

Python Numpy

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- Numpy is the core library for scientific computing in python
- High-performance multi-dimensional array object and tools for working with these arrays
- Familiar with MATLAB??

- A numpy array is a grid of values, all of the same type
- indexed by a tuple of nonnegative integers
- number of dimensions is the rank of the array
- the *shape* of an array is a tuple of integers giving the size of the array along each dimension.

```
import numpy as np

a = np.array([1, 2, 3])      # Create a rank 1 array
print(type(a))             # Prints "<class 'numpy.ndarray'>"
print(a.shape)             # Prints "(3,)"
print(a[0], a[1], a[2])    # Prints "1 2 3"
a[0] = 5                   # Change an element of the array
print(a)                   # Prints "[5, 2, 3]"

b = np.array([[1,2,3],[4,5,6]]) # Create a rank 2 array
print(b.shape)             # Prints "(2, 3)"
print(b[0, 0], b[0, 1], b[1, 0]) # Prints "1 2 4"
```

```
import numpy as np

a = np.zeros((2,2))      # Create an array of all zeros
print(a)                # Prints "[[ 0.  0.]
                        #           [ 0.  0.]]"

b = np.ones((1,2))     # Create an array of all ones
print(b)                # Prints "[[ 1.  1.]]"

c = np.full((2,2), 7)  # Create a constant array
print(c)                # Prints "[[ 7.  7.]
                        #           [ 7.  7.]]"

d = np.eye(2)          # Create a 2x2 identity matrix
print(d)                # Prints "[[ 1.  0.]
                        #           [ 0.  1.]]"

e = np.random.random((2,2)) # Create an array filled with random values
print(e)                # Might print "[[ 0.91940167  0.08143941]
                        #           [ 0.68744134  0.87236687]]"
```

```
import numpy as np

# Create the following rank 2 array with shape (3, 4)
# [[ 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]])

# Use slicing to pull out the subarray consisting of the first 2 rows
# and columns 1 and 2; b is the following array of shape (2, 2):
# [[2 3]
#  [6 7]]
b = a[:2, 1:3]

# A slice of an array is a view into the same data, so modifying it
# will modify the original array.
print(a[0, 1])    # Prints "2"
b[0, 0] = 77     # b[0, 0] is the same piece of data as a[0, 1]
print(a[0, 1])    # Prints "77"
```

```
# Two ways of accessing the data in the middle row of the array.
# Mixing integer indexing with slices yields an array of lower rank,
# while using only slices yields an array of the same rank as the
# original array:
row_r1 = a[1, :]      # Rank 1 view of the second row of a
row_r2 = a[1:2, :]   # Rank 2 view of the second row of a
print(row_r1, row_r1.shape)  # Prints "[5 6 7 8] (4,)"
print(row_r2, row_r2.shape)  # Prints "[[5 6 7 8]] (1, 4)"

# We can make the same distinction when accessing columns of an array:
col_r1 = a[:, 1]
col_r2 = a[:, 1:2]
print(col_r1, col_r1.shape)  # Prints "[ 2  6 10] (3,)"
print(col_r2, col_r2.shape)  # Prints "[[ 2]
                              #          [ 6]
                              #          [10]] (3, 1)"
```

```
import numpy as np

a = np.array([[1,2], [3, 4], [5, 6]])

# An example of integer array indexing.
# The returned array will have shape (3,) and
print(a[[0, 1, 2], [0, 1, 0]]) # Prints "[1 4 5]"

# The above example of integer array indexing is equivalent to this:
print(np.array([a[0, 0], a[1, 1], a[2, 0]])) # Prints "[1 4 5]"

# When using integer array indexing, you can reuse the same
# element from the source array:
print(a[[0, 0], [1, 1]]) # Prints "[2 2]"

# Equivalent to the previous integer array indexing example
print(np.array([a[0, 1], a[0, 1]])) # Prints "[2 2]"
