted "y" values
Principal Component Analysis	scaler...fit_transform...	

- aka "general factor analysis" - determines several orthogonal(right-angled) lines of best fit to data set - transform higher dimensions of variables to lower dimension that still contain most info - principal component =. new variable that contain info in desc. order - find out which feature explains the most variance in data - can use new df for analysis	from sklearn.decomposition import PCA pca = PCA(n_components = 2) x_pca = pca.fit_transform(scaled_data) x_pca.shape plt.scatter(x_pca[:,0], x_pca[:,1], c = df['Target']) plt.xlabel('First PC') plt.ylabel('Second PC') pca.components_ df_comp = pd.DataFrame(pca_components, columns = df.columns[:-1]) sns.heatmap(df_comp, cmap = 'Plasma')	--> how many variables you want --> see that shape of matrix reduced to 2 principal component --> 1st PC, 2nd PC, target class --> does not corresponds to a single feature but a combination of all --> new df --> shows rs btw feature and PC

Recommenders Systems	- content-based: focus on attibutes of items & give recommendations based on similarity btw them - collaborative filtering: based on knowledge of users' attitude to items to recommend items(based on others buying habits) CF 1)memory based CF by computing cosine similarity CF 2) model based CF by using singular value decomposition(SVD) CF 1)a) user-item filtering = users who are similar to u also liked... CF 1)b) item-item filtering = users who liked this item also liked...

Natural Language Processing	- bag of words = words that you are finding - convert words to vector: 'Red house' -> (red, blue, house) -> (1,0,1) | 'Blue house' -> (0,1,1) - cosine similarity: sin(A,B) = cos $\theta = \frac{A \cdot B}{\|\|A\|\|B\|\|}$ - TF - IDF : Term Frequency - Inverse Document Frequency - TF(d,t) = no. of occurrence of term t in document d (importance of term within document) - IDF(df_t) = log(N, df_t) where N = total no. of documents, df_t = no. of documents with term t (importance of term in corpus(grp of all documents)) - $W_{t,d}$ = TF(d,t) * log($\frac{N}{df_t}$)

	import nltk
	nltk.download()
	messages = [line.rstrip() for line in open('sms/SMS')]
	for mess_no, message in enumerate(messages[:10]):
	  print(mess_no, message)
	  print('\n')
	messages = pd.read_csv('sms/SMS', sep = '\t', names = ['label', 'message']
	import string
	string.punctuation
	from nltk.corpus import stopwords
	def text_process(mess)
	  nopunc = [char for char in mess if char not in string.punctuation]
	  nopunc = ' '.join(nopunc)
	
	  return [word for word in nopunc.split() if word.lower() not stopwords.words('english')
	messages['message'].head(5).apply(text_process)
	from sklearn.feature_extraction.text import CountVectorizer, TfidfTransformer
		--> to download dataset
		--> no. the items in data
		--> to see the file and how data is stored
		
		--> remove punctuation & change list to indv letters
		--> join indv letter according to
		' ' (nothing in this case)
		--> remove stopwords
		
		--> test if function works

1)	bow = CountVectorizer(analyzer = text_process) print(len(bow.vocabulary_)) X2 = bow.fit_transform(messages['message']) X2.nnz tfidf = TfidfTransformer() X = tfidf.fit_transform(X2) train test split... from sklearn.naive_bayes import MultinomialNB model = MultinomialNB().fit(X_train, messages['label']) pred...error report...	--> default analyzer = 'word' --> to see no. of unique words --> fit & transform --> no. of non-zero occurrence --> fit & transform --> train test split --> fit
OR 2)	train test split... from sklearn.pipeline import Pipeline pipeline = Pipeline([('bow', CountVectorizer(analyser = text_process)), ('tfidf', TfidfTransformer()), ('classifier', MultinomialNB())] pipeline.fit(X_train, y_train) pred...error report...	
Neural Network & Deep Learning	1. Perceptron Model Input -> f(x) -> Output ↳insert 'weights' to affect inputs = w ↳bias' as offset value / threshold = b	If f(x) is sum $\hat{y} = \sum_{i=1}^{n} x_i w_i + b_i$
	2. Neural Networks - Multilayer perceptron model - output of 1 perceptron become input to another perceptron - Hidden layers are grp of perceptron btw input and output layers - When >= 2 layers, neural network -> deep neural network	
	3. Activation Function - limit output value	a. step-up function (for classification problem) output 0 or 1 b. sigmoid function : output btw 0 & 1 c. hyperbolic tangent [tanh(z)] : output btw -1 & 1 d. rectified linear unit (ReLU) : if f(z) < 0, output = 0, if f(z) > 0, output = f(z)
	4. Multi-Class Classification Considerations - Non-exclusive classes: data can have multiple classes assigned to it (e.g. photo with multiple tags) - Mutually exclusive classes: 1 class per data pt (1 output node per class) - one-hot encoding / dummy variable -> use matrix to represent diff. class | (1,0,0), (0,1,0) - sigmoid function for non-exclusive classes (have cutoff values to determine which class) | (1,0,1) ↳classes independent of one another = can have multiple classes - softmax function for mutually-exclusive classes	
	5. Cost Function & Gradient Descent - cost / loss function is avg. of how far off predictions is from true value ↳quadratic cost function -> to find minimum cost/value in function -> step-size to find min. cost = (grad = 0) / aka learning rate	

