Phyton For Data Science

Cheat-Sheet Phyton Basic

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Variables and Data Types

Variable Assignment

```
>>> x=5
>>> x
5
```

Calculations With Variables

```
>>> x+2
7                    Sum of two variables
>>> x-2
3                    Subtraction of two variables
>>> x*2
10                   Multiplication of two variables
>>> x**2
25                   Exponentiation of a variable
>>> x%2
1                    Remainder of a variable
>>> x/float(2)
2.5                  Division of a variable
```

Calculations With Variables

str()	'5', '3.45', 'True'	Variables to strings
int()	5, 3, 1	Variables to integers
float()	5.0, 1.0	Variables to floats
bool()	True, True, True	Variables to booleans

Asking For Help

```
>>> help(str)
```

Lists

Also see NumPy Arrays

```
>>> a = 'is'
>>> b = 'nice'
>>> my_list = ['my', 'list', a, b]
>>> my_list2 = [[4,5,6,7], [3,4,5,6]]
```

Selecting List Elements

Index starts at 0

Subset

```
>>> my_list[1]          Select item at index 1
>>> my_list[-3]         Select 3rd last item
```

Slice

```
>>> my_list[1:3]        Select items at index 1 and 2
>>> my_list[1:]         Select items after index 0
>>> my_list[:3]         Select items before index 3
>>> my_list[:]          Copy my_list
```

Subset Lists of Lists

```
>>> my_list2[1][0]      my_list[list][itemOfList]
>>> my_list2[1][:2]
```

List Operations

```
>>> my_list + my_list
['my', 'list', 'is', 'nice', 'my', 'list', 'is', 'nice']
>>> my_list * 2
['my', 'list', 'is', 'nice', 'my', 'list', 'is', 'nice']
>>> my_list2 > 4
True
```

List Methods

```
>>> my_list.index(a)        Get the index of an item
>>> my_list.count(a)        Count an item
>>> my_list.append('!')     Append an item at a time
>>> my_list.remove('!')     Remove an item
>>> del(my_list[0:1])       Remove an item
>>> my_list.reverse()       Reverse the list
>>> my_list.extend('!')     Append an item
>>> my_list.pop(-1)         Remove an item
>>> my_list.insert(0,'!')   Insert an item
>>> my_list.sort()          Sort the list
```

Numpy Arrays

Also see Lists

```
>>> my_list = [1, 2, 3, 4]
>>> my_array = np.array(my_list)
>>> my_2darray =
np.array([[1,2,3],[4,5,6]])
```

Selecting Numpy Array Elements

Index starts at 0

Subset

```
>>> my_array[1]         Select item at index 1
2
```

Slice

```
>>> my_array[0:2]       Select items at index 0 and 1
array([1, 2])
```

Subset 2D Numpy arrays

```
>>> my_2darray[:,0]     my_2darray[rows, columns]
array([1, 4])
```

Numpy Array Operations

```
>>> my_array > 3
array([False, False, False, True], dtype=bool)
>>> my_array * 2
array([2, 4, 6, 8])
>>> my_array + np.array([5, 6, 7, 8])
array([6, 8, 10, 12])
```

Numpy Array Operations

```
>>> my_array.shape          Get the dimensions of the array
>>> np.append(other_array)  Append items to an array
>>> np.insert(my_array, 1, 5)  Insert items in an array
>>> np.delete(my_array,[1])    Delete items in an array
>>> np.mean(my_array)       Mean of the array
>>> np.median(my_array)     Median of the array
>>> my_array.corrcoef()     Correlation coefficient
>>> np.std(my_array)        Standard deviation
```

Strings

Also see NumPy Arrays

```
>>> my_string = 'thisStringIsAwesome'
>>> my_string
'thisStringIsAwesome'
```

String Operations

```
>>> my_string * 2
'thisStringIsAwesomethisStringIsAwesome'
>>> my_string + 'Innit'
'thisStringIsAwesomeInnit'
>>> 'm' in my_string
True
```

String Operations

Index starts at 0

```
>>> my_string[3]
>>> my_string[4:9]
```

String Methods

```
>>> my_string.upper()              String to uppercase
>>> my_string.lower()              String to lowercase
>>> my_string.count('w')           Count String elements
>>> my_string.replace('e', 'i')    Replace String elements
>>> my_string.strip()              Strip whitespaces
```

Libraries

Import libraries

```
>>> import numpy
>>> import numpy as np
```

Selective import

```
>>> from math import pi
```

Install Python

ANACONDA. — Leading open data science platform powered by Pytho

SPYDER — Free IDE that is included with Anaconda

jupyter — Create and share documents with live code, visualizations, text, ...

