

# Problem Set 4

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## QUESTION 1

Select a subset of relevant attributes from the given dataset that are necessary to know about the total volume of avocados with product lookup codes (PLU) 4046, 4225, 4770) which are of organic type. (Use AVOCADO dataset)

```
In [1]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
```

```
In [2]: Data = pd.read_csv("Avocado Dataset.csv")
Data.head()
```

Out[2]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

```
In [3]: #PLU codes and bag attributes affect total volume
Organic = Data.loc[Data['type']=="organic"] #To select only those tuples with

Organic.reset_index(drop=True,inplace=True)
Organic.head()
```

Out[3]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.83	989.55	8.16	88.59	0.0	892.80	892.80	0.00	0.0	organic	2015	Albany
1	20-12-2015	1.89	1163.03	30.24	172.14	0.0	960.65	960.65	0.00	0.0	organic	2015	Albany
2	13-12-2015	1.85	995.96	10.44	178.70	0.0	806.82	806.82	0.00	0.0	organic	2015	Albany
3	06-12-2015	1.84	1158.42	90.29	104.18	0.0	963.95	948.52	15.43	0.0	organic	2015	Albany
4	29-11-2015	1.94	831.69	0.00	94.73	0.0	736.96	736.96	0.00	0.0	organic	2015	Albany

```
In [4]: #Take only the certain Attributes

Organic = Organic[['Total Volume','4046','4225','4770','Total Bags','Small Bags','Large Bags','XLarge Bags']]

Organic.head()
```

Out[4]:

	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags
0	989.55	8.16	88.59	0.0	892.80	892.80	0.00	0.0

	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags
1	1163.03	30.24	172.14	0.0	960.65	960.65	0.00	0.0
2	995.96	10.44	178.70	0.0	806.82	806.82	0.00	0.0
3	1158.42	90.29	104.18	0.0	963.95	948.52	15.43	0.0
4	831.69	0.00	94.73	0.0	736.96	736.96	0.00	0.0

## QUESTION 2

Discard all duplicate entries in the given dataset and fill all the missing values in the attribute “AveragePrice” as 1.25. Also print the size of the dataset before and after removing duplicates. (Use Trail dataset)

```
In [5]: Data = pd.read_csv("Trail.csv")

#Before Removing Duplicates
print("Size:-"+str(Data.shape[0])+" rows")

Data.head()
```

```
Out[5]: Size:-202 rows
```

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
1	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
2	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
3	22-11-2015	NaN	55979.78	1184.27	48067.99	43.61	6683.91	6556.47	127.44	0.0	conventional	2015	Albany
4	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany

```
In [6]: Data = Data.drop_duplicates()

#After Removing Duplicates
print("Size:-"+str(Data.shape[0])+" rows")

Size:-195 rows
```

```
In [7]: #To show number of missing data
Data.isnull().sum()
```

```
Out[7]: Date      0
AveragePrice    24
Total Volume    0
4046            0
4225            0
4770            0
Total Bags      0
Small Bags      0
Large Bags      0
XLarge Bags     0
type           0
year           0
region         0
dtype: int64
```

```
In [8]: #Fill Missing Values
Data['AveragePrice'].fillna(1.25,inplace=True)
```

```
#To show Missing Values are gone
Data.isnull().sum()
```

```
Out[8]: Date          0
AveragePrice        0
Total Volume        0
4046                0
4225                0
4770                0
Total Bags          0
Small Bags          0
Large Bags          0
XLarge Bags         0
type                0
year                0
region              0
dtype: int64
```

### QUESTION 3

Binarize the attribute “Year”. Set the threshold above 2016 and print it without truncation. (Use AVOCADO dataset)

```
In [9]: Data = pd.read_csv("Avocado Dataset.csv")

Data.head()
```

```
Out[9]:
```

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

```
In [10]: #Using 2016 as the threshold we binarise the "Year" ttribute

Data["year"] = (Data["year"] > 2016).astype(int)

Data.head()
```

```
Out[10]:
```

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	0	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	0	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	0	Albany
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	0	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	0	Albany

### QUESTION 4

Transform all categorical attributes in the dataset AVOCADO using Integer Encoding.

```
In [11]: Data = pd.read_csv("Avocado Dataset.csv")
```

```
Data.head()
```

Out[11]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

In [12]:

```
#Encode attributes type and region

Data['type'] = Data['type'].astype('category')
Data['type'] = Data['type'].cat.codes

Data['region'] = Data['region'].astype('category')
Data['region'] = Data['region'].cat.codes

Data
```

