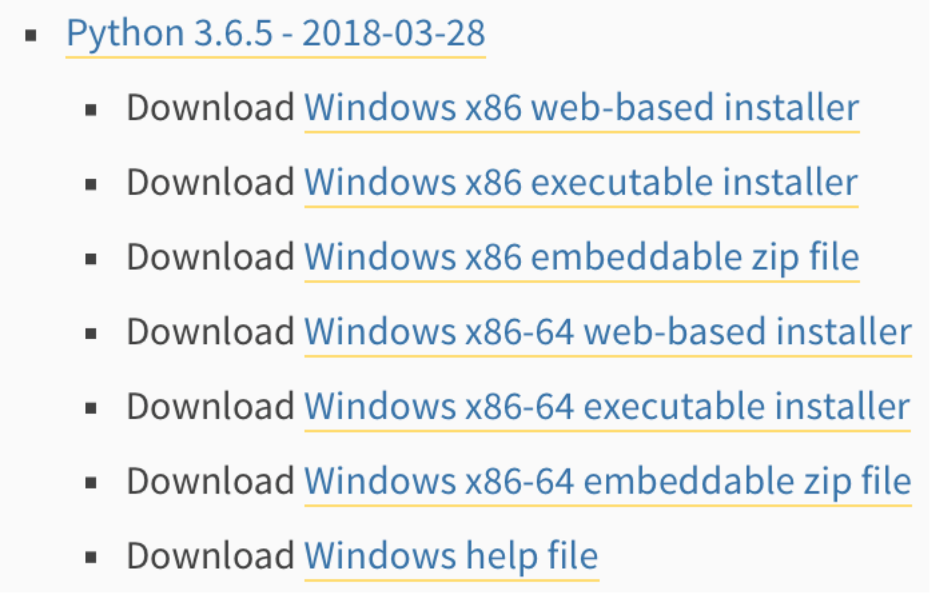
Python Tutorial

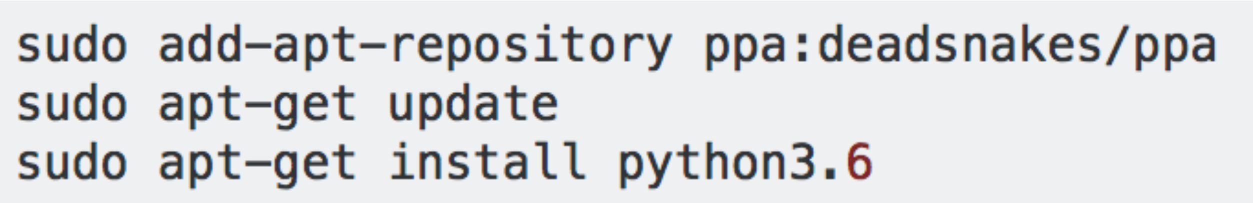
Setup - Window

- Window
  - https://www.python.org/downloads/windows/
  - Recommend to download 3.6 version
  - And install..!



- Python 3.6.5 - 2018-03-28
  - Download Windows x86 web-based installer
  - Download Windows x86 executable installer
  - Download Windows x86 embeddable zip file
  - Download Windows x86-64 web-based installer
  - Download Windows x86-64 executable installer
  - Download Windows x86-64 embeddable zip file
  - Download Windows help file

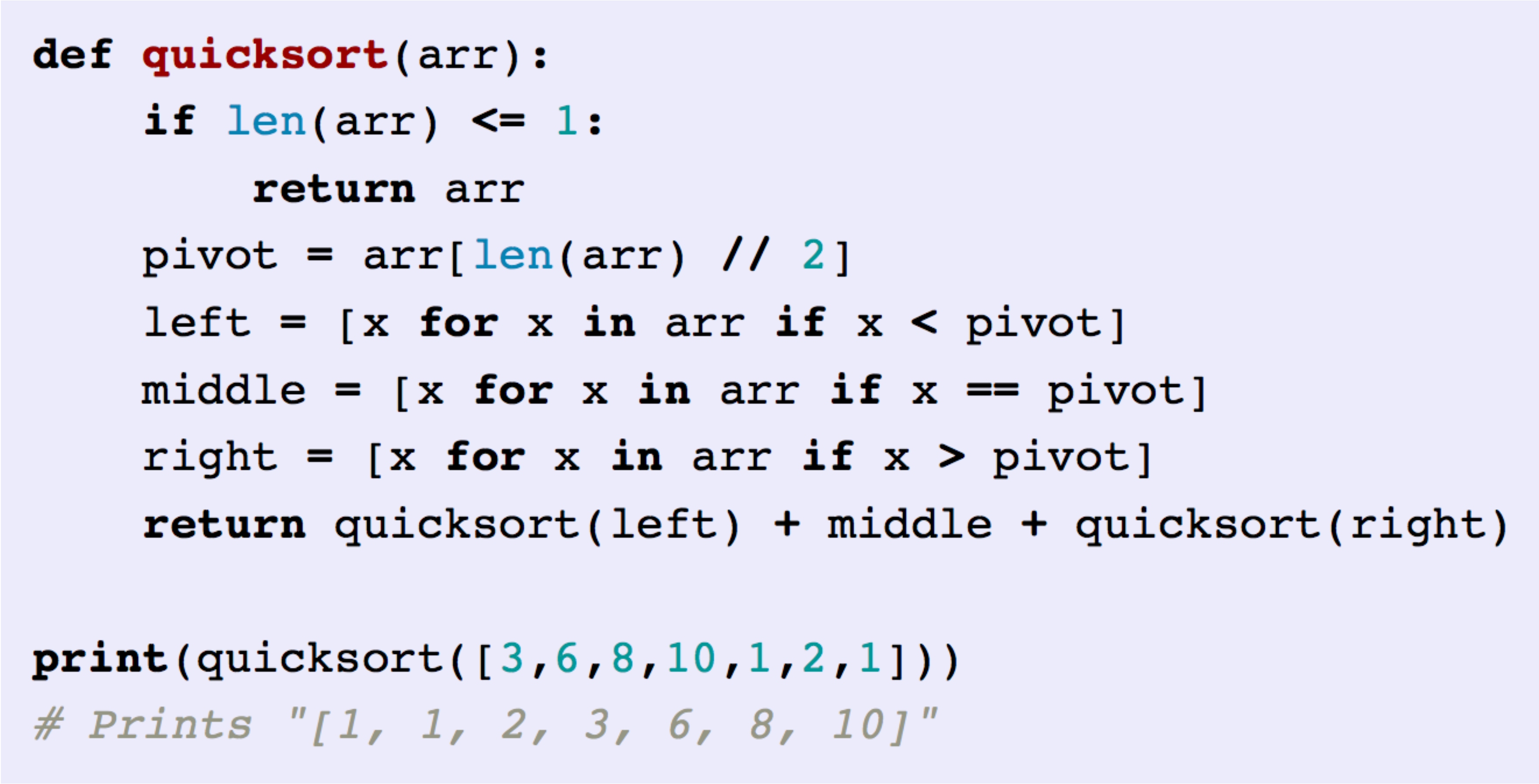
Setup - Ubuntu & macOS

- Ubuntu (Recommend)
  - 

    ```
    sudo add-apt-repository ppa:deadsnakes/ppa
    sudo apt-get update
    sudo apt-get install python3.6
    ```
  - Type python —version to check version
  - Use *virtualenv* if possible to manage package safe and efficient
- macOS (Recommend)
  - Install brew, and >> brew install python3
  - Type python —version to check version
  - Use *virtualenv* if possible to manage package safe and efficient

Python at-a-glance

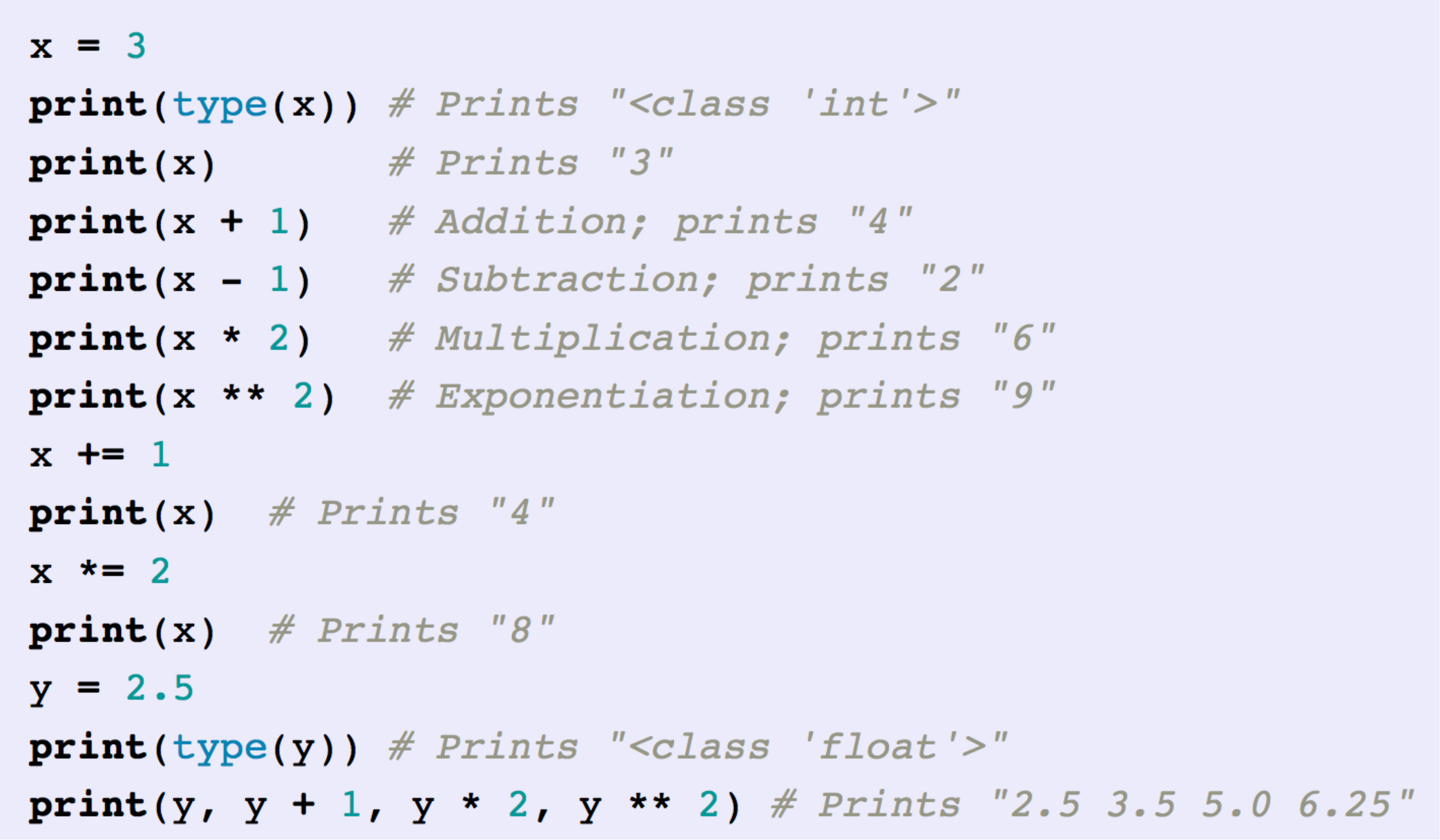
- Easy quick sort



