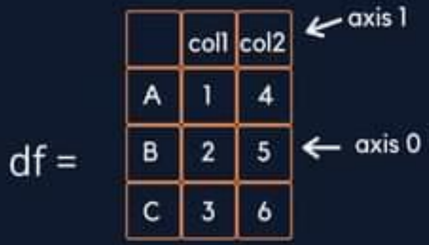
# Pandas Cheat Sheet

Pandas provides data analysis tools for Python. All of the following code examples refer to the dataframe below.



df =

|   | col1 | col2 |
|---|---|---|
| A | 1 | 4 |
| B | 2 | 5 |
| C | 3 | 6 |

## Getting Started

Import pandas:

```
  import pandas as pd
```

Create a series:

```
   s = pd.Series([1, 2, 3],
                 index=['A', 'B', 'C'],
                 name='col1')
```

Create a dataframe:

```
   data = [[1, 4], [2, 5], [3, 6]]
   index = ['A', 'B', 'C']
   df = pd.DataFrame(data, index=index,
                     columns=['col1', 'col2'])
```

Load a dataframe:

```
   df = pd.read_csv('filename.csv', sep=',',
                    names=['col1', 'col2'],
                    index_col=0,
                    encoding='utf-8',
                    nrows=3)
```

## Selecting rows and columns

Select single column:

```
 df['col1']
```

Select multiple columns:

```
 df[['col1', 'col2']]
```

Show first n rows:

```
 df.head(2)
```

Show last n rows:

```
 df.tail(2)
```

Select rows by index values:

```
 df.loc['A'] df.loc[['A', 'B']]
```

Select rows by position:

```
 df.loc[1] df.loc[1:]
```

## Data wrangling

Filter by value:

```
 df[df['col1'] > 1]
```

Sort by columns:

```
 df.sort_values(['col2', 'col2'],
         ascending=[False, True])
```

Identify duplicate rows:

```
 df.duplicated()
```

Identify unique rows:

```
 df['col1'].unique()
```

Swap rows and columns:

```
 df = df.transpose()
 df = df.T
```

Drop a column:

```
 df = df.drop('col1', axis=1)
```

Clone a data frame:

```
 clone = df.copy()
```

Connect multiple data frames vertically:

```
 df2 = df + 5 #new dataframe
 pd.concat([df,df2])
```

Merge multiple data frames horizontally:

```
 df3 = pd.DataFrame([[1, 7],[8,9]],
                             index=['B', 'D'],
                    columns=['col1', 'col3'])
#df3: new dataframe
```

Only merge complete rows (INNER JOIN):

```
 df.merge(df3)
```

Left column stays complete (LEFT OUTER JOIN):

```
 df.merge(df3, how='left')
```

Right column stays complete (RIGHT OUTER JOIN):

```
 df.merge(df3, how='right')
```

Preserve all values (OUTER JOIN):

```
 df.merge(df3, how='outer')
```

Merge rows by index:

```
 df.merge(df3,left_index=True,
          right_index=True)
```

Fill NaN values:

```
 df.fillna(0)
```

Apply your own function:

```
 def func(x):
     return 2**x
 df.apply(func)
```

## Arithmetics and statistics

Add to all values:

```
 df + 10
```

Sum over columns:

```
 df.sum()
```

Cumulative sum over columns:

```
 df.cumsum()
```

Mean over columns:

```
 df.mean()
```

Standard deviation over columns:

```
 df.std()
```

Count unique values:

```
 df['col1'].value_counts()
```

Summarize descriptive statistics:

```
 df.describe()
```

# Hierarchical indexing

Create hierarchical index:

```
df.stack()
```

Dissolve hierarchical index:

```
df.unstack()
```

# Aggregation

Create group object:

```
g = df.groupby('col1')
```

Iterate over groups:

```
for i, group in g:
      print(i, group)
```

Aggregate groups:

```
g.sum()
g.prod()
g.mean()
g.std()
g.describe()
```

Select columns from groups:

```
g['col2'].sum()
g[['col2', 'col3']].sum()
```

Transform values:

```
 import math
 g.transform(math.log)
```

Apply a list function on each group:

```
def strsum(group):
 return ''.join([str(x) for x in group.value])

 g['col2'].apply(strsum)
```