Out[12]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	0	2015	0
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	0	2015	0
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	0	2015	0
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	0	2015	0
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	0	2015	0
...	...	...	...	...	...	...	...	...	...	...	...	...	...
18245	28-01-2018	1.71	13888.04	1191.70	3431.50	0.00	9264.84	8940.04	324.80	0.0	1	2018	53
18246	21-01-2018	1.87	13766.76	1191.92	2452.79	727.94	9394.11	9351.80	42.31	0.0	1	2018	53
18247	14-01-2018	1.93	16205.22	1527.63	2981.04	727.01	10969.54	10919.54	50.00	0.0	1	2018	53
18248	07-01-2018	1.62	17489.58	2894.77	2356.13	224.53	12014.15	11988.14	26.01	0.0	1	2018	53
18249	18-03-2018	1.56	15896.38	2055.35	1499.55	0.00	12341.48	12114.81	226.67	0.0	1	2018	53

18250 rows × 13 columns

## QUESTION 5

Transform the attribute = “Region” in the given dataset AVOCADO using One-Hot Encoding.

In [13]:

```
Data = pd.read_csv("Avocado Dataset.csv")
Data.head()
```

Out[13]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

In [14]:

```
#One Hot Encode in seperate data frame

OneHot = pd.get_dummies(Data.region,prefix="Region")
OneHot['region'] = Data['region']
OneHot.head()
```

Out[14]:

	Region_Albany	Region_Atlanta	Region_BaltimoreWashington	Region_Boise	Region_Boston	Region_BuffaloRochester	Region_California	Region_Charlotte	Region_Chicago	Region_CincinnatiDayton	...	Region_SouthCentral
0	1	0	0	0	0	0	0	0	0	0	...	0
1	1	0	0	0	0	0	0	0	0	0	...	0
2	1	0	0	0	0	0	0	0	0	0	...	0
3	1	0	0	0	0	0	0	0	0	0	...	0
4	1	0	0	0	0	0	0	0	0	0	...	0

5 rows × 55 columns

In [15]:

```
#Join Encoded Attribute to Main Data Frame
for reg in OneHot.columns:
    Data[reg]=OneHot[reg]

Data.head()
```

Out[15]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	...	Region_SouthCarolina	Region_SouthCentral	Region_Southeast	Region_Spokane	Region_StLouis	Region_Syracuse	Region_1
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	...	0	0	0	0	0	0	
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	...	0	0	0	0	0	0	
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	...	0	0	0	0	0	0	
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	...	0	0	0	0	0	0	
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	...	0	0	0	0	0	0	

5 rows × 67 columns

QUESTION 6

Ignore the tuples that hold missing values and print the subset of data from AVOCADO dataset.

```
In [16]: Data = pd.read_csv("Avocado Dataset.csv")
Data.head()
```

Out[16]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

```
In [17]: #Numberof Missing Data Tuples
Data.isnull().sum()
```

Out[17]:

Date	0
AveragePrice	28
Total Volume	0
4046	0
4225	0
4770	0
Total Bags	0
Small Bags	0
Large Bags	0
XLarge Bags	0
type	0
year	0
region	0

dtype: int64

```
In [18]: #Ignore tuples with missing data

Data.dropna(axis=0,how='any',inplace=True)

Data.isnull().sum()
```

Out[18]:

Date	0
AveragePrice	0
Total Volume	0
4046	0
4225	0
4770	0
Total Bags	0
Small Bags	0
Large Bags	0
XLarge Bags	0
type	0
year	0
region	0

dtype: int64

QUESTION 7

Drop the attribute that has high nullity as it facilitates efficient prediction.

```
In [19]: Data = pd.read_csv("Avocado Dataset.csv")
Data.head()
```

Out[19]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

In [20]:

```
Data.isnull().sum()
```

Out[20]:

```
Date      0
AveragePrice  28
Total Volume  0
4046      0
4225      0
4770      0
Total Bags  0
Small Bags  0
Large Bags  0
XLarge Bags 0
type       0
year       0
region     0
dtype: int64
```

In [21]:

```
#Drop Columns with missing data

Data.dropna(axis=1,how='any',inplace=True)

Data.isnull().sum()
```

Out[21]:

```
Date      0
Total Volume  0
4046      0
4225      0
4770      0
Total Bags  0
Small Bags  0
Large Bags  0
XLarge Bags 0
type       0
year       0
region     0
dtype: int64
```

QUESTION 8

Study the entire dataset and report the complete statistical summary about the data (Use AVOCADO dataset)

- Dimension of the dataset
- Most frequently occurring value under every attribute.
- Datatype of every attribute
- Count
- Mean
- Standard Deviation
- Minimum Value

- Maximum value
- 25% (Lower Quartile)
- Median i.e. 50%
- 75% (Upper Quartile)
- Find whether the class distribution of dataset is imbalanced. (Note: Fix the class label as "Type" in the given dataset)
- Correlation matrix
- Skewness of every attribute.