```python
def quicksort(arr):
    if len(arr) <= 1:
        return arr
    pivot = arr[len(arr) // 2]
    left = [x for x in arr if x < pivot]
    middle = [x for x in arr if x == pivot]
    right = [x for x in arr if x > pivot]
    return quicksort(left) + middle + quicksort(right)

print(quicksort([3,6,8,10,1,2,1]))
# Prints "[1, 1, 2, 3, 6, 8, 10]"
```

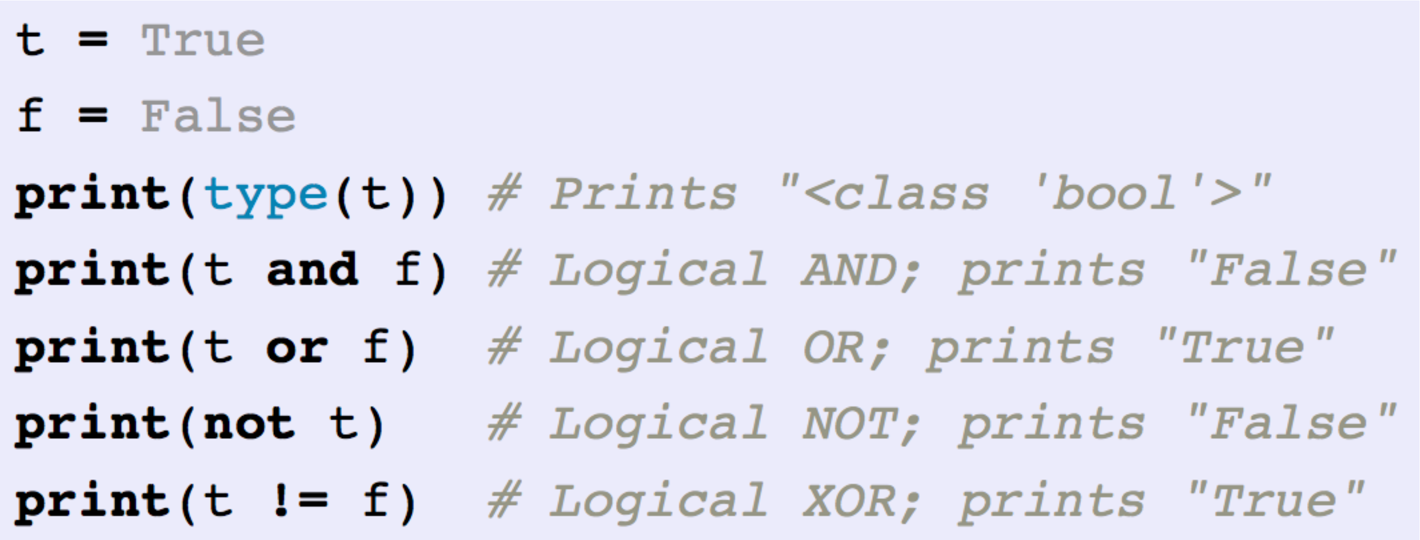
Data types

- No need of *int x = 3;*

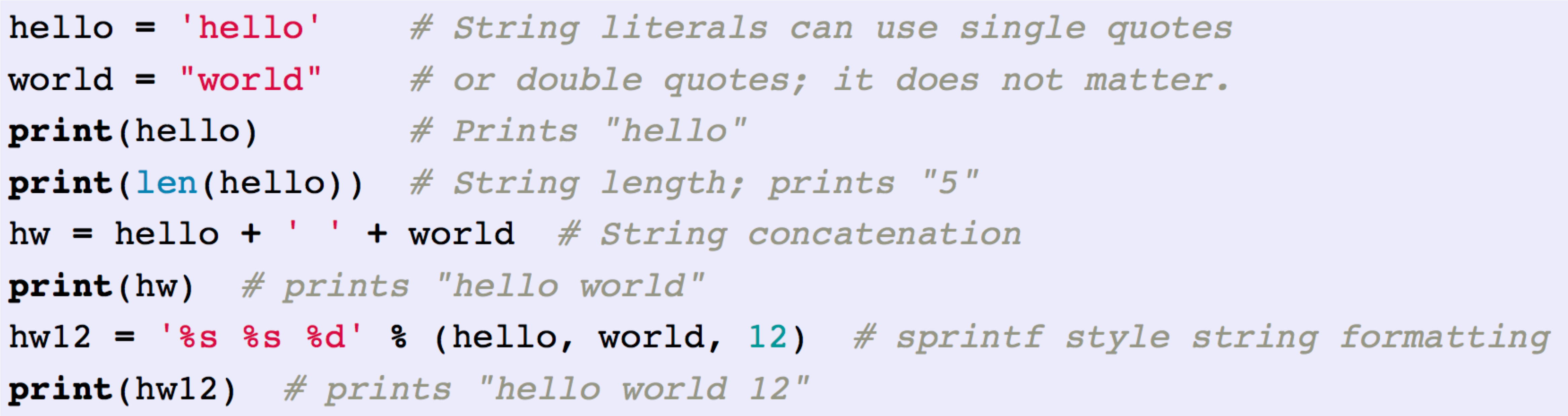


```
x = 3
print(type(x)) # Prints "<class 'int'>"
print(x)       # Prints "3"
print(x + 1)   # Addition; prints "4"
print(x - 1)   # Subtraction; prints "2"
print(x * 2)   # Multiplication; prints "6"
print(x ** 2)  # Exponentiation; prints "9"
x += 1
print(x)  # Prints "4"
x *= 2
print(x)  # Prints "8"
y = 2.5
print(type(y)) # Prints "<class 'float'>"
print(y, y + 1, y * 2, y ** 2) # Prints "2.5 3.5 5.0 6.25"
```

Booleans and strings



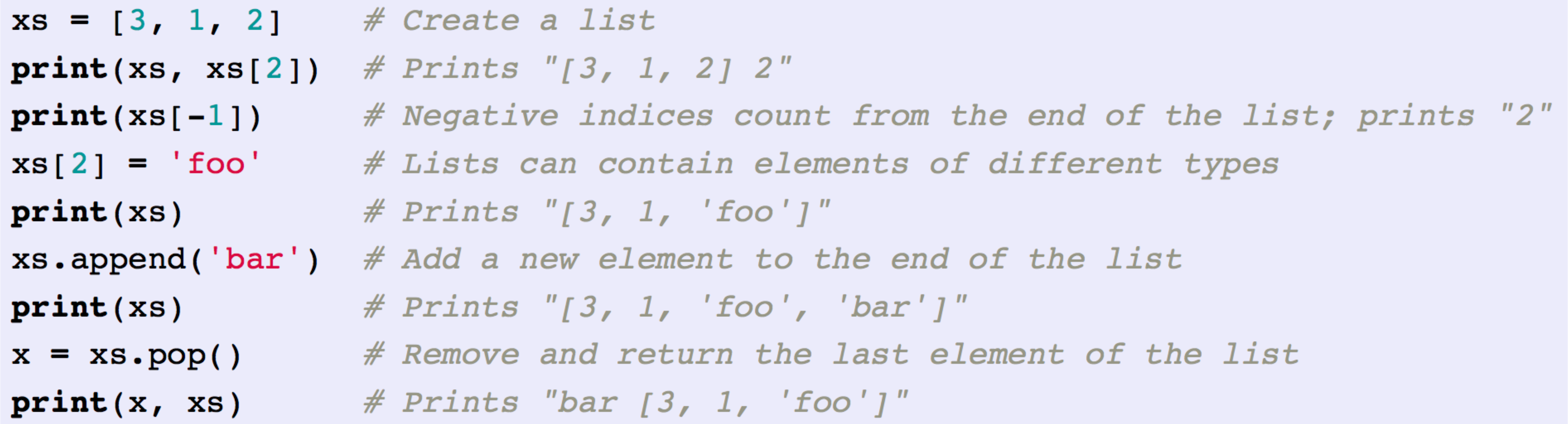
```python
t = True
f = False
print(type(t)) # Prints "<class 'bool'>"
print(t and f) # Logical AND; prints "False"
print(t or f)  # Logical OR; prints "True"
print(not t)   # Logical NOT; prints "False"
print(t != f)  # Logical XOR; prints "True"
```



```python
hello = 'hello'    # String literals can use single quotes
world = "world"    # or double quotes; it does not matter.
print(hello)       # Prints "hello"
print(len(hello))  # String length; prints "5"
hw = hello + ' ' + world  # String concatenation
print(hw)  # prints "hello world"
hw12 = '%s %s %d' % (hello, world, 12)  # sprintf style string formatting
print(hw12)  # prints "hello world 12"
```

Containers

- List (equivalent of an array in C)

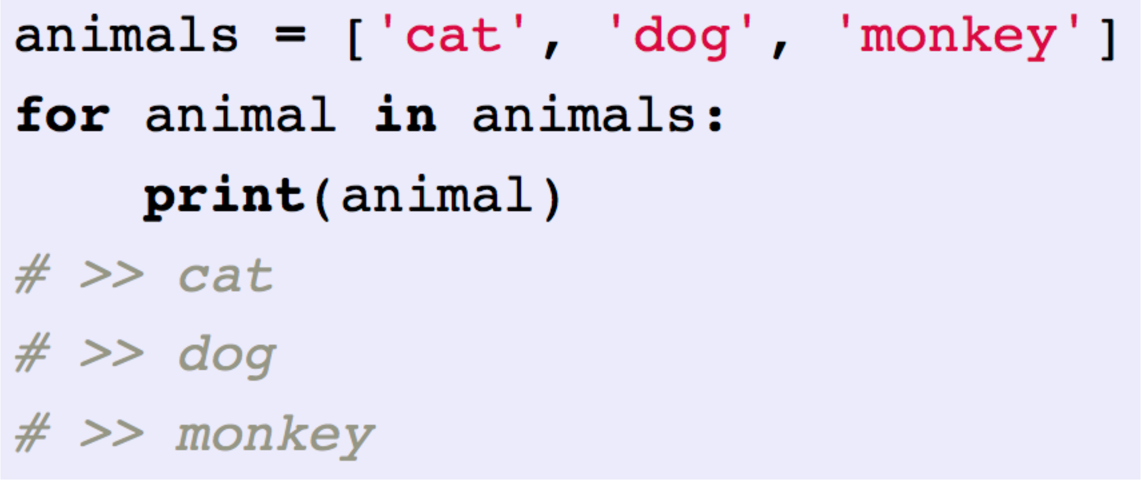


