MINI PROJECT

(2021-2022)

"WINE QUALITY ANALYSIS"

Project Report

Institute of Engineering & Technology

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Under the Supervision Of

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CONTENTS

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Declaration

I/we hereby declare that the work which is being presented in the Bachelor of technology. Project **"Wine Quality Analysis"**, in partial fulfillment of the requirements for the award of the ***Bachelor of Technology*** in Computer Science and Engineering and submitted to the Department of Computer Engineering and Applicationsof GLA University, Mathura, is an authentic record of my/our own work carried underthe supervision of **Mr. Farmanul Haque, Technical Trainer, Dept. of CEA,GLA University.**

The contents of this project report, in full or in parts, have not been submitted to any other Institute or University for the award of any degree.

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Certificate

This is to certify that the project entitled "Wine Quality Analysis", carried outin Mini Project – II , is a bonafide work by Utkarsh Kulshrestha and Rishika Sharma and is submitted in partial fulfillment of the requirements for the award of the degree Bachelor of Technology (Computer Science & Engineering).

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ACKNOWLEDGEMENT

Presenting the ascribed project paper report in this very simple and official form, we would like to place my deep gratitude to GLA University for providing us the instructor Mr. Farmanul Haque, our technical trainer and supervisor.

He has been helping us since Day 1 in this project. He provided us with the roadmap, the basic guidelines explaining on how to work on the project. He has been conducting regular meeting to check the progress of the project and providing us with the resourcesrelated to the project. Without his help, we wouldn't have been able to complete this project.

And at last but not the least we would like to thank our dear parents for helping us to grab this opportunity to get trained and also my colleagues who helped me find resources during the training.

Thanking You

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ABSTRACT

As each and every sector of the market is growing, data is building up day by day, we need to keep the record of the data which can be helpful for the analytics and evaluation. Now we don't have data in gigabyte or terabyte but in zetta byte and petabyte and this data cannot be handled with the day to day software such as Excel or Matlab. Therefore in this report we will be dealing with large data sets with the high-level programming language 'Python'. The main goal of this project is to aggregate and analyze the data collected from the different data sources available on the internet. This project mainly focuses on the usage of the python programming language in the field of Wine Quality Check. This language has not only its application in the field of just analyzing the data but also for the prediction of the upcoming scenarios in the Wine Prodction. The purpose of using this specific language is due to its versatility, vast libraries (Pandas, Numpy, Matplotlib, etc.), speed limitations, and ease of learning. We will be analyzing large wine data sets in this project which cannot be easily analyzed in other tools as compared to python. Python does not have its limitation to only data analytics but also in many other fields such as Artificial intelligence, Machine learning, and many more.

Details about the Hardware and the Software

***System Requirements:* - Windows 7/8/10**

Software Required:

- Technology Implemented: Machine Learning and Data Science.
- Language : Python.
- Database: Google Collab, VS Code
- Browser: Google Chrome

Hardware Requirements: -

- Processor: Intel i3
- Operating System: Windows 7/8/10
- RAM: 4+GB
- Hard Disk: 64 GB
- Hardware Devices: Computer System.

CHAPTER 1 – DATA SCIENCE INTRODUCTION

DATA SCIENCE

Data science is the field of data analytics and data visualization in which raw data or the un structured data is cleaned and made ready for the analysis purpose. Data scientists use this data to get the required information for the future purpose. ”Data science uses many processes and methods on the big data, the data may be structured or unstructured”. Data frames available on the internet is the raw data we get. It may be either in unstructured or semi structured format .This data is further filtered, cleaned and then number of required task are performed for the analysis with the use of the high programming language. This data is further analyzed and then presented for our better understanding and evaluation.

One must be clear that data science is not about making complicated models or making awesome visualization neither it is about writing code but about using the data to create an impact for your company, for this impact we need tools like complicated data models and data visualization.

STAGES OF DATA SCIENCE

There are many tools used to handle the big data available to us. ”Data scientists use programming tools such as Python, R, SAS, Java, Perl, and C/C++ to extract knowledge from prepared data”.

Data scientists use many algorithms and mathematical models on the data.

Following are the stages and their cycle performed on the unstructured data.

- Identifying the problem.
- Identify available data sources
- Identify available data sources
- Identify if additional data sources are needed.
- Statistical analysis
- Implementation, development
- Communicate results
- Maintenance

7 steps that together constitute this life-cycle model of Data science

Data science finds its application in many fields. With the assistance of data science it is easy to get the search query on search engines in plenty of time. A role of the data scientist is to have adeep understanding of the data as well as a good command on the programming language, he should also know how to work with the raw data extracted from the data source. Many programming languages are used to analyze and evaluate the data such as Python, Java, MATLAB, Scala, Julia, R., SQL and Tensor Flow. Among which python is the most user friendly and vastly used programming language in the field of data Science .

This life cycle is applied in each and every field , in this project we will be considering all this seven stages of data science to analyze the data. The process will be starting from data collection,data preparation, data modeling and finally data evaluation.

CHAPTER 2- PYTHON PROGRAMMING LANGUAGE BASICS.

WHY PYTHON?

”Python is an interpreted, object-oriented, high-level programming language with dynamic semantics . This language consist of mainly data structures which make it very easy for the data scientists to analyse the data very effectively. It does not only help in forecasting and analysis it also helps in connecting the two different languages. Two best features of this programming language is that it does not have any compilation step as compared to the other programming language in which compilation is done before the program is being executed andother one is the reuse of the code, it consist of modules and packages due to which we can usethe previously written code any where in between the program whenever is required.
There are multiple languages for example R., Java, SQL, Julia, Scala, MATLAB available in market which can be used to analyze and evaluate the data, but due to some outstanding featurespython is the most famous language used in the field of data science.

Python is mostly used and easy among all other programming languages is due to the following reasons.

Data structures in Python

Data structures are the way of storing the data so that we can easily perform different operationson the data whenever it's required. When the data has been collected from the data source the data is available in different forms. So later it is easy for the data scientists to perform differentoperation on the data once it is sorted in to different data structures.

Data structures are mainly classified in to two categories and then further their subcategories shown below.

1. Primitive Data Structures.

They are also called as basic data structures. This type of data structures contains simple values of the data.[7]

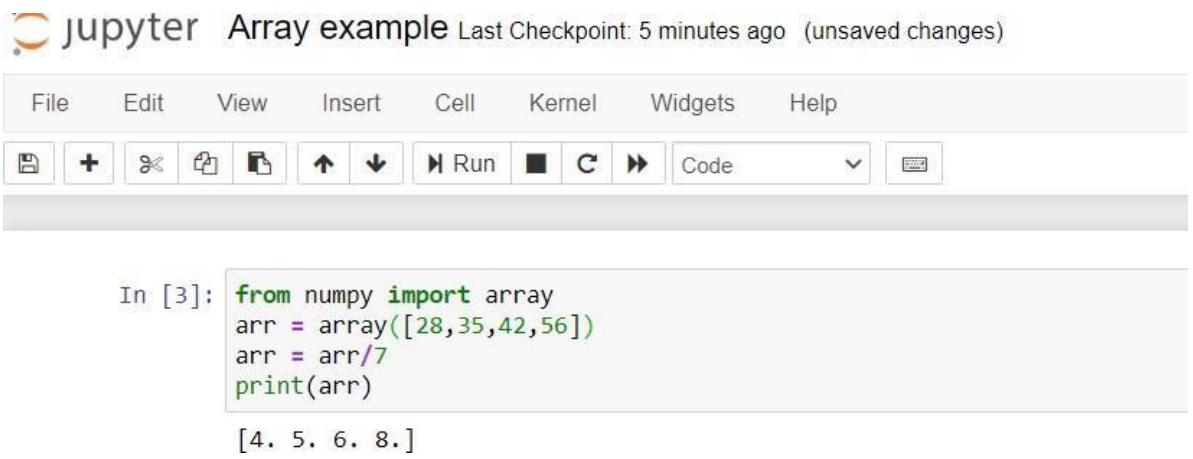
- **Integers** - All the whole numbers from negative infinity to positive infinity comes underinteger data types. for example 4,9,-2,-6.
- **Float** - The decimal figure numbers or rational numbers comes under float data types. forexample 3.1,2.2,8.96
- **Strings** - Collection of alphabets or characters are called strings. We enclose the stringeither in single or double quotes in python. for example 'hello' and "bread".
- **Boolean**- These are the built in data types which take two values that are 'True' and'False'. True represents the 1 and False represents 0 in python.

2. Non-Primitive Data Structures

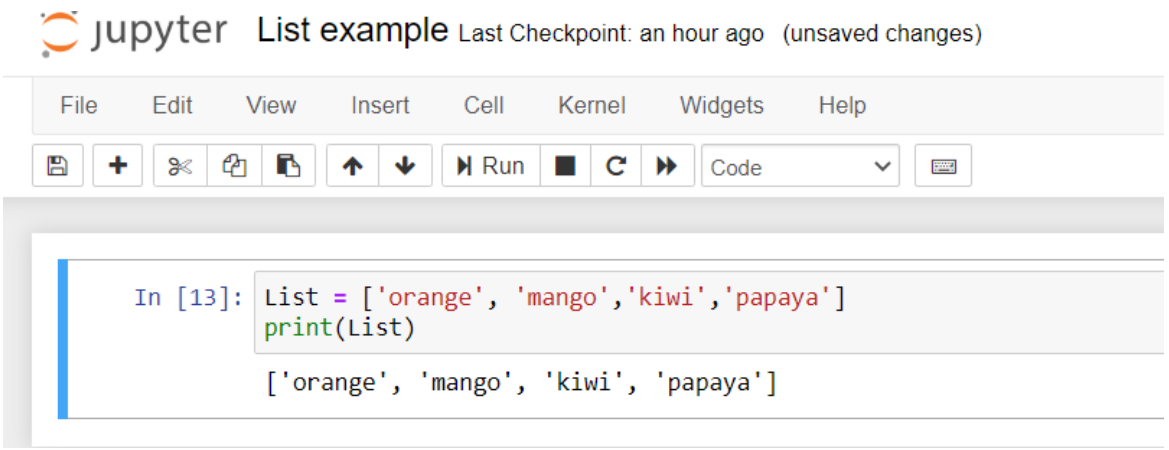
These are the derived type or reference variables data structures. They are called derived data structures because they derived from the basic data structures such as integer and float. Pythonhas mainly five types of data structures.

Following are the non primitive data structures.