In [22]:

```
Data = pd.read_csv("Avocado Dataset.csv")
Data.head()
```

Out[22]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

In [23]:

```
# Dimensions
Data.shape
```

Out[23]: (18250, 13)

In [24]:

```
# Most frequently occurring value under every attribute

for attr in Data.columns:
    print(attr+ " = " + str(Data[attr].mode()[0]))
```

Date= 18-03-2018  
AveragePrice= 1.15  
Total Volume= 2038.99  
4046= 0.0  
4225= 0.0  
4770= 0.0  
Total Bags= 0.0  
Small Bags= 0.0  
Large Bags= 0.0  
XLarge Bags= 0.0  
type= conventional  
year= 2017  
region= Albany

In [25]:

```
# Count
Data.apply(pd.Series.value_counts)
```

Out[25]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region	
	0.0	NaN	NaN	NaN	242.0	61.0	5498.0	15.0	159.0	2370.0	12049.0	NaN	NaN	NaN
	0.83	NaN	NaN	NaN	NaN	NaN	1.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN
	0.97	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	1.0	NaN	NaN	NaN	NaN
	1.0	NaN	NaN	NaN	8.0	NaN	3.0	NaN	NaN	NaN	1.0	NaN	NaN	NaN
	1.01	NaN	NaN	NaN	NaN	NaN	1.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN



	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
	...	...	...	...	...	...	...	...	...	...	...	...	...
WestTexNewMexico	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	336.0
conventional	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	9126.0	NaN	NaN
na	NaN	2.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
nil	NaN	1.0	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN
organic	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	9124.0	NaN	NaN

116354 rows × 13 columns

In [26]:

```
# Mean
Data.mean()
```

Out[26]: Total Volume 850598.273413  
4046 292992.481896  
4225 295138.477670  
4770 22838.484500  
Total Bags 239626.747390  
Small Bags 182185.367250  
Large Bags 54335.123135  
XLarge Bags 3106.256292  
year 2016.148000  
dtype: float64

In [27]:

```
#Standard Deviation
Data.std()
```

Out[27]: Total Volume 3.453456e+06  
4046 1.264956e+06  
4225 1.204089e+06  
4770 1.074613e+05  
Total Bags 9.862168e+05  
Small Bags 7.461591e+05  
Large Bags 2.439596e+05  
XLarge Bags 1.769242e+04  
year 9.400127e-01  
dtype: float64

In [28]:

```
#Minimum
Data.min()
```

Out[28]: Date 01-01-2017  
Total Volume 84.56  
4046 0.0  
4225 0.0  
4770 0.0  
Total Bags 0.0  
Small Bags 0.0  
Large Bags 0.0  
XLarge Bags 0.0  
type conventional  
year 2015  
region Albany  
dtype: object

In [29]:

```
#Maximum
Data.max()
```

Out[29]: Date 31-12-2017  
Total Volume 62505646.52  
4046 22743616.17  
4225 20470572.61  
4770 2546439.11  
Total Bags 19373134.37  
Small Bags 13384586.8  
Large Bags 5719096.61  
XLarge Bags 551693.65  
type organic  
year 2018  
region WestTexNewMexico  
dtype: object

```
In [30]: #25% (Lower Quartile)
# Median i.e. 50%
# 75% (Upper Quartile)

Quant = Data.quantile([0.25,0.5,0.75])
print("0.25 = LOWER QUARTILE , 0.5= MEDIAN , 0.75 =UPPER QUARTILE ")
Quant
```

0.25 = LOWER QUARTILE , 0.5= MEDIAN , 0.75 =UPPER QUARTILE

Out[30]:

	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	year
0.25	10839.6275	854.2100	3008.0975	0.000	5089.0825	2850.3225	127.580	0.0000	2015.0
0.50	107365.5050	8643.2000	29058.8750	184.975	39741.1800	26351.6150	2647.270	0.0000	2016.0
0.75	432952.6650	111008.7125	150166.3350	6242.055	110781.1150	83336.2100	22018.275	132.4325	2017.0

