

PROJECT REPORT - Lisa Wagner

GitHub URL:

Lisa's GitHub Repository for UCDPA Data Analytics Training Assignment
(https://github.com/WagnerLD/UCDPA_LisaWagner.git)

Abstract

This project's purpose is to demonstrate a specific set of competencies learned in the UCDPA Fidelity International - Data Analytics Training course. Given I had no prior experience in data science, coding (I knew Python to be a snake and Jupyter as the 5th planet from the sun) or statistics, the learning curve was steep. As a result, I have chosen straightforward datasets, and in some cases individual datasets to demonstrate a lone competency. The intention is to build a strong foundation, before moving on to more complex datasets and problems, including refining my code writing skills to be succinct and easier to understand.

Introduction

The two main datasets used through the project are "Wine Quality" and "Data Science Salaries", both chosen as I find the topics interesting and could think of various problem statements to investigate in the data.

1. Wine Quality - the data is all numeric and had 11 features from which to predict the quality, this dataset was used for the Machine Learning competencies.
2. Data Science Salaries - originally I was interested in what salary ranges exist for various qualities (title, year of experience, employee location), but in the end, the dataset chosen was more suitable for importing and data cleaning competencies.
3. Other datasets:
 - a. Stock prices - demonstrate use of API, data merging and presenting charts on financial data
 - b. Tweets - demonstrate Regex to extract a pattern in data from text

Datasets

Description and source for each data set used is below (also repeated at the beginning of the notebook section where the dataset is used)

1. Wine Quality
Source: UCI Machine Learning Repository
<https://archive.ics.uci.edu/ml/datasets/Wine+Quality>
Reason for choosing:
 - a. the website and dataset was suggested in more than one search result for "good datasets for beginners to learn Machine Learning"
 - b. the website itself appeared safe and the data was explained
2. Data Science Salaries
Source: Kaggle.com
<https://www.kaggle.com/datasets/ruchi798/data-science-job-salaries?resource=download>
Reason for choosing:
 - a. the website is well known for data sources
 - b. the data itself was complete and appeared well organized (a good basis for a beginner)

3. Stock Prices

Source: www.alphavantage.co

[https://www.alphavantage.co/query?](https://www.alphavantage.co/query?function=TIME_SERIES_MONTHLY&symbol=V&apikey=NLZ2TGZGULE9VS10)

[function=TIME_SERIES_MONTHLY&symbol=V&apikey=NLZ2TGZGULE9VS10](https://www.alphavantage.co/query?function=TIME_SERIES_MONTHLY&symbol=V&apikey=NLZ2TGZGULE9VS10)

Reason for choosing:

a. website was used for demonstration during the course and I found it easy to use and understand the structure of the data retrieved

4. Tweets

Source: Kaggle.com

<https://www.kaggle.com/datasets/mmmarchetti/tweets-dataset>

Reason for choosing:

a. search for tweets datasets returned Kaggle, data is clear and understandable

Implementation process

Please refer to descriptions within the notebook at each section

Results

Please refer to descriptions within the notebook at each section

Insights

Summarized below but can also be found within the workbook at the relevant sections:

1. Stock Prices - prices for a stock (Visa) were being compared to a benchmark (S&P500 Index), the result showed a deep, sharp decline in the stock part way through the time period.

On further investigation, the stock went through a 4:1 split in the time frame the data was selected for.

The resulting chart (based on the original data retrieved) is not suitable to answer the problem statement, the data for the stock price will need to be restated to normalize for the stock split.

2. Stock Prices - Once Visa's stock prices are restated to reflect the stock split, the chart more accurately shows Visa's performance compared to the benchmark (S&P500 Index). Visa's performance was aligned to the Index until 2013 when Visa's growth was stronger than the general market. Dips in Visa's stock price in latter years broadly correspond to dips in the Index; Visa's stock is not immune to outside conditions which impact other stocks in the Index.

3. Wine Quality - Ridge and Lasso regression models returned poor accuracy (mid-20%), which was anticipated as the attempt to predict quality is a Classification issue. KNN Classifier model returned better accuracy than the Regression models, but still not good (at 45%) before adjusting for outliers, simplifying target values or optimizing # of neighbors

4. Wine Quality - Optimizing neighbors value to 25 returns a 70.4% accuracy - significantly improved from original model, but not considered a good result as model accuracy should exceed 90% to be considered useable.

5. Wine Quality - Further fine tuning of the model did not produce any better accuracy after optimizing neighbors to 25.

a. Changing target values (original had a range of 3 - 9) to 0 or 1 (original quality value of <6 being "Not Good" = 0, >5 being "Good" = 1)

b. Outliers made up 4% of the dataset. Removing them improved the KNN Classifier model (before target values were transformed to 1 / 0) marginally from 45% to 48%. As expected, removing outliers had little impact on accuracy after the target values were transformed

References

Special Mention

Appreciation to:

1. Riju Sathyan for his assistance with making the API data useable
2. Phillip Marsh for help with formatting text

Data Science Salaries - importing data, data analysis and cleaning

```
In [201... # Import data from csv, data analysis & cleaning (replace missing values, drop duplicate
# Data Science Salaries from Kaggle.com
```

```
In [202... # Import .csv file into a Pandas Dataframe

import pandas as pd
import numpy as np
```

```
In [203... # data source = Kaggle.com (https://www.kaggle.com/datasets/ruchi798/data-science-job-sa

df_sal = pd.read_csv('ds_salaries.csv')
```

```
In [204... # view what the data frame looks like - columns and beginning / ending data, confirm
# no missing data and check data format types

df_sal.head()
```

```
Out[204]:
```

	Unnamed: 0	work_year	experience_level	employment_type	job_title	salary	salary_currency	salary_in_usd	en
0	0	2020	MI	FT	Data Scientist	70000	EUR	79833	
1	1	2020	SE	FT	Machine Learning Scientist	260000	USD	260000	
2	2	2020	SE	FT	Big Data Engineer	85000	GBP	109024	
3	3	2020	MI	FT	Product Data Analyst	20000	USD	20000	
4	4	2020	SE	FT	Machine Learning Engineer	150000	USD	150000	

```
In [205... df_sal.tail()
```

```
Out[205]:
```

	Unnamed: 0	work_year	experience_level	employment_type	job_title	salary	salary_currency	salary_in_usd	
602	602	2022	SE	FT	Data Engineer	154000	USD	154000	
603	603	2022	SE	FT	Data Engineer	126000	USD	126000	

604	604	2022	SE	FT	Data Analyst	129000	USD	129000
605	605	2022	SE	FT	Data Analyst	150000	USD	150000
606	606	2022	MI	FT	AI Scientist	200000	USD	200000

In [206...

```
# confirms no missing info - count for each column is same value as RangeIndex entries

df_sal.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 607 entries, 0 to 606
Data columns (total 12 columns):
 #   Column              Non-Null Count  Dtype
---  -
 0   Unnamed: 0          607 non-null   int64
 1   work_year           607 non-null   int64
 2   experience_level     607 non-null   object
 3   employment_type     607 non-null   object
 4   job_title           607 non-null   object
 5   salary              607 non-null   int64
 6   salary_currency     607 non-null   object
 7   salary_in_usd       607 non-null   int64
 8   employee_residence  607 non-null   object
 9   remote_ratio        607 non-null   int64
10   company_location    607 non-null   object
11   company_size        607 non-null   object
dtypes: int64(5), object(7)
memory usage: 57.0+ KB
```

In [207...

```
# Data Cleaning - the index column is repeated in the first (unnamed) column, use drop
# based on index to remove the duplicate column creating df2 to retain original format o

df_sal2 = df_sal.drop(df_sal.columns[0], axis=1)
```

In [208...

```
df_sal2
```

Out[208]:

	work_year	experience_level	employment_type	job_title	salary	salary_currency	salary_in_usd	employee_re
0	2020	MI	FT	Data Scientist	70000	EUR	79833	
1	2020	SE	FT	Machine Learning Scientist	260000	USD	260000	
2	2020	SE	FT	Big Data Engineer	85000	GBP	109024	
3	2020	MI	FT	Product Data Analyst	20000	USD	20000	
4	2020	SE	FT	Machine Learning Engineer	150000	USD	150000	
...	
602	2022	SE	FT	Data Engineer	154000	USD	154000	
603	2022	SE	FT	Data Engineer	126000	USD	126000	

604	2022	SE	FT	Data Analyst	129000	USD	129000
605	2022	SE	FT	Data Analyst	150000	USD	150000
606	2022	MI	FT	AI Scientist	200000	USD	200000

607 rows × 11 columns

```
In [209... # Data cleaning - replace missing values. The original data did not having any missing
# values, so an amended file was created with some values missing to show the next compe

# import amended file above to replace missing values

df_sal3 = pd.read_csv('ds_salaries_missing.csv')
```

```
In [210... df_sal3.head()
```

Out[210]:

	Unnamed: 0	work_year	experience_level	employment_type	job_title	salary	salary_currency	salary_in_usd	en
0	0	2020.0	MI	FT	Data Scientist	70000	EUR	79833	
1	1	2020.0	SE	FT	Machine Learning Scientist	260000	USD	260000	
2	2	2020.0	SE	FT	Big Data Engineer	85000	GBP	109024	
3	3	2020.0	MI	FT	Product Data Analyst	20000	USD	20000	
4	4	2020.0	SE	FT	Machine Learning Engineer	150000	USD	150000	

```
In [211... # shows missing data in column work_year - only 591 count, should be 607
# work_year has also been changed from integer to float during the process of creating
# missing data - will be ignored as the data frame is only being used to demonstrate
# data cleaning to replace missing data)

df_sal3.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 607 entries, 0 to 606
Data columns (total 12 columns):
#   Column                Non-Null Count  Dtype
---  -
0   Unnamed: 0            607 non-null   int64
1   work_year             591 non-null   float64
2   experience_level       607 non-null   object
3   employment_type       607 non-null   object
4   job_title             607 non-null   object
5   salary                607 non-null   int64
6   salary_currency       607 non-null   object
7   salary_in_usd         607 non-null   int64
8   employee_residence    607 non-null   object
9   remote_ratio          607 non-null   int64
10  company_location      607 non-null   object
```

```
11 company_size      607 non-null object
dtypes: float64(1), int64(4), object(7)
memory usage: 57.0+ KB
```

```
In [212... # same as above, more explicitly shows the exact number of missing values in the
# one column "work_year"

df_sal3.isna().sum()
```

```
Out[212]: Unnamed: 0      0
work_year      16
experience_level 0
employment_type 0
job_title      0
salary         0
salary_currency 0
salary_in_usd   0
employee_residence 0
remote_ratio    0
company_location 0
company_size    0
dtype: int64
```

```
In [213... # missing data is in the year column, for which same years are grouped together - use pr

df_sal_cleaned=df_sal3.fillna(method="ffill")
```

```
In [214... # rechecking, no more missing data

df_sal_cleaned.isna().sum()
```

```
Out[214]: Unnamed: 0      0
work_year      0
experience_level 0
employment_type 0
job_title      0
salary         0
salary_currency 0
salary_in_usd   0
employee_residence 0
remote_ratio    0
company_location 0
company_size    0
dtype: int64
```