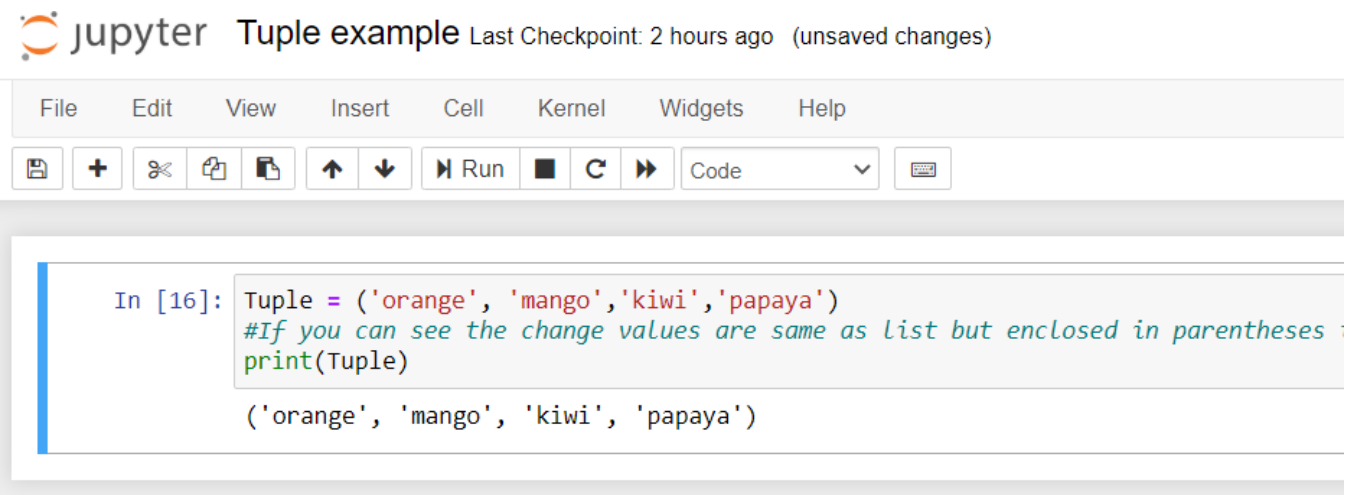
- **Array** - Array is the collection of data types of same type. Arrays data structures are used mostly in the NumPy library of python. In the below example we have first imported the pack-age array from numpy library and defined the array as variable arr then divided the array by 7 and we have printed our array to get output.



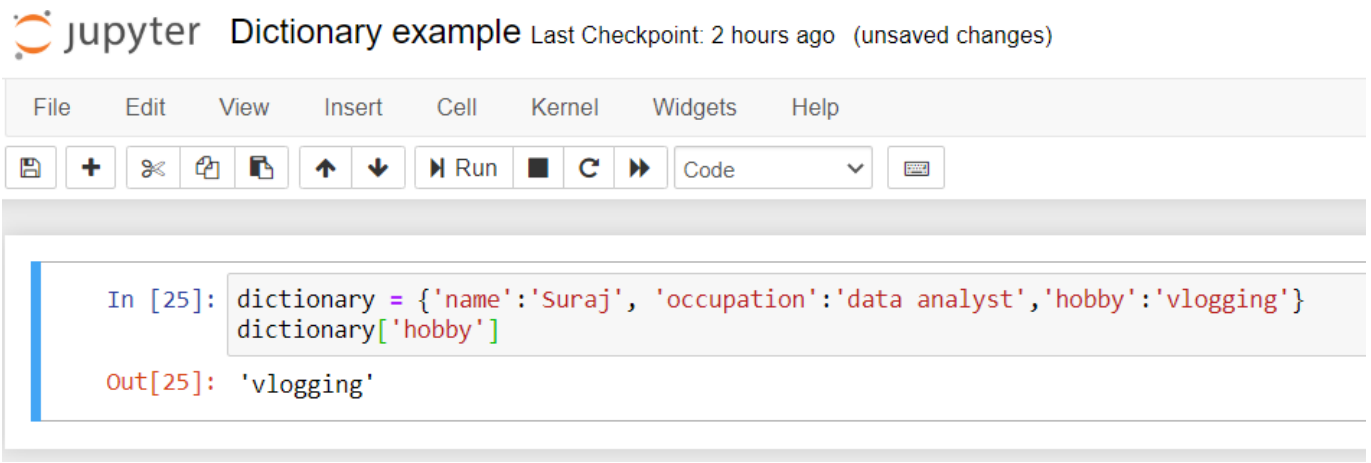
- **List** - A list is a value that contains multiple values in an ordered sequence". Values in the list referred to list itself, that is the value can be stored in a variable or passed to a function. List are changeable and values in the list are enclosed inside a square bracket, we can perform multiple operations such as indexing, slicing, adding and multiplying.



- **Tuple** - A tuple is a list of non changeable objects. The differences between tuples and lists are that the tuples cannot be changed, tuples use parentheses, whereas list uses squarebrackets.

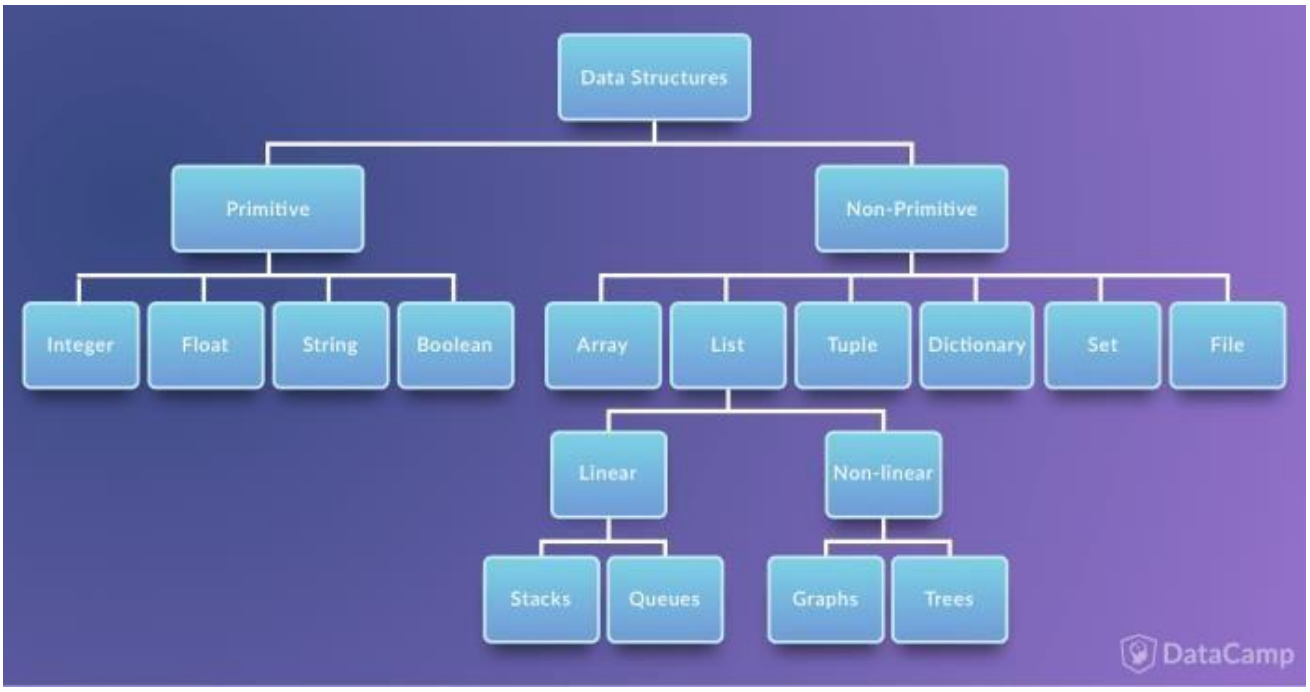


- **Dictionary**- These are nothing but a type of data structure which consist of key value pairs enclosed in the curly brackets. It is same as the any dictionary we use in day to day life in which we find the meaning of the particular words. So if I compare normal dictionary to this python dictionary data structure then the a word in a dictionary will be our key and its meaningwill be the value of the dictionary. In the figure name, occupation and hobby are the keys and Suraj, data analyst and vlogging are the values assigned to the keys.



- **Sets** - Set are used for calculating mathematical operation such as union, intersection and sym-metric difference.

Below is the data structure tree which explains the category and sub-category of each data types.



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Operators

OPERATORS - Operators are the symbols in python that are used to perform Arithmetic orlogical operations. Following are the different types of operators in python.

Arithmetic operators - Arithmetic operators carry out mathematical operations and they aremostly used with the numeric values.

Arithmetic operators		
Operator	Name	Example
+	Addition	A+B
-	Subtraction	A-B
*	Multiplication	A*B
/	Division	A/B
%	Modulus	A%B
**	Exponentiation	A**B
//	Quotient	A//B

Table 2.1: Arithmetic

operatorsA and B are the numeric values.

Assignment operators - As the name decides this operators are used for assigning the valuesto the variables.

ASSIGNMENT OPERATORS		
Operator	Example	may also be writ-ten
=	a = 6	a = 6
+=	a += 3	a = a + 3
-=	a -= 4	a = a - 4
*=	a *= 5	a = a * 5
/=	a /= 6	a = a / 6
%=	a %= 7	a = a % 7
//=	a //= 8	a = a // 8
**=	a **= 9	a = a ** 9
&=	a &= 1	a = a & 1

Table 2.2: Assignment Operators

Here a is any value and number of operations are performed on this value.

Logical operators - These operators are used to join conditional statements

Logical Operators		
Operator	Description	Example
and	if both statements are true it returns true	x <5 **and** x <10
or	if any of the two statement is true it returns true	x <4 **or** x <8
not	if the result is true it reverses the result and gives false	**not** (x <4 **and** x <8)

Table 2.3: Logical Operators

Here a is any value provided by us and on which multiple operations can be performed.

Comparison operators - These operators are used to compare two different values.

Comparison operators		
Operator	Name	Example
==	Equal	a == b
!=	Not equal	a!=b
>	Greater than	a >b
<	less than	a <b
>=	Greater than equal to	a>= b
<=	less than equal to	a <=b

Table 2.4: Comparison operators

Here a and b are two different values and these values are compared.

Membership operators - These operators are used to check membership of a particular value. It is used to check whether a specific value is present in the object or not.

Membership operators		
Operator	Description	Example
in	it returns a True if the value is present inside the object	a **in** b
not in	it returns a True if the value is notpresent inside the object	a **not in** b

Table 2.5: Membership operators.

