Python programming
: continue

ECE30007 Intro to AI Project

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- Numpy
- Matplotlib
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Python Function

- Why we use functions?
  - Easy to modify
  - Flexible to maintain
  - Readability
- Built-in Function vs User-defined Function
- Local Variable vs Global Variable
- Recursion
- Lambda

Python Function

- **Built-in Function**
  - The Python interpreter has a number of functions and types built into it that are always available.
  - Already defined in Python libraries and we can call them directly.

- print()
- input()
- int()
- float()
- range()
- len()

...

		Built-in Functions		
abs()	dict()	help()	min()	setattr()
all()	dir()	hex()	next()	slice()
any()	divmod()	id()	object()	sorted()
ascii()	enumerate()	input()	oct()	staticmethod()
bin()	eval()	int()	open()	str()
bool()	exec()	isinstance()	ord()	sum()
bytearray()	filter()	issubclass()	pow()	super()
bytes()	float()	iter()	print()	tuple()
callable()	format()	len()	property()	type()
chr()	frozenset()	list()	range()	vars()
classmethod()	getattr()	locals()	repr()	zip()
compile()	globals()	map()	reversed()	__import__()
complex()	hasattr()	max()	round()	
delattr()	hash()	memoryview()	set()	

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

Python Function

- **User-Defined Function**
  - User(programmer) define functions in a program

    and then call them wherever they are needed.

  - In order to use user-defined functions
    - Define Function
    - Call Function

```
In [2]:
def user_define(x,y):
    print(x,y,"is taking ECE30007")
    return x+ " "+y

string = user_define("Hanse","21100394")
print(string)
```

```
Hanse 21100394 is taking ECE30007
Hanse 21100394
```

Python Function

- **Local Variable**
  - Local variable can be accessed only inside the function in which they are declared.

```
def foo():
    y = "local"
    print("local : ", y)

foo()
print(y)
```

```
local :  local

---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-3-39fd7c4ee928> in <module>
      4
      5 foo()
----> 6 print(y)

NameError: name 'y' is not defined
```

- **Global Variable**
  - Global variables can be accessed throughout the program body by all functions.

```
x = "global"
def foo():
    print("x inside:", x)

foo()
print("x outside:", x)
```

```
x inside: global
x outside: global
```

Python Function

- **Recursion**
  - Function calls itself.

```python
def recur_fac(x):
    if x<1:
        return 1
    return x*recur_fac(x-1)


recur_fac(5)
```

```
120
```

- **Lambda**
  - A lambda function is a small anonymous function. A lambda function can take any number of arguments but can only have one expression.

```python
x = lambda a, b:print(a*b)
x(5,6)
```

```
30
```

Exercise(1) – Python Function

- Function that sums 0 to n using recursion
  - Get n as an integer parameter.
  - Return the added number

```
In [70]: def sum(n):


         sum(10)
Out[70]: 55
```

- Function that checks if the number is odd or even
  - Get n as an integer parameter.
  - Return string “Even” if the number is even.
  - Return string “Odd” if the number is odd

```
In [73]: def is_odd(num):


         is_odd(3)
Out[73]: 'Odd'
```

Python Object-Oriented Programming

- Object oriented programming can be defined as a programming model which is based upon the concept of objects.
  - **Class**: A class is a blueprint for the object.
  - **Object**: An object (instance) is an instantiation of a class. It has two characteristics: attributes, behavior(method)

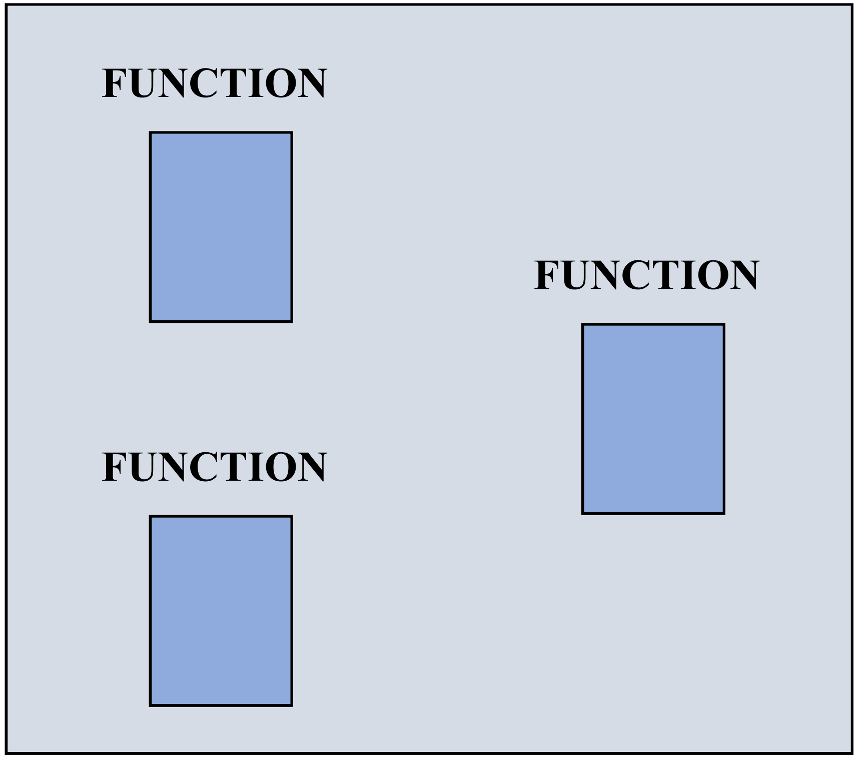
object oriented programming

- object-oriented programming (OOP)
  - encapsulates data (attributes) and functions (behavior) into classes.
- so, classes are user-defined (programmer-defined) types.
  - data (data members)
  - functions (member functions or methods)
- they look like a structure with member functions