# Data export

Data as NumPy array:

```
df.values
```

Save data as CSV file:

```
df.to_csv('output.csv', sep=",")
```

Format a dataframe as tabular string:

```
df.to_string()
```

Convert a dataframe to a dictionary:

```
df.to_dict()
```

Save a dataframe as an Excel table:

```
df.to_excel('output.xlsx')
```

# Visualization

Import matplotlib:

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

Start a new diagram:

```
plt.figure()
```

Scatter plot:

```
df.plot.scatter('col1', 'col2',
                 style='ro')
```

Bar plot:

```
df.plot.bar(x='col1', y='col2',
            width=0.7)
```

Area plot:

```
df.plot.area(stacked=True,
             alpha=1.0)
```

Box-and-whisker plot:

```
df.plot.box()
```

Histogram over one column:

```
df['col1'].plot.hist(bins=3)
```

Histogram over all columns:

```
df.plot.hist(bins=3, alpha=0.5)
```

Set tick marks:

```
labels = ['A', 'B', 'C', 'D']
positions = [1, 2, 3, 4]
plt.xticks(positions, labels)
plt.yticks(positions, labels)
```

Select area to plot:

```
plt.axis([0, 2.5, 0, 10]) # [from
x, to x, from y, to y]
```

Label diagram and axes:

```
plt.title('Correlation')
plt.xlabel('Nunstück')
plt.ylabel('Slotermeyer')
```

Save most recent diagram:

```
plt.savefig('plot.png')
plt.savefig('plot.png',dpi=300)
plt.savefig('plot.svg')
```

Find practical examples in these guides I made:

- Pandas Guide for Excel Users(link)
- Data Wrangling Guide (link)
- Regular Expression Guide (link)

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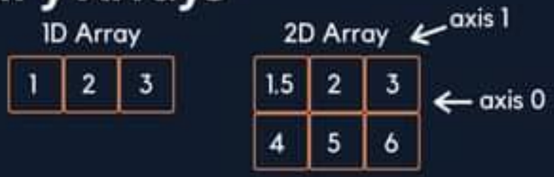
# NumPy Cheat Sheet

NumPy provides tools for working with arrays. All of the following code examples refer to the arrays below.

## NumPy Arrays



## Getting Started

Import numpy:

```
import numpy as np
```

Create 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)
d = np.arange(10,25,5)
np.linspace( 0,2, 9)
e = np.full((2,2), 7)
f = np.eye(2)
np.random.random((2,2))
np.empty((3,2))
```

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('my_file.txt')
np.genfromtxt('my_file.csv',
              delimiter=',')
np.savetxt('myarray.txt', a,
           delimiter= ' ')
```

Inspecting Your Array

```
a.shape
len(a)
b.ndim
e.size
b.dtype #data type
b.dtype.name
b.astype(int) #change data type
```

Data Types

```
np.int64
np.float32
np.complex
np.bool
np.object
np.string_
np.unicode_
```

## Array Mathematics

Arithmetic Operations

```
>>> g = a-b
 array([[-0.5, 0. , 0. ],
        [-3. , 3. , 3. ]])
>>> np.subtract(a,b)

>>> b+a
 array([[2.5, 4. , 6. ],
        [ 5. , 7. , 9. ]])
>>> np.add(b,a)

>>> a/b
 array([[ 0.66666667, 1. , 1. ],
        [ 0.2 5 , 0.4 , 0 . 5 ]])
>>> np.divide(a,b)

>>> a*b
 array([[ 1 . 5, 4. , 9. ],
        [ 4. , 10. , 18. ]])
>>> np.multiply(a,b)

>>> np.exp(b)
>>> np.sqrt(b)
>>> np.sin(a)
>>> np.log(a)
>>> e.dot(f)
```

Aggregate functions:

```
a.sum()
a.min()
b.max(axis= 0)
b.cumsum(axis= 1) #Cumulative sum
a.mean()
b.median()
a.corrcoef() #Correlation coefficient
np.std(b) #Standard deviation
```