Conditional statements

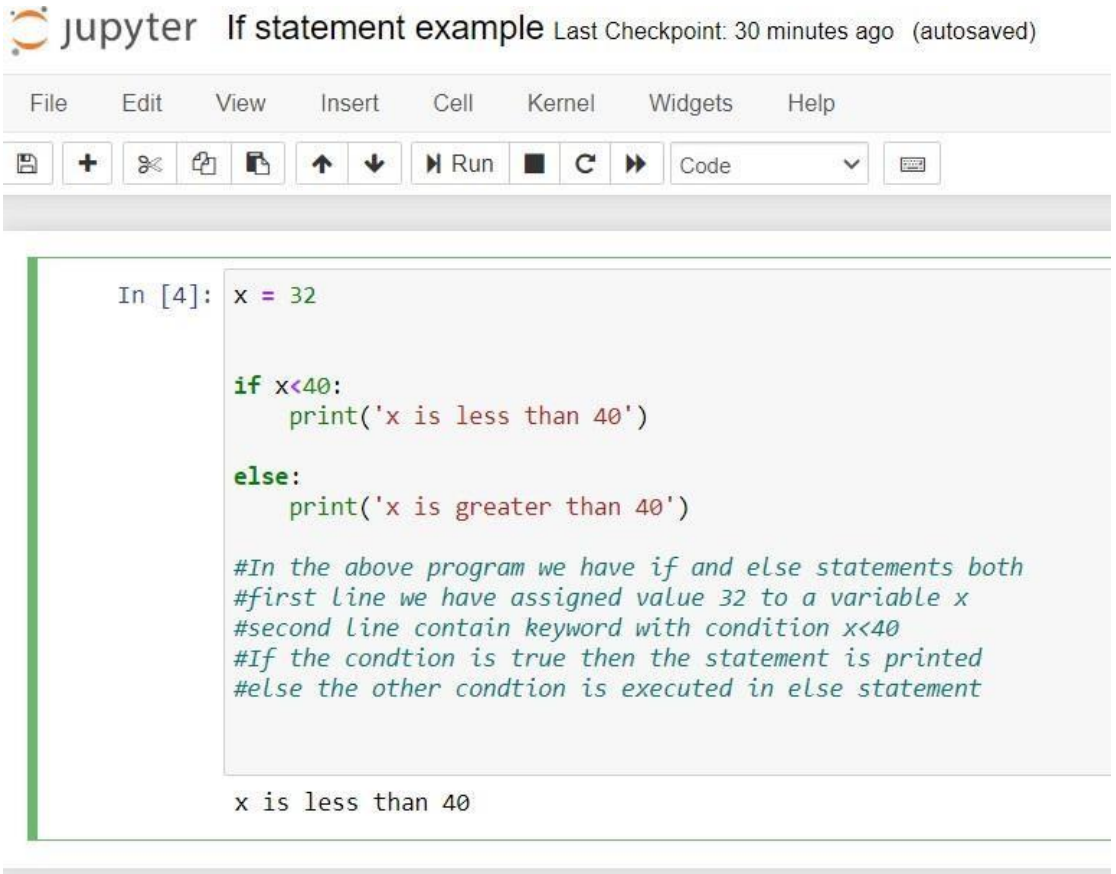
If else statements

”The most common type of statement is the if statement. if statement consist of a block which is called as clause”, it is the block after if statement, it executed the statement if the condition istrue. The statement is omitted if the condition is False. then the statement in the else part is printed

If statement consist of following -

- If keyword itself
- Condition which may be True or False
- Colon
- If clause or a block of code

Below is the figure shows how If and else statements are used with description inside it.



x

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elif statements

In this statement only one statement is executed, There are many cases in which there is only one possibility to execute. ”The elif statement is an else if statement that always follows an if or another elif statement”[8]. The elif statement provides another condition that is checked onlyif any of the previous conditions were False. In code, an elif statement always consists of the following:. The only difference between if else and elif statement is that in elif statement we have the condition where as in else statement we do not have any condition.

elIf statement consist of following -

- elIf keyword itself
- Condition which may be True or False
- Colon
- elIf clause or a block of code

Below is the figure shows how elIf statement is used with description inside it.

jupyter If statement example Last Checkpoint: 2 hours ago (unsaved changes)

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Run Code

In [9]:
```
var = 't'

if var == 'a':
    print('this is the vowel a')
elif var == 'e':
    print('this is the vowel e')
elif var == 'i':
    print('this is the vowel i')
elif var == 'o':
    print('this is the vowel o')
elif var == 'u':
    print('this is the vowel u')
else:
    print('The value in variable var is constant')

#In the above program we have if, else and elif statements.
#first line we have assigned value t to a variable 'var'
#second line contain keyword if with condition if var==a
#If the condtion is true then the statement is printed
#elif the other condtion is executed in elif statement in furhter lines
#if all the conditions are not true then we come to else statement
#and then statement in else block is printed on the output
```

```
The value in variable var is constant
```

Figure 2.7: elif example

Loops in python

For loop

When do we use for loops ?

for loops are traditionally used when you have a block of code which you want to repeat a fixednumber of times. The Python for statement iterates over the members of a sequence in order, executing the block each time.[9]

Range statement - This statement 'range()' is used with for loop statements where you can specify one value. For example, if you specify 10, the loop statement starts from 1 and ends with 9, which is n-1. Also, you can specify the start and end values. The following examples demonstrate loop statements.

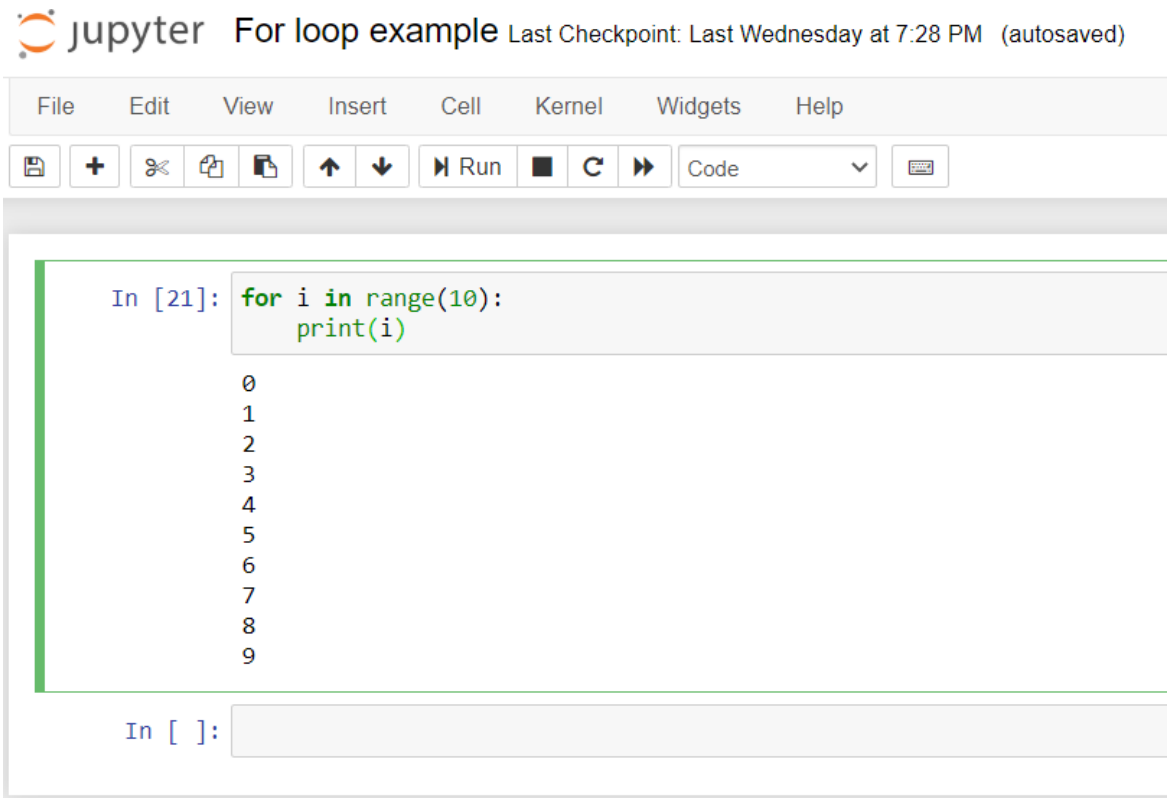


Figure 2.8: for example with range statement

While loop

While loops are used for repeating the section of code but not same as for loop, the while loopdoes not run n times, but until a defined condition is no longer met. If the condition is initially false, the loop body will not be executed at all.

