Python For Data Science *Cheat Sheet*

Python Basics

Learn More Python for Data Science Interactively at www.datacamp.com

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

Types and Type Conversion

`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

Libraries

Import libraries

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

Selective import

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

pandas — Data analysis

learn — Machine learning

NumPy — Scientific computing

matplotlib — 2D plotting

Install Python

ANACONDA — Leading open data science platform powered by Python

spyder — Free IDE that is included with Anaconda

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

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]` → `2`	Select item at index 1
Slice	
`>>> my_array[0:2]` → `array([1, 2])`	Select items at index 0 and 1
Subset 2D Numpy arrays	
`>>> my_2darray[:,0]` → `array([1, 4])`	my_2darray[rows, columns]

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 Functions

`>>> 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

```
>>> 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

Data Science Cheat Sheet

Python - Intermediate

KEY BASICS, PRINTING AND GETTING HELP

This cheat sheet assumes you are familiar with the content of our Python Basics Cheat Sheet

`s` - A Python string variable
`i` - A Python integer variable
`f` - A Python float variable
`l` - A Python list variable
`d` - A Python dictionary variable

LISTS

`l.pop(3)` - Returns the fourth item from `l` and deletes it from the list
`l.remove(x)` - Removes the first item in `l` that is equal to `x`
`l.reverse()` - Reverses the order of the items in `l`
`l[1::2]` - Returns every second item from `l`, commencing from the `1`st item
`l[-5:]` - Returns the last 5 items from `l` specific axis

STRINGS

`s.lower()` - Returns a lowercase version of `s`
`s.title()` - Returns `s` with the first letter of every word capitalized
`"23".zfill(4)` - Returns `"0023"` by left-filling the string with `0`'s to make it's length `4`.
`s.splitlines()` - Returns a list by splitting the string on any newline characters.

Python strings share some common methods with lists

`s[:5]` - Returns the first `5` characters of `s`
`"fri" + "end"` - Returns `"friend"`
`"end" in s` - Returns `True` if the substring `"end"` is found in `s`

RANGE

Range objects are useful for creating sequences of integers for looping.

`range(5)` - Returns a sequence from `0` to `4`
`range(2000,2018)` - Returns a sequence from `2000` to `2017`
`range(0,11,2)` - Returns a sequence from `0` to `10`, with each item incrementing by `2`
`range(0,-10,-1)` - Returns a sequence from `0` to `-9`
`list(range(5))` - Returns a list from `0` to `4`

DICTIONARIES

`max(d, key=d.get)` - Return the key that corresponds to the largest value in `d`
`min(d, key=d.get)` - Return the key that corresponds to the smallest value in `d`

SETS

`my_set = set(l)` - Return a `set` object containing the unique values from `l`
`len(my_set)` - Returns the number of objects in `my_set` (or, the number of unique values from `l`)
`a in my_set` - Returns `True` if the value `a` exists in `my_set`

REGULAR EXPRESSIONS

`import re` - Import the Regular Expressions module
`re.search("abc",s)` - Returns a `match` object if the regex `"abc"` is found in `s`, otherwise `None`
`re.sub("abc","xyz",s)` - Returns a string where all instances matching regex `"abc"` are replaced by `"xyz"`

LIST COMPREHENSION

A one-line expression of a for loop

`[i ** 2 for i in range(10)]` - Returns a list of the squares of values from `0` to `9`
`[s.lower() for s in l_strings]` - Returns the list `l_strings`, with each item having had the `.lower()` method applied
`[i for i in l_floats if i < 0.5]` - Returns the items from `l_floats` that are less than `0.5`

FUNCTIONS FOR LOOPING

```
for i, value in enumerate(l):
  print("The value of item {} is {}".
  format(i,value))
```

- Iterate over the list `l`, printing the index location of each item and its value

```
for one, two in zip(l_one,l_two):
  print("one: {}, two: {}".format(one,two))
```

- Iterate over two lists, `l_one` and `l_two` and print each value

```
while x < 10:
  x += 1
```

- Run the code in the body of the loop until the value of `x` is no longer less than `10`

DATETIME

`import datetime as dt` - Import the `datetime` module
`now = dt.datetime.now()` - Assign `datetime` object representing the current time to `now`
`wks4 = dt.datetime.timedelta(weeks=4)` - Assign a `timedelta` object representing a timespan of 4 weeks to `wks4`
`now - wks4` - Return a `datetime` object representing the time 4 weeks prior to `now`
`newyear_2020 = dt.datetime(year=2020, month=12, day=31)` - Assign a `datetime` object representing December 25, 2020 to `newyear_2020`
`newyear_2020.strftime("%A, %b %d, %Y")` - Returns `"Thursday, Dec 31, 2020"`
`dt.datetime.strptime('Dec 31, 2020',"%b %d, %Y")` - Return a `datetime` object representing December 31, 2020

RANDOM

`import random` - Import the `random` module
`random.random()` - Returns a random float between `0.0` and `1.0`
`random.randint(0,10)` - Returns a random integer between `0` and `10`
`random.choice(l)` - Returns a random item from the list `l`

COUNTER

`from collections import Counter` - Import the `Counter` class
`c = Counter(l)` - Assign a `Counter` (dict-like) object with the counts of each unique item from `l`, to `c`
`c.most_common(3)` - Return the 3 most common items from `l`

TRY/EXCEPT

Catch and deal with Errors

`l_ints = [1, 2, 3, "", 5]` - Assign a list of integers with one missing value to `l_ints`

```
l_floats = []
for i in l_ints:
  try:
    l_floats.append(float(i))
  except:
    l_floats.append(i)
```

- Convert each value of `l_ints` to a float, catching and handling `ValueError: could not convert string to float:` where values are missing.

Data Science Cheat Sheet

Python Regular Expressions

SPECIAL CHARACTERS

`^` | Matches the expression to its right at the start of a string. It matches every such instance before each `\n` in the string.

`$` | Matches the expression to its left at the end of a string. It matches every such instance before each `\n` in the string.

`.` | Matches any character except line terminators like `\n`.

`\` | Escapes special characters or denotes character classes.

`A|B` | Matches expression `A` or `B`. If A is matched first, B is left untried.

`+` | Greedily matches the expression to its left 1 or more times.

`*` | Greedily matches the expression to its left 0 or more times.

`?` | Greedily matches the expression to its left 0 or 1 times. But if `?` is added to qualifiers (`+`, `*`, and `?` itself) it will perform matches in a non-greedy manner.

`{m}` | Matches the expression to its left `m` times, and not less.

`{m,n}` | Matches the expression to its left `m` to `n` times, and not less.

`{m,n}?` | Matches the expression to its left `m` times, and ignores `n`. See `?` above.

CHARACTER CLASSES [A.K.A. SPECIAL SEQUENCES]

`\w` | Matches alphanumeric characters, which means `a-z`, `A-Z`, and `0-9`. It also matches the underscore, `_`.

`\d` | Matches digits, which means `0-9`.

`\D` | Matches any non-digits.

`\s` | Matches whitespace characters, which include the `\t`, `\n`, `\r`, and space characters.

`\S` | Matches non-whitespace characters.

`\b` | Matches the boundary (or empty string) at the start and end of a word, that is, between `\w` and `\W`.

`\B` | Matches where `\b` does not, that is, the boundary of `\w` characters.

`\A` | Matches the expression to its right at the absolute start of a string whether in single or multi-line mode.

`\Z` | Matches the expression to its left at the absolute end of a string whether in single or multi-line mode.

SETS

`[ ]` | Contains a set of characters to match.

`[amk]` | Matches either `a`, `m`, or `k`. It does not match `amk`.

`[a-z]` | Matches any alphabet from `a` to `z`.

`[a\-z]` | Matches `a`, `-`, or `z`. It matches `-` because `\` escapes it.

`[a-]` | Matches `a` or `-`, because `-` is not being used to indicate a series of characters.

`[-a]` | As above, matches `a` or `-`.

`[a-z0-9]` | Matches characters from `a` to `z` and also from `0` to `9`.

`[(+*)]` | Special characters become literal inside a set, so this matches `(`, `+`, `*`, and `)`.

`[^ab5]` | Adding `^` excludes any character in the set. Here, it matches characters that are not `a`, `b`, or `5`.

GROUPS

`( )` | Matches the expression inside the parentheses and groups it.

`(?)` | Inside parentheses like this, `?` acts as an extension notation. Its meaning depends on the character immediately to its right.

`(?PAB)` | Matches the expression `AB`, and it can be accessed with the group name.

`(?aiLmsux)` | Here, `a`, `i`, `L`, `m`, `s`, `u`, and `x` are flags:

- `a` — Matches ASCII only
- `i` — Ignore case
- `L` — Locale dependent
- `m` — Multi-line
- `s` — Matches all
- `u` — Matches unicode
- `x` — Verbose

`(?:A)` | Matches the expression as represented by `A`, but unlike `(?PAB)`, it cannot be retrieved afterwards.

`(?#...)` | A comment. Contents are for us to read, not for matching.

`A(?=B)` | Lookahead assertion. This matches the expression `A` only if it is followed by `B`.

`A(?!B)` | Negative lookahead assertion. This matches the expression `A` only if it is not followed by `B`.

`(?<=B)A` | Positive lookbehind assertion. This matches the expression `A` only if `B` is immediately to its left. This can only matched fixed length expressions.

`(?<!B)A` | Negative lookbehind assertion. This matches the expression `A` only if `B` is not immediately to its left. This can only matched fixed length expressions.

`(?P=name)` | Matches the expression matched by an earlier group named "name".

`(...)\1` | The number `1` corresponds to the first group to be matched. If we want to match more instances of the same expression, simply use its number instead of writing out the whole expression again. We can use from `1` up to `99` such groups and their corresponding numbers.

POPULAR PYTHON RE MODULE FUNCTIONS

`re.findall(A, B)` | Matches all instances of an expression `A` in a string `B` and returns them in a list.

`re.search(A, B)` | Matches the first instance of an expression `A` in a string `B`, and returns it as a re match object.

`re.split(A, B)` | Split a string `B` into a list using the delimiter `A`.

`re.sub(A, B, C)` | Replace `A` with `B` in the string `C`.

Python For Data Science *Cheat Sheet*

Importing Data

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Importing Data in Python

Most of the time, you'll use either **NumPy** or **pandas** to import your data:

```
>>> import numpy as np
>>> import pandas as pd
```

Help

```
>>> np.info(np.ndarray.dtype)
>>> help(pd.read_csv)
```

Text Files

Plain Text Files

```
>>> filename = 'huck_finn.txt'
>>> file = open(filename, mode='r')
>>> text = file.read()
>>> print(file.closed)
>>> file.close()
>>> print(text)
```

Open the file for reading
Read a file's contents
Check whether file is closed
Close file

Using the context manager `with`

```
>>> with open('huck_finn.txt', 'r') as file:
        print(file.readline())
        print(file.readline())
        print(file.readline())
```

Read a single line

Table Data: Flat Files

Importing Flat Files with numpy

Files with one data type

```
>>> filename = 'mnist.txt'
>>> data = np.loadtxt(filename,
                      delimiter=',',
                      skiprows=2,
                      usecols=[0,2],
                      dtype=str)
```

String used to separate values
Skip the first 2 lines
Read the 1st and 3rd column
The type of the resulting array

Files with mixed data types

```
>>> filename = 'titanic.csv'
>>> data = np.genfromtxt(filename,
                         delimiter=',',
                         names=True,
                         dtype=None)
```

Look for column header

```
>>> data_array = np.recfromcsv(filename)
```

The default `dtype` of the `np.recfromcsv()` function is `None`.

Importing Flat Files with pandas

```
>>> filename = 'winequality-red.csv'
>>> data = pd.read_csv(filename,
                       nrows=5,
                       header=None,
                       sep='\t',
                       comment='#',
                       na_values[""])
```

Number of rows of file to read
Row number to use as col names
Delimiter to use
Character to split comments
String to recognize as NA/NaN

Excel Spreadsheets

```
>>> file = 'urbanpop.xlsx'
>>> data = pd.ExcelFile(file)
>>> df_sheet2 = data.parse('1960-1966',
                           skiprows=[0],
                           names=['Country',
                                  'AAM: War(2002)'])
>>> df_sheet1 = data.parse(0,
                           parse_cols=[0],
                           skiprows=[0],
                           names=['Country'])
```

To access the sheet names, use the `sheet_names` attribute:

```
>>> data.sheet_names
```

SAS Files

```
>>> from sas7bdat import SAS7BDAT
>>> with SAS7BDAT('urbanpop.sas7bdat') as file:
        df_sas = file.to_data_frame()
```

Stata Files

```
>>> data = pd.read_stata('urbanpop.dta')
```

Relational Databases

```
>>> from sqlalchemy import create_engine
>>> engine = create_engine('sqlite://Northwind.sqlite')
```

Use the `table_names()` method to fetch a list of table names:

```
>>> table_names = engine.table_names()
```

Querying Relational Databases

```
>>> con = engine.connect()
>>> rs = con.execute("SELECT * FROM Orders")
>>> df = pd.DataFrame(rs.fetchall())
>>> df.columns = rs.keys()
>>> con.close()
```

Using the context manager `with`

```
>>> with engine.connect() as con:
        rs = con.execute("SELECT OrderID FROM Orders")
        df = pd.DataFrame(rs.fetchmany(size=5))
        df.columns = rs.keys()
```

Querying relational databases with pandas

```
>>> df = pd.read_sql_query("SELECT * FROM Orders", engine)
```

Exploring Your Data

NumPy Arrays

```
>>> data_array.dtype
>>> data_array.shape
>>> len(data_array)
```

Data type of array elements
Array dimensions
Length of array

pandas DataFrames

```
>>> df.head()
>>> df.tail()
>>> df.index
>>> df.columns
>>> df.info()
>>> data_array = data.values
```

Return first DataFrame rows
Return last DataFrame rows
Describe index
Describe DataFrame columns
Info on DataFrame
Convert a DataFrame to an a NumPy array

Pickled Files

```
>>> import pickle
>>> with open('pickled_fruit.pkl', 'rb') as file:
        pickled_data = pickle.load(file)
```

HDF5 Files

```
>>> import h5py
>>> filename = 'H-H1_LOSC_4_v1-815411200-4096.hdf5'
>>> data = h5py.File(filename, 'r')
```

Matlab Files

```
>>> import scipy.io
>>> filename = 'workspace.mat'
>>> mat = scipy.io.loadmat(filename)
```

Exploring Dictionaries

Accessing Elements with Functions

```
>>> print(mat.keys())
>>> for key in data.keys():
        print(key)
meta
quality
strain
>>> pickled_data.values()
>>> print(mat.items())
```

Print dictionary keys
Print dictionary keys

Return dictionary values
Returns items in list format of (key, value) tuple pairs

Accessing Data Items with Keys

```
>>> for key in data ['meta'].keys()
        print(key)
Description
DescriptionURL
Detector
Duration
GPSstart
Observatory
Type
UTCstart
>>> print(data['meta']['Description'].value)
```

Explore the HDF5 structure

Retrieve the value for a key

Navigating Your FileSystem

Magic Commands

```
!ls
%cd ..
%pwd
```

List directory contents of files and directories
Change current working directory
Return the current working directory path

`os` Library

```
>>> import os
>>> path = "/usr/tmp"
>>> wd = os.getcwd()
>>> os.listdir(wd)
>>> os.chdir(path)
>>> os.rename("test1.txt",
              "test2.txt")
>>> os.remove("test1.txt")
>>> os.mkdir("newdir")
```

Store the name of current directory in a string
Output contents of the directory in a list
Change current working directory
Rename a file

Delete an existing file
Create a new directory

Python For Data Science *Cheat Sheet*

NumPy Basics

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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.

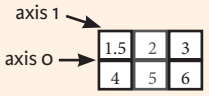
Use the following import convention:

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

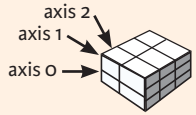
NumPy Arrays

1D array

2D array



3D array



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=" ")
```

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 values
>>> np.object      Python object type
>>> np.string_     Fixed-length string type
>>> np.unicode_    Fixed-length unicode type
```

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
```

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
>>> a.corrcoef()                       Correlation coefficient
>>> np.std(b)                          Standard deviation
```

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

Also see Lists

Subsetting


```
>>> a[2]
  3
```

Select the element at the 2nd index


```
>>> b[1,2]
  6.0
```

Select the element at row 1 column 2 (equivalent to `b[1][2]`)

Slicing


```
>>> a[0:2]
  array([1, 2])
```

Select items at index 0 and 1


```
>>> b[0:2,1]
  array([ 2.,  5.])
```

Select items at rows 0 and 1 in column 1


```
>>> b[:1]
  array([[1.5, 2., 3.]])
```

Select all items at row 0 (equivalent to `b[0:1, :]`)

```
>>> c[1,...]
  array([[[ 3.,  2.,  1.],
          [ 4.,  5.,  6.]]])
```

Same as `[1,:,:]`

```
>>> a[ : :-1]
  array([3, 2, 1])
```

Reversed array `a`

Boolean Indexing


```
>>> a[a<2]
  array([1])
```

Select elements from `a` less than 2

Fancy Indexing

```
>>> b[[1, 0, 1, 0],[0, 1, 2, 0]]
  array([ 4. , 2. , 6. , 1.5])
```

Select elements $(1,0)$, $(0,1)$, $(1,2)$ and $(0,0)$

```
>>> b[[1, 0, 1, 0]][:,[0,1,2,0]]
  array([[ 4. , 5. , 6. , 4. ],
         [ 1.5, 2. , 3. , 1.5],
         [ 4. , 5. , 6. , 4. ],
         [ 1.5, 2. , 3. , 1.5]])
```

Select a subset of the matrix's rows and columns

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

Python Cheat Sheet: NumPy

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Name	Description	Example
`a.shape`	The shape attribute of NumPy array a keeps a tuple of integers. Each integer describes the number of elements of the axis.	`a = np.array([[1,2],[1,1],[0,0]])` `print(np.shape(a))  # (3, 2)`
`a.ndim`	The ndim attribute is equal to the length of the shape tuple.	`print(np.ndim(a))  # 2`

`*`	The asterisk (star) operator performs the Hadamard product, i.e., multiplies two matrices with equal shape element-wise.	`a = np.array([[2, 0], [0, 2]])`
		`b = np.array([[1, 1], [1, 1]])`
		`print(a*b)  # [[2 0] [0 2]]`

`np.matmul(a,b), a@b`	The standard matrix multiplication operator. Equivalent to the @ operator.	`print(np.matmul(a,b))` `# [[2 2] [2 2]]`
`np.arange([start, ]stop, [step, ])`	Creates a new 1D numpy array with evenly spaced values	`print(np.arange(0,10,2))` `# [0 2 4 6 8]`
`np.linspace(start, stop, num=50)`	Creates a new 1D numpy array with evenly spread elements within the given interval	`print(np.linspace(0,10,3))` `# [ 0.  5. 10.]`
`np.average(a)`	Averages over all the values in the numpy array	`a = np.array([[2, 0], [0, 2]])` `print(np.average(a))  # 1.0`

`<slice> = <val>`	Replace the <slice> as selected by the slicing operator with the value <val>.	`a = np.array([0, 1, 0, 0, 0])`
		`a[::2] = 2`
		`print(a)  # [2 1 2 0 2]`

`np.var(a)`	Calculates the variance of a numpy array.	`a = np.array([2, 6])` `print(np.var(a))  # 4.0`
`np.std(a)`	Calculates the standard deviation of a numpy array	`print(np.std(a))  # 2.0`

`np.diff(a)`	Calculates the difference between subsequent values in NumPy array a	`fibs = np.array([0, 1, 1, 2, 3, 5])`
		`print(np.diff(fibs, n=1))`
		`# [1 0 1 1 2]`

`np.cumsum(a)`	Calculates the cumulative sum of the elements in NumPy array a.	`print(np.cumsum(np.arange(5)))` `# [ 0  1  3  6 10]`

`np.sort(a)`	Creates a new NumPy array with the values from a (ascending).	`a = np.array([10,3,7,1,0])`
		`print(np.sort(a))`
		`# [ 0  1  3  7 10]`

`np.argsort(a)`	Returns the indices of a NumPy array so that the indexed values would be sorted.	`a = np.array([10,3,7,1,0])`
		`print(np.argsort(a))`
		`# [4 3 1 2 0]`

`np.max(a)`	Returns the maximal value of NumPy array a.	`a = np.array([10,3,7,1,0])` `print(np.max(a))  # 10`
`np.argmax(a)`	Returns the index of the element with maximal value in the NumPy array a.	`a = np.array([10,3,7,1,0])` `print(np.argmax(a))  # 0`
`np.nonzero(a)`	Returns the indices of the nonzero elements in NumPy array a.	`a = np.array([10,3,7,1,0])` `print(np.nonzero(a))  # [0 1 2 3]`

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Python For Data Science *Cheat Sheet*

SciPy - Linear Algebra

Learn More Python for Data Science Interactively at www.datacamp.com

SciPy

The **SciPy** library is one of the core packages for scientific computing that provides mathematical algorithms and convenience functions built on the NumPy extension of Python.

Interacting With NumPy

Also see NumPy