```



```
import numpy as np
# Create a new array from which we will select elements
a = np.array([[1,2,3], [4,5,6], [7,8,9], [10, 11, 12]])

print(a) # prints "array([[ 1,  2,  3],
#           [ 4,  5,  6],
#           [ 7,  8,  9],
#           [10, 11, 12]])"

# Create an array of indices
b = np.array([0, 2, 0, 1])
# Select one element from each row of a using the indices in b
print(a[np.arange(4), b]) # Prints "[ 1  6  7 11]"
# Mutate one element from each row of a using the indices in b
a[np.arange(4), b] += 10

print(a) # prints "array([[11,  2,  3],
#           [ 4,  5, 16],
#           [17,  8,  9],
#           [10, 21, 12]])"
```

```
import numpy as np

a = np.array([[1,2], [3, 4], [5, 6]])

bool_idx = (a > 2)    # Find the elements of a that are bigger than 2;
                      # this returns a numpy array of Booleans of the same
                      # shape as a, where each slot of bool_idx tells
                      # whether that element of a is > 2.

print(bool_idx)      # Prints "[[False False]
                    #           [ True  True]
                    #           [ True  True]]"

# We use boolean array indexing to construct a rank 1 array
# consisting of the elements of a corresponding to the True values
# of bool_idx
print(a[bool_idx])   # Prints "[3 4 5 6]"

# We can do all of the above in a single concise statement:
print(a[a > 2])      # Prints "[3 4 5 6]"
```

```
import numpy as np

x = np.array([1, 2])      # Let numpy choose the datatype
print(x.dtype)           # Prints "int64"

x = np.array([1.0, 2.0])  # Let numpy choose the datatype
print(x.dtype)           # Prints "float64"

x = np.array([1, 2], dtype=np.int64)  # Force a particular datatype
print(x.dtype)
```

```
import numpy as np

x = np.array([[1,2],[3,4]], dtype=np.float64)
y = np.array([[5,6],[7,8]], dtype=np.float64)

# Elementwise sum; both produce the array
# [[ 6.0  8.0]
#  [10.0 12.0]]
print(x + y)
print(np.add(x, y))

# Elementwise difference; both produce the array
# [[-4.0 -4.0]
#  [-4.0 -4.0]]
print(x - y)
print(np.subtract(x, y))
```

```
# Elementwise product; both produce the array  
# [[ 5.0 12.0]  
#  [21.0 32.0]]  
print(x * y)  
print(np.multiply(x, y))
```

```
# Elementwise division; both produce the array  
# [[ 0.2          0.33333333]  
#  [ 0.42857143  0.5         ]]  
print(x / y)  
print(np.divide(x, y))
```

```
# Elementwise square root; produces the array  
# [[ 1.          1.41421356]  
#  [ 1.73205081  2.         ]]  
print(np.sqrt(x))
```

```
import numpy as np

x = np.array([[1,2],[3,4]])
y = np.array([[5,6],[7,8]])

v = np.array([9,10])
w = np.array([11, 12])
# Inner product of vectors; both produce 219
print(v.dot(w))
print(np.dot(v, w))
# Matrix / vector product; both produce the rank 1 array [29 67]
print(x.dot(v))
print(np.dot(x, v))

# Matrix / matrix product; both produce the rank 2 array
# [[19 22]
#  [43 50]]
print(x.dot(y))
print(np.dot(x, y))
```

```
import numpy as np

x = np.array([[1,2],[3,4]])

print(np.sum(x))    # Compute sum of all elements; prints "10"
print(np.sum(x, axis=0))  # Compute sum of each column; prints "[4 6]"
print(np.sum(x, axis=1))  # Compute sum of each row; prints "[3 7]"
```

```
import numpy as np

x = np.array([[1,2], [3,4]])
print(x)      # Prints "[[1 2]
               #           [3 4]]"
print(x.T)    # Prints "[[1 3]
               #           [2 4]]"

# Note that taking the transpose of a rank 1 array does nothing:
v = np.array([1,2,3])
print(v)      # Prints "[1 2 3]"
print(v.T)    # Prints "[1 2 3]"
```




End of Python Numpy



IP[y]:
IPython

