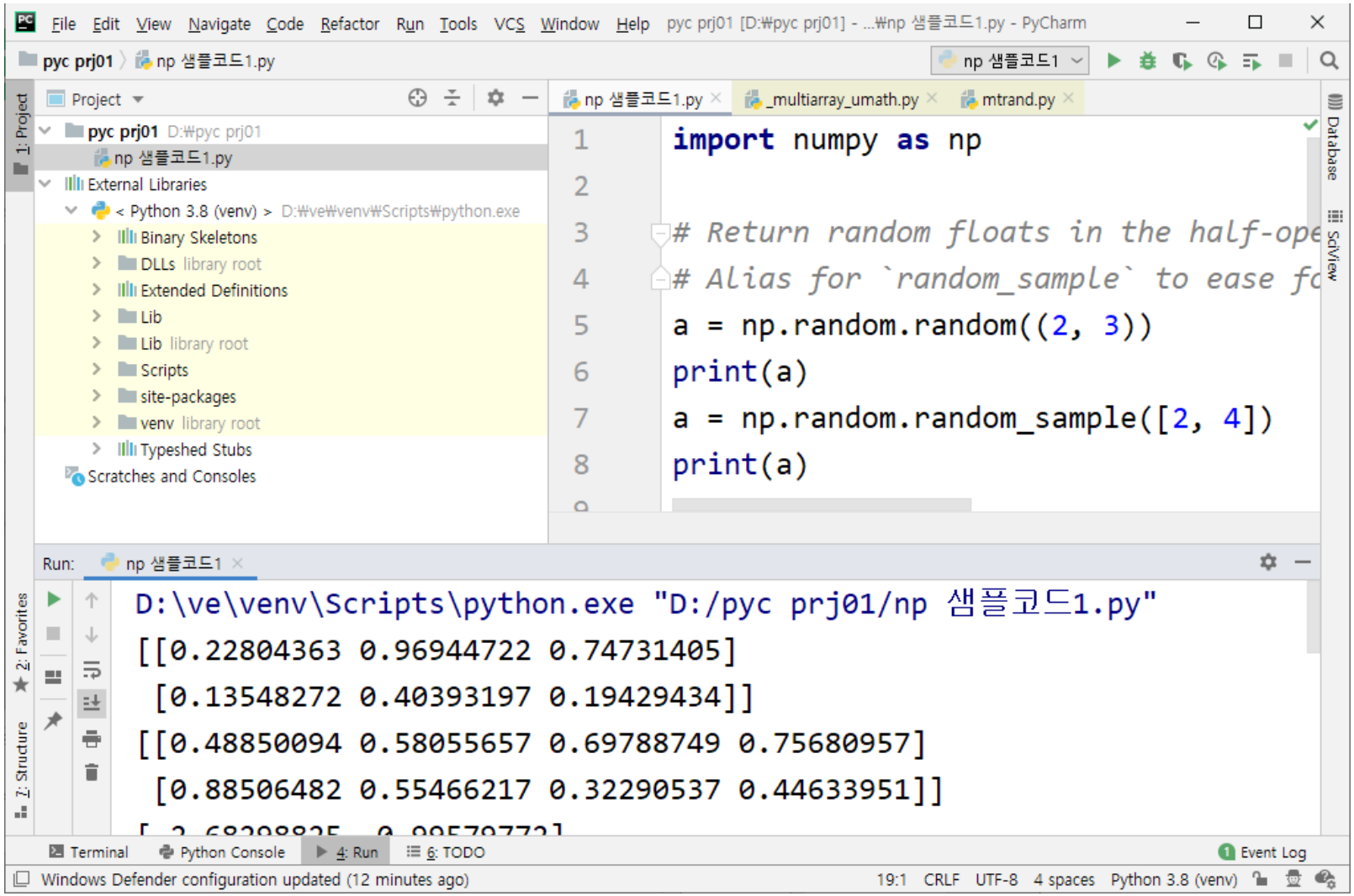
파이참 프로젝트에서 데이터 과학을 위한 준비

numpy

numpy npsample1.py

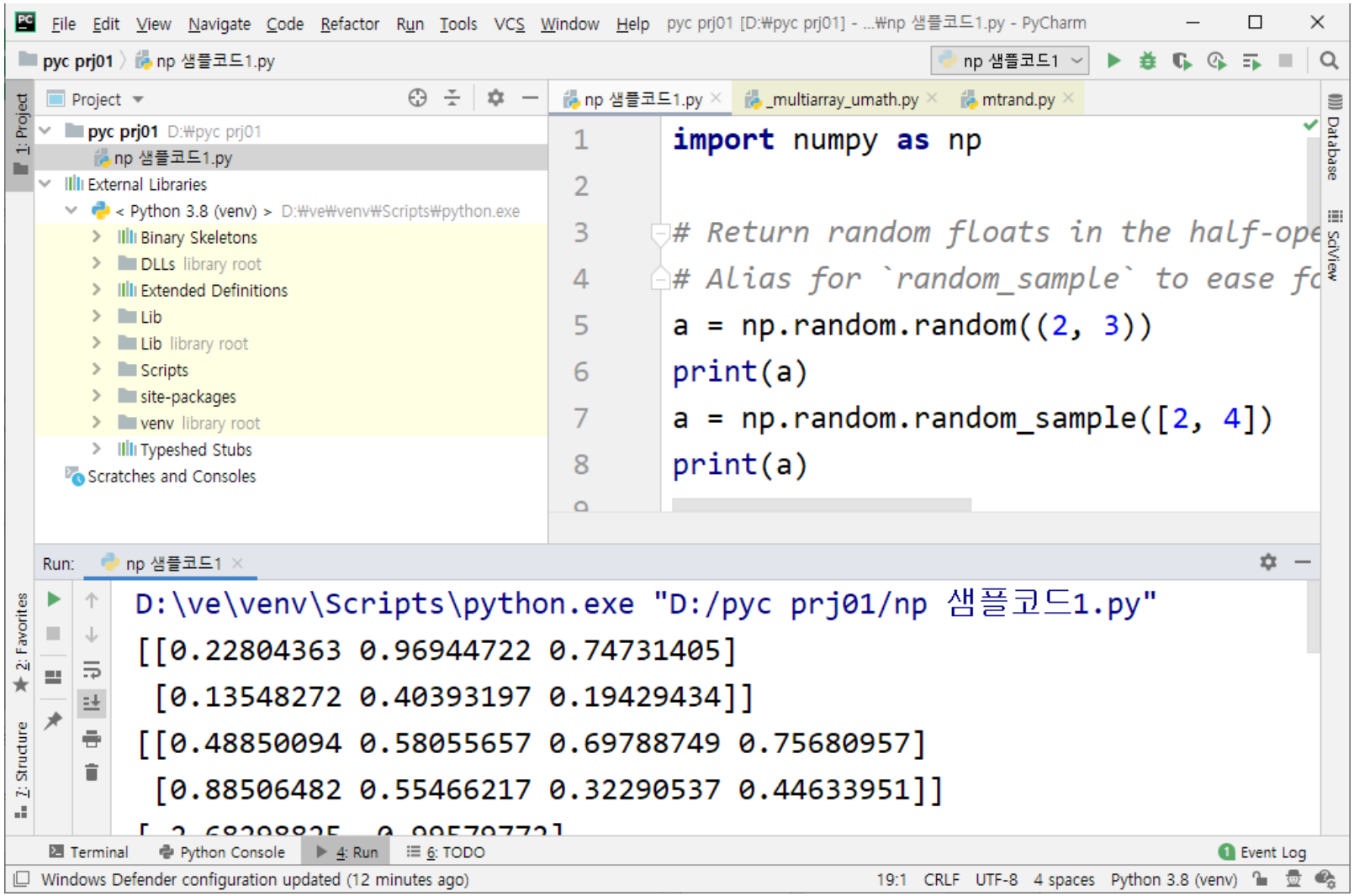


numpy npsample1.py 이해

```
import numpy as np

# Return random floats in the half-open interval
[0.0, 1.0).
# Alias for `random_sample` to ease forward-
porting to the new random API.
a = np.random.random((2, 3))
print(a)
a = np.random.random_sample([2, 4])
print(a)

# 정규분포의 난수 생성
b = np.random.randn(2)
print(b)
b = np.random.randn(2, 3)
print(b)
b = np.random.randn(3, 4)
print(b)

# 값이 모두 1인 텐서
c = np.ones(3)
print(c)

# 값이 모두 0인 텐서
c = np.zeros((2, 3))
print(c)
c = np.zeros([3, 4])
print(c)
```

```
D:₩ve₩venv₩Scripts₩python.exe "D:/pyc prj01/np 샘플코드1.py"
[[0.22804363 0.96944722 0.74731405]
 [0.13548272 0.40393197 0.19429434]]
[[0.48850094 0.58055657 0.69788749 0.75680957]
 [0.88506482 0.55466217 0.32290537 0.44633951]]
[-2.68298825 -0.99579772]
[[-0.16099173  1.29978199  1.66469465]
 [ 0.68463138 -1.58433849 -0.06550564]]
[[ 0.02758157 -0.77454657  0.49862683  0.70299809]
 [ 1.57338867 -0.71034582  0.06683078 -1.51798292]
 [-0.20716991 -0.45346911  0.20735756 -0.76737582]]
[1. 1. 1.]
[[0. 0. 0.]
 [0. 0. 0.]]
[[0. 0. 0. 0.]
 [0. 0. 0. 0.]
 [0. 0. 0. 0.]]

Process finished with exit code 0
```

numpy npsample2.py

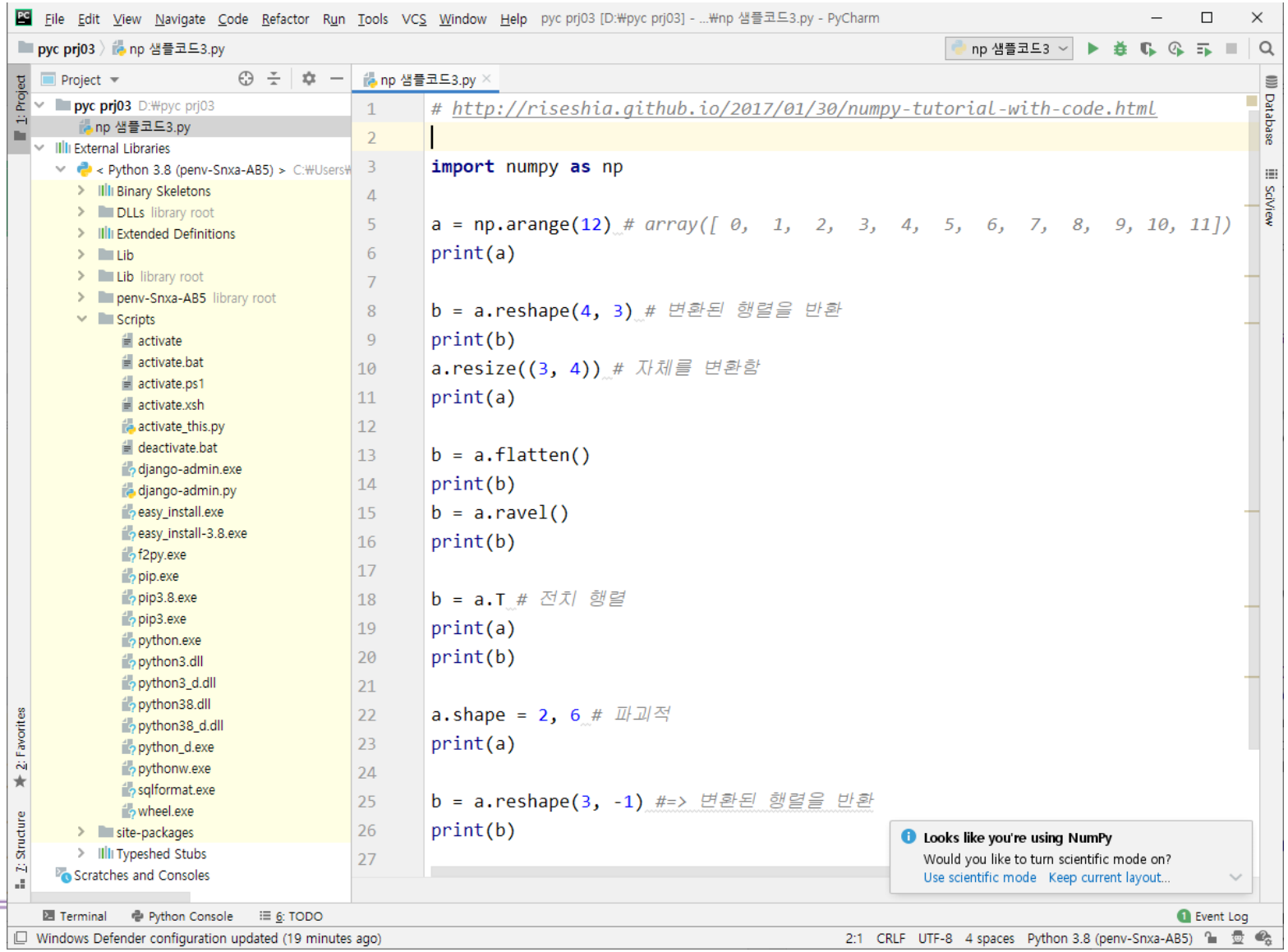


numpy npsample2.py 이해

```python
import numpy as np

# [0, 1) 난수 생성
a = np.random.random((2, 3))
print(type(a))
print(a)
b = a.reshape(3, 2)
print(b)

# 정규분포의 난수 생성
c = np.random.randn(3, 4)
print(c.reshape(2, 6))

# 값이 모두 1인 텐서
d = np.ones((4, 5))
print(d.reshape(2, 5, 2))

# 값이 모두 0인 텐서
e = np.zeros((3, 4))
print(e.reshape(2, 3, 2))
```

```
D:₩ve₩venv_test₩Scripts₩python.exe "D:/pyc prj02/np 샘플코드2.py"
<class 'numpy.ndarray'>
[[0.82253794 0.94805217 0.18727646]
 [0.93734334 0.64931534 0.34043917]]
[[0.82253794 0.94805217]
 [0.18727646 0.93734334]
 [0.64931534 0.34043917]]
[[ 0.75831872  0.48717349  0.28570681 -1.52723675 -0.44313711 -0.95670083]
 [-0.12955399  0.60647143  0.33132981  0.63755303  1.12009118  0.09013185]]
[[[1. 1.]
  [1. 1.]
  [1. 1.]
  [1. 1.]
  [1. 1.]]

 [[1. 1.]
  [1. 1.]
  [1. 1.]
  [1. 1.]
  [1. 1.]]]
[[[0. 0.]
  [0. 0.]
  [0. 0.]]

 [[0. 0.]
  [0. 0.]
  [0. 0.]]]

Process finished with exit code 0
```