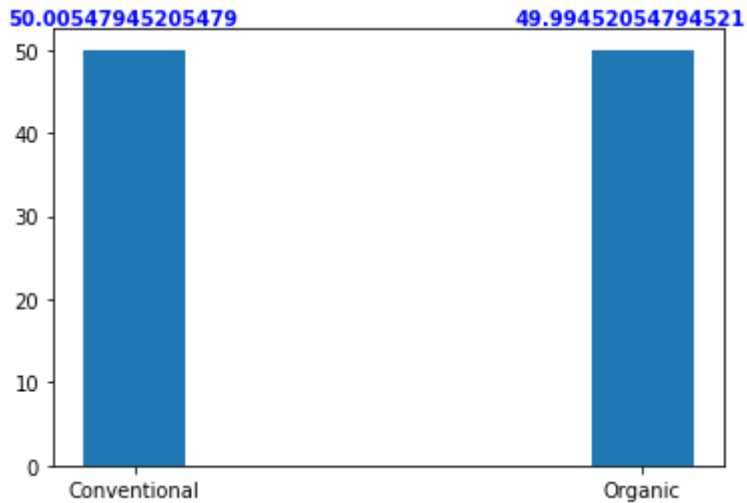
```
In [31]: #If class is imbalanced or not

typ = Data.type.value_counts()
typ = typ/typ.sum() * 100
x = ["Conventional","Organic"]

plt.bar( x, typ ,width=0.2)

for i, v in enumerate(typ):
    plt.text(i-0.25, v + 3, str(v), color='blue', fontweight='bold')

plt.show()
```



```
In [32]: # dataset is balanced
```

```
In [33]: #Correlation Matrix

Data.corr()
```

Out[33]:

	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	year
Total Volume	1.000000	0.977863	0.974181	0.872203	0.963047	0.967238	0.880640	0.747158	0.017165
4046	0.977863	1.000000	0.926110	0.833390	0.920057	0.925280	0.838645	0.699378	0.003328
4225	0.974181	0.926110	1.000000	0.887855	0.905788	0.916031	0.810016	0.688809	-0.009584
4770	0.872203	0.833390	0.887855	1.000000	0.792315	0.802733	0.698472	0.679862	-0.036550
Total Bags	0.963047	0.920057	0.905788	0.792315	1.000000	0.994335	0.943009	0.804233	0.071520
Small Bags	0.967238	0.925280	0.916031	0.802733	0.994335	1.000000	0.902589	0.806845	0.063883
Large Bags	0.880640	0.838645	0.810016	0.698472	0.943009	0.902589	1.000000	0.710859	0.087858
XLarge Bags	0.747158	0.699378	0.688809	0.679862	0.804233	0.806845	0.710859	1.000000	0.081005
year	0.017165	0.003328	-0.009584	-0.036550	0.071520	0.063883	0.087858	0.081005	1.000000

```
In [34]: #Skewness of each attribute

Data.skew()
```

Out[34]:

Total Volume	9.007930
4046	8.648456
4225	8.942706
4770	10.159671
Total Bags	9.756334
Small Bags	9.540917
Large Bags	9.796719
XLarge Bags	13.140106
year	0.215371

dtype: float64

QUESTION 9

The following dataset has been chosen from kaggle, and does not require and preprocessing for cleaning, encoding and imputation for the decision tree model. It is an already preprocessed dataset.

```
In [35]: df = pd.read_csv('diabetes.csv')
df.head()
```

Out[35]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
0	6	148	72	35	0	33.6	0.627	50	1
1	1	85	66	29	0	26.6	0.351	31	0
2	8	183	64	0	0	23.3	0.672	32	1
3	1	89	66	23	94	28.1	0.167	21	0
4	0	137	40	35	168	43.1	2.288	33	1

```
In [36]: df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 768 entries, 0 to 767
Data columns (total 9 columns):
```

```
#      Column      Non-Null Count  Dtype
---  -
0     Pregnancies    768 non-null    int64
1     Glucose        768 non-null    int64
2     BloodPressure   768 non-null    int64
3     SkinThickness    768 non-null    int64
4     Insulin          768 non-null    int64
5     BMI              768 non-null    float64
6     DiabetesPedigreeFunction  768 non-null    float64
7     Age              768 non-null    int64
8     Outcome          768 non-null    int64
dtypes: float64(2), int64(7)
memory usage: 54.1 KB
```

```
In [37]: df.describe()
```