```python
xs = [3, 1, 2]    # Create a list
print(xs, xs[2])  # Prints "[3, 1, 2] 2"
print(xs[-1])     # Negative indices count from the end of the list; prints "2"
xs[2] = 'foo'     # Lists can contain elements of different types
print(xs)         # Prints "[3, 1, 'foo']"
xs.append('bar')  # Add a new element to the end of the list
print(xs)         # Prints "[3, 1, 'foo', 'bar']"
x = xs.pop()      # Remove and return the last element of the list
print(x, xs)      # Prints "bar [3, 1, 'foo']"
```

For loops

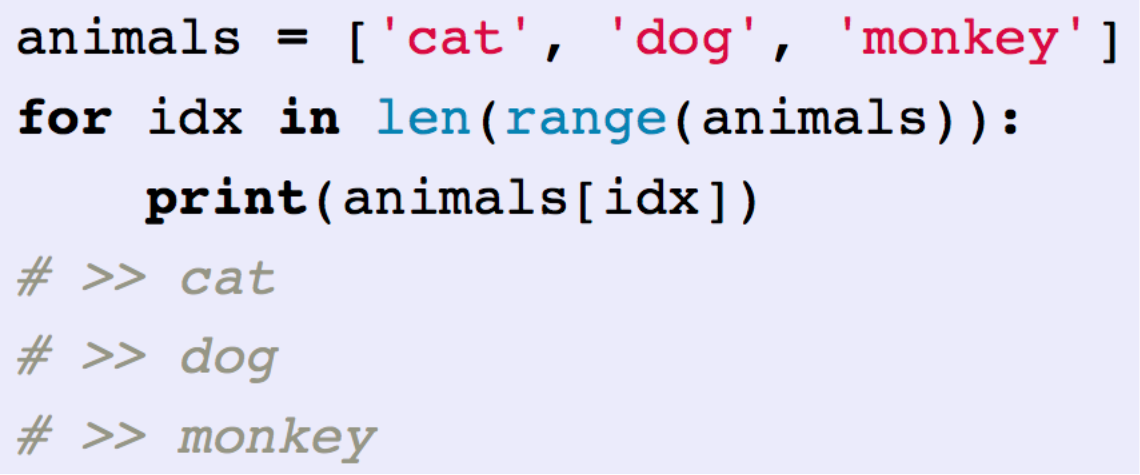
- Be pythonic! Better to use 1) and 3)

1)



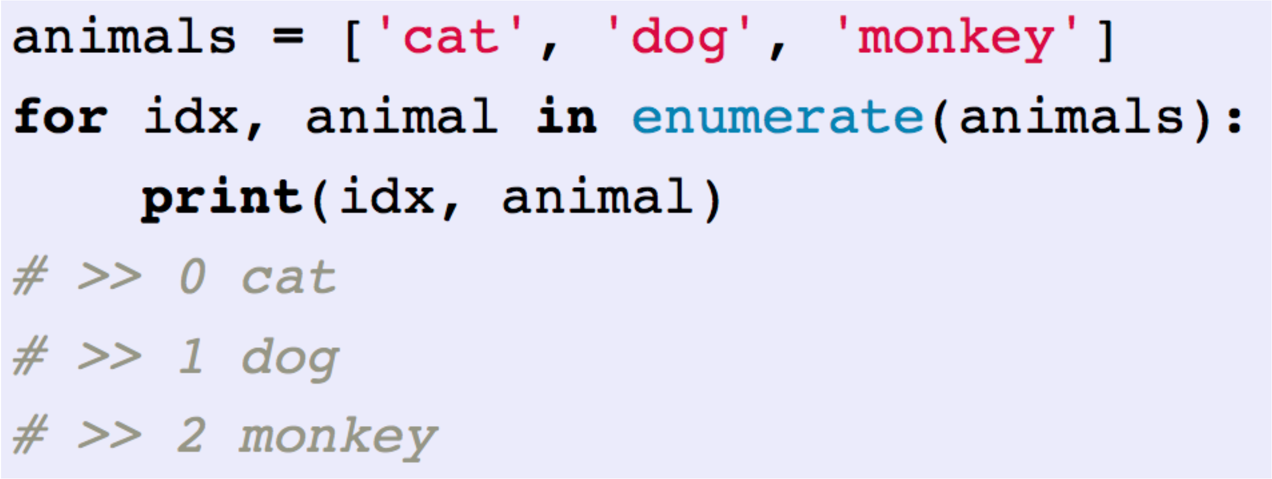
```
animals = ['cat', 'dog', 'monkey']
for animal in animals:
    print(animal)
# >> cat
# >> dog
# >> monkey
```

2)



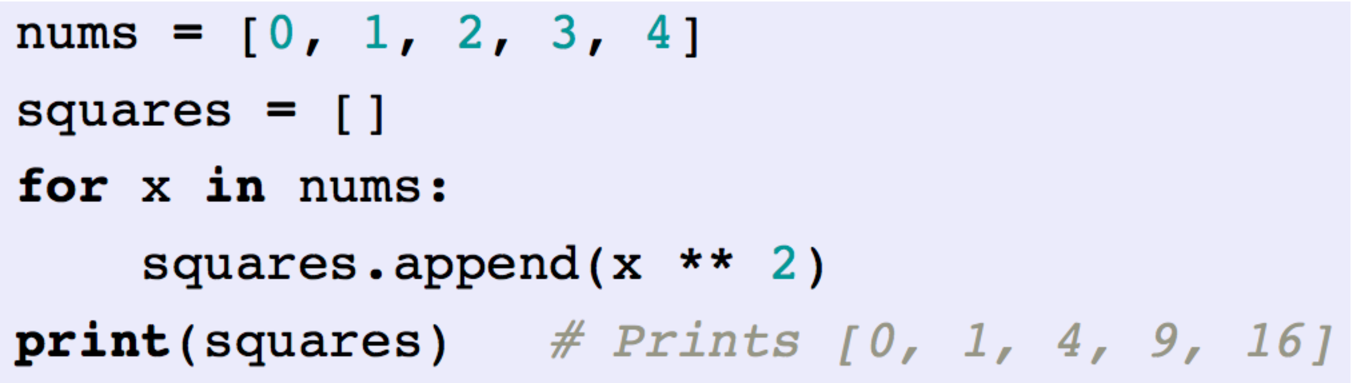
```
animals = ['cat', 'dog', 'monkey']
for idx in len(range(animals)):
    print(animals[idx])
# >> cat
# >> dog
# >> monkey
```

3)



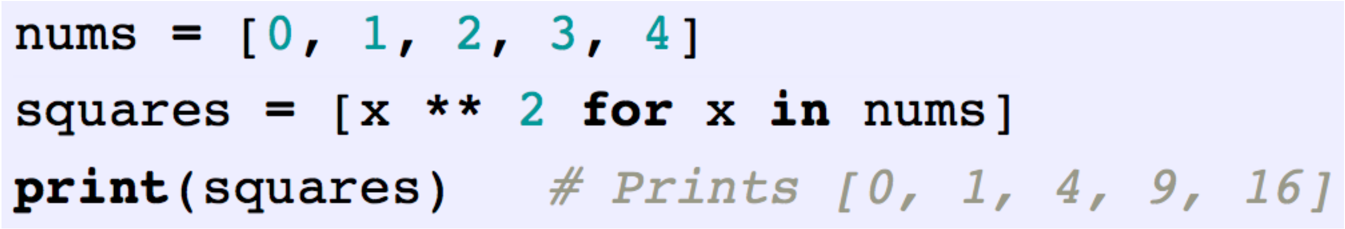
```
animals = ['cat', 'dog', 'monkey']
for idx, animal in enumerate(animals):
    print(idx, animal)
# >> 0 cat
# >> 1 dog
# >> 2 monkey
```

List comprehension



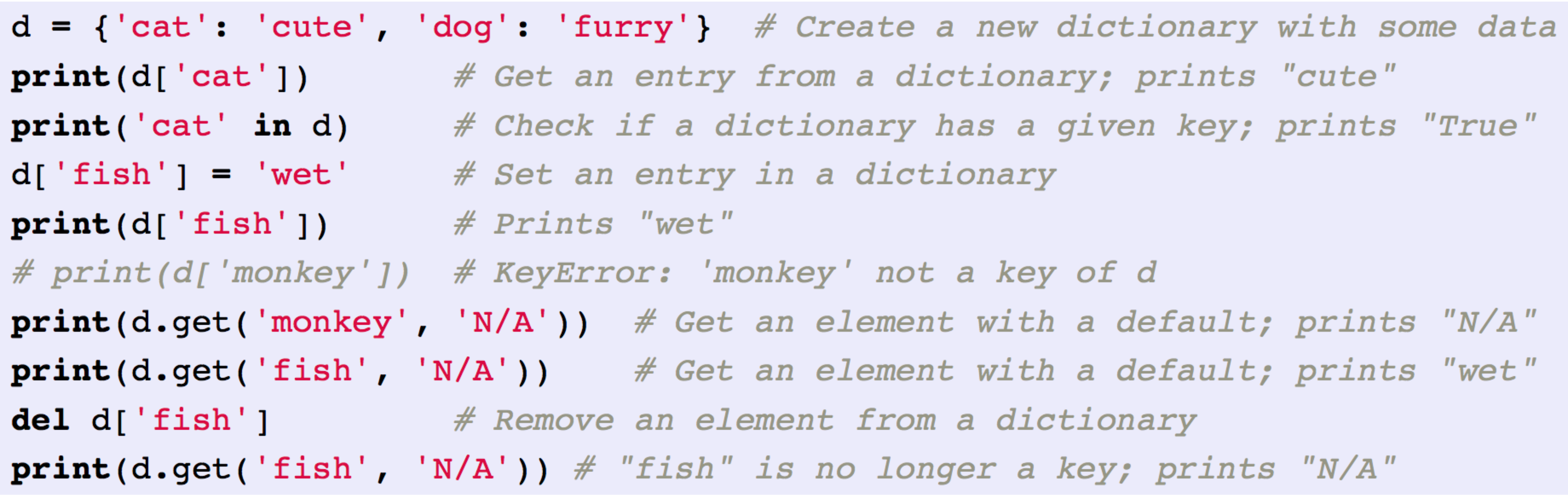
```
nums = [0, 1, 2, 3, 4]
squares = []
for x in nums:
    squares.append(x ** 2)
print(squares)   # Prints [0, 1, 4, 9, 16]
```

- equivalent syntax



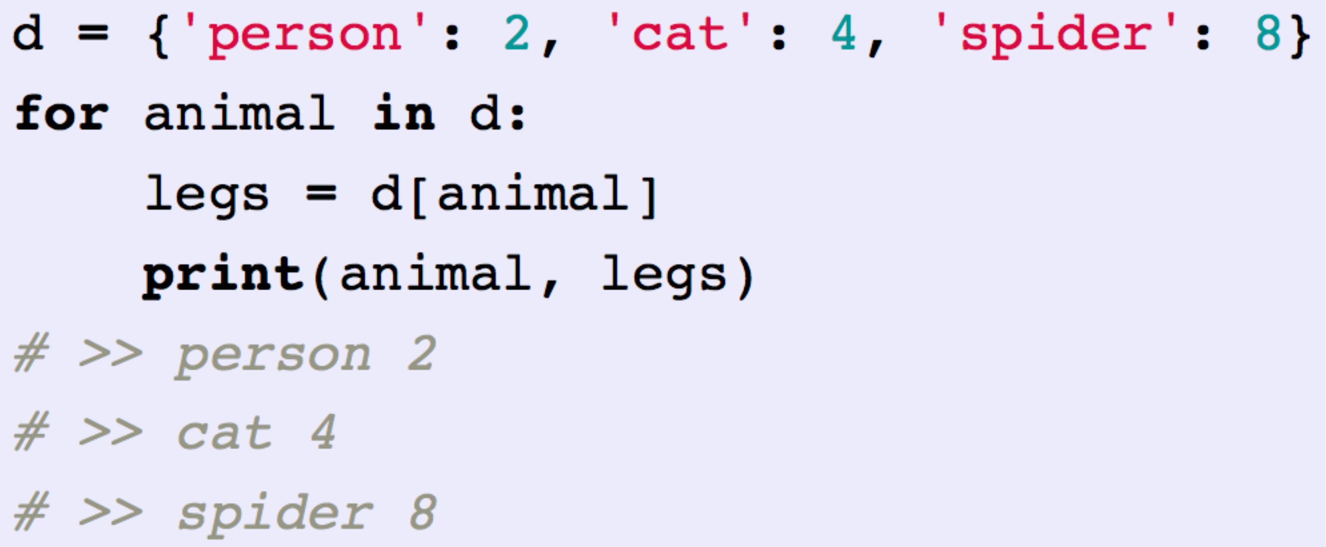
```
nums = [0, 1, 2, 3, 4]
squares = [x ** 2 for x in nums]
print(squares)   # Prints [0, 1, 4, 9, 16]
```

Dictionary



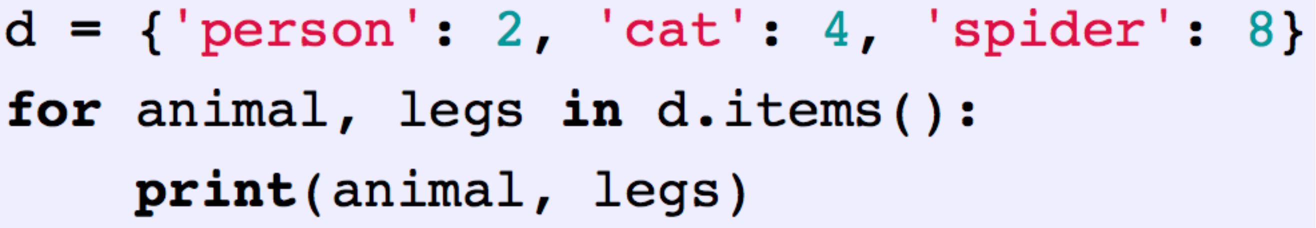
```python
d = {'cat': 'cute', 'dog': 'furry'}  # Create a new dictionary with some data
print(d['cat'])       # Get an entry from a dictionary; prints "cute"
print('cat' in d)     # Check if a dictionary has a given key; prints "True"
d['fish'] = 'wet'     # Set an entry in a dictionary
print(d['fish'])      # Prints "wet"
# print(d['monkey'])  # KeyError: 'monkey' not a key of d
print(d.get('monkey', 'N/A'))  # Get an element with a default; prints "N/A"
print(d.get('fish', 'N/A'))    # Get an element with a default; prints "wet"
del d['fish']         # Remove an element from a dictionary
print(d.get('fish', 'N/A')) # "fish" is no longer a key; prints "N/A"
```

Indexing the dict



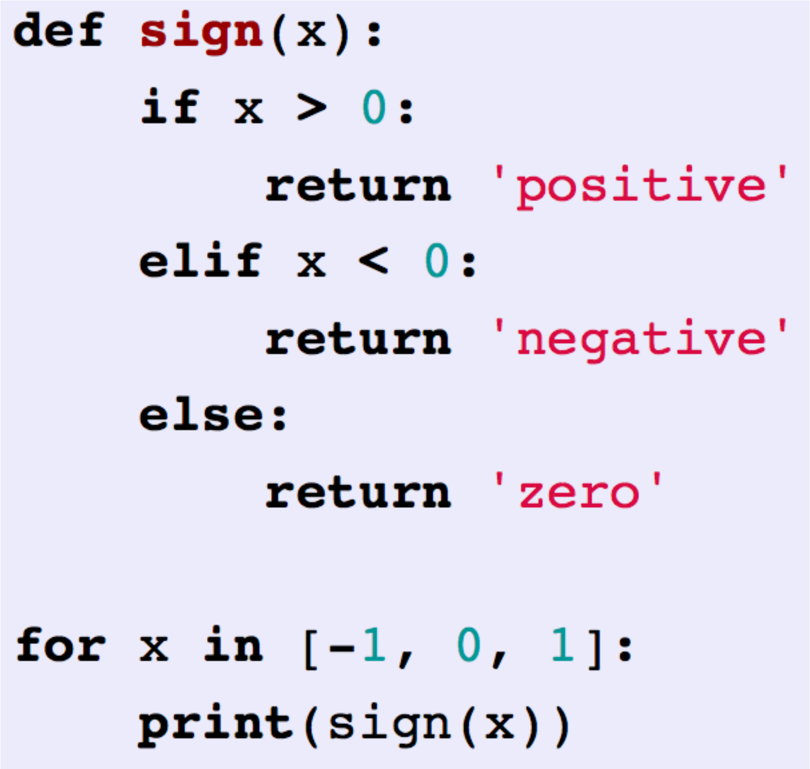
```
d = {'person': 2, 'cat': 4, 'spider': 8}
for animal in d:
    legs = d[animal]
    print(animal, legs)
# >> person 2
# >> cat 4
# >> spider 8
```

- or use .items()

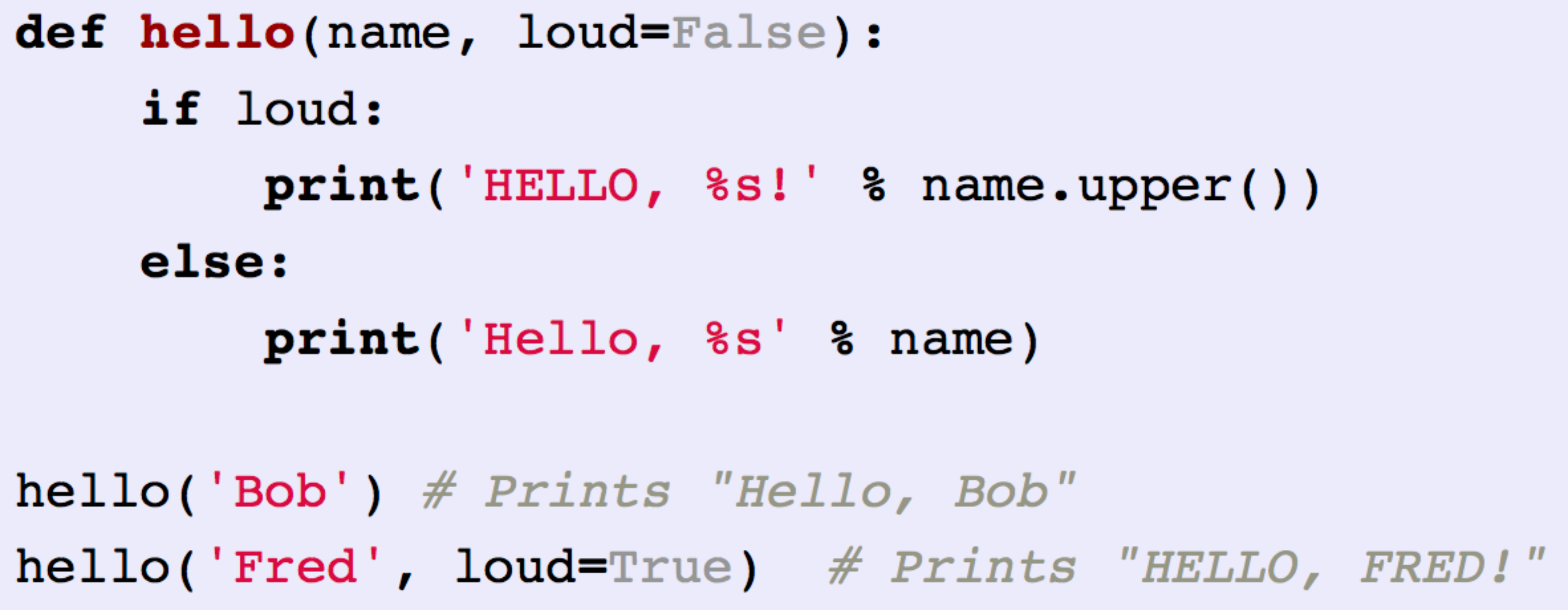