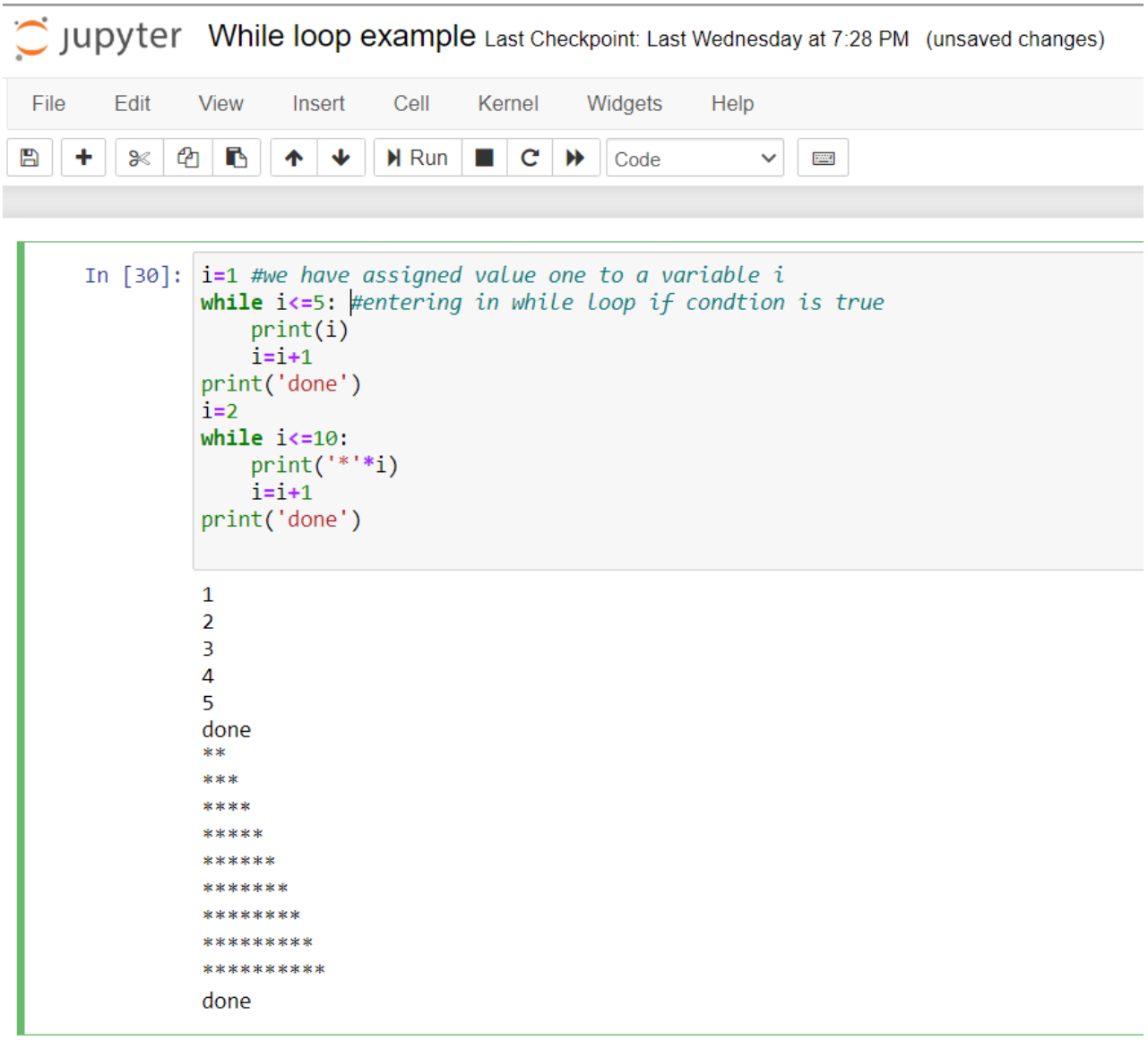


Figure 2.9: While loop example

Module, Package and Functions

- **Module**

Modules are Python files which has extension as .py. The name of the module will be the name of the file. A Python module can have a set of functions, classes or variables defined and implemented.

Module has some python codes, this codes can define the classes, functions and variables. The reason behind using the module is that it organizes your python code by grouping the python code so that it is easier to use.

- **Package**

A package consist of the collection of modules in which python codes are written with name init.py. It means that each python code inside of the python path, which contains a file named init.py, will be treated as a package by Python. Packages are used for organizing the module by using dotted names.

for example -
We have a package named simple package which consist of two modules a and b. We willimport the module from package in following way.

from simple package import a, b

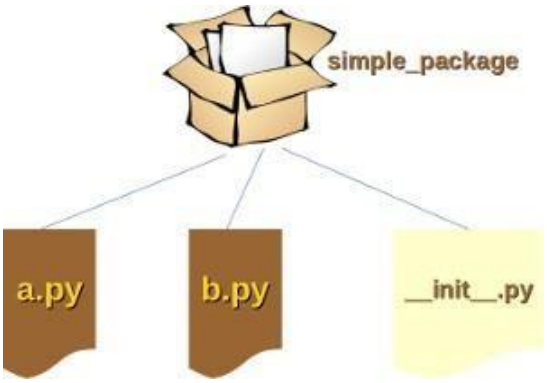


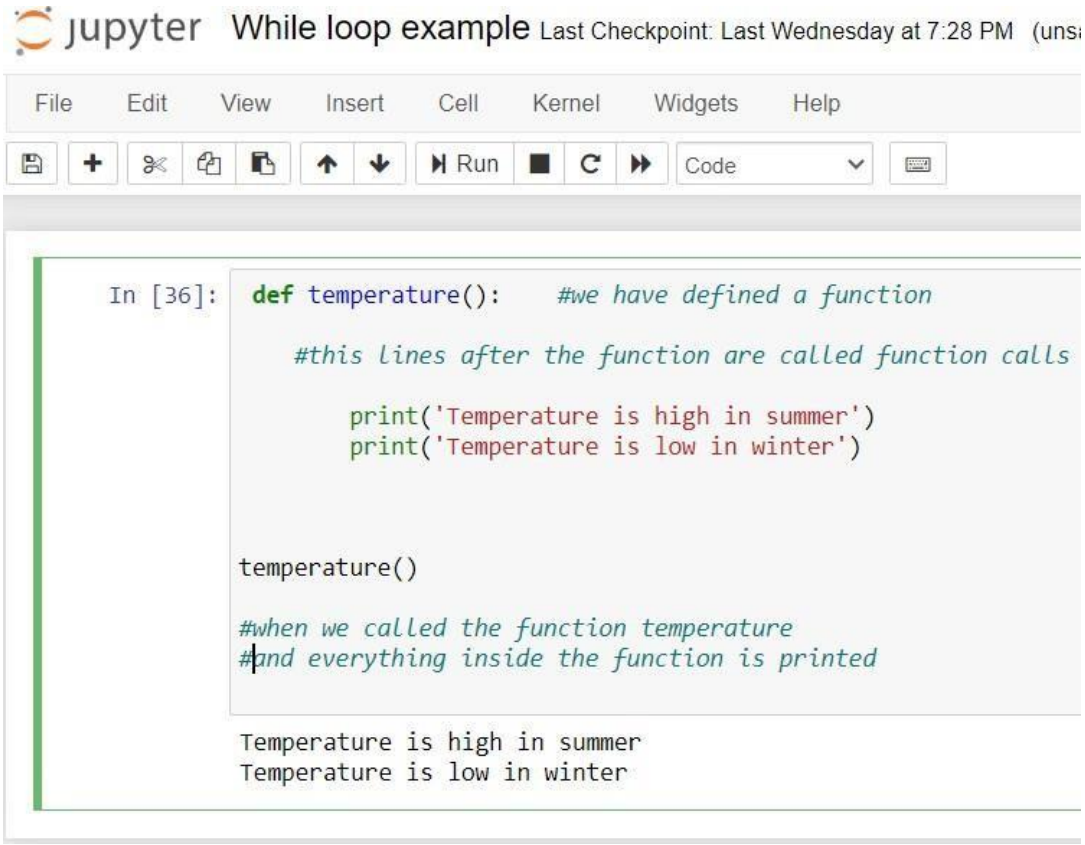
Figure 2.10: packages example [10]

- **Functions**

A function is a python code which can be reused at any anytime in the whole python code. Function performs specific task whenever it is called during the program.With the help of function the program is divided in to multiple codes.

- **Built in functions** - The functions which are already in the python programming and have specific action to perform are called as built in functions. This function are immutable. Some examples of this functions are -
  chr() - used to get string
  print() - used to print an object in terminal min()
  - used to get minimum value interminal

- **User defined functions** - This functions are user to defined functions and it starts with the key word 'def' as shown in the example below. We have defined the function names temperature and its task to be performed when called. Below is the example of it.



Chapter 3

Libraries in Python

Python library is vast. There are built in functions in the library which are written in C language. This library provide access to system functionality such as file input output and that is not accessible to Python programmers. This modules and library provide solution to themany problems in programming.

Following are some Python

libraries.Matplotlib

Pandas

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TensorFlo

wNumpy

Keras

PyTorch

LightGBM

Eli5

SciPy

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Matplotlib

”Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy”[11]. Matlab provides an application that is used in graphical user interface tool kits. Another such libraby is pylab which is almost same as MATLAB.

It is a library for 2D graphics, it finds its application in web application servers, graphicaluser interface toolkit and shell.Below is the example of a basic plot in python.

jupyter Matplotlib basic graph Last Checkpoint: 18 minutes ago (unsaved changes)

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Run Code

In [10]:
```
import matplotlib.pyplot as plt
#we have imported matplotlib library first
#we have imported the pyplot module from matplotlib library
#we have give name 'plt' instead of using whole function name
plt.plot([1,2,3],[1,3,4])
#we used plot function to plot a graph
#we have take simple list in plot function
plt.xlabel('x label') #This function is used to name x axis
plt.ylabel('y label') #This function is used to name y axis
plt.title('basic plot') #This function used for title of grapho
plt.show() #This function show the graph
```

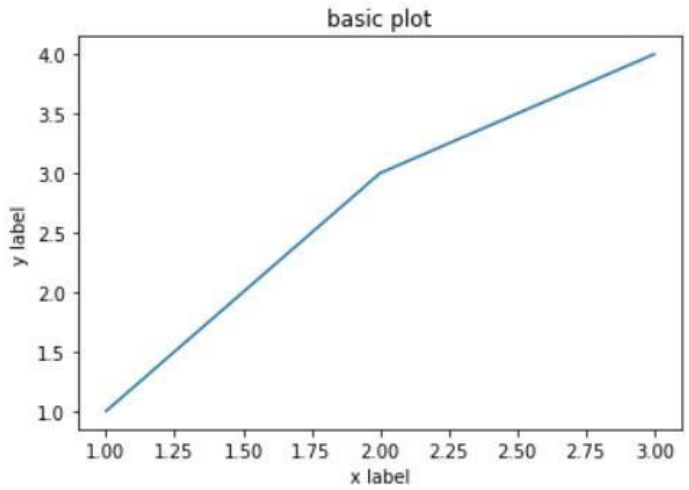

Figure 3.1: Matplotlib basic example

Pandas

Pandas is also a library or a data analysis tool in python which is written in python programming language. It is mostly used for data analysis and data manipulation. It is also used for datastructures and time series.

We can see the application of python in many fields such as - Economics, Recommendation Systems - Spotify, Netflix and Amazon, Stock Prediction, Neuro science, Statistics, Advertising, Analytics, Natural Language Processing. Data can be analyzed in pandas in two ways -

Data frames - In this data is two dimensional and consist of multiple series. Data is always represented in rectangular table.

Series - In this data is one dimensional and consist of single list with index.

jupyter Pandas example (series and data frame) Last Checkpoint:

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Run Code

In [7]:
```
#SERIES
import pandas as pd
#We are first importing the librabry
#and keeping its name as 'pd' for our convenience
odd_numbers = pd.Series([3,9,13,15])
#we have imported series array from pandas
odd_numbers
```

Out[7]:
```
0     3
1     9
2    13
3    15
dtype: int64
```

In [32]:
```
#DATAFRAME - IT HAS TWO OR MORE ARRAYS IN IT
info_stu = {'students':['john','mike','harry','robert'],
     'age':[28,26,29,25],
     'country':['spain','rome','holand','russia']}
#here we have defind our 3 differnet arrays

#then we have imported 'DataFrame' from pandas

info =pd.DataFrame(info_stu)

info

#0,1,2,3 are the index number of different rows
```

Out[32]:

	students	age	country
0	john	28	spain
1	mike	26	rome
2	harry	29	holand
3	robert	25	russia

Figure 3.2: series and data frame in pandas

NumPy

”NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical func- tions to operate on these arrays”. The previous similar programming of NumPy is Numeric, and this language was originally created by Jim Hugunin with contributions from several other developers. In 2005, Travis Oliphant created NumPy by incorporating features of the compet- ingNumarray into Numeric, with extensive modifications. [12] It is an open source library and free ofcost.