numpy npsample3.py



numpy npsample3.py 이해

```
# http://riseshia.github.io/2017/01/30/numpy-tutorial-with-code.html

import numpy as np

a = np.arange(12) # array([ 0, … 11])
print(a)

b = a.reshape(4, 3) # 변환된 행렬을 반환
print(b)
a.resize((3, 4)) # 자체를 변환함
print(a)

b = a.flatten()
print(b)
b = a.ravel()
print(b)

b = a.T # 전치 행렬
print(a)
print(b)

a.shape = 2, 6 # 파괴적
print(a)

b = a.reshape(3, -1) # 변환된 행렬을 반환
print(b)
```

```
C:₩Users₩217₩.virtualenvs₩penv-Snxa-AB5₩Scripts₩python.exe "D:/pyc prj03/np 샘플코드3.py"
[ 0  1  2  3  4  5  6  7  8  9 10 11]
[[ 0  1  2]
 [ 3  4  5]
 [ 6  7  8]
 [ 9 10 11]]
[[ 0  1  2  3]
 [ 4  5  6  7]
 [ 8  9 10 11]]
[ 0  1  2  3  4  5  6  7  8  9 10 11]
[ 0  1  2  3  4  5  6  7  8  9 10 11]
[[ 0  1  2  3]
 [ 4  5  6  7]
 [ 8  9 10 11]]
[[ 0  4  8]
 [ 1  5  9]
 [ 2  6 10]
 [ 3  7 11]]
[[ 0  1  2  3  4  5]
 [ 6  7  8  9 10 11]]
[[ 0  1  2  3]
 [ 4  5  6  7]
 [ 8  9 10 11]]

Process finished with exit code 0
```

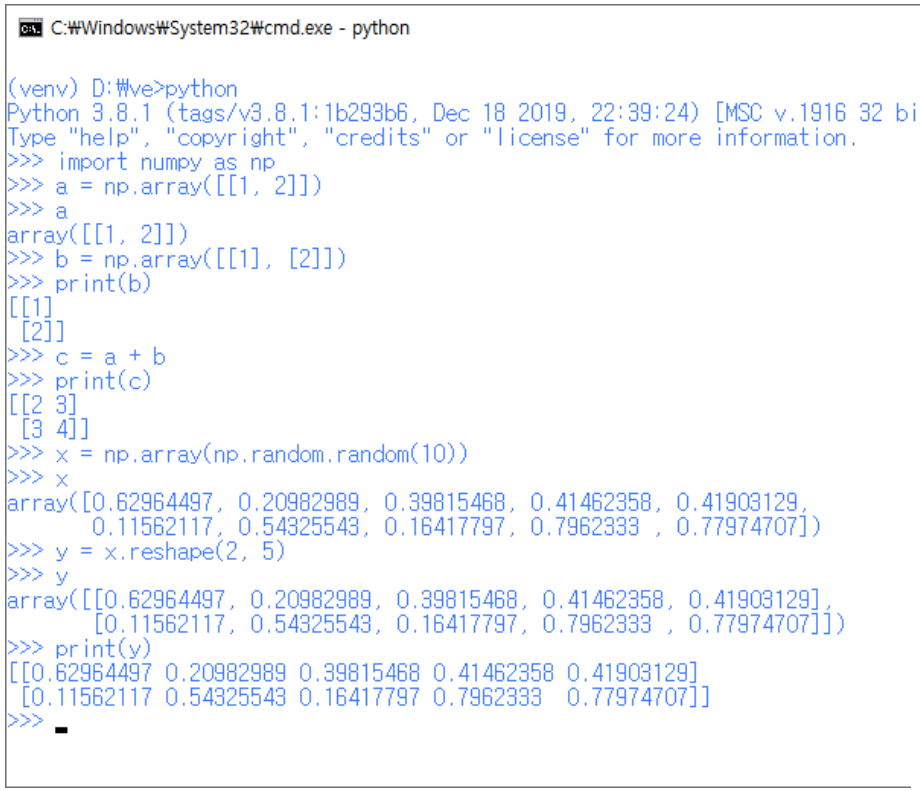
Numpy npsample4.py 이해

```
import numpy as np

a = np.array(3)
print(type(a))
print(a.ndim, a.shape)
print(a)

b = np.array([1, 2, 3])
print(type(b))
print(b.ndim, b.shape)
print(b)

c = np.array([[1, 2], [3, 4]])
print(type(c))
print(c.ndim, c.shape)
print(c)

d = np.arange(10)
print(type(c))
print(d.ndim, d.shape)
print(d)

e = range(10)
print(type(e))
print(e)
print(list(e))
```

```
<class 'numpy.ndarray'>
0 ()
3
<class 'numpy.ndarray'>
1 (3,)
[1 2 3]
<class 'numpy.ndarray'>
2 (2, 2)
[[1 2]
 [3 4]]
<class 'numpy.ndarray'>
1 (10,)
[0 1 2 3 4 5 6 7 8 9]
<class 'range'>
range(0, 10)
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

Numpy npsample5.py 이해

- **numpy 테스트**
  - 브로드캐스팅과 행렬 모양 변환

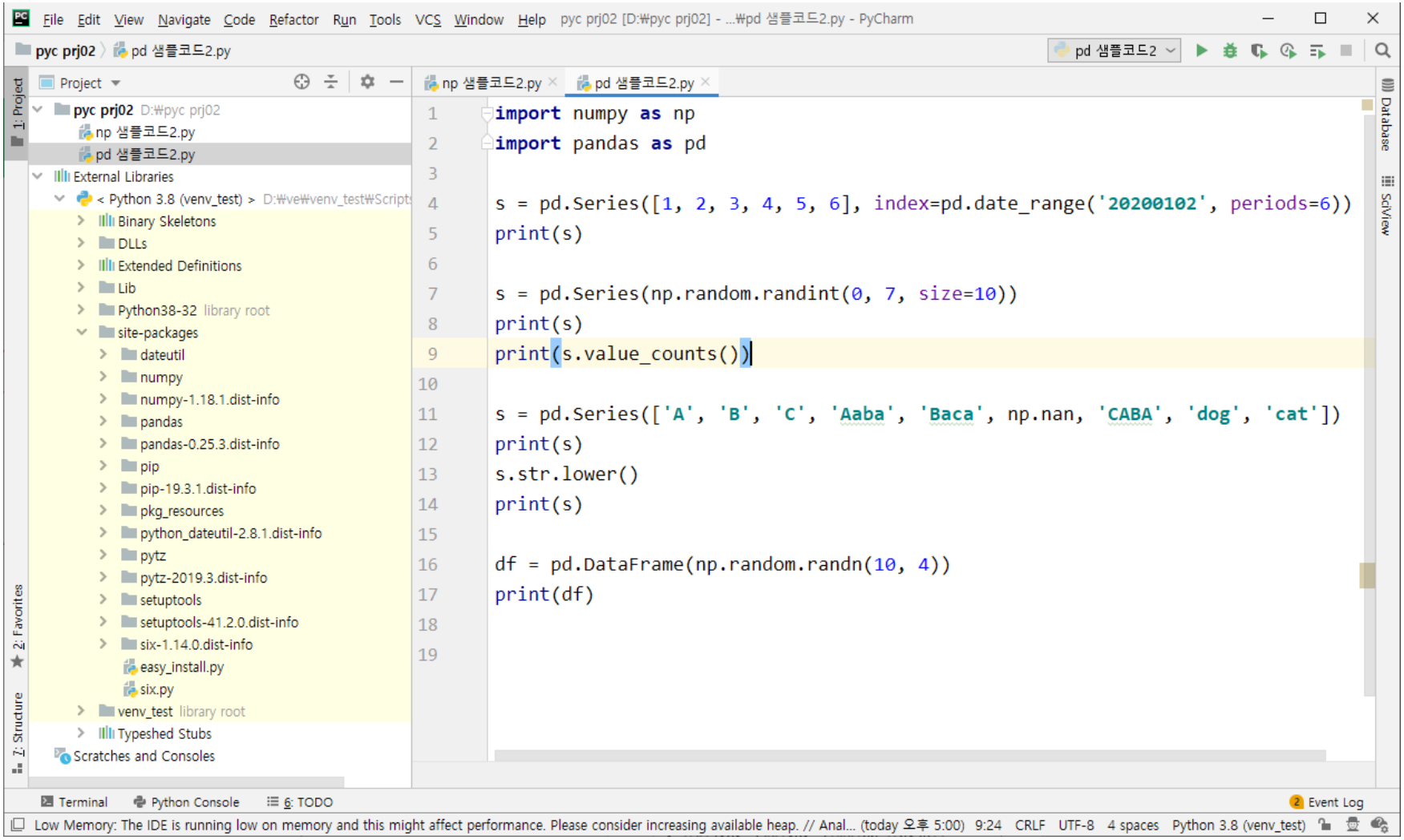



```python
# 일반 리스트 더하기
m = [1, 2, 3]
n = [4, 5, 6]
print(m + n)
# print(m - n)

import numpy as np
# 브로드캐스팅
a = np.array([[1, 2]])
print(a)
b = np.array([[1], [2]])
print(b)
c = a + b
print(c)

# 행렬 모양 바꾸기
x = np.array(np.random.random(10))
print(x)
y = x.reshape(2, 5)
print(y)
```

파이참 프로젝트에서 데이터 과학을 위한 준비

pandas

Pandas, pdsample1.py



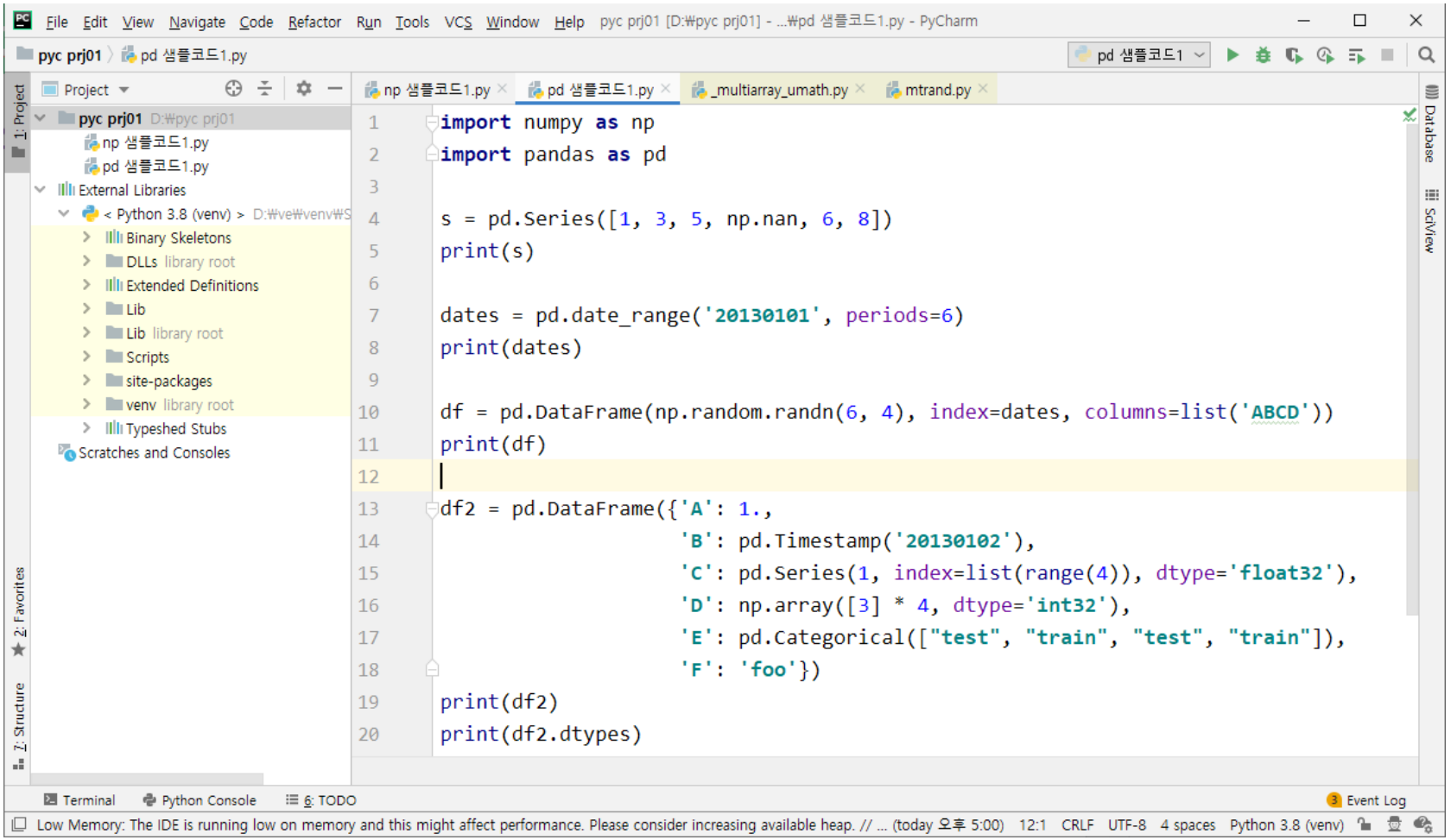
Pandas, pdsample1.py 이해