```
>>> import numpy as np
>>> a = np.array([1,2,3])
>>> b = np.array([(1+5j,2j,3j), (4j,5j,6j)])
>>> c = np.array([[(1.5,2,3), (4,5,6)], [(3,2,1), (4,5,6)]])
```

Index Tricks

```
>>> np.mgrid[0:5,0:5]          Create a dense meshgrid
>>> np.ogrid[0:2,0:2]          Create an open meshgrid
>>> np.r_[[3,[0]*5,-1:1:10j]   Stack arrays vertically (row-wise)
>>> np.c_[b,c]                 Create stacked column-wise arrays
```

Shape Manipulation

```
>>> np.transpose(b)            Permute array dimensions
>>> b.flatten()                Flatten the array
>>> np.hstack((b,c))           Stack arrays horizontally (column-wise)
>>> np.vstack((a,b))           Stack arrays vertically (row-wise)
>>> np.hsplit(c,2)             Split the array horizontally at the 2nd index
>>> np.vpslit(d,2)             Split the array vertically at the 2nd index
```

Polynomials

```
>>> from numpy import poly1d
>>> p = poly1d([3,4,5])        Create a polynomial object
```

Vectorizing Functions

```
>>> def myfunc(a):
        if a < 0:
          return a*2
        else:
          return a/2
>>> np.vectorize(myfunc)       Vectorize functions
```

Type Handling

```
>>> np.real(c)                 Return the real part of the array elements
>>> np.imag(c)                 Return the imaginary part of the array elements
>>> np.real_if_close(c,tol=1000)  Return a real array if complex parts close to 0
>>> np.cast['f'](np.pi)        Cast object to a data type
```

Other Useful Functions

```
>>> np.angle(b,deg=True)       Return the angle of the complex argument
>>> g = np.linspace(0,np.pi,num=5)  Create an array of evenly spaced values
                                    (number of samples)
>>> g [3:] += np.pi
>>> np.unwrap(g)               Unwrap
>>> np.logspace(0,10,3)        Create an array of evenly spaced values (log scale)
>>> np.select([c<4],[c*2])     Return values from a list of arrays depending on
                               conditions
>>> misc.factorial(a)          Factorial
>>> misc.comb(10,3,exact=True)  Combine N things taken at k time
>>> misc.central_diff_weights(3)  Weights for Np-point central derivative
>>> misc.derivative(myfunc,1.0)  Find the n-th derivative of a function at a point
```

Linear Algebra

Also see NumPy

You'll use the `linalg` and `sparse` modules. Note that `scipy.linalg` contains and expands on `numpy.linalg`.

```
>>> from scipy import linalg, sparse
```

Creating Matrices

```
>>> A = np.matrix(np.random.random((2,2)))
>>> B = np.asmatrix(b)
>>> C = np.mat(np.random.random((10,5)))
>>> D = np.mat([[3,4], [5,6]])
```

Basic Matrix Routines

Inverse

```
>>> A.I                        Inverse
>>> linalg.inv(A)              Inverse
>>> A.T                        Tranpose matrix
>>> A.H                        Conjugate transposition
>>> np.trace(A)                Trace
```

Norm

```
>>> linalg.norm(A)             Frobenius norm
>>> linalg.norm(A,1)           L1 norm (max column sum)
>>> linalg.norm(A,np.inf)      L inf norm (max row sum)
```

Rank

```
>>> np.linalg.matrix_rank(C)   Matrix rank
```

Determinant

```
>>> linalg.det(A)              Determinant
```

Solving linear problems

```
>>> linalg.solve(A,b)          Solver for dense matrices
>>> E = np.mat(a).T            Solver for dense matrices
>>> linalg.lstsq(D,E)          Least-squares solution to linear matrix
                               equation
```

Generalized inverse

```
>>> linalg.pinv(C)             Compute the pseudo-inverse of a matrix
                               (least-squares solver)
>>> linalg.pinv2(C)            Compute the pseudo-inverse of a matrix
                               (SVD)
```

Creating Sparse Matrices

```
>>> F = np.eye(3, k=1)         Create a 2X2 identity matrix
>>> G = np.mat(np.identity(2)) Create a 2x2 identity matrix
>>> C[C > 0.5] = 0
>>> H = sparse.csr_matrix(C)   Compressed Sparse Row matrix
>>> I = sparse.csc_matrix(D)   Compressed Sparse Column matrix
>>> J = sparse.dok_matrix(A)   Dictionary Of Keys matrix
>>> E.todense()                Sparse matrix to full matrix
>>> sparse.isspmatrix_csc(A)   Identify sparse matrix
```

Sparse Matrix Routines

Inverse

```
>>> sparse.linalg.inv(I)       Inverse
```

Norm

```
>>> sparse.linalg.norm(I)      Norm
```

Solving linear problems

```
>>> sparse.linalg.spsolve(H,I)  Solver for sparse matrices
```

Sparse Matrix Functions

```
>>> sparse.linalg.expm(I)      Sparse matrix exponential
```

Matrix Functions

Addition

```
>>> np.add(A,D)                Addition
```

Subtraction

```
>>> np.subtract(A,D)           Subtraction
```

Division

```
>>> np.divide(A,D)             Division
```

Multiplication

```
>>> np.multiply(D,A)           Multiplication
>>> np.dot(A,D)                Dot product
>>> np.vdot(A,D)               Vector dot product
>>> np.inner(A,D)              Inner product
>>> np.outer(A,D)              Outer product
>>> np.tensordot(A,D)          Tensor dot product
>>> np.kron(A,D)               Kronecker product
```

Exponential Functions

```
>>> linalg.expm(A)             Matrix exponential
>>> linalg.expm2(A)            Matrix exponential (Taylor Series)
>>> linalg.expm3(D)            Matrix exponential (eigenvalue
                               decomposition)
```

Logarithm Function

```
>>> linalg.logm(A)             Matrix logarithm
```

Trigonometric Tunctions

```
>>> linalg.sinm(D)             Matrix sine
>>> linalg.cosm(D)             Matrix cosine
>>> linalg.tanm(A)             Matrix tangent
```

Hyperbolic Trigonometric Functions

```
>>> linalg.sinhm(D)            Hypberbolic matrix sine
>>> linalg.coshm(D)            Hyperbolic matrix cosine
>>> linalg.tanhm(A)            Hyperbolic matrix tangent
```

Matrix Sign Function

```
>>> np.sigm(A)                 Matrix sign function
```

Matrix Square Root

```
>>> linalg.sqrtm(A)            Matrix square root
```

Arbitrary Functions

```
>>> linalg.funm(A, lambda x: x*x)  Evaluate matrix function
```

Decompositions

Eigenvalues and Eigenvectors

```
>>> la, v = linalg.eig(A)      Solve ordinary or generalized
                               eigenvalue problem for square matrix
>>> l1, l2 = la                Unpack eigenvalues
>>> v[:,0]                     First eigenvector
>>> v[:,1]                     Second eigenvector
>>> linalg.eigvals(A)          Unpack eigenvalues
```

Singular Value Decomposition

```
>>> U,s,Vh = linalg.svd(B)     Singular Value Decomposition (SVD)
>>> M,N = B.shape
>>> Sig = linalg.diagsvd(s,M,N)  Construct sigma matrix in SVD
```

LU Decomposition

```
>>> P,L,U = linalg.lu(C)       LU Decomposition
```

Sparse Matrix Decompositions

```
>>> la, v = sparse.linalg.eigs(F,1)  Eigenvalues and eigenvectors
>>> sparse.linalg.svds(H, 2)         SVD
```

Asking For Help

```
>>> help(scipy.linalg.diagsvd)
>>> np.info(np.matrix)
```

Python For Data Science *Cheat Sheet*

Pandas Basics

Learn Python for Data Science Interactively at www.DataCamp.com

Pandas

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

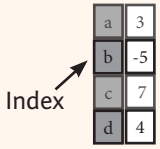
Use the following import convention:

```
>>> import pandas as pd
```

Pandas Data Structures

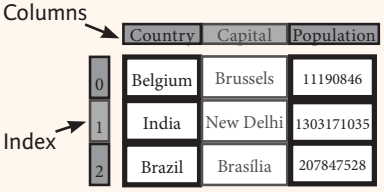
Series

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




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

DataFrame



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

```
>>> data = {'Country': ['Belgium', 'India', 'Brazil'],
            'Capital': ['Brussels', 'New Delhi', 'Brasília'],
            'Population': [11190846, 1303171035, 207847528]}

>>> df = pd.DataFrame(data,
                      columns=['Country', 'Capital', 'Population'])
```

Asking For Help

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

Selection

Also see NumPy Arrays

Getting

```
>>> s['b']
 -5

>>> df[1:]
   Country    Capital  Population
 1   India  New Delhi  1303171035
 2  Brazil   Brasília   207847528
```

Get one element

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    Brasília
Population  207847528
```

Select single row of subset of rows

```
>>> df.ix[:,'Capital']
0     Brussels
1    New Delhi
2     Brasília
```

Select a single column of subset of columns

```
>>> df.ix[1,'Capital']
 'New Delhi'
```

Select rows and columns

Boolean Indexing

```
>>> s[~(s > 1)]
>>> s[(s < -1)  |  (s > 2)]
>>> df[df['Population']>1200000000]
```

Series `s` where value is not >1
`s` where value is <-1 or >2
Use filter to adjust DataFrame

Setting

```
>>> s['a'] = 6
```

Set index `a` of Series `s` to 6

Dropping

```
>>> s.drop(['a', 'c'])
>>> df.drop('Country', axis=1)
```

Drop values from rows (axis=0)
Drop values from columns(axis=1)

Sort & Rank

```
>>> df.sort_index()
>>> df.sort_values(by='Country')
>>> df.rank()
```

Sort by labels along an axis
Sort by the values along an axis
Assign ranks to entries

Retrieving Series/DataFrame Information

Basic Information

```
>>> df.shape
>>> df.index
>>> df.columns
>>> df.info()
>>> df.count()
```

(rows,columns)
Describe index
Describe DataFrame columns
Info on DataFrame
Number of non-NA values

Summary

```
>>> df.sum()
>>> df.cumsum()
>>> df.min()/df.max()
>>> df.idxmin()/df.idxmax()
>>> df.describe()
>>> df.mean()
>>> df.median()
```

Sum of values
Cummulative sum of values
Minimum/maximum values
Minimum/Maximum index value
Summary statistics
Mean of values
Median of values

Applying Functions

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

Apply function
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)
>>> s.mul(s3, fill_value=3)
```

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)
```

Data Science Cheat Sheet

Pandas

KEY

We'll use shorthand in this cheat sheet

`df` - A pandas DataFrame object

`s` - A pandas Series object

IMPORTS

Import these to start

```
import pandas as pd
import numpy as np
```

IMPORTING DATA

`pd.read_csv(filename)` - From a CSV file

`pd.read_table(filename)` - From a delimited text file (like TSV)

`pd.read_excel(filename)` - From an Excel file

`pd.read_sql(query, connection_object)` - Reads from a SQL table/database

`pd.read_json(json_string)` - Reads from a JSON formatted string, URL or file.

`pd.read_html(url)` - Parses an html URL, string or file and extracts tables to a list of dataframes

`pd.read_clipboard()` - Takes the contents of your clipboard and passes it to `read_table()`

`pd.DataFrame(dict)` - From a dict, keys for columns names, values for data as lists

EXPORTING DATA

`df.to_csv(filename)` - Writes to a CSV file

`df.to_excel(filename)` - Writes to an Excel file

`df.to_sql(table_name, connection_object)` - Writes to a SQL table

`df.to_json(filename)` - Writes to a file in JSON format

`df.to_html(filename)` - Saves as an HTML table

`df.to_clipboard()` - Writes to the clipboard

CREATE TEST OBJECTS

Useful for testing

`pd.DataFrame(np.random.rand(20,5))` - 5 columns and 20 rows of random floats

`pd.Series(my_list)` - Creates a series from an iterable `my_list`

`df.index = pd.date_range('1900/1/30', periods=df.shape[0])` - Adds a date index

VIEWING/INSPECTING DATA

`df.head(n)` - First `n` rows of the DataFrame

`df.tail(n)` - Last `n` rows of the DataFrame

`df.shape` - Number of rows and columns

`df.info()` - Index, Datatype and Memory information

`df.describe()` - Summary statistics for numerical columns

`s.value_counts(dropna=False)` - Views unique values and counts

`df.apply(pd.Series.value_counts)` - Unique values and counts for all columns

SELECTION

`df[col]` - Returns column with label `col` as Series

`df[[col1, col2]]` - Returns Columns as a new DataFrame

`s.iloc[0]` - Selection by position

`s.loc[0]` - Selection by index

`df.iloc[0,:]` - First row

`df.iloc[0,0]` - First element of first column

DATA CLEANING

`df.columns = ['a','b','c']` - Renames columns

`pd.isnull()` - Checks for null Values, Returns Boolean Array

`pd.notnull()` - Opposite of `s.isnull()`

`df.dropna()` - Drops all rows that contain null values

`df.dropna(axis=1)` - Drops all columns that contain null values

`df.dropna(axis=1,thresh=n)` - Drops all rows have have less than `n` non null values

`df.fillna(x)` - Replaces all null values with `x`

`s.fillna(s.mean())` - Replaces all null values with the mean (mean can be replaced with almost any function from the statistics section)

`s.astype(float)` - Converts the datatype of the series to float

`s.replace(1,'one')` - Replaces all values equal to `1` with `'one'`

`s.replace([1,3],['one','three'])` - Replaces all `1` with `'one'` and `3` with `'three'`

`df.rename(columns=lambda x: x + 1)` - Mass renaming of columns

`df.rename(columns={'old_name': 'new_name'})` - Selective renaming

`df.set_index('column_one')` - Changes the index

`df.rename(index=lambda x: x + 1)` - Mass renaming of index

FILTER, SORT, & GROUPBY

`df[df[col] > 0.5]` - Rows where the `col` column is greater than `0.5`

`df[(df[col] > 0.5) & (df[col] < 0.7)]` - Rows where `0.7 > col > 0.5`

`df.sort_values(col1)` - Sorts values by `col1` in ascending order

`df.sort_values(col2,ascending=False)` - Sorts values by `col2` in descending order

`df.sort_values([col1,col2], ascending=[True,False])` - Sorts values by `col1` in ascending order then `col2` in descending order

`df.groupby(col)` - Returns a groupby object for values from one column

`df.groupby([col1,col2])` - Returns a groupby object values from multiple columns

`df.groupby(col1)[col2].mean()` - Returns the mean of the values in `col2`, grouped by the values in `col1` (mean can be replaced with almost any function from the statistics section)

`df.pivot_table(index=col1,values=[col2,col3],aggfunc=mean)` - Creates a pivot table that groups by `col1` and calculates the mean of `col2` and `col3`

`df.groupby(col1).agg(np.mean)` - Finds the average across all columns for every unique column 1 group

`df.apply(np.mean)` - Applies a function across each column

`df.apply(np.max, axis=1)` - Applies a function across each row

JOIN/COMBINE

`df1.append(df2)` - Adds the rows in `df1` to the end of `df2` (columns should be identical)

`pd.concat([df1, df2],axis=1)` - Adds the columns in `df1` to the end of `df2` (rows should be identical)

`df1.join(df2,on=col1,how='inner')` - SQL-style joins the columns in `df1` with the columns on `df2` where the rows for `col` have identical values. `how` can be one of `'left'`, `'right'`, `'outer'`, `'inner'`

STATISTICS

These can all be applied to a series as well.

`df.describe()` - Summary statistics for numerical columns

`df.mean()` - Returns the mean of all columns

`df.corr()` - Returns the correlation between columns in a DataFrame

`df.count()` - Returns the number of non-null values in each DataFrame column

`df.max()` - Returns the highest value in each column

`df.min()` - Returns the lowest value in each column

`df.median()` - Returns the median of each column

`df.std()` - Returns the standard deviation of each column

Python For Data Science *Cheat Sheet*

Pandas

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Reshaping Data

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

Stack / Unstack

```
>>> stacked = df5.stack()
>>> stacked.unstack()
```

Pivot a level of column labels
Pivot a level of index labels

		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

Iteration

```
>>> df.iteritems()
>>> df.iterrows()
```

(Column-index, Series) pairs
(Row-index, Series) pairs

Advanced Indexing

Also see NumPy Arrays

Selecting

```
>>> df3.loc[:,(df3>1).any()]
>>> df3.loc[:,(df3>1).all()]
>>> df3.loc[:,df3.isnull().any()]
>>> df3.loc[:,df3.notnull().all()]
```

Select cols with any vals >1
Select cols with vals > 1
Select cols with NaN
Select cols without NaN

Indexing With isin

```
>>> df[(df.Country.isin(df2.Type))]
>>> df3.filter(items="a","b"])
>>> df.select(lambda x: not x%5)
```

Find same elements
Filter on values
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')
>>> df4 = df.reset_index()
>>> df = df.rename(index=str,
                   columns={"Country":"cntry",
                            "Capital":"cptl",
                            "Population":"ppltn"})
```

Set the index
Reset the index
Rename DataFrame

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

Backward 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()
>>> df2.duplicated('Type')
>>> df2.drop_duplicates('Type', keep='last')
>>> df.index.duplicated()
```

Return unique values
Check duplicates
Drop duplicates
Check index 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()
>>> df3.fillna(df3.mean())
>>> df2.replace("a", "f")
```

Drop NaN values
Fill NaN values with a predetermined value
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

Merge

```
>>> 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	20.784

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

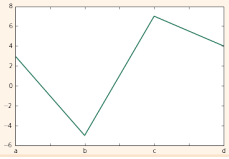
```
>>> df2['Date']= pd.to_datetime(df2['Date'])
>>> df2['Date']= pd.date_range('2000-1-1',
                               periods=6,
                               freq='M')
>>> dates = [datetime(2012,5,1), datetime(2012,5,2)]
>>> index = pd.DatetimeIndex(dates)
>>> index = pd.date_range(datetime(2012,2,1),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

Visualization

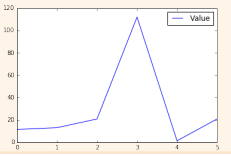
Also see Matplotlib

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

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



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



Python For Data Science *Cheat Sheet*

Matplotlib

Learn Python Interactively at www.DataCamp.com

Matplotlib

Matplotlib is a Python 2D plotting library which produces publication-quality figures in a variety of hardcopy formats and interactive environments across platforms.

matplotlib

1 Prepare The Data

Also see Lists & NumPy

1D Data

```
>>> import numpy as np
>>> x = np.linspace(0, 10, 100)
>>> y = np.cos(x)
>>> z = np.sin(x)
```

2D Data or Images

```
>>> data = 2 * np.random.random((10, 10))
>>> data2 = 3 * np.random.random((10, 10))
>>> Y, X = np.mgrid[-3:3:100j, -3:3:100j]
>>> U = -1 - X**2 + Y
>>> V = 1 + X - Y**2
>>> from matplotlib.cbook import get_sample_data
>>> img = np.load(get_sample_data('axes_grid/bivariate_normal.npy'))
```

2 Create Plot

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

Figure

```
>>> fig = plt.figure()
>>> fig2 = plt.figure(figsize=plt.figaspect(2.0))
```

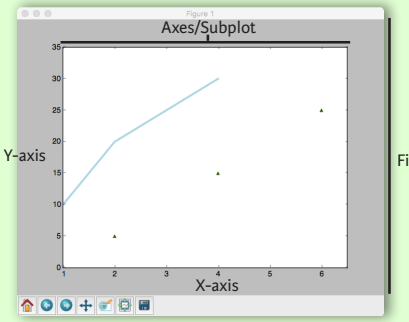
Axes

All plotting is done with respect to an `Axes`. In most cases, a subplot will fit your needs. A subplot is an axes on a grid system.