```
d = {'person': 2, 'cat': 4, 'spider': 8}
for animal, legs in d.items():
    print(animal, legs)
```

Functions

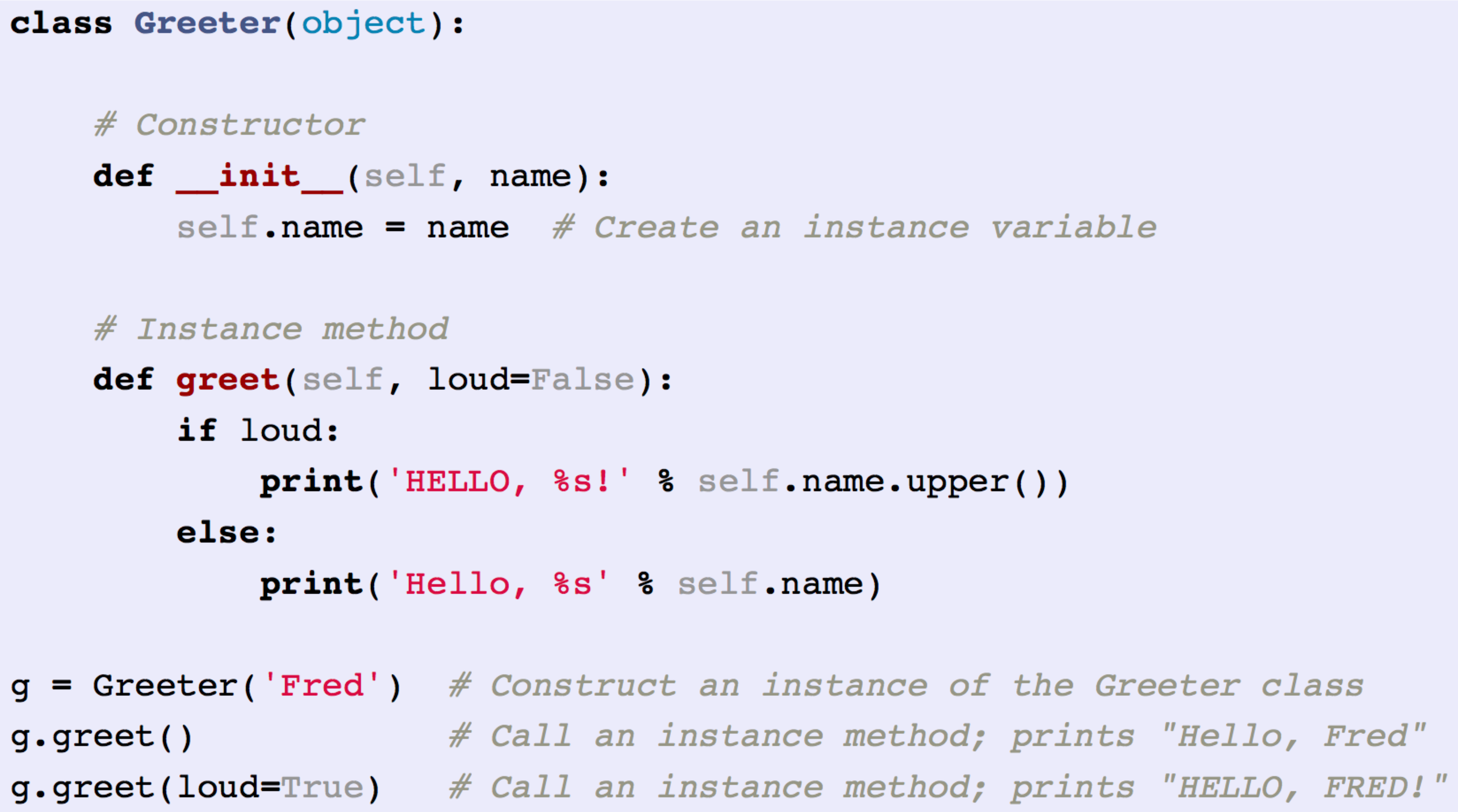


```python
def sign(x):
    if x > 0:
        return 'positive'
    elif x < 0:
        return 'negative'
    else:
        return 'zero'

for x in [-1, 0, 1]:
    print(sign(x))
```



```python
def hello(name, loud=False):
    if loud:
        print('HELLO, %s!' % name.upper())
    else:
        print('Hello, %s' % name)

hello('Bob') # Prints "Hello, Bob"
hello('Fred', loud=True)  # Prints "HELLO, FRED!"
```

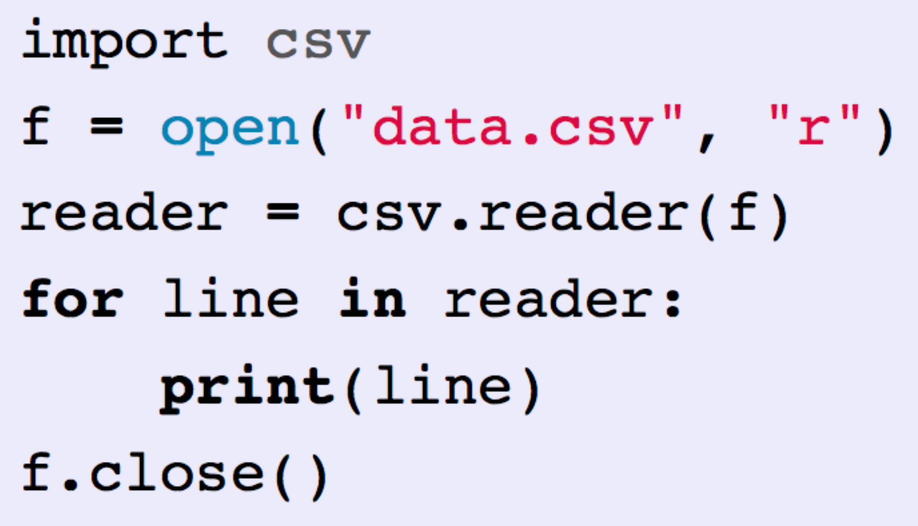
Classes



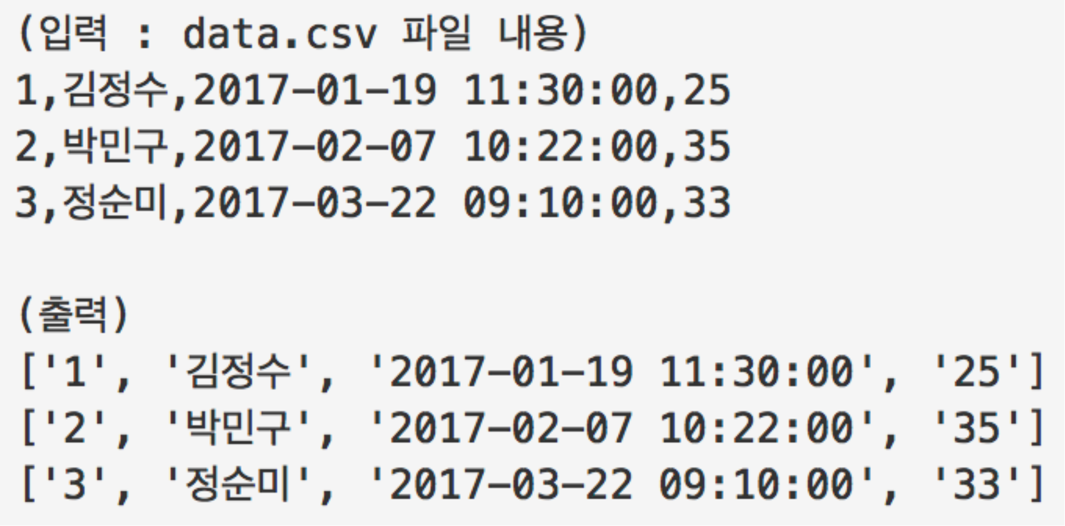
```
class Greeter(object):