```
import numpy as np
import pandas as pd

s = pd.Series([1, 2, 3, 4, 5, 6], index=pd.date_range('20200102', periods=6))
print(s)

s = pd.Series(np.random.randint(0, 7, size=10))
print(s)
print(s.value_counts())

s = pd.Series(['A', 'B', 'C', 'Aaba', 'Baca', np.nan, 'CABA', 'dog', 'cat'])
print(s)
s.str.lower()
print(s)

df = pd.DataFrame(np.random.randn(10, 4))
print(df)
```

```
D:₩ve₩venv_test₩Scripts₩python.exe
"D:/pyc prj02/pd 샘플코드2.py"
2020-01-02    1
2020-01-03    2
2020-01-04    3
2020-01-05    4
2020-01-06    5
2020-01-07    6
Freq: D, dtype: int64
0    5
1    2
2    0
3    5
4    6
5    1
6    6
7    6
8    2
9    4
dtype: int32
6    3
5    2
2    2
4    1
1    1
0    1
dtype: int64
```

```
0       A
1       B
2       C
3    Aaba
4    Baca
5     NaN
6    CABA
7     dog
8     cat
dtype: object
0       A
1       B
2       C
3    Aaba
4    Baca
5     NaN
6    CABA
7     dog
8     cat
dtype: object
          0         1         2         3
0 -0.827856 -0.591318 -0.446506  1.639843
1 -0.455133  0.652168 -0.542553  0.015321
2 -0.790744  0.088498  0.499716 -0.355695
3  0.252766  0.853125  1.609860 -1.235949
4 -0.778862  0.734792 -0.559469  2.637026
5 -0.066913 -2.701452  0.196265 -1.475756
6 -1.171109 -1.312982 -0.123534 -0.467198
7 -0.560191 -0.025275  0.336903 -0.202051
8 -0.472363  2.441893  2.044766  0.685911
9 -0.899807 -1.176664  0.391078  0.148584

Process finished with exit code 0
```

Pandas, pdsample2.py

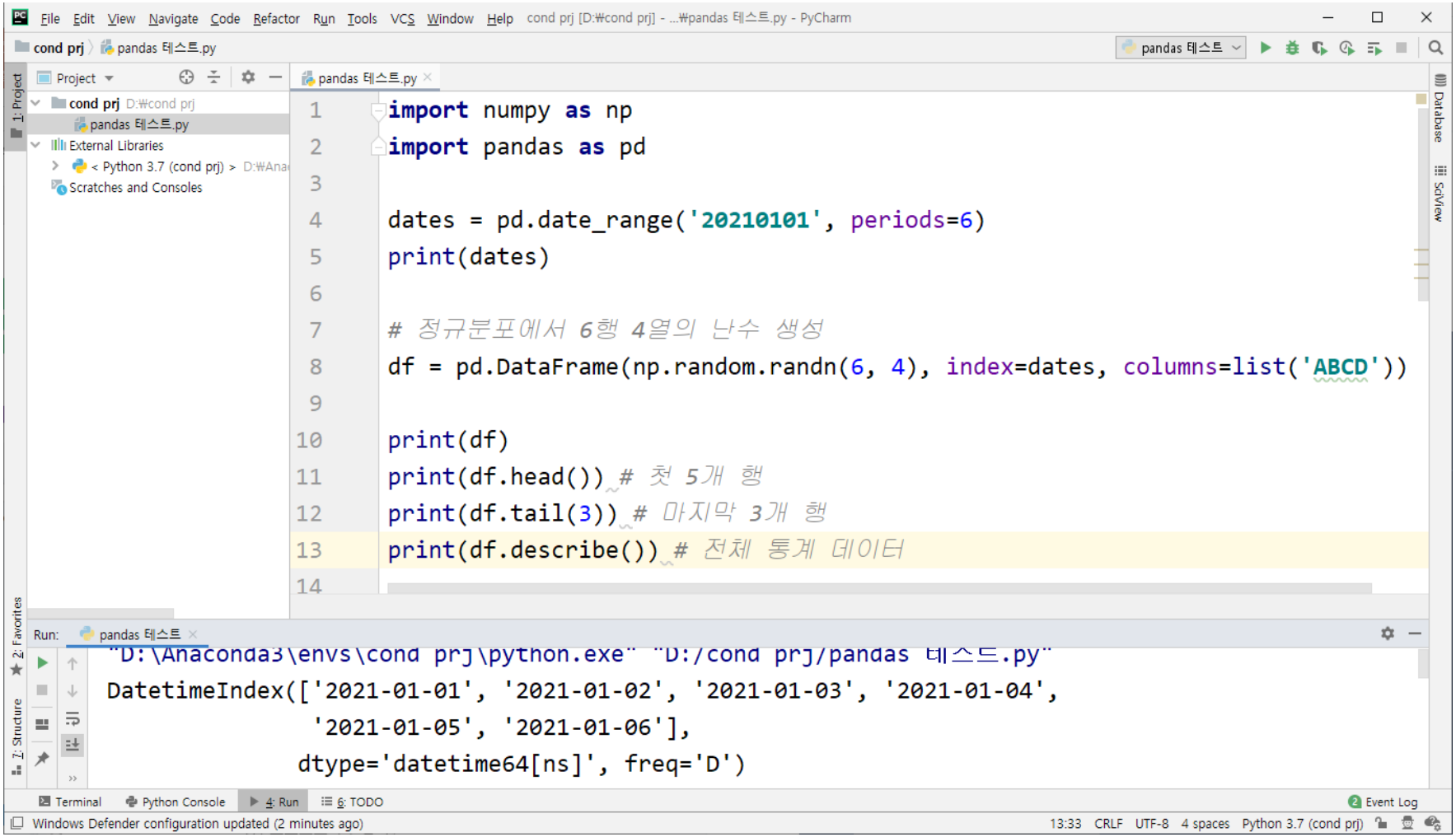


Pandas, pdsample2.py 이해

```
import numpy as np
import pandas as pd

s = pd.Series([1, 3, 5, np.nan, 6, 8])
print(s)

dates = pd.date_range('20130101', periods=6)
print(dates)

df = pd.DataFrame(np.random.randn(6, 4), index=dates,
                                         columns=list('ABCD'))
print(df)

df2 = pd.DataFrame(
         {'A': 1.,
          'B': pd.Timestamp('20130102'),
          'C': pd.Series(1, index=list(range(4)), dtype='float32'),
          'D': np.array([3] * 4, dtype='int32'),
          'E': pd.Categorical(["test", "train", "test", "train"]),
          'F': 'foo'})
print(df2)
print(df2.dtypes)
```

```
D:₩ve₩venv₩Scripts₩python.exe "D:/pyc prj01/pd 샘플코드1.py"
0    1.0
1    3.0
2    5.0
3    NaN
4    6.0
5    8.0
dtype: float64
DatetimeIndex(['2013-01-01', '2013-01-02', '2013-01-03', '2013-01-04',
               '2013-01-05', '2013-01-06'],
              dtype='datetime64[ns]', freq='D')
                   A         B         C         D
2013-01-01  0.617621  0.711937  0.555614  1.261003
2013-01-02 -1.378531 -0.325374  0.788234  1.223037
2013-01-03 -1.228281 -0.682720 -0.564663  0.107814
2013-01-04  0.552391 -0.354623 -0.488619 -0.072650
2013-01-05 -1.099271  0.108479 -2.062795  2.163172
2013-01-06 -0.034693  0.705632  0.194938  0.800431
     A          B    C  D      E    F
0  1.0 2013-01-02  1.0  3   test  foo
1  1.0 2013-01-02  1.0  3  train  foo
2  1.0 2013-01-02  1.0  3   test  foo
3  1.0 2013-01-02  1.0  3  train  foo
A           float64
B    datetime64[ns]
C           float32
D             int32
E          category
F            object
dtype: object

Process finished with exit code 0
```

Pandas, pdsample3.py



Pandas, pdsample3.py 이해

```
import numpy as np
import pandas as pd

dates = pd.date_range('20210101', periods=6)
print(dates)

# 정규분포에서 6행 4열의 난수 생성
df = pd.DataFrame(np.random.randn(6, 4),
     index=dates, columns=list('ABCD'))

print(df)
print(df.head()) # 첫 5개 행
print(df.tail(3)) # 마지막 3개 행
print(df.describe()) # 전체 통계 데이터
```

```
pandas 테스트
"D:\Anaconda3\envs\cond_prj\python.exe" "D:/cond_prj/pandas 테스트.py"
DatetimeIndex(['2021-01-01', '2021-01-02', '2021-01-03', '2021-01-04',
               '2021-01-05', '2021-01-06'],
              dtype='datetime64[ns]', freq='D')
                   A         B         C         D
2021-01-01 -0.958072 -1.586224  0.035237 -0.232481
2021-01-02  1.575099  0.614962 -1.060176 -1.841971
2021-01-03  0.141609 -1.511011  0.308956  0.467325
2021-01-04  1.394936  1.297629 -1.176749 -0.972958
2021-01-05 -0.197864  1.432869  0.252815 -1.134095
2021-01-06  0.176109  1.741329  1.367940  1.021468
                   A         B         C         D
2021-01-01 -0.958072 -1.586224  0.035237 -0.232481
2021-01-02  1.575099  0.614962 -1.060176 -1.841971
2021-01-03  0.141609 -1.511011  0.308956  0.467325
2021-01-04  1.394936  1.297629 -1.176749 -0.972958
2021-01-05 -0.197864  1.432869  0.252815 -1.134095
                   A         B         C         D
2021-01-04  1.394936  1.297629 -1.176749 -0.972958
2021-01-05 -0.197864  1.432869  0.252815 -1.134095
2021-01-06  0.176109  1.741329  1.367940  1.021468
              A         B         C         D
count  6.000000  6.000000  6.000000  6.000000
mean   0.355303  0.331592 -0.045329 -0.448785
std    0.967209  1.502458  0.951657  1.070800
min   -0.958072 -1.586224 -1.176749 -1.841971
25%   -0.112996 -0.979518 -0.786323 -1.093810
50%    0.158859  0.956296  0.144026 -0.602720
75%    1.090229  1.399059  0.294920  0.292373
max    1.575099  1.741329  1.367940  1.021468

Process finished with exit code 0
```

파이참 프로젝트에서 데이터 시각화를 위한 준비

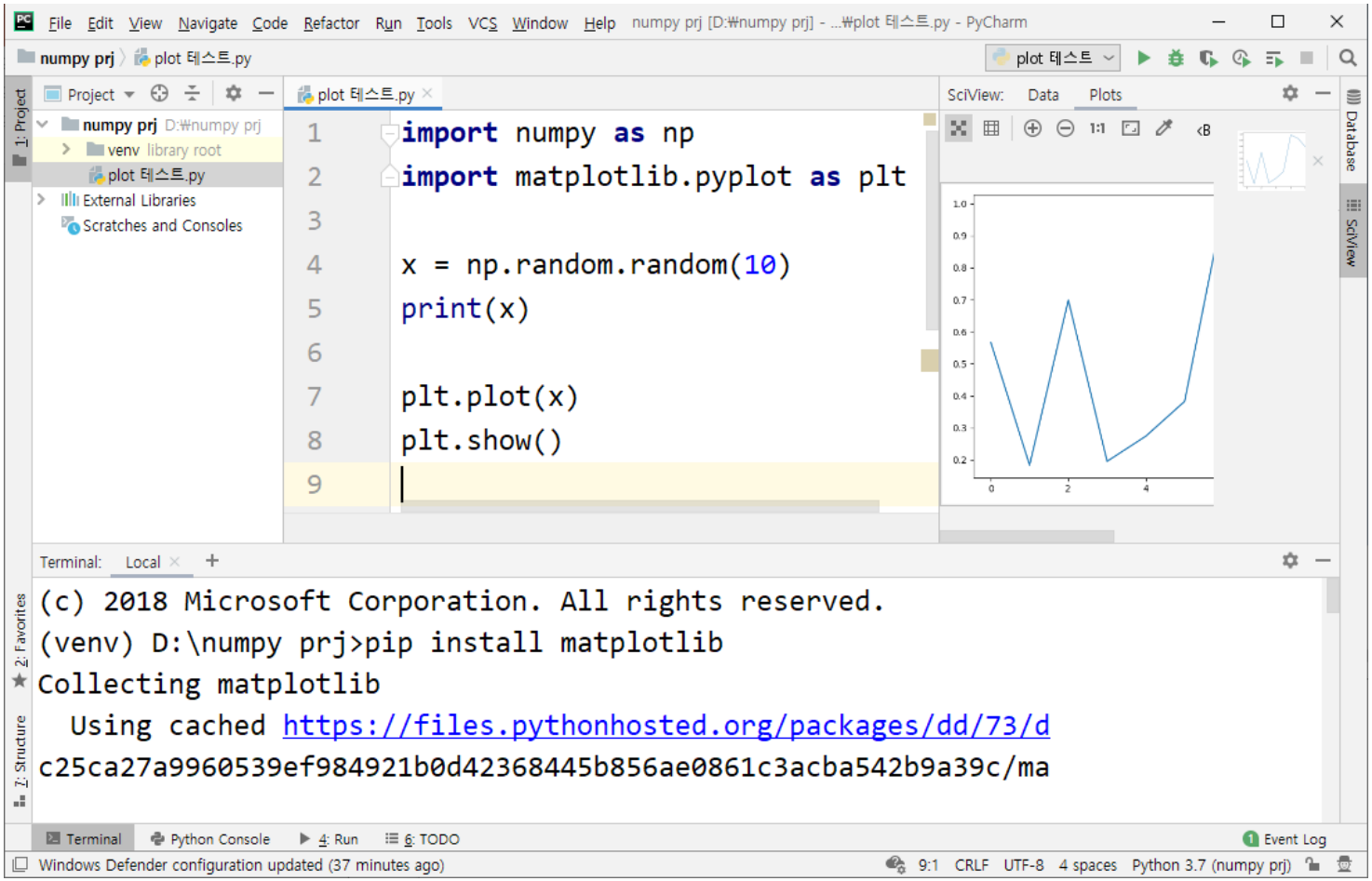
matplotlib

Matplotlib, matplot1.py

- pip install matplotlib

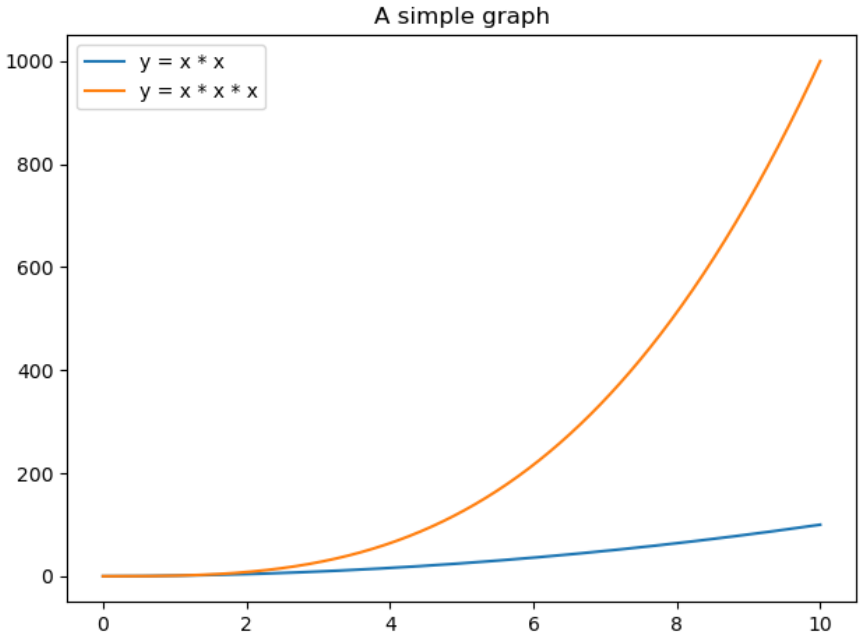
> pip show matplotlib

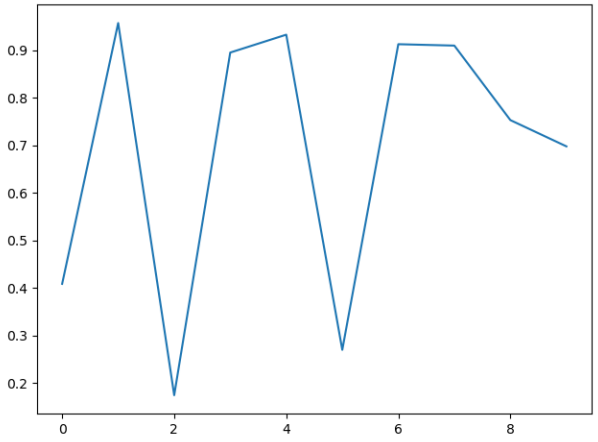
설치 유무 확인 방법



Matplotlib, matplot1.py 이해

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

x = np.random.random(10)
print(x)
plt.plot(x)
plt.show()

x = np.linspace(0.0, 10.0, 1000)

plt.plot(x, x*x)
plt.plot(x, x**3)
plt.title('A simple graph')
plt.legend(['y = x * x', 'y = x * x * x'], loc='upper left')
plt.show()
```