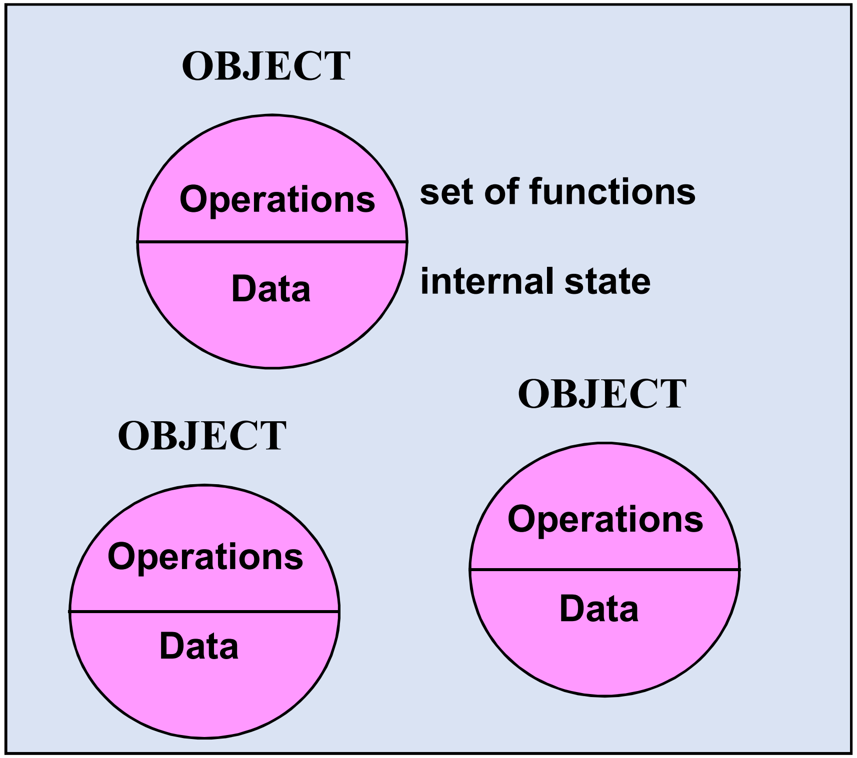
- programmer defines the attributes and behavior of objects.
- often the objects are modeled after real-world entities.
- very different approach than *function-based* programming (like C).

two programming methodologies

functional decomposition



object-oriented design



Python Object-Oriented Programming

- ex) A bird can be an object, as it has the following properties:
  - name, age, color as attributes
  - singing, flying as behavior

```
class Bird:
    def __init__(self,name,age,color):
        self.name = name
        self.age = age
        self.color = color
    def sing(self):
        print("Tweets! ")
    def flying(self):
        print(self.name + ' is flying...')
b0 = Bird('John', 3, 'yellow')
b0.sing()
b0.flying()
```

```
Tweets!
John is flying...
```

Python OOP Concepts

- **Inheritance**: Inheritance specifies that one object acquires all the properties and behaviors of parent object. By using inheritance, we can define a new class with a little or no changes to the existing class. The old class is called the superclass and the new one is called the subclass. The subclass can use all the stuff that is inside a superclass.

- **Polymorphism**: Ability to use the same method for multiple forms (data types). We have a class animal, and all animals talk. But they talk differently. Here, the "talk" behavior totally depends on the animal. So, the abstract "animal" does not actually "talk", but specific animals have a concrete implementation of the action "talk".

- **Encapsulation**: Used to restrict access to methods and variables. This prevents data from direct modification.

- **Data Abstraction**: displaying only essential information and hiding the details. Data abstraction and encapsulation are synonymous as data abstraction is achieved through encapsulation. Abstraction is used to hide internal details and show only functionalities. Abstracting something means to give names to things, so that the name captures the basic idea of what a function or a whole program does.

inheritance and overriding

```
class Bird:
    def __init__(self,name,age,color):
        self.name = name
        self.age = age
        self.color = color
    def sing(self):
        print("Tweets! ")
    def flying(self):
        print(self.name + ' is flying...')
b0 = Bird('John', 3, 'yellow')
b0.sing()
b0.flying()
```

```
Tweets!
John is flying...
```

```
class Parrot(Bird):
    def __init__(self, name, age, character):
        Bird.__init__(self,name,age,'blue')
        self.character = character

class Craw(Bird):
    def __init__(self, name, age):
        Bird.__init__(self,name,age,'black')
    def sing(self): # overriding
        print("krrrrrrrrr")
```

```
c0 = Craw('John', 3)
c0.sing()
c0.flying()
p1 = Parrot("Hanse", 3, "mimic")
p1.sing()
p1.flying()
```

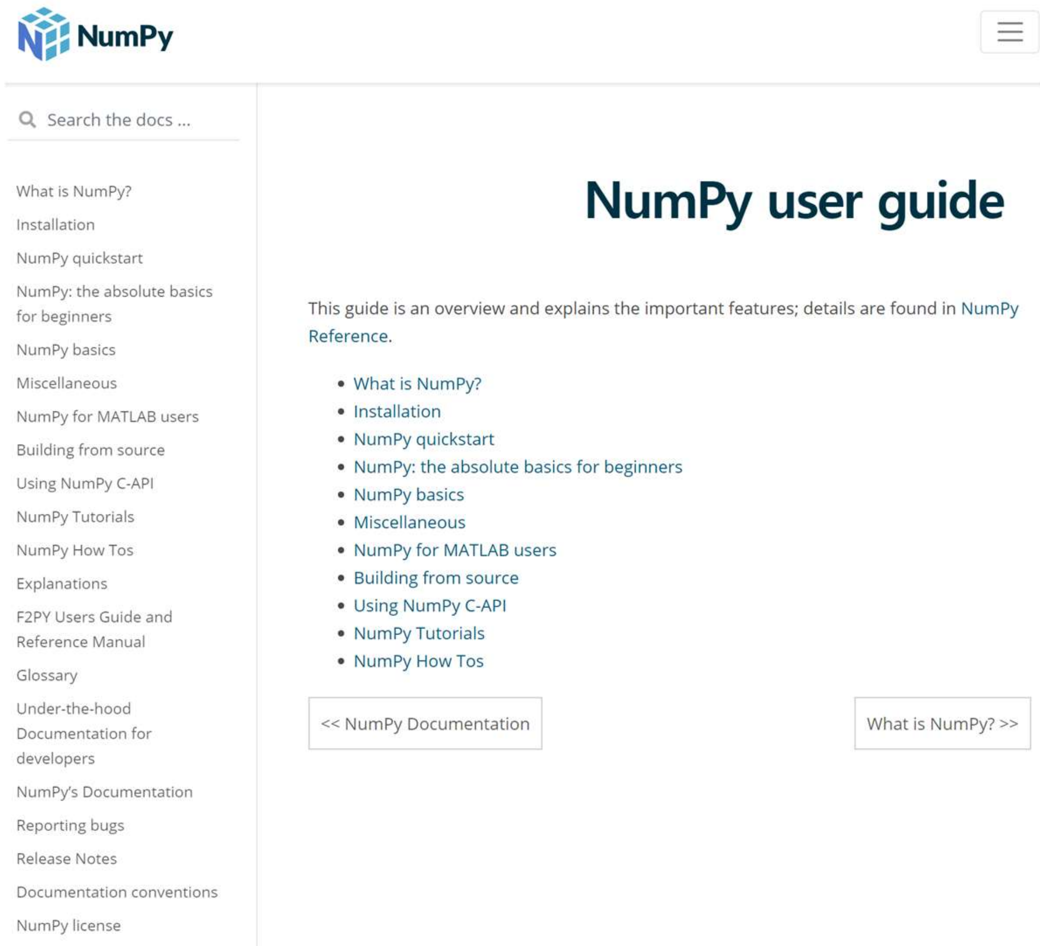
```
krrrrrrrrr
John is flying...
Tweets!
Hanse is flying...
```