```
>>> fig.add_axes()
>>> ax1 = fig.add_subplot(221) # row-col-num
>>> ax3 = fig.add_subplot(212)
>>> fig3, axes = plt.subplots(nrows=2,ncols=2)
>>> fig4, axes2 = plt.subplots(ncols=3)
```

Plot Anatomy & Workflow

Plot Anatomy



Workflow

The basic steps to creating plots with matplotlib are:

1 Prepare data 2 Create plot 3 Plot 4 Customize plot 5 Save plot 6 Show plot

```
>>> import matplotlib.pyplot as plt
>>> x = [1,2,3,4]                          Step 1
>>> y = [10,20,25,30]
>>> fig = plt.figure()                     Step 2
>>> ax = fig.add_subplot(111)              Step 3
>>> ax.plot(x, y, color='lightblue', linewidth=3)   Step 3, 4
>>> ax.scatter([2,4,6],
               [5,15,25],
               color='darkgreen',
               marker='^')
>>> ax.set_xlim(1, 6.5)
>>> plt.savefig('foo.png')
>>> plt.show()                             Step 6
```

4 Customize Plot

Colors, Color Bars & Color Maps

```
>>> plt.plot(x, x, x, x**2, x, x**3)
>>> ax.plot(x, y, alpha = 0.4)
>>> ax.plot(x, y, c='k')
>>> fig.colorbar(im, orientation='horizontal')
>>> im = ax.imshow(img,
                   cmap='seismic')
```

Markers

```
>>> fig, ax = plt.subplots()
>>> ax.scatter(x,y,marker=".")
>>> ax.plot(x,y,marker="o")
```

Linestyles

```
>>> plt.plot(x,y,linewidth=4.0)
>>> plt.plot(x,y,ls='solid')
>>> plt.plot(x,y,ls='--')
>>> plt.plot(x,y,'--',x**2,y**2,'-.')
>>> plt.setp(lines,color='r',linewidth=4.0)
```

Text & Annotations

```
>>> ax.text(1,
            -2.1,
            'Example Graph',
            style='italic')
>>> ax.annotate("Sine",
                xy=(8, 0),
                xycoords='data',
                xytext=(10.5, 0),
                textcoords='data',
                arrowprops=dict(arrowstyle="->",
                                connectionstyle="arc3"),)
```

Mathtext

```
>>> plt.title(r'$sigma_i=15$', fontsize=20)
```

Limits, Legends & Layouts

Limits & Autoscaling

```
>>> ax.margins(x=0.0,y=0.1)                  Add padding to a plot
>>> ax.axis('equal')                         Set the aspect ratio of the plot to 1
>>> ax.set(xlim=[0,10.5],ylim=[-1.5,1.5])    Set limits for x-and y-axis
>>> ax.set_xlim(0,10.5)                      Set limits for x-axis
```

Legends

```
>>> ax.set(title='An Example Axes',          Set a title and x-and y-axis labels
           ylabel='Y-Axis',
           xlabel='X-Axis')
>>> ax.legend(loc='best')                    No overlapping plot elements
```

Ticks

```
>>> ax.xaxis.set(ticks=range(1,5),           Manually set x-ticks
                 ticklabels=[3,100,-12,"foo"])
>>> ax.tick_params(axis='y',                 Make y-ticks longer and go in and out
                   direction='inout',
                   length=10)
```

Subplot Spacing

```
>>> fig3.subplots_adjust(wspace=0.5,         Adjust the spacing between subplots
                         hspace=0.3,
                         left=0.125,
                         right=0.9,
                         top=0.9,
                         bottom=0.1)
>>> fig.tight_layout()                       Fit subplot(s) in to the figure area
```

Axis Spines

```
>>> ax1.spines['top'].set_visible(False)     Make the top axis line for a plot invisible
>>> ax1.spines['bottom'].set_position(('outward',10))   Move the bottom axis line outward
```

3 Plotting Routines

1D Data

```
>>> fig, ax = plt.subplots()
>>> lines = ax.plot(x,y)                     Draw points with lines or markers connecting them
>>> ax.scatter(x,y)                          Draw unconnected points, scaled or colored
>>> axes[0,0].bar([1,2,3],[3,4,5])           Plot vertical rectangles (constant width)
>>> axes[1,0].barh([0.5,1,2.5],[0,1,2])      Plot horiontal rectangles (constant height)
>>> axes[1,1].axhline(0.45)                  Draw a horizontal line across axes
>>> axes[0,1].axvline(0.65)                  Draw a vertical line across axes
>>> ax.fill(x,y,color='blue')                Draw filled polygons
>>> ax.fill_between(x,y,color='yellow')      Fill between y-values and o
```

Vector Fields

```
>>> axes[0,1].arrow(0,0,0.5,0.5)             Add an arrow to the axes
>>> axes[1,1].quiver(y,z)                    Plot a 2D field of arrows
>>> axes[0,1].streamplot(X,Y,U,V)            Plot a 2D field of arrows
```

Data Distributions

```
>>> ax1.hist(y)                              Plot a histogram
>>> ax3.boxplot(y)                           Make a box and whisker plot
>>> ax3.violinplot(z)                        Make a violin plot
```

2D Data or Images

```
>>> fig, ax = plt.subplots()
>>> im = ax.imshow(img,                      Colormapped or RGB arrays
                   cmap='gist_earth',
                   interpolation='nearest',
                   vmin=-2,
                   vmax=2)
```

```
>>> axes2[0].pcolor(data2)                   Pseudocolor plot of 2D array
>>> axes2[0].pcolormesh(data)                Pseudocolor plot of 2D array
>>> CS = plt.contour(Y,X,U)                  Plot contours
>>> axes2[2].contourf(data1)                 Plot filled contours
>>> axes2[2]= ax.clabel(CS)                  Label a contour plot
```

5 Save Plot

Save figures

```
>>> plt.savefig('foo.png')
```

Save transparent figures

```
>>> plt.savefig('foo.png', transparent=True)
```

6 Show Plot

```
>>> plt.show()
```

Close & Clear

```
>>> plt.cla()                                Clear an axis
>>> plt.clf()                                Clear the entire figure
>>> plt.close()                              Close a window
```

Python For Data Science *Cheat Sheet*

Seaborn

Learn Data Science Interactively at www.DataCamp.com

Statistical Data Visualization With Seaborn

The Python visualization library **Seaborn** is based on matplotlib and provides a high-level interface for drawing attractive statistical graphics.

Make use of the following aliases to import the libraries:

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

The basic steps to creating plots with Seaborn are:

1. Prepare some data
2. Control figure aesthetics
3. Plot with Seaborn
4. Further customize your plot

```
>>> import matplotlib.pyplot as plt
>>> import seaborn as sns
>>> tips = sns.load_dataset("tips")                    Step 1
>>> sns.set_style("whitegrid")                         Step 2
>>> g = sns.lmplot(x="tip",                            Step 3
                   y="total_bill",
                   data=tips,
                   aspect=2)
>>> g = (g.set_axis_labels("Tip","Total bill(USD)").
set(xlim=(0,10),ylim=(0,100)))                         Step 4
>>> plt.title("title")
>>> plt.show(g)                                        Step 5
```

1 Data

Also see Lists, NumPy & Pandas

```
>>> import pandas as pd
>>> import numpy as np
>>> uniform_data = np.random.rand(10, 12)
>>> data = pd.DataFrame({'x':np.arange(1,101),
                         'y':np.random.normal(0,4,100)})
```

Seaborn also offers built-in data sets:

```
>>> titanic = sns.load_dataset("titanic")
>>> iris = sns.load_dataset("iris")
```

2 Figure Aesthetics

Also see Matplotlib

```
>>> f, ax = plt.subplots(figsize=(5,6))
```
Create a figure and one subplot

Seaborn styles

```
>>> sns.set()
>>> sns.set_style("whitegrid")
>>> sns.set_style("ticks",
                  {"xtick.major.size":8,
                   "ytick.major.size":8})
>>> sns.axes_style("whitegrid")
```
(Re)set the seaborn default
Set the matplotlib parameters
Set the matplotlib parameters

Return a dict of params or use with `with` to temporarily set the style

Context Functions

```
>>> sns.set_context("talk")
>>> sns.set_context("notebook",
                    font_scale=1.5,
                    rc={"lines.linewidth":2.5})
```
Set context to `"talk"`
Set context to `"notebook"`, scale font elements and override param mapping

Color Palette

```
>>> sns.set_palette("husl",3)
>>> sns.color_palette("husl")
>>> flatui = ["#9b59b6","#3498db","#95a5a6","#e74c3c","#34495e","#2ecc71"]
>>> sns.set_palette(flatui)
```
Define the color palette
Use with `with` to temporarily set palette
Set your own color palette

3 Plotting With Seaborn

Axis Grids

```
>>> g = sns.FacetGrid(titanic,
                      col="survived",
                      row="sex")
>>> g = g.map(plt.hist,"age")
```
Subplot grid for plotting conditional relationships

```
>>> sns.factorplot(x="pclass",
                   y="survived",
                   hue="sex",
                   data=titanic)
```
Draw a categorical plot onto a Facetgrid

```
>>> sns.lmplot(x="sepal_width",
               y="sepal_length",
               hue="species",
               data=iris)
```
Plot data and regression model fits across a FacetGrid

```
>>> h = sns.PairGrid(iris)
>>> h = h.map(plt.scatter)
>>> sns.pairplot(iris)
```
Subplot grid for plotting pairwise relationships
Plot pairwise bivariate distributions

```
>>> i = sns.JointGrid(x="x",
                      y="y",
                      data=data)
>>> i = i.plot(sns.regplot,
               sns.distplot)
```
Grid for bivariate plot with marginal univariate plots

```
>>> sns.jointplot("sepal_length",
                  "sepal_width",
                  data=iris,
                  kind='kde')
```
Plot bivariate distribution

Categorical Plots

Scatterplot

```
>>> sns.stripplot(x="species",
                  y="petal_length",
                  data=iris)
```
Scatterplot with one categorical variable

```
>>> sns.swarmplot(x="species",
                  y="petal_length",
                  data=iris)
```
Categorical scatterplot with non-overlapping points

Bar Chart

```
>>> sns.barplot(x="sex",
                y="survived",
                hue="class",
                data=titanic)
```
Show point estimates and confidence intervals with scatterplot glyphs

Count Plot

```
>>> sns.countplot(x="deck",
                  data=titanic,
                  palette="Greens_d")
```
Show count of observations

Point Plot

```
>>> sns.pointplot(x="class",
                  y="survived",
                  hue="sex",
                  data=titanic,
                  palette={"male":"g",
                           "female":"m"},
                  markers=["^","o"],
                  linestyles=["-","--"])
```
Show point estimates and confidence intervals as rectangular bars

Boxplot

```
>>> sns.boxplot(x="alive",
                y="age",
                hue="adult_male",
                data=titanic)
```
Boxplot

```
>>> sns.boxplot(data=iris,orient="h")
```
Boxplot with wide-form data

Violinplot

```
>>> sns.violinplot(x="age",
                   y="sex",
                   hue="survived",
                   data=titanic)
```
Violin plot

Regression Plots

```
>>> sns.regplot(x="sepal_width",
                y="sepal_length",
                data=iris,
                ax=ax)
```
Plot data and a linear regression model fit

Distribution Plots

```
>>> plot = sns.distplot(data.y,
                        kde=False,
                        color="b")
```
Plot univariate distribution

Matrix Plots

```
>>> sns.heatmap(uniform_data,vmin=0,vmax=1)
```
Heatmap

4 Further Customizations

Also see Matplotlib

Axisgrid Objects

```
>>> g.despine(left=True)
>>> g.set_ylabels("Survived")
>>> g.set_xticklabels(rotation=45)
>>> g.set_axis_labels("Survived",
                      "Sex")
```
Remove left spine
Set the labels of the y-axis
Set the tick labels for x
Set the axis labels

```
>>> h.set(xlim=(0,5),
          ylim=(0,5),
          xticks=[0,2.5,5],
          yticks=[0,2.5,5])
```
Set the limit and ticks of the x-and y-axis

Plot

```
>>> plt.title("A Title")
>>> plt.ylabel("Survived")
>>> plt.xlabel("Sex")
>>> plt.ylim(0,100)
>>> plt.xlim(0,10)
>>> plt.setp(ax,yticks=[0,5])
>>> plt.tight_layout()
```
Add plot title
Adjust the label of the y-axis
Adjust the label of the x-axis
Adjust the limits of the y-axis
Adjust the limits of the x-axis
Adjust a plot property
Adjust subplot params

5 Show or Save Plot

Also see Matplotlib

```
>>> plt.show()
>>> plt.savefig("foo.png")
>>> plt.savefig("foo.png",
                transparent=True)
```
Show the plot
Save the plot as a figure
Save transparent figure

Close & Clear

Also see Matplotlib

```
>>> plt.cla()
>>> plt.clf()
>>> plt.close()
```
Clear an axis
Clear an entire figure
Close a window

Python For Data Science *Cheat Sheet*

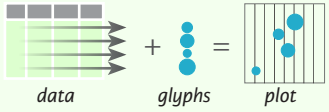
Bokeh

Learn Bokeh Interactively at www.DataCamp.com, taught by Bryan Van de Ven, core contributor

Plotting With Bokeh

The Python interactive visualization library **Bokeh** enables high-performance visual presentation of large datasets in modern web browsers.

Bokeh's mid-level general purpose `bokeh.plotting` interface is centered around two main components: data and glyphs.



The basic steps to creating plots with the `bokeh.plotting` interface are:

1. Prepare some data:

Python lists, NumPy arrays, Pandas DataFrames and other sequences of values

2. Create a new plot
3. Add renderers for your data, with visual customizations
4. Specify where to generate the output
5. Show or save the results

```
>>> from bokeh.plotting import figure
>>> from bokeh.io import output_file, show
>>> x = [1, 2, 3, 4, 5]                          Step 1
>>> y = [6, 7, 2, 4, 5]
>>> p = figure(title="simple line example",      Step 2
              x_axis_label='x',
              y_axis_label='y')
>>> p.line(x, y, legend="Temp.", line_width=2)   Step 3
>>> output_file("lines.html")                    Step 4
>>> show(p)                                      Step 5
```

1 Data

Also see Lists, NumPy & Pandas

Under the hood, your data is converted to Column Data Sources. You can also do this manually:

```
>>> import numpy as np
>>> import pandas as pd
>>> df = pd.DataFrame(np.array([[33.9,4,65, 'US'],
                                [32.4,4,66, 'Asia'],
                                [21.4,4,109, 'Europe']]),
                      columns=['mpg','cyl', 'hp', 'origin'],
                      index=['Toyota', 'Fiat', 'Volvo'])
```

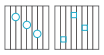
```
>>> from bokeh.models import ColumnDataSource
>>> cds_df = ColumnDataSource(df)
```

2 Plotting

```
>>> from bokeh.plotting import figure
>>> p1 = figure(plot_width=300, tools='pan,box_zoom')
>>> p2 = figure(plot_width=300, plot_height=300,
                x_range=(0, 8), y_range=(0, 8))
>>> p3 = figure()
```

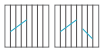
3 Renderers & Visual Customizations

Glyphs



Scatter Markers

```
>>> p1.circle(np.array([1,2,3]), np.array([3,2,1]),
              fill_color='white')
>>> p2.square(np.array([1.5,3.5,5.5]), [1,4,3],
              color='blue', size=1)
```



Line Glyphs

```
>>> p1.line([1,2,3,4], [3,4,5,6], line_width=2)
>>> p2.multi_line(pd.DataFrame([[1,2,3],[5,6,7]]),
                  pd.DataFrame([[3,4,5],[3,2,1]]),
                  color="blue")
```

Customized Glyphs

Also see Data

Selection and Non-Selection Glyphs

```
>>> p = figure(tools='box_select')
>>> p.circle('mpg', 'cyl', source=cds_df,
             selection_color='red',
             nonselection_alpha=0.1)
```

Hover Glyphs

```
>>> from bokeh.models import HoverTool
>>> hover = HoverTool(tooltips=None, mode='vline')
>>> p3.add_tools(hover)
```

Colormapping

```
>>> from bokeh.models import CategoricalColorMapper
>>> color_mapper = CategoricalColorMapper(
                   factors=['US', 'Asia', 'Europe'],
                   palette=['blue', 'red', 'green'])
>>> p3.circle('mpg', 'cyl', source=cds_df,
             color=dict(field='origin',
                        transform=color_mapper),
             legend='Origin')
```

Legend Location

Inside Plot Area

```
>>> p.legend.location = 'bottom_left'
```

Outside Plot Area

```
>>> from bokeh.models import Legend
>>> r1 = p2.asterisk(np.array([1,2,3]), np.array([3,2,1])
>>> r2 = p2.line([1,2,3,4], [3,4,5,6])
>>> legend = Legend(items=[("One" ,[p1, r1]),("Two",[r2])],
                    location=(0, -30))
>>> p.add_layout(legend, 'right')
```

Legend Orientation

```
>>> p.legend.orientation = "horizontal"
>>> p.legend.orientation = "vertical"
```

Legend Background & Border

```
>>> p.legend.border_line_color = "navy"
>>> p.legend.background_fill_color = "white"
```

Rows & Columns Layout

Rows

```
>>> from bokeh.layouts import row
>>> layout = row(p1,p2,p3)
```

Columns

```
>>> from bokeh.layouts import columns
>>> layout = column(p1,p2,p3)
```

Nesting Rows & Columns

```
>>>layout = row(column(p1,p2), p3)
```

Grid Layout

```
>>> from bokeh.layouts import gridplot
>>> row1 = [p1,p2]
>>> row2 = [p3]
>>> layout = gridplot([[p1,p2],[p3]])
```

Tabbed Layout

```
>>> from bokeh.models.widgets import Panel, Tabs
>>> tab1 = Panel(child=p1, title="tab1")
>>> tab2 = Panel(child=p2, title="tab2")
>>> layout = Tabs(tabs=[tab1, tab2])
```

Linked Plots

Linked Axes

```
>>> p2.x_range = p1.x_range
>>> p2.y_range = p1.y_range
```

Linked Brushing

```
>>> p4 = figure(plot_width = 100,
                tools='box_select,lasso_select')
>>> p4.circle('mpg', 'cyl', source=cds_df)
>>> p5 = figure(plot_width = 200,
                tools='box_select,lasso_select')
>>> p5.circle('mpg', 'hp', source=cds_df)
>>> layout = row(p4,p5)
```

4 Output & Export

Notebook

```
>>> from bokeh.io import output_notebook, show
>>> output_notebook()
```

HTML

Standalone HTML

```
>>> from bokeh.embed import file_html
>>> from bokeh.resources import CDN
>>> html = file_html(p, CDN, "my_plot")
```

```
>>> from bokeh.io import output_file, show
>>> output_file('my_bar_chart.html', mode='cdn')
```

Components

```
>>> from bokeh.embed import components
>>> script, div = components(p)
```

PNG

```
>>> from bokeh.io import export_png
>>> export_png(p, filename="plot.png")
```

SVG

```
>>> from bokeh.io import export_svgs
>>> p.output_backend = "svg"
>>> export_svgs(p, filename="plot.svg")
```

5 Show or Save Your Plots

```
>>> show(p1)
>>> save(p1)
```

```
>>> show(layout)
>>> save(layout)
```

Python For Data Science *Cheat Sheet*

Scikit-Learn

Learn Python for data science Interactively at www.DataCamp.com

Scikit-learn

Scikit-learn is an open source Python library that implements a range of machine learning, preprocessing, cross-validation and visualization algorithms using a unified interface.

A Basic Example

```
>>> from sklearn import neighbors, datasets, preprocessing
>>> from sklearn.model_selection import train_test_split
>>> from sklearn.metrics import accuracy_score
>>> iris = datasets.load_iris()
>>> X, y = iris.data[:, :2], iris.target
>>> X_train, X_test, y_train, y_test = train_test_split(X, y, random_state=33)
>>> scaler = preprocessing.StandardScaler().fit(X_train)
>>> X_train = scaler.transform(X_train)
>>> X_test = scaler.transform(X_test)
>>> knn = neighbors.KNeighborsClassifier(n_neighbors=5)
>>> knn.fit(X_train, y_train)
>>> y_pred = knn.predict(X_test)
>>> accuracy_score(y_test, y_pred)
```

Loading The Data

Also see NumPy & Pandas

Your data needs to be numeric and stored as NumPy arrays or SciPy sparse matrices. Other types that are convertible to numeric arrays, such as Pandas DataFrame, are also acceptable.