NumPy Basics Cheat Sheet

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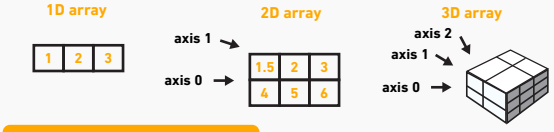
NumPy

The NumPy library is the core library for scientific computing in Python. It provides a high-performance multidimensional array object, and tools for working with these arrays.



Creating Arrays

```
>>> a = np.array([1,2,3])
>>> b = np.array([(1.5,2,3), (4,5,6)], dtype = float)
>>> c = np.array([[(1.5,2,3), (4,5,6)], [(3,2,1), (4,5,6)]],dtype = float)
```

Initial Placeholders

```
>>> np.zeros((3,4))                    Create an array of zeros
>>> np.ones((2,3,4),dtype=np.int16)    Create an array of ones
>>> d = np.arange(10,25,5)             Create an array of evenly spaced values (step value)
>>> np.linspace(0,2,9)                 Create an array of evenly spaced values (number of samples)
>>> e = np.full((2,2),7)               Create a constant array
>>> f = np.eye(2)                      Create a 2X2 identity matrix
>>> np.random.random((2,2))            Create an array with random values
>>> np.empty((3,2))                    Create an empty array
```

I/O

Saving & Loading On Disk

```
>>> np.save('my_array', a)
>>> np.savez('array.npz', a, b)
>>> np.load('my_array.npy')
```

Saving & Loading Text Files

```
>>> np.loadtxt("myfile.txt")
>>> np.genfromtxt("my_file.csv", delimiter=",")
>>> np.savetxt("myarray.txt", a, delimiter=" ")
```

Inspecting Your Array

```
>>> a.shape          Array dimensions
>>> len(a)           Length of array
>>> b.ndim           Number of array dimensions
>>> e.size           Number of array elements
>>> b.dtype          Data type of array elements
>>> b.dtype.name     Name of data type
>>> b.astype(int)    Convert an array to a different type
```

Data Types

```
>>> np.int64         Signed 64-bit integer types
>>> np.float32       Standard double-precision floating point
>>> np.complex       Complex numbers represented by 128 floats
>>> np.bool          Boolean type storing TRUE and FALSE
>>> np.object        Python object type values
>>> np.string_       Fixed-length string type
>>> np.unicode_      Fixed-length unicode type
```

Asking For Help

```
>>> np.info(np.ndarray.dtype)
```

Array Mathematics

Arithmetic Operations

```
>>> g = a - b                          Subtraction
  array([[-0.5, 0. , 0. ],
         [-3. , -3. , -3. ]])
>>> np.subtract(a,b)                   Subtraction
>>> b + a                              Addition
  array([[ 2.5, 4. , 6. ],
         [ 5. , 7. , 9. ]])
>>> np.add(b,a)                        Addition
>>> a / b                              Division
  array([[ 0.66666667, 1. , 1. ],
         [ 0.25 , 0.4 , 0.5 ]])
>>> np.divide(a,b)                     Division
>>> a * b                              Multiplication
  array([[ 1.5, 4. , 9. ],
         [ 4. , 10. , 18. ]])
>>> np.multiply(a,b)                   Multiplication
>>> np.exp(b)                          Exponentiation
>>> np.sqrt(b)                         Square root
>>> np.sin(a)                          Print sines of an array
>>> np.cos(b)                          Element-wise cosine
>>> np.log(a)                          Element-wise natural logarithm
>>> e.dot(f)                           Dot product
  array([[ 7., 7.],
         [ 7., 7.]])
```