Python Numpy

- **Numpy** is the core library for scientific computing in Python.
  - It provides a high-performance multidimensional array object, tools for working with these arrays, and simple yet powerful data structure: the n-dimensional array.
  - The NumPy API is used extensively in Pandas, SciPy, Matplotlib, scikit-learn, scikit-image and most other data science and scientific Python packages.
  - **ndarray object**
    This encapsulates n-dimensional arrays of homogeneous data types, considering the mathematical operations

Numpy

- How to install Numpy?
  - conda install numpy
  - pip install numpy
- How to use Numpy?
  - import numpy as np



Numpy Methods

Adding/removing Elements
`np.append(arr,values)` | Appends values to end of `arr`
`np.insert(arr,2,values)` | Inserts values into `arr` before index `2`
`np.delete(arr,3,axis=0)` | Deletes row on index `3` of `arr`
`np.delete(arr,4,axis=1)` | Deletes column on index `4` of `arr`
Combining/splitting
`np.concatenate((arr1,arr2),axis=0)` | Adds `arr2` as rows to the end of `arr1`
`np.concatenate((arr1,arr2),axis=1)` | Adds `arr2` as columns to end of `arr1`
`np.split(arr,3)` | Splits `arr` into `3` sub-arrays
`np.hsplit(arr,5)` | Splits `arr` horizontally on the `5`th index

Statistics
`np.mean(arr,axis=0)` | Returns mean along specific axis
`arr.sum()` | Returns sum of `arr`
`arr.min()` | Returns minimum value of `arr`
`arr.max(axis=0)` | Returns maximum value of specific axis
`np.var(arr)` | Returns the variance of array
`np.std(arr,axis=1)` | Returns the standard deviation of specific axis
`arr.corrcoef()` | Returns correlation coefficient of array

Vector Math
`np.add(arr1,arr2)` | Elementwise add `arr2` to `arr1`
`np.subtract(arr1,arr2)` | Elementwise subtract `arr2` from `arr1`
`np.multiply(arr1,arr2)` | Elementwise multiply `arr1` by `arr2`
`np.divide(arr1,arr2)` | Elementwise divide `arr1` by `arr2`
`np.power(arr1,arr2)` | Elementwise raise `arr1` raised to the power of `arr2`
`np.array_equal(arr1,arr2)` | Returns `True` if the arrays have the same elements and shape
`np.sqrt(arr)` | Square root of each element in the array
`np.sin(arr)` | Sine of each element in the array
`np.log(arr)` | Natural log of each element in the array
`np.abs(arr)` | Absolute value of each element in the array
`np.ceil(arr)` | Rounds up to the nearest int
`np.floor(arr)` | Rounds down to the nearest int
`np.round(arr)` | Rounds to the nearest int

https://numpy.org/doc/stable/reference/index.html

Numpy Methods

- Create Array

numpy.array(***object***, ***dtype=None***, *****, ***copy=True***, ***order='K'***, ***subok=False***, ***ndmin=0***, ***like=None***)¶
Create an array.

```
In [11]: np.array([0, 1, 2, 3, 4, 5, 6, 7, 8, 9,10,11,12,13,14,15],dtype=int)

Out[11]: array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10, 11, 12, 13, 14, 15])
```

numpy.zeros(***shape***, ***dtype=float***, ***order='C'***, *****, ***like=None***)
Return a new array of given shape and type, filled with zeros.

```
In [12]: np.zeros((3,5),dtype=int)

Out[12]: array([[0, 0, 0, 0, 0],
                [0, 0, 0, 0, 0],
                [0, 0, 0, 0, 0]])
```

numpy.ones(***shape***, ***dtype=None***, ***order='C'***, *****, ***like=None***)
Return a new array of given shape and type, filled with ones.

```
In [13]: np.ones((2,10),dtype=int)

Out[13]: array([[1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
                [1, 1, 1, 1, 1, 1, 1, 1, 1, 1]])
```

Numpy Methods

- Create Array

random.rand(*d0*, *d1*, *...*, *dn*)
Random values in a given shape.

```
In [14]: np.random.rand(3,4)

Out[14]: array([[0.77346856, 0.25394362, 0.94552963, 0.41694801],
                [0.91914791, 0.6209941 , 0.04587166, 0.16780006],
                [0.23261847, 0.82562203, 0.19127386, 0.63336303]])
```

random.randn(*d0*, *d1*, *...*, *dn*)
Return a sample (or samples) from the “standard normal(mean 0, std 1)” distribution.

```
In [15]: np.random.randn(3,5)

Out[15]: array([[ 0.00966639, -0.25538476, -0.28408495, -0.42225605,  0.41118189],
                [-0.21870338,  1.21832862, -1.37189564, -1.52318496, -0.66407713],
                [ 0.0981202 , -1.0098723 , -0.46043182, -0.03360769,  1.60932296]])
```