Out[37]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
count	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000
mean	3.845052	120.894531	69.105469	20.536458	79.799479	31.992578	0.471876	33.240885	0.348958
std	3.369578	31.972618	19.355807	15.952218	115.244002	7.884160	0.331329	11.760232	0.476951
min	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.078000	21.000000	0.000000
25%	1.000000	99.000000	62.000000	0.000000	0.000000	27.300000	0.243750	24.000000	0.000000
50%	3.000000	117.000000	72.000000	23.000000	30.500000	32.000000	0.372500	29.000000	0.000000
75%	6.000000	140.250000	80.000000	32.000000	127.250000	36.600000	0.626250	41.000000	1.000000
max	17.000000	199.000000	122.000000	99.000000	846.000000	67.100000	2.420000	81.000000	1.000000

```
In [38]: df.isnull().sum()
```

```
Out[38]: Pregnancies      0
Glucose      0
BloodPressure  0
SkinThickness  0
Insulin      0
BMI          0
DiabetesPedigreeFunction  0
Age          0
Outcome      0
dtype: int64
```

```
In [39]: # Seperating target(dependent) from features(independent)
target = ['Outcome']
features = list(set(df.columns) - set(target))
features
```

```
Out[39]: ['Age',
'SkinThickness',
'Pregnancies',
'BMI',
'Insulin',
'Glucose',
'DiabetesPedigreeFunction',
'BloodPressure']
```

```
In [40]: X = df[features]
y = df[target]
```

```
In [41]: from sklearn.tree import DecisionTreeClassifier
        from sklearn.model_selection import train_test_split
        from sklearn import metrics
```

Since we would be using different selection parameters while building the decision tree, we need to split the dataset into train and test datasets, to fit using the training set and evaluate the accuracy of the model using the test set.

```
In [42]: ## Splitting the dataset into train and test datasets, for the model to fit and predict
        X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=1)
```

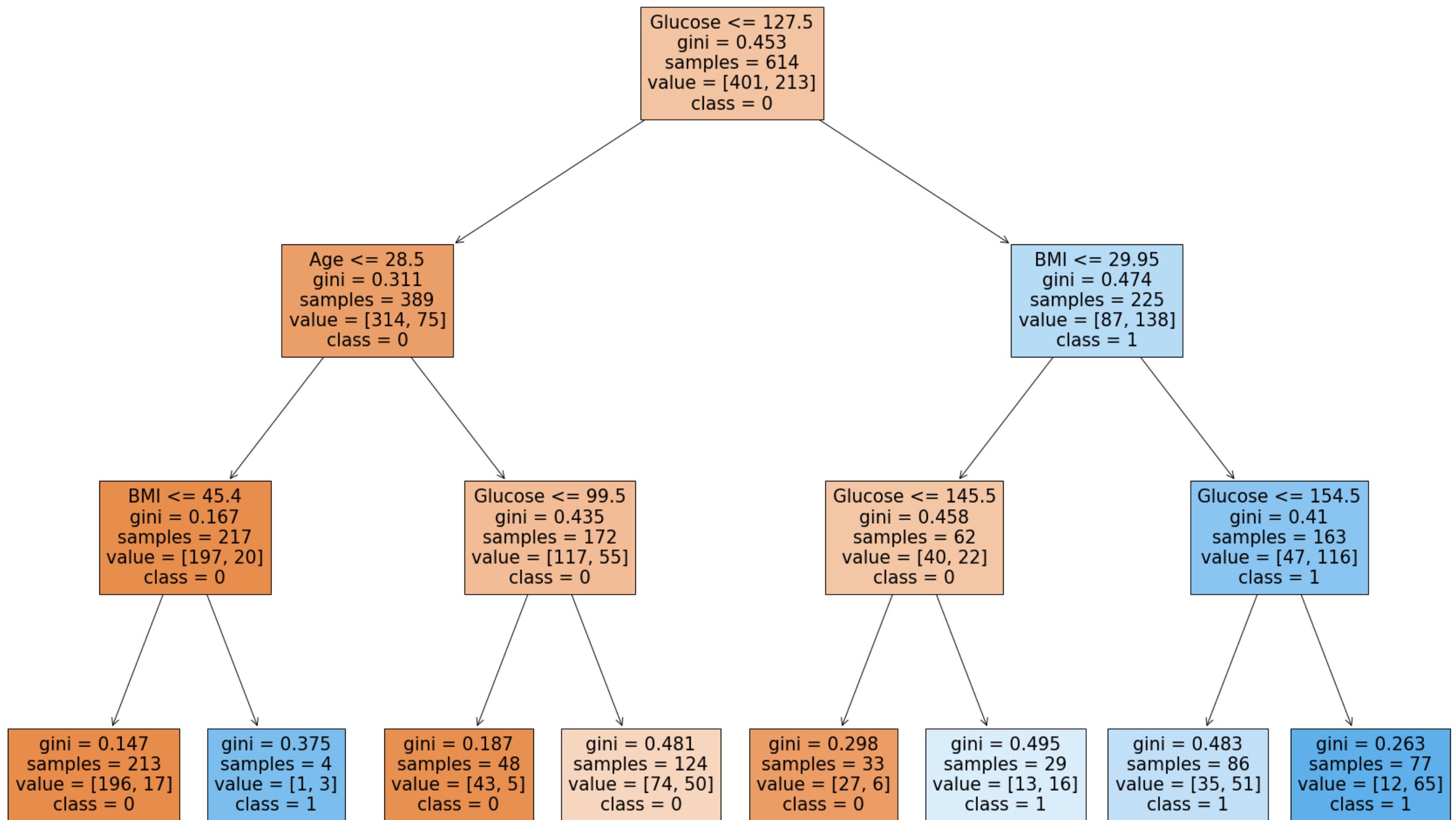
```
In [43]: #Using gini index for information gain
```

```
In [44]: model = DecisionTreeClassifier(criterion="gini", max_depth=3)
        model.fit(X_train,y_train)
        y_pred = model.predict(X_test)
```

```
In [45]: print(f'For gini index as selection parameter, the accuracy is {metrics.accuracy_score(y_test, y_pred)}')
```