Comparison

```
>>> a == b                             Element-wise comparison
  array([[False, True, True],
         [False, False, False]], dtype=bool)
>>> a < 2                              Element-wise comparison
  array([True, False, False], dtype=bool)
>>> np.array_equal(a, b)               Array-wise comparison
```

Aggregate Functions

```
>>> a.sum()                            Array-wise sum
>>> a.min()                            Array-wise minimum value
>>> b.max(axis=0)                      Maximum value of an array row
>>> b.cumsum(axis=1)                   Cumulative sum of the elements
>>> a.mean()                           Mean
>>> b.median()                         Median
```

Copying Arrays

```
>>> h = a.view()          Create a view of the array with the same data
>>> np.copy(a)            Create a copy of the array
>>> h = a.copy()          Create a deep copy of the array
```

Sorting Arrays

```
>>> a.sort()              Sort an array
>>> c.sort(axis=0)        Sort the elements of an array's axis
```

Subsetting, Slicing, Indexing

Subsetting

```
>>> a[2]                  Select the element at the 2nd index
  3
>>> b[1,2]                Select the element at row 1 column 2 (equivalent to b[1][2])
  6.0
```

Slicing

```
>>> a[0:2]                Select items at index 0 and 1
  array([1, 2])
>>> b[0:2,1]              Select items at rows 0 and 1 in column 1
  array([ 2., 5.])
>>> b[:1]                 Select all items at row 0 (equivalent to b[0:1, :])
  array([[1.5, 2., 3.]])
>>> c[1,...]              Same as [1,:,:]
  array([[[ 3., 2., 1.],
          [ 4., 5., 6.]]])
>>> a[ : :-1]             Reversed array a
  array([3, 2, 1])
```

Boolean Indexing

```
>>> a[a<2]                Select elements from a less than 2
  array([1])
```

Fancy Indexing

```
>>> b[[1, 0, 1, 0],[0, 1, 2, 0]]   Select elements (1,0),(0,1),(1,2) and (0,0)
  array([ 4. , 2. , 6. , 1.5])
>>> b[[1, 0, 1, 0]][:,[0,1,2,0]]   Select a subset of the matrix's rows and columns
  array([[ 4. , 5. , 6. , 4. ],
         [ 1.5, 2. , 3. , 1.5],
         [ 4. , 5. , 6. , 4. ],
         [ 1.5, 2. , 3. , 1.5]])
```

Array Manipulation

Transposing Array

```
>>> i = np.transpose(b)   Permute array dimensions
>>> i.T                   Permute array dimensions
```

Changing Array Shape

```
>>> b.ravel()             Flatten the array
>>> g.reshape(3,-2)       Reshape, but don't change data
```

Adding/Removing Elements

```
>>> h.resize((2,6))       Return a new array with shape (2,6)
>>> np.append(h,g)         Append items to an array
>>> np.insert(a, 1, 5)     Insert items in an array
>>> np.delete(a,[1])       Delete items from an array
```

Combining Arrays

```
>>> np.concatenate((a,d),axis=0)   Concatenate arrays
  array([ 1, 2, 3, 10, 15, 20])
>>> np.vstack((a,b))               Stack arrays vertically (row-wise)
  array([[ 1. , 2. , 3. ],
         [ 1.5, 2. , 3. ],
         [ 4. , 5. , 6. ]])
>>> np.r_[e,f]                     Stack arrays vertically (row-wise)
>>> np.hstack((e,f))               Stack arrays horizontally (column-wise)
  array([[ 7., 7., 1., 0.],
         [ 7., 7., 0., 1.]])
>>> np.column_stack((a,d))         Create stacked column-wise arrays
  array([[ 1, 10],
         [ 2, 15],
         [ 3, 20]])
>>> np.c_[a,d]                     Create stacked column-wise arrays
```

Splitting Arrays

```
>>> np.hsplit(a,3)                 Split the array horizontally at the 3rd
  [array([1]),array([2]),array([3])] index
>>> np.vsplit(c,2) Split the array vertically at the 2nd index
  [array([[[ 1.5, 2. , 1. ],
           [ 4. , 5. , 6. ]]]),
```

Pandas Basics

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Use the following import convention: >>> import pandas as pd

The Pandas library is built on NumPy and provides easy-to-use data structures and data analysis tools for the Python programming language.