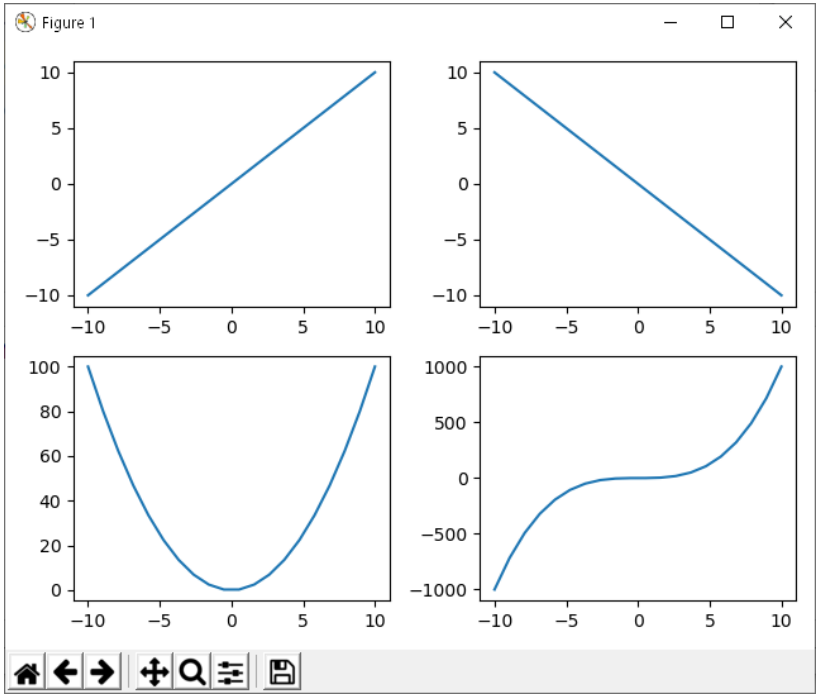




Matplotlib, matplot2.py 이해

- 여러 그림을 하나의 캔버스에 그리는 방법

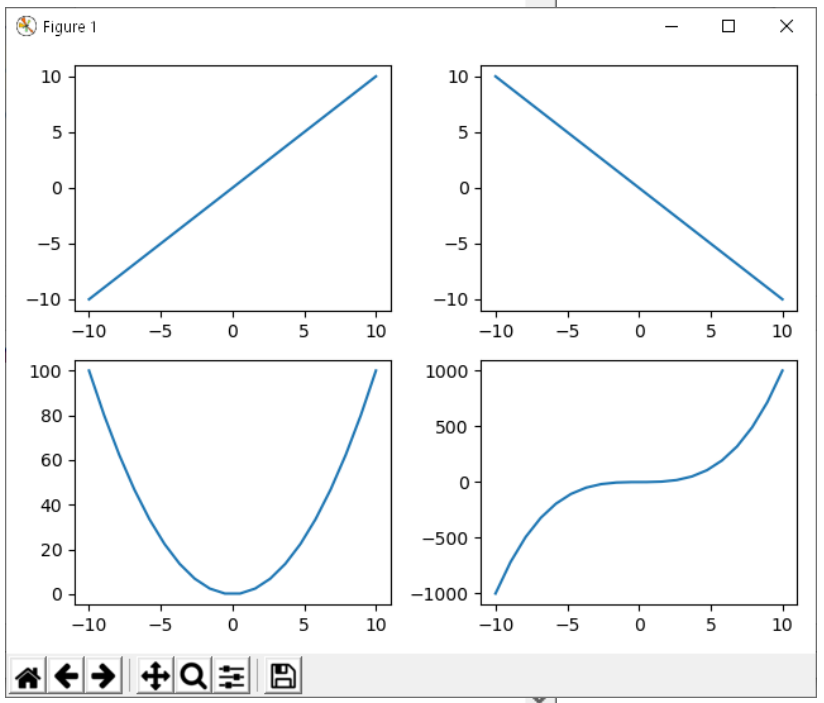
```
import numpy as np
import matplotlib.pyplot as plt

# -10에서 10까지 20등분한 자료
x = np.linspace(-10, 10, 20)

# 2행 2열의 부분 그림
plt.subplot(2, 2, 1) # 첫 번째 부분 그림
plt.plot(x, x)
plt.subplot(2, 2, 2) # 두 번째 부분 그림
plt.plot(x, -x)
plt.subplot(2, 2, 3) # 세 번째 부분 그림
plt.plot(x, x*x)
plt.subplot(2, 2, 4) # 네 번째 부분 그림
plt.plot(x, pow(x, 3))

plt.tight_layout() # 적정한 공간 배치
plt.show() # 그리기
```



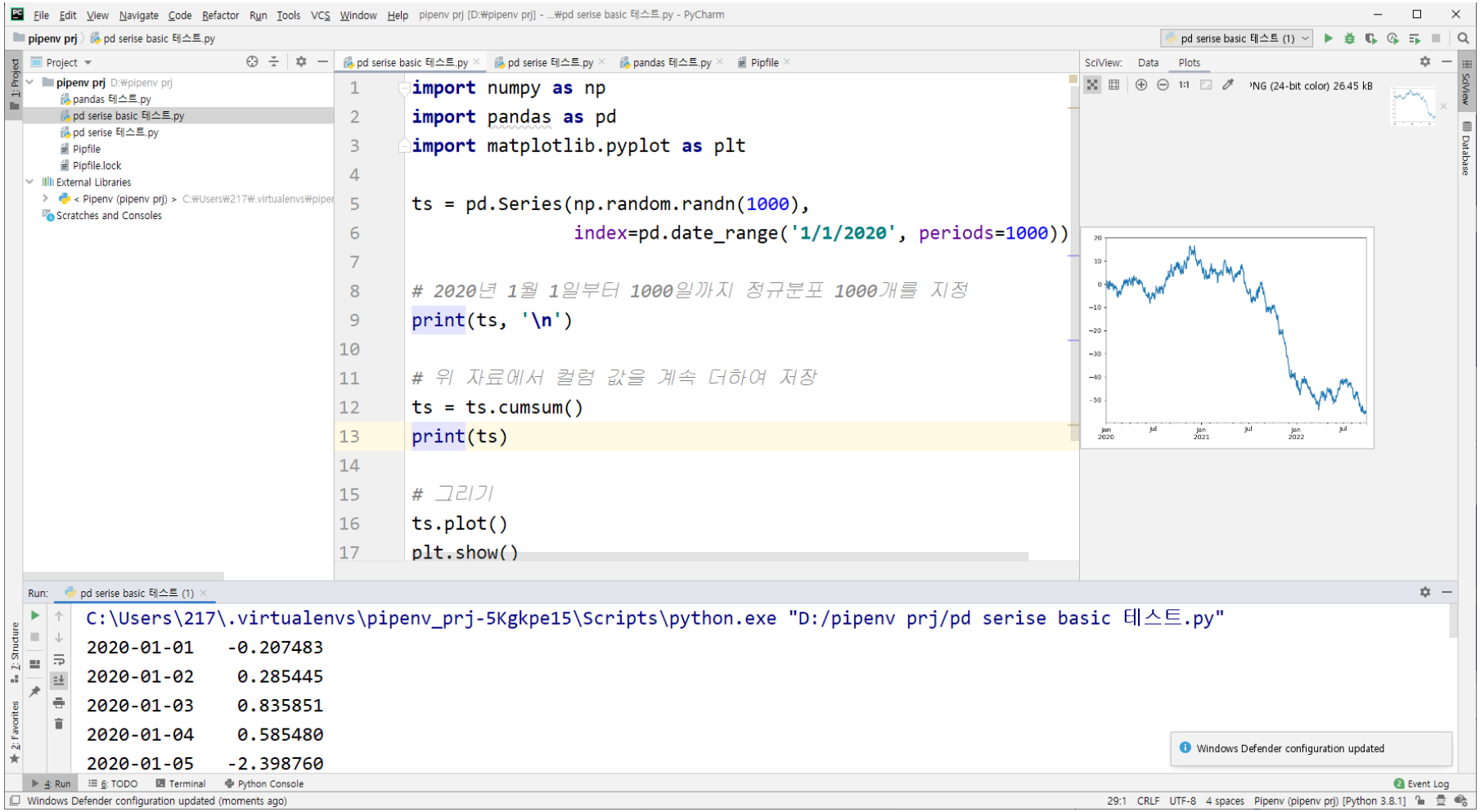
Matplotlib, matplot2.py 쉘에서 코딩

- **Python 실행**

```
C:₩Windows₩System32₩cmd.exe - pipenv  shell - python

(penv-Snxa-AB5) D:₩ve₩penv>python
Python 3.8.1 (tags/v3.8.1:1b293b6, Dec 18 2019, 22:39:24) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> import numpy as np
>>> import matplotlib.pyplot as plt
>>> x = np.linspace(-10, 10, 20)
>>> plt.subplot(2, 2, 1)
<matplotlib.axes._subplots.AxesSubplot object at 0x037C3910>
>>> plt.plot(x, x)
[<matplotlib.lines.Line2D object at 0x10815340>]
>>> plit.subplot(2, 2, 2)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
NameError: name 'plit' is not defined
>>> plt.subplot(2, 2, 2)
<matplotlib.axes._subplots.AxesSubplot object at 0x10806BB0>
>>> plt.plot(x, -x)
[<matplotlib.lines.Line2D object at 0x00DB9178>]
>>> plt.subplot(2, 2, 3)
<matplotlib.axes._subplots.AxesSubplot object at 0x00DB9AA8>
>>> plt.plot(x, x**2)
[<matplotlib.lines.Line2D object at 0x00DD2700>]
>>> plt.subplot(2, 2, 4)
<matplotlib.axes._subplots.AxesSubplot object at 0x00DD2DD8>
>>> plt.plot(x, pow(x, 3))
[<matplotlib.lines.Line2D object at 0x012D7388>]
>>> plt.show()
```



