DataRitz Technologies
Enhancing Technology Experience

Topics to be covered

- Universal Functions
- Searching
- Sorting
- Filtering

NumPy

¶

Importing Numpy Package

In [1]:

```
import numpy as np
```

Computation on NumPy arrays

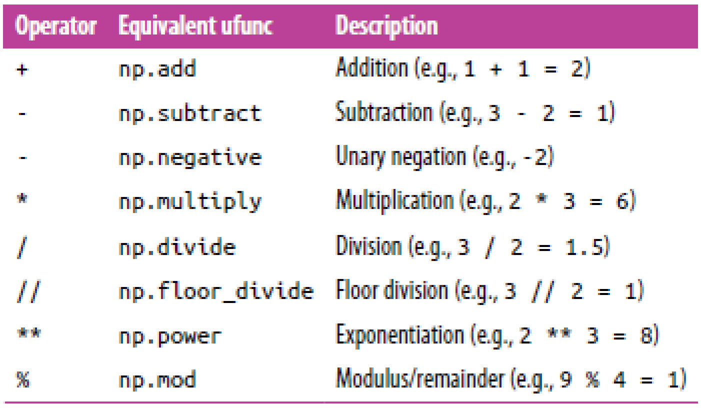
- **Computation on NumPy arrays can be very fast, or it can be very slow.**
- **The key to making it fast is to use vectorized operations, generally implemented through NumPy's universal functions (ufuncs).**

What is Vectorization?

Converting iterative statements into a vector based operation is called vectorization.

It is faster as modern CPUs are optimized for such operations.

Array arithmetic



Operator	Equivalent ufunc	Description
+	np.add	Addition (e.g., 1 + 1 = 2)
-	np.subtract	Subtraction (e.g., 3 - 2 = 1)
-	np.negative	Unary negation (e.g., -2)
*	np.multiply	Multiplication (e.g., 2 * 3 = 6)
/	np.divide	Division (e.g., 3 / 2 = 1.5)
//	np.floor_divide	Floor division (e.g., 3 // 2 = 1)
**	np.power	Exponentiation (e.g., 2 ** 3 = 8)
%	np.mod	Modulus/remainder (e.g., 9 % 4 = 1)

Absolute value

In [3]:

```
x = np.array([-2,-1,0,1,2])
np.absolute(x)
```

Out[3]:

```
array([2, 1, 0, 1, 2])
```

Exponents and logarithms

In [4]:

```
# e^x
x = [1,2,3]
np.exp(x)
```

Out[4]:

```
array([ 2.71828183,  7.3890561 , 20.08553692])
```

In [5]:

```
#2^x
x=[1,2,3]
np.exp2(x)
```

Out[5]:

```
array([2., 4., 8.])
```

In [6]:

```
# ln(x)
x=[1,2,3]
np.log(x)
```

Out[6]:

```
array([0.        , 0.69314718, 1.09861229])
```

In [7]:

```
np.log2(x)
```

Out[7]:

```
array([0.        , 1.        , 1.5849625])
```

In [8]:

```
np.log10(x)
```

Out[8]:

```
array([0.        , 0.30103   , 0.47712125])
```

Advanced Ufunc Features

1. Specifying output

For large calculations, it is sometimes useful to be able to specify the array where the result of the calculation will be stored.

In [11]:

```
# Example
x = np.arange(5)
y = np.empty(5)
np.multiply(x, 10, out=y)
```

Out[11]:

```
array([ 0., 10., 20., 30., 40.])
```

if we write y = x*10 then , It create a temporary array to hold the results of x*10 , followed by a second operation copying those values into the y array

2. Aggregations (Reduce method)

- **if you like to reduce an array with a particular operation, we can use the reduce method of any ufunc.**
- **A reduce repeatedly applies a given operation to the elements of an array until only a single result remains.**

In [14]:

```
# alling reduce on the add ufunc returns the sum of all elements in the
#array
x = np.arange(1,11)
np.add.reduce(x)
```

Out[14]:

```
55
```

In [15]:

```
# If you like to store all intermidiate results of the computation the we can
# use accumlate().

np.add.accumulate(x)
```

Out[15]:

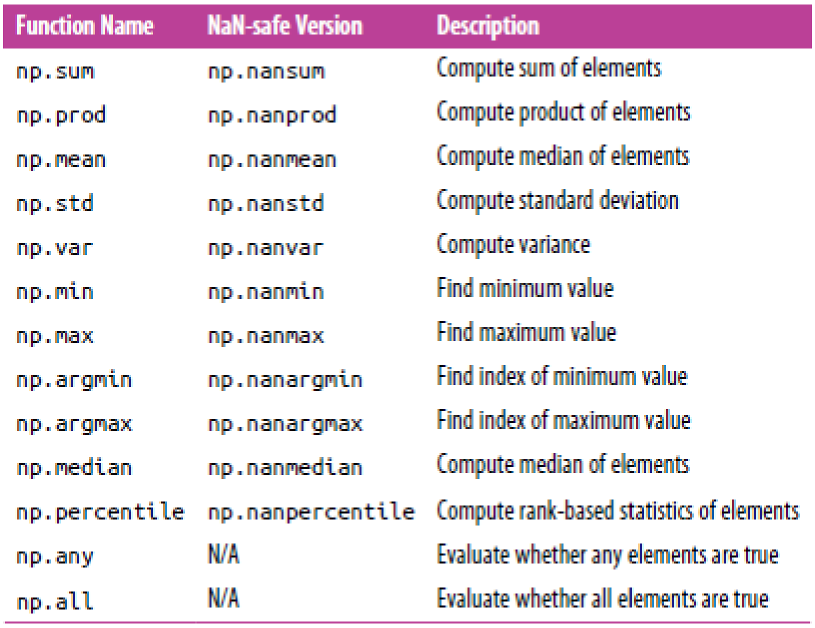
```
array([ 1,  3,  6, 10, 15, 21, 28, 36, 45, 55], dtype=int32)
```

Note - there are dedicated NumPy functions to compute the results

- np.sum
- np.prod
- np.cumsum
- np.cumprod

Aggregation functions available in NumPy

- **Often when you are faced with a large amount of data, a first step is to compute summary statistics for the data in question.**
- **numpy provides following Aggregation function**



Function Name	NaN-safe Version	Description
np.sum	np.nansum	Compute sum of elements
np.prod	np.nanprod	Compute product of elements
np.mean	np.nanmean	Compute median of elements
np.std	np.nanstd	Compute standard deviation
np.var	np.nanvar	Compute variance
np.min	np.nanmin	Find minimum value
np.max	np.nanmax	Find maximum value
np.argmin	np.nanargmin	Find index of minimum value
np.argmax	np.nanargmax	Find index of maximum value
np.median	np.nanmedian	Compute median of elements
np.percentile	np.nanpercentile	Compute rank-based statistics of elements
np.any	N/A	Evaluate whether any elements are true
np.all	N/A	Evaluate whether all elements are true

In [86]:

```
x = np.arange(1,101).reshape(10,10)
print(x)
x[:,[1]]
```

```
[[  1   2   3   4   5   6   7   8   9  10]
 [ 11  12  13  14  15  16  17  18  19  20]
 [ 21  22  23  24  25  26  27  28  29  30]
 [ 31  32  33  34  35  36  37  38  39  40]
 [ 41  42  43  44  45  46  47  48  49  50]
 [ 51  52  53  54  55  56  57  58  59  60]
 [ 61  62  63  64  65  66  67  68  69  70]
 [ 71  72  73  74  75  76  77  78  79  80]
 [ 81  82  83  84  85  86  87  88  89  90]
 [ 91  92  93  94  95  96  97  98  99 100]]
```

Out[86]:

```
array([[ 2],
       [12],
       [22],
       [32],
       [42],
       [52],
       [62],
       [72],
       [82],
       [92]])
```

In [89]:

```
print(" Sum of Elements ",np.sum(x[:,[1]]))
print(" Product of Elements ",np.prod(x[:,[1]]))
print(" Mean of Elements ",np.mean(x[:,[1]]))
#Standard deviation is a number used to tell how measurements for a group
# are spread out from the average (mean), or expected value
print(" Standard deviation ",np.std(x[:,[1]]))
print(" Minimum Value ",np.min(x[:,[1]]))
print(" Maximum Value ",np.max(x[:,[1]]))
print(" Meadian ",np.median(x[:,[1]]))
print("ANy elemet are True : ",np.any(x[:,[1]]))
```

```
 Sum of Elements  470
 Product of Elements  189267968
 Mean of Elements  47.0
 Standard deviation  28.722813232690143
 Minimum Value  2
 Maximum Value  92
 Meadian  47.0
ANy elemet are True True
```

In [52]:

```
# Working with nan
x = np.array([1,2,3,4,5,np.nan,6,7,8,9])
np.nanmean(x)
```

Out[52]:

```
5.0
```

In [84]:

```
x = np.array([1,2,3,'',4,5])
def m(x):
    if x == '':
        return np.nan
    else:
        return float(x)
y = np.frompyfunc(m,1,1)
x = y(x).astype(float)
np.nanmean(x)
```

Out[84]:

```
nan
```

In [ ]:

How To Create Your Own ufunc

To create you own ufunc, you have to define a function, like you do with normal functions in Python, then you add it to your NumPy ufunc library with the frompyfunc() method.