```
>>> import numpy as np
>>> X = np.random.random((10,5))
>>> y = np.array(['M','M','F','F','M','F','M','M','F','F','F'])
>>> X[X < 0.7] = 0
```

Training And Test Data

```
>>> from sklearn.model_selection import train_test_split
>>> X_train, X_test, y_train, y_test = train_test_split(X,
                                                        y,
                                                        random_state=0)
```

Create Your Model

Supervised Learning Estimators

Linear Regression

```
>>> from sklearn.linear_model import LinearRegression
>>> lr = LinearRegression(normalize=True)
```

Support Vector Machines (SVM)

```
>>> from sklearn.svm import SVC
>>> svc = SVC(kernel='linear')
```

Naive Bayes

```
>>> from sklearn.naive_bayes import GaussianNB
>>> gnb = GaussianNB()
```

KNN

```
>>> from sklearn import neighbors
>>> knn = neighbors.KNeighborsClassifier(n_neighbors=5)
```

Unsupervised Learning Estimators

Principal Component Analysis (PCA)

```
>>> from sklearn.decomposition import PCA
>>> pca = PCA(n_components=0.95)
```

K Means

```
>>> from sklearn.cluster import KMeans
>>> k_means = KMeans(n_clusters=3, random_state=0)
```

Model Fitting

Supervised learning	
`>>> lr.fit(X, y)`	Fit the model to the data
`>>> knn.fit(X_train, y_train)`	
`>>> svc.fit(X_train, y_train)`	
Unsupervised Learning	
`>>> k_means.fit(X_train)`	Fit the model to the data
`>>> pca_model = pca.fit_transform(X_train)`	Fit to data, then transform it

Prediction

Supervised Estimators	
`>>> y_pred = svc.predict(np.random.random((2,5)))`	Predict labels
`>>> y_pred = lr.predict(X_test)`	Predict labels
`>>> y_pred = knn.predict_proba(X_test)`	Estimate probability of a label
Unsupervised Estimators	
`>>> y_pred = k_means.predict(X_test)`	Predict labels in clustering algos

Preprocessing The Data

Standardization

```
>>> from sklearn.preprocessing import StandardScaler
>>> scaler = StandardScaler().fit(X_train)
>>> standardized_X = scaler.transform(X_train)
>>> standardized_X_test = scaler.transform(X_test)
```

Normalization

```
>>> from sklearn.preprocessing import Normalizer
>>> scaler = Normalizer().fit(X_train)
>>> normalized_X = scaler.transform(X_train)
>>> normalized_X_test = scaler.transform(X_test)
```

Binarization

```
>>> from sklearn.preprocessing import Binarizer
>>> binarizer = Binarizer(threshold=0.0).fit(X)
>>> binary_X = binarizer.transform(X)
```

Encoding Categorical Features

```
>>> from sklearn.preprocessing import LabelEncoder
>>> enc = LabelEncoder()
>>> y = enc.fit_transform(y)
```

Imputing Missing Values

```
>>> from sklearn.preprocessing import Imputer
>>> imp = Imputer(missing_values=0, strategy='mean', axis=0)
>>> imp.fit_transform(X_train)
```

Generating Polynomial Features

```
>>> from sklearn.preprocessing import PolynomialFeatures
>>> poly = PolynomialFeatures(5)
>>> poly.fit_transform(X)
```

Evaluate Your Model's Performance

Classification Metrics

Accuracy Score

```
>>> knn.score(X_test, y_test)
```
Estimator score method

```
>>> from sklearn.metrics import accuracy_score
>>> accuracy_score(y_test, y_pred)
```
Metric scoring functions

Classification Report

```
>>> from sklearn.metrics import classification_report
>>> print(classification_report(y_test, y_pred))
```
Precision, recall, f1-score and support

Confusion Matrix

```
>>> from sklearn.metrics import confusion_matrix
>>> print(confusion_matrix(y_test, y_pred))
```

Regression Metrics

Mean Absolute Error

```
>>> from sklearn.metrics import mean_absolute_error
>>> y_true = [3, -0.5, 2]
>>> mean_absolute_error(y_true, y_pred)
```

Mean Squared Error

```
>>> from sklearn.metrics import mean_squared_error
>>> mean_squared_error(y_test, y_pred)
```

R^2 Score

```
>>> from sklearn.metrics import r2_score
>>> r2_score(y_true, y_pred)
```

Clustering Metrics

Adjusted Rand Index

```
>>> from sklearn.metrics import adjusted_rand_score
>>> adjusted_rand_score(y_true, y_pred)
```

Homogeneity

```
>>> from sklearn.metrics import homogeneity_score
>>> homogeneity_score(y_true, y_pred)
```

V-measure

```
>>> from sklearn.metrics import v_measure_score
>>> metrics.v_measure_score(y_true, y_pred)
```

Cross-Validation

```
>>> from sklearn.cross_validation import cross_val_score
>>> print(cross_val_score(knn, X_train, y_train, cv=4))
>>> print(cross_val_score(lr, X, y, cv=2))
```

Tune Your Model

Grid Search

```
>>> from sklearn.grid_search import GridSearchCV
>>> params = {"n_neighbors": np.arange(1,3),
              "metric": ["euclidean", "cityblock"]}
>>> grid = GridSearchCV(estimator=knn,
                        param_grid=params)
>>> grid.fit(X_train, y_train)
>>> print(grid.best_score_)
>>> print(grid.best_estimator_.n_neighbors)
```

Randomized Parameter Optimization

```
>>> from sklearn.grid_search import RandomizedSearchCV
>>> params = {"n_neighbors": range(1,5),
              "weights": ["uniform", "distance"]}
>>> rsearch = RandomizedSearchCV(estimator=knn,
                                 param_distributions=params,
                                 cv=4,
                                 n_iter=8,
                                 random_state=5)
>>> rsearch.fit(X_train, y_train)
>>> print(rsearch.best_score_)
```

Python For Data Science *Cheat Sheet*

Keras

Learn Python for data science Interactively at www.DataCamp.com

Keras

Keras is a powerful and easy-to-use deep learning library for Theano and TensorFlow that provides a high-level neural networks API to develop and evaluate deep learning models.

A Basic Example

```
>>> import numpy as np
>>> from keras.models import Sequential
>>> from keras.layers import Dense
>>> data = np.random.random((1000,100))
>>> labels = np.random.randint(2,size=(1000,1))
>>> model = Sequential()
>>> model.add(Dense(32,
                    activation='relu',
                    input_dim=100))
>>> model.add(Dense(1, activation='sigmoid'))
>>> model.compile(optimizer='rmsprop',
                  loss='binary_crossentropy',
                  metrics=['accuracy'])
>>> model.fit(data,labels,epochs=10,batch_size=32)
>>> predictions = model.predict(data)
```

Data

Also see NumPy, Pandas & Scikit-Learn

Your data needs to be stored as NumPy arrays or as a list of NumPy arrays. Ideally, you split the data in training and test sets, for which you can also resort to the `train_test_split` module of `sklearn.cross_validation`.

Keras Data Sets

```
>>> from keras.datasets import boston_housing,
                               mnist,
                               cifar10,
                               imdb
>>> (x_train,y_train),(x_test,y_test) = mnist.load_data()
>>> (x_train2,y_train2),(x_test2,y_test2) = boston_housing.load_data()
>>> (x_train3,y_train3),(x_test3,y_test3) = cifar10.load_data()
>>> (x_train4,y_train4),(x_test4,y_test4) = imdb.load_data(num_words=20000)
>>> num_classes = 10
```

Other

```
>>> from urllib.request import urlopen
>>> data = np.loadtxt(urlopen("http://archive.ics.uci.edu/
ml/machine-learning-databases/pima-indians-diabetes/
pima-indians-diabetes.data"),delimiter=",")
>>> X = data[:,0:8]
>>> y = data [:,8]
```

Model Architecture

Sequential Model

```
>>> from keras.models import Sequential
>>> model = Sequential()
>>> model2 = Sequential()
>>> model3 = Sequential()
```

Multilayer Perceptron (MLP)

Binary Classification

```
>>> from keras.layers import Dense
>>> model.add(Dense(12,
                    input_dim=8,
                    kernel_initializer='uniform',
                    activation='relu'))
>>> model.add(Dense(8,kernel_initializer='uniform',activation='relu'))
>>> model.add(Dense(1,kernel_initializer='uniform',activation='sigmoid'))
```

Multi-Class Classification

```
>>> from keras.layers import Dropout
>>> model.add(Dense(512,activation='relu',input_shape=(784,)))
>>> model.add(Dropout(0.2))
>>> model.add(Dense(512,activation='relu'))
>>> model.add(Dropout(0.2))
>>> model.add(Dense(10,activation='softmax'))
```

Regression

```
>>> model.add(Dense(64,activation='relu',input_dim=train_data.shape[1]))
>>> model.add(Dense(1))
```

Convolutional Neural Network (CNN)

```
>>> from keras.layers import Activation,Conv2D,MaxPooling2D,Flatten
>>> model2.add(Conv2D(32,(3,3),padding='same',input_shape=x_train.shape[1:]))
>>> model2.add(Activation('relu'))
>>> model2.add(Conv2D(32,(3,3)))
>>> model2.add(Activation('relu'))
>>> model2.add(MaxPooling2D(pool_size=(2,2)))
>>> model2.add(Dropout(0.25))

>>> model2.add(Conv2D(64,(3,3), padding='same'))
>>> model2.add(Activation('relu'))
>>> model2.add(Conv2D(64,(3, 3)))
>>> model2.add(Activation('relu'))
>>> model2.add(MaxPooling2D(pool_size=(2,2)))
>>> model2.add(Dropout(0.25))

>>> model2.add(Flatten())
>>> model2.add(Dense(512))
>>> model2.add(Activation('relu'))
>>> model2.add(Dropout(0.5))
>>> model2.add(Dense(num_classes))
>>> model2.add(Activation('softmax'))
```

Recurrent Neural Network (RNN)

```
>>> from keras.klayers import Embedding,LSTM
>>> model3.add(Embedding(20000,128))
>>> model3.add(LSTM(128,dropout=0.2,recurrent_dropout=0.2))
>>> model3.add(Dense(1,activation='sigmoid'))
```

Inspect Model

`>>> model.output_shape`	Model output shape
`>>> model.summary()`	Model summary representation
`>>> model.get_config()`	Model configuration
`>>> model.get_weights()`	List all weight tensors in the model

Compile Model

MLP: Binary Classification

```
>>> model.compile(optimizer='adam',
                  loss='binary_crossentropy',
                  metrics=['accuracy'])
```

MLP: Multi-Class Classification

```
>>> model.compile(optimizer='rmsprop',
                  loss='categorical_crossentropy',
                  metrics=['accuracy'])
```

MLP: Regression

```
>>> model.compile(optimizer='rmsprop',
                  loss='mse',
                  metrics=['mae'])
```

Recurrent Neural Network

```
>>> model3.compile(loss='binary_crossentropy',
                   optimizer='adam',
                   metrics=['accuracy'])
```

Model Training

```
>>> model3.fit(x_train4,
               y_train4,
               batch_size=32,
               epochs=15,
               verbose=1,
               validation_data=(x_test4,y_test4))
```

Evaluate Your Model's Performance

```
>>> score = model3.evaluate(x_test,
                            y_test,
                            batch_size=32)
```

Prediction

```
>>> model3.predict(x_test4, batch_size=32)
>>> model3.predict_classes(x_test4,batch_size=32)
```

Save/ Reload Models

```
>>> from keras.models import load_model
>>> model3.save('model_file.h5')
>>> my_model = load_model('my_model.h5')
```

Model Fine-tuning

Optimization Parameters

```
>>> from keras.optimizers import RMSprop
>>> opt = RMSprop(lr=0.0001, decay=1e-6)
>>> model2.compile(loss='categorical_crossentropy',
                   optimizer=opt,
                   metrics=['accuracy'])
```

Early Stopping

```
>>> from keras.callbacks import EarlyStopping
>>> early_stopping_monitor = EarlyStopping(patience=2)
>>> model3.fit(x_train4,
               y_train4,
               batch_size=32,
               epochs=15,
               validation_data=(x_test4,y_test4),
               callbacks=[early_stopping_monitor])
```

Preprocessing

Also see NumPy & Scikit-Learn

Sequence Padding

```
>>> from keras.preprocessing import sequence
>>> x_train4 = sequence.pad_sequences(x_train4,maxlen=80)
>>> x_test4 = sequence.pad_sequences(x_test4,maxlen=80)
```

One-Hot Encoding

```
>>> from keras.utils import to_categorical
>>> Y_train = to_categorical(y_train, num_classes)
>>> Y_test = to_categorical(y_test, num_classes)
>>> Y_train3 = to_categorical(y_train3, num_classes)
>>> Y_test3 = to_categorical(y_test3, num_classes)
```

Train and Test Sets

```
>>> from sklearn.model_selection import train_test_split
>>> X_train5,X_test5,y_train5,y_test5 = train_test_split(X,
                                                         y,
                                                         test_size=0.33,
                                                         random_state=42)
```

Standardization/Normalization

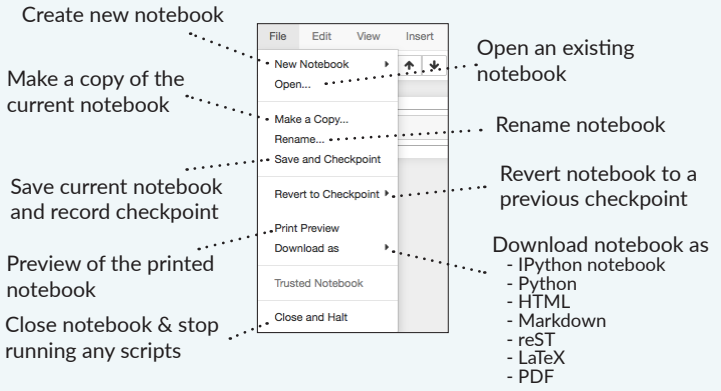
```
>>> from sklearn.preprocessing import StandardScaler
>>> scaler = StandardScaler().fit(x_train2)
>>> standardized_X = scaler.transform(x_train2)
>>> standardized_X_test = scaler.transform(x_test2)
```

Python For Data Science *Cheat Sheet*

Jupyter Notebook

Learn More Python for Data Science Interactively at www.DataCamp.com

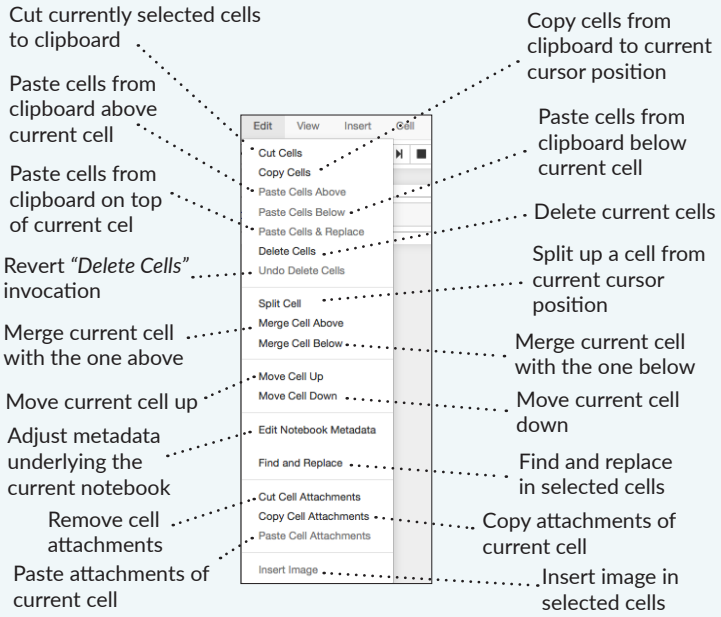
Saving/Loading Notebooks



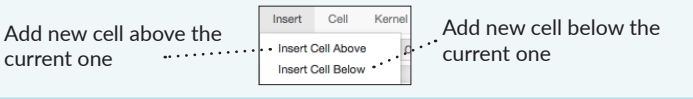
Writing Code And Text

Code and text are encapsulated by 3 basic cell types: markdown cells, code cells, and raw NBConvert cells.

Edit Cells



Insert Cells

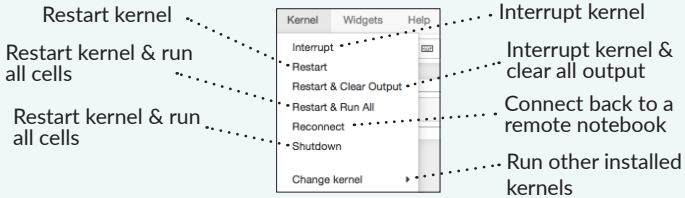


Working with Different Programming Languages

Kernels provide computation and communication with front-end interfaces like the notebooks. There are three main kernels:

IPython IRkernel IJulia

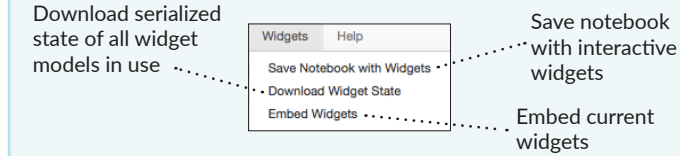
Installing Jupyter Notebook will automatically install the IPython kernel.



Widgets

Notebook widgets provide the ability to visualize and control changes in your data, often as a control like a slider, textbox, etc.

You can use them to build interactive GUIs for your notebooks or to synchronize stateful and stateless information between Python and JavaScript.

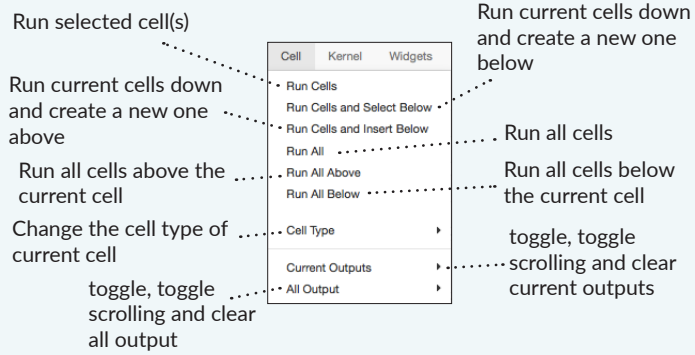


Command Mode:

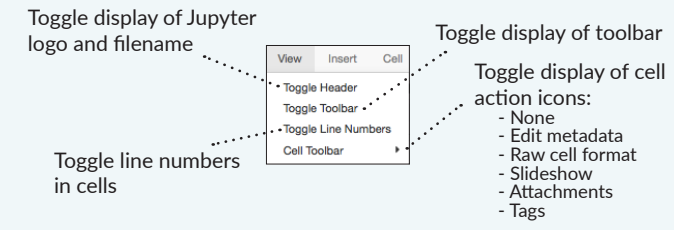
Edit Mode:

1. Save and checkpoint
2. Insert cell below
3. Cut cell
4. Copy cell(s)
5. Paste cell(s) below
6. Move cell up
7. Move cell down
8. Run current cell
9. Interrupt kernel
10. Restart kernel
11. Display characteristics
12. Open command palette
13. Current kernel
14. Kernel status
15. Log out from notebook server

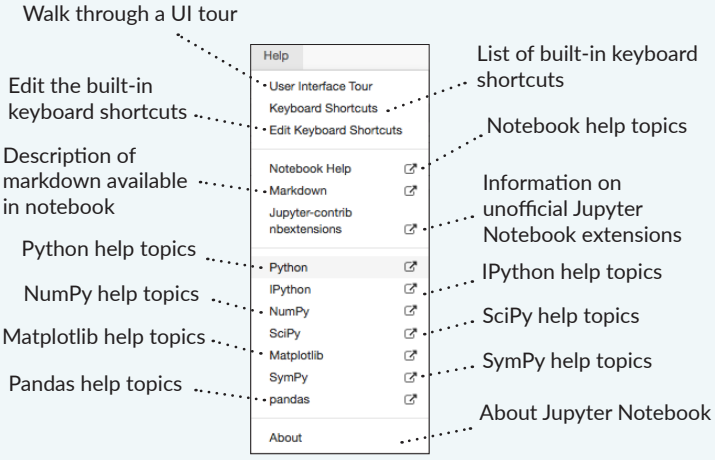
Executing Cells



View Cells



Asking For Help



Mémento Python 3

Dernière version sur :
https://perso.limsi.fr/pointal/python:memento

Types de base

entier, flottant, booléen, chaîne, octets

