Numpy_Indexing_2

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1 NumPy Indexing and Selection

In this lecture we will discuss how to select elements or groups of elements from an array.

[1]:
```
import numpy as np
```

[2]:
```
#Creating sample array
arr = np.arange(0,11)
```

[3]:
```
#Show
arr
```

[3]:
```
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10])
```

1.1 Bracket Indexing and Selection

The simplest way to pick one or some elements of an array looks very similar to python lists:

[4]:
```
#Get a value at an index
arr[8]
```

[4]:
```
8
```

[5]:
```
#Get values in a range
arr[1:5]
```

[5]:
```
array([1, 2, 3, 4])
```

[6]:
```
#Get values in a range
arr[0:6]
```

[6]:
```
array([0, 1, 2, 3, 4, 5])
```

1.2 Broadcasting

Numpy arrays differ from a normal Python list because of their ability to broadcast:

[7]:
```
#Setting a value with index range (Broadcasting)
arr[0:5]=100

#Show
arr
```

[7]:
```
array([100, 100, 100, 100, 100,   5,   6,   7,   8,   9,  10])
```

[8]:
```
# Reset array, we'll see why I had to reset in  a moment
arr = np.arange(0,11)

#Show
arr
```

[8]:
```
array([ 0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10])
```

[9]:
```
#Important notes on Slices
slice_of_arr = arr[0:6]

#Show slice
slice_of_arr
```

[9]:
```
array([0, 1, 2, 3, 4, 5])
```

[10]:
```
#Change Slice
slice_of_arr[:]=99

#Show Slice again
slice_of_arr
```

[10]:
```
array([99, 99, 99, 99, 99, 99])
```

Now note the changes also occur in our original array!

[11]:
```
arr
```

[11]:
```
array([99, 99, 99, 99, 99, 99,  6,  7,  8,  9, 10])
```

Data is not copied, it's a view of the original array! This avoids memory problems!

[12]:
```
#To get a copy, need to be explicit
arr_copy = arr.copy()

arr_copy
```

[12]:
```
array([99, 99, 99, 99, 99, 99,  6,  7,  8,  9, 10])
```

1.3 Indexing a 2D array (matrices)

The general format is **arr_2d[row][col]** or **arr_2d[row,col]**. I recommend usually using the comma notation for clarity.

[13]:
```
arr_2d = np.array(([5,10,15],[20,25,30],[35,40,45]))

#Show
arr_2d
```

[13]:
```
array([[ 5, 10, 15],
       [20, 25, 30],
       [35, 40, 45]])
```

[14]:
```
#Indexing row
arr_2d[1]
```

[14]:
```
array([20, 25, 30])
```

[15]:
```
arr_2d[2][1]
```

[15]:
```
40
```

[16]:
```
arr_2d[1][2]
```

[16]:
```
30
```

[17]:
```
# Format is arr_2d[row][col] or arr_2d[row,col]

# Getting individual element value
arr_2d[1][0]
```

[17]:
```
20
```

[18]:
```
# Getting individual element value
arr_2d[1,0]
```

[18]:
```
20
```

[19]:
```
arr_2d
```

[19]:
```
array([[ 5, 10, 15],
       [20, 25, 30],
       [35, 40, 45]])
```

[20]:
```
# 2D array slicing

#Shape (2,2) from top right corner
```

```
arr_2d[0:3,0:1]
```

[20]:
```
array([[ 5],
       [20],
       [35]])
```

[21]:
```
#Shape bottom row
arr_2d[1]
```

[21]:
```
array([20, 25, 30])
```

[22]:
```
#Shape bottom row
arr_2d[1,:]
```

[22]:
```
array([20, 25, 30])
```

1.3.1 Fancy Indexing

Fancy indexing allows you to select entire rows or columns out of order,to show this, let's quickly build out a numpy array:

[23]:
```
#Set up matrix
arr2d = np.zeros((10,10))
arr2d
```

[23]:
```
array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [0., 0., 0., 0., 0., 0., 0., 0., 0., 0.]])
```

[24]:
```
#Length of array
arr_length = arr2d.shape[1]
```

[25]:
```
#Set up array

for i in range(arr_length):
    arr2d[i] = i

arr2d
```

[25]:
```
array([[0., 0., 0., 0., 0., 0., 0., 0., 0., 0.],
       [1., 1., 1., 1., 1., 1., 1., 1., 1., 1.],
       [2., 2., 2., 2., 2., 2., 2., 2., 2., 2.],
       [3., 3., 3., 3., 3., 3., 3., 3., 3., 3.],
       [4., 4., 4., 4., 4., 4., 4., 4., 4., 4.],
       [5., 5., 5., 5., 5., 5., 5., 5., 5., 5.],
       [6., 6., 6., 6., 6., 6., 6., 6., 6., 6.],
       [7., 7., 7., 7., 7., 7., 7., 7., 7., 7.],
       [8., 8., 8., 8., 8., 8., 8., 8., 8., 8.],
       [9., 9., 9., 9., 9., 9., 9., 9., 9., 9.]])
```

Fancy indexing allows the following

[26]:
```
arr2d[[2,4,6,8]]
```

[26]:
```
array([[2., 2., 2., 2., 2., 2., 2., 2., 2., 2.],
       [4., 4., 4., 4., 4., 4., 4., 4., 4., 4.],
       [6., 6., 6., 6., 6., 6., 6., 6., 6., 6.],
       [8., 8., 8., 8., 8., 8., 8., 8., 8., 8.]])
```

[27]:
```
#Allows in any order
arr2d[[6,4,2,7]]
```

[27]:
```
array([[6., 6., 6., 6., 6., 6., 6., 6., 6., 6.],
       [4., 4., 4., 4., 4., 4., 4., 4., 4., 4.],
       [2., 2., 2., 2., 2., 2., 2., 2., 2., 2.],
       [7., 7., 7., 7., 7., 7., 7., 7., 7., 7.]])
```

1.4 More Indexing Help

Indexing a 2d matrix can be a bit confusing at first, especially when you start to add in step size. Try google image searching NumPy indexing to fins useful images, like this one:

1.5 Selection

Let's briefly go over how to use brackets for selection based off of comparison operators.

[28]:
```
arr = np.arange(1,11)
arr
```

[28]:
```
array([ 1,  2,  3,  4,  5,  6,  7,  8,  9, 10])
```

[29]:
```
arr > 4
```

[29]:
```
array([False, False, False, False,  True,  True,  True,  True,  True,
        True])
```

[30]:
```
bool_arr = arr>4
```

[31]:
```
bool_arr
```

[31]:
```
array([False, False, False, False,  True,  True,  True,  True,  True,
        True])
```

[32]:
```
arr[bool_arr]
```

[32]:
```
array([ 5,  6,  7,  8,  9, 10])
```

[33]:
```
arr[arr>2]
```

[33]:
```
array([ 3,  4,  5,  6,  7,  8,  9, 10])
```

[34]:
```
x = 2
arr[arr>x]
```

[34]:
```
array([ 3,  4,  5,  6,  7,  8,  9, 10])
```

[ ]:
```

```