    # Constructor
    def __init__(self, name):
        self.name = name  # Create an instance variable

    # Instance method
    def greet(self, loud=False):
        if loud:
            print('HELLO, %s!' % self.name.upper())
        else:
            print('Hello, %s' % self.name)

g = Greeter('Fred')  # Construct an instance of the Greeter class
g.greet()            # Call an instance method; prints "Hello, Fred"
g.greet(loud=True)   # Call an instance method; prints "HELLO, FRED!"
```

“With”

- Example: read CSV

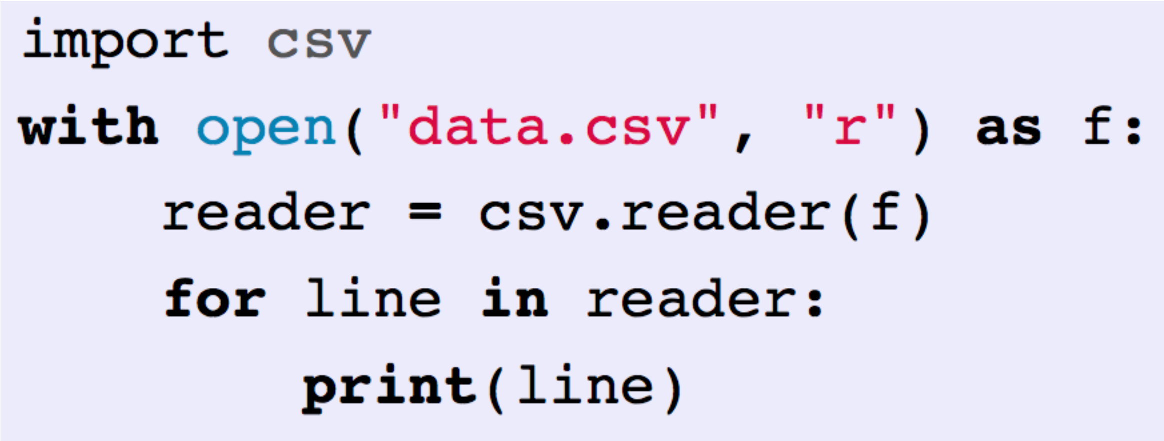


```
import csv
f = open("data.csv", "r")
reader = csv.reader(f)
for line in reader:
    print(line)
f.close()
```



```
(입력 : data.csv 파일 내용)
1,김정수,2017-01-19 11:30:00,25
2,박민구,2017-02-07 10:22:00,35
3,정순미,2017-03-22 09:10:00,33

(출력)
['1', '김정수', '2017-01-19 11:30:00', '25']
['2', '박민구', '2017-02-07 10:22:00', '35']
['3', '정순미', '2017-03-22 09:10:00', '33']
```

- with scope 밖으로 나가면 자동적으로 close



```
import csv
with open("data.csv", "r") as f:
    reader = csv.reader(f)
    for line in reader:
        print(line)
```

Further reading

- 점프투파이썬 https://wikidocs.net/book/1

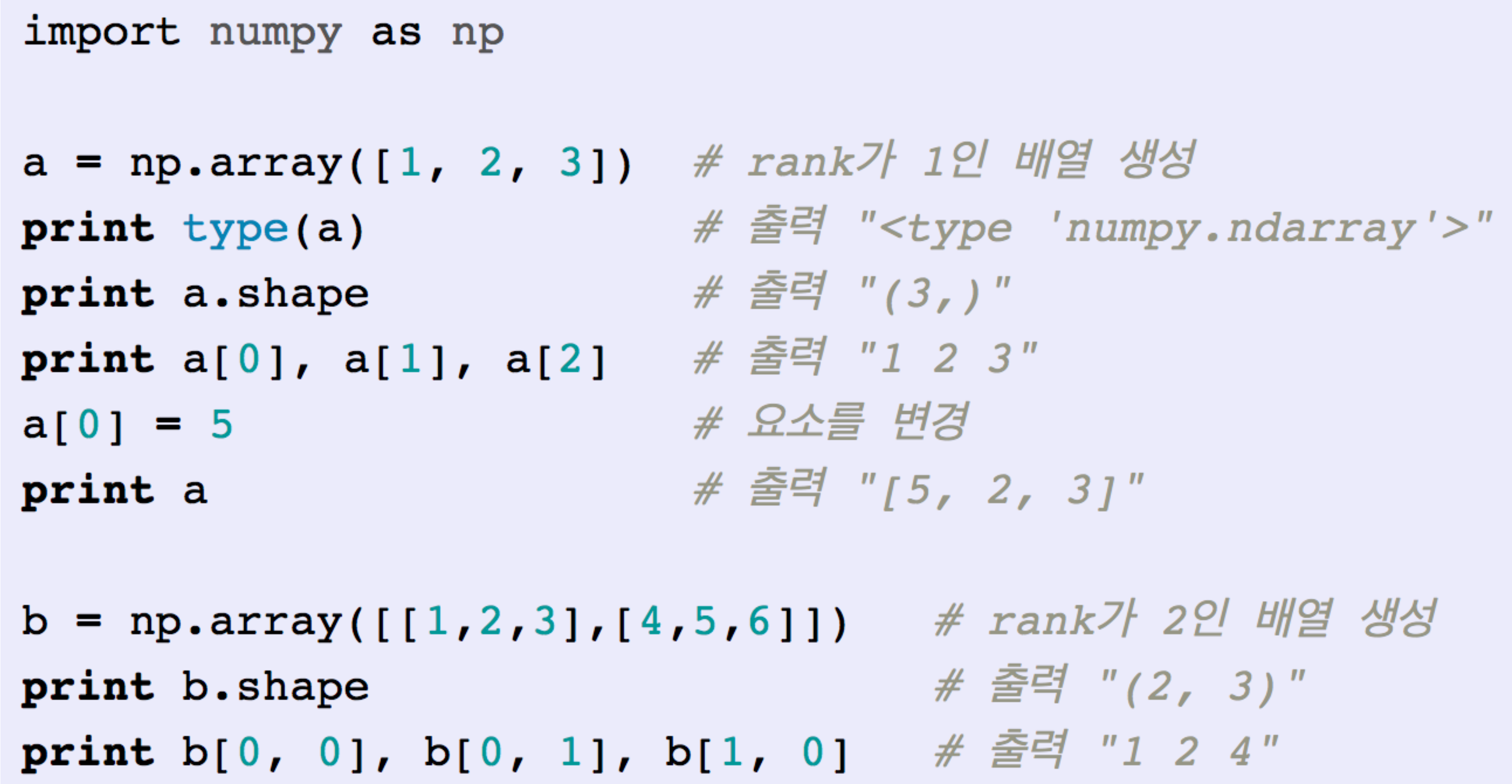
Python packages

- To download and install packages..
  1. Install pip (https://www.makeuseof.com/tag/install-pip-for-python/)
  2. (optional) Install virtualenv (https://beomi.github.io/2016/12/28/HowToSetup-Virtualenv-VirtualenvWrapper/)
  3. pip install <package_name>

- In our class;
- >> pip install numpy scipy matplotlib scikit-learn

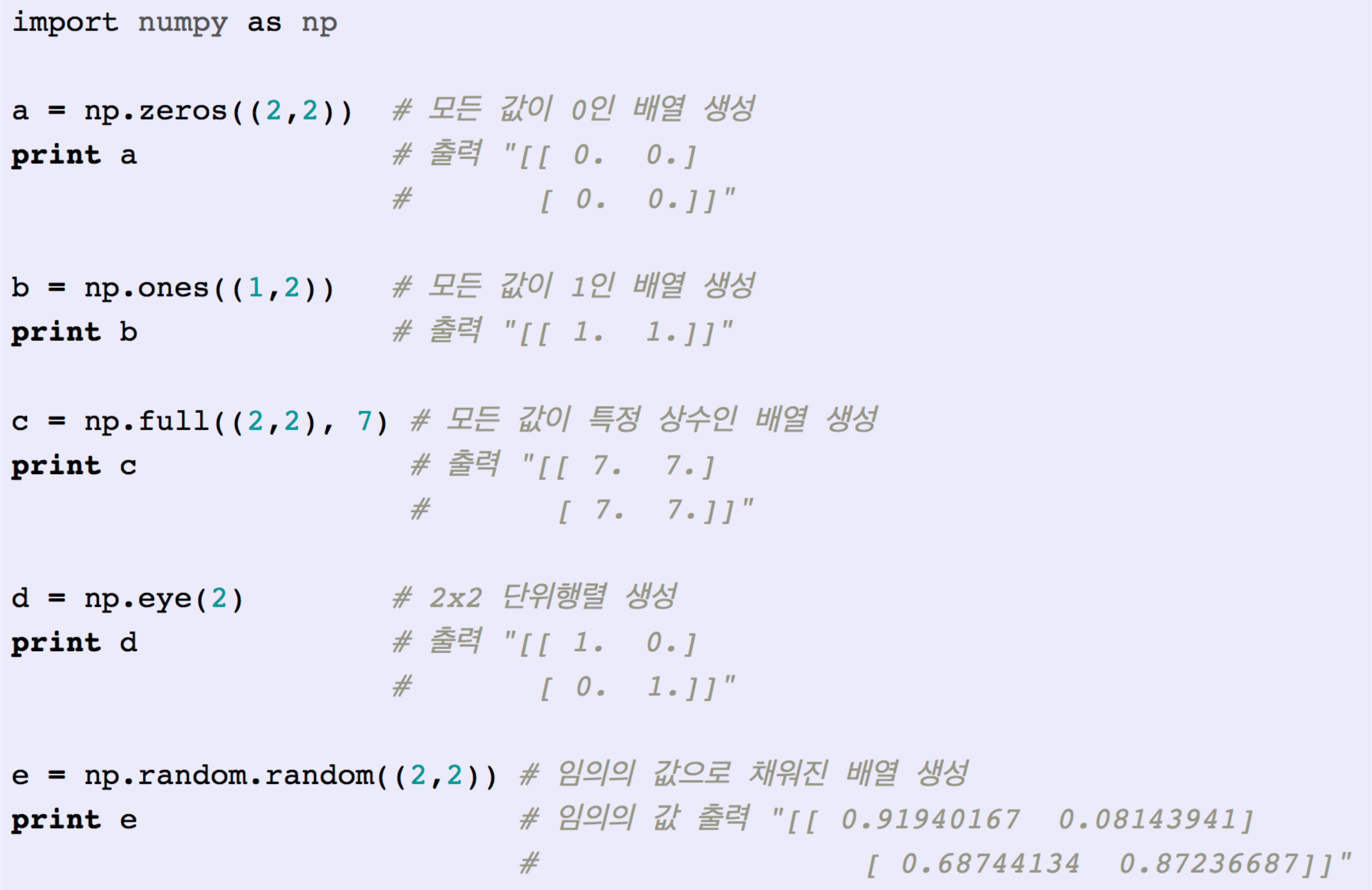
Numpy

- Core package for scientific computing



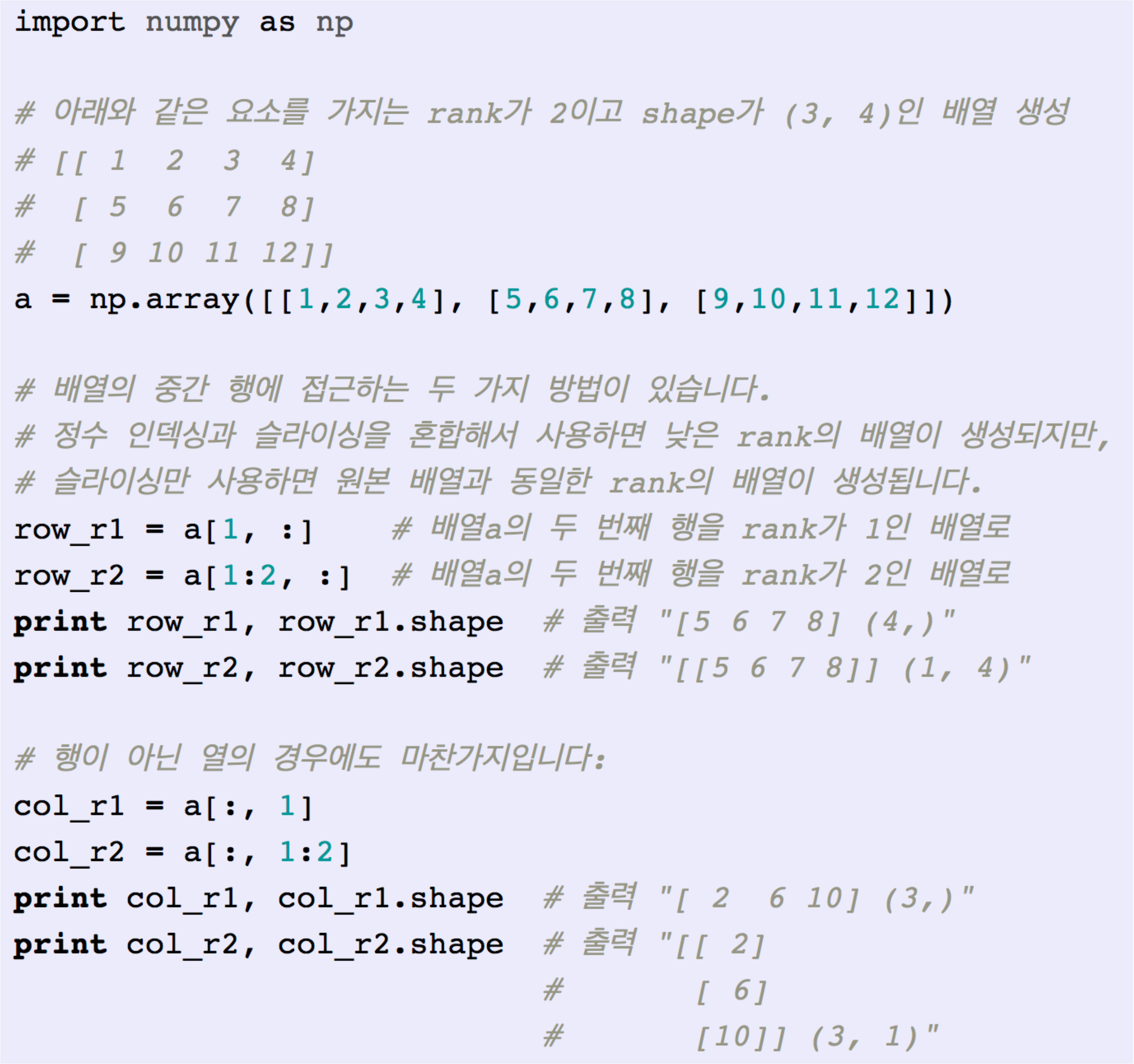
```
import numpy as np