```
int 783  0 -192  0b010 0o642 0xF3
          zéro   binaire octal  hexa
float 9.23 0.0  -1.7e-6
                        ×10^-6
bool True  False
str "Un\nDeux"        Chaîne multiligne :
     retour à la ligne échappé  """X\tY\tZ
    'L\'âme'                    1\t2\t3"""
      ' échappé                tabulation échappée
bytes b"toto\xfe\775"
        hexadécimal  octal
```

☝ immutables

Types conteneurs

- **séquences ordonnées**, accès par index rapide, valeurs répétables

```
list [1,5,9]   ["x",11,8.9]   ["mot"]   []
tuple (1,5,9)  11,"y",7.4     ("mot",)  ()
```

Valeurs non modifiables (immutables) — ☝ *expression juste avec des virgules →* `tuple`

```
str bytes  (séquences ordonnées de caractères / d'octets)   "" b""
```

- **conteneurs clés**, sans ordre *a priori*, accès par clé rapide, chaque clé unique

```
dictionnaire dict {"clé":"valeur"}   dict(a=3,b=4,k="v")   {}
(couples clé/valeur)  {1:"un",3:"trois",2:"deux",3.14:"π"}
ensemble     set  {"clé1","clé2"}    {1,9,3,0}            set()
```

☝ *clés=valeurs hachables (types base, immutables…)* `frozenset` *ensemble immutable* *vide*

Identificateurs

pour noms de variables, fonctions, modules, classes…

`a…zA…Z_` suivi de `a…zA…Z_0…9`

- accents possibles mais à éviter
- mots clés du langage interdits
- distinction casse min/MAJ

☺ `a toto x7 y_max BigOne`
☹ ~~`8y and for`~~

Variables & affectation

`=` ☝ affectation ⇔ **association** d'un *nom* à une *valeur*

1) évaluation de la valeur de l'expression de droite
2) affectation dans l'ordre avec les noms de gauche

```
x=1.2+8+sin(y)
a=b=c=0   affectation à la même valeur
y,z,r=9.2,-7.6,0   affectations multiples
a,b=b,a   échange de valeurs
a,*b=seq  }  dépaquetage de séquence en
*a,b=seq  }  élément et liste
```

`x+=3` *incrémentation ⇔* `x=x+3`
`x-=2` *décrémentation ⇔* `x=x-2`
`x=None` *valeur constante « non défini »*
`del x` *suppression du nom* `x`

et `*=` `/=` `%=` …

Conversions

`type(`*expression*`)`

```
int("15") → 15
int("3f",16) → 63        spécification de la base du nombre entier en 2nd paramètre
int(15.56) → 15          troncature de la partie décimale
float("-11.24e8") → -1124000000.0
round(15.56,1)→15.6      arrondi à 1 décimale (0 décimale → nb entier)
bool(x)  False pour x zéro, x conteneur vide, x None ou False ; True pour autres x
str(x)→"…"               chaîne de représentation de x pour l'affichage (cf. Formatage au verso)
chr(64)→'@'  ord('@')→64   code ↔ caractère
repr(x)→"…"              chaîne de représentation littérale de x
bytes([72,9,64]) → b'H\t@'
list("abc") → ['a','b','c']
dict([(3,"trois"),(1,"un")]) → {1:'un',3:'trois'}
set(["un","deux"]) → {'un','deux'}
str de jointure et séquence de str → str assemblée
    ':'.join(['toto','12','pswd']) → 'toto:12:pswd'
str découpée sur les blancs → list de str
    "des mots  espacés".split() → ['des','mots','espacés']
str découpée sur str séparateur → list de str
    "1,4,8,2".split(",") → ['1','4','8','2']
séquence d'un type → list d'un autre type (par liste en compréhension)
    [int(x) for x in ('1','29','-3')] → [1,29,-3]
```

Indexation conteneurs séquences

pour les listes, tuples, chaînes de caractères, bytes…

```
index négatif  -5  -4  -3  -2  -1
index positif   0   1   2   3   4
lst=[10, 20, 30, 40, 50]
tranche positive  0   1   2   3   4   5
tranche négative -5  -4  -3  -2  -1
```

Nombre d'éléments `len(lst)→5`

☝ **index à partir de 0** (de 0 à 4 ici)

Accès individuel aux **éléments** par `lst[`*index*`]`

`lst[0]→10` *⇒ le premier* `lst[1]→20`
`lst[-1]→50` *⇒ le dernier* `lst[-2]→40`

Sur les séquences modifiables (`list`*), suppression avec* `del lst[3]` *et modification par affectation* `lst[4]=25`

Accès à des **sous-séquences** par `lst[`*tranche début*`:`*tranche fin*`:`*pas*`]`

```
lst[:-1]→[10,20,30,40]   lst[::-1]→[50,40,30,20,10]   lst[1:3]→[20,30]   lst[:3]→[10,20,30]
lst[1:-1]→[20,30,40]     lst[::-2]→[50,30,10]         lst[-3:-1]→[30,40]  lst[3:]→[40,50]
lst[::2]→[10,30,50]      lst[:]→[10,20,30,40,50]   copie superficielle de la séquence
```

Indication de tranche manquante → à partir du début / jusqu'à la fin.
Sur les séquences modifiables (`list`*), suppression avec* `del lst[3:5]` *et modification par affectation* `lst[1:4]=[15,25]`

Logique booléenne

Comparateurs: `<` `>` `<=` `>=` `==` `!=` (résultats booléens) ≤ ≥ = ≠

`a and b` et logique — *les deux en même temps*
`a or b` ou logique — *l'un ou l'autre ou les deux*

☝ piège : `and` *et* `or` *retournent la valeur de* `a` *ou de* `b` *(selon l'évaluation au plus court).*
⇒ s'assurer que `a` *et* `b` *sont booléens.*

`not a` non logique

`True` `False` } constantes Vrai/Faux

Blocs d'instructions

instruction parente :
  bloc d'instructions 1…
  ⋮
instruction parente :
  bloc d'instructions 2…
  ⋮
instruction suivante après bloc 1

indentation !

☝ *régler l'éditeur pour insérer 4 espaces à la place d'une tabulation d'indentation.*

Imports modules/noms

module `truc` ⇔ *fichier* `truc.py`

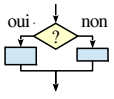
```
from monmod import nom1,nom2 as fct
                →accès direct aux noms, renommage avec as
import monmod →accès via monmod.nom1 …
```

☝ modules et packages cherchés dans le *python path* (cf. `sys.path`)

Instruction conditionnelle

un bloc d'instructions exécuté, uniquement ***si*** *sa condition est vraie*

`if` *condition logique* `:`
→ *bloc d'instructions*



Combinable avec des *sinon si, sinon si…* et un seul *sinon* final. Seul le bloc de la première condition trouvée vraie est exécuté.

☝ *avec une variable* `x`*:*
`if bool(x)==True:` ⇔ `if x:`
`if bool(x)==False:` ⇔ `if not x:`

```
if age<=18:
  etat="Enfant"
elif age>65:
  etat="Retraité"
else:
  etat="Actif"
```

Maths

☝ *nombres flottants… valeurs approchées !* *angles en radians*

Opérateurs : `+` `-` `*` `/` `//` `%` `**`
Priorités `(…)` × ÷ ↑ ↑ a^b
÷ entière reste ÷

`@` → × matricielle *python3.5+* `numpy`

```
(1+5.3)*2→12.6
abs(-3.2)→3.2
round(3.57,1)→3.6
pow(4,3)→64.0
```

☝ *priorités usuelles*

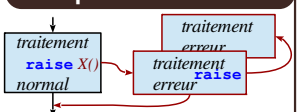
```
from math import sin,pi…
sin(pi/4)→0.707…
cos(2*pi/3)→-0.4999…
sqrt(81)→9.0   √
log(e**2)→2.0
ceil(12.5)→13
floor(12.5)→12
```

modules `math`, `statistics`, `random`, `decimal`, `fractions`, `numpy`, etc.

Exceptions sur erreurs

Signalisation :
`raise` *ExcClass(…)*

Traitement :
`try:`
→ *bloc traitement normal*
`except` *ExcClass* `as e:`
→ *bloc traitement erreur*



☝ *bloc* `finally` *pour traitements finaux dans tous les cas.*

Instruction boucle conditionnelle

*bloc d'instructions exécuté **tant que** la condition est vraie*

```
while condition logique :
    bloc d'instructions
```


```
s = 0          # initialisations avant la boucle
i = 1
while i <= 100:          # condition avec au moins une valeur variable (ici i)
    s = s + i**2
    i = i + 1            # faire varier la variable de condition !
print("somme:",s)
```

Algo : $s = \sum_{i=1}^{i=100} i^2$

Contrôle de boucle

`break` sortie immédiate
`continue` itération suivante
bloc `else` en sortie ***normale*** de boucle.

attention aux boucles sans fin !

Affichage

```
print("v=",3,"cm :",x,",",y+4)
```

éléments à afficher : valeurs littérales, variables, expressions
Options de `print` :

- `sep=" "` séparateur d'éléments, défaut espace
- `end="\n"` fin d'affichage, défaut fin de ligne
- `file=sys.stdout` print vers fichier, défaut sortie standard

Saisie

```
s = input("Directives:")
```

`input` retourne toujours une **chaîne**, la convertir vers le type désiré (cf. encadré *Conversions* au recto).

Opérations génériques sur conteneurs

`len(c)` → nb d'éléments
`min(c)` `max(c)` `sum(c)`
`sorted(c)` → `list` *copie* triée
`val in c` → booléen, opérateur `in` de test de présence (`not in` d'absence)
`enumerate(c)` → *itérateur* sur (index, valeur)
`zip(c1,c2…)` → *itérateur* sur tuples contenant les éléments de même index des c_i
`all(c)` → `True` si **tout** élément de `c` évalué vrai, sinon `False`
`any(c)` → `True` si **au moins un** élément de `c` évalué vrai, sinon `False`
`c.clear()` supprime le contenu des dictionnaires, ensembles, listes

*Note: Pour dictionnaires et ensembles, ces opérations travaillent sur les **clés**.*

*Spécifique aux **conteneurs de séquences ordonnées** (listes, tuples, chaînes, bytes…)*
`reversed(c)` → *itérateur inversé* `c*5`→ duplication `c+c2`→ concaténation
`c.index(val)` → *position* `c.count(val)` → *nb d'occurences*

```
import copy
copy.copy(c) → copie superficielle du conteneur
copy.deepcopy(c) → copie en profondeur du conteneur
```

Opérations sur listes

modification de la liste originale

`lst.append(val)`	ajout d'un élément à la fin
`lst.extend(seq)`	ajout d'une séquence d'éléments à la fin
`lst.insert(idx,val)`	insertion d'un élément à une position
`lst.remove(val)`	suppression du premier élément de valeur *val*
`lst.pop([idx])`→*valeur*	supp. & retourne l'item d'index *idx* (défaut le dernier)
`lst.sort()` `lst.reverse()`	tri / inversion de la liste sur place

Opérations sur dictionnaires

`d[clé]=valeur` `del d[clé]`
`d[clé]` → *valeur*
`d.update(d2)` mise à jour/ajout des couples
`d.keys()` `d.values()` `d.items()` →*vues itérables sur les clés / valeurs / couples*
`d.pop(clé[,défaut])` → *valeur*
`d.popitem()` → *(clé,valeur)*
`d.get(clé[,défaut])` → *valeur*
`d.setdefault(clé[,défaut])` →*valeur*

Opérations sur ensembles

Opérateurs :
`|` → union (caractère barre verticale)
`&` → intersection
`-` `^` → différence/diff. symétrique
`<` `<=` `>` `>=` → relations d'inclusion
Les opérateurs existent aussi sous forme de méthodes.

`s.update(s2)` `s.copy()`
`s.add(clé)` `s.remove(clé)`
`s.discard(clé)` `s.pop()`

Fichiers

stockage de données sur disque, et relecture

```
f = open("fic.txt","w",encoding="utf8")
```

- **variable** fichier pour les opérations
- **nom** du fichier sur le disque (+chemin…) — cf modules `os`, `os.path` et `pathlib`
- **mode** d'ouverture
  - `'r'` lecture (read)
  - `'w'` écriture (write)
  - `'a'` ajout (append)
  - …`'+'` `'x'` `'b'` `'t'`
- **encodage** des caractères pour les *fichiers textes*: `utf8` `ascii` `latin1` …

en **écriture**

```
f.write("coucou")
f.writelines(list de lignes)
```

en **lecture**

lit chaîne vide si fin de fichier

```
f.read([n])          → caractères suivants
                       si n non spécifié, lit jusqu'à la fin !
f.readlines([n])     → list lignes suivantes
f.readline()         → ligne suivante
```

*par défaut mode texte `t` (lit/écrit `str`), mode binaire `b` possible (lit/écrit `bytes`). **Convertir de/vers le type désiré** !*

`f.close()` ne pas oublier de **refermer le fichier** après son utilisation !

`f.flush()` écriture du cache `f.truncate([taille])` retaillage
lecture/écriture progressent séquentiellement dans le fichier, modifiable avec :
`f.tell()` →*position* `f.seek(position[,origine])`

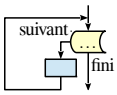
Très courant : ouverture en bloc gardé (fermeture automatique) et boucle de lecture des lignes d'un fichier texte.

```
with open(…) as f:
    for ligne in f :
        # traitement de ligne
```

Instruction boucle itérative

*bloc d'instructions exécuté **pour chaque** élément d'un conteneur ou d'un itérateur*

```
for var in séquence :
    bloc d'instructions
```



Parcours des **valeurs** d'un conteneur

```
s = "Du texte"          # initialisations avant la boucle
cpt = 0
                        # variable de boucle, affectation gérée par l'instruction for
for c in s:
    if c == "e":
        cpt = cpt + 1
print("trouvé",cpt,"'e'")
```

Algo : comptage du nombre de `e` *dans la chaîne.*

boucle sur dict/set ⇔ boucle sur séquence des clés
utilisation des *tranches* pour parcourir un sous-ensemble d'une séquence

Parcours des **index** d'un conteneur séquence

- changement de l'élément à la position
- accès aux éléments autour de la position (avant/après)

```
lst = [11,18,9,12,23,4,17]
perdu = []
for idx in range(len(lst)):
    val = lst[idx]
    if val > 15:
        perdu.append(val)
        lst[idx] = 15
print("modif:",lst,"-modif:",perdu)
```

Algo: bornage des valeurs supérieures à 15, mémorisation des valeurs perdues.

Parcours simultané **index** et **valeurs** de la séquence :

```
for idx,val in enumerate(lst):
```

bonne habitude : ne pas modifier la variable de boucle

Séquences d'entiers

```
range([début,] fin [,pas])
```

début défaut 0, *fin* non compris dans la séquence, *pas* signé et défaut 1

`range(5)` → 0 1 2 3 4 `range(2,12,3)` → 2 5 8 11
`range(3,8)` → 3 4 5 6 7 `range(20,5,-5)` → 20 15 10
`range(len(séq))` → *séquence des index des valeurs dans séq*

range fournit une séquence immutable d'entiers construits au besoin

Définition de fonction

nom de la fonction (identificateur) — paramètres nommés

```
def fct(x,y,z):
    """documentation"""
    # bloc instructions, calcul de res, etc.
    return res
```

valeur résultat de l'appel, si pas de résultat calculé à retourner : `return None`

les paramètres et toutes les variables de ce bloc n'existent que *dans* le bloc et *pendant* l'appel à la fonction (penser "*boîte noire*")

Avancé : `def fct(x,y,z,*args,a=3,b=5,**kwargs):`
**args nb variables d'arguments positionnels (→`tuple`), valeurs par défaut, **kwargs nb variable d'arguments nommés (→`dict`)*

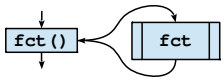
Appel de fonction

```
r = fct(3,i+2,2*i)
```

stockage/utilisation de la valeur de retour — *une valeur d'argument par paramètre*

c'est l'utilisation du nom de la fonction *avec les parenthèses* qui fait l'appel

*Avancé: *séquence **dict*



Opérations sur chaînes

`s.startswith(prefix[,début[,fin]])` `s.endswith(suffix[,début[,fin]])` `s.strip([caractères])`
`s.count(sub[,début[,fin]])` `s.partition(sep)` → *(avant,sep,après)*
`s.index(sub[,début[,fin]])` `s.find(sub[,début[,fin]])`
`s.is…()` *tests sur les catégories de caractères (ex. `s.isalpha()`)*
`s.upper()` `s.lower()` `s.title()` `s.swapcase()`
`s.casefold()` `s.capitalize()` `s.center([larg,rempl])`
`s.ljust([larg,rempl])` `s.rjust([larg,rempl])` `s.zfill([larg])`
`s.encode(codage)` `s.split([sep])` `s.join(séq)`

Formatage

directives de formatage — valeurs à formater

```
"modele{} {} {}".format(x,y,r) → str
```

`"{`*sélection*`:`*formatage*`!`*conversion*`}"`

- **Sélection** :
  `2`
  `nom`
  `0.nom`
  `4[clé]`
  `0[2]`
- **Formatage** :
  car-rempl. *alignement* *signe* *larg.mini*`.`*précision~larg.max* *type*
  `< > ^ =` `+ - espace` `0` au début pour remplissage avec des 0
  entiers : `b` binaire, `c` caractère, `d` décimal (défaut), `o` octal, `x` ou `X` hexa…
  flottant : `e` ou `E` exponentielle, `f` ou `F` point fixe, `g` ou `G` approprié (défaut),
  chaîne : `s` … `%` pourcentage
- **Conversion** : `s` (texte lisible) ou `r` (représentation littérale)

Exemples