Numpy Methods

- Methods

```
In [16]: ndarray=np.ones((2,4))
         ndarray

Out[16]: array([[1., 1., 1., 1.],
                [1., 1., 1., 1.]])
```

ndarray.shape

Tuple of array dimensions.

```
In [17]: ndarray.shape

Out[17]: (2, 4)
```

ndarray.ndim

Number of array dimensions.

```
In [18]: ndarray.ndim

Out[18]: 2
```

Numpy Methods

- Methods

ndarray.reshape(***shape*, *order='C'***)
Returns an array containing the same data with a new shape.

```
In [19]: ndarray.reshape(4,2)
Out[19]: array([[1., 1.],
                [1., 1.],
                [1., 1.],
                [1., 1.]])
```

cf) ndarray.reshape(1,-1) : One shape dimension can be -1. In this case, the value is inferred from the length of the array and remaining dimensions

```
In [21]: ndarray.reshape(1,-1)
Out[21]: array([[1., 1., 1., 1., 1., 1., 1., 1.]])
```

Numpy Methods

- Methods

ndarray.dtype
Data-type of the array's elements.

```
In [20]: ndarray.dtype
Out[20]: dtype('float64')
```

numpy.arange([*start*,]*stop*, [*step*,]*dtype=None*, *, *like=None*)
Return evenly spaced values within a given interval.

```
In [23]: ndarray1=np.arange(2,22).reshape(4,5)
         ndarray1
Out[23]: array([[ 2,  3,  4,  5,  6],
                [ 7,  8,  9, 10, 11],
                [12, 13, 14, 15, 16],
                [17, 18, 19, 20, 21]])
```

```
In [24]: ndarray2=np.arange(0,5).reshape(5,1)
         ndarray2
Out[24]: array([[0],
                [1],
                [2],
                [3],
                [4]])
```

Numpy Methods

- Methods

ndarray.dot(*a*, *b*, *out=None*)

Dot product of two arrays.

```
In [25]: ndarray3=np.dot(ndarray1,ndarray2)
         ndarray3

Out[25]: array([[ 50],
                [100],
                [150],
                [200]])
```

ndarray.T

The transposed array.

```
In [26]: ndarray3.T

Out[26]: array([[ 50, 100, 150, 200]])
```

```
In [27]: ndarray4=ndarray3.reshape(2,2)
         ndarray4

Out[27]: array([[ 50, 100],
                [150, 200]])
```

```
In [28]: ndarray4.T

Out[28]: array([[ 50, 150],
                [100, 200]])
```

Numpy Methods

- Methods

numpy.add(*x1*, *x2*, */*, *out=None*, *, *where=True*, *casting='same_kind'*, *order='K'*, *dtype=None*, *subok=True*[, *signature*, *extobj*]) = *<ufunc 'add'>*
Add arguments element-wise.

```
In [29]: np.add(ndarray4,ndarray4)
Out[29]: array([[100, 200],
                [300, 400]])
```

numpy.subtract(*x1*, *x2*, */*, *out=None*, *, *where=True*, *casting='same_kind'*, *order='K'*, *dtype=None*, *subok=True*[, *signature*, *extobj*]) = *<ufunc 'subtract'>*
Subtract arguments, element-wise.

```
In [30]: np.subtract(ndarray4,ndarray4.T)
Out[30]: array([[  0, -50],
                [ 50,   0]])
```

Numpy Methods

- Methods

numpy.multiply(*x1*, *x2*, /, *out=None*, *, *where=True*, *casting='same_kind'*, *order='K'*, *dtype=None*, *subok=True*[, *signature*, *extobj*]) = *<ufunc 'multiply'>*
Multiply arguments element-wise.

```
In [31]: np.multiply(ndarray4,ndarray4.T)
Out[31]: array([[ 2500, 15000],
               [15000, 40000]])
```

numpy.divide(*x1*, *x2*, /, *out=None*, *, *where=True*, *casting='same_kind'*, *order='K'*, *dtype=None*, *subok=True*[, *signature*, *extobj*]) = *<ufunc 'true_divide'>*
Returns a true division of the inputs, element-wise.

```
In [32]: np.divide(ndarray4,ndarray4.T)
Out[32]: array([[1.        , 0.66666667],
               [1.5       , 1.        ]])
```

Numpy Methods

- **Broadcasting** : How Numpy treats arrays with different shapes during arithmetic operations.
  - the smaller array is "broadcast" across the larger array so that they have compatible shapes

In [36]:
```
ndarray4=ndarray4+1
ndarray4
```
Out[36]:
```
array([[ 51, 101],
       [151, 201]])
```

In [37]:
```
ndarray4=ndarray4-5
ndarray4
```
Out[37]:
```
array([[ 46,  96],
       [146, 196]])
```

In [38]:
```
ndarray4=ndarray4*2
ndarray4
```
Out[38]:
```
array([[ 92, 192],
       [292, 392]])
```

In [54]:
```
ndarray4=ndarray4/3
ndarray4
```
Out[54]:
```
array([[ 30.66666667,  64.        ],
       [ 97.33333333, 130.66666667]])
```

In [55]:
```
ndarray4+[5,8]
```
Out[55]:
```
array([[ 35.66666667,  72.        ],
       [102.33333333, 138.66666667]])
```

In [56]:
```
ndarray4-[[4],
          [2]]

```
Out[56]:
```
array([[ 26.66666667,  60.        ],
       [ 95.33333333, 128.66666667]])
```

Numpy Methods

- **subarray**

```
ndarray1=np.arange(2,22).reshape(4,5)
ndarray1
```

```
array([[ 2,  3,  4,  5,  6],
       [ 7,  8,  9, 10, 11],
       [12, 13, 14, 15, 16],
       [17, 18, 19, 20, 21]])
```

```
index = ndarray1 < 10
index
```

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

```
ndarray1[index]
```

```
array([2, 3, 4, 5, 6, 7, 8, 9])
```

```
idx1 = ndarray1[:,0] > 10
ndarray1[idx1,:]
```

```
array([[12, 13, 14, 15, 16],
       [17, 18, 19, 20, 21]])
```

Retrieving Data in Python

```
import numpy as np
import openpyxl # if you don't' have this, then pip install openpyxl first
file= openpyxl.load_workbook('data_set_train.xlsx') # assuming that the file is in the current directory
ws = file.active

data=[] # list type
col_name=[]      # list type
for row in ws.iter_rows(max_row=1): # read the first row
    for cell in row:
      col_name.append(cell.value)
for row in ws.iter_rows(min_row=2): # read from the 2nd row
    one_line=[]
    for cell in row:
        one_line.append(cell.value)
    data.append(one_line)
```

```
In [68]: data[:1]

Out[68]: [['강남역우정에쉐르',
  '200601',
  9000.0,
  2004.0,
  '역삼동',
  17.23,
  7.0,
  37.4942041,
  127.0435446,
  225613.0,
  6.3,
  0.152880864,
  5.55949463170584,
  452.717843152131,
  794.544848855622,
  231.845431815105,
  2395.0282409397,
  291.146809661849,
  1694.41981012148,
  849.353652859484,
  0.0,
  52.0,
  1.0,
  0.75,
  '개별난방',
  536.0,
  58.0,
  13.0,
  12.0]]
```