Copying arrays:

```
h = a.view() #Create a view
np.copy(a)
h = a.copy() #Create a deep copy
```

Sorting arrays:

```
a.sort() #Sort an array
c.sort(axis=0)
```

## Array Manipulation

Transposing Array:

```
i = np.transpose(b)
i.T
```

Changing Array Shape:

```
b.ravel()
g.reshape(3,-2)
```

Adding/removing elements:

```
h.resize((2,6))
np.append(h,g)
np.insert(a, 1, 5)
np.delete(a,[1])
```

Combining arrays:

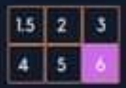
```
np.concatenate((a,d),axis=0)
np.vstack((a,b)) #stack vertically
np.hstack((e,f)) #stack horizontally
```

Splitting arrays:

```
np.hsplit(a,3) #Split horizontally
np.vsplit(c,2) #Split vertically
```

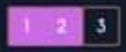
Subsetting

```
b[1,2]
```



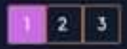
Slicing:

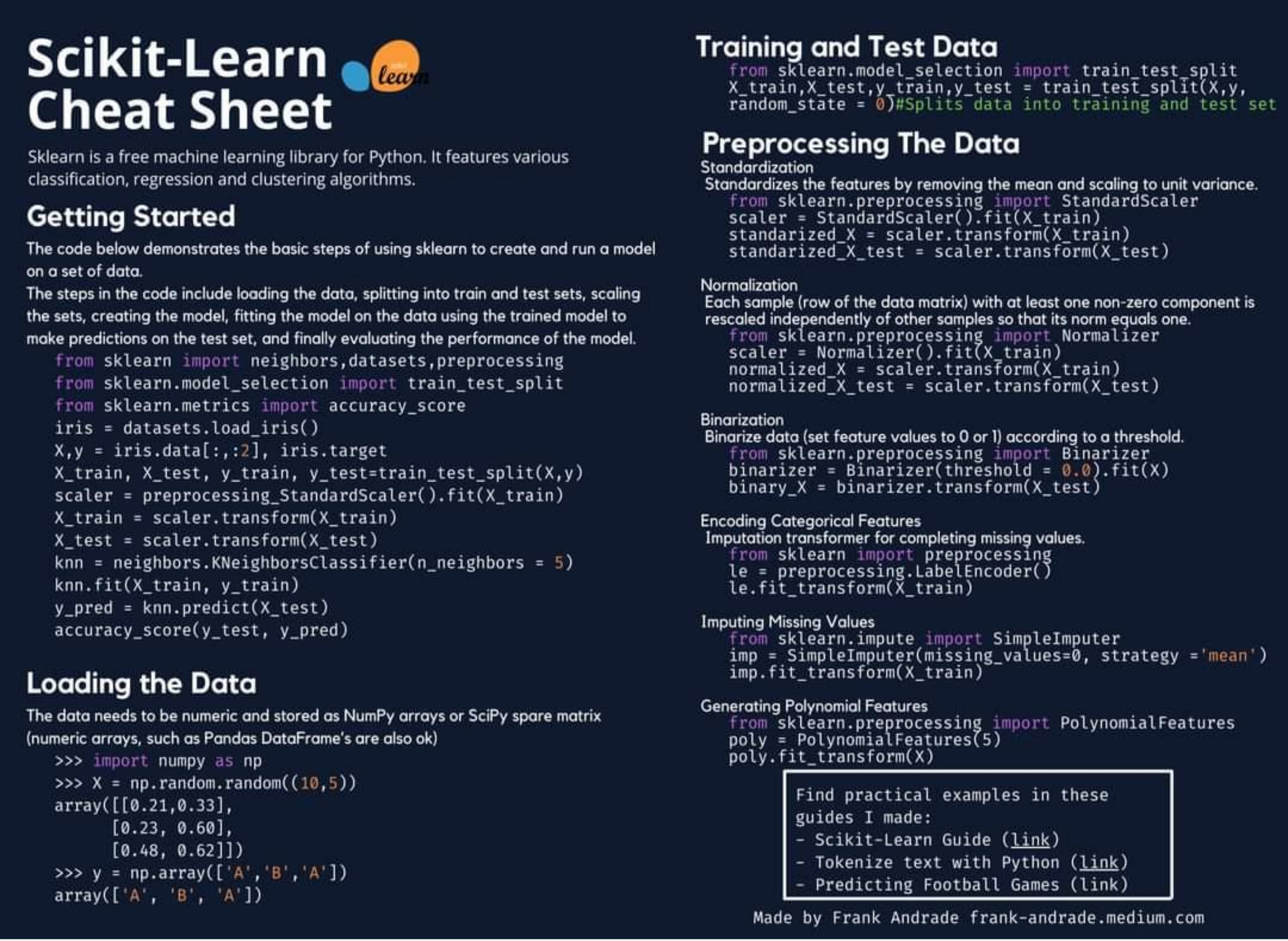
```
a[0:2]
```



Boolean Indexing:

```
a[a<2]
```





# Scikit-Learn Cheat Sheet

Sklearn is a free machine learning library for Python. It features various classification, regression and clustering algorithms.

## Getting Started

The code below demonstrates the basic steps of using sklearn to create and run a model on a set of data.

The steps in the code include loading the data, splitting into train and test sets, scaling the sets, creating the model, fitting the model on the data using the trained model to make predictions on the test set, and finally evaluating the performance of the model.

```
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)
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

The data needs to be numeric and stored as NumPy arrays or SciPy spare matrix (numeric arrays, such as Pandas DataFrame's are also ok)

```
>>> import numpy as np
>>> X = np.random.random((10,5))
array([[0.21,0.33],
      [0.23, 0.60],
      [0.48, 0.62]])
>>> y = np.array(['A','B','A'])
array(['A', 'B', 'A'])
```

## 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)#Splits data into training and test set
```

## Preprocessing The Data

Standardization

Standardizes the features by removing the mean and scaling to unit variance.

```
from sklearn.preprocessing import StandardScaler
scaler = StandardScaler().fit(X_train)
standarized_X = scaler.transform(X_train)
standarized_X_test = scaler.transform(X_test)
```

Normalization

Each sample (row of the data matrix) with at least one non-zero component is rescaled independently of other samples so that its norm equals one.