```
"{:+2.3f}".format(45.72793)
→'+45.728'
"{1:>10s}".format(8,"toto")
→'      toto'
"{x!r}".format(x="L'ame")
→'"L\'ame"'
```

finxter

The Ultimate Python Cheat Sheet

Keywords

Keyword	Description	Code Examples
`False`, `True`	Boolean data type	`False == (1 > 2)` `True == (2 > 1)`

`and`, `or`, `not`	Logical operators
	→ Both are true
	→ Either is true
	→ Flips Boolean
		`True and True  # True`
		`True or False  # True`
		`not False  # True`

`break`	Ends loop prematurely	`while True:` `  break # finite loop`

`continue`	Finishes current loop iteration	`while True:`
		`  continue`
		`  print("42") # dead code`

`class`	Defines new class	`class Coffee:` `  # Define your class`
`def`	Defines a new function or class method.	`def say_hi():` `  print('hi')`

`if`, `elif`, `else`	Conditional execution:
	- "if" condition == True?
	- "elif" condition == True?
	- Fallback: else branch
		`x = int(input("ur val:"))`
		`if  x > 3:  print("Big")`
		`elif x == 3:  print("3")`
		`else:  print("Small")`

`for`, `while`	`# For loop`
	`for i in [0,1,2]:`
	`  print(i)`
		`# While loop does same`
		`j = 0`
		`while j < 3:`
		`  print(j); j = j + 1`

`in`	Sequence membership	`42 in [2, 39, 42] # True`

`is`	Same object memory location	`y = x = 3`
		`x is y  # True`
		`[3] is [3]  # False`

`None`	Empty value constant	`print() is None # True`
`lambda`	Anonymous function	`(lambda x: x+3)(3) # 6`

`return`	Terminates function. Optional return value defines function result.	`def increment(x):`
		`  return x + 1`
		`increment(4) # returns 5`

Basic Data Structures

Type	Description	Code Examples

Boolean	The Boolean data type is either `True` or `False`. Boolean operators are ordered by priority: `not` → `and` → `or`
	{ } → 👎
	{1, 2, 3} → 👍
		`## Evaluates to True:`
		`1<2 and 0<=1 and 3>2 and 2>=2 and 1==1 and 1!=0`
		`## Evaluates to False:`
		`bool(None or 0 or 0.0 or '' or [] or {} or set())`
		Rule: *None, 0, 0.0, empty strings, or empty container types evaluate to False*

Integer, Float	An **integer** is a positive or negative number without decimal point such as `3`.
	A **float** is a positive or negative number with floating point precision such as `3.1415926`.
	Integer division rounds toward the smaller integer (example: `3//2==1`).
		`## Arithmetic Operations`
		`x, y = 3, 2`
		`print(x + y)  # = 5`
		`print(x - y)  # = 1`
		`print(x * y)  # = 6`
		`print(x / y)  # = 1.5`
		`print(x // y)  # = 1`
		`print(x % y)  # = 1`
		`print(-x)  # = -3`
		`print(abs(-x))  # = 3`
		`print(int(3.9))  # = 3`
		`print(float(3))  # = 3.0`
		`print(x ** y)  # = 9`

String	Python Strings are sequences of characters.
	String Creation Methods:
	1. Single quotes
	`>>> 'Yes'`
	2. Double quotes
	`>>> "Yes"`
	3. Triple quotes (multi-line)
	`>>> """Yes`
	`  We Can"""`
	4. String method
	`>>> str(5) == '5'`
	`True`
	5. Concatenation
	`>>> "Ma" + "hatma"`
	`'Mahatma'`
	Whitespace chars:
	Newline `\n`,
	Space `\s`,
	Tab `\t`
		`## Indexing and Slicing`
		`s = "The youngest pope was 11 years"`
		`s[0] # 'T'`
		`s[1:3] # 'he'`
		`s[-3:-1] # 'ar'`
		`s[-3:] # 'ars'`
		Slice [::2]
		0 1 2 3
		1 2 3 4
		`x = s.split()`
		`x[-2] + " " + x[2] + "s" # '11 popes'`
		`## String Methods`
		`y = "  Hello world\t\n  "`
		`y.strip() # Remove Whitespace`
		`"HI".lower() # Lowercase: 'hi'`
		`"hi".upper() # Uppercase: 'HI'`
		`"hello".startswith("he") # True`
		`"hello".endswith("lo") # True`
		`"hello".find("ll") # Match at 2`
		`"cheat".replace("ch", "m") # 'meat'`
		`''.join(["F", "B", "I"]) # 'FBI'`
		`len("hello world") # Length: 15`
		`"ear" in "earth" # True`

Complex Data Structures

Type	Description	Example
List	Stores a sequence of elements. Unlike strings, you can modify list objects (they're *mutable*).	`l = [1, 2, 2]` `print(len(l)) # 3`

Adding elements	Add elements to a list with (i) append, (ii) insert, or (iii) list concatenation.	`[1, 2].append(4) # [1, 2, 4]`
		`[1, 4].insert(1,9) # [1, 9, 4]`
		`[1, 2] + [4] # [1, 2, 4]`

Removal	Slow for lists	`[1, 2, 2, 4].remove(1) # [2, 2, 4]`
Reversing	Reverses list order	`[1, 2, 3].reverse() # [3, 2, 1]`
Sorting	Sorts list using fast Timsort	`[2, 4, 2].sort() # [2, 2, 4]`

Indexing	Finds the first occurrence of an element & returns index. Slow worst case for whole list traversal.	`[2, 2, 4].index(2)`
		`# index of item 2 is 0`
		`[2, 2, 4].index(2,1)`
		`# index of item 2 after pos 1 is 1`

Stack	Use Python lists via the list operations append() and pop()	`stack = [3]`
		`stack.append(42) # [3, 42]`
		`stack.pop() # 42 (stack: [3])`
		`stack.pop() # 3 (stack: [])`

Set	An unordered collection of unique elements (*at-most-once*) → fast membership *O(1)*	`basket = {'apple', 'eggs',`
		`  'banana', 'orange'}`
		`same = set(['apple', 'eggs',`
		`  'banana', 'orange'])`

Dictionary	Useful data structure for storing (key, value) pairs	`cal = {'apple' : 52, 'banana' : 89,` `  'choco' : 546} # calories`

Reading and writing elements	Read and write elements by specifying the key within the brackets. Use the **`keys()`** and **`values()`** functions to access all keys and values of the dictionary	`print(cal['apple'] < cal['choco'])`
		`# True`
		`cal['cappu'] = 74`
		`print(cal['banana'] < cal['cappu'])`
		`# False`
		`print('apple' in cal.keys()) # True`
		`print(52 in cal.values())  # True`

Dictionary Iteration	You can access the (key, value) pairs of a dictionary with the **`items()`** method.	`for k, v in cal.items():`
		`  print(k) if v > 500 else ''`
		`# 'choco'`

Membership operator	Check with the **`in`** keyword if set, list, or dictionary contains an element. Set membership is faster than list membership.	`basket = {'apple', 'eggs',`
		`  'banana', 'orange'}`
		`print('eggs' in basket)  # True`
		`print('mushroom' in basket) # False`

List & set comprehension	List comprehension is the concise Python way to create lists. Use brackets plus an expression, followed by a for clause. Close with zero or more for or if clauses. Set comprehension works similar to list comprehension.	`l = ['hi ' + x for x in ['Alice', 'Bob', 'Pete']]`
		`# ['Hi Alice', 'Hi Bob', 'Hi Pete']`
		`l2 = [x * y for x in range(3) for y in range(3) if x>y] # [0, 0, 2]`
		`squares = { x**2 for x in [0,2,4] if x < 4 } # {0, 4}`

Python Cheat Sheet - Basic Data Types

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	Description	Example

Boolean	The Boolean data type is a truth value, either `True` or `False`.
	
	The Boolean operators ordered by priority:
	`not x` → "if x is False, then x, else y"
	`x and y` → "if x is False, then x, else y"
	`x or y` → "if x is False, then y, else x"
	
	These comparison operators evaluate to `True`:
	`1 < 2 and 0 <= 1 and 3 > 2 and 2 >=2 and 1 == 1 and 1 != 0 # True`
		`## 1. Boolean Operations`
		`x, y = True, False`
		`print(x and not y) # True`
		`print(not x and y or x) # True`
		
		`## 2. If condition evaluates to False`
		`if None or 0 or 0.0 or '' or [] or {} or set():`
		`  # None, 0, 0.0, empty strings, or empty`
		`  # container types are evaluated to False`
		`  print("Dead code") # Not reached`

Integer, Float	An integer is a positive or negative number without floating point (e.g. `3`). A float is a positive or negative number with floating point precision (e.g. `3.14159265359`).
	
	The '`//`' operator performs integer division. The result is an integer value that is rounded towards the smaller integer number (e.g. `3 // 2 == 1`).
		`## 3. Arithmetic Operations`
		`x, y = 3, 2`
		`print(x + y) # = 5`
		`print(x - y) # = 1`
		`print(x * y) # = 6`
		`print(x / y) # = 1.5`
		`print(x // y) # = 1`
		`print(x % y) # = 1s`
		`print(-x) # = -3`
		`print(abs(-x)) # = 3`
		`print(int(3.9)) # = 3`
		`print(float(3)) # = 3.0`
		`print(x ** y) # = 9`

String	Python Strings are sequences of characters.
	
	The four main ways to create strings are the following.
	
	1. Single quotes
	`'Yes'`
	2. Double quotes
	`"Yes"`
	3. Triple quotes (multi-line)
	`"""Yes`
	`We Can"""`
	4. String method
	`str(5) == '5' # True`
	5. Concatenation
	`"Ma" + "hatma" # 'Mahatma'`
	
	These are whitespace characters in strings.
	• Newline `\n`
	• Space `\s`
	• Tab `\t`
		`## 4. Indexing and Slicing`
		`s = "The youngest pope was 11 years old"`
		`print(s[0])  # 'T'`
		`print(s[1:3])  # 'he'`
		`print(s[-3:-1])  # 'ol'`
		`print(s[-3:])  # 'old'`
		`x = s.split()  # creates string array of words`
		`print(x[-3] + " " + x[-1] + " " + x[2] + "s")`
		`  # '11 old popes'`
		
		`## 5. Most Important String Methods`
		`y = "  This is lazy\t\n  "`
		`print(y.strip()) # Remove Whitespace: 'This is lazy'`
		`print("DrDre".lower()) # Lowercase: 'drdre'`
		`print("attention".upper()) # Uppercase: 'ATTENTION'`
		`print("smartphone".startswith("smart")) # True`
		`print("smartphone".endswith("phone")) # True`
		`print("another".find("other")) # Match index: 2`
		`print("cheat".replace("ch", "m")) # 'meat'`
		`print(','.join(["F", "B", "I"])) # 'F,B,I'`
		`print(len("Rumpelstiltskin")) # String length: 15`
		`print("ear" in "earth") # Contains: True`

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Python Cheat Sheet - Complex Data Types

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	Description	Example
List	A container data type that stores a sequence of elements. Unlike strings, lists are mutable: modification possible.	`l = [1, 2, 2]` `print(len(l)) # 3`

Adding elements	Add elements to a list with (i) append, (ii) insert, or (iii) list concatenation.
	The append operation is very fast.
		`[1, 2, 2].append(4) # [1, 2, 2, 4]`
		`[1, 2, 4].insert(2,2) # [1, 2, 2, 4]`
		`[1, 2, 2] + [4] # [1, 2, 2, 4]`

Removal	Removing an element can be slower.	`[1, 2, 2, 4].remove(1) # [2, 2, 4]`
Reversing	This reverses the order of list elements.	`[1, 2, 3].reverse() # [3, 2, 1]`
Sorting	Sorts a list. The computational complexity of sorting is O(n log n) for n list elements.	`[2, 4, 2].sort() # [2, 2, 4]`
Indexing	Finds the first occurence of an element in the list & returns its index. Can be slow as the whole list is traversed.	`[2, 2, 4].index(2) # index of element 4 is "0"` `[2, 2, 4].index(2,1) # index of element 2 after pos 1 is "1"`

Stack	Python lists can be used intuitively as stack via the two list operations append() and pop().	`stack = [3]`
		`stack.append(42) # [3, 42]`
		`stack.pop() # 42 (stack: [3])`
		`stack.pop() # 3 (stack: [])`

Set	A set is an unordered collection of elements. Each can exist only once.	`basket = {'apple', 'eggs', 'banana', 'orange'}` `same = set(['apple', 'eggs', 'banana', 'orange'])`
Dictionary	The dictionary is a useful data structure for storing (key, value) pairs.	`calories = {'apple' : 52, 'banana' : 89, 'choco' : 546}`

Reading and writing elements	Read and write elements by specifying the key within the brackets. Use the keys() and values() functions to access all keys and values of the dictionary.	`print(calories['apple'] < calories['choco']) # True`
		`calories['cappu'] = 74`
		`print(calories['banana'] < calories['cappu']) # False`
		`print('apple' in calories.keys()) # True`
		`print(52 in calories.values()) # True`

Dictionary Looping	You can loop over the (key, value) pairs of a dictionary with the items() method.	`for k, v in calories.items():` `  print(k) if v > 500 else None # 'chocolate'`

Membership operator	Check with the 'in' keyword whether the set, list, or dictionary contains an element. Set containment is faster than list containment.	`basket = {'apple', 'eggs', 'banana', 'orange'}`
		`print('eggs' in basket} # True`
		`print('mushroom' in basket} # False`

List and Set Comprehension	List comprehension is the concise Python way to create lists. Use brackets plus an expression, followed by a for clause. Close with zero or more for or if clauses.
	
	Set comprehension is similar to list comprehension.
		`# List comprehension`
		`l = [('Hi ' + x) for x in ['Alice', 'Bob', 'Pete']]`
		`print(l) # ['Hi Alice', 'Hi Bob', 'Hi Pete']`
		`l2 = [x * y for x in range(3) for y in range(3) if x>y]`
		`print(l2) # [0, 0, 2]`
		`# Set comprehension`
		`squares = { x**2 for x in [0,2,4] if x < 4 } # {0, 4}`

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Python Cheat Sheet: List Methods

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Method	Description	Example

`lst.append(x)`	Appends element `x` to the list `lst`.	`>>> l = []`
		`>>> l.append(42)`
		`>>> l.append(21)`
		`[42, 21]`

`lst.clear()`	Removes all elements from the list lst–which becomes empty.	`>>> lst = [1, 2, 3, 4, 5]`
		`>>> lst.clear()`
		`[]`

`lst.copy()`	Returns a copy of the list `lst`. Copies only the list, not the elements in the list (shallow copy).	`>>> lst = [1, 2, 3]`
		`>>> lst.copy()`
		`[1, 2, 3]`

`lst.count(x)`	Counts the number of occurrences of element `x` in the list `lst`.	`>>> lst = [1, 2, 42, 2, 1, 42, 42]`
		`>>> lst.count(42)`
		`3`
		`>>> lst.count(2)`
		`2`

`lst.extend(iter)`	Adds all elements of an iterable `iter` (e.g. another list) to the list `lst`.	`>>> lst = [1, 2, 3]`
		`>>> lst.extend([4, 5, 6])`
		`[1, 2, 3, 4, 5, 6]`

`lst.index(x)`	Returns the position (index) of the first occurrence of value `x` in the list `lst`.	`>>> lst = ["Alice", 42, "Bob", 99]`
		`>>> lst.index("Alice")`
		`0`
		`>>> lst.index(99, 1, 3)`
		`ValueError: 99 is not in list`

`lst.insert(i, x)`	Inserts element `x` at position (index) `i` in the list `lst`.	`>>> lst = [1, 2, 3, 4]`
		`>>> lst.insert(3, 99)`
		`[1, 2, 3, 99, 4]`

`lst.pop()`	Removes and returns the final element of the list `lst`.	`>>> lst = [1, 2, 3]`
		`>>> lst.pop()`
		`3`
		`>>> lst`
		`[1, 2]`

`lst.remove(x)`	Removes and returns the first occurrence of element `x` in the list `lst`.	`>>> lst = [1, 2, 99, 4, 99]`
		`>>> lst.remove(99)`
		`>>> lst`
		`[1, 2, 4, 99]`

`lst.reverse()`	Reverses the order of elements in the list `lst`.	`>>> lst = [1, 2, 3, 4]`
		`>>> lst.reverse()`
		`>>> lst`
		`[4, 3, 2, 1]`

`lst.sort()`	Sorts the elements in the list `lst` in ascending order.	`>>> lst = [88, 12, 42, 11, 2]`
		`>>> lst.sort()`
		`# [2, 11, 12, 42, 88]`
		`>>> lst.sort(key=lambda x: str(x)[0])`
		`# [11, 12, 2, 42, 88]`

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Python Cheat Sheet - Keywords

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Keyword	Description	Code example
`False, True`	Data values from the data type Boolean	`False == (1 > 2), True == (2 > 1)`

`and, or, not`	Logical operators:
	`(x and y)` → both x and y must be True
	`(x or y)` → either x or y must be True
	`(not x)` → x must be false
		`x, y = True, False`
		`(x or y) == True  # True`
		`(x and y) == False  # True`
		`(not y) == True  # True`

`break`	Ends loop prematurely	`while(True):`
		`  break # no infinite loop`
		`print("hello world")`

`continue`	Finishes current loop iteration	`while(True):`
		`  continue`
		`  print("43") # dead code`

`class`
 	
`def`
	Defines a new class → a real-world concept (object oriented programming)
	
	Defines a new function or class method. For latter, first parameter ("self") points to the class object. When calling class method, first parameter is implicit.
		`class Beer:`
		`  def __init__(self):`
		`  self.content = 1.0`
		`  def drink(self):`
		`  self.content = 0.0`
		
		`becks = Beer() # constructor - create class`
		`becks.drink() # beer empty: b.content == 0`

`if, elif, else`	Conditional program execution: program starts with "if" branch, tries the "elif" branches, and finishes with "else" branch (until one branch evaluates to True).	`x = int(input("your value: "))`
		`if x > 3: print("Big")`
		`elif x == 3: print("Medium")`
		`else: print("Small")`

`for, while`	`# For loop declaration`
	`for i in [0,1,2]:`
	`  print(i)`
		`# While loop - same semantics`
		`j = 0`
		`while j < 3:`
		`  print(j)`
		`  j = j + 1`

`in`	Checks whether element is in sequence	`42 in [2, 39, 42] # True`

`is`	Checks whether both elements point to the same object	`y = x = 3`
		`x is y # True`
		`[3] is [3] # False`

`None`	Empty value constant	`def f():`
		`  x = 2`
		`f() is None # True`

`lambda`	Function with no name (anonymous function)	`(lambda x: x + 3)(3) # returns 6`

`return`	Terminates execution of the function and passes the flow of execution to the caller. An optional value after the return keyword specifies the function result.	`def incrementor(x):`
		`  return x + 1`
		`incrementor(4) # returns 5`

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Python Cheat Sheet - Functions and Tricks

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		Description	Example	Result
ADVANCED FUNCTIONS	`map(func, iter)`	Executes the function on all elements of the iterable	`list(map(lambda x: x[0], ['red', 'green', 'blue']))`	`['r', 'g', 'b']`
	`map(func, i1, ..., ik)`	Executes the function on all k elements of the k iterables	`list(map(lambda x, y: str(x) + ' ' + y + 's' , [0, 2, 2], ['apple', 'orange', 'banana']))`	`['0 apples', '2 oranges', '2 bananas']`
	`string.join(iter)`	Concatenates iterable elements separated by `string`	`' marries '.join(list(['Alice', 'Bob']))`	`'Alice marries Bob'`
	`filter(func, iterable)`	Filters out elements in iterable for which function returns False (or 0)	`list(filter(lambda x: True if x>17 else False, [1, 15, 17, 18]))`	`[18]`
	`string.strip()`	Removes leading and trailing whitespaces of string	`print("\n  \t  42  \t ".strip())`	`42`
	`sorted(iter)`	Sorts iterable in ascending order	`sorted([8, 3, 2, 42, 5])`	`[2, 3, 5, 8, 42]`
	`sorted(iter, key=key)`	Sorts according to the key function in ascending order	`sorted([8, 3, 2, 42, 5], key=lambda x: 0 if x==42 else x)`	`[42, 2, 3, 5, 8]`
	`help(func)`	Returns documentation of func	`help(str.upper())`	`'... to uppercase.'`
	`zip(i1, i2, ...)`	Groups the i-th elements of iterators i1, i2, ... together	`list(zip(['Alice', 'Anna'], ['Bob', 'Jon', 'Frank']))`	`[('Alice', 'Bob'), ('Anna', 'Jon')]`
	Unzip	Equal to: 1) unpack the zipped list, 2) zip the result	`list(zip(*[('Alice', 'Bob'), ('Anna', 'Jon')]`	`[('Alice', 'Anna'), ('Bob', 'Jon')]`
	`enumerate(iter)`	Assigns a counter value to each element of the iterable	`list(enumerate(['Alice', 'Bob', 'Jon']))`	`[(0, 'Alice'), (1, 'Bob'), (2, 'Jon')]`
TRICKS	python -m http.server <P>	Share files between PC and phone? Run command in PC's shell. <P> is any port number 0–65535. Type < IP address of PC>:<P> in the phone's browser. You can now browse the files in the PC directory.		
	Read comic	`import antigravity`	Open the comic series xkcd in your web browser	
	Zen of Python	`import this`	`'...Beautiful is better than ugly. Explicit is ...'`	
	Swapping numbers	Swapping variables is a breeze in Python. No offense, Java!	`a, b = 'Jane', 'Alice'` `a, b = b, a`	`a = 'Alice'` `b = 'Jane'`

	Unpacking arguments	Use a sequence as function arguments via asterisk operator *. Use a dictionary (key, value) via double asterisk operator **	`def f(x, y, z): return x + y * z`
			`f(*[1, 3, 4])`
			`f(**{'z' : 4, 'x' : 1, 'y' : 3})`
				
				`13`
				`13`

	Extended Unpacking	Use unpacking for multiple assignment feature in Python	`a, *b = [1, 2, 3, 4, 5]`	`a = 1` `b = [2, 3, 4, 5]`

	Merge two dictionaries	Use unpacking to merge two dictionaries into a single one	`x={'Alice' : 18}`
			`y={'Bob' : 27, 'Ann' : 22}`
			`z = {**x,**y}`
				`z = {'Alice': 18, 'Bob': 27, 'Ann': 22}`

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Python Cheat Sheet - Classes

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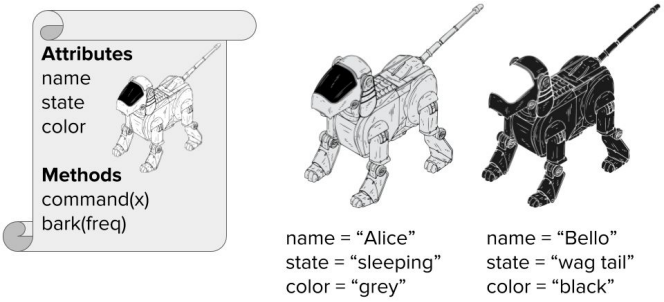
	Description	Example
Classes	A class encapsulates data and functionality - data as attributes, and functionality as methods. It is a blueprint to create concrete instances in the memory. Class Instances 	
Instance	You are an instance of the class human. An instance is a concrete implementation of a class: all attributes of an instance have a fixed value. Your hair is blond, brown, or black - but never unspecified. Each instance has its own attributes independent of other instances. Yet, class variables are different. These are data values associated with the class, not the instances. Hence, all instance share the same class variable `species` in the example.	
Self	The first argument when defining any method is always the `self` argument. This argument specifies the instance on which you call the method. `self` gives the Python interpreter the information about the concrete instance. To *define* a method, you use `self` to modify the instance attributes. But to *call* an instance method, you do not need to specify `self`.	

Creation	You can create classes "on the fly" and use them as logical units to store complex data types.
	
	`class Employee():`
	`  pass`
	`employee = Employee()`
	`employee.salary = 122000`
	`employee.firstname = "alice"`
	`employee.lastname = "wonderland"`
	
	`print(employee.firstname + " "`
	`  + employee.lastname + " "`
	`  + str(employee.salary) + "$")`
	`# alice wonderland 122000$`	