Stock Prices - importing data via API, dataframe merging and charts

```
In [215... # Import data via API, merge dataframe, iterator, dictionaries/lists) and
# visualization using stock data for Visa vs a benchmark (S&P 500 Index ETF)
```

```
In [216... # data set source = https://www.alphavantage.co/documentation/ with ticker symbol V sele
# a stock for which I will compare performance against a general market benchmark (S&P 5

import requests

dataV = requests.get("https://www.alphavantage.co/query?function=TIME_SERIES_MONTHLY&sym
```

```
In [217... dataV = dataV.json()
```

```
In [218... # view the format and structure of the data

dataV
```

```
{'Meta Data': {'1. Information': 'Monthly Prices (open, high, low, close) and Volumes',
```

Out[218]:

```
'2. Symbol': 'V',
'3. Last Refreshed': '2022-09-16',
'4. Time Zone': 'US/Eastern'},
'Monthly Time Series': {'2022-09-16': {'1. open': '198.7200',
'2. high': '207.1900',
'3. low': '188.2200',
'4. close': '193.3000',
'5. volume': '57174925'},
'2022-08-31': {'1. open': '208.4500',
'2. high': '217.6100',
'3. low': '198.6400',
'4. close': '198.7100',
'5. volume': '130178837'},
'2022-07-29': {'1. open': '196.7900',
'2. high': '218.0700',
'3. low': '194.1400',
'4. close': '212.1100',
'5. volume': '118596952'},
'2022-06-30': {'1. open': '212.0500',
'2. high': '217.5800',
'3. low': '185.9100',
'4. close': '196.8900',
'5. volume': '128123527'},
'2022-05-31': {'1. open': '211.7700',
'2. high': '214.8000',
'3. low': '189.9500',
'4. close': '212.1700',
'5. volume': '171858850'},
'2022-04-29': {'1. open': '223.0800',
'2. high': '229.2400',
'3. low': '201.1000',
'4. close': '213.1300',
'5. volume': '151474586'},
'2022-03-31': {'1. open': '214.4800',
'2. high': '228.8100',
'3. low': '186.6700',
'4. close': '221.7700',
'5. volume': '188732371'},
'2022-02-28': {'1. open': '226.9000',
'2. high': '235.8500',
'3. low': '201.4500',
'4. close': '216.1200',
'5. volume': '171668723'},
'2022-01-31': {'1. open': '217.5200',
'2. high': '228.1200',
'3. low': '195.6500',
'4. close': '226.1700',
'5. volume': '224640154'},
'2021-12-31': {'1. open': '196.0300',
'2. high': '219.7300',
'3. low': '190.1000',
'4. close': '216.7100',
'5. volume': '189072557'},
'2021-11-30': {'1. open': '213.4900',
'2. high': '221.6100',
'3. low': '192.5500',
'4. close': '193.7700',
'5. volume': '303787625'},
'2021-10-29': {'1. open': '224.1700',
'2. high': '236.9600',
'3. low': '208.5400',
'4. close': '211.7700',
'5. volume': '170235962'},
'2021-09-30': {'1. open': '229.1000',
'2. high': '233.3300',
'3. low': '216.3100',
```

```
'4. close': '222.7500',  
'5. volume': '175674100'},  
'2021-08-31': {'1. open': '246.2400',  
'2. high': '247.8300',  
'3. low': '228.6600',  
'4. close': '229.1000',  
'5. volume': '148464103'},  
'2021-07-30': {'1. open': '234.2000',  
'2. high': '252.6700',  
'3. low': '234.0499',  
'4. close': '246.3900',  
'5. volume': '157809397'},  
'2021-06-30': {'1. open': '229.4400',  
'2. high': '238.4800',  
'3. low': '226.2800',  
'4. close': '233.8200',  
'5. volume': '151631040'},  
'2021-05-28': {'1. open': '234.0500',  
'2. high': '235.7400',  
'3. low': '220.3100',  
'4. close': '227.3000',  
'5. volume': '127250043'},  
'2021-04-30': {'1. open': '213.7840',  
'2. high': '237.5000',  
'3. low': '212.3000',  
'4. close': '233.5600',  
'5. volume': '152922449'},  
'2021-03-31': {'1. open': '214.9700',  
'2. high': '228.2298',  
'3. low': '205.7800',  
'4. close': '211.7300',  
'5. volume': '228910433'},  
'2021-02-26': {'1. open': '195.1400',  
'2. high': '220.5300',  
'3. low': '195.0200',  
'4. close': '212.3900',  
'5. volume': '196654813'},  
'2021-01-29': {'1. open': '220.2500',  
'2. high': '220.2500',  
'3. low': '192.8100',  
'4. close': '193.2500',  
'5. volume': '198356580'},  
'2020-12-31': {'1. open': '212.1300',  
'2. high': '220.3900',  
'3. low': '204.5000',  
'4. close': '218.7300',  
'5. volume': '178457456'},  
'2020-11-30': {'1. open': '184.5100',  
'2. high': '217.6500',  
'3. low': '183.8900',  
'4. close': '210.3500',  
'5. volume': '156651025'},  
'2020-10-30': {'1. open': '202.2100',  
'2. high': '207.9700',  
'3. low': '179.2300',  
'4. close': '181.7100',  
'5. volume': '172181178'},  
'2020-09-30': {'1. open': '212.2100',  
'2. high': '217.3500',  
'3. low': '193.1300',  
'4. close': '199.9700',  
'5. volume': '176375547'},  
'2020-08-31': {'1. open': '191.8000',  
'2. high': '216.1600',  
'3. low': '190.0800',  
'4. close': '211.9900',
```



```
'5. volume': '161589042'},
'2020-07-31': {'1. open': '193.8500',
'2. high': '200.9500',
'3. low': '187.1800',
'4. close': '190.4000',
'5. volume': '168844674'},
'2020-06-30': {'1. open': '194.7100',
'2. high': '202.1800',
'3. low': '186.2100',
'4. close': '193.1700',
'5. volume': '192103395'},
'2020-05-29': {'1. open': '174.4500',
'2. high': '198.2900',
'3. low': '171.7200',
'4. close': '195.2400',
'5. volume': '189585116'},
'2020-04-30': {'1. open': '156.3200',
'2. high': '182.2500',
'3. low': '150.6000',
'4. close': '178.7200',
'5. volume': '263495312'},
'2020-03-31': {'1. open': '186.3200',
'2. high': '194.4900',
'3. low': '133.9300',
'4. close': '161.1200',
'5. volume': '417542977'},
'2020-02-28': {'1. open': '199.9400',
'2. high': '214.1700',
'3. low': '172.9800',
'4. close': '181.7600',
'5. volume': '199776179'},
'2020-01-31': {'1. open': '189.0000',
'2. high': '210.1300',
'3. low': '187.1600',
'4. close': '198.9700',
'5. volume': '183582543'},
'2019-12-31': {'1. open': '184.2400',
'2. high': '189.8900',
'3. low': '179.6600',
'4. close': '187.9000',
'5. volume': '160394084'},
'2019-11-29': {'1. open': '180.1300',
'2. high': '184.8500',
'3. low': '175.1800',
'4. close': '184.5100',
'5. volume': '134065026'},
'2019-10-31': {'1. open': '173.0200',
'2. high': '180.1800',
'3. low': '168.5900',
'4. close': '178.8600',
'5. volume': '162923578'},
'2019-09-30': {'1. open': '180.5200',
'2. high': '187.0500',
'3. low': '172.0100',
'4. close': '172.0100',
'5. volume': '171931176'},
'2019-08-30': {'1. open': '179.1900',
'2. high': '182.4000',
'3. low': '166.9800',
'4. close': '180.8200',
'5. volume': '154470525'},
'2019-07-31': {'1. open': '175.3300',
'2. high': '184.0700',
'3. low': '172.7400',
'4. close': '178.0000',
'5. volume': '126736340'},
```

```
'2019-06-28': {'1. open': '161.5400',  
  '2. high': '174.9400',  
  '3. low': '156.7500',  
  '4. close': '173.5500',  
  '5. volume': '158885114'},  
'2019-05-31': {'1. open': '165.5400',  
  '2. high': '165.7700',  
  '3. low': '156.4200',  
  '4. close': '161.3300',  
  '5. volume': '147282119'},  
'2019-04-30': {'1. open': '157.5300',  
  '2. high': '165.7000',  
  '3. low': '156.3200',  
  '4. close': '164.4300',  
  '5. volume': '136490658'},  
'2019-03-29': {'1. open': '149.4600',  
  '2. high': '156.8200',  
  '3. low': '144.5000',  
  '4. close': '156.1900',  
  '5. volume': '207401562'},  
'2019-02-28': {'1. open': '135.3900',  
  '2. high': '148.8200',  
  '3. low': '135.2600',  
  '4. close': '148.1200',  
  '5. volume': '154776247'},  
'2019-01-31': {'1. open': '130.0000',  
  '2. high': '139.9000',  
  '3. low': '127.8800',  
  '4. close': '135.0100',  
  '5. volume': '193205412'},  
'2018-12-31': {'1. open': '145.0000',  
  '2. high': '145.7200',  
  '3. low': '121.6000',  
  '4. close': '131.9400',  
  '5. volume': '242677721'},  
'2018-11-30': {'1. open': '139.0000',  
  '2. high': '145.4600',  
  '3. low': '129.5400',  
  '4. close': '141.7100',  
  '5. volume': '208766205'},  
'2018-10-31': {'1. open': '150.8900',  
  '2. high': '151.5600',  
  '3. low': '129.7900',  
  '4. close': '137.8500',  
  '5. volume': '254092004'},  
'2018-09-28': {'1. open': '146.9300',  
  '2. high': '150.6400',  
  '3. low': '142.5400',  
  '4. close': '150.0900',  
  '5. volume': '147500495'},  
'2018-08-31': {'1. open': '137.7400',  
  '2. high': '147.7100',  
  '3. low': '137.0000',  
  '4. close': '146.8900',  
  '5. volume': '143157273'},  
'2018-07-31': {'1. open': '131.9600',  
  '2. high': '143.1400',  
  '3. low': '131.1500',  
  '4. close': '136.7400',  
  '5. volume': '161562542'},  
'2018-06-29': {'1. open': '131.8400',  
  '2. high': '136.6900',  
  '3. low': '129.5300',  
  '4. close': '132.4500',  
  '5. volume': '154720393'},  
'2018-05-31': {'1. open': '126.8600',
```

```
'2. high': '132.5000',
'3. low': '125.3200',
'4. close': '130.7200',
'5. volume': '147562270'},
'2018-04-30': {'1. open': '119.2700',
'2. high': '127.9000',
'3. low': '116.7100',
'4. close': '126.8800',
'5. volume': '165231144'},
'2018-03-29': {'1. open': '123.2600',
'2. high': '125.4400',
'3. low': '116.0300',
'4. close': '119.6200',
'5. volume': '182392051'},
'2018-02-28': {'1. open': '124.7400',
'2. high': '126.2600',
'3. low': '111.0200',
'4. close': '122.9400',
'5. volume': '183890719'},
'2018-01-31': {'1. open': '114.5700',
'2. high': '126.8800',
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In [219... *# isolate the data excluding the Metadata*

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Out[219]:

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'3. low': '163.6000',  
'4. close': '178.1400',  
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'4. close': '73.3500',
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'5. volume': '197268700'},
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'5. volume': '329707000'},
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'5. volume': '82607100'},
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'4. close': '69.1100',
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'5. volume': '153747700'},
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'3. low': '60.2700',
'4. close': '62.2600',
'5. volume': '193053500'},
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'3. low': '62.6400',
'4. close': '67.7100',
'5. volume': '198672200'},
'2009-04-30': {'1. open': '54.7500',
'2. high': '68.0000',
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'5. volume': '222924500'},
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'3. low': '48.7400',
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'5. volume': '231948800'},
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'2. high': '57.9500',
'3. low': '47.5400',
'4. close': '56.7100',
'5. volume': '186385800'},
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'3. low': '41.7800',
'4. close': '49.3500',
'5. volume': '160611600'},
'2008-12-31': {'1. open': '51.0000',
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'3. low': '47.5300',
'4. close': '52.4500',
'5. volume': '141021400'},
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'3. low': '43.5400',
'4. close': '52.5600',
'5. volume': '191852000'},
'2008-10-31': {'1. open': '60.7500',
'2. high': '62.1100',
'3. low': '43.7400',
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```

'4. close': '55.3500',
'5. volume': '302537300'},
'2008-09-30': {'1. open': '76.8300',
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'3. low': '55.8900',
'4. close': '61.3900',
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'2. high': '76.5300',
'3. low': '69.1100',
'4. close': '75.9000',
'5. volume': '158540800'},
'2008-07-31': {'1. open': '79.2000',
'2. high': '82.4000',
'3. low': '66.5100',
'4. close': '73.0600',
'5. volume': '333151100'},
'2008-06-30': {'1. open': '86.2100',
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'3. low': '77.6000',
'4. close': '81.3100',
'5. volume': '255456900'},
'2008-05-30': {'1. open': '84.6800',
'2. high': '89.8400',
'3. low': '74.3600',
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'5. volume': '388428400'},
'2008-04-30': {'1. open': '63.0000',
'2. high': '84.8100',
'3. low': '60.3100',
'4. close': '83.4500',
'5. volume': '346330900'}}