a = np.array([1, 2, 3])  # rank가 1인 배열 생성
print type(a)            # 출력 "<type 'numpy.ndarray'>"
print a.shape            # 출력 "(3,)"
print a[0], a[1], a[2]   # 출력 "1 2 3"
a[0] = 5                 # 요소를 변경
print a                  # 출력 "[5, 2, 3]"

b = np.array([[1,2,3],[4,5,6]])    # rank가 2인 배열 생성
print b.shape                      # 출력 "(2, 3)"
print b[0, 0], b[0, 1], b[1, 0]    # 출력 "1 2 4"
```

Numpy - Create an array



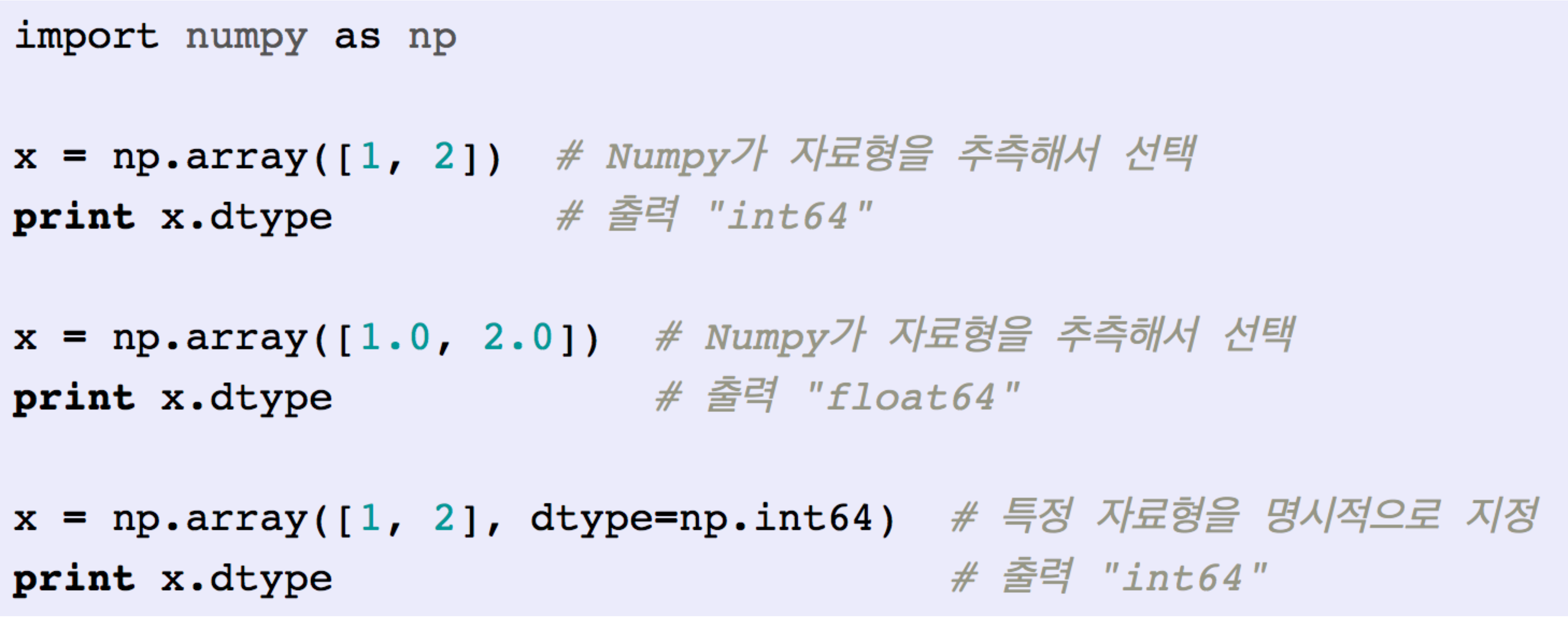
```
import numpy as np

a = np.zeros((2,2))  # 모든 값이 0인 배열 생성
print a              # 출력 "[[ 0.   0.]
                     #       [ 0.   0.]]"

b = np.ones((1,2))   # 모든 값이 1인 배열 생성
print b              # 출력 "[[ 1.   1.]]"

c = np.full((2,2), 7) # 모든 값이 특정 상수인 배열 생성
print c               # 출력 "[[ 7.   7.]
                      #       [ 7.   7.]]"

d = np.eye(2)        # 2x2 단위행렬 생성
print d              # 출력 "[[ 1.   0.]
                     #       [ 0.   1.]]"

e = np.random.random((2,2)) # 임의의 값으로 채워진 배열 생성
print e                     # 임의의 값 출력 "[[ 0.91940167   0.08143941]
                            #                  [ 0.68744134   0.87236687]]"
```

Numpy - Indexing and slicing



```
import numpy as np

# 아래와 같은 요소를 가지는 rank가 2이고 shape가 (3, 4)인 배열 생성
# [[ 1  2  3  4]
#  [ 5  6  7  8]
#  [ 9 10 11 12]]
a = np.array([[1,2,3,4], [5,6,7,8], [9,10,11,12]])

# 배열의 중간 행에 접근하는 두 가지 방법이 있습니다.
# 정수 인덱싱과 슬라이싱을 혼합해서 사용하면 낮은 rank의 배열이 생성되지만,
# 슬라이싱만 사용하면 원본 배열과 동일한 rank의 배열이 생성됩니다.
row_r1 = a[1, :]    # 배열a의 두 번째 행을 rank가 1인 배열로
row_r2 = a[1:2, :]  # 배열a의 두 번째 행을 rank가 2인 배열로
print row_r1, row_r1.shape  # 출력 "[5 6 7 8] (4,)"
print row_r2, row_r2.shape  # 출력 "[[5 6 7 8]] (1, 4)"

# 행이 아닌 열의 경우에도 마찬가지입니다:
col_r1 = a[:, 1]
col_r2 = a[:, 1:2]
print col_r1, col_r1.shape  # 출력 "[ 2  6 10] (3,)"
print col_r2, col_r2.shape  # 출력 "[[ 2]
                            #          [ 6]
                            #          [10]] (3, 1)"
```

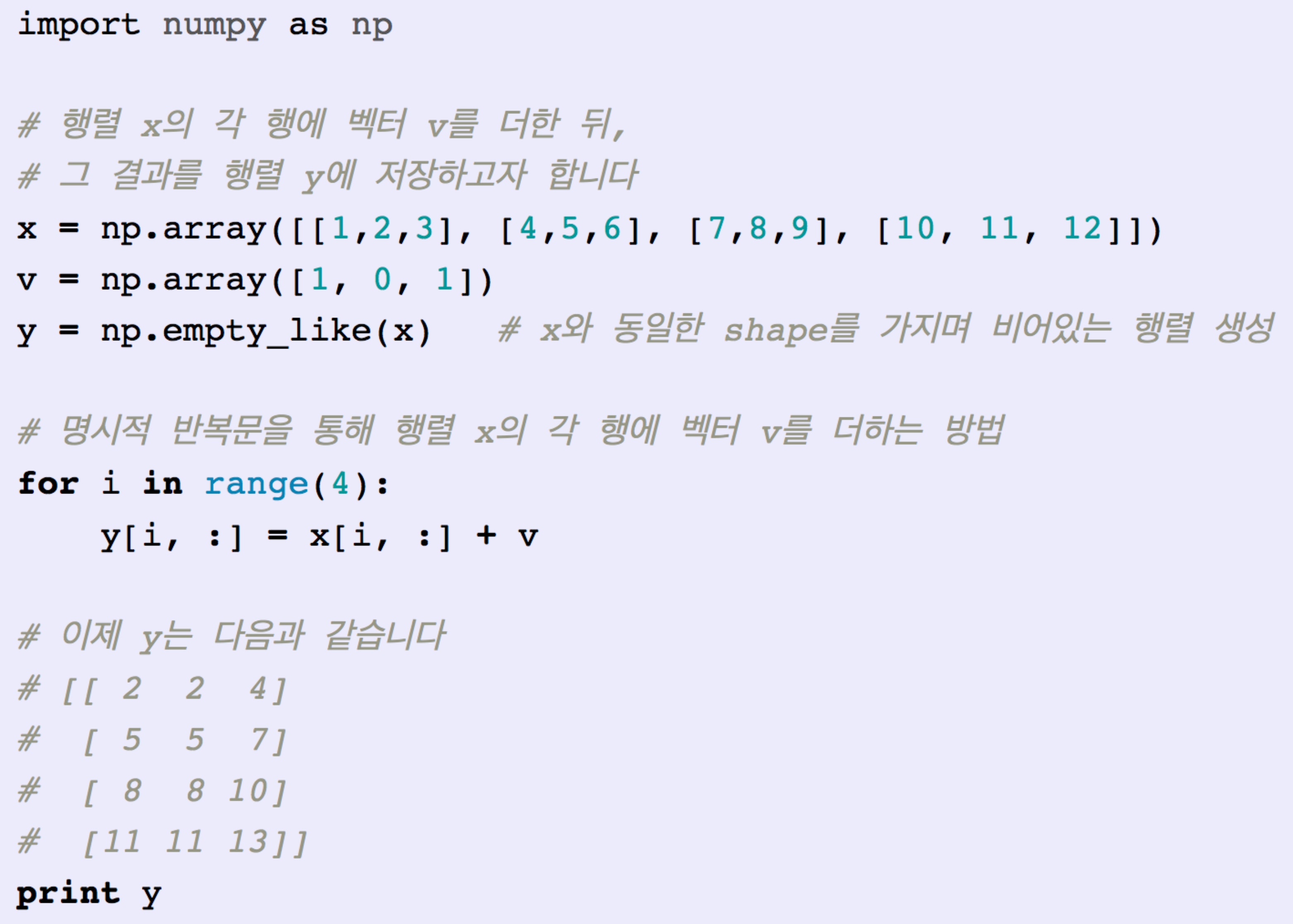
Numpy - Data type