Numpy Methods

- Converting list to numpy ndarray

```
In [27]:  print(type(data))
          arr=np.array(data)
          print(type(arr))

<class 'list'>
<class 'numpy.ndarray'>

In [33]:  arr.shape

Out[33]:  (17400, 29)
```

Numpy Methods

```
In [39]: data_set= arr[:,:9]
         data_set

Out[39]: array([['강남역우정에쉐르', '2006Q1', '9000.0', ..., '7.0', '37.4942041',
                 '127.0435446'],
                ['강남역우정에쉐르', '2006Q1', '9000.0', ..., '7.0', '37.4942041',
                 '127.0435446'],
                ['개포주공1단지', '2006Q1', '73000.0', ..., '3.0', '37.4784072',
                 '127.061375'],
                ...,
                ['현대하이츠', '2017Q3', '64000.0', ..., '1.0', '37.4913789',
                 '127.0348797'],
                ['현대한강', '2017Q3', '170000.0', ..., '8.0', '37.5246752',
                 '127.056226'],
                ['현대한강', '2017Q3', '170000.0', ..., '8.0', '37.5246752',
                 '127.056226']], dtype='<U32')
```

```
In [40]: data_set.shape

Out[40]: (17400, 9)
```

Exercise(2) – Slice only 2006

- Slice array based on a condition
  - Condition that only meets 2006 in column "yyyyqrt(거래년도 분기별)"
  - Slice rows that satisfy the condition.

```
In [11]: 

Out[11]: array([['강남역우정에쉐르', '2006Q1', '9000.0', ..., '7.0', '37.4942041',
         '127.0435446'],
        ['강남역우정에쉐르', '2006Q1', '9000.0', ..., '7.0', '37.4942041',
         '127.0435446'],
        ['개포주공1단지', '2006Q1', '73000.0', ..., '3.0', '37.4784072',
         '127.061375'],
        ...,
        ['현대빌라트', '2006Q4', '125000.0', ..., '3.0', '37.5179279',
         '127.0428004'],
        ['현대빌라트', '2006Q4', '125000.0', ..., '3.0', '37.5179279',
         '127.0428004'],
        ['현대빌라트', '2006Q4', '125000.0', ..., '3.0', '37.5179279',
         '127.0428004']], dtype='<U18')
```

- data_set2006.shape

```
In [49]: data_set2006.shape
Out[49]: (2617, 9)
```

Numpy Methods

ndarray.astype(*dtype*, *order='K'*, *casting='unsafe'*, *subok=True*, *copy=True*)
Copy of the array, cast to a specified type.

In [51]:
```
price = data_set2006[:,2]
price.dtype
```
Out[51]:
```
dtype('<U32')
```
<= not number type, needs to be casted.

In [45]:
```
print(data_set2006[0])


price = data_set2006[:,2].astype(float)
lat = data_set2006[:,7].astype(float)
lng = data_set2006[:,8].astype(float)
```
```
['강남역우정에쉐르' '2006Q1' '9000.0' '2004.0' '역삼동' '17.23' '7.0' '37.4942041'
 '127.0435446']
```

Numpy Data Types

Referring data type with one character.

- i - integer
- b - boolean
- u - unsigned integer
- f - float
- c - complex float
- m - timedelta
- M - datetime
- O - object
- S - string
- U - unicode string
- V - fixed chunk of memory for other type (void)

- bool_ : Boolean (True or False) stored as a byte
- int_ : Default integer type (same as C long; normally either int64 or int32)
- intc : Identical to C int (normally int32 or int64)
- intp : Integer used for indexing (same as C ssize_t; normally either int32 or int64)
- int8 : Byte (-128 to 127)
- int16 : Integer (-32768 to 32767)
- int32 : Integer (-2147483648 to 2147483647)
- int64 : Integer (-9223372036854775808 to 9223372036854775807)
- uint8 : Unsigned integer (0 to 255)
- uint16 :Unsigned integer (0 to 65535)
- uint32 : Unsigned integer (0 to 4294967295)
- uint64 : Unsigned integer (0 to 18446744073709551615)
- float_ : Shorthand for float64
- float16 : Half precision float: sign bit, 5 bits exponent, 10 bits mantissa
- float32 : Single precision float: sign bit, 8 bits exponent, 23 bits mantissa
- float64 : Double precision float: sign bit, 11 bits exponent, 52 bits mantissa
- complex_ : Shorthand for complex128
- complex64 : Complex number, represented by two 32-bit floats (real and imaginary components)
- complex128 : Complex number, represented by two 64-bit floats (real and imaginary components)

Numpy Methods

numpy.amax(***a**, **axis**=None, **out**=None, **keepdims**=<no value>, **initial**=<no value>, **where**=<no value>*)[source]

Return the maximum of an array or maximum along an axis.

numpy.mean(***a**, **axis**=None, **dtype**=None, **out**=None, **keepdims**=<no value>, *, **where**=<no value>*)[source]

Compute the arithmetic mean along the specified axis.

numpy.amin(***a**, **axis**=None, **out**=None, **keepdims**=<no value>, **initial**=<no value>, **where**=<no value>*)[source]

Return the minimum of an array or minimum along an axis.

```
In [53]:  np.amax(price)
Out[53]:  310000.0

In [54]:  np.mean(price)
Out[54]:  67076.57928926252

In [55]:  np.amin(price)
Out[55]:  5500.0
```

Exercise(3) – Convert type of ndarrays

- Find correlation between “price” and “dis_subway”
  - Slice only dis_subway column values   arr[:, 2] and arr[:,19]
  - Slice only price column values
  - Convert datatype of two ndarray (string to float).
  - Use corrcoef method.

numpy.corrcoef(*x*, *y=None*, *rowvar=True*, *bias=<no value>*, *ddof=<no value>*, *, *dtype=None*)[source]
Return Pearson product-moment correlation coefficients.

```
In [74]:
np.corrcoef(price, station)

Out[74]: array([[1.        , 0.03241268],
               [0.03241268, 1.        ]])
```

Numpy Methods

numpy.concatenate(*(a1, a2, ...), axis=0, out=None, dtype=None, casting="same_kind"*)
Join a sequence of arrays along an existing axis.