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

Binarization

Binarize data (set feature values to 0 or 1) according to a threshold.

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

Encoding Categorical Features

Imputation transformer for completing missing values.

```
from sklearn import preprocessing
le = preprocessing.LabelEncoder()
le.fit_transform(X_train)
```

Imputing Missing Values

```
from sklearn.impute import SimpleImputer
imp = SimpleImputer(missing_values=0, strategy ='mean')
imp.fit_transform(X_train)
```

Generating Polynomial Features

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

```
Find practical examples in these
guides I made:
- Scikit-Learn Guide (link)
- Tokenize text with Python (link)
- Predicting Football Games (link)
```

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# Create Your Model

### Supervised Learning Models

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 Models

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

Fitting supervised and unsupervised learning models onto data.

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
```

# Prediction

Predict Labels

```
  y_pred = lr.predict(X_test) #Supervised Estimators
  y_pred = k_means.predict(X_test) #Unsupervised Estimators
```

Estimate probability of a label

```
  y_pred = knn.predict_proba(X_test)
```

# Evaluate Your Model's Performance

### Classification Metrics

Accuracy Score

```
   knn.score(X_test,y_test)
   from sklearn.metrics import accuracy_score
   accuracy_score(y_test,y_pred)
```

Classification Report

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

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
   mean_absolute_error(y_test,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_test, y_pred)
```

### Clustering Metrics

Adjusted Rand Index

```
   from sklearn.metrics import adjusted_rand_score
   adjusted_rand_score(y_test,y_pred)
```

Homogeneity

```
   from sklearn.metrics import homogeneity_score
   homogeneity_score(y_test,y_pred)
```

V-measure

```
   from sklearn.metrics import v_measure_score
   v_measure_score(y_test,y_pred)
```

# Tune Your Model

Grid Search

```
   from sklearn.model_selection 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)
```

# Data Viz Cheat Sheet

Matplotlib is a Python 2D plotting library that produces figures in a variety of formats.