Matplotlib, matplot3.py

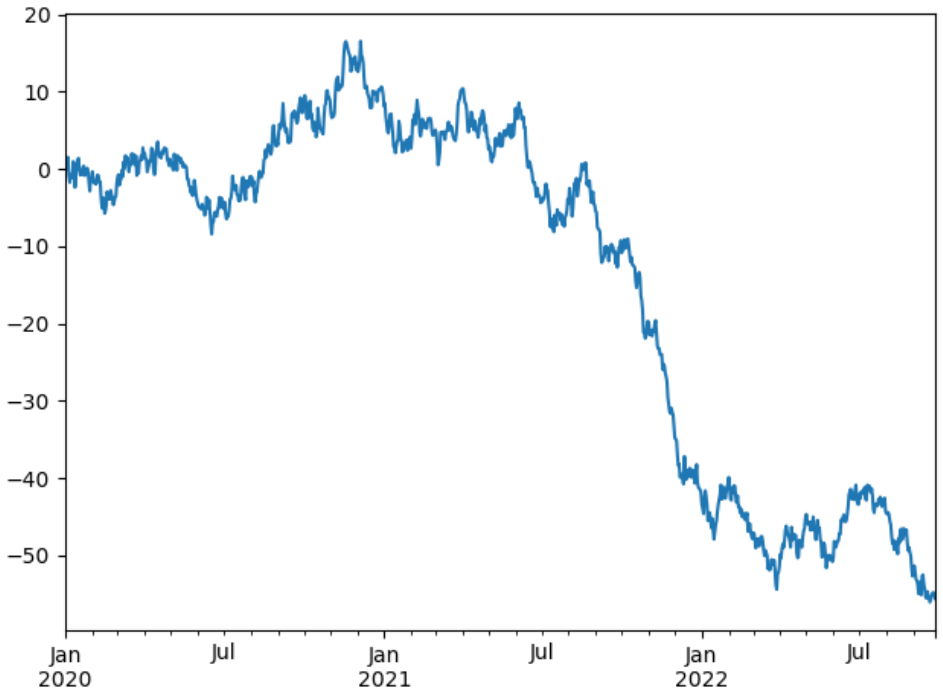


Matplotlib, matplot3.py 이해

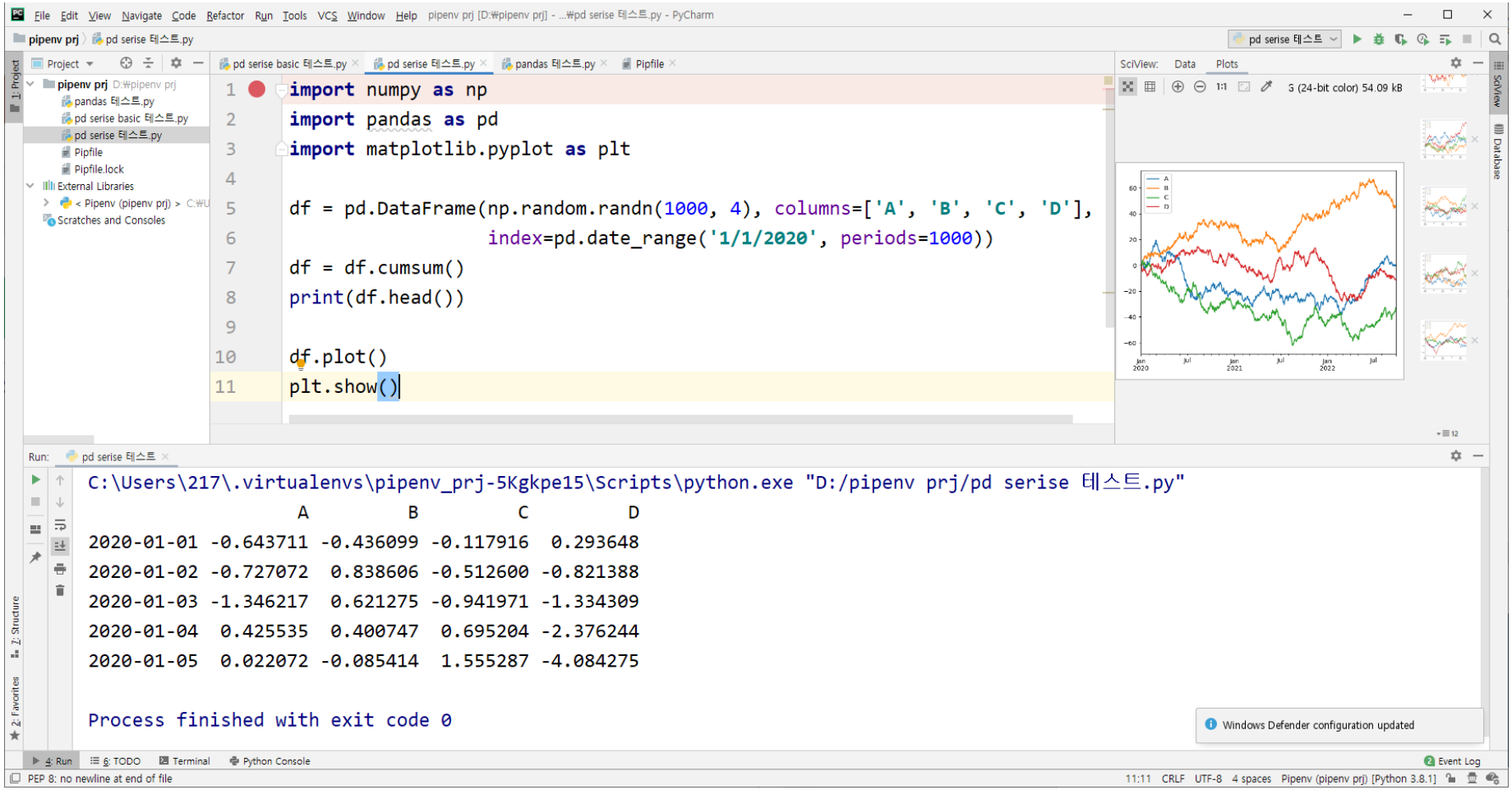
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

# Series는 1차원 데이터를 다루는 데 효과적인 자료구조
# value와 index의 형태를 지니는 Pandas의 자료 구조
# 별도의 인덱스 레이블을 지정하지 않으면 자동적으로
# 0부터 시작되는 디폴트 정수 인덱스를 사용
# 다음은 인덱스를 날짜 1000개로 지정, 자료 값은 난수 1000개
# 즉 2020년 1월 1일부터 1000일까지 정규분포 1000개를 지정
ts = pd.Series(np.random.randn(1000), index=pd.date_range('1/1/2020', periods=1000))
print(ts, '\n')

# 위 자료에서 컬럼 값을 계속 더하여 저장
ts = ts.cumsum()
print(ts)

# 그리기
ts.plot()
plt.show()
```

```
2020-01-01   -0.207483
2020-01-02    0.285445
2020-01-03    0.835851
```

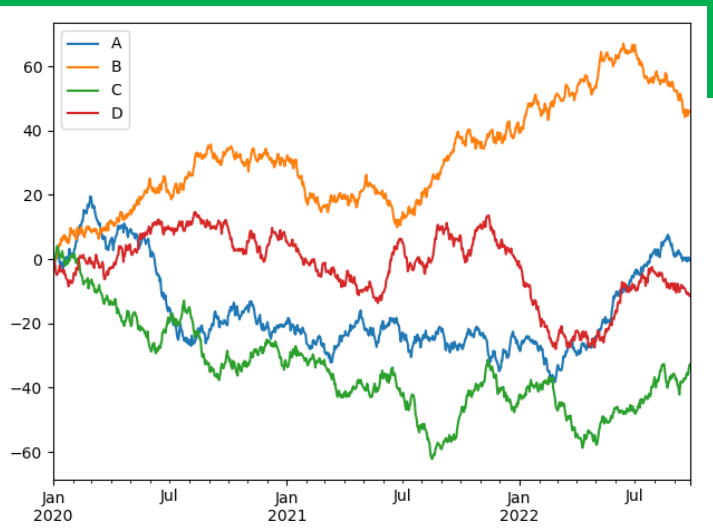
```
2020-01-01   -0.207483
2020-01-02    0.077963
2020-01-03    0.913813
```



Matplotlib, matplot4.py



Matplotlib, matplot3.py 이해




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

df = pd.DataFrame(np.random.randn(1000, 4), columns=['A', 'B', 'C', 'D'],
                  index=pd.date_range('1/1/2020', periods=1000))
df = df.cumsum()
print(df.head())

df.plot()
plt.show()
```

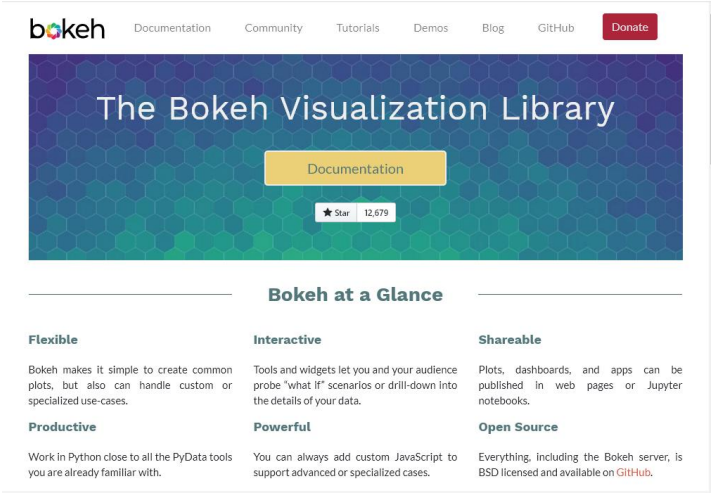
	A	B	C	D
2020-01-01	-0.643711	-0.436099	-0.117916	0.293648
2020-01-02	-0.727072	0.838606	-0.512600	-0.821388
2020-01-03	-1.346217	0.621275	-0.941971	-1.334309
2020-01-04	0.425535	0.400747	0.695204	-2.376244
2020-01-05	0.022072	-0.085414	1.555287	-4.084275

파이참 프로젝트에서 데이터 시각화를 위한 준비

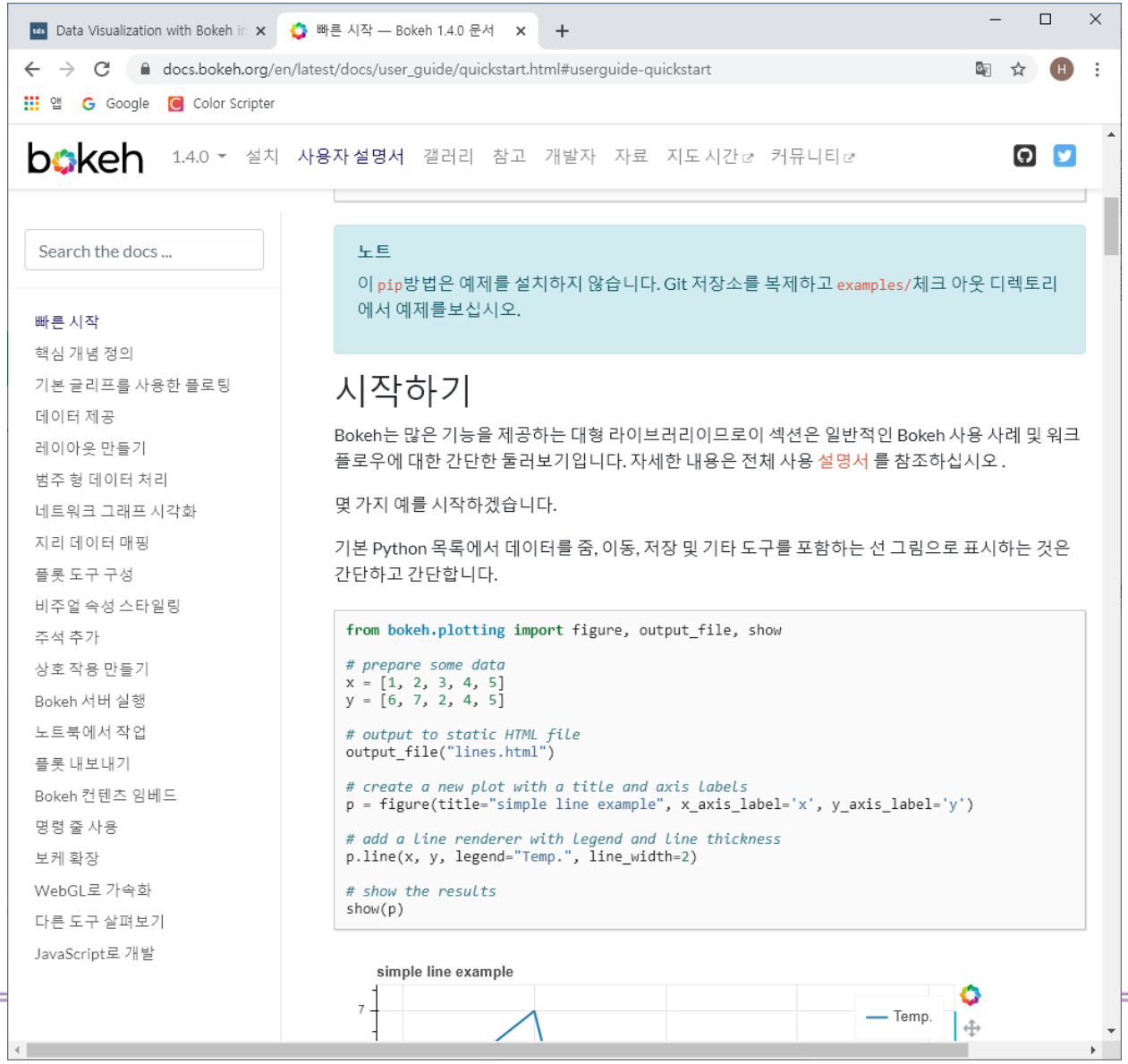
bokeh

Bokeh 개요

- **Bokeh.org**
  - 최신 웹 브라우저를 위한 대화 형 시각화 라이브러리
    - **다목적 그래픽의 우아하고 간결한 구성을 제공**
    - **대용량 또는 스트리밍 데이터 세트에 대한 고성능 대화식 기능을 제공**
  - 대화 형 플롯, 대시 보드 및 데이터 응용 프로그램을 빠르고 쉽게 만들고 싶은 사람에게 적합
  - Bokeh를 사용하여 시각화를 시작하려면
    - **사용 설명서로 시작**
      - https://docs.bokeh.org/en/latest/docs/user_guide/quickstart.html#userguide-quickstart