- Combine data_set and "dis_subway"

```
station=arr[:,19]
print(data_set.shape)
print(station.shape)
station=station.reshape(-1,1)
print(station.shape)
```

```
(17400, 9)
(17400,)
(17400, 1)
```

```
concat=np.concatenate((data_set,station),axis=1)  # axis indicates how to concatenate
print(concat.shape)
print(concat[0])
```

```
(17400, 10)
['강남역우정에쉐르' '2006Q1' '9000.0' '2004.0' '역삼동' '17.23' '7.0' '37.4942041'
 '127.0435446' '849.353652859484']
```

Python Matplotlib

- **Matplotlib** is one of the most popular and oldest plotting libraries in Python which is used in Machine Learning.
  - It helps to understand the huge amount of data through different visualizations.
  - It consists of several plots like the Line Plot, Bar Plot, Scatter Plot, Histogram etc. through which we can visualize various types of data.

Matplotlib

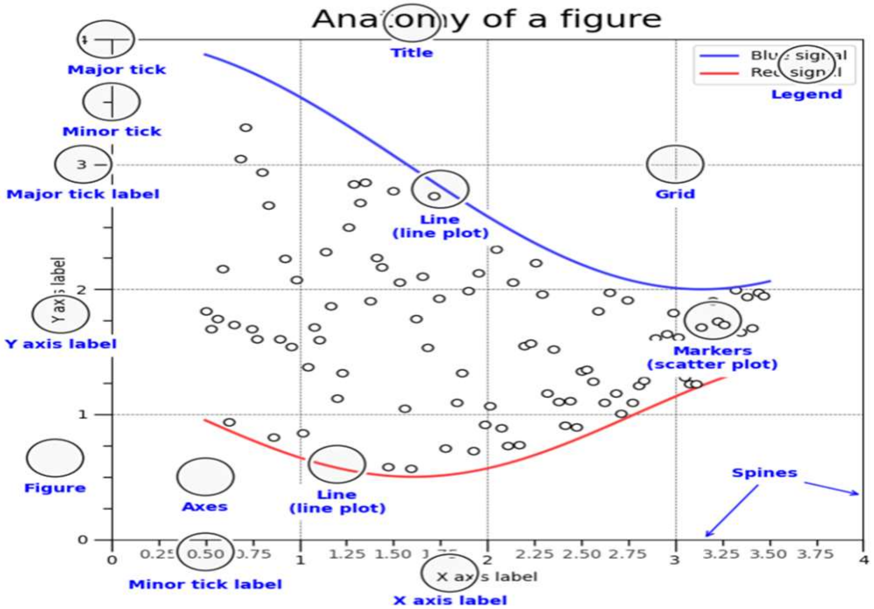
- How to install Matplotlib?
  - conda install matplotlib
  - pip install matplotlib

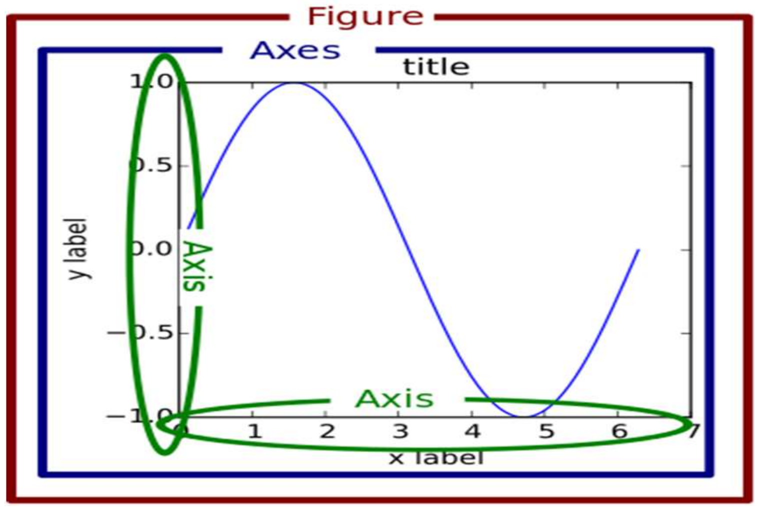
- How to use Matplotlib?
  - import matplotlib.pyplot as plt

Matplotlib

- Concepts in Matplotlib
  - **Figure**: Top level container for all plot elements
  - **Axes**: An area where plot appears in
  - **Legend**: An area describing the elements of the graph
  - **Grid**: line that show axis divisions
  - **Plot**: draw lines or markers.
  - **Axis**: A reference line drawn on a graph