> The frompyfunc() method takes the following arguments:
>
> - function - the name of the function.
> - inputs - the number of input arguments (arrays).
> - outputs - the number of output arrays.

In [19]:

```
# Create a ufunc which return cube of a given number

def myufunc(x):
    return x**3
```

In [21]:

```
x = np.arange(1,11)
cube = np.frompyfunc(myufunc,1,1)
cube(x)
```

Out[21]:

```
array([1, 8, 27, 64, 125, 216, 343, 512, 729, 1000], dtype=object)
```

In [26]:

```
# Check if a Function is a ufunc
type(cube)
```

Out[26]:

```
numpy.ufunc
```

In [28]:

```
# inbuild add ufunc
type(np.add)
```

Out[28]:

```
numpy.ufunc
```

Searching Arrays

You can search an array for a certain value, and return the indexes that get a match.

To search an array, use the where() method.

In [96]:

```
x = np.random.randint(1,10,size=10)
print(x)
```

```
[1 4 5 2 8 7 4 4 5 4]
```

In [97]:

```
np.where(x == 4)
```

Out[97]:

```
(array([1, 6, 7, 9], dtype=int64),)
```

In [101]:

```
np.where(x>4)
```

Out[101]:

```
(array([2, 4, 5, 8], dtype=int64),)
```

Fast Sorting in NumPy: np.sort and np.argsort

By default np.sort uses an O(N log N)

In [117]:

```
# np.sort return sorted array
x = np.array([34,2,45,3,2,1,89,54])
np.sort(x)
```

Out[117]:

```
array([ 1,  2,  2,  3, 34, 45, 54, 89])
```

In [120]:

```
# If you prefer to sort the array in-place
x.sort()
x
```

Out[120]:

```
array([ 1,  2,  2,  3, 34, 45, 54, 89])
```

Sorting along rows or columns

A useful feature of NumPy’s sorting algorithms is the ability to sort along specific rows or columns of a multidimensional array using the axis argument

In [122]:

```
data = np.random.randint(10,100,(10,4))
data
```

Out[122]:

```
array([[15, 33, 22, 15],
       [34, 81, 87, 93],
       [57, 96, 13, 70],
       [28, 45, 10, 30],
       [97, 21, 45, 35],
       [56, 16, 47, 95],
       [55, 59, 20, 22],
       [20, 20, 96, 28],
       [88, 69, 12, 88],
       [96, 24, 57, 10]])
```

In [123]:

```
# Sort each column of data
np.sort(data,axis = 0)
```

Out[123]:

```
array([[15, 16, 10, 10],
       [20, 20, 12, 15],
       [28, 21, 13, 22],
       [34, 24, 20, 28],
       [55, 33, 22, 30],
       [56, 45, 45, 35],
       [57, 59, 47, 70],
       [88, 69, 57, 88],
       [96, 81, 87, 93],
       [97, 96, 96, 95]])
```

In [124]:

```
# Sort each row of data
np.sort(data,axis = 1)
```

Out[124]:

```
array([[15, 15, 22, 33],
       [34, 81, 87, 93],
       [13, 57, 70, 96],
       [10, 28, 30, 45],
       [21, 35, 45, 97],
       [16, 47, 56, 95],
       [20, 22, 55, 59],
       [20, 20, 28, 96],
       [12, 69, 88, 88],
       [10, 24, 57, 96]])
```

In [127]:

```
# Sort Single Column
np.sort(data[:,[1]],axis=0)
```

Out[127]:

```
array([[16],
       [20],
       [21],
       [24],
       [33],
       [45],
       [59],
       [69],
       [81],
       [96]])
```

Filtering Arrays

Getting some elements out of an existing array and creating a new array out of them is called filtering.

In NumPy, you filter an array using a boolean index list.

In [130]:

```
x = np.array([1,2,3,5,6])
f = [True,False,True,True,False]
x[f]
```

Out[130]:

```
array([1, 3, 5])
```

In [132]:

```
x = np.array([1,2,3,5,6])
f = x%2==1
x[f]
```

Out[132]:

```
array([1, 3, 5])
```

In [133]:

```
x = np.array([1,2,3,5,6])
x[x%2==1]
```

Out[133]:

```
array([1, 3, 5])
```

In [ ]:

```

```