```

```

In [220... # create static shortcut for stock symbol from Meta Data for future use and test it retu

mts_visa = dataV['Meta Data']['2. Symbol']

```

```

In [221... mts_visa

```

```

Out[221]: 'V'

```

```

In [222... # extract only the required data from the entirety brought in from the website:
# - create lists for the 3 needed items (name, date and price)
# - run a loop to take data from dataV (created above) and extract the price at each dat
#   above (with appreciation to Riju Sathyan for the assistance in getting this code to

from datetime import datetime

stock_nameV=[]
date_stampV=[]
close_priceV=[]

for x,y in dataV['Monthly Time Series'].items():
    stock_nameV.append(mts_visa)
    date_stampV.append(datetime.strptime(x, '%Y-%m-%d'))
    close_priceV.append(float(y['4. close']))

```

```

In [223... # combine the lists, adding column headers, to then create the dataframe

dataV_pd = {"date_stamp": date_stampV, "ticker": stock_nameV, "close_price": close_price

```

```

In [224... df_mtsV=pd.DataFrame(dataV_pd)

```

```
df mtsV
```

	date_stamp	ticker	close_price
0	2022-09-16	V	193.30
1	2022-08-31	V	198.71
2	2022-07-29	V	212.11
3	2022-06-30	V	196.89
4	2022-05-31	V	212.17
...
169	2008-08-29	V	75.90
170	2008-07-31	V	73.06
171	2008-06-30	V	81.31
172	2008-05-30	V	86.36
173	2008-04-30	V	83.45

174 rows × 3 columns

```
# Repeat the above process to take S&P500 Index prices from www.alphavantage.co to merge
# Additional cleaning step needed to drop additional rows so the chart starts at the sam

# data set source = https://www.alphavantage.co/documentation/ with ticker symbol IVV se
# as a benchmark for the general market
dataIVV = requests.get("https://www.alphavantage.co/query?function=TIME SERIES MONTHLY&s
```

```
dataIVV = dataIVV.json()
```