```
class Dog:
        """ Blueprint of a dog """

        # class variable shared by all instances
        species = ["canis lupus"]

        def __init__(self, name, color):
                self.name = name
                self.state = "sleeping"
                self.color = color

        def command(self, x):
                if x == self.name:
                        self.bark(2)
                elif x == "sit":
                self.state = "sit"
                else:
                        self.state = "wag tail"

        def bark(self, freq):
                for i in range(freq):
                        print("[" + self.name
                                + "]: Woof!")

bello = Dog("bello", "black")
alice = Dog("alice", "white")

print(bello.color) # black
print(alice.color) # white

bello.bark(1) # [bello]: Woof!

alice.command("sit")
print("[alice]: " + alice.state)
# [alice]: sit

bello.command("no")
print("[bello]: " + bello.state)
# [bello]: wag tail

alice.command("alice")
# [alice]: Woof!
# [alice]: Woof!

bello.species += ["wulf"]
print(len(bello.species)
        == len(alice.species)) # True (!)
```

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Python Cheat Sheet: Object Orientation Terms

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	Description	Example
Class	A blueprint to create objects. It defines the data (attributes) and functionality (methods) of the objects. You can access both attributes and methods via the dot notation.	
Object (=instance)	A piece of encapsulated data with functionality in your Python program that is built according to a class definition. Often, an object corresponds to a thing in the real world. An example is the object "Obama" that is created according to the class definition "Person". An object consists of an arbitrary number of attributes and methods, encapsulated within a single unit.	
Instantiation	The process of creating an object of a class. This is done with the constructor method __init__(self, ...).	
Method	A subset of the overall functionality of an object. The method is defined similarly to a function (using the keyword "def") in the class definition. An object can have an arbitrary number of methods.	
Self	The first argument when defining any method is always the `self` argument. This argument specifies the instance on which you call the method. `self` gives the Python interpreter the information about the concrete instance. To *define* a method, you use `self` to modify the instance attributes. But to *call* an instance method, you do not need to specify `self`.	
Encapsulation	Binding together data and functionality that manipulates the data.	
Attribute	A variable defined for a class (class attribute) or for an object (instance attribute). You use attributes to package data into enclosed units (class or instance).	
Class attribute	(=class variable, static variable, static attribute) A variable that is created statically in the class definition and that is shared by all class objects.	
Instance attribute (=instance variable)	A variable that holds data that belongs only to a single instance. Other instances do not share this variable (in contrast to class attributes). In most cases, you create an instance attribute x in the constructor when creating the instance itself using the self keywords (e.g. self.x = <val>).	
Dynamic attribute	An instance attribute that is defined dynamically during the execution of the program and that is not defined within any method. For example, you can simply add a new attribute `neew` to any object o by calling `o.neew = <val>`.	
Method overloading	You may want to define a method in a way so that there are multiple options to call it. For example for class X, you define a method f(...) that can be called in three ways: f(a), f(a,b), or f(a,b,c). To this end, you can define the method with default parameters (e.g. f(a, b=None, c=None).	
Inheritance	Class A can inherit certain characteristics (like attributes or methods) from class B. For example, the class "Dog" may inherit the attribute "number_of_legs" from the class "Animal". In this case, you would define the inherited class "Dog" as follows: "class Dog(Animal): ..."	

```
class Dog:

    # class attribute
    is_hairy = True

    # constructor
    def __init__(self, name):
        # instance attribute
        self.name = name

    # method
    def bark(self):
        print("Wuff")


bello = Dog("bello")
paris = Dog("paris")

print(bello.name)
"bello"

print(paris.name)
"paris"


class Cat:

    # method overloading
    def miau(self, times=1):
        print("miau " * times)

fifi = Cat()

fifi.miau()
"miau "

fifi.miau(5)
"miau miau miau miau miau "

# Dynamic attribute
fifi.likes = "mice"
print(fifi.likes)
"mice"

# Inheritance
class Persian_Cat(Cat):
    classification = "Persian"

mimi = Persian_Cat()
print(mimi.miau(3))
"miau miau miau "


print(mimi.classification)
```

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Python Cheat Sheet: 14 Interview Questions

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Question	Code	Question	Code

Check if list contains integer x	`l = [3, 3, 4, 5, 2, 111, 5]`
	`print(111 in l) # True`
		Get missing number in [1...100]	`def get_missing_number(lst):`
			`  return set(range(lst[len(lst)-1])[1:]) - set(l)`
			`l = list(range(1,100))`
			`l.remove(50)`
			`print(get_missing_number(l)) # 50`

Find duplicate number in integer list	`def find_duplicates(elements):`
	`  duplicates, seen = set(), set()`
	`  for element in elements:`
	`  if element in seen:`
	`  duplicates.add(element)`
	`  seen.add(element)`
	`  return list(duplicates)`
		Compute the intersection of two lists	`def intersect(lst1, lst2):`
			`  res, lst2_copy = [], lst2[:]`
			`  for el in lst1:`
			`  if el in lst2_copy:`
			`  res.append(el)`
			`  lst2_copy.remove(el)`
			`  return res`

Check if two strings are anagrams	`def is_anagram(s1, s2):`
	`  return set(s1) == set(s2)`
	`print(is_anagram("elvis", "lives")) # True`
		Find max and min in unsorted list	`l = [4, 3, 6, 3, 4, 888, 1, -11, 22, 3]`
			`print(max(l)) # 888`
			`print(min(l)) # -11`

Remove all duplicates from list	`lst = list(range(10)) + list(range(10))`
	`lst = list(set(lst))`
	`print(lst)`
	`# [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`
		Reverse string using recursion	`def reverse(string):`
			`  if len(string)<=1: return string`
			`  return reverse(string[1:])+string[0]`
			`print(reverse("hello")) # olleh`

Find pairs of integers in list so that their sum is equal to integer x	`def find_pairs(l, x):`
	`  pairs = []`
	`  for (i, el_1) in enumerate(l):`
	`  for (j, el_2) in enumerate(l[i+1:]):`
	`  if el_1 + el_2 == x:`
	`  pairs.append((el_1, el_2))`
	`  return pairs`
		Compute the first n Fibonacci numbers	`a, b = 0, 1`
			`n = 10`
			`for i in range(n):`
			`  print(b)`
			`  a, b = b, a+b`
			`# 1, 1, 2, 3, 5, 8, ...`

Check if a string is a palindrome	`def is_palindrome(phrase):`
	`  return phrase == phrase[::-1]`
	`print(is_palindrome("anna")) # True`
		Sort list with Quicksort algorithm	`def qsort(L):`
			`  if L == []: return []`
			`  return qsort([x for x in L[1:] if x< L[0]]) + L[0:1] +`
			`qsort([x for x in L[1:] if x>=L[0]])`
			`lst = [44, 33, 22, 5, 77, 55, 999]`
			`print(qsort(lst))`
			`# [5, 22, 33, 44, 55, 77, 999]`

Use list as stack, array, and queue	`# as a list ...`
	`l = [3, 4]`
	`l +=  [5, 6] # l = [3, 4, 5, 6]`
	
	`# ... as a stack ...`
	`l.append(10) # l = [4, 5, 6, 10]`
	`l.pop() # l = [4, 5, 6]`
	
	`# ... and as a queue`
	`l.insert(0, 5) # l = [5, 4, 5, 6]`
	`l.pop() # l = [5, 4, 5]`
		Find all permutations of string	`def get_permutations(w):`
			`  if len(w)<=1:`
			`  return set(w)`
			`  smaller = get_permutations(w[1:])`
			`  perms = set()`
			`  for x in smaller:`
			`  for pos in range(0,len(x)+1):`
			`  perm = x[:pos] + w[0] + x[pos:]`
			`  perms.add(perm)`
			`  return perms`
			`print(get_permutations("nan"))`
			`# {'nna', 'ann', 'nan'}`

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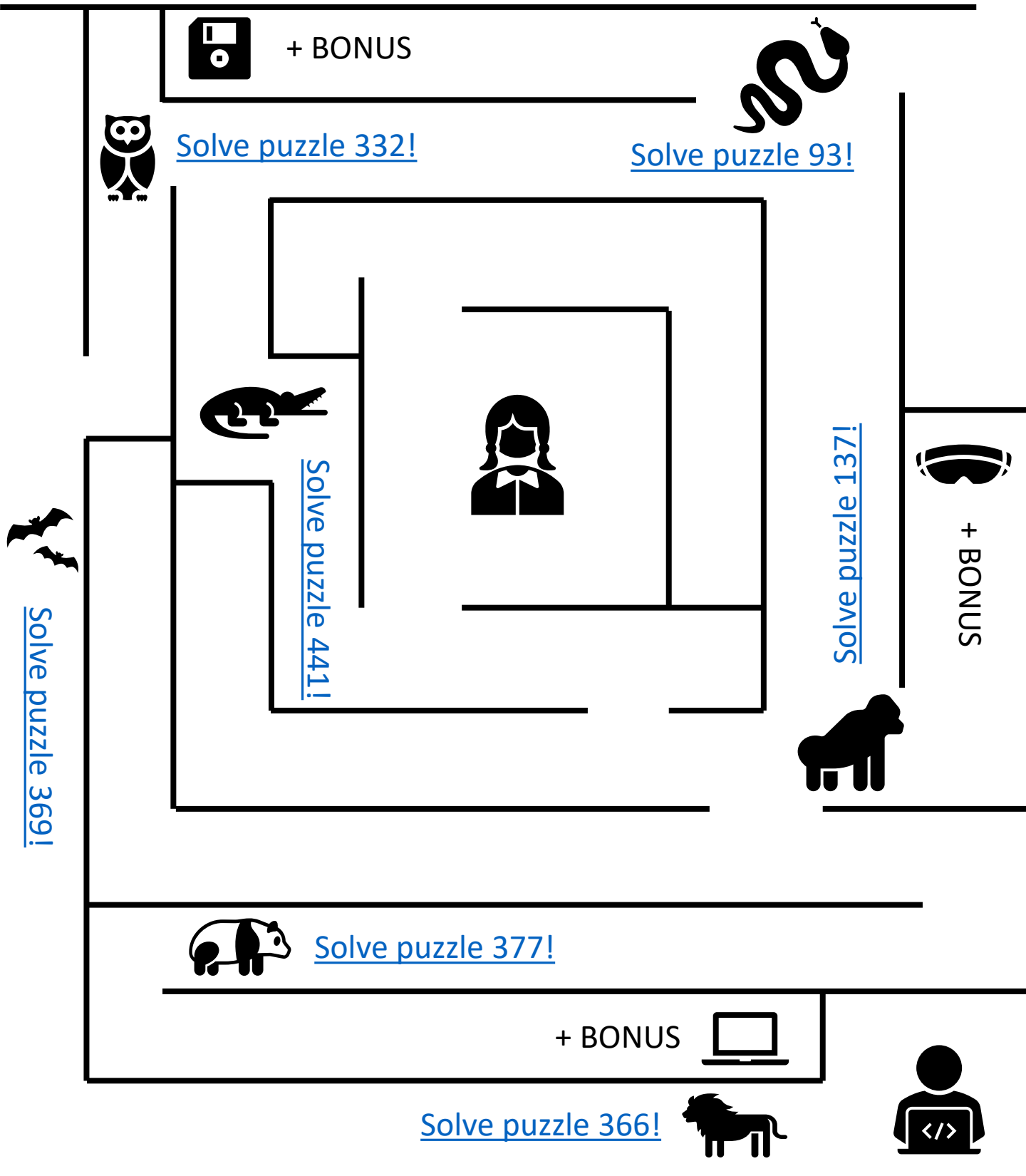
[Test Sheet] Help Alice Find Her Coding Dad!

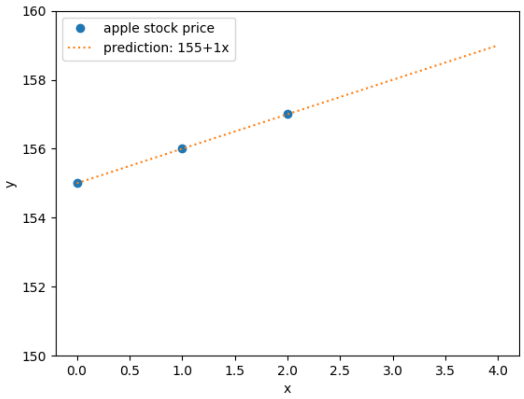


[Cheat Sheet] 6 Pillar Machine Learning Algorithms

Complete Course: https://academy.finxter.com/

Linear Regression

https://blog.finxter.com/logistic-regression-in-one-line-python/



K-Means Clustering

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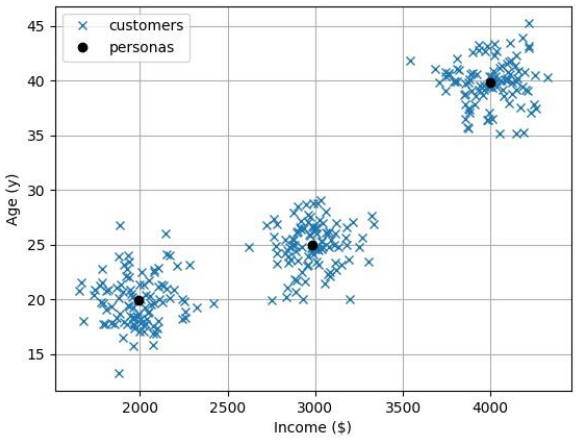
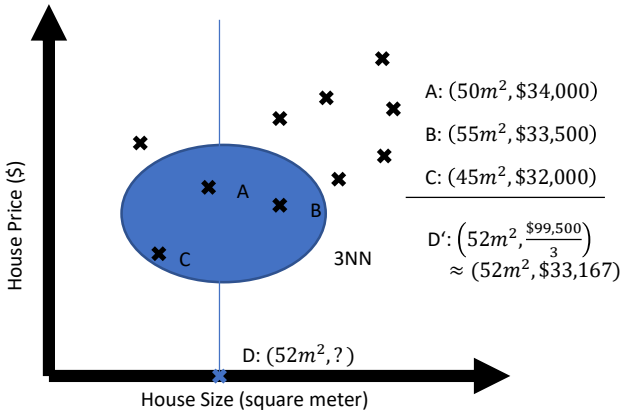


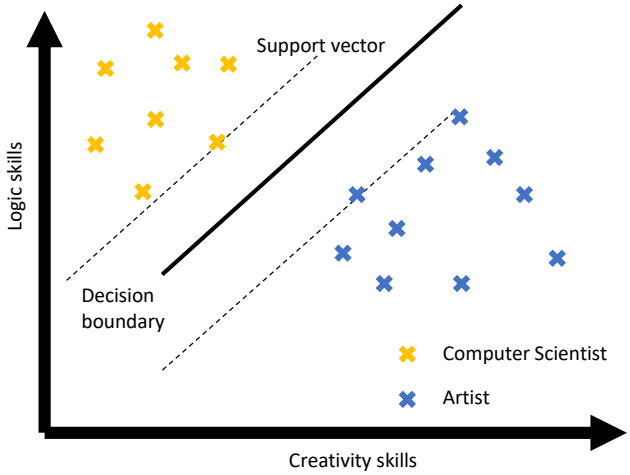
K Nearest Neighbors

https://blog.finxter.com/k-nearest-neighbors-as-a-python-one-liner/



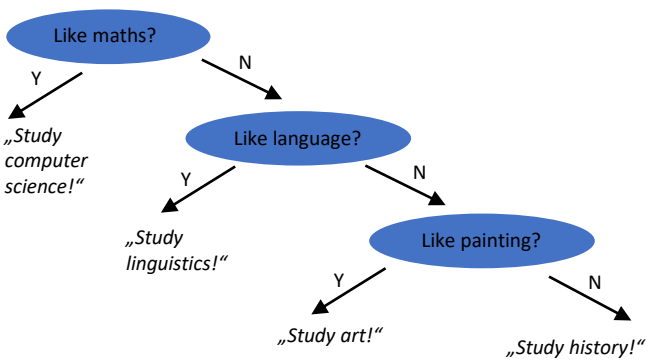
Support Vector Machine Classification

https://blog.finxter.com/support-vector-machines-python/



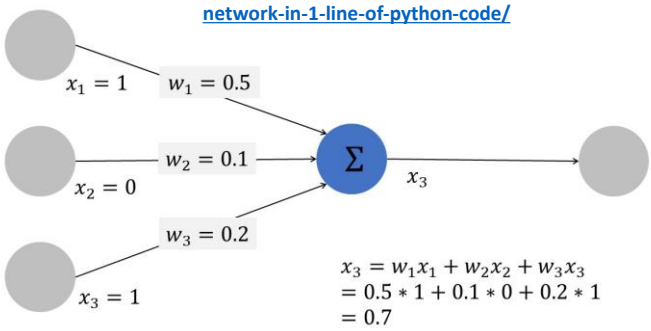
Decision Tree Classification

https://blog.finxter.com/decision-tree-learning-in-one-line-python/



Multilayer Perceptron

https://blog.finxter.com/tutorial-how-to-create-your-first-neural-network-in-1-line-of-python-code/



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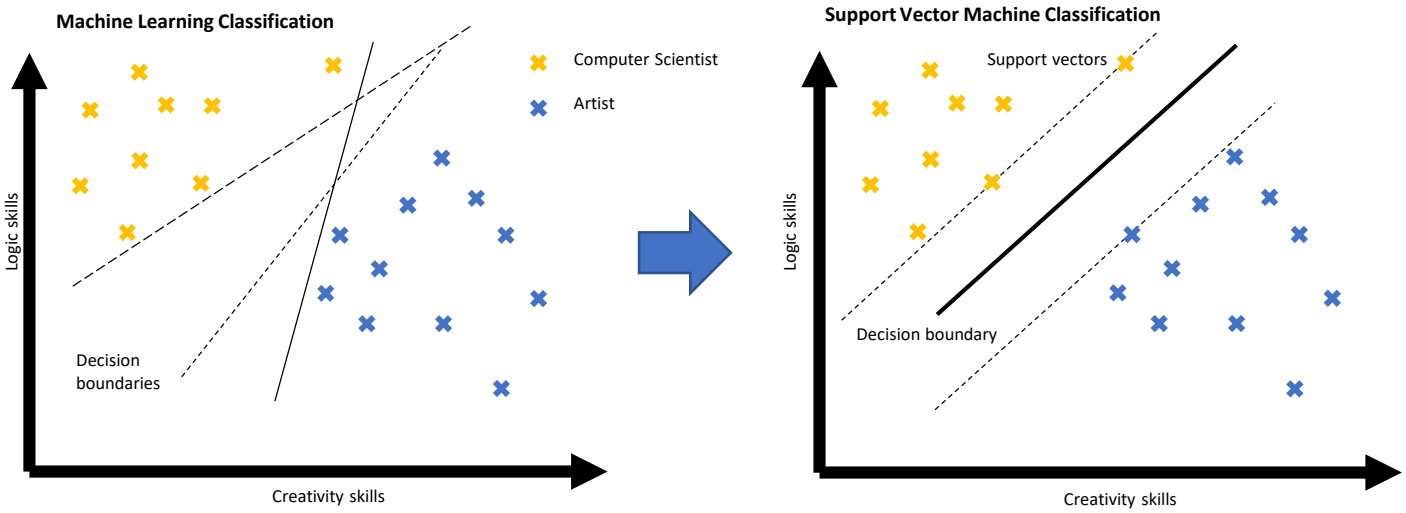
„Continuous Improvement in Your Coffee Break Python!“

[Machine Learning Cheat Sheet] Support Vector Machines

Based on Article: https://blog.finxter.com/support-vector-machines-python/

Main idea: Maximize width of separator zone → increases „margin of safety“ for classification



What are basic SVM properties?

Support Vector Machines	
Alternatives:	SVM, support-vector networks
Learning:	Classification, Regression
Advantages:	Robust for high-dimensional space Memory efficient (only uses support vectors) Flexible and customizable
Disadvantages:	Danger of overfitting in high-dimensional space No classification probabilities like Decision trees
Boundary:	Linear and Non-linear

What‘s the most basic Python code example?