For gini index as selection parameter, the accuracy is 0.7857142857142857

```
In [46]: #printing the decision tree
        from sklearn.tree import plot_tree
        fig = plt.figure(figsize=(30,20))
        _ = plot_tree(model, feature_names=features, class_names=['0','1'], filled=True)
```

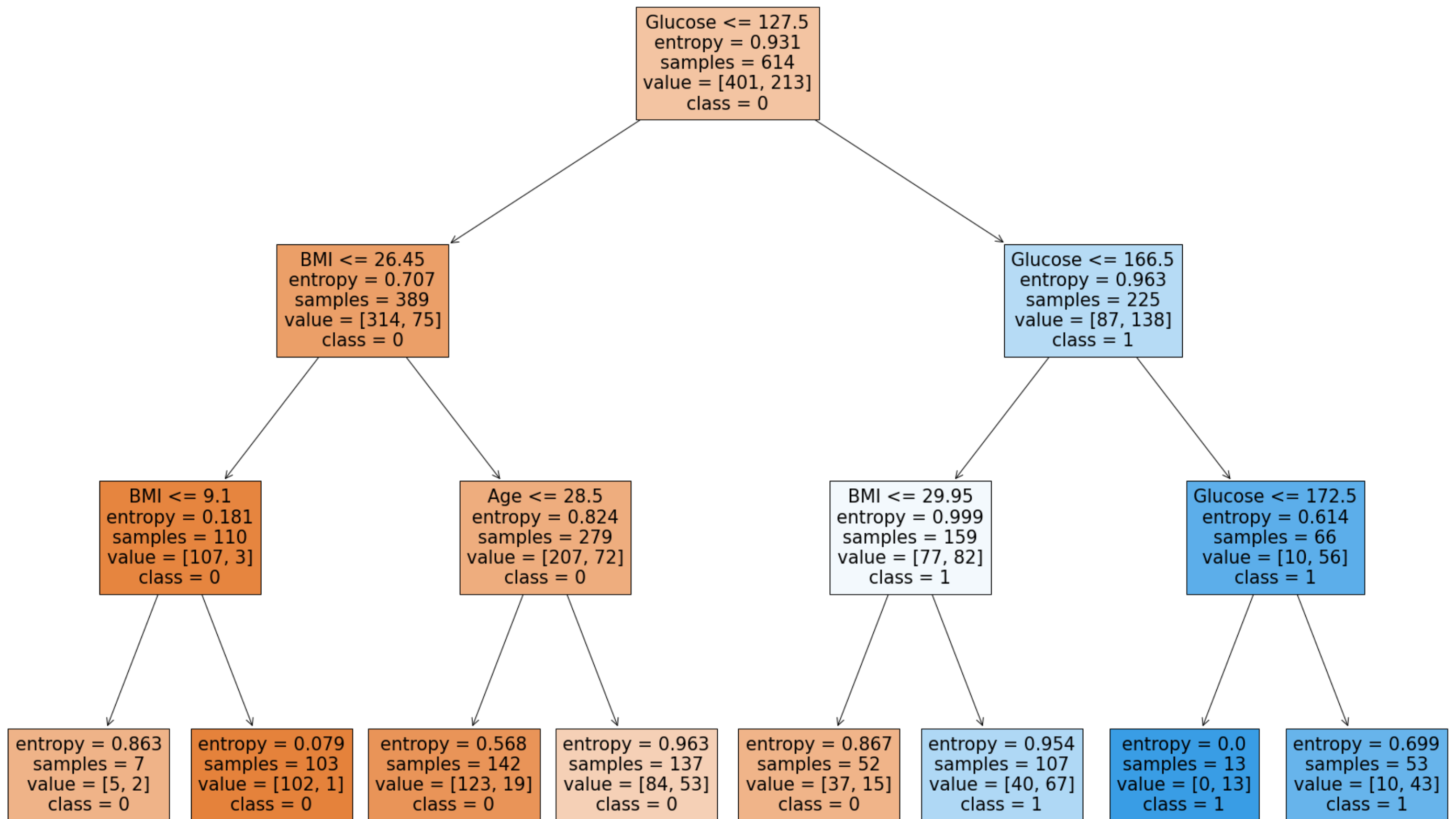


```
In [47]: #Using entropy for information gain
model = DecisionTreeClassifier(criterion="entropy", max_depth=3)
model.fit(X_train,y_train)
y_pred = model.predict(X_test)
```

```
In [48]: print(f'For entropy index as selection parameter, the accuracy is {metrics.accuracy_score(y_test, y_pred)}')
```