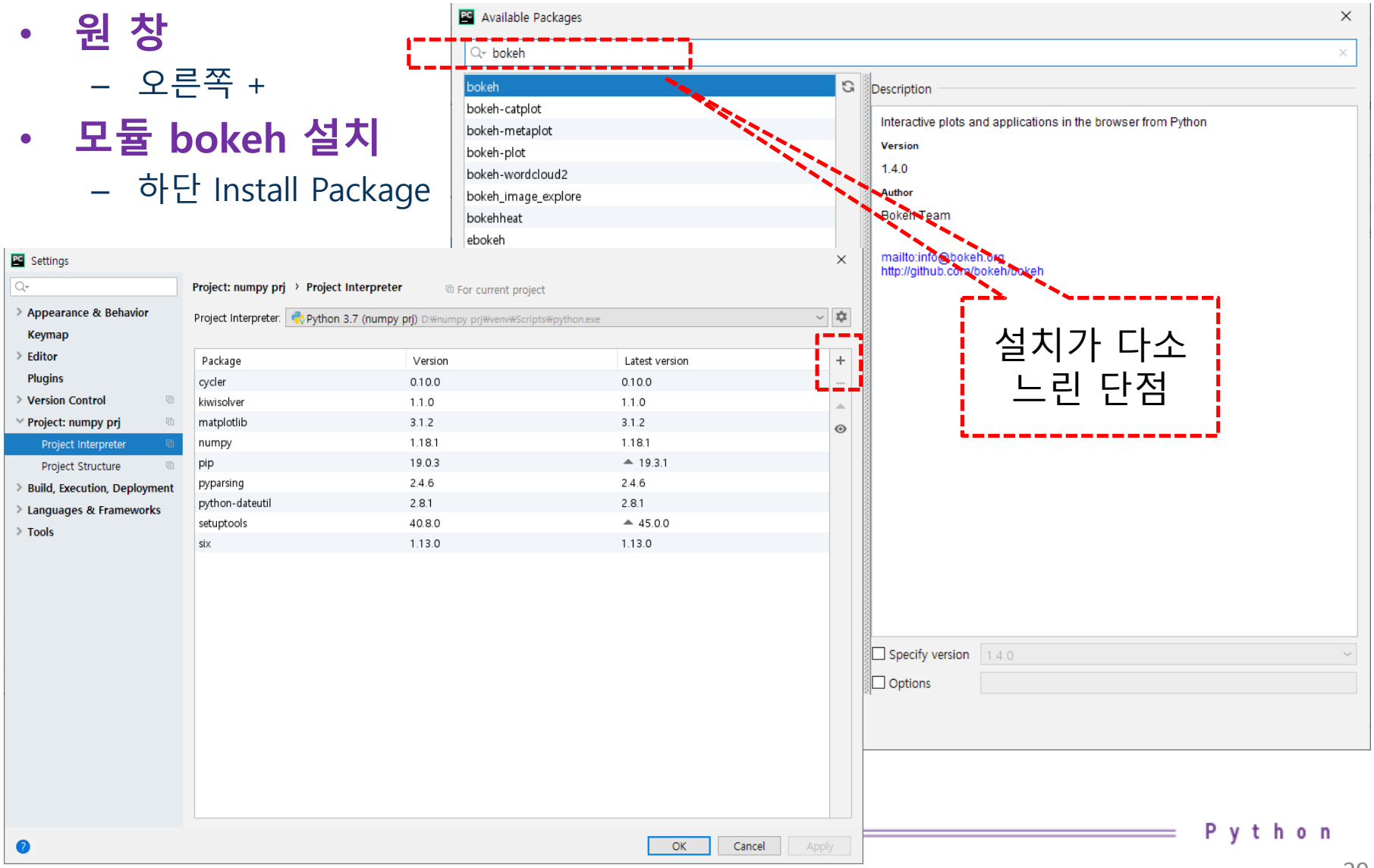


보케 가이드 페이지

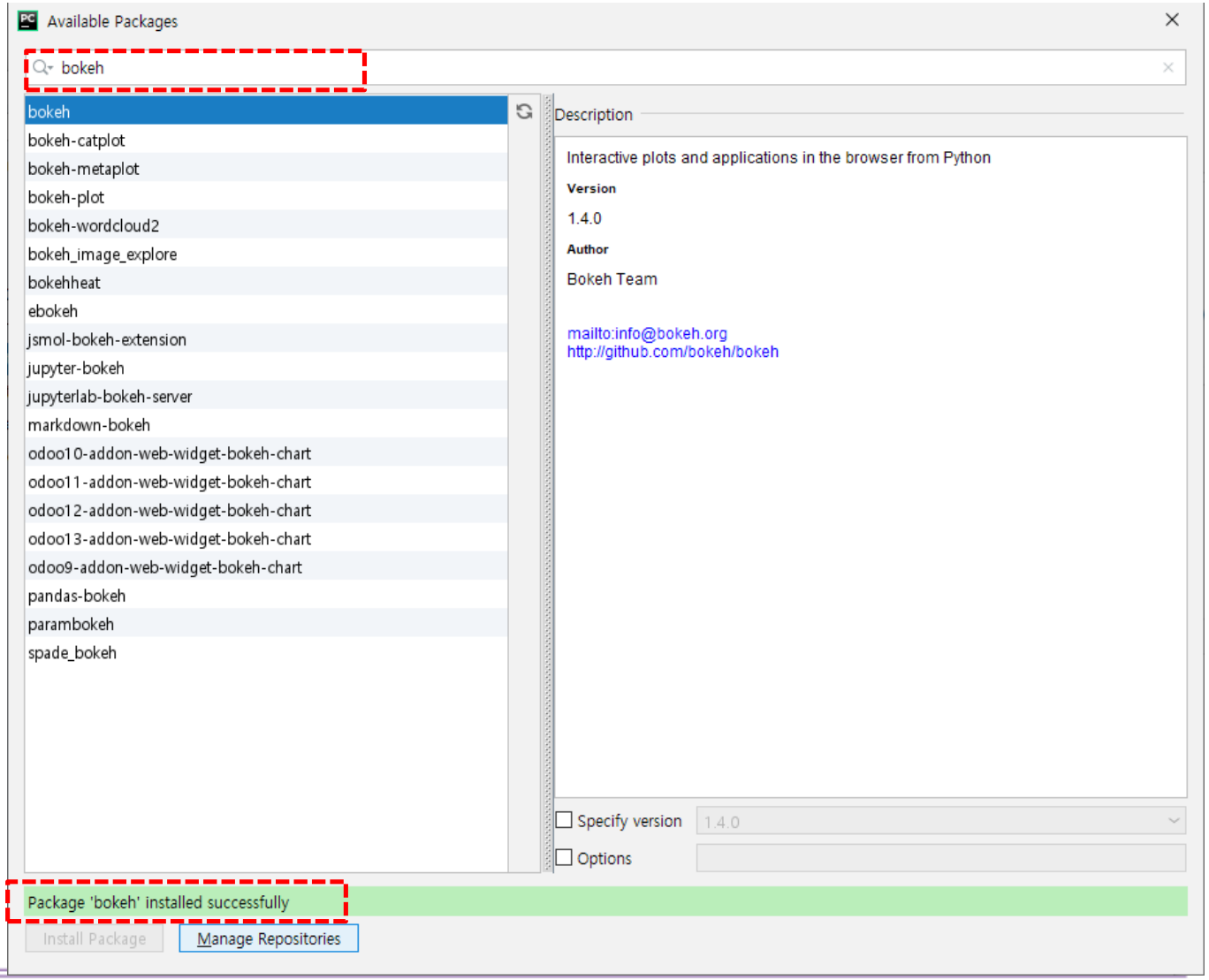

Data Visualization with Bokeh
빠른 시작 — Bokeh 1.4.0 문서
docs.bokeh.org/en/latest/docs/user_guide/quickstart.html#userguide-quickstart
Google
Color Scripter
bokeh
1.4.0
설치
사용자 설명서
갤러리
참고
개발자
자료
지도 시간
커뮤니티
Search the docs ...
빠른 시작
핵심 개념 정의
기본 글리프를 사용한 플로팅
데이터 제공
레이아웃 만들기
범주 형 데이터 처리
네트워크 그래프 시각화
지리 데이터 매핑
플롯 도구 구성
비주얼 속성 스타일링
주석 추가
상호 작용 만들기
Bokeh 서버 실행
노트북에서 작업
플롯 내보내기
Bokeh 컨텐츠 임베드
명령 줄 사용
보케 확장
WebGL로 가속화
다른 도구 살펴보기
JavaScript로 개발
노트
이 pip방법은 예제를 설치하지 않습니다. Git 저장소를 복제하고 examples/체크 아웃 디렉토리에서 예제를보십시오.
시작하기
Bokeh는 많은 기능을 제공하는 대형 라이브러리이므로이 섹션은 일반적인 Bokeh 사용 사례 및 워크플로우에 대한 간단한 둘러보기입니다. 자세한 내용은 전체 사용 설명서 를 참조하십시오 .
몇 가지 예를 시작하겠습니다.
기본 Python 목록에서 데이터를 줌, 이동, 저장 및 기타 도구를 포함하는 선 그림으로 표시하는 것은 간단하고 간단합니다.
from bokeh.plotting import figure, output_file, show
# prepare some data
x = [1, 2, 3, 4, 5]
y = [6, 7, 2, 4, 5]
# output to static HTML file
output_file("lines.html")
# create a new plot with a title and axis labels
p = figure(title="simple line example", x_axis_label='x', y_axis_label='y')
# add a line renderer with legend and line thickness
p.line(x, y, legend="Temp.", line_width=2)
# show the results
show(p)
simple line example
7
Temp.

Settings... 에서 모듈 추가하기

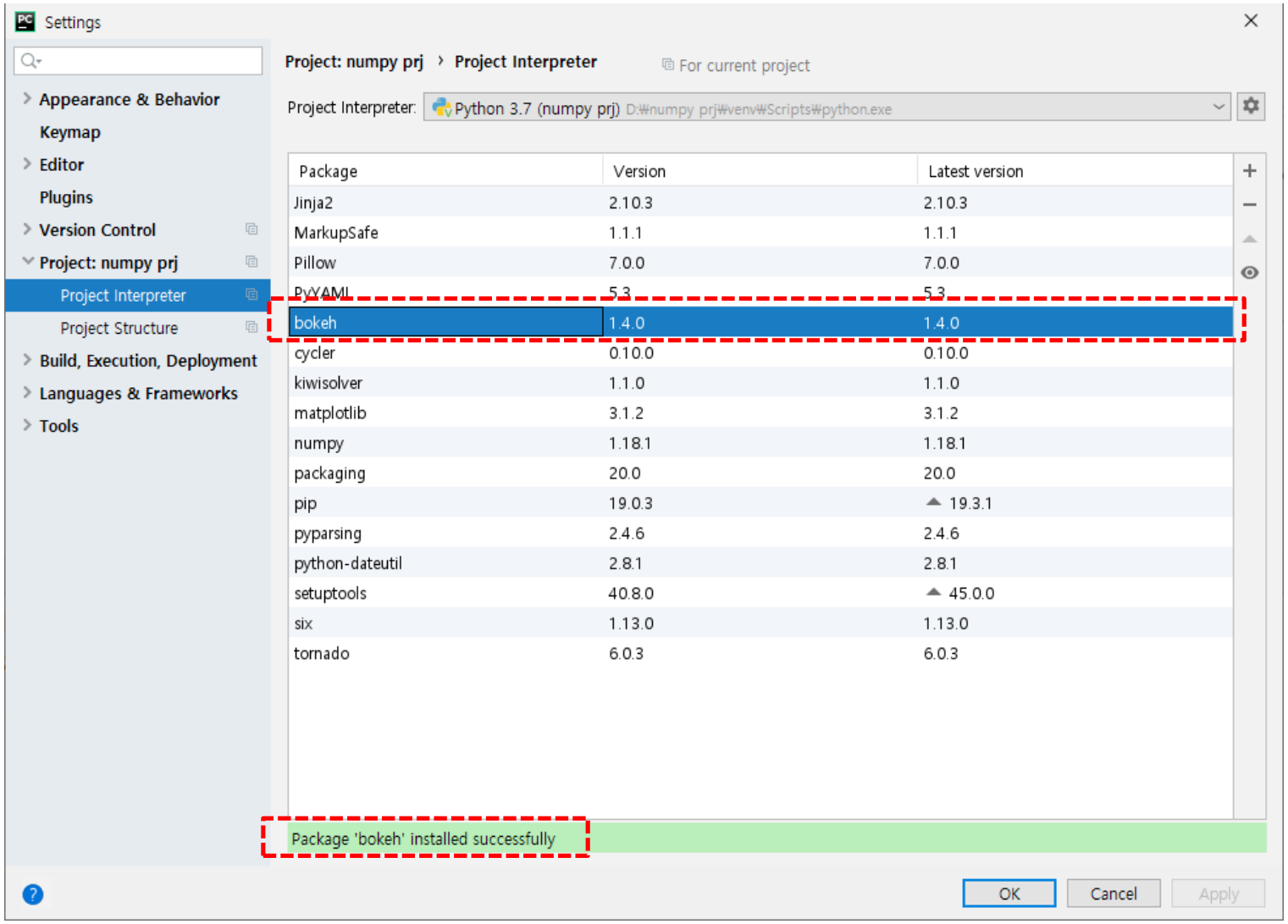
- 원 창
  - 오른쪽 +
- 모듈 bokeh 설치
  - 하단 Install Package



모듈 bokeh 설치 화면



Settings 화면


Settings
Appearance & Behavior
Keymap
Editor
Plugins
Version Control
Project: numpy prj
Project Interpreter
Project Structure
Build, Execution, Deployment
Languages & Frameworks
Tools
Project: numpy prj › Project Interpreter
For current project
Project Interpreter: Python 3.7 (numpy prj) D:₩numpy prj₩venv₩Scripts₩python.exe
Package
Version
Latest version
Jinja2 2.10.3 2.10.3
MarkupSafe 1.1.1 1.1.1
Pillow 7.0.0 7.0.0
PyYAML 5.3 5.3
bokeh 1.4.0 1.4.0
cycler 0.10.0 0.10.0
kiwisolver 1.1.0 1.1.0
matplotlib 3.1.2 3.1.2
numpy 1.18.1 1.18.1
packaging 20.0 20.0
pip 19.0.3 19.3.1
pyparsing 2.4.6 2.4.6
python-dateutil 2.8.1 2.8.1
setuptools 40.8.0 45.0.0
six 1.13.0 1.13.0
tornado 6.0.3 6.0.3
Package 'bokeh' installed successfully
OK
Cancel
Apply