```
import numpy as np

x = np.array([1, 2])  # Numpy가 자료형을 추측해서 선택
print x.dtype         # 출력 "int64"

x = np.array([1.0, 2.0])  # Numpy가 자료형을 추측해서 선택
print x.dtype             # 출력 "float64"

x = np.array([1, 2], dtype=np.int64)  # 특정 자료형을 명시적으로 지정
print x.dtype                         # 출력 "int64"
```

Numpy - Braodcasting

- 다른 shape를 가지는 행렬끼리 연산
  - 이해하기 어렵지만 알고나면 효과적

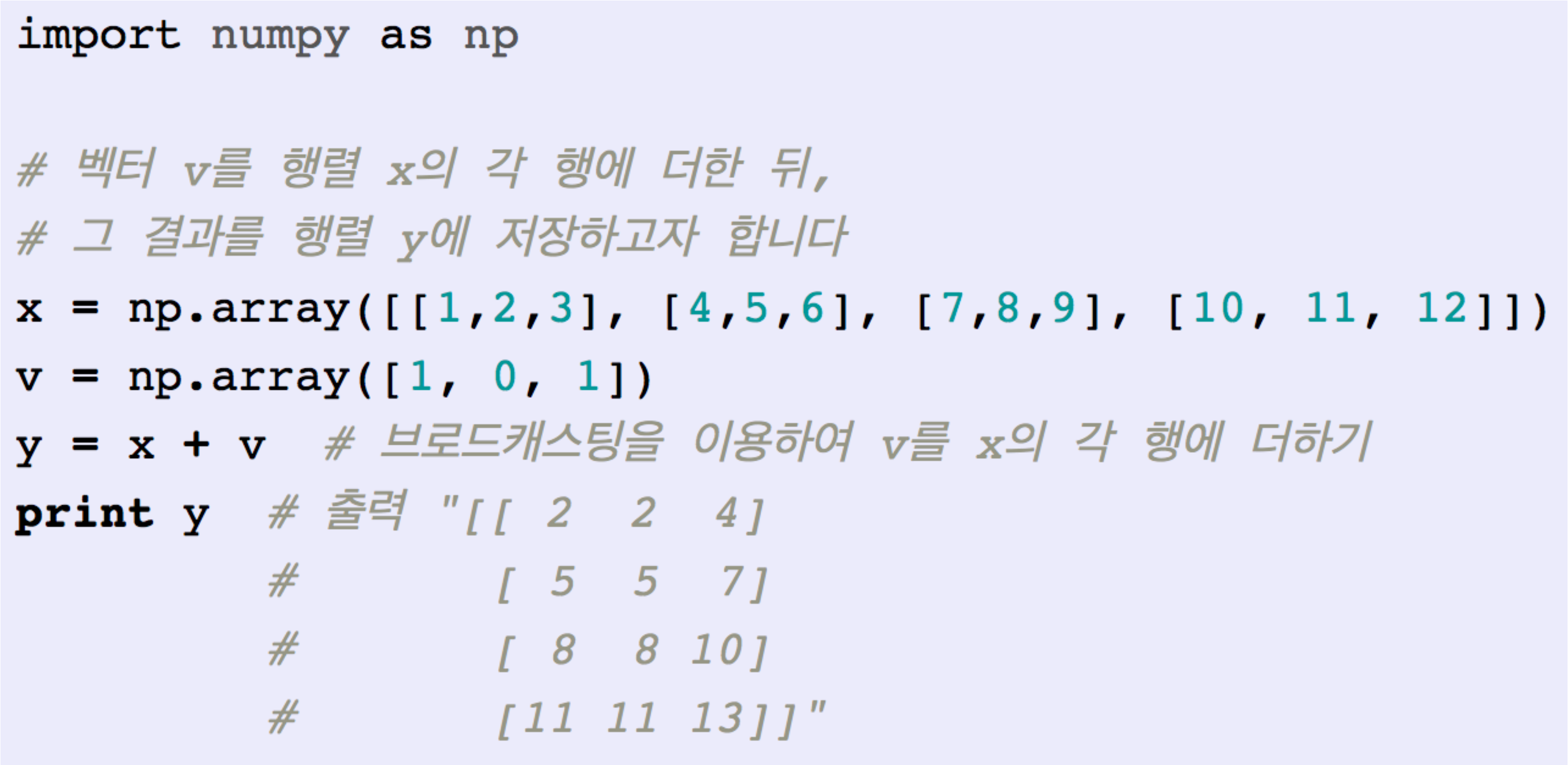


```
import numpy as np

# 행렬 x의 각 행에 벡터 v를 더한 뒤,
# 그 결과를 행렬 y에 저장하고자 합니다
x = np.array([[1,2,3], [4,5,6], [7,8,9], [10, 11, 12]])
v = np.array([1, 0, 1])
y = np.empty_like(x)   # x와 동일한 shape를 가지며 비어있는 행렬 생성

# 명시적 반복문을 통해 행렬 x의 각 행에 벡터 v를 더하는 방법
for i in range(4):
    y[i, :] = x[i, :] + v

# 이제 y는 다음과 같습니다
# [[ 2  2  4]
#  [ 5  5  7]
#  [ 8  8 10]
#  [11 11 13]]
print y
```

반복문을 통해 행렬 연산
(매우 느림)

Numpy - Braodcasting

- 다른 shape를 가지는 행렬끼리 연산
  - 이해하기 어렵지만 알고나면 효과적

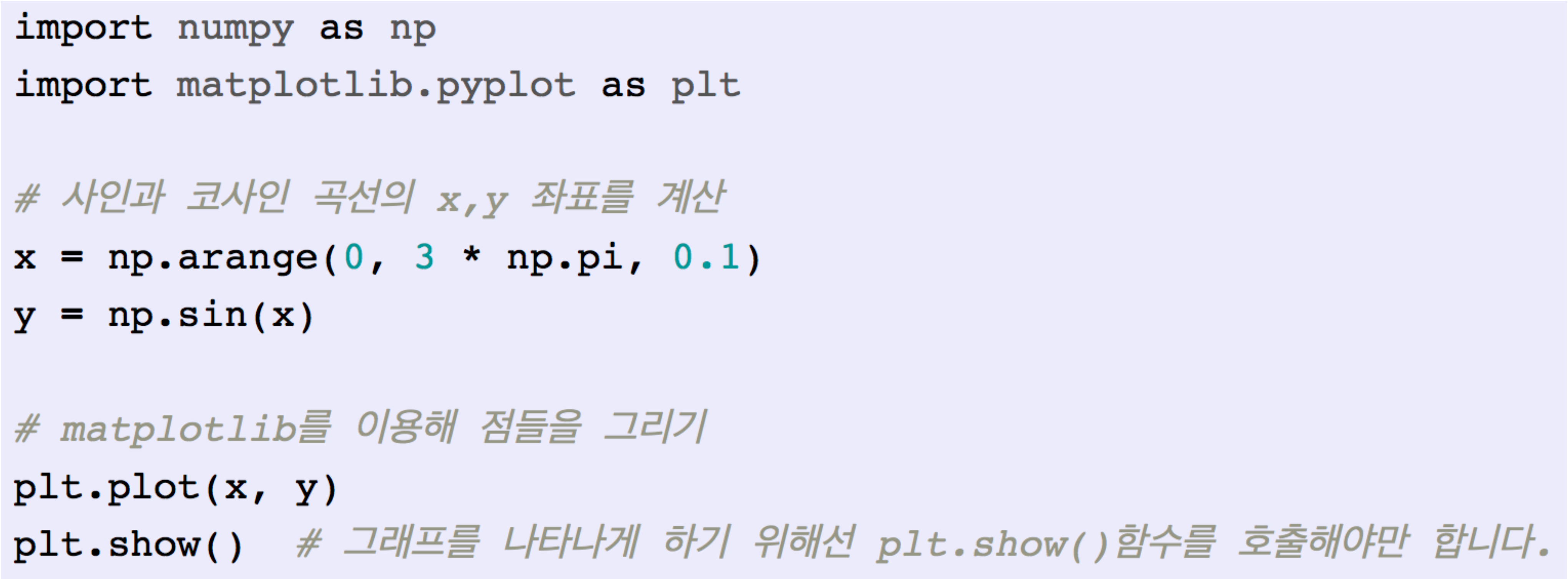


```
import numpy as np

# 벡터 v를 행렬 x의 각 행에 더한 뒤,
# 그 결과를 행렬 y에 저장하고자 합니다
x = np.array([[1,2,3], [4,5,6], [7,8,9], [10, 11, 12]])
v = np.array([1, 0, 1])
y = x + v  # 브로드캐스팅을 이용하여 v를 x의 각 행에 더하기
print y  # 출력 "[[ 2  2  4]
         #          [ 5  5  7]
         #          [ 8  8 10]
         #          [11 11 13]]"
```

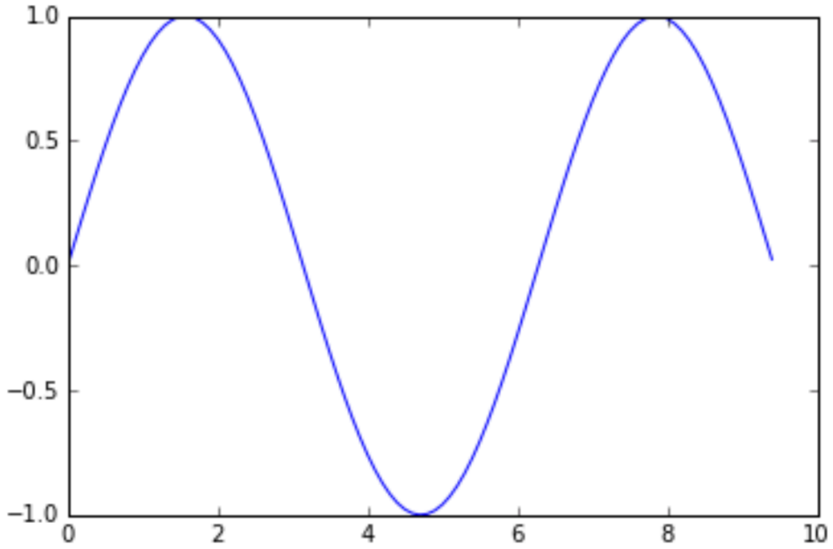
브로드캐스팅을 사용한 코드

Matplotlib

- plotting 라이브러리



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

# 사인과 코사인 곡선의 x,y 좌표를 계산
x = np.arange(0, 3 * np.pi, 0.1)
y = np.sin(x)

# matplotlib를 이용해 점들을 그리기
plt.plot(x, y)
plt.show()  # 그래프를 나타나게 하기 위해선 plt.show()함수를 호출해야만 합니다.
```



Jupyter notebook

- web에서 interactive 하게 파이썬 코딩
  - 장점: visual coding
  - 단점: 구조적으로 “잘 짜기” 어려움
  - >> pip install jupyter (설치)
  - >> jupyter notebook (실행)

  - 참고:
    - http://aikorea.org/cs231n/ipython-tutorial/
    - https://dojang.io/mod/page/view.php?id=1157

Scikit-learn

- Python package for machine learning

- Basic flow:
  1. 데이터 로드 (파일 읽기 -> numpy나 pandas 타입으로 변환)
  2. 데이터 전처리, EDA
  3. 모델 생성 및 학습
  4. 모델 평가

데이터 로드 & EDA

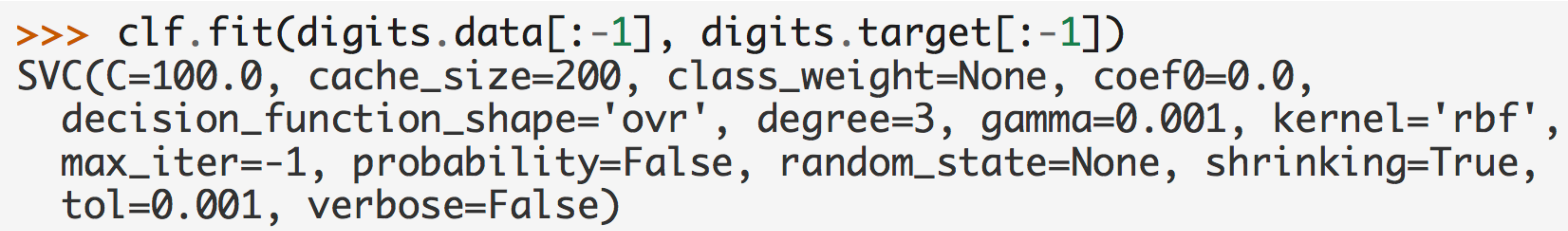
- (과제에서) 주로 CSV 파일
  1. CSV 읽기 (python tutorial 참고)
  2. List에 넣기 (append 사용)
  3. List 타입 -> numpy 타입

- EDA
  - matplotlib 등으로 feature plotting
  - 통계량, correlation 등 출력

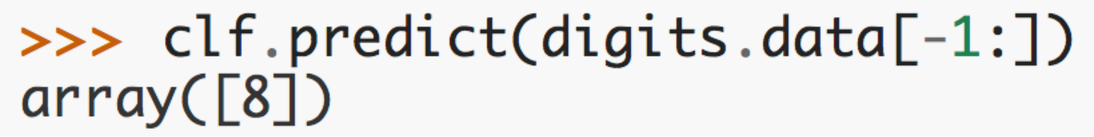
모델 생성 및 학습

- 모델 생성 (SVM)
  - >> from sklearn import svm
  - >> model = svm.SVC(gamma=0.001, C=100.)