For entropy index as selection parameter, the accuracy is 0.7987012987012987

```
In [49]: #printing the decision tree
from sklearn.tree import plot_tree
fig = plt.figure(figsize=(30,20))
_ = plot_tree(model, feature_names=features, class_names=['0','1'], filled=True)
```



## QUESTION 10

```
In [50]: df = pd.read_csv('Avocado Dataset.csv')
df.head()
```



Out[50]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	27-12-2015	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	20-12-2015	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	13-12-2015	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	06-12-2015	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	29-11-2015	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

In [51]:

```
df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 18250 entries, 0 to 18249
Data columns (total 13 columns):
#   Column          Non-Null Count  Dtype
---  ---
0   Date            18250 non-null  object
1   AveragePrice    18222 non-null  object
2   Total Volume    18250 non-null  float64
3   4046            18250 non-null  float64
4   4225            18250 non-null  float64
5   4770            18250 non-null  float64
6   Total Bags      18250 non-null  float64
7   Small Bags      18250 non-null  float64
8   Large Bags      18250 non-null  float64
9   XLarge Bags     18250 non-null  float64
10  type            18250 non-null  object
11  year            18250 non-null  int64
12  region          18250 non-null  object
dtypes: float64(8), int64(1), object(4)
memory usage: 1.8+ MB
```

Target feature is AveragePrice, but it is of type object. We have to first convert it to float64. Furthermore, we can convert the Date feature to datetime for our convenience.

In [52]:

```
df['AveragePrice'] = pd.to_numeric(df['AveragePrice'],errors = 'coerce')
df['Date'] = pd.to_datetime(df['Date'])
df.head()
```

Out[52]:

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	2015-12-27	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	2015-12-20	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	2015-12-13	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	2015-06-12	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	2015-11-29	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

In [53]:

```
df.info()

<class 'pandas.core.frame.DataFrame'>
RangeIndex: 18250 entries, 0 to 18249
Data columns (total 13 columns):
#   Column          Non-Null Count  Dtype
---  ---
0   Date            18250 non-null  datetime64[ns]
1   AveragePrice    18202 non-null  float64
2   Total Volume    18250 non-null  float64
3   4046            18250 non-null  float64
4   4225            18250 non-null  float64
5   4770            18250 non-null  float64
```

```
6   Total Bags      18250 non-null float64
7   Small Bags      18250 non-null float64
8   Large Bags      18250 non-null float64
9   XLarge Bags     18250 non-null float64
10  type            18250 non-null object
11  year            18250 non-null int64
12  region          18250 non-null object
dtypes: datetime64[ns](1), float64(9), int64(1), object(2)
memory usage: 1.8+ MB
```

```
In [54]: l1 = df['AveragePrice'].isnull().sum()
l2 = df.shape[0]
print(f'Percentage of null rows in the dataset is {(l2-l1)/l2:.8f}')
```