dataIVV

```
{ 'Meta Data': {'1. Information': 'Monthly Prices (open, high, low, close) and Volumes',
  '2. Symbol': 'IVV',
  '3. Last Refreshed': '2022-09-16',
  '4. Time Zone': 'US/Eastern'},
  'Monthly Time Series': {'2022-09-16': {'1. open': '394.9000',
    '2. high': '413.9400',
    '3. low': '385.6900',
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    '5. volume': '48649568'},
    '2022-08-31': {'1. open': '411.3400',
      '2. high': '434.0299',
      '3. low': '397.0900',
      '4. close': '397.1800',
      '5. volume': '93399466'},
      '2022-07-29': {'1. open': '378.5200',
        '2. high': '415.2000',
        '3. low': '372.9700',
        '4. close': '414.2800',
        '5. volume': '95301237'},
        '2022-06-30': {'1. open': '416.9900',
          '2. high': '419.2900',
          '3. low': '364.0300',
          '4. close': '379.1500',
          '5. volume': '146298953'},
          '2022-05-31': {'1. open': '413.6200',
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            '3. low': '382.1700',
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```
'4. close': '414.8700',
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'3. low': '412.9800',
'4. close': '413.5600',
'5. volume': '120564640'},
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'2. high': '464.0500',
'3. low': '416.9100',
'4. close': '453.6900',
'5. volume': '177475497'},
'2022-02-28': {'1. open': '452.6900',
'2. high': '460.1400',
'3. low': '412.4000',
'4. close': '438.7200',
'5. volume': '164962179'},
'2022-01-31': {'1. open': '478.3800',
'2. high': '482.0700',
'3. low': '422.5600',
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'5. volume': '198009750'},
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'3. low': '450.7400',
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'5. volume': '142018898'},
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'3. low': '457.1300',
'4. close': '457.6300',
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'2. high': '461.3900',
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'2. high': '456.0800',
'3. low': '430.6000',
'4. close': '430.8200',
'5. volume': '93219169'},
'2021-08-31': {'1. open': '442.2800',
'2. high': '455.0900',
'3. low': '438.0100',
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'2. high': '443.7161',
'3. low': '423.8100',
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'3. low': '416.4800',
'4. close': '429.9200',
'5. volume': '86553485'},
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'2. high': '424.4300',
'3. low': '406.3400',
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'2. high': '422.2800',
'3. low': '399.6600',
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```

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'5. volume': '97180254'},
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'4. close': '381.7700',
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'3. low': '366.1600',
'4. close': '371.5200',
'5. volume': '93227993'},
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'2. high': '376.0400',
'3. low': '363.3800',
'4. close': '375.3900',
'5. volume': '93094341'},
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'3. low': '328.3800',
'4. close': '363.3200',
'5. volume': '81441796'},
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'3. low': '323.7200',
'4. close': '327.6200',
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'5. volume': '86022831'},
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'3. low': '329.0639',
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'5. volume': '59150438'},
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'3. low': '310.2500',
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'5. volume': '76578094'},
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'4. close': '309.6900',
'5. volume': '115249434'},
'2020-05-29': {'1. open': '286.1900',
'2. high': '307.9100',
'3. low': '275.0000',
'4. close': '305.1800',
'5. volume': '113650186'},
'2020-04-30': {'1. open': '248.7600',
'2. high': '295.8400',
'3. low': '244.6200',
'4. close': '291.1600',
'5. volume': '166337553'},
'2020-03-31': {'1. open': '299.3400',
'2. high': '315.1500',
'3. low': '220.2800',
'4. close': '258.4000',
'5. volume': '306347948'},
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'2005-04-29': {'1. open': '118.6000',  
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  '3. low': '113.5300',  
  '4. close': '115.7000',  
  '5. volume': '14907600'},  
'2005-03-31': {'1. open': '121.0300',  
  '2. high': '123.3600',  
  '3. low': '116.1800',  
  '4. close': '117.8200',  
  '5. volume': '16610600'},  
'2005-02-28': {'1. open': '118.4500',
```

```
'2. high': '121.6500',
'3. low': '118.2100',
'4. close': '120.7500',
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'3. low': '116.5300',
'4. close': '118.2900',
'5. volume': '15538300'},
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'2. high': '122.2600',
'3. low': '118.1700',
'4. close': '121.0000',
'5. volume': '17184200'},
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'2. high': '119.5200',
'3. low': '113.2600',
'4. close': '118.2200',
'5. volume': '13129300'},
'2004-10-29': {'1. open': '112.3500',
'2. high': '114.6800',
'3. low': '109.4100',
'4. close': '113.2000',
'5. volume': '9305400'},
'2004-09-30': {'1. open': '111.0400',
'2. high': '113.9700',
'3. low': '110.5000',
'4. close': '111.8000',
'5. volume': '7105900'},
'2004-08-31': {'1. open': '110.2300',
'2. high': '111.6700',
'3. low': '106.6400',
'4. close': '111.2000',
'5. volume': '7684500'},
'2004-07-30': {'1. open': '114.3900',
'2. high': '114.4300',
'3. low': '108.2400',
'4. close': '110.9800',
'5. volume': '14111300'},
'2004-06-30': {'1. open': '112.5600',
'2. high': '115.3600',
'3. low': '111.9500',
'4. close': '114.5700',
'5. volume': '9531500'},
'2004-05-28': {'1. open': '111.4600',
'2. high': '113.2300',
'3. low': '108.1300',
'4. close': '112.9700',
'5. volume': '9276500'},
'2004-04-30': {'1. open': '113.2200',
'2. high': '115.4500',
'3. low': '110.9600',
'4. close': '111.1100',
'5. volume': '12980000'},
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'2. high': '117.0000',
'3. low': '108.4800',
'4. close': '113.2300',
'5. volume': '14486700'},
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'2. high': '116.4800',
'3. low': '112.8700',
'4. close': '115.0400',
'5. volume': '7021900'},
'2004-01-30': {'1. open': '111.6300',
'2. high': '116.0000',
```

```
'3. low': '10.8100',
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'5. volume': '14379600'},
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'4. close': '111.2200',
'5. volume': '16350200'},
'2003-11-28': {'1. open': '105.9200',
'2. high': '106.9100',
'3. low': '103.7400',
'4. close': '106.5800',
'5. volume': '4475600'},
'2003-10-31': {'1. open': '100.2000',
'2. high': '105.8800',
'3. low': '100.2000',
'4. close': '105.3000',
'5. volume': '9098200'},
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'2. high': '104.3500',
'3. low': '99.2600',
'4. close': '99.9000',
'5. volume': '8747800'},
'2003-08-29': {'1. open': '99.3100',
'2. high': '101.7500',
'3. low': '96.4500',
'4. close': '101.3300',
'5. volume': '7824900'},
'2003-07-31': {'1. open': '97.3400',
'2. high': '101.8800',
'3. low': '96.5000',
'4. close': '99.4600',
'5. volume': '7436600'},
'2003-06-30': {'1. open': '97.6100',
'2. high': '101.8000',
'3. low': '96.9500',
'4. close': '97.7800',
'5. volume': '15700100'},
'2003-05-30': {'1. open': '91.9500',
'2. high': '97.0200',
'3. low': '90.5500',
'4. close': '96.9900',
'5. volume': '10693500'},
'2003-04-30': {'1. open': '85.2000',
'2. high': '92.7200',
'3. low': '84.9410',
'4. close': '92.0100',
'5. volume': '10338000'},
'2003-03-31': {'1. open': '85.4000',
'2. high': '89.8200',
'3. low': '79.0600',
'4. close': '84.8100',
'5. volume': '12538600'},
'2003-02-28': {'1. open': '85.9300',
'2. high': '86.7800',
'3. low': '81.0000',
'4. close': '84.9700',
'5. volume': '4042900'},
'2003-01-31': {'1. open': '89.1900',
'2. high': '93.7700',
'3. low': '84.3400',
'4. close': '86.1700',
'5. volume': '18096000'},
'2002-12-31': {'1. open': '95.4700',
'2. high': '96.0100',
'3. low': '87.0900',
```



```
'4. close': '88.3500',
'5. volume': '17106000'},
'2002-11-29': {'1. open': '88.1000',
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'3. low': '87.5900',
'4. close': '93.7800',
'5. volume': '11185200'},
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'2. high': '91.3300',
'3. low': '77.0500',
'4. close': '88.7000',
'5. volume': '8073100'},
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'2. high': '93.2200',
'3. low': '80.1300',
'4. close': '81.8900',
'5. volume': '7050300'},
'2002-08-30': {'1. open': '91.1000',
'2. high': '96.9900',
'3. low': '83.6000',
'4. close': '91.7600',
'5. volume': '4778800'},
'2002-07-31': {'1. open': '99.1700',
'2. high': '99.5500',
'3. low': '77.7700',
'4. close': '91.3300',
'5. volume': '11207600'},
'2002-06-28': {'1. open': '107.1000',
'2. high': '107.6000',
'3. low': '95.2400',
'4. close': '99.0200',
'5. volume': '4460400'},
'2002-05-31': {'1. open': '108.0000',
'2. high': '111.2000',
'3. low': '104.9000',
'4. close': '107.1000',
'5. volume': '7202600'},
'2002-04-30': {'1. open': '115.0000',
'2. high': '115.0000',
'3. low': '106.7000',
'4. close': '108.0000',
'5. volume': '5141100'},
'2002-03-28': {'1. open': '111.6000',
'2. high': '117.8000',
'3. low': '111.5000',
'4. close': '114.5000',
'5. volume': '4699100'},
'2002-02-28': {'1. open': '113.3000',
'2. high': '113.3000',
'3. low': '107.8000',
'4. close': '111.0000',
'5. volume': '3872500'},
'2002-01-31': {'1. open': '115.0000',
'2. high': '118.0000',
'3. low': '108.5000',
'4. close': '113.1000',
'5. volume': '4699500'},
'2001-12-31': {'1. open': '113.9000',
'2. high': '117.9000',
'3. low': '111.9000',
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'2001-11-30': {'1. open': '106.6000',
'2. high': '116.6000',
'3. low': '105.9000',
'4. close': '114.1000',
```

```
'5. volume': '3264200'},
'2001-10-31': {'1. open': '104.1000',
'2. high': '111.1000',
'3. low': '103.3000',
'4. close': '105.9000',
'5. volume': '4821600'},
'2001-09-28': {'1. open': '114.0000',
'2. high': '116.1000',
'3. low': '94.2500',
'4. close': '104.4000',
'5. volume': '5869700'},
'2001-08-31': {'1. open': '122.0000',
'2. high': '123.1000',
'3. low': '112.9000',
'4. close': '114.2000',
'5. volume': '2628400'},
'2001-07-31': {'1. open': '123.0000',
'2. high': '124.2000',
'3. low': '116.7000',
'4. close': '121.3000',
'5. volume': '8972700'},
'2001-06-29': {'1. open': '126.2000',
'2. high': '129.2000',
'3. low': '120.7000',
'4. close': '122.7000',
'5. volume': '8452500'},
'2001-05-31': {'1. open': '125.1000',
'2. high': '132.0000',
'3. low': '123.5000',
'4. close': '125.7000',
'5. volume': '11307200'},
'2001-04-30': {'1. open': '116.1000',
'2. high': '127.3000',
'3. low': '109.5000',
'4. close': '125.2000',
'5. volume': '11260300'},
'2001-03-30': {'1. open': '124.0000',
'2. high': '127.2000',
'3. low': '108.4000',
'4. close': '116.7000',
'5. volume': '9610200'},
'2001-02-28': {'1. open': '136.8000',
'2. high': '137.9000',
'3. low': '122.0000',
'4. close': '124.1000',
'5. volume': '2017900'},
'2001-01-31': {'1. open': '131.5000',
'2. high': '138.4000',
'3. low': '127.8000',
'4. close': '136.9000',
'5. volume': '2672900'},
'2000-12-29': {'1. open': '132.9000',
'2. high': '139.3000',
'3. low': '125.7000',
'4. close': '131.4000',
'5. volume': '2888400'},
'2000-11-30': {'1. open': '142.7000',
'2. high': '144.3000',
'3. low': '129.9000',
'4. close': '132.3000',
'5. volume': '3381700'},
'2000-10-31': {'1. open': '144.5000',
'2. high': '145.7000',
'3. low': '131.0000',
'4. close': '143.1000',
'5. volume': '2921000'},
```

```

'2000-09-29': {'1. open': '153.0000',
'2. high': '153.5000',
'3. low': '142.3000',
'4. close': '143.7000',
'5. volume': '2701500'},
'2000-08-31': {'1. open': '143.3000',
'2. high': '153.0000',
'3. low': '142.9000',
'4. close': '152.3000',
'5. volume': '5156700'},
'2000-07-31': {'1. open': '145.5000',
'2. high': '151.9000',
'3. low': '141.5000',
'4. close': '142.9000',
'5. volume': '8460400'},
'2000-06-30': {'1. open': '143.9000',
'2. high': '149.0000',
'3. low': '143.6000',
'4. close': '145.5000',
'5. volume': '3683300'}}

```

```
In [230... mts_sp500etf = dataIVV['Meta Data']['2. Symbol']
```

```
In [231... mts_sp500etf
```

```
Out[231]: 'IVV'
```

```
In [232... stock_nameIVV=[]
date_stampIVV=[]
close_priceIVV=[]

for x,y in dataIVV['Monthly Time Series'].items():
    stock_nameIVV.append(mts_sp500etf)
    date_stampIVV.append(datetime.strptime(x, '%Y-%m-%d'))
    close_priceIVV.append(float(y['4. close']))
```

```
In [233... dataIVV_pd = {"date_stamp": date_stampIVV,"ticker": stock_nameIVV, "close_price": close_
```

```
In [234... df_mtsIVV=pd.DataFrame(dataIVV_pd)
```

```
In [235... # remove rows from df_mtsIVV for data prior to earliest date in df_mtsV for chart vizual
# (so that both time series are same length)
```

```
df_mtsIVV.drop(df_mtsIVV.index[174:268],0,inplace=True)
```

C:\Users\Lisa Wagner\AppData\Local\Temp\ipykernel_29292\3245525353.py:4: FutureWarning:
In a future version of pandas all arguments of DataFrame.drop except for the argument 'labels' will be keyword-only.

```
df_mtsIVV.drop(df_mtsIVV.index[174:268],0,inplace=True)
```

```
In [236... df_mtsIVV
```

```
Out[236]:
```

	date_stamp	ticker	close_price
0	2022-09-16	IVV	389.10
1	2022-08-31	IVV	397.18
2	2022-07-29	IVV	414.28
3	2022-06-30	IVV	379.15
4	2022-05-31	IVV	414.87

...
169	2008-08-29	IVV	128.94
170	2008-07-31	IVV	127.05
171	2008-06-30	IVV	128.00
172	2008-05-30	IVV	140.39
173	2008-04-30	IVV	138.61

174 rows × 3 columns

In [237... *# check dataframes have same columns*

```
df_mtsV.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 174 entries, 0 to 173
Data columns (total 3 columns):
#   Column          Non-Null Count  Dtype  
---  -
0   date_stamp      174 non-null   datetime64[ns]
1   ticker          174 non-null   object  
2   close_price     174 non-null   float64 
dtypes: datetime64[ns](1), float64(1), object(1)
memory usage: 4.2+ KB
```

In [238... df_mtsIVV.info()

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 174 entries, 0 to 173
Data columns (total 3 columns):
#   Column          Non-Null Count  Dtype  
---  -
0   date_stamp      174 non-null   datetime64[ns]
1   ticker          174 non-null   object  
2   close_price     174 non-null   float64 
dtypes: datetime64[ns](1), float64(1), object(1)
memory usage: 4.2+ KB
```

In [239... *#merge data frame based on date so prices of each stock (including ticker symbol) are co*

```
pd.merge(df_mtsV,df_mtsIVV, on="date_stamp", how = "inner")
```

Out[239]:

	date_stamp	ticker_x	close_price_x	ticker_y	close_price_y
0	2022-09-16	V	193.30	IVV	389.10
1	2022-08-31	V	198.71	IVV	397.18
2	2022-07-29	V	212.11	IVV	414.28
3	2022-06-30	V	196.89	IVV	379.15
4	2022-05-31	V	212.17	IVV	414.87
...
169	2008-08-29	V	75.90	IVV	128.94
170	2008-07-31	V	73.06	IVV	127.05
171	2008-06-30	V	81.31	IVV	128.00
172	2008-05-30	V	86.36	IVV	140.39
173	2008-04-30	V	83.45	IVV	138.61

174 rows × 5 columns

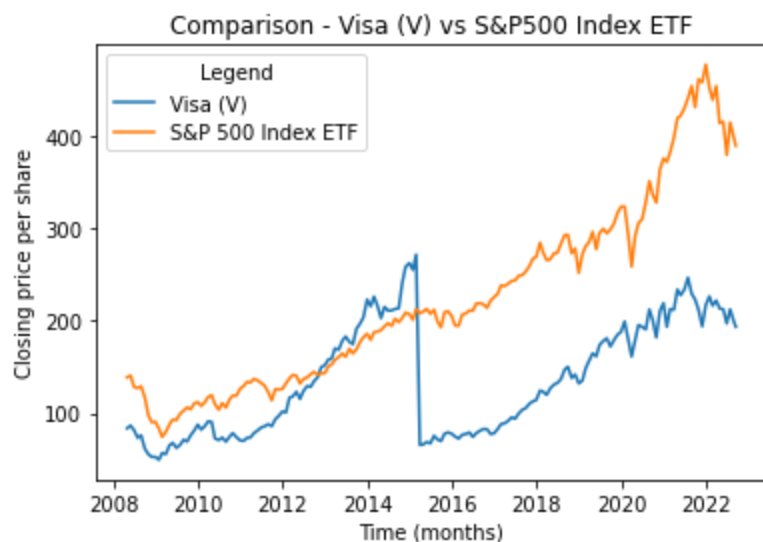
```
In [240... import matplotlib.pyplot as plt
import numpy as np
```