Figure
Y-axis
X-axis

## Matplotlib

### Workflow

The basic steps to creating plots with matplotlib are Prepare Data, Plot, Customize Plot, Save Plot and Show Plot.

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

**Example with lineplot**

Prepare data

```
    x = [2017, 2018, 2019, 2020, 2021]
    y = [43, 45, 47, 48, 50]
```

Plot & Customize Plot

```
    plt.plot(x,y,marker='o',linestyle='--',
    color='g', label='USA')
    plt.xlabel('Years')
    plt.ylabel('Population (M)')
    plt.title('Years vs Population')
    plt.legend(loc='lower right')
    plt.yticks([41, 45, 48, 51])
```

Save Plot

```
    plt.savefig('example.png')
```

Show Plot

```
    plt.show()
```

**Markers:** '.', 'o', 'v', '<', '>'

**Line Styles:** '-', '--', '-.', ':'

**Colors:** 'b', 'g', 'r', 'y' #blue, green, red, yellow

Barplot

```
 x = ['USA', 'UK', 'Australia']
 y = [40, 50, 33]
 plt.bar(x, y)
 plt.show()
```

Piechart

```
 plt.pie(y, labels=x, autopct='%.0f %%')
 plt.show()
```

Histogram

```
 ages = [15, 16, 17, 30, 31, 32, 35]
 bins = [15, 20, 25, 30, 35]
 plt.hist(ages, bins, edgecolor='black')
 plt.show()
```

Boxplots

```
 ages = [15, 16, 17, 30, 31, 32, 35]
 plt.boxplot(ages)
 plt.show()
```

Scatterplot

```
 a = [1, 2, 3, 4, 5, 4, 3 ,2, 5, 6, 7]
 b = [7, 2, 3, 5, 5, 7, 3, 2, 6, 3, 2]
 plt.scatter(a, b)
 plt.show()
```

## Subplots

Add the code below to make multple plots with 'n' number of rows and columns.

```
fig, ax = plt.subplots(nrows=1,
                       ncols=2,
                       sharey=True,
                       figsize=(12, 4))
```

Plot & Customize Each Graph

```
 ax[0].plot(x, y, color='g')
 ax[0].legend()
 ax[1].plot(a, b, color='r')
 ax[1].legend()
 plt.show()
```

```
Find practical examples in these
guides I made:
- Matplotlib & Seaborn Guide (link)
- Wordclouds Guide (link)
- Comparing Data Viz libraries(link)
```

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## Seaborn

### Workflow

```
import seaborn as sns
import matplotlib.pyplot as plt
import pandas as pd
```

Lineplot

```
 plt.figure(figsize=(10, 5))
 flights = sns.load_dataset("flights")
 may_flights=flights.query("month=='May'")
 ax = sns.lineplot(data=may_flights,
                   x="year",
                   y="passengers")
 ax.set(xlabel='x', ylabel='y',
        title='my_title, xticks=[1,2,3])
 ax.legend(title='my_legend,
           title_fontsize=13)
 plt.show()
```

Barplot

```
 tips = sns.load_dataset("tips")
 ax = sns.barplot(x="day",
                  y="total_bill,
                  data=tips)
```

Histogram

```
 penguins = sns.load_dataset("penguins")
 sns.histplot(data=penguins,
              x="flipper_length_mm")
```

Boxplot

```
 tips = sns.load_dataset("tips")
 ax = sns.boxplot(x=tips["total_bill"])
```

Scatterplot

```
  tips = sns.load_dataset("tips")
  sns.scatterplot(data=tips,
                  x="total_bill",
                  y="tip")
```

### Figure aesthetics

```
 sns.set_style('darkgrid') #stlyes
 sns.set_palette('husl', 3) #palettes
 sns.color_palette('husl') #colors
```

Fontsize of the axes title, x and y labels, tick labels and legend:

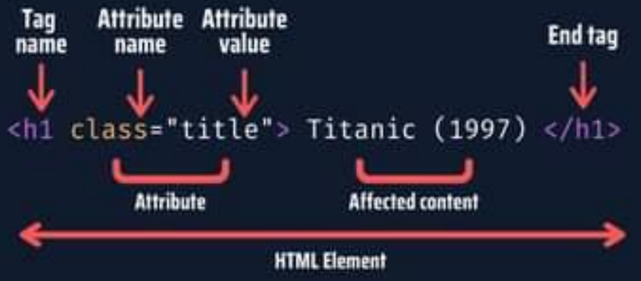
```
 plt.rc('axes', titlesize=18)
 plt.rc('axes', labelsize=14)
 plt.rc('xtick', labelsize=13)
 plt.rc('ytick', labelsize=13)
 plt.rc('legend', fontsize=13)
 plt.rc('font', size=13)
```

# Web Scraping Cheat Sheet

Web Scraping is the process of extracting data from a website. Before studying Beautiful Soup and Selenium, it's good to review some HTML basics first.

## HTML for Web Scraping

Let's take a look at the HTML element syntax.

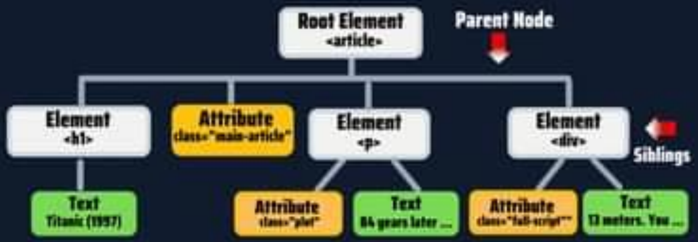


This is a single HTML element, but the HTML code behind a website has hundreds of them.

**HTML code example**

```
<article class="main-article">
 <h1> Titanic (1997) </h1>
 <p class="plot"> 84 years later ... </p>
 <div class="full-script"> 13 meters. You ... </div>
</article>
```

The HTML code is structured with "nodes". Each rectangle below represents a node (element, attribute and text nodes)



- "Siblings" are nodes with the same parent.
- A node's children and its children's children are called its "descendants". Similarly, a node's parent and its parent's parent are called its "ancestors".
- it's recommended to find element in this order.
  a. ID
  b. Class name
  c. Tag name
  d. Xpath

## Beautiful Soup

### Workflow

```
Importing the libraries
 from bs4 import BeautifulSoup
 import requests
```

Fetch the pages

```
 result=requests.get("www.google.com")
 result.status_code #get status code
 result.headers #get the headers
```

Page content

```
 content = result.text
```

Create soup

```
 soup = BeautifulSoup(content,"lxml")
```

HTML in a readable format

```
 print(soup.prettify())
```

Find an element

```
 soup.find(id="specific_id")
```

Find elements

```
 soup.find_all("a")
 soup.find_all("a","css_class")
 soup.find_all("a",class_="my_class")
 soup.find_all("a",attrs={"class":
                              "my_class"})
```

Get inner text

```
 sample = element.get_text()
 sample = element.get_text(strip=True,
                           separator= ' ')
```

Get specific attributes

```
 sample = element.get('href')
```

## XPath

We need to learn XPath to scrape with Selenium or Scrapy.

### XPath Syntax

An XPath usually contains a tag name, attribute name, and attribute value.

```
//tagName[@AttributeName="Value"]
```

Let's check some examples to locate the article, title, and transcript elements of the HTML code we used before.

```
//article[@class="main-article"]
//h1
//div[@class="full-script"]
```

### XPath Functions and Operators

XPath functions

```
//tag[contains(@AttributeName, "Value")]
```

XPath Operators: and, or

```
//tag[(expression 1) and (expression 2)]
```

### XPath Special Characters

| | |
|---|---|
| / | Selects the children from the node set on the left side of this character |
| // | Specifies that the matching node set should be located at any level within the document |
| . | Specifies the current context should be used (refers to present node) |
| .. | Refers to a parent node |
| * | A wildcard character that selects all elements or attributes regardless of names |
| @ | Select an attribute |
| () | Grouping an XPath expression |
| [n] | Indicates that a node with index "n" should be selected |