Pandas Data Structures

Series

A one-dimensional labeled array a capable of holding any data type

```
>>> s = pd.Series([3, -5, 7, 4], index=['a', 'b', 'c', 'd'])
```

Data Frame

A two-dimensional labeled data structure with columns of potentially different types

	Belgium	Capital	Population
0	Belgium	Brussels	11190846
1	India	New Delhi	1303171035
2	Brazil	Brasilia	207847528

```
>>> data = {'Country': ['Belgium', 'India', 'Brazil'],
            'Capital': ['Brussels', 'New Delhi', 'Brasilia'],
            'Population': [11190846, 1303171035, 207847528]}
>>> df = pd.DataFrame(data,
                      columns=['Country', 'Capital', 'Population'])
```

a	3
b	-5
c	7
d	4

Dropping

```
>>> s.drop(['a', 'c'])
```
Drop values from rows (axis=0)

```
>>> df.drop('Country', axis=1)
```
Drop values from columns(axis=1)

Sort & Rank

```
>>> df.sort_index()
```
Sort by labels along an axis

```
>>> df.sort_values(by='Country')
```
Sort by the values along an axis

```
>>> df.rank()
```
Assign ranks to entries

Retrieving Series/ DataFrame Information

```
>>> df.shape
```
(rows,columns)

```
>>> df.index
```
Describe index

```
>>> df.columns
```
Describe DataFrame columns

```
>>> df.info()
```
Info on DataFrame

```
>>> df.count()
```
Number of non-NA values

Summary

```
>>> df.sum()
```
Sum of values

```
>>> df.cumsum()
```
Cummulative sum of values

```
>>> df.min()/df.max()
```
Minimum/maximum values

```
>>> df.idxmin()/df.idxmax()
```
Minimum/Maximum index value

```
>>> df.describe()
```
Summary statistics

```
>>> df.mean()
```
Mean of values

```
>>> df.median()
```
Median of values

Selection

Also see NumPy Arrays

Getting

```
>>> s['b']
-5
```
Get one element

```
>>> df[1:]
   Country Capital      Population
1  India   New Delhi    1303171035
2  Brazil  Brasilia     207847528
```
Get subset of a DataFrame

Selecting, Boolean Indexing & Setting

By Position

```
>>> df.iloc[[0],[0]]
'Belgium'
>>> df.iat([0],[0])
'Belgium'
```
Select single value by row & column

By Label

```
>>> df.loc[[0], ['Country']]
'Belgium'
>>> df.at([0], ['Country']) 'Belgium'
```
Select single value by row & column labels

By Label/Position

```
>>> df.ix[2]
Country      Brazil
Capital      Brasilia
Population   207847528
```
Select single row of subset of rows

```
>>> df.ix[:,'Capital']
0 Brussels
1 New Delhi
2 Brasilia
```
Select a single column of subset of columns

```
>>> df.ix[1,'Capital']
'New Delhi'
```
Select rows and columns

Boolean Indexing

```
>>> s[~(s > 1)]
```
Series s where value is not >1

```
>>> s[(s < -1) | (s > 2)]
```
s where value is <-1 or >2

```
>>> df[df['Population']>1200000000]
```
Use filter to adjust DataFrame

Setting

```
>>> s['a'] = 6
```
Set index a of Series s to 6

Asking For Help

```
>>> help(pd.Series.loc)
```

Applying Functions

```
>>> f = lambda x: x*2
>>> df.apply(f)
```
Apply function

```
>>> df.applymap(f)
```
Apply function element-wise

Data Alignment

Internal Data Alignment

NA values are introduced in the indices that don't overlap:

```
>>> s3 = pd.Series([7, -2, 3], index=['a', 'c', 'd'])
>>> s + s3
  a 10.0
  b NaN
  c 5.0
  d 7.0
```