```
In [241... fig, ax = plt.subplots()

ax.plot(df_mtsV["date_stamp"],df_mtsV["close_price"], label = 'Visa (V)')
ax.plot(df_mtsIVV["date_stamp"],df_mtsIVV["close_price"], label = 'S&P 500 Index ETF')
ax.set_xlabel("Time (months)")
ax.set_ylabel("Closing price per share")
ax.set_title("Comparison - Visa (V) vs S&P500 Index ETF")

ax.legend(title = 'Legend',loc = 'upper left')

plt.show()
```



```
In [242... # At first glance, the chart above appears to show Visa's price crashed around 2015. A
# a 4 for 1 Stock Split in March 2015. In order for the chart to show the relationship
# accurately, Visa stock prices will need to be restated to normalize the price across t
```

```
In [243... # Restate prices post stock split - extract post stock split prices, apply factor of 4,
# prices to form new df with prices restated. Inelegant and likely more code than neede
# that restated only those prices post the stock split date - but it works in the end!

# removing rows for dates pre-stock split

df_postss = df_mtsV.loc[~df_mtsV['date_stamp'].isin(pd.date_range(start='20080430', end=
```

```
In [244... df_postss
```

```
Out[244]:
```

	date_stamp	ticker	close_price
0	2022-09-16	V	193.30
1	2022-08-31	V	198.71
2	2022-07-29	V	212.11
3	2022-06-30	V	196.89
4	2022-05-31	V	212.17
...

86	2015-07-31	V	75.34
87	2015-06-30	V	67.15
88	2015-05-29	V	68.68
89	2015-04-30	V	66.05
90	2015-03-31	V	65.41

91 rows × 3 columns

```
In [245... # restate stock prices post stock split based on 4:1 split factor

df_postss.loc[:, 'close_price'] *= 4
```

```
In [246... df_postss
```

```
Out[246]:
```

	date_stamp	ticker	close_price
0	2022-09-16	V	773.20
1	2022-08-31	V	794.84
2	2022-07-29	V	848.44
3	2022-06-30	V	787.56
4	2022-05-31	V	848.68
...
86	2015-07-31	V	301.36
87	2015-06-30	V	268.60
88	2015-05-29	V	274.72
89	2015-04-30	V	264.20
90	2015-03-31	V	261.64

91 rows × 3 columns

```
In [247... # extract stock prices pre-stock split (remain unchanged)

df_press=df_mtsV[~df_mtsV['date_stamp'].isin(pd.date_range(start='20150331', end='202209
```

```
In [248... df_press
```

```
Out[248]:
```

	date_stamp	ticker	close_price
91	2015-02-27	V	271.31
92	2015-01-30	V	254.91
93	2014-12-31	V	262.20
94	2014-11-28	V	258.19
95	2014-10-31	V	241.43
...
169	2008-08-29	V	75.90
170	2008-07-31	V	73.06

171	2008-06-30	V	81.31
172	2008-05-30	V	86.36
173	2008-04-30	V	83.45

83 rows × 3 columns

```
In [249... # merge restated stock prices with pre-stock split (unchanged) prices

frames = [df_postss, df_press]

df_mtsV_rs = pd.concat(frames)
display(df_mtsV_rs)
```

	date_stamp	ticker	close_price
0	2022-09-16	V	773.20
1	2022-08-31	V	794.84
2	2022-07-29	V	848.44
3	2022-06-30	V	787.56
4	2022-05-31	V	848.68
...
169	2008-08-29	V	75.90
170	2008-07-31	V	73.06
171	2008-06-30	V	81.31
172	2008-05-30	V	86.36
173	2008-04-30	V	83.45

174 rows × 3 columns

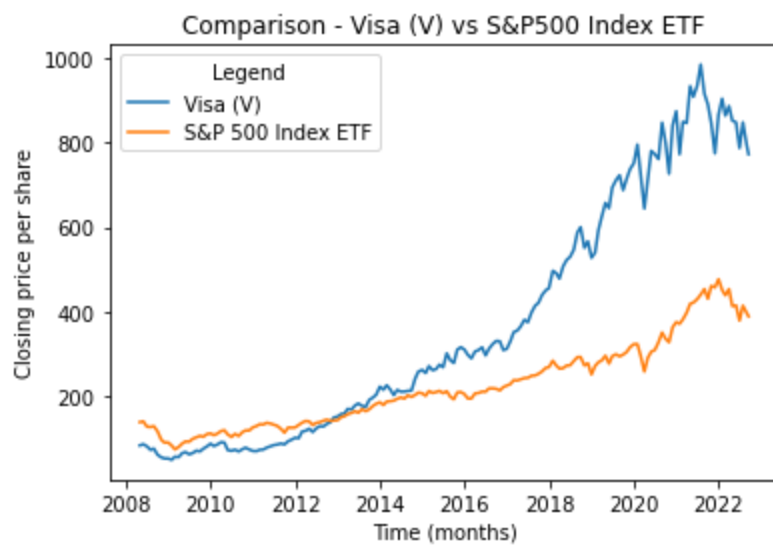
```
In [250... # Rerun chart comparing V and S&P500 Index with V prices restated post March 2015 stock

fig, ax = plt.subplots()

ax.plot(df_mtsV_rs["date_stamp"],df_mtsV_rs["close_price"], label = 'Visa (V)')
ax.plot(df_mtsIVV["date_stamp"],df_mtsIVV["close_price"], label = 'S&P 500 Index ETF')
ax.set_xlabel("Time (months)")
ax.set_ylabel("Closing price per share")
ax.set_title("Comparison - Visa (V) vs S&P500 Index ETF")

ax.legend(title = 'Legend',loc = 'upper left')

plt.show()
```



```
In [251...] # Restated chart shows Visa's performance was aligned with the S&P500 Index until 2013 w
# Visa's stock price has grown faster since 2013, but also has followed the general peak
# This shows that Visa has been a generally better performing stock than most stocks in
# to the same factors which cause price declines in the general market
```

Tweets - Regex to extract pattern in data

```
In [252...] # Import dataset from Kaggle.com (https://www.kaggle.com/datasets/mmmarchetti/tweets-dat

import re

df = pd.read_csv('tweets.csv')
```

```
In [253...] df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 52542 entries, 0 to 52541
Data columns (total 10 columns):
 #   Column                Non-Null Count  Dtype
---  -
 0   author                52542 non-null  object
 1   content               52542 non-null  object
 2   country               36 non-null     object
 3   date_time             52542 non-null  object
 4   id                   52542 non-null  float64
 5   language              52542 non-null  object
 6   latitude              1 non-null      float64
 7   longitude             1 non-null      float64
 8   number_of_likes       52542 non-null  int64
 9   number_of_shares      52542 non-null  int64
dtypes: float64(3), int64(2), object(5)
memory usage: 4.0+ MB
```

```
In [254...] # Find all instances of "learning" in the "contents" column, irrespective of upper/lower

results = df['content'].str.contains(r'learning', flags=re.IGNORECASE, regex=True, na=Fa

print(df[results])
```

	author	content \
942	katyperry	SHAME on schools that allow students to have t...
1559	katyperry	YO! Impress all ur homies & stay straight ...
11347	rihanna	Learning how to be selfish...
13273	YouTube	Learning begins with listening. \n\n\nFirst-...
13955	YouTube	Learning about black holes while blindfolded w...

16747	ladygaga	Learning lines, writing songs, rolling around ...
21940	Twitter	We've acquired Magic Pony Technology to enhanc...
22209	Twitter	@avneeshk91 Keep learning and growing, Avneesh...
22555	Twitter	Yesterday we opened the @NeighborNest, our loc...
23086	Twitter	That's great! "@melissacrn: @twitter #ladies...
23476	Twitter	Had the pleasure of learning what Bollywood th...
32410	Cristiano	You asked: Hi Cristiano! You are my idol and i...
34038	Cristiano	You and @Ochocinco both. @shrue I just starte...
36662	selenagomez	Loving, learning and growing with @Rock_Mafia ...
43897	ArianaGrande	learning/feeling so many new things at the mom...
44903	ArianaGrande	need to clean up this mouth of mine & set ...
45391	shakira	Join me in creating a #LearningGeneration to p...
45989	shakira	RT @HispanicEd's Commissioner @Shakira on Earl...
46002	shakira	Agree! RT @arneduncan .@FeimM Please challenge...
46011	shakira	.@stumpteacher babies have an innate thirst fo...
46103	shakira	Learning to read with mommy / Aprendiendo a l...
46303	shakira	+400 children now have access to quality early...
46569	shakira	¿Dónde debemos invertir el primer dólar para c...
46570	shakira	Where should we invest the first dollar to get...
46581	shakira	Millions of kids cannot reach the first step o...
46955	shakira	Important conversations in Miami today on the ...
46957	shakira	Participation in quality early learning prog. ...
48548	instagram	Bicycling from Mexico to Argentina, learning t...
49569	instagram	Learning to embrace yourself with @euvulcanica...
51762	ddlovato	I'm learning so much every day by this new cha...

	country	date_time	id	language	latitude	longitude	\
942	NaN	15/07/2015 00:39	6.211170e+17	en	NaN	NaN	
1559	NaN	24/07/2014 14:07	4.923100e+17	en	NaN	NaN	
11347	NaN	22/08/2013 18:51	3.706190e+17	en	NaN	NaN	
13273	NaN	21/11/2016 20:30	8.007980e+17	en	NaN	NaN	
13955	NaN	27/08/2016 19:00	7.696100e+17	en	NaN	NaN	
16747	NaN	20/09/2015 00:56	6.454010e+17	en	NaN	NaN	
21940	NaN	20/06/2016 13:00	7.448780e+17	en	NaN	NaN	
22209	NaN	21/03/2016 17:21	7.119660e+17	en	NaN	NaN	
22555	NaN	21/05/2015 23:35	6.015320e+17	en	NaN	NaN	
23086	NaN	18/07/2011 19:28	9.303940e+16	en	NaN	NaN	
23476	NaN	02/03/2010 03:06	9.856313e+09	en	NaN	NaN	
32410	NaN	29/08/2014 15:45	5.053810e+17	en	NaN	NaN	
34038	NaN	10/12/2010 17:43	1.328760e+16	en	NaN	NaN	
36662	NaN	07/04/2011 00:58	5.579660e+16	en	NaN	NaN	
43897	NaN	03/11/2015 15:27	6.615650e+17	en	NaN	NaN	
44903	NaN	08/07/2015 22:12	6.189060e+17	en	NaN	NaN	
45391	NaN	18/09/2016 17:12	7.775560e+17	en	NaN	NaN	
45989	NaN	10/12/2014 15:43	5.427060e+17	en	NaN	NaN	
46002	NaN	10/12/2014 15:20	5.427000e+17	en	NaN	NaN	
46011	NaN	10/12/2014 15:13	5.426990e+17	en	NaN	NaN	
46103	NaN	24/09/2014 14:42	5.147870e+17	en	NaN	NaN	
46303	NaN	15/05/2014 08:33	4.668590e+17	en	NaN	NaN	
46569	NaN	20/03/2014 14:15	4.466510e+17	es	NaN	NaN	
46570	NaN	20/03/2014 14:15	4.466510e+17	en	NaN	NaN	
46581	NaN	18/03/2014 15:35	4.459470e+17	en	NaN	NaN	
46955	NaN	18/09/2013 16:17	3.803650e+17	en	NaN	NaN	
46957	NaN	17/09/2013 13:31	3.799610e+17	en	NaN	NaN	
48548	NaN	22/08/2016 17:30	7.677760e+17	en	NaN	NaN	
49569	NaN	06/04/2016 21:29	7.178270e+17	en	NaN	NaN	
51762	NaN	04/09/2015 11:02	6.397550e+17	en	NaN	NaN	

	number_of_likes	number_of_shares
942	18708	9156
1559	8550	6304
11347	7493	15152
13273	994	175
13955	1401	208
16747	6303	3143
21940	1156	744

22209	108	36
22555	671	261
23086	54	59
23476	50	113
32410	1824	675
34038	60	80
36662	779	2254
43897	40840	22137
44903	79767	49582
45391	2481	602
45989	586	307
46002	344	170
46011	393	184
46103	5169	2831
46303	1294	477
46569	604	351
46570	615	312
46581	1155	700
46955	286	270
46957	316	416
48548	826	173
49569	981	196
51762	36204	28035

Wine Quality - Machine Learning

Wine Quality - Predict wine quality based on the chemical attributes (features) for each wine and test against quality (target) assigned to the wine.