```
## Dependencies
from sklearn import svm
import numpy as np


## Data: student scores in (math, language, creativity)
## --> study field
X = np.array([[9, 5, 6, "computer science"],
              [10, 1, 2, "computer science"],
              [1, 8, 1, "literature"],
              [4, 9, 3, "literature"],
              [0, 1, 10, "art"],
              [5, 7, 9, "art"]])


## One-liner
svm = svm.SVC().fit(X[:,:-1], X[:,-1])


## Result & puzzle
student_0 = svm.predict([[3, 3, 6]])
print(student_0)

student_1 = svm.predict([[8, 1, 1]])
print(student_1)
```

What‘s the explanation of the code example?

Explanation: A Study Recommendation System with SVM

- NumPy array holds labeled training data (one row per user and one column per feature).
- Features: skill level in maths, language, and creativity.
- Labels: last column is recommended study field.
- 3D data → SVM separates data using 2D planes (the linear separator) rather than 1D lines.
- One-liner:
    1. Create model using constructor of scikit-learn’s svm.SVC class (SVC = support vector classification).
    2. Call fit function to perform training based on labeled training data.
- Results: call predict function on new observations
    - student_0 (skills maths=3, language=3, and creativity=6) → SVM predicts “art”
    - student_1 (maths=8, language=1, and creativity=1) → SVM predicts “computer science”
- Final output of one-liner:

```
## Result & puzzle
student_0 = svm.predict([[3, 3, 6]])
print(student_0)
# ['art']

student_1 = svm.predict([[8, 1, 1]])
print(student_1)
## ['computer science']
```

finxter Book: Simplicity – The Finer Art of Creating Software

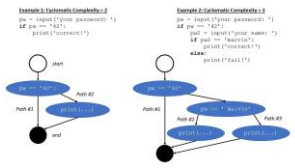
Complexity

"A whole, made up of parts—difficult to analyze, understand, or explain".

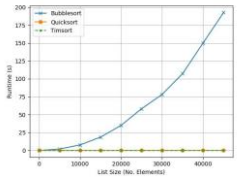
Complexity appears in
- Project Lifecycle
- Code Development
- Algorithmic Theory
- Processes
- Social Networks
- Learning & Your Daily Life

Project Lifecycle

Cyclomatic Complexity



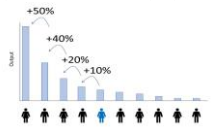
Runtime Complexity

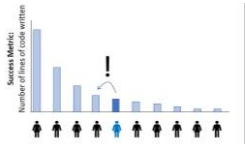


→ Complexity reduces productivity and focus. It'll consume your precious time. Keep it simple!

80/20 Principle

Majority of effects come from the minority of causes.



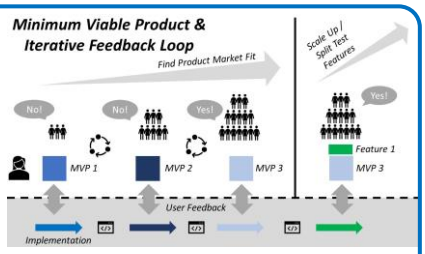


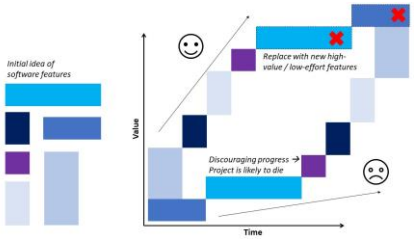
Pareto Tips
1. Figure out your success metrics.
2. Figure out your big goals in life.
3. Look for ways to achieve the same things with fewer resources.
4. Reflect on your own successes
5. Reflect on your own failures
6. Read more books in your industry.
7. Spend much of your time improving and tweaking existing products
8. Smile.
9. Don't do things that reduce value

Maximize Success Metric:
#lines of code written

Minimum Viable Product (MVP)

A minimum viable product in the software sense is code that is stripped from all features to focus on the core functionality.





How to MVP?
- Formulate hypothesis
- Omit needless features
- Split test to validate each new feature
- Focus on product-market fit
- Seek high-value and low-cost features

Clean Code Principles

1. You Ain't Going to Need It
2. The Principle of Least Surprise
3. Don't Repeat Yourself
4. **Code For People Not Machines**
5. Stand on the Shoulders of Giants
6. Use the Right Names
7. Single-Responsibility Principle
8. Use Comments
9. Avoid Unnecessary Comments
10. Be Consistent
11. Test
12. Think in Big Pictures
13. Only Talk to Your Friends
14. Refactor
15. Don't Overengineer
16. Don't Overuse Indentation
17. Small is Beautiful
18. Use Metrics
19. Boy Scout Rule: Leave Camp Cleaner Than You Found It

Unix Philosophy

1. Simple's Better Than Complex
2. **Small is Beautiful (*Again*)**
3. Make Each Program Do One Thing Well
4. Build a Prototype First
5. Portability Over Efficiency
6. Store Data in Flat Text Files
7. Use Software Leverage
8. Avoid Captive User Interfaces
9. **Program = Filter**
10. Worse is Better
11. Clean > Clever Code
12. **Design *Connected* Programs**
13. Make Your Code Robust
14. Repair What You Can — But Fail Early and Noisily
15. Write Programs to Write Programs

Premature Optimization

"Programmers waste enormous amounts of time thinking about […] the speed of noncritical parts of their programs. We should forget about small efficiencies, say about 97 % of the time: premature optimization is the root of all evil." – **Donald Knuth**

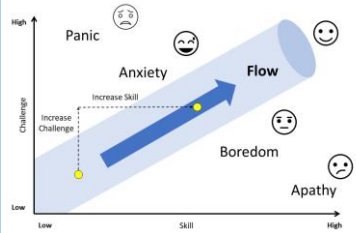
Performance Tuning 101
1. Measure, then improve
2. Focus on the slow 20%
3. Algorithmic optimization wins
4. All hail to the cache
5. Solve an easier problem version
6. Know when to stop

Less Is More in Design

How to Simplify Design?
1. Use whitespace
2. Remove design elements
3. Remove features
4. Reduce variation of fonts, font types, colors
5. Be consistent across UIs

Flow

"… the source code of ultimate human performance" – ***Kotler***

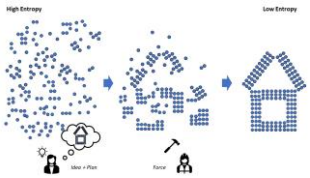


How to Achieve Flow? (1) clear goals, (2) immediate feedback, and (3) balance opportunity & capacity.

Flow Tips for Coders
1. Always work on an explicit practical code project
2. Work on fun projects that fulfill your purpose
3. Perform from your strengths
4. Big chunks of coding time
5. Reduce distractions: smartphone + social
6. Sleep a lot, eat healthily, read quality books, and exercise → garbage in, garbage out!

Focus

You can take raw resources and move them from a state of high entropy into a state of low entropy—using *focused effort towards the attainment of a greater plan*.



3-Step Approach of Efficient Software Creation
1. Plan your code
2. Apply focused effort to make it real.
3. Seek feedback

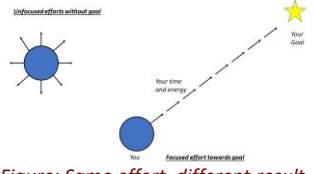


Figure: Same effort, different result.

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Git Cheat Sheet

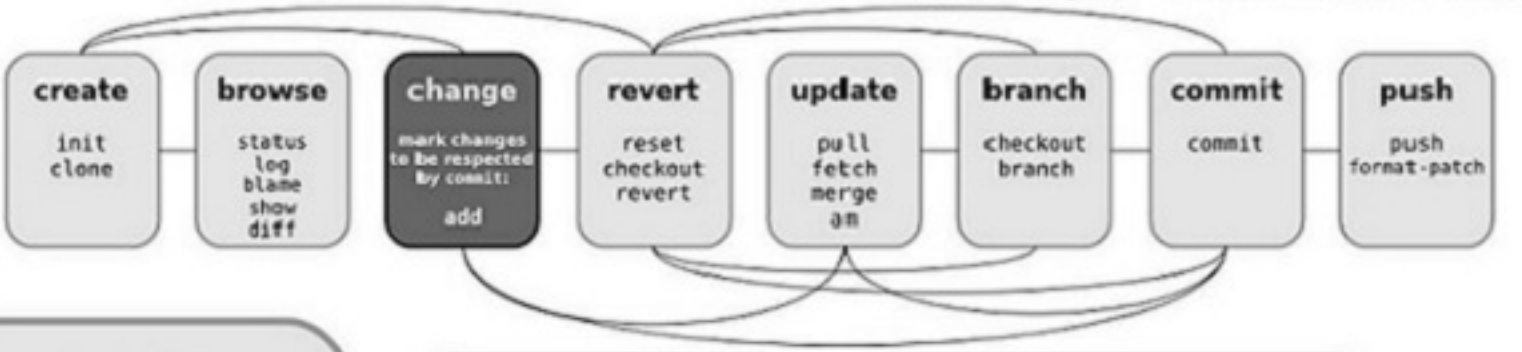
by Jan Krüger <jk@jk.gs>, http://jan-krueger.net/git/
Based on work by Zack Rusin

Basics

Use git help [*command*] if you're stuck.

master	default devel branch
origin	default upstream branch
HEAD	current branch
HEAD^	parent of HEAD
HEAD~4	great-great grandparent of HEAD
foo..*bar*	from branch *foo* to branch *bar*

(left to right) Command Flow



Create

From existing files

```
git init
git add .
```

From existing repository

```
git clone ~/old ~/new
git clone git://...
git clone ssh://...
```

View

```
git status
git diff [oldid newid]
git log [-p] [file|dir]
git blame file
git show id (meta data + diff)
git show id:file
git branch (shows list, * = current)
git tag -l (shows list)
```

Revert

In Git, revert usually describes a new commit that undoes previous commits.

```
git reset --hard (NO UNDO)
        (reset to last commit)
git revert branch
git commit -a --amend
        (replaces prev. commit)
git checkout id file
```

Publish

In Git, commit only respects changes that have been marked explicitly with add.

```
git commit [-a]
        (-a: add changed files automatically)
git format-patch origin
        (create set of diffs)
git push remote
        (push to origin or remote)
git tag foo
        (mark current version)
```

Update

```
git fetch (from def. upstream)
git fetch remote
git pull (= fetch & merge)
git am -3 patch.mbox
git apply patch.diff
```

Branch

```
git checkout branch
        (switch working dir to branch)
git merge branch
        (merge into current)
git branch branch
        (branch current)
git checkout -b new other
        (branch new from other and switch to it)
```

Useful Tools

```
git archive
        Create release tarball
git bisect
        Binary search for defects
git cherry-pick
        Take single commit from elsewhere
git fsck
        Check tree
git gc
        Compress metadata (performance)
git rebase
        Forward-port local changes to remote branch
git remote add URL
        Register a new remote repository for this tree
git stash
        Temporarily set aside changes
git tag
        (there's more to it)
gitk
        Tk GUI for Git
```

Conflicts

Use add to mark files as resolved.

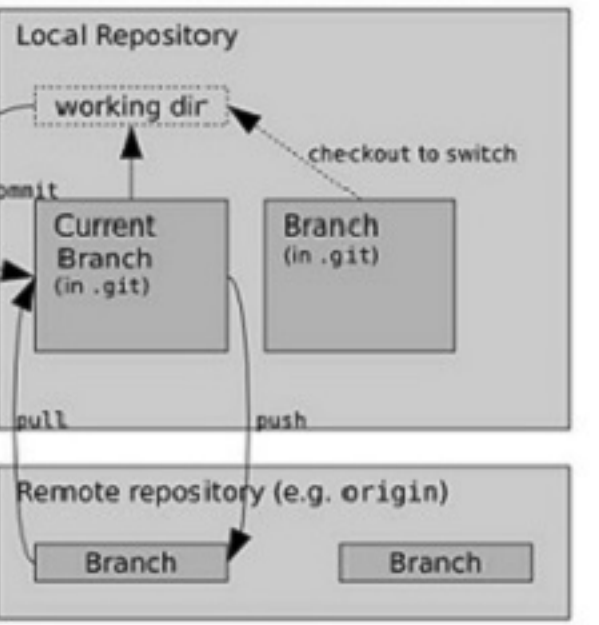
```
git diff [--base]
git diff --ours
git diff --theirs
git log --merge
gitk --merge
```

Tracking Files

```
git add files
git mv old new
git rm files
git rm --cached files
```

(stop tracking but keep files in working dir)

Structure Overview



Git Cheat Sheet

Setup

Set the name and email that will be attached to your commits and tags

```
$ git config --global user.name "Danny Adams"
$ git config --global user.email "my-email@gmail.com"
```

Start a Project

Create a local repo (omit <directory> to initialise the current directory as a git repo

```
$ git init <directory>
```

Download a remote repo

```
$ git clone <url>
```

Make a Change

Add a file to staging

```
$ git add <file>
```

Stage all files

```
$ git add .
```

Commit all staged files to git

```
$ git commit -m "commit message"
```

Add all changes made to tracked files & commit

```
$ git commit -am "commit message"
```

Basic Concepts

main: default development branch
origin: default upstream repo
HEAD: current branch
HEAD^: parent of HEAD
HEAD~4: great-great grandparent of HEAD

By @DoableDanny

Branches

List all local branches. Add -r flag to show all remote branches. -a flag for all branches.

```
$ git branch
```

Create a new branch

```
$ git branch <new-branch>
```

Switch to a branch & update the working directory

```
$ git checkout <branch>
```

Create a new branch and switch to it

```
$ git checkout -b <new-branch>
```

Delete a merged branch

```
$ git branch -d <branch>
```

Delete a branch, whether merged or not

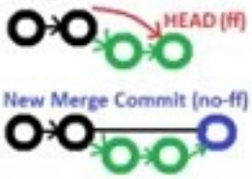
```
$ git branch -D <branch>
```

Add a tag to current commit (often used for new version releases)

```
$ git tag <tag-name>
```

Merging

Merge branch a into branch b. Add --no-ff option for no-fast-forward merge



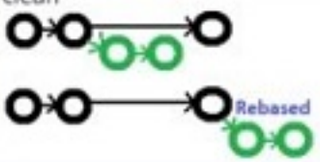

```
$ git checkout b
$ git merge a
```

Merge & squash all commits into one new commit

```
$ git merge --squash a
```

Rebasing

Rebase feature branch onto main (to incorporate new changes made to main). Prevents unnecessary merge commits into feature, keeping history clean




```
$ git checkout feature
$ git rebase main
```

Interatively clean up a branches commits before rebasing onto main

```
$ git rebase -i main
```

Interatively rebase the last 3 commits on current branch

```
$ git rebase -i Head~3
```

Undoing Things

Move (&/or rename) a file & stage move

```
$ git mv <existing_path> <new_path>
```

Remove a file from working directory & staging area, then stage the removal

```
$ git rm <file>
```

Remove from staging area only

```
$ git rm --cached <file>
```

View a previous commit (READ only)

```
$ git checkout <commit_ID>
```

Create a new commit, reverting the changes from a specified commit

```
$ git revert <commit_ID>
```

Go back to a previous commit & delete all commits ahead of it (revert is safer). Add --hard flag to also delete workspace changes (BE VERY CAREFUL)

```
$ git reset <commit_ID>
```

Review your Repo

List new or modified files not yet committed

```
$ git status
```

List commit history, with respective IDs

```
$ git log --oneline
```

Show changes to unstaged files. For changes to staged files, add --cached option

```
$ git diff
```

Show changes between two commits

```
$ git diff commit1_ID commit2_ID
```

Stashing

Store modified & staged changes. To include untracked files, add -u flag. For untracked & ignored files, add -a flag.

```
$ git stash
```

As above, but add a comment.

```
$ git stash save "comment"
```

Partial stash. Stash just a single file, a collection of files, or individual changes from within files

```
$ git stash -p
```

List all stashes

```
$ git stash list
```

Re-apply the stash without deleting it

```
$ git stash apply
```

Re-apply the stash at index 2, then delete it from the stash list. Omit stash@{n} to pop the most recent stash.

```
$ git stash pop stash@{2}
```

Show the diff summary of stash 1. Pass the -p flag to see the full diff.

```
$ git stash show stash@{1}
```

Delete stash at index 1. Omit stash@{n} to delete last stash made

```
$ git stash drop stash@{1}
```

Delete all stashes

```
$ git stash clear
```

Synchronizing

Add a remote repo

```
$ git remote add <alias> <url>
```

View all remote connections. Add -v flag to view urls.

```
$ git remote
```

Remove a connection

```
$ git remote remove <alias>
```

Rename a connection

```
$ git remote rename <old> <new>
```

Fetch all branches from remote repo (no merge)

```
$ git fetch <alias>
```

Fetch a specific branch

```
$ git fetch <alias> <branch>
```

Fetch the remote repo's copy of the current branch, then merge

```
$ git pull
```

Move (rebase) your local changes onto the top of new changes made to the remote repo (for clean, linear history)

```
$ git pull --rebase <alias>
```

Upload local content to remote repo

```
$ git push <alias>
```

Upload to a branch (can then pull request)

```
$ git push <alias> <branch>
```

Git Cheat Sheet

Git is a version control system.

The essentials: Using Git	
`git clone`	Clone a Git repository to your local computer
`git fetch`	Fetch changes from a remote repository
`git pull`	Fetch and merge changes from a remote repository
`git status`	See a summary of local changes, remote commits, and untracked files.
`git diff`	See specific local changes. Use **`--name-only`** to see filenames.
`git add`	Stage changes to tracked and untracked files.
`git commit`	Create a new commit with changes previously added.
`git push`	Send changes to your configured remote repository (like GitLab or GitHub).

Important options: Keeping things organized	
`git reset HEAD --`	Get back to the last known commit and unstage files.
`git add -u`	Add only updated, previously committed files.
`git log --graph --oneline`	See a pretty branch history. Create an alias (**git lg**) for easy access.

Basic branching: Branches represent a series of commits	
`git branch --all`	List all local and remote branches
`git checkout bugfix`	Change to an existing branch called **bugfix**
`git checkout -b dev main`	Make and checkout a branch called **dev** based on **main**
`git checkout main` `git merge dev`	Merge branch changes from **dev** into **main**

Pushing changes: Sending data from your local repository to a remote repository	
`git remote -v`	View all configured remotes
`git push origin HEAD`	Push commits located at the HEAD of your repo to the **origin** repo
`git push origin +HEAD`	Push commits, forcing remote to adopt local changes
`git push origin -d dev`	Delete **dev** branch from remote after pushing changes

Matt Broberg & Seth Kenlon

Opensource.com

Supported by Red Hat

The Simple Git Cheat Sheet – A Helpful Illustrated Guide

The Centralized Git Workflow

- Every coder has own copy of project
- Independence of workflow
- No advanced branching and merging needed

Git Master Branch

Alice

Remote Repository:
Master Branch

Bob

git init

Create new repository

Clone

git clone alice@host:/path/repos

Clone repository

Clone

git clone bob@host:/path/repos

git add main.py

Add file „main.py“ to project

„new file“

git commit -m “new file”

Commit change and add message „new file“ to the master branch

git push origin master

Send master branch to remote repository

Push

„new file“

Pull

git pull

Update local repository with master branch

„new file“

git add *

Add all changes to master

git rm main.py

Remove file „main.py“ from master branch

git commit -m “add 2, rem 1”

„add 2, rem 1“

Commit change and add message to the master

git push origin master

Send master branch to remote repository

Push

„add 2, rem 1“

finxter

„A Puzzle A Day to Learn, Code, and Play!“