- 모델 클래스의 methods
  - fit(X, y): 입력 X와 라벨 y를 통해 해당 모델 학습
  - predict(T): 입력 T에 해당하는 예측값 리턴

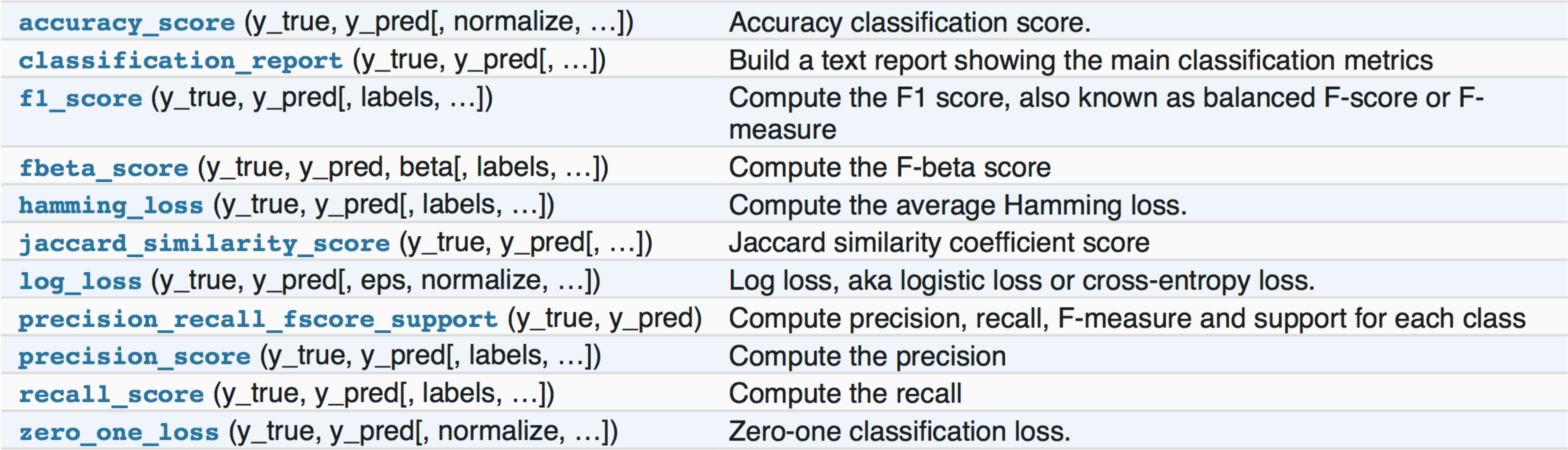


```
>>> clf.fit(digits.data[:-1], digits.target[:-1])
SVC(C=100.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.001, kernel='rbf',
  max_iter=-1, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
```

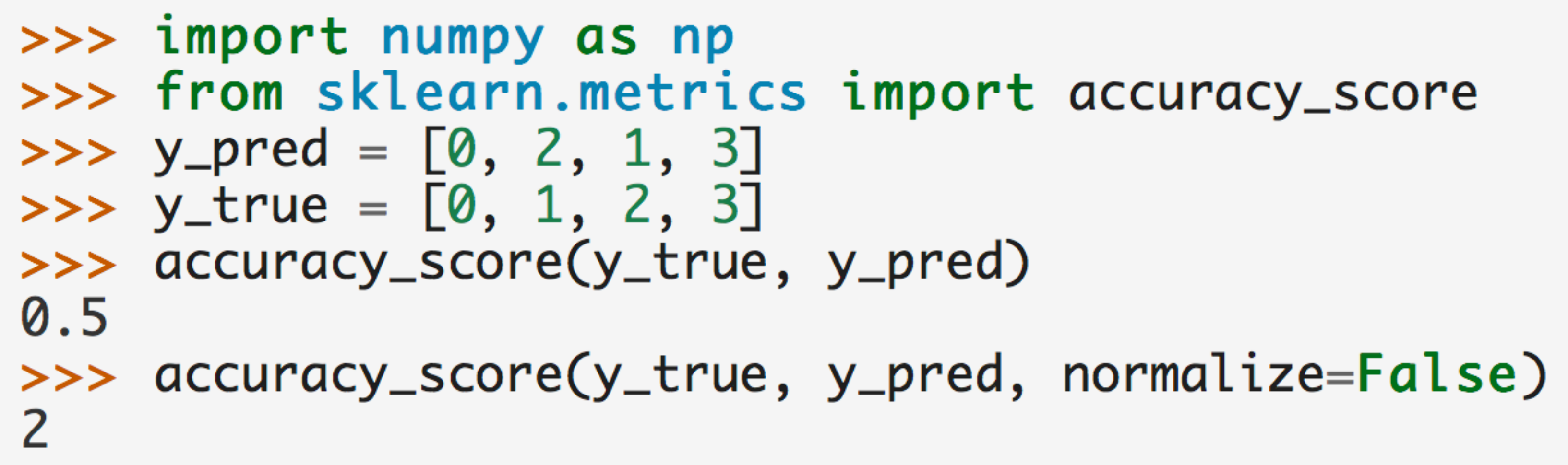


```
>>> clf.predict(digits.data[-1:])
array([8])
```

모델 평가



accuracy_score (y_true, y_pred[, normalize, …])	Accuracy classification score.
classification_report (y_true, y_pred[, …])	Build a text report showing the main classification metrics
f1_score (y_true, y_pred[, labels, …])	Compute the F1 score, also known as balanced F-score or F-measure
fbeta_score (y_true, y_pred, beta[, labels, …])	Compute the F-beta score
hamming_loss (y_true, y_pred[, labels, …])	Compute the average Hamming loss.
jaccard_similarity_score (y_true, y_pred[, …])	Jaccard similarity coefficient score
log_loss (y_true, y_pred[, eps, normalize, …])	Log loss, aka logistic loss or cross-entropy loss.
precision_recall_fscore_support (y_true, y_pred)	Compute precision, recall, F-measure and support for each class
precision_score (y_true, y_pred[, labels, …])	Compute the precision
recall_score (y_true, y_pred[, labels, …])	Compute the recall
zero_one_loss (y_true, y_pred[, normalize, …])	Zero-one classification loss.

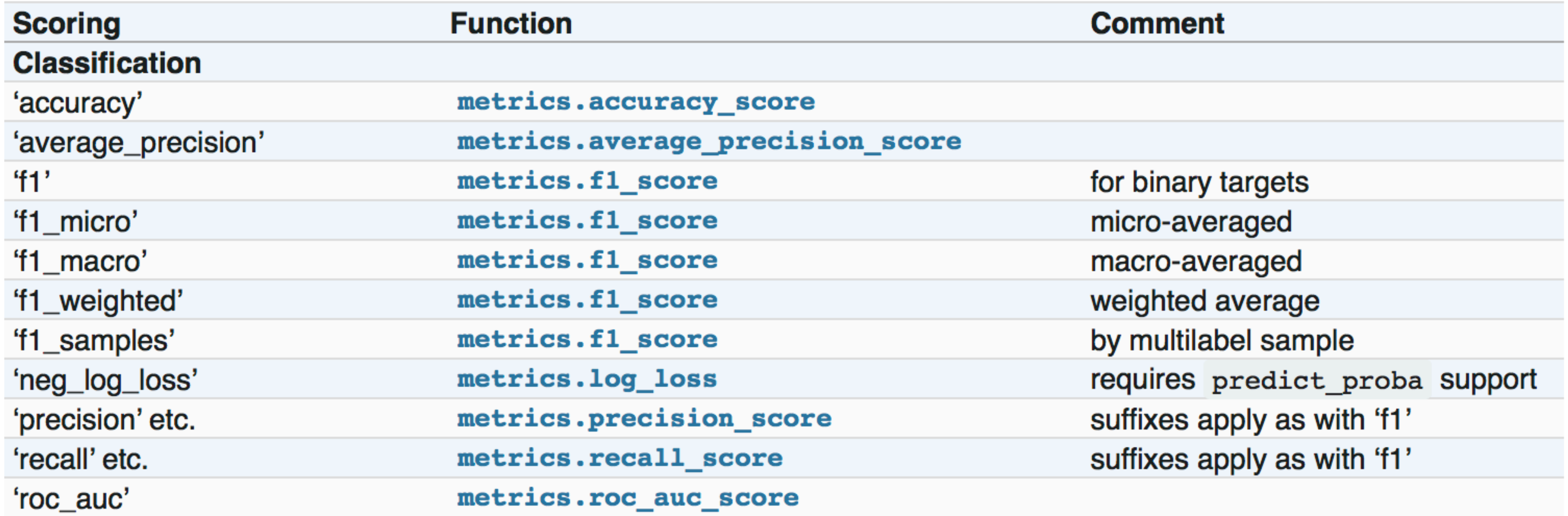


```
>>> import numpy as np
>>> from sklearn.metrics import accuracy_score
>>> y_pred = [0, 2, 1, 3]
>>> y_true = [0, 1, 2, 3]
>>> accuracy_score(y_true, y_pred)
0.5
>>> accuracy_score(y_true, y_pred, normalize=False)
2
```

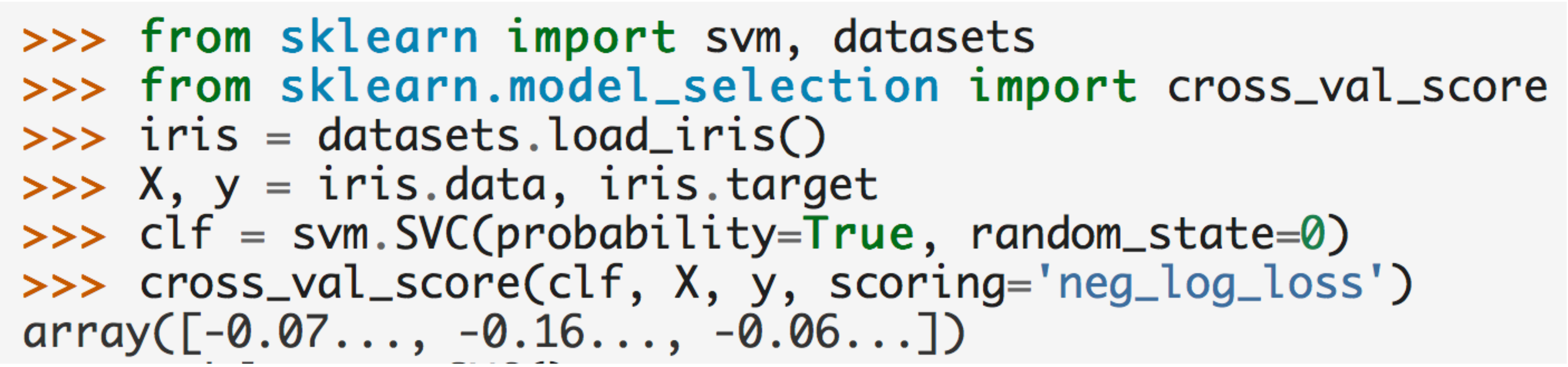
http://scikit-learn.org/stable/modules/model_evaluation.html

모델 평가

- Cross-validation을 사용할 경우 (아래 예제 참고)



Scoring	Function	Comment
Classification		
‘accuracy’	`metrics.accuracy_score`	
‘average_precision’	`metrics.average_precision_score`	
‘f1’	`metrics.f1_score`	for binary targets
‘f1_micro’	`metrics.f1_score`	micro-averaged
‘f1_macro’	`metrics.f1_score`	macro-averaged
‘f1_weighted’	`metrics.f1_score`	weighted average
‘f1_samples’	`metrics.f1_score`	by multilabel sample
‘neg_log_loss’	`metrics.log_loss`	requires `predict_proba` support
‘precision’ etc.	`metrics.precision_score`	suffixes apply as with ‘f1’
‘recall’ etc.	`metrics.recall_score`	suffixes apply as with ‘f1’
‘roc_auc’	`metrics.roc_auc_score`	



```
>>> from sklearn import svm, datasets
>>> from sklearn.model_selection import cross_val_score
>>> iris = datasets.load_iris()
>>> X, y = iris.data, iris.target
>>> clf = svm.SVC(probability=True, random_state=0)
>>> cross_val_score(clf, X, y, scoring='neg_log_loss')
array([-0.07..., -0.16..., -0.06...])
```

cross-validation을 사용해서 모델 평가

Further readings

- cs231n http://cs231n.github.io/python-numpy-tutorial/
- 혹은 한글 번역본 http://aikorea.org/cs231n/python-numpy-tutorial/

- scikit-learn 튜토리얼 http://scikit-learn.org/stable/tutorial/basic/tutorial.html
- scikit-learn 예제 http://scikit-learn.org/stable/auto_examples/index.html