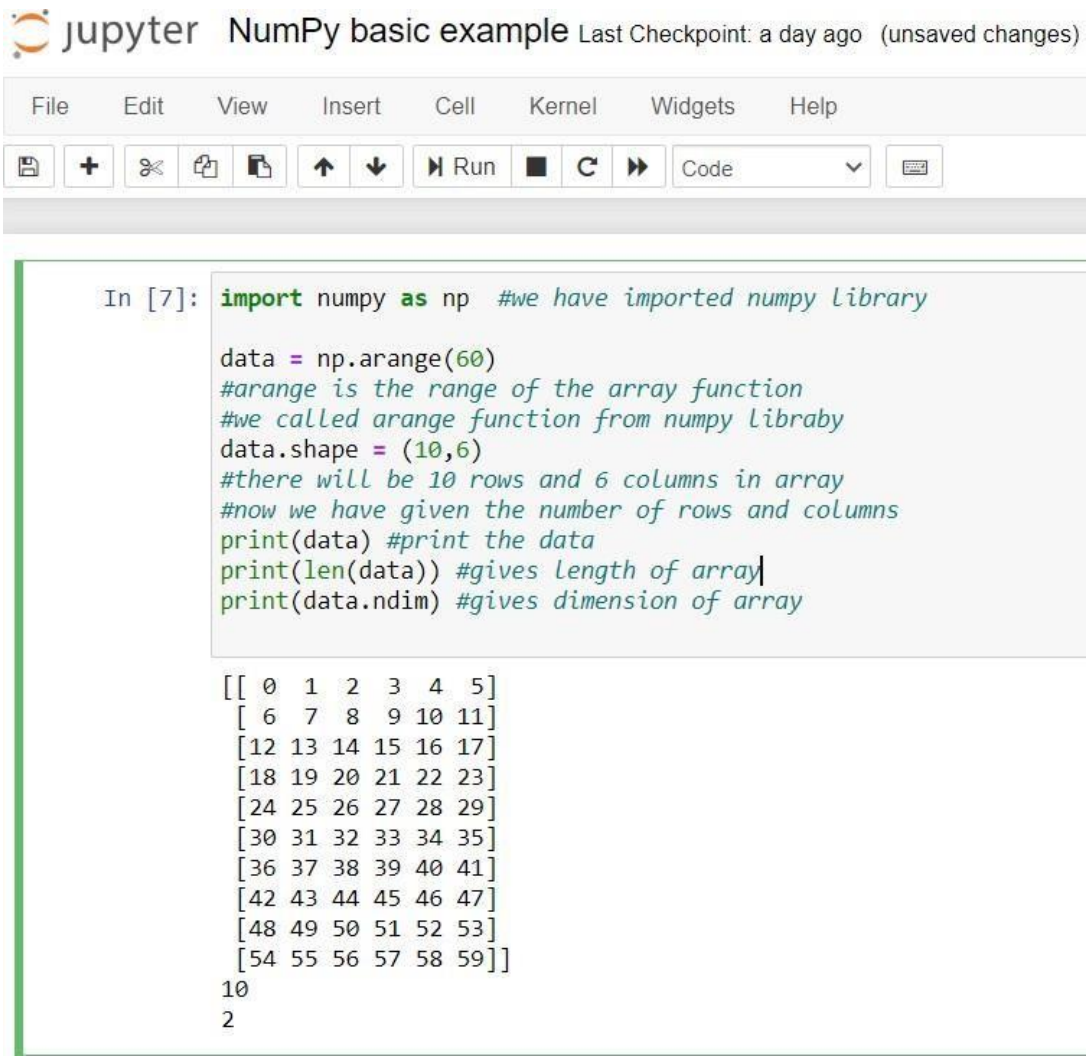


Figure 3.3: NumPy basic example

Chapter 4

Data collection

RED WINE CLASSIFICATION USING REGRESSION

PROCDURE:

• Here first we Imported Library then we loaded wine data then we moved on to check if there is anynull or missing value in the dataset here this wasn't the case we had preprocessed dataset so we moved on to visualize the correlation of the parameter present in the dataset using corr () after that we plotted it using matplotlib and we went to visualize whole dataset using hist () to better insight ofthe dataset.

• There was one minor issue: so first after we visualized data we took Quality of wine and converted itto categorical value (True or False) since we can say that if a wine has quality value over 5 it's a
good vine otherwise it's a not good wine (Here are just classifying wine based on True and False i.e.if it has quality score over 5 and not on values from 3-8) so the next step to change the value of quality.

• After that we can now split our data into training data and testing data and now we use standardscalar to standardize our both data (training as well as testing).

• After we start to build our logistic regression model, then feed our training data and then we moveforward to predictions.

• After predictions are done on testing data now it's time to calculate Accuracy score, Precision,Recall and Confusion matrix**.**

ABOUT DATA:

fixed acidity: most acids involved with wine or fixed or nonvolatile (do not evaporate readily) volatileacidity : the amount of acetic acid in wine, which at too high of levels can lead

to an unpleasant, vinegar taste citric acid : found in small quantities, citric acid can add 'freshness' andflavor to wines residual sugar: the amount of sugar remaining after fermentation

stops, it's rare to find wines with less than 1 gram/liter and chlorides: the amount of salt in the wine freesulfur dioxide: the free form of SO2 exists in equilibrium between molecular

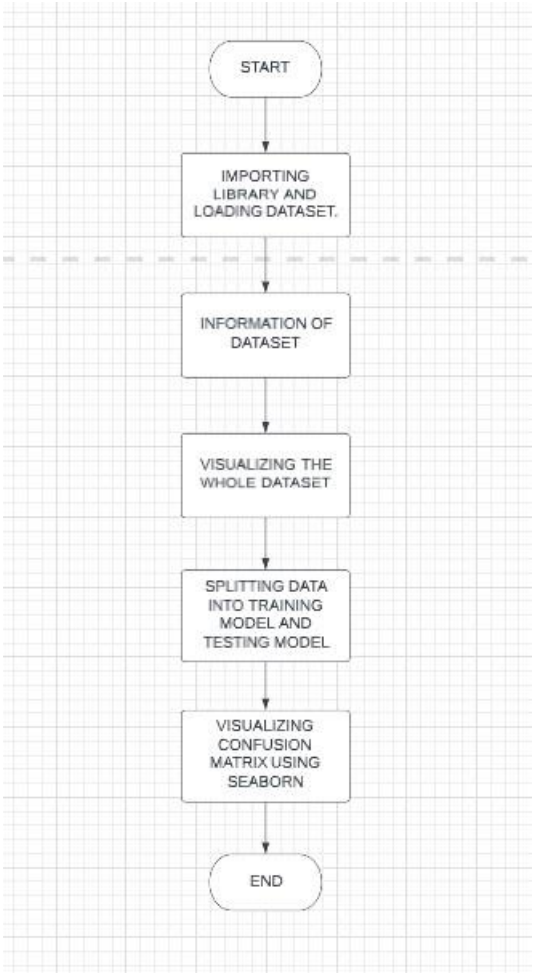
SO2 (as a dissolved gas) and bisulfate ion; it prevents total sulfur dioxide: amount of free and boundforms of S02; in low concentrations, SO2is mostly undetectable in wine, but at free

SO2 density :the density of water is close to that of water depending on the percent alcohol and sugarcontent pH: describes how acidic or basic a wine is on a scale from 0 (very acidic)

to 14 (very basic); most wines are between 3-4 on the sulphates: a wine additive which can contribute tosulfur dioxide gas (S02) levels, which acts as an antimicrobial an alcohol:

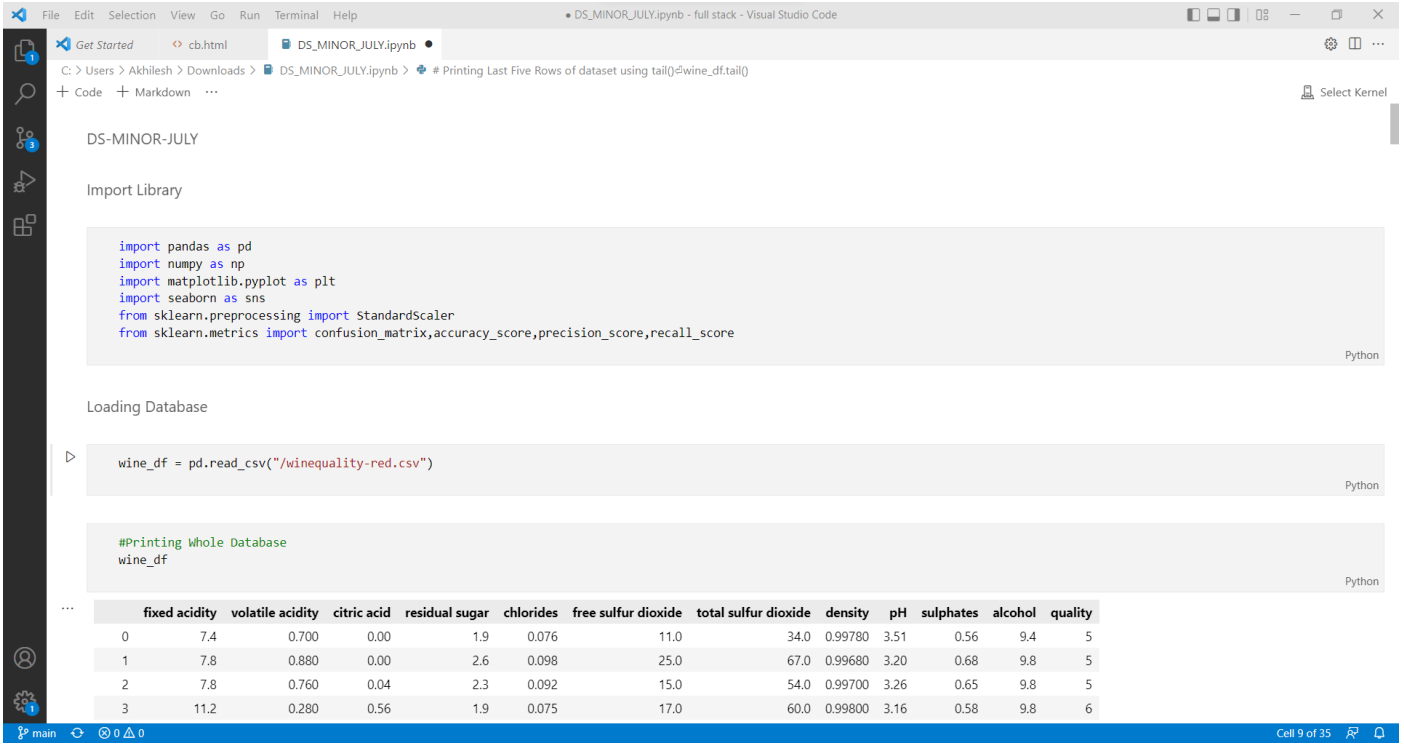
the percent alcohol content of the wine quality: output variable (based on sensory data, score between 0 to 10.