https://realpython.com/python-matplotlib-guide/





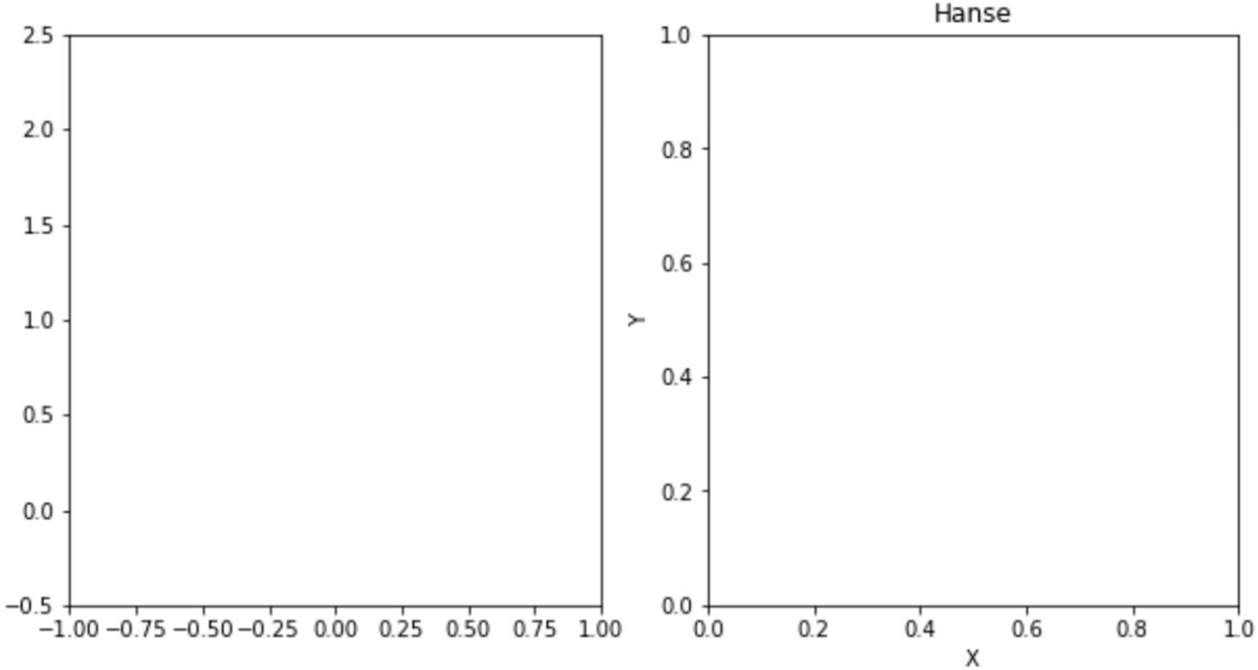
https://matplotlib.org/1.5.1/faq/usage_faq.html#parts-of-a-figure

Matplotlib Methods List

tripcolor	Create a pseudocolor plot of an unstructured triangular grid.	subplot	Add a subplot to the current figure.
triplot	Draw a unstructured triangular grid as lines and/or markers.	subplot2grid	Create a subplot at a specific location inside a regular grid.
twinx	Make and return a second axes that shares the *x*-axis.	subplot_mosaic	Build a layout of Axes based on ASCII art or nested lists.
twiny	Make and return a second axes that shares the *y*-axis.	subplot_tool	Launch a subplot tool window for a figure.
uninstall_repl_displayhook	Uninstall the matplotlib display hook.	subplots	Create a figure and a set of subplots.
violinplot	Make a violin plot.	subplots_adjust	Adjust the subplot layout parameters.
vlines	Plot vertical lines.	suptitle	Add a centered title to the figure.
xcorr	Plot the cross correlation between *x* and *y*.	switch_backend	Close all open figures and set the Matplotlib backend.
xkcd	Turn on xkcd sketch-style drawing mode.	table	Add a table to an Axes.
xlabel	Set the label for the x-axis.	text	Add text to the axes.
xlim	Get or set the x limits of the current axes.	thetagrids	Get or set the theta gridlines on the current polar plot.
xscale	Set the x-axis scale.	tick_params	Change the appearance of ticks, tick labels, and gridlines.
xticks	Get or set the current tick locations and labels of the x-axis.	ticklabel_format	Configure the ScalarFormatter used by default for linear axes.
ylabel	Set the label for the y-axis.	tight_layout	Adjust the padding between and around subplots.
ylim	Get or set the y-limits of the current axes.	title	Set a title for the axes.
yscale	Set the y-axis scale.	tricontour	Draw contour lines on an unstructured triangular grid.
yticks	Get or set the current tick locations and labels of the y-axis.	tricontourf	Draw contour regions on an unstructured triangular grid.

Matplotlib Methods

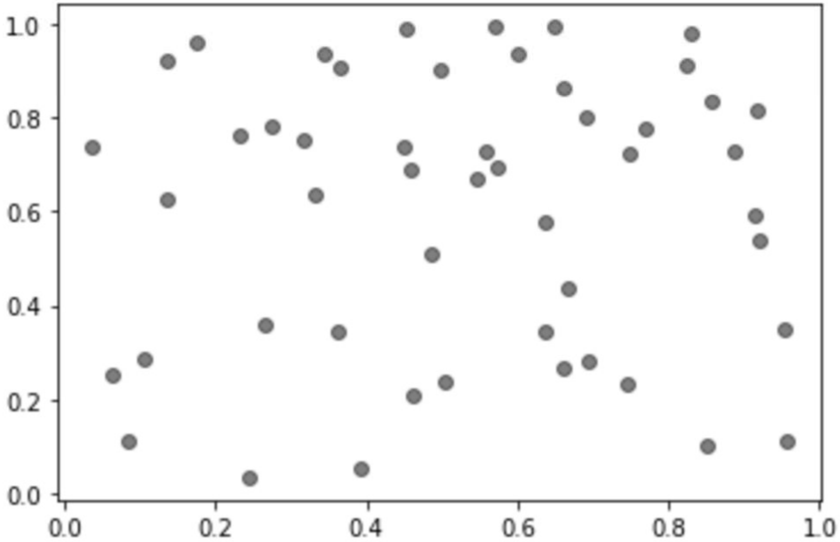
```python
plt.figure(figsize=(10,5)) # Create figure
plt.subplot(1,2,1) # add a subplot to the current figure
plt.xlim([-1., 1.]) # set the x limits of the current axes
plt.ylim([-0.5, 2.5]) # set the y limits of the current axes.

plt.subplot(1,2,2) # 2nd subplot
plt.ylabel('Y') # set the y label
plt.xlabel('X') # set the x label
plt.title("Hanse") # Set the title
plt.show() # display this figure
```



Matplotlib Methods

- Scatter plot

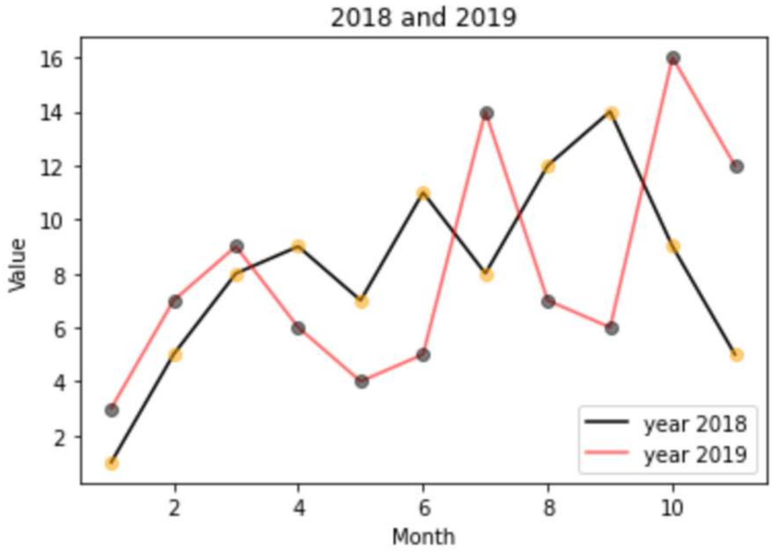
```
np.random.seed(500)
N = 50
x = np.random.rand(N)
y = np.random.rand(N)

#creating scatter plot
plt.scatter(x, y,c='black', alpha=0.5)
plt.show()
```