Bokeh 터미널 설치도 물론 가능

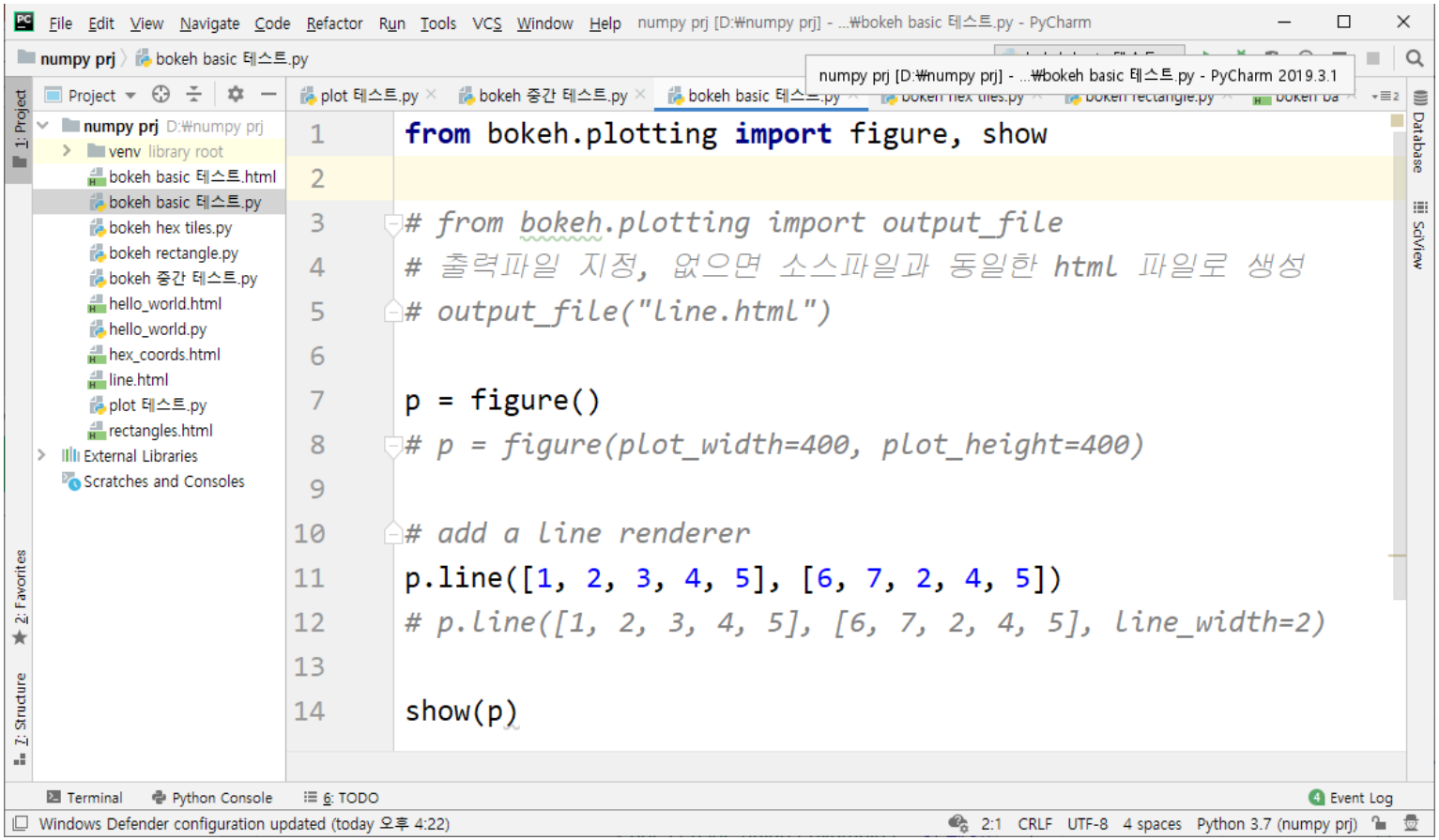
- **터미널에서 설치**
  - pip install bokeh

- **확인**
  - pip list
  - pip show bokeh

```
(venv) D:\numpy prj>pip list
Package          Version
---------------- -------
bokeh            1.4.0
cycler           0.10.0
Jinja2           2.10.3
kiwisolver       1.1.0
MarkupSafe       1.1.1
matplotlib       3.1.2
numpy            1.18.1
packaging        20.0
pandas           0.25.3
Pillow           7.0.0
pip              19.0.3
pyparsing        2.4.6
python-dateutil  2.8.1
pytz             2019.3
PyYAML           5.3
setuptools       40.8.0
six              1.13.0
tornado          6.0.3
```

Bokeh, bksample1.py

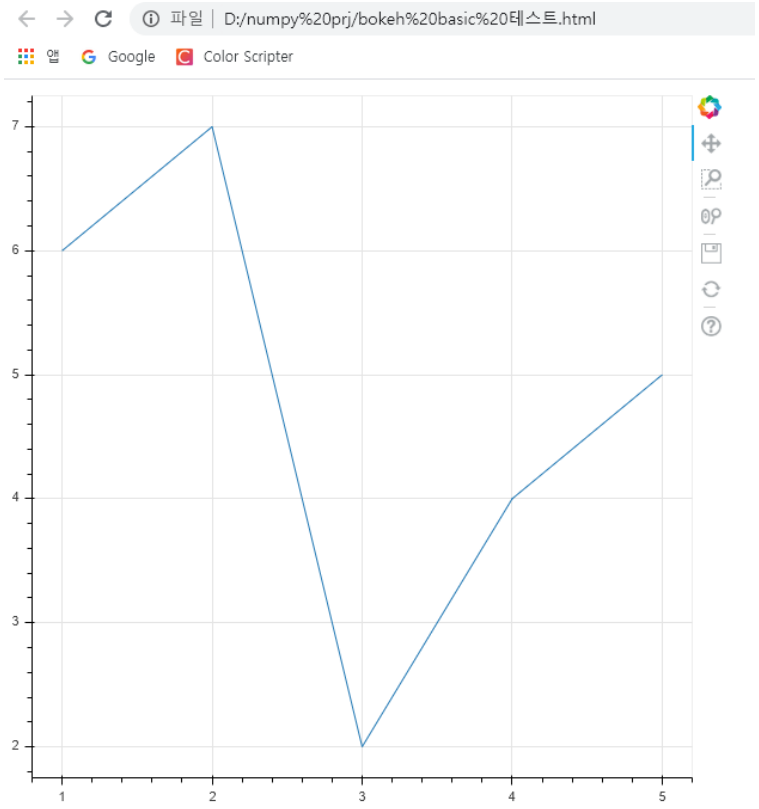
- 결과는 html 파일



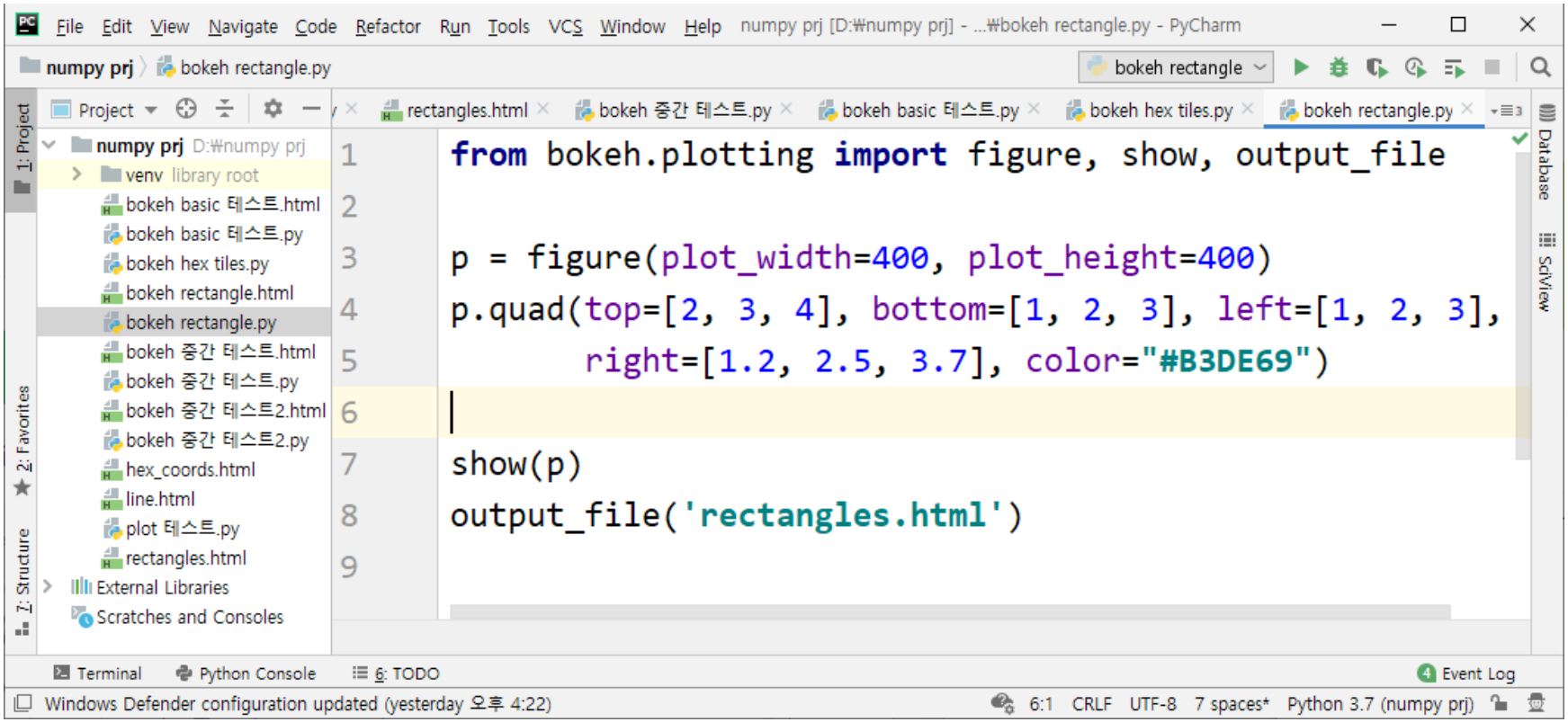
Bokeh, bksample1.py 이해

- 소스 파일과 동일한 폴더에 html 파일로 생성

```
from bokeh.plotting import figure, show


p = figure()

# add a line renderer
p.line([1, 2, 3, 4, 5], [6, 7, 2, 4, 5])

show(p)
```

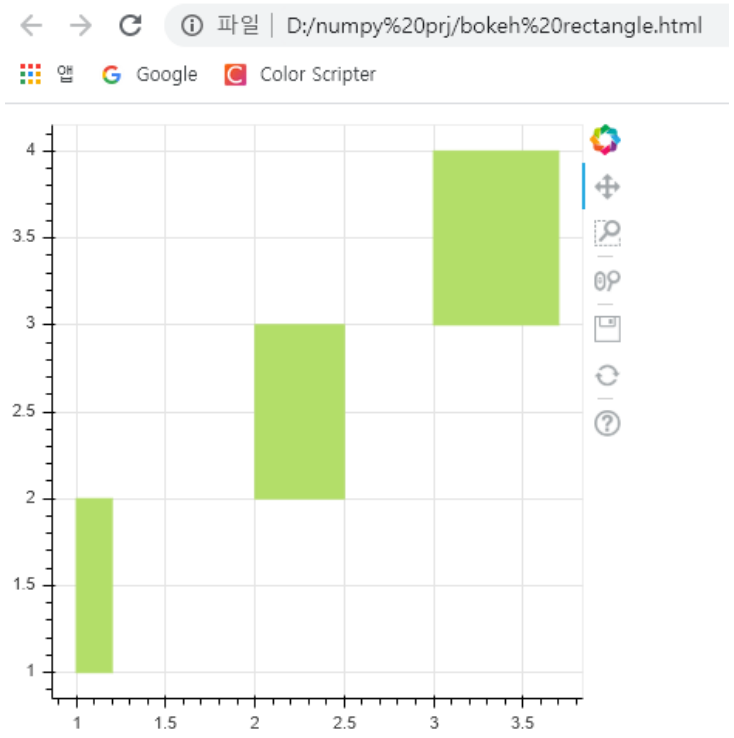


Bokeh, bksample2.py

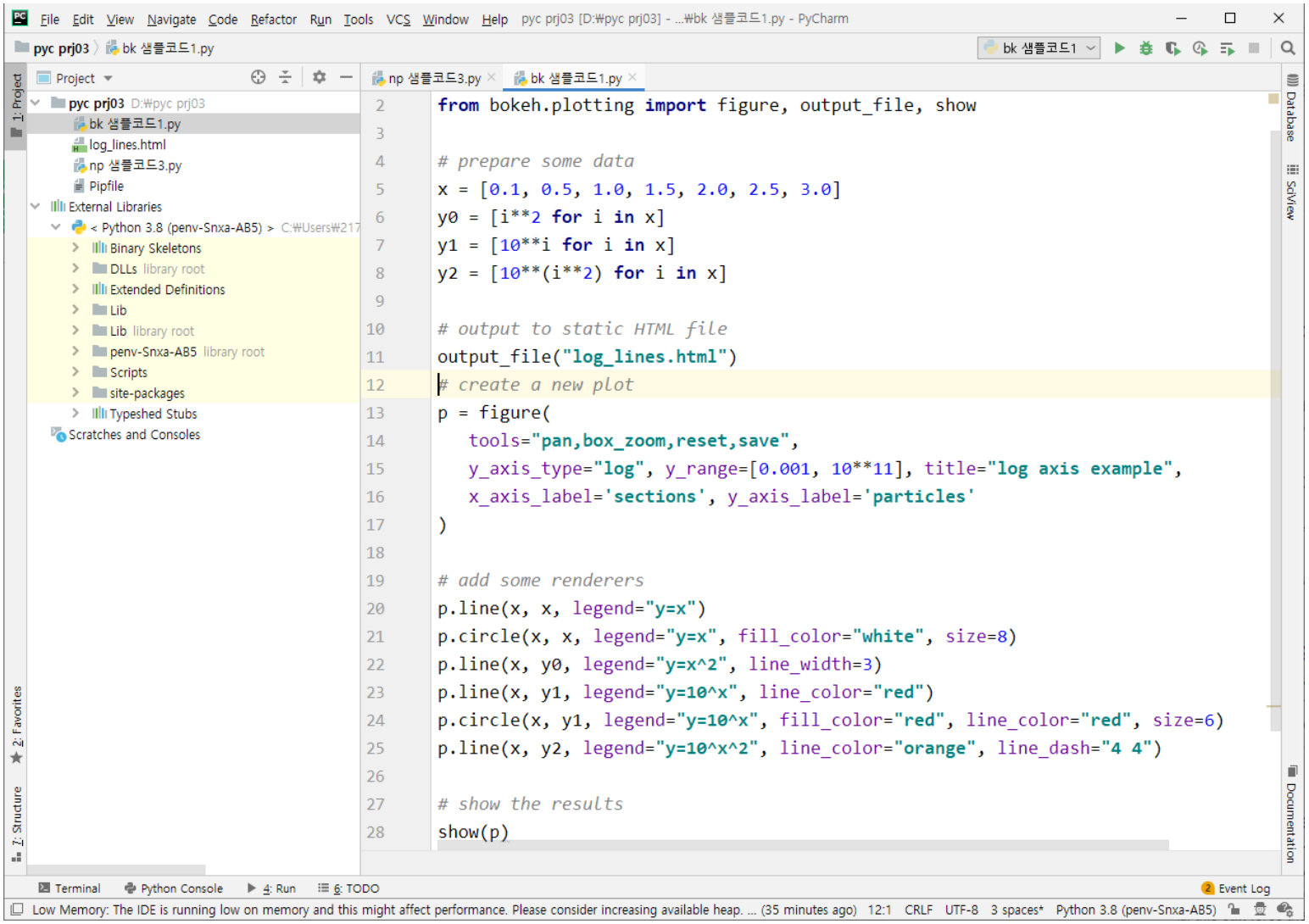


Bokeh, bksample2.py 이해

```
from bokeh.plotting import figure, show, output_file

p = figure(plot_width=400, plot_height=400)
p.quad(top=[2, 3, 4], bottom=[1, 2, 3], left=[1, 2, 3],
       right=[1.2, 2.5, 3.7], color="#B3DE69")

show(p)
output_file('rectangles.html')
```