FLOW DIAGRAM OF PROJECT



SNAPSHOTS OF PROJECT:-

1. Importing Library and Loading Database



	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality
0	7.4	0.700	0.00	1.9	0.076	11.0	34.0	0.99780	3.51	0.56	9.4	5
1	7.8	0.880	0.00	2.6	0.098	25.0	67.0	0.99680	3.20	0.68	9.8	5
2	7.8	0.760	0.04	2.3	0.092	15.0	54.0	0.99700	3.26	0.65	9.8	5
3	11.2	0.280	0.56	1.9	0.075	17.0	60.0	0.99800	3.16	0.58	9.8	6

2. Running Some Operations

```python
# Printing First Five Rows of dataset using head()
wine_df.head()
```

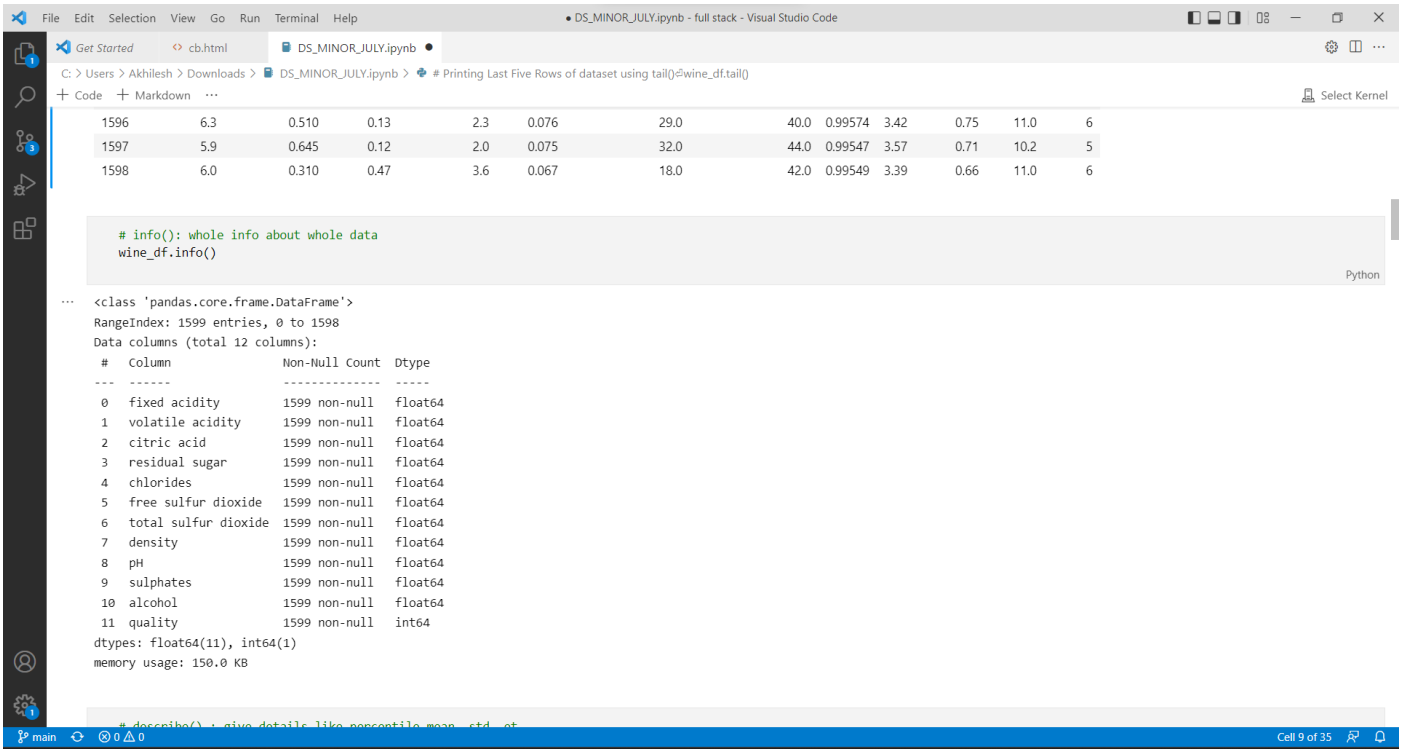
	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality
0	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	5
1	7.8	0.88	0.00	2.6	0.098	25.0	67.0	0.9968	3.20	0.68	9.8	5
2	7.8	0.76	0.04	2.3	0.092	15.0	54.0	0.9970	3.26	0.65	9.8	5
3	11.2	0.28	0.56	1.9	0.075	17.0	60.0	0.9980	3.16	0.58	9.8	6
4	7.4	0.70	0.00	1.9	0.076	11.0	34.0	0.9978	3.51	0.56	9.4	5

```python
# Printing Last Five Rows of dataset using tail()
wine_df.tail()
```

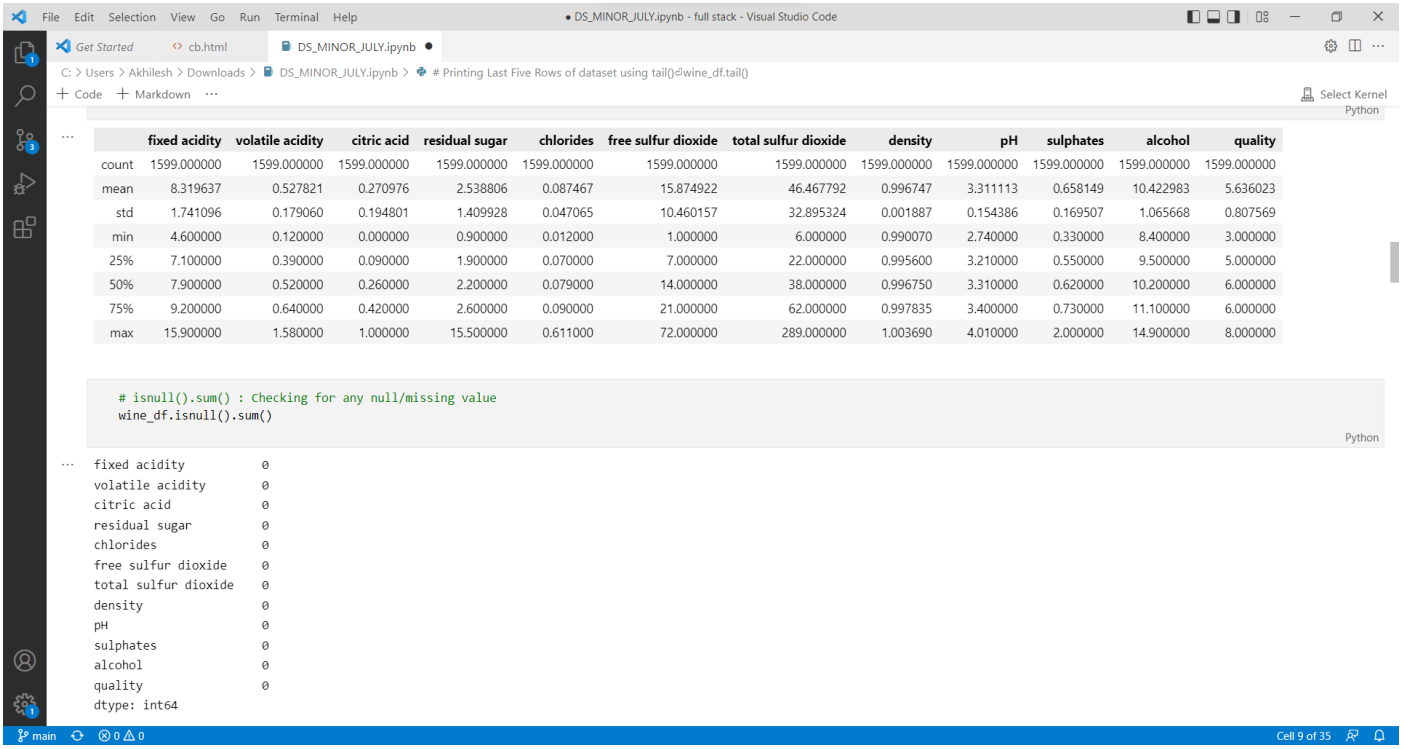
	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality
1594	6.2	0.600	0.08	2.0	0.090	32.0	44.0	0.99490	3.45	0.58	10.5	5
1595	5.9	0.550	0.10	2.2	0.062	39.0	51.0	0.99512	3.52	0.76	11.2	6
1596	6.3	0.510	0.13	2.3	0.076	29.0	40.0	0.99574	3.42	0.75	11.0	6
1597	5.9	0.645	0.12	2.0	0.075	32.0	44.0	0.99547	3.57	0.71	10.2	5
1598	6.0	0.310	0.47	3.6	0.067	18.0	42.0	0.99549	3.39	0.66	11.0	6

```python
# info(): whole info about whole data
wine_df.info()
```