Arithmetic Operations with Fill Methods

You can also do the internal data alignment yourself with the help of the fill methods:

```
>>> s.add(s3, fill_value=0)
  a 10.0
  b -5.0
  c 5.0
  d 7.0
>>> s.sub(s3, fill_value=2)
>>> s.div(s3, fill_value=4)
```

I/O

Read and Write to CSV

```
>>> pd.read_csv('file.csv', header=None, nrows=5)
>>> df.to_csv('myDataFrame.csv')
```

Read and Write to Excel

```
>>> pd.read_excel('file.xlsx')
>>> pd.to_excel('dir/myDataFrame.xlsx', sheet_name='Sheet1')
```

Read multiple sheets from the same file

```
>>> xlsx = pd.ExcelFile('file.xls')
>>> df = pd.read_excel(xlsx, 'Sheet1')
```

Read and Write to SQL Query or Database Table

```
>>> from sqlalchemy import create_engine
>>> engine = create_engine('sqlite:///:memory:')
>>> pd.read_sql("SELECT * FROM my_table;", engine)
>>> pd.read_sql_table('my_table', engine)
>>> pd.read_sql_query("SELECT * FROM my_table;", engine)
```

read_sql()is **a convenience wrapper around** read_sql_table() and read_sql_query()

```
>>> pd.to_sql('myDf', engine)
```

Pandas Cheat Sheet

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Pandas Data Structures

Pivot

```
>>> df3= df2.pivot(index='Date',
                   columns='Type',
                   values='Value')
```

Spread rows into columns

	Date	Type	Value
0	2016-03-01	a	11.432
1	2016-03-02	b	13.031
2	2016-03-01	c	20.784
3	2016-03-03	a	99.906
4	2016-03-02	a	1.303
5	2016-03-03	c	20.784

Type	a	b	c
Date			
2016-03-01	11.432	NaN	20.784
2016-03-02	1.303	13.031	NaN
2016-03-03	99.906	NaN	20.784

Pivot Table

```
>>> df4 = pd.pivot_table(df2,
                         values='Value',
                         index='Date',
                         columns='Type'])
```

Spread rows into columns

		0	1
1	5	0.233482	0.390959
2	4	0.184713	0.237102
3	3	0.433522	0.429401

Unstacked

1	5	0	0.233482
		1	0.390959
2	4	0	0.184713
		1	0.237102
3	3	0	0.433522
		1	0.429401

Stacked

Melt

```
>>> pd.melt(df2,
            id_vars=['Date'],
            value_vars=['Type', 'Value'],
            value_name='Observations')
```

Gather columns into rows

	Date	Type	Value
0	2016-03-01	a	11.432
1	2016-03-02	b	13.031
2	2016-03-01	c	20.784
3	2016-03-03	a	99.906
4	2016-03-02	a	1.303
5	2016-03-03	c	20.784

	Date	Variable	Observations
0	2016-03-01	Type	a
1	2016-03-02	Type	b
2	2016-03-01	Type	c
3	2016-03-03	Type	a
4	2016-03-02	Type	a
5	2016-03-03	Type	c
6	2016-03-01	Value	11.432
7	2016-03-02	Value	13.031
8	2016-03-01	Value	20.784
9	2016-03-03	Value	99.906
10	2016-03-02	Value	1.303
11	2016-03-03	Value	20.784

Advanced Indexing

Also see NumPy Arrays

Selecting

```
>>> df3.loc[:,(df3>1).any()]      Select cols with any vals >1
>>> df3.loc[:,(df3>1).all()]      Select cols with vals > 1
>>> df3.loc[:,df3.isnull().any()] Select cols with NaN
>>> df3.loc[:,df3.notnull().all()] Select cols without NaN
```

Indexing With isin

```
>>> df[(df.Country.isin(df2.Type))] Find same elements
>>> df3.filter(items="a","b"])      Filter on values
>>> df.select(lambda x: not x%5)    Select specific elements
```