```
In [255... from sklearn.linear_model import LinearRegression, Ridge, Lasso
from sklearn.metrics import confusion_matrix
from sklearn.neighbors import KNeighborsClassifier
```

```
In [256... # data source = UCI Machine Learning Repository (https://archive.ics.uci.edu/ml/datasets
df_wine = pd.read_csv('winequality-white.csv')
```

```
In [257... # view what the data frame looks like - columns and beginning / ending data, confirm no
df_wine.head()
```

Out[257]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality
0	7.0	0.27	0.36	20.7	0.045	45.0	170.0	1.0010	3.00	0.45	8.8	6
1	6.3	0.30	0.34	1.6	0.049	14.0	132.0	0.9940	3.30	0.49	9.5	6
2	8.1	0.28	0.40	6.9	0.050	30.0	97.0	0.9951	3.26	0.44	10.1	6
3	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.40	9.9	6
4	7.2	0.23	0.32	8.5	0.058	47.0	186.0	0.9956	3.19	0.40	9.9	6

```
In [258... df_wine.tail()
```

Out[258]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality
4893	6.2	0.21	0.29	1.6	0.039	24.0	92.0	0.99114	3.27	0.50	11.2	6

4894	6.6	0.32	0.36	8.0	0.047	57.0	168.0	0.99490	3.15	0.46	9.6	5
4895	6.5	0.24	0.19	1.2	0.041	30.0	111.0	0.99254	2.99	0.46	9.4	6
4896	5.5	0.29	0.30	1.1	0.022	20.0	110.0	0.98869	3.34	0.38	12.8	7
4897	6.0	0.21	0.38	0.8	0.020	22.0	98.0	0.98941	3.26	0.32	11.8	6

```
In [259... df_wine.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4898 entries, 0 to 4897
Data columns (total 12 columns):
#   Column                                Non-Null Count  Dtype
---  -
0   fixed acidity                         4898 non-null   float64
1   volatile acidity                     4898 non-null   float64
2   citric acid                          4898 non-null   float64
3   residual sugar                       4898 non-null   float64
4   chlorides                           4898 non-null   float64
5   free sulfur dioxide                 4898 non-null   float64
6   total sulfur dioxide                 4898 non-null   float64
7   density                             4898 non-null   float64
8   pH                                  4898 non-null   float64
9   sulphates                           4898 non-null   float64
10  alcohol                             4898 non-null   float64
11  quality                             4898 non-null   int64
dtypes: float64(11), int64(1)
memory usage: 459.3 KB
```

```
In [260... df_wine.describe()
```

Out[260]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density
count	4898.000000	4898.000000	4898.000000	4898.000000	4898.000000	4898.000000	4898.000000	4898.000000
mean	6.854788	0.278241	0.334192	6.391415	0.045772	35.308085	138.360657	0.994027
std	0.843868	0.100795	0.121020	5.072058	0.021848	17.007137	42.498065	0.002991
min	3.800000	0.080000	0.000000	0.600000	0.009000	2.000000	9.000000	0.987110
25%	6.300000	0.210000	0.270000	1.700000	0.036000	23.000000	108.000000	0.991723
50%	6.800000	0.260000	0.320000	5.200000	0.043000	34.000000	134.000000	0.993740
75%	7.300000	0.320000	0.390000	9.900000	0.050000	46.000000	167.000000	0.996100
max	14.200000	1.100000	1.660000	65.800000	0.346000	289.000000	440.000000	1.038980

```
In [261... # count of all results in the target (quality)

count = df_wine['quality'].value_counts(ascending=False)
countd = count.to_dict()
df_count = pd.DataFrame(list(countd.items()), columns = ['quality score', 'count'])
print(df_count)

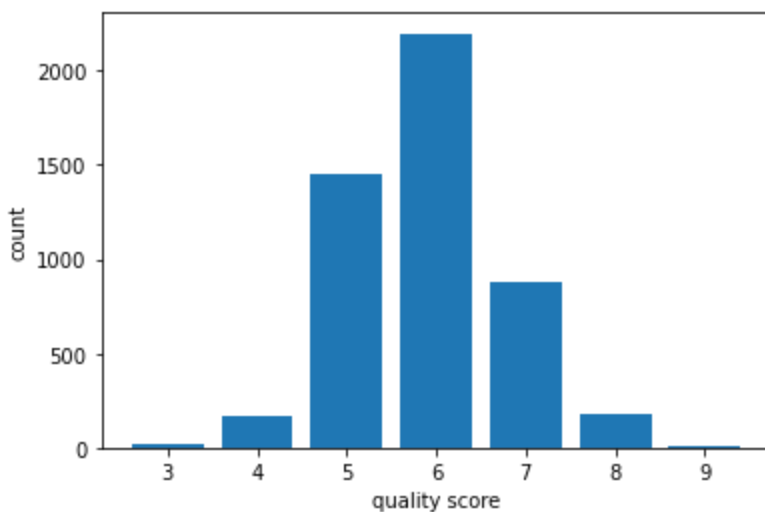
quality score  count
0              6    2198
1              5    1457
2              7     880
3              8     175
4              4     163
5              3      20
6              9       5
```

```
In [262...] df_count.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 7 entries, 0 to 6
Data columns (total 2 columns):
 #   Column      Non-Null Count  Dtype  
---  -
 0   quality score  7 non-null     int64  
 1   count         7 non-null     int64  
dtypes: int64(2)
memory usage: 240.0 bytes
```

```
In [263...] # show the count of quality variables - consider to split quality into two buckets being
# lower (5 and below - 35%) and higher (6 and above - 65%)
# the bar chart also implies outliers in both lower (quality = 3,4) and upper (8,9) rang

plt.bar(df_count['quality score'], df_count['count'])
plt.xlabel("quality score")
plt.ylabel("count")
plt.show()
```



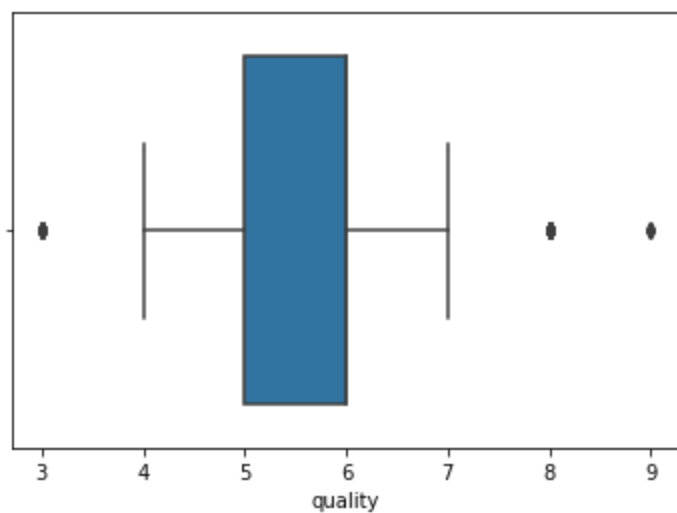
```
In [264...] # use Box Plot to identify outliers - quality values 3, 8 and 9 are acting as outliers,

import seaborn as sns

sns.boxplot(df_wine['quality'])
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\_decorators.py:36: FutureWarning: Pass the following variable as a keyword arg: x. From version 0.12, the only valid positional argument will be `data`, and passing other arguments without an explicit keyword will result in an error or misinterpretation.
  warnings.warn(
```

```
Out[264]: <AxesSubplot: xlabel='quality'>
```



```
In [265... # import train_test_split as need to split the data into a training and a test set to ch
from sklearn.model_selection import train_test_split
```

```
In [266... # assign feature and target arrays for the model, check type is numpy
```

```
X = df_wine.drop("quality", axis=1).values
y = df_wine["quality"].values
names = df_wine.drop("quality", axis=1).columns
print(type(X), type(y))
```

```
<class 'numpy.ndarray'> <class 'numpy.ndarray'>
```

```
In [267... # check shape - y (target) can be 1 dimensional, but X (features) must be two dimensiona
```