3. Information of Dataset

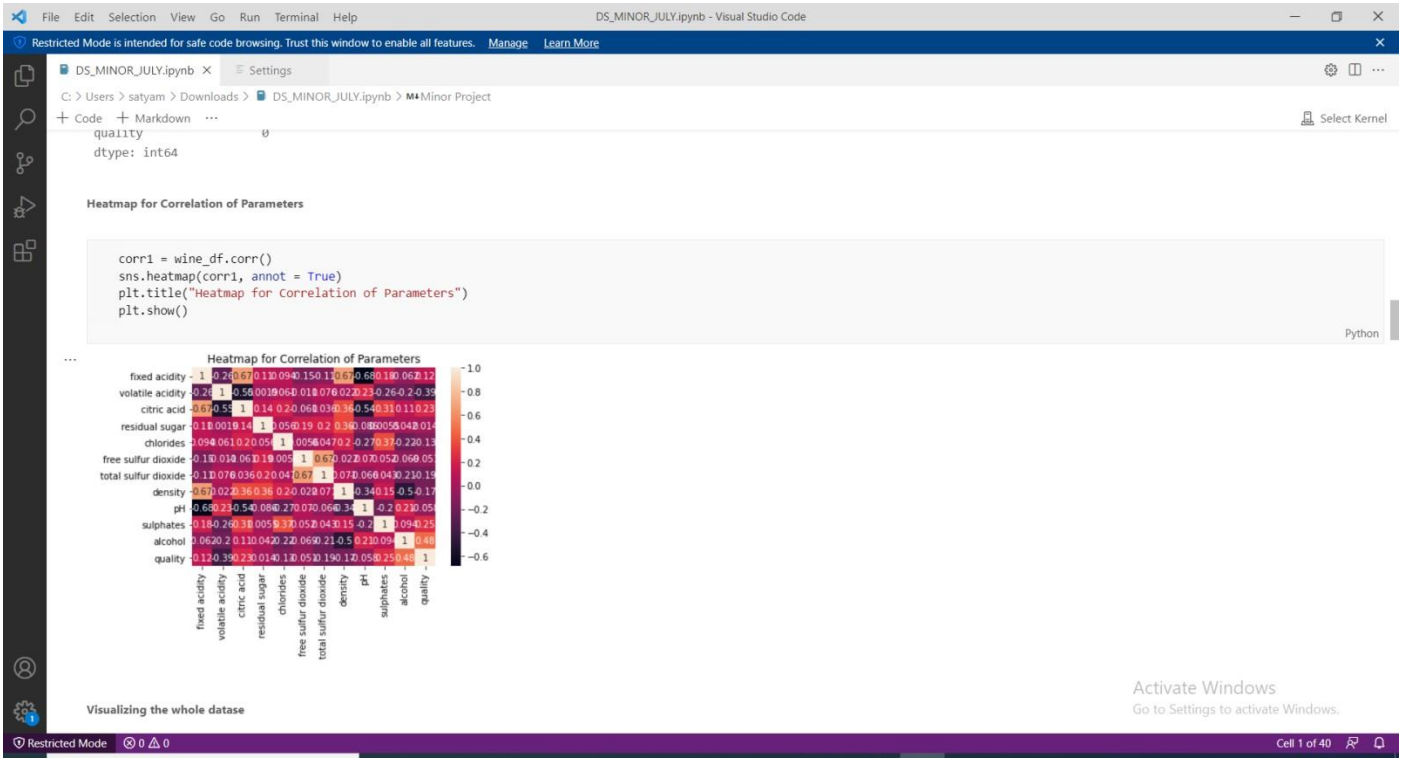


4. Checking for Null Value

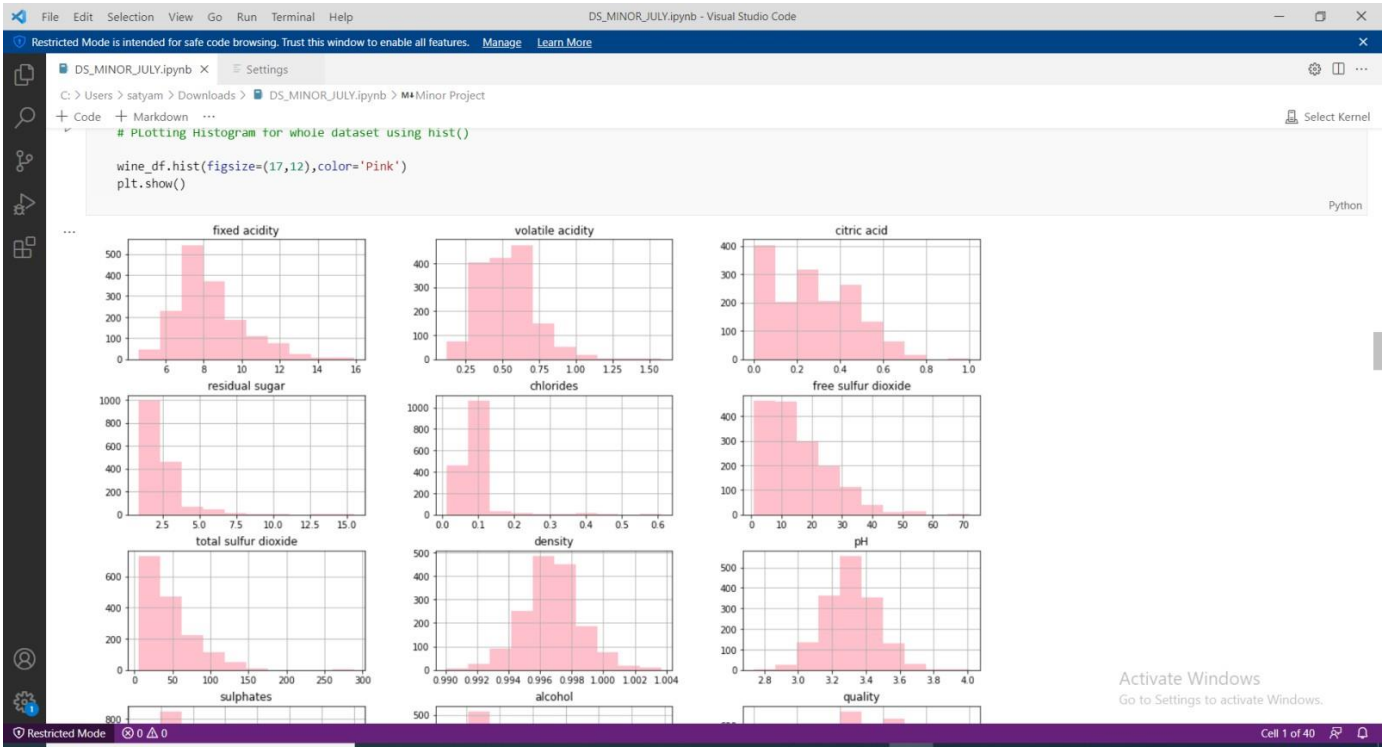


	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	alcohol	quality
count	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000	1599.000000
mean	8.319637	0.527821	0.270976	2.538806	0.087467	15.874922	46.467792	0.996747	3.311113	0.658149	10.422983	5.636023
std	1.741096	0.179060	0.194801	1.409928	0.047065	10.460157	32.895324	0.001887	0.154386	0.169507	1.065668	0.807569
min	4.600000	0.120000	0.000000	0.900000	0.012000	1.000000	6.000000	0.990070	2.740000	0.330000	8.400000	3.000000
25%	7.100000	0.390000	0.090000	1.900000	0.070000	7.000000	22.000000	0.995600	3.210000	0.550000	9.500000	5.000000
50%	7.900000	0.520000	0.260000	2.200000	0.079000	14.000000	38.000000	0.996750	3.310000	0.620000	10.200000	6.000000
75%	9.200000	0.640000	0.420000	2.600000	0.090000	21.000000	62.000000	0.997835	3.400000	0.730000	11.100000	6.000000
max	15.900000	1.580000	1.000000	15.500000	0.611000	72.000000	289.000000	1.003690	4.010000	2.000000	14.900000	8.000000

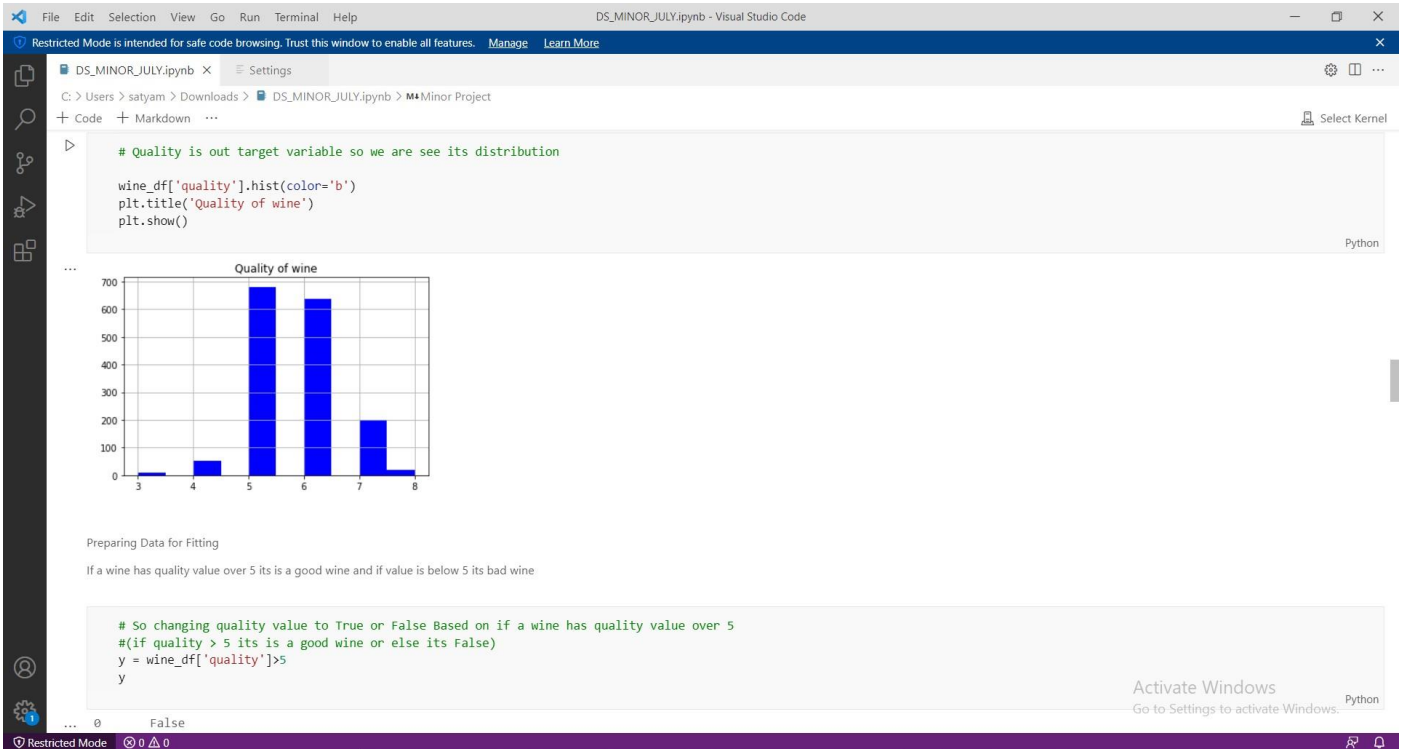
5. HeatMap for Correlation and Parameters