Where

```
>>> s.where(s > 0)                  Subset the data
```

Query

```
>>> df6.query('second > first')     Query DataFrame
```

Setting/Resetting Index

```
>>> df.set_index('Country')         Set the index
>>> df4 = df.reset_index()          Reset the index
>>> df = df.rename(index=str,       Rename DataFrame
                   columns={"Country":"cntry",
                            "Capital":"cptl",
                            "Population":"ppltn"})
```

Reindexing

```
>>> s2 = s.reindex(['a','c','d','e','b'])
```

Forward Filling

```
>>> df.reindex(range(4),
               method='ffill')
```

	Country	Capital	Population
0	Belgium	Brussels	11190846
1	India	New Delhi	1303171035
2	Brazil	Brasília	207847528
3	Brazil	Brasília	207847528

Forward Filling

```
>>> s3 = s.reindex(range(5),
                   method='bfill')
```

0	3
1	3
2	3
3	3
4	3

MultiIndexing

```
>>> arrays = [np.array([1,2,3]),
              np.array([5,4,3])]
>>> df5 = pd.DataFrame(np.random.rand(3, 2), index=arrays)
>>> tuples = list(zip(*arrays))
>>> index = pd.MultiIndex.from_tuples(tuples,
                                      names=['first', 'second'])
>>> df6 = pd.DataFrame(np.random.rand(3, 2), index=index)
>>> df2.set_index(["Date", "Type"])
```

Duplicate Data

```
>>> s3.unique()                     Return unique values
>>> df2.duplicated('Type')          Check duplicates
>>> df2.drop_duplicates('Type', keep='last') Drop duplicates
>>> df.index.duplicated()           Drop duplicates
```

Grouping Data

Aggregation

```
>>> df2.groupby(by=['Date','Type']).mean()
>>> df4.groupby(level=0).sum()
>>> df4.groupby(level=0).agg({'a':lambda x:sum(x)/len(x), 'b': np.sum})
```

Transformation

```
>>> customSum = lambda x: (x+x%2)
>>> df4.groupby(level=0).transform(customSum)
```

Missing Data

```
>>> df.dropna()                     Drop NaN value
>>> df3.fillna(df3.mean())          Fill NaN values with a predetermined value
>>> df2.replace("a", "f")           Replace values with others
```

Combining Data

data1

	X1	X2
a	11.432
b	1.303
c	99.906

data2

	X1	X3
a	20.784
b	NaN
d	20.784

Pivot

```
>>> pd.merge(data1,
             data2,
             how='left',
             on='X1')
```

	X1	X2	X3
a	11.432	20.784
b	1.303	NaN
c	99.906	NaN

```
>>> pd.merge(data1,
             data2,
             how='right',
             on='X1')
```

	X1	X2	X3
a	11.432	20.784
b	1.303	NaN
d	NaN	20.784

```
>>> pd.merge(data1,
             data2,
             how='inner',
             on='X1')
```

	X1	X2	X3
a	11.432	20.784
b	1.303	NaN

```
>>> pd.merge(data1,
             data2,
             how='outer',
             on='X1')
```

	X1	X2	X3
a	11.432	20.784
b	1.303	NaN
c	99.906	NaN
d	NaN	

Join

```
>>> data1.join(data2, how='right')
```

Concatenate

Vertical

```
>>> s.append(s2)
```

Horizontal/Vertical

```
>>> pd.concat([s,s2],axis=1, keys=['One','Two'])
>>> pd.concat([data1, data2], axis=1, join='inner')
```

Dates

```
>>> df2['Date']= pd.to_datetime(df2['Date'])
>>> df2['Date']= pd.date_range('2000-1-1', periods=6,
                               freq='M')
>>> dates = [datetime(2012,5,1), datetime(2012,5,2)]
>>> index = pd.DatetimeIndex(dates)
>>> index = pd.date_range(datetime(2012,2,1), end, freq='BM')
```

Visualization

```
>>> import matplotlib.pyplot as plt
```

```
>>> s.plot()
>>> plt.show()
```

```
>>> df2.plot()
>>> plt.show()
```