Matplotlib Methods

- Line and point plot

```
year2018 = [1, 5, 8, 9, 7, 11, 8, 12, 14, 9, 5]
year2019 = [3, 7, 9, 6, 4, 5, 14, 7, 6, 16, 12]
#plotting line plots
plt.plot(range(1,12), year2018,color='black')
plt.plot(range(1,12), year2019,color='r',alpha=0.6)
#creating  points
plt.plot(range(1,12), year2019, 'COo', alpha=0.5,color='black')
plt.plot(range(1,12), year2018, 'COo', alpha=0.5,color='orange')
#creating title,Y-label,X-label & legend
plt.title('2018 and 2019')
plt.ylabel('Value')
plt.xlabel('Month')
plt.legend(['year 2018', 'year 2019'], loc=4)
plt.show() # plot shows automatically in Jupyter
```



Week 3 Exercise(4) : Yearly Average Price

- output

> - Print yearly average price
> - Note that "yyyyqrt(거래년도 분기별)" values consist of year and quarter.

```
2006 avg : 67076.58
2007 avg : 58405.72
2008 avg : 66136.67
2009 avg : 83060.50
2010 avg : 77282.03
2011 avg : 76748.97
2012 avg : 72714.52
2013 avg : 78839.02
2014 avg : 84002.70
2015 avg : 87213.44
2016 avg : 97149.95
2017 avg : 114656.79
```

Week 3 Exercise(5) : Quarterly Average Price

- output

- Print quarterly average price

```
2006Q1 avg : 65661.17   2006Q2 avg : 59592.49   2006Q3 avg : 62410.72   2006Q4 avg : 79588.83
2007Q1 avg : 47336.40   2007Q2 avg : 65344.61   2007Q3 avg : 58634.69   2007Q4 avg : 59687.89
2008Q1 avg : 63515.58   2008Q2 avg : 62458.85   2008Q3 avg : 72233.96   2008Q4 avg : 72608.62
2009Q1 avg : 85574.77   2009Q2 avg : 84314.42   2009Q3 avg : 83246.47   2009Q4 avg : 78589.30
2010Q1 avg : 80386.73   2010Q2 avg : 71885.82   2010Q3 avg : 72697.58   2010Q4 avg : 82475.98
2011Q1 avg : 77359.50   2011Q2 avg : 68071.24   2011Q3 avg : 78499.77   2011Q4 avg : 82607.86
2012Q1 avg : 73633.61   2012Q2 avg : 73102.35   2012Q3 avg : 78050.49   2012Q4 avg : 69313.77
2013Q1 avg : 77980.51   2013Q2 avg : 76391.85   2013Q3 avg : 76638.47   2013Q4 avg : 84570.14
2014Q1 avg : 84038.77   2014Q2 avg : 81931.40   2014Q3 avg : 79218.36   2014Q4 avg : 90134.39
2015Q1 avg : 76180.14   2015Q2 avg : 81677.28   2015Q3 avg : 98509.43   2015Q4 avg : 93279.71
2016Q1 avg : 87456.07   2016Q2 avg : 94492.74   2016Q3 avg : 104774.82  2016Q4 avg : 102236.93
2017Q1 avg : 113074.15  2017Q2 avg : 110766.67  2017Q3 avg : 124098.44
```

Week 3 Exercise(6) : Quarterly Price Graph & Histogram

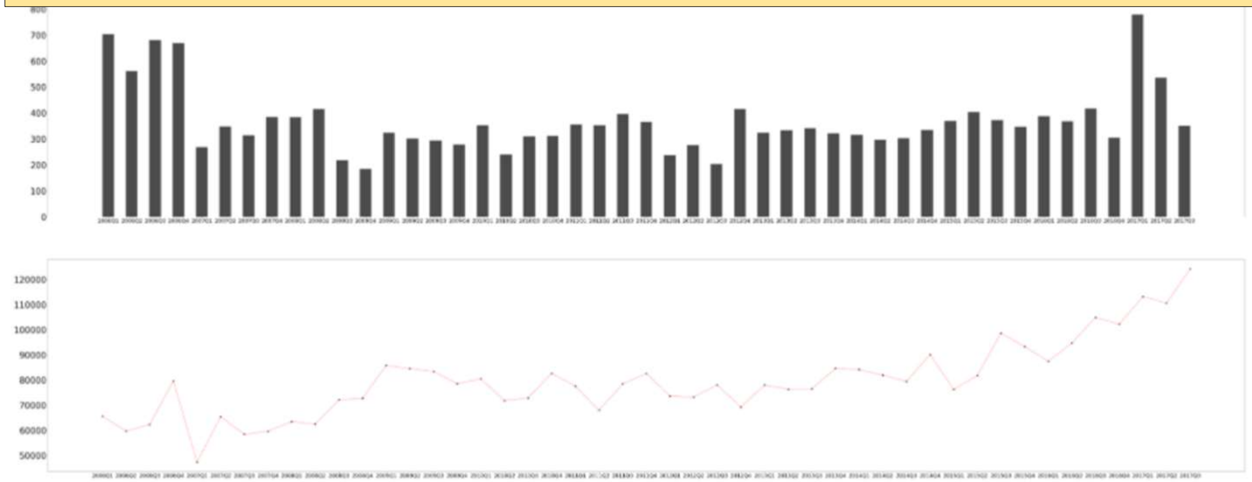
- Output (use subplot)

In [95]:

- Plot the count of trading in quarters,
  (quarterly on x-axis, counts on y-axis.)
- Draw bar graph using counted values in quarterly

use matplotlib.pyplot.bar(x, height, width=0.5, bottom=None, *, align='center', data=None, **kwargs)

- Draw quarterly average price.



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