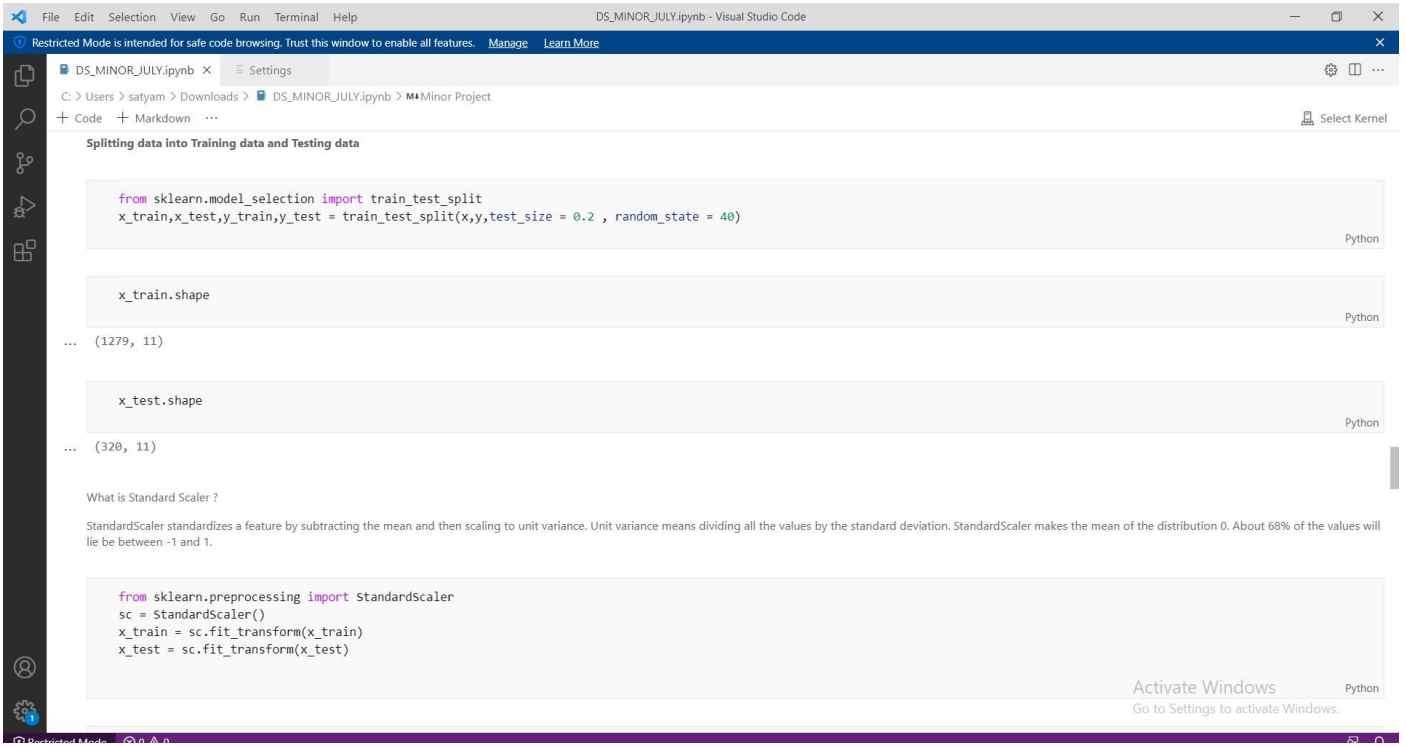
6. Visualizing the Whole Database



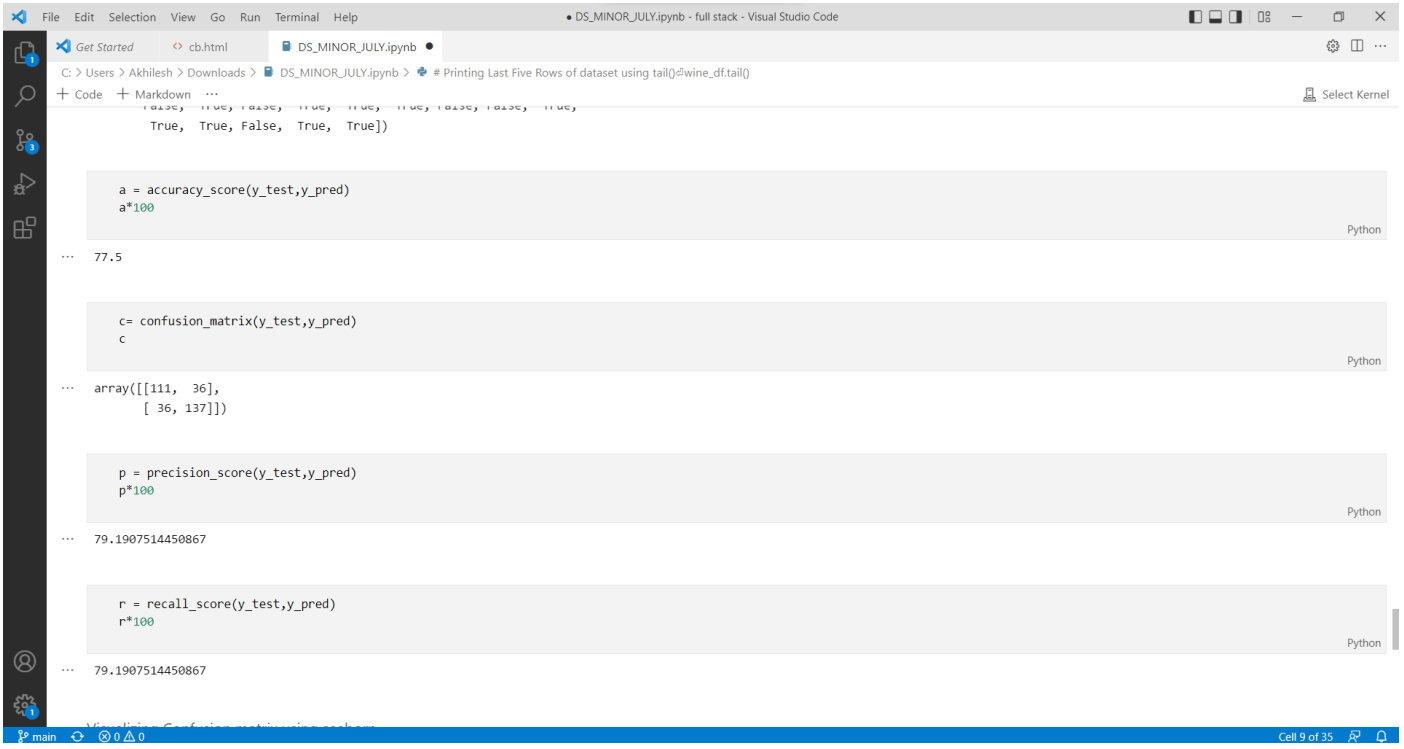
7. Quality Of Wine



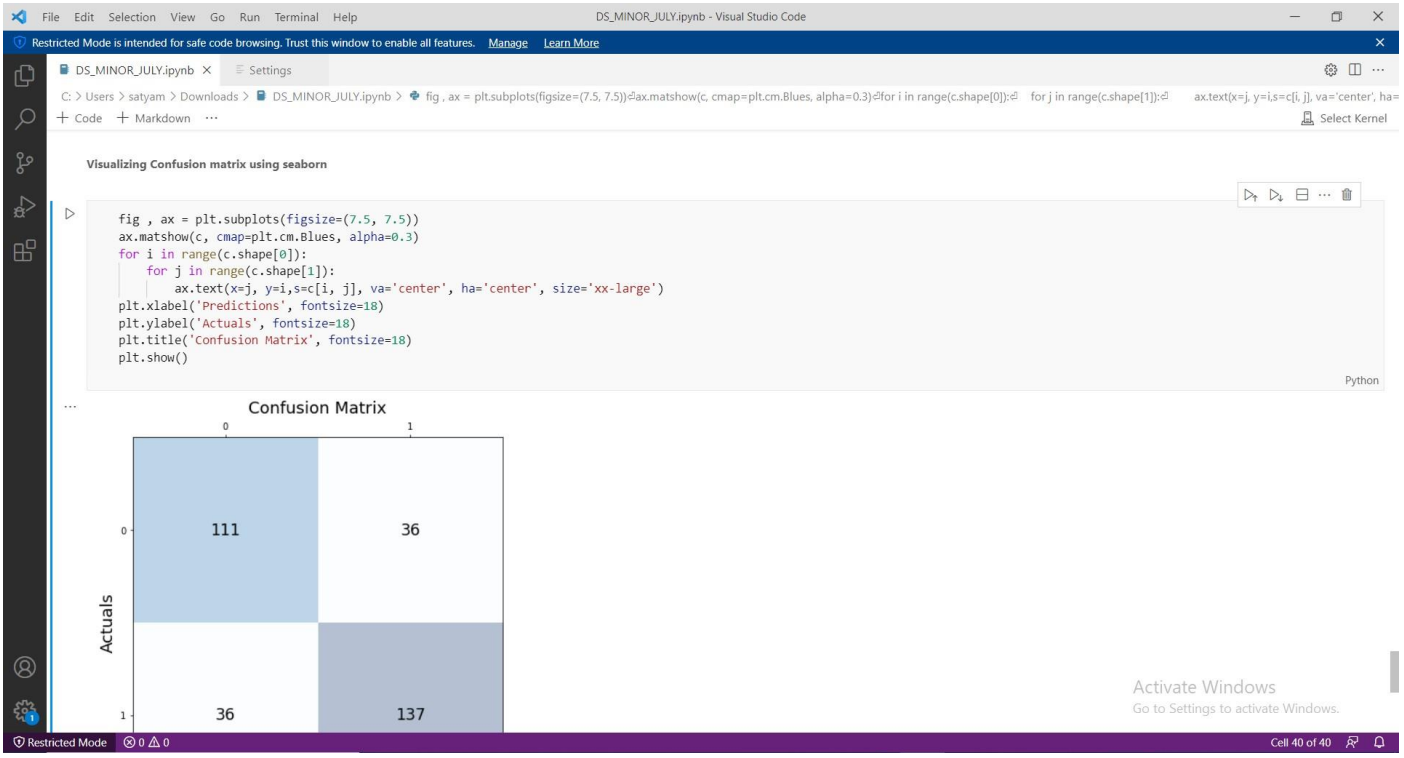
8. Splitting Data into Training Data and Testing Data.



9. Conclusion (Accuracy and precision)



10. Visualizing Confusion Matrix Using Seaborn



CONCLUSION:

Overall our logistic regression model performs quite well with:

- **Accuracy:** 77.5
- **Precision:** 79.1907514450867
- **Recall:** 79.1907514450867

Bibliography:

[1] Data science https://en.wikipedia.org/wiki/Data_science

[2] A book on data science by Dr. Ossama Embarak, https://www.academia.edu/37886932/Data_Analysis_and_Visualization_Using_Python_-_Dr._Ossama_Embarak.pdf

Python website https://www.python.org/doc/essays/blurb/

Matplotlib https://en.wikipedia.org/wiki/Matplotlib

Numpy online https://en.wikipedia.org/wiki/NumPy

https://www.w3schools.com

https://stackoverflow.com