```
print(y.shape, X.shape)
```

```
(4898,) (4898, 11)
```

```
In [268... # create the train and test data sets
```

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42
print(type(X_train), type(y_train))
```

```
<class 'numpy.ndarray'> <class 'numpy.ndarray'>
```

```
In [269... # Model #1 - Ridge Regression
# scores show this model is not a good fit for the data;
# score does not material change as the alpha is varied, implies tuning not likely to im
```

```
alphas = [0.1, 1.0, 10.0, 100.0, 1000.0, 10000.0]
ridge_scores = []
for alpha in alphas:
```

```
    # Create a Ridge regression model
    ridge = Ridge(alpha=alpha)
```

```
    # Fit the data
    ridge.fit(X_train, y_train)
```

```
    # Obtain R-squared
    score = ridge.score(X_test, y_test)
    ridge_scores.append(score)
print(ridge_scores)
```

```
[0.253882033094209, 0.2537816239676387, 0.25355183350458244, 0.23366235986958594, 0.2105
5971854463496, 0.1318418298130537]
```

```
In [270... # Model #2 - Lasso Regression
```

```
# scores show this model is also not a good fit for the data, also progressively worse as alpha increases

# Lasso Regression module

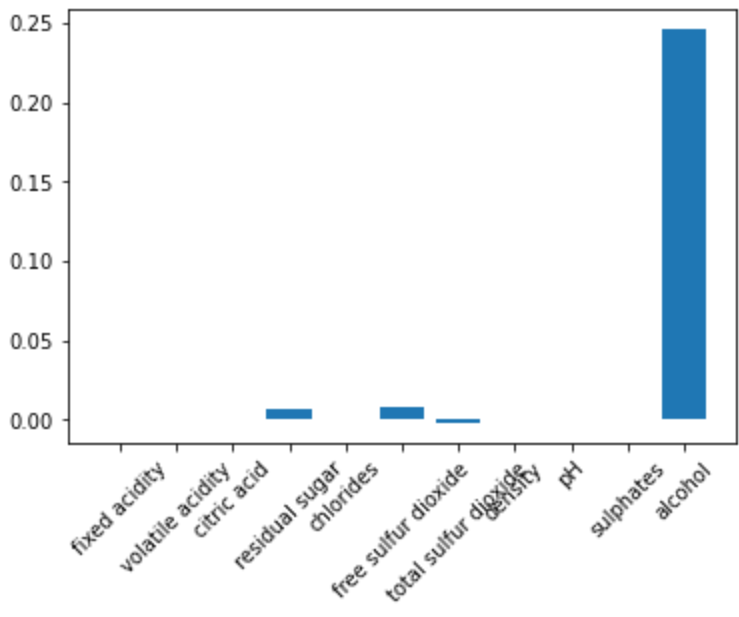
scores = []

for alpha in [0.01, 1.0, 10.0, 20.0, 50.0]:
    lasso = Lasso(alpha=alpha)
    lasso.fit(X_train, y_train)
    lasso_pred = lasso.predict(X_test)
    scores.append(lasso.score(X_test, y_test))
print(scores)

[0.24492793942460256, 0.04739580078497285, -0.0011619661806652193, -0.0011619661806652193, -0.0011619661806652193]
```

```
In [271]: # use Lasso to check which (if any) feature(s) have more of an impact in predicting high quality
# single best predictor of quality, none of the remaining features predict quality at a significant level

lasso = Lasso(alpha=0.1)
lasso_coef = lasso.fit(X, y).coef_
plt.bar(names, lasso_coef)
plt.xticks(rotation=45)
plt.show()
```



```
In [272]: # running a simple correlation on the data is another data focused method to present same data in a different way

df_wine.corr()
```

Out[272]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates
fixed acidity	1.000000	-0.022697	0.289181	0.089021	0.023086	-0.049396	0.091070	0.265331	-0.425858	-0.017351
volatile acidity	-0.022697	1.000000	-0.149472	0.064286	0.070512	-0.097012	0.089261	0.027114	-0.031915	-0.035206
citric acid	0.289181	-0.149472	1.000000	0.094212	0.114364	0.094077	0.121131	0.149503	-0.163748	0.062813
residual sugar	0.089021	0.064286	0.094212	1.000000	0.088685	0.299098	0.401439	0.838966	-0.194133	-0.026043
chlorides	0.023086	0.070512	0.114364	0.088685	1.000000	0.101392	0.198910	0.257211	-0.090439	0.016758
free sulfur dioxide	-0.049396	-0.097012	0.094077	0.299098	0.101392	1.000000	0.247554	0.017749	0.091601	-0.121875
total sulfur dioxide	0.091070	0.089261	0.121131	0.401439	0.198910	0.247554	1.000000	0.469709	-0.111508	-0.070591
density	0.265331	0.027114	0.149503	0.838966	0.257211	0.017749	0.469709	1.000000	-0.114354	-0.047132
pH	-0.425858	-0.031915	-0.163748	-0.194133	-0.090439	0.091601	-0.111508	-0.114354	1.000000	0.015872
sulphates	-0.017351	-0.035206	0.062813	-0.026043	0.016758	-0.121875	-0.070591	-0.047132	0.015872	1.000000

free sulfur dioxide	-0.049396	-0.097012	0.094077	0.299098	0.101392	1.000000	0.615501	0.294210	-0.000618	0.0591
total sulfur dioxide	0.091070	0.089261	0.121131	0.401439	0.198910	0.615501	1.000000	0.529881	0.002321	0.1341
density	0.265331	0.027114	0.149503	0.838966	0.257211	0.294210	0.529881	1.000000	-0.093591	0.0741
pH	-0.425858	-0.031915	-0.163748	-0.194133	-0.090439	-0.000618	0.002321	-0.093591	1.000000	0.1551
sulphates	-0.017143	-0.035728	0.062331	-0.026664	0.016763	0.059217	0.134562	0.074493	0.155951	1.0000
alcohol	-0.120881	0.067718	-0.075729	-0.450631	-0.360189	-0.250104	-0.448892	-0.780138	0.121432	-0.0171
quality	-0.113663	-0.194723	-0.009209	-0.097577	-0.209934	0.008158	-0.174737	-0.307123	0.099427	0.0531

Initial review of model accuracy

Originally, I wondered if regression models might work better given the multiple values in the target column, but ultimately this is really a classification problem.

Out of curiosity, I ran the regression models first to see their accuracy (or lack thereof), result being the regression models were not accurate.

From that (and presented below), applied KNN Classifier model, optimized the neighbors value and compared results of further fine-tuning to:

1. Remove Outliers
2. Simplify target values from original options of 3 - 9 to 1 or 0:
 - a. Good (6 and above)
 - b. Not Good (5 and below)

Results were:

- a - KNN on original data with a randomly selected neighbors value of 6 = 44.9% (not great)
- b - KNN on original data with optimized neighbors of 25 = 47.6% (marginally improved)
- c - KNN on simplified data with optimized neighbors of 25 = 70.4% (significantly improved but still not accurate enough)
- d - KNN on original data with optimized neighbors of 25 and outliers removed = 47.3% (worse in absolute %, but statistically same as version b)
- e - KNN on simplified data with optimized neighbors of 25 and outliers removed = 70.4% (outliers removed from simplified data had no impact on accuracy)

```
In [273... # APPLY KNN CLASSIFIER MODEL

# Model #3 (original) - run Classifier Model before removing outliers and changing target
# in order to see impact of optimization and fine-tuning

# Create a KNN classifier with 6 neighbors
knn = KNeighborsClassifier(n_neighbors=6)
```

```
In [274... # Fit the classifier to the data, predict the labels for X and print

knn.fit(X, y)
y_pred = knn.predict(X)
print("Predictions: {}".format(y_pred))

Predictions: [6 5 6 ... 6 6 6]
```

```
In [275... # Fit the classifier to the training data and print accuracy
# Accuracy is not great at 46%
```

```
knn.fit(X_train,y_train)
print(knn.score(X_test, y_test))
```

0.4489795918367347

In [276...

```
# Check Model complexity and find optimal knn neighbor value
```

```
neighbors = np.arange(1, 30)
train_accuracies = {}
test_accuracies = {}

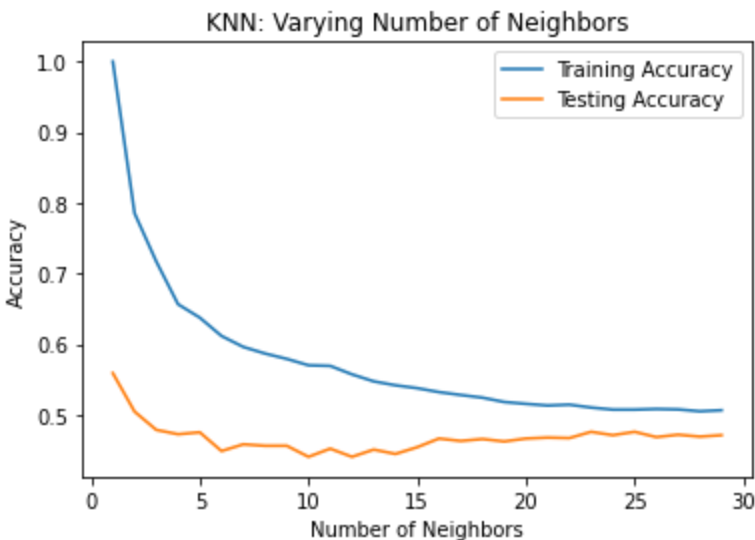
for neighbor in neighbors:
    knn = KNeighborsClassifier(n_neighbors=neighbor)
    knn.fit(X_train, y_train)
    train_accuracies[neighbor] = knn.score(X_train, y_train)
    test_accuracies[neighbor] = knn.score(X_test, y_test)
print(neighbors, '\n', train_accuracies, '\n', test_accuracies)
```

```
[ 1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
 25 26 27 28 29]
{1: 1.0, 2: 0.7852975495915986, 3: 0.7170361726954493, 4: 0.6566511085180864, 5: 0.6376
896149358227, 6: 0.6117269544924154, 7: 0.5962660443407235, 8: 0.5869311551925321, 9: 0.
5793465577596266, 10: 0.5703033838973163, 11: 0.5694282380396732, 12: 0.557467911318553
1, 13: 0.5475495915985997, 14: 0.5420070011668612, 15: 0.5379229871645275, 16: 0.5323803
967327888, 17: 0.5282963827304551, 18: 0.5245040840140023, 19: 0.5183780630105017, 20:
0.5157526254375729, 21: 0.5134189031505251, 22: 0.514585764294049, 23: 0.510501750291715
3, 24: 0.5075845974329055, 25: 0.5075845974329055, 26: 0.5084597432905484, 27: 0.5078763
127187864, 28: 0.5052508751458576, 29: 0.5067094515752626}
{1: 0.5591836734693878, 2: 0.5047619047619047, 3: 0.47891156462585033, 4: 0.47278911564
625853, 5: 0.47551020408163264, 6: 0.4489795918367347, 7: 0.45850340136054424, 8: 0.4564
625850340136, 9: 0.4564625850340136, 10: 0.44081632653061226, 11: 0.4523809523809524, 1
2: 0.44081632653061226, 13: 0.45102040816326533, 14: 0.4448979591836735, 15: 0.454421768
707483, 16: 0.46666666666666667, 17: 0.463265306122449, 18: 0.46598639455782315, 19: 0.46
258503401360546, 20: 0.46666666666666667, 21: 0.46802721088435373, 22: 0.467346938775510
2, 23: 0.47619047619047616, 24: 0.4714285714285714, 25: 0.47619047619047616, 26: 0.46870
748299319726, 27: 0.47210884353741495, 28: 0.46938775510204084, 29: 0.4714285714285714}
```