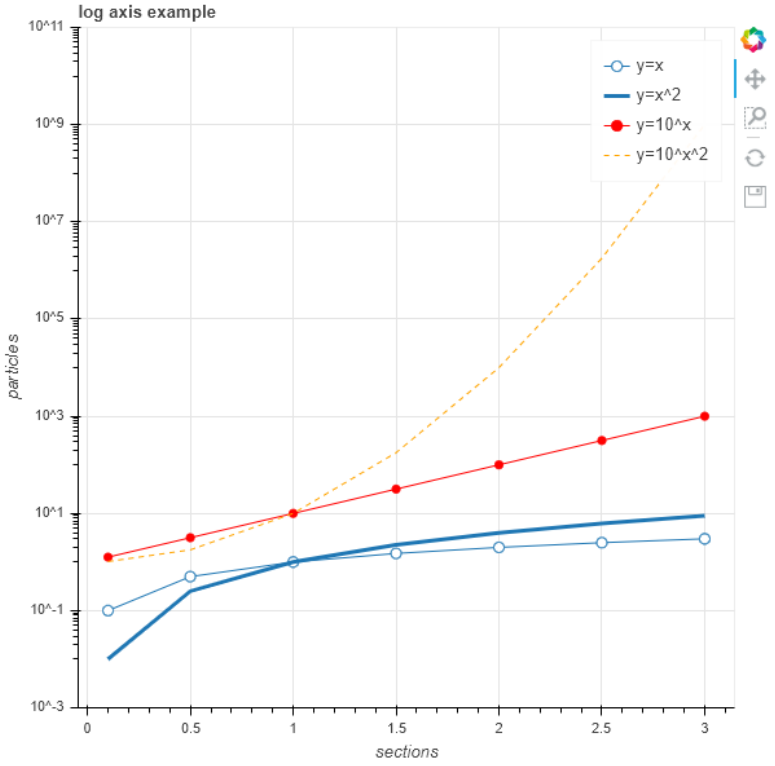


Bokeh, bksample3.py



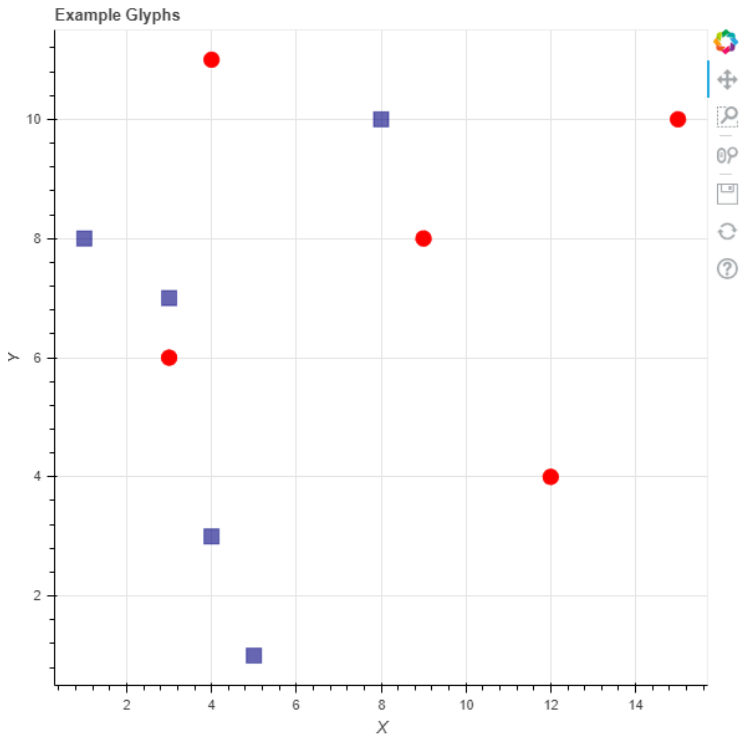
Bokeh, bksample3.py 이해

```
#
https://docs.bokeh.org/en/latest/docs/user_guide/quickstart.html#userguide-
quickstart
from bokeh.plotting import figure, output_file, show

# prepare some data
x = [0.1, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0]
y0 = [i**2 for i in x]
y1 = [10**i for i in x]
y2 = [10**(i**2) for i in x]

# output to static HTML file
output_file("log_lines.html")

# create a new plot
p = figure(
   tools="pan,box_zoom,reset,save",
   y_axis_type="log", y_range=[0.001, 10**11],
   title="log axis example",
   x_axis_label='sections', y_axis_label='particles'
)

# add some renderers
p.line(x, x, legend="y=x")
p.circle(x, x, legend="y=x", fill_color="white", size=8)
p.line(x, y0, legend="y=x^2", line_width=3)
p.line(x, y1, legend="y=10^x", line_color="red")
p.circle(x, y1, legend="y=10^x", fill_color="red", line_color="red", size=6)
p.line(x, y2, legend="y=10^x^2", line_color="orange", line_dash="4 4")

# show the results
show(p)
```

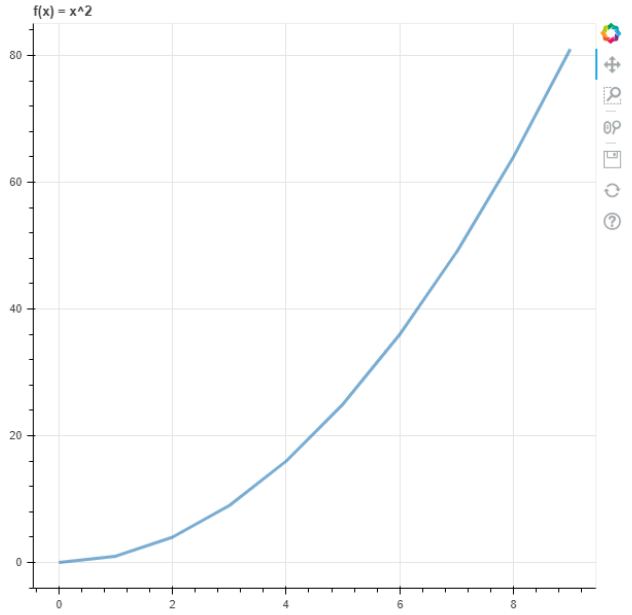


Bokeh, bksample4.py 이해

```
# bokeh basics
from bokeh.plotting import figure
from bokeh.io import show
# from bokeh.io import show, output_notebook

# Create a blank figure with labels
p = figure(plot_width = 600, plot_height = 600,
           title = 'Example Glyphs',
           x_axis_label = 'X', y_axis_label = 'Y')

# Example data
squares_x = [1, 3, 4, 5, 8]
squares_y = [8, 7, 3, 1, 10]
circles_x = [9, 12, 4, 3, 15]
circles_y = [8, 4, 11, 6, 10]

# Add squares glyph
p.square(squares_x, squares_y, size = 12, color = 'navy', alpha =
0.6)
# Add circle glyph
p.circle(circles_x, circles_y, size = 12, color = 'red')

# Set to output the plot in the notebook
# output_notebook()
# Show the plot
show(p)
```



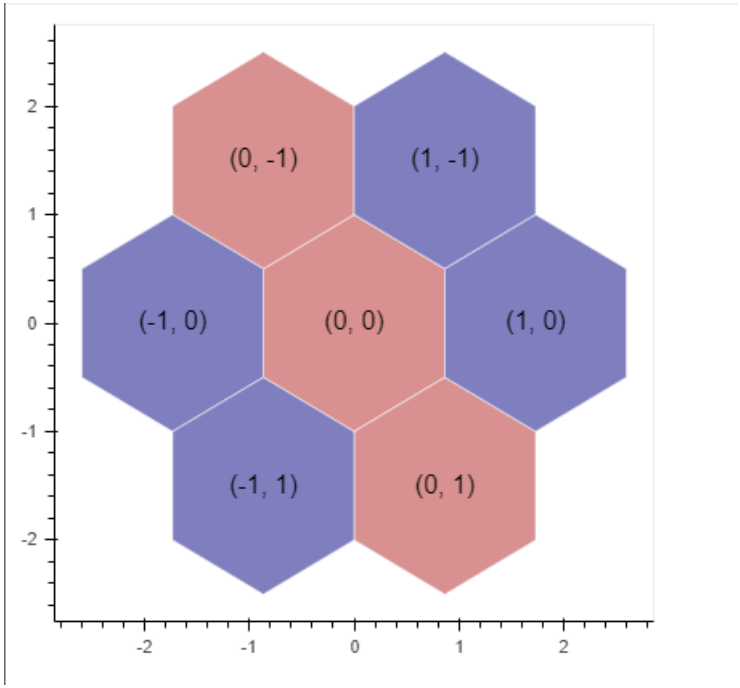
Bokeh, bksample5.py 이해



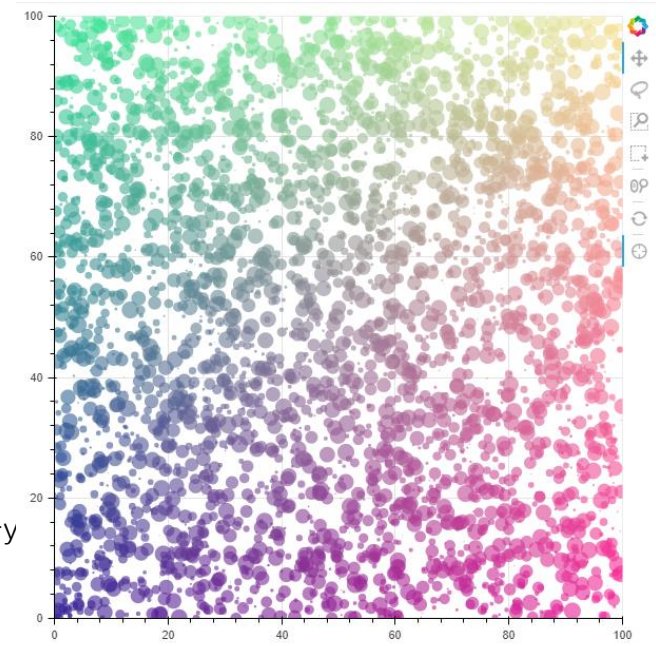

```
from bokeh.io import show
from bokeh.plotting import figure
from bokeh.models import ColumnDataSource

x_values = range(10)
y_values = [x ** 2 for x in x_values]
data_source = ColumnDataSource(data=dict(x=x_values, y=y_values))

plot = figure(title = 'f(x) = x^2')
plot.line('x', 'y', source = data_source, line_width=3, line_alpha=0.6)
show(plot)
```

Bokeh, bksample6.py 이해

```
import numpy as np

from bokeh.io import output_file, show
from bokeh.plotting import figure
from bokeh.util.hex import axial_to_cartesian

output_file("hex_coords.html")

q = np.array([0,  0, 0, -1, -1,  1, 1])
r = np.array([0, -1, 1,  0,  1, -1, 0])

p = figure(plot_width=400, plot_height=400, toolbar_location=None)
p.grid.visible = False

p.hex_tile(q, r, size=1, fill_color=["firebrick"]*3 + ["navy"]*4,
           line_color="white", alpha=0.5)

x, y = axial_to_cartesian(q, r, 1, "pointytop")

p.text(x, y, text=["(%d, %d)" % (q,r) for (q, r) in zip(q, r)],
       text_baseline="middle", text_align="center")

show(p)
```



Bokeh, bksample7.py 이해




```
import numpy as np

from bokeh.plotting import figure, output_file, show

# prepare some data
N = 4000
x = np.random.random(size=N) * 100
y = np.random.random(size=N) * 100
radii = np.random.random(size=N) * 1.5
colors = [
    "#%02x%02x%02x" % (int(r), int(g), 150) for r, g in zip(50+2*x, 30+2*y
]

# output to static HTML file (with CDN resources)
output_file("color_scatter.html", title="color_scatter.py example", mode="cdn")

TOOLS = "crosshair,pan,wheel_zoom,box_zoom,reset,box_select,lasso_select"

# create a new plot with the tools above, and explicit ranges
p = figure(tools=TOOLS, x_range=(0, 100), y_range=(0, 100))

# add a circle renderer with vectorized colors and sizes
p.circle(x, y, radius=radii, fill_color=colors, fill_alpha=0.6, line_color=None)

# show the results
show(p)
```