	- adaptive gradient descent -> larger steps initially, smaller steps as approach grad = 0, ∇ (symbol for grad) [e.g. Adam optimizer] - cross-entropy loss function for classification problems (assume model predict prob. dist.)	
	6. BackPropagation $z^L = w^L a^{L-1} + b^L$ $a^L = \sigma(z^L)$ $C_0(\dots) = (a^L - y)^2$ - partial derivative for weight (can do for bias also) - use grad to adjust w and b to minimise output of error vector - Hadamard Pdt - error vector -backpropagate the error	where L = last layer | w = weight | b = bias | σ = activation function | C = cost function | x = 1st input ($a^0 = x$) $\frac{\partial C_0}{\partial w^L} = \frac{\partial z^L}{\partial w^L}\frac{\partial a^L}{\partial z^L}\frac{\partial C_0}{\partial a^L}$ $\begin{bmatrix}1\\2\end{bmatrix} \odot \begin{bmatrix}3\\4\end{bmatrix} = \begin{bmatrix}1 * 3\\2 * 4\end{bmatrix} = \begin{bmatrix}3\\8\end{bmatrix}$ $\delta^L = \nabla_a C \odot \sigma'(z^L)$ where $\nabla_a C = (a^L - y)$: rate of change of C wrt output activation $\delta^l = (w^{l+1})^T \delta^{l+1} \odot \sigma'(z^l)$
Tensorflow	X = df[['feature 1', 'feature 2']].values y = df['price'].values from sklearn.preprocessing import MinMaxScaler fit...transform...train test split... from tensorflow.keras.models import Sequential from tensorflow.keras.layers import Dense, Activation	--> tensorflow need numpy array --> fit only for train data | transform & train test split for both train & test data
	model = Sequential([Dense(4, activation = 'relu'), Dense(2, activation = 'relu') OR Dense(1)]) model = Sequential() model.add(Dense(4, activation = 'relu')) model.add(Dense(2, activation = 'relu')) model.add(Dense(1))	--> (no. of neurons/unit, activation function) --> next layer --> model: units usually decrease by half until last layer = 1
from tensorflow.keras.optimizers import Adam - can use optimizer = 'Adam', loss = 'mse'	model.compile(...) model.fit(X_train, y_train, epochs = 250, validation_data = (X_test, y_test), batch_size = 128) losses = pd.DataFrame(model.history.history) losses.plot()	# For a multi-class classification problem model.compile(optimizer='rmsprop', loss='categorical_crossentropy', metrics=['accuracy']) # For a binary classification problem model.compile(optimizer='rmsprop', loss='binary_crossentropy', metrics=['accuracy']) # For a mean squared error regression problem model.compile(optimizer='rmsprop', loss='mse') --> epochs: how many time model go through data validation data: evaluate data btw train & test; check for overfitting batch size: Number of samples per gradient update

(model.predict(X_test) > 0.5).astype("int32") for binary classification	pred = model.predict(X_test) pred = pd.Series(pred.reshape(..,1)) true_y = pd.DataFrame(y_test, columns = ['True Y']) pred_df = pd.concat([true_y, pred], axis = 1) pred_df.columns = ['True Y', 'Predictions'] sns.scatterplot(x='True Y',y='Predictions',data=pred_df) pred_df['Error'] = pred_df['True Y'] - pred_df['Predictions'] sns.distplot(pred_df['Error'],bins=50) from sklearn.metrics import mean_squared_error, mean_absolute_error, explained_variance_score explained_variance_score(y_test,predictions)	--> predict --> reshape to (no. of data, 1) --> change to DataFrame --> concat --> name columns --> ideally straight line --> ideally normally dist. --> best score is 1.0
	from tensorflow.kera.models import load_model model.save('model_name.h5') later_model = load_model('model_name') new_data = scaler.transform(new_data) model.predict(new_data)	 --> save model --> load and use model --> transform new data --> predict new data
TF Classification	train test split...scaling...model... model fit...model_loss.plot... from tensorflow.keras.callbacks import EarlyStopping early_stop = EarlyStopping(monitor = 'val_loss', mode = min, verbose = 1, patience = 25) fit model again..plot...	--> last layer activation = 'sigmoid' --> if overfit --> monitor: validation loss; mode: minimise loss patience: Number of epochs with no improvement after which training will be stopped --> if still not aligned
	from tensorflow.keras.layers import Dropout model = Sequential() model.add(Dense(units=30,activation='relu')) model.add(Dropout(0.5)) model.add(Dense(units=15,activation='relu')) model.add(Dropout(0.5)) model.add(Dense(units=1,activation='sigmoid')) model.compile(loss='binary_crossentropy', optimizer='adam') model.fit(X_train, y_train, epochs=600, validation_data=(X_test, y_test), verbose=1, callbacks=[early_stop]) plot...predict...error report...	