In [277...

```
# plot the results on a chart to visualize where optimal # of neighbors is - appears aro
```

```
plt.title("KNN: Varying Number of Neighbors")
plt.plot(neighbors, train_accuracies.values(), label="Training Accuracy")
plt.plot(neighbors, test_accuracies.values(), label="Testing Accuracy")
plt.legend()
plt.xlabel("Number of Neighbors")
plt.ylabel("Accuracy")
plt.show()
```




```
In [278... # Model #3 KNN (optimalN) - re run Classifier Model using optimal neighbors value of 25
```

```
knn = KNeighborsClassifier(n_neighbors=25)
```

```
In [279...
```

```
knn.fit(X, y)
y_pred = knn.predict(X)
print("Predictions: {}".format(y_pred))
```

```
Predictions: [6 5 6 ... 6 6 6]
```

```
In [280...
```

```
# rerunning the model improves marginally to 47.6% from 44.9%
```

```
knn.fit(X_train,y_train)
print(knn.score(X_test, y_test))
```

```
0.47619047619047616
```

```
In [281...
```

```
# Rerun Model #3 KNN (simplify) - Simplify the target values to reflect:
```

```
# 1. <6 as 0 (being Not Good); and
```

```
# 2. >5 as 1 (being Good)
```

```
df_wine2 = df_wine.replace({'quality':{3:0, 4:0, 5:0, 6:1, 7:1, 8:1, 9:1}})
df_wine2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 4898 entries, 0 to 4897
```

```
Data columns (total 12 columns):
```

#	Column	Non-Null Count	Dtype
0	fixed acidity	4898 non-null	float64
1	volatile acidity	4898 non-null	float64
2	citric acid	4898 non-null	float64
3	residual sugar	4898 non-null	float64
4	chlorides	4898 non-null	float64
5	free sulfur dioxide	4898 non-null	float64
6	total sulfur dioxide	4898 non-null	float64
7	density	4898 non-null	float64
8	pH	4898 non-null	float64
9	sulphates	4898 non-null	float64
10	alcohol	4898 non-null	float64
11	quality	4898 non-null	int64

```
dtypes: float64(11), int64(1)
```

```
memory usage: 459.3 KB
```

```
In [282...
```

```
# Check that all target values are either 1 or 0 - confirmed
```

```
count2 = df_wine2['quality'].value_counts(ascending=False)
```

```
countd2 = count2.to_dict()
```

```
df_count2 = pd.DataFrame(list(countd2.items()),columns = ['quality score','count'])
```

```
print(df_count2)
```

	quality score	count
0	1	3258
1	0	1640

```
In [283...
```

```
#RERUN MODEL #3 AFTER TARGET VALUES CHANGED TO 1/0
```

```
# Revise feature and target arrays for the model, check type is numpy
```

```
X2 = df_wine2.drop("quality", axis=1).values
```

```
y2 = df_wine2["quality"].values
```

```
names = df_wine2.drop("quality", axis=1).columns
```

```
print(type(X2), type(y2))
```

```
<class 'numpy.ndarray'> <class 'numpy.ndarray'>
```

```
# Revise the train and test data sets
```

```
In [284... X2_train, X2_test, y2_train, y2_test = train_test_split(X2, y2, test_size=0.3, random_st
print(type(X2_train), type(y2_train))
```

```
<class 'numpy.ndarray'> <class 'numpy.ndarray'>
```

```
In [285... # Fit the classifier to the new data, predict the labels and print
```

```
knn.fit(X2, y2)
y2_pred = knn.predict(X2)
print("Predictions: {}".format(y2_pred))
```

```
Predictions: [1 0 1 ... 1 1 1]
```

```
In [286... # Fit the classifier to the revised training data
# Print the accuracy of the model after the target values are simplified
# Accuracy has improved, but it is still not high enough (would expect 90% or higher)
```

```
#Score for Model #3 KNN (simplify) (simplified with optimal neighbors of 25) is 70.4%
```

```
knn.fit(X2_train,y2_train)
print(knn.score(X2_test, y2_test))
```

```
0.7040816326530612
```

```
In [287... # RERUN MODEL #3 KNN(ex-outliers) REVISED FOR OUTLIERS
# Identify and drop outliers using IQR method (interquartile range), then revise all ste
```

```
df_wine3 = df_wine
```

```
# IQR
```

```
Q1 = np.percentile(df_wine3['quality'], 25,
                    interpolation = 'midpoint')
```

```
Q3 = np.percentile(df_wine3['quality'], 75,
                    interpolation = 'midpoint')
```

```
IQR = Q3 - Q1
```

```
print("Old Shape: ", df_wine.shape)
```

```
# Upper bound
```

```
upper = np.where(df_wine3['quality'] >= (Q3+1.5*IQR))
```

```
# Lower bound
```

```
lower = np.where(df_wine3['quality'] <= (Q1-1.5*IQR))
```

```
''' Removing the Outliers '''
```

```
df_wine3.drop(upper[0], inplace = True)
```

```
df_wine3.drop(lower[0], inplace = True)
```

```
print("New Shape: ", df_wine3.shape)
```

```
Old Shape: (4898, 12)
```

```
New Shape: (4698, 12)
```

```
In [288... df_wine3.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
Int64Index: 4698 entries, 0 to 4897
```

```
Data columns (total 12 columns):
```

#	Column	Non-Null Count	Dtype
0	fixed acidity	4698 non-null	float64
1	volatile acidity	4698 non-null	float64
2	citric acid	4698 non-null	float64
3	residual sugar	4698 non-null	float64
4	chlorides	4698 non-null	float64

```

5   free sulfur dioxide      4698 non-null    float64
6   total sulfur dioxide     4698 non-null    float64
7   density                  4698 non-null    float64
8   pH                       4698 non-null    float64
9   sulphates                4698 non-null    float64
10  alcohol                  4698 non-null    float64
11  quality                  4698 non-null    int64
dtypes: float64(11), int64(1)
memory usage: 477.1 KB

```

```

In [289.. X3 = df_wine3.drop("quality", axis=1).values
y3 = df_wine3["quality"].values
names = df_wine3.drop("quality", axis=1).columns
print(type(X3), type(y3))
print(y3.shape, X3.shape)

<class 'numpy.ndarray'> <class 'numpy.ndarray'>
(4698,) (4698, 11)

```

```

In [290.. X3_train, X3_test, y3_train, y3_test = train_test_split(X3, y3, test_size=0.3, random_st
print(type(X3_train), type(y3_train))

<class 'numpy.ndarray'> <class 'numpy.ndarray'>

```

```

In [291.. # ACCURACY OF MODEL #3 AFTER OUTLIERS DROPPED - DECREASES FROM 47.6% TO 47.3% WHEN USING

#Score for Model #3 KNN(ex-outliers) (not simplified, outliers removed, optimal neighbor

knn = KNeighborsClassifier(n_neighbors=25)
knn.fit(X3, y3)
y3_pred = knn.predict(X3)
print("Predictions: {}".format(y3_pred))
knn.fit(X3_train,y3_train)
print(knn.score(X3_test, y3_test))

Predictions: [6 5 6 ... 6 6 6]
0.47304964539007094

```

```

In [292.. # MODEL #3 KNN(simplified + ex-outliers) REVISED FURTHER FOR:
# Drop outliers and then transform target values to 1/0 - revise all steps
# this version is not expected to change the overall accuracy as what was previously con
# and the volume of outliers are 200 ~ 4% of the original dataset

df_wine4 = df_wine

# IQR
Q1 = np.percentile(df_wine4['quality'], 25,
                    interpolation = 'midpoint')

Q3 = np.percentile(df_wine4['quality'], 75,
                    interpolation = 'midpoint')
IQR = Q3 - Q1

print("Old Shape: ", df_wine.shape)

# Upper bound
upper = np.where(df_wine4['quality'] >= (Q3+1.5*IQR))
# Lower bound
lower = np.where(df_wine4['quality'] <= (Q1-1.5*IQR))

''' Removing the Outliers '''
df_wine4.drop(upper[0], inplace = True)
df_wine4.drop(lower[0], inplace = True)

print("New Shape: ", df_wine4.shape)

Old Shape:  (4698, 12)

```

New Shape: (4698, 12)

```
In [293... df_wine4 = df_wine4.replace({'quality':{3:0, 4:0, 5:0, 6:1, 7:1, 8:1, 9:1}})
df_wine4.info()
count4 = df_wine4['quality'].value_counts(ascending=False)
countd4 = count4.to_dict()
df_count4 = pd.DataFrame(list(countd4.items()), columns = ['quality score', 'count'])
print(df_count4)
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 4698 entries, 0 to 4897
Data columns (total 12 columns):
#   Column                Non-Null Count  Dtype
---  -
0   fixed acidity          4698 non-null   float64
1   volatile acidity       4698 non-null   float64
2   citric acid            4698 non-null   float64
3   residual sugar         4698 non-null   float64
4   chlorides              4698 non-null   float64
5   free sulfur dioxide    4698 non-null   float64
6   total sulfur dioxide   4698 non-null   float64
7   density               4698 non-null   float64
8   pH                    4698 non-null   float64
9   sulphates             4698 non-null   float64
10  alcohol               4698 non-null   float64
11  quality               4698 non-null   int64
dtypes: float64(11), int64(1)
memory usage: 477.1 KB
   quality score  count
0              1   3078
1              0   1620
```

```
In [294... X4 = df_wine4.drop("quality", axis=1).values
y4 = df_wine4["quality"].values
names = df_wine4.drop("quality", axis=1).columns
print(type(X4), type(y4))
print(y4.shape, X4.shape)
```

```
<class 'numpy.ndarray'> <class 'numpy.ndarray'>
(4698,) (4698, 11)
```

```
In [295... X4_train, X4_test, y4_train, y4_test = train_test_split(X4, y4, test_size=0.3, random_st
print(type(X4_train), type(y4_train))
```

```
<class 'numpy.ndarray'> <class 'numpy.ndarray'>
```

```
In [296... # ACCURACY OF MODEL #3 AFTER TARGET SIMPLIFIED AND OUTLIERS DROPPED - NO CHANGE FROM Mod
# Removing outliers from the dataset once target values simplified had no effect on the mo

knn = KNeighborsClassifier(n_neighbors=25)
knn.fit(X2, y2)
y2_pred = knn.predict(X)
print("Predictions: {}".format(y2_pred))
knn.fit(X2_train, y2_train)
print(knn.score(X2_test, y2_test))
```

```
Predictions: [1 0 1 ... 1 1 1]
0.7040816326530612
```

THE END

```
In [ ]:
```