Percentage of null rows in the dataset is 0.99736986

We see that less than 1 percent of the dataset has null values in rows. Thus, we can comfortably drop these rows for further analysis.

```
In [55]: df.dropna(inplace=True)
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 18202 entries, 0 to 18249
Data columns (total 13 columns):
#   Column      Non-Null Count  Dtype
---  -
0   Date        18202 non-null  datetime64[ns]
1   AveragePrice 18202 non-null  float64
2   Total Volume 18202 non-null  float64
3   4046         18202 non-null  float64
4   4225         18202 non-null  float64
5   4770         18202 non-null  float64
6   Total Bags   18202 non-null  float64
7   Small Bags   18202 non-null  float64
8   Large Bags   18202 non-null  float64
9   XLarge Bags  18202 non-null  float64
10  type         18202 non-null  object
11  year         18202 non-null  int64
12  region       18202 non-null  object
dtypes: datetime64[ns](1), float64(9), int64(1), object(2)
memory usage: 1.9+ MB
```

We see that the `Total Bags` should be equal to the sum of `Large Bags` , `Small Bags` and `XLarge Bags` for every record.

```
In [56]: df.shape[0] - (df['Total Bags'] == df['Large Bags'] + df['Small Bags'] + df['XLarge Bags']).sum()
```

Out[56]: 4028

There are 4036 records that do not follow this consistency. So we need to rectify these records.

```
In [57]: df['Total Bags'] = df['Large Bags'] + df['Small Bags'] + df['XLarge Bags']
```

```
In [58]: df.shape[0] - (df['Total Bags'] == df['Large Bags'] + df['Small Bags'] + df['XLarge Bags']).sum()
```

Out[58]: 0

```
In [59]: df.head()
```

```
Out[59]:
```

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
--	------	--------------	--------------	------	------	------	------------	------------	------------	-------------	------	------	--------

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	2015-12-27	1.33	64236.62	1036.74	54454.85	48.16	8696.87	8603.62	93.25	0.0	conventional	2015	Albany
1	2015-12-20	1.35	54876.98	674.28	44638.81	58.33	9505.56	9408.07	97.49	0.0	conventional	2015	Albany
2	2015-12-13	0.93	118220.22	794.70	109149.67	130.50	8145.35	8042.21	103.14	0.0	conventional	2015	Albany
3	2015-06-12	1.08	78992.15	1132.00	71976.41	72.58	5811.16	5677.40	133.76	0.0	conventional	2015	Albany
4	2015-11-29	1.29	51039.60	941.48	43838.39	75.78	6183.95	5986.26	197.69	0.0	conventional	2015	Albany

We will use Z-score normalization for normalizing the Large Bags, Small Bags, XLarge Bags and Total Bags. We could also normalize features such as Total Volume, 4046, 4225, 4770.

```
In [60]: norm_features = ['Total Volume', '4046', '4225', '4770', 'Total Bags', 'Small Bags', 'Large Bags', 'XLarge Bags']
```

```
In [61]: for col in norm_features:
          m = df[col].mean()
          s = df[col].std()
          df[col] = (df[col]-m)/s
```

```
In [62]: df.head()
```

```
Out[62]:
```

	Date	AveragePrice	Total Volume	4046	4225	4770	Total Bags	Small Bags	Large Bags	XLarge Bags	type	year	region
0	2015-12-27	1.33	-0.227812	-0.231097	-0.199756	-0.212175	-0.234327	-0.232758	-0.222626	-0.175808	conventional	2015	Albany
1	2015-12-20	1.35	-0.230519	-0.231383	-0.207898	-0.212080	-0.233508	-0.231681	-0.222609	-0.175808	conventional	2015	Albany
2	2015-12-13	0.93	-0.212201	-0.231288	-0.154389	-0.211410	-0.234885	-0.233510	-0.222586	-0.175808	conventional	2015	Albany
3	2015-06-12	1.08	-0.223545	-0.231022	-0.185222	-0.211948	-0.237249	-0.236675	-0.222460	-0.175808	conventional	2015	Albany
4	2015-11-29	1.29	-0.231629	-0.231172	-0.208562	-0.211918	-0.236872	-0.236262	-0.222199	-0.175808	conventional	2015	Albany

## Question 11

1. Test drive the basic version of Apriori algorithms for Frequent Itemset Mining using the package / library support in the platform of your choice. Test it with various support and confidence measures and generate a time comparison for varied data set sizes. To do the performance comparison you may use benchmark datasets provided for FIM such as the FIMI workshop or other sources

```
In [63]: !pip3 install apyori
```

Requirement already satisfied: apyori in /home/paleti/.local/lib/python3.8/site-packages (1.1.2)

```
In [64]: from mlxtend.frequent_patterns import apriori, association_rules
import csv
```

```
In [65]: # Obtaining the individual transactions
l = [i.strip('\n').split(',') for i in open("store_data.csv").readlines()]
```

```
In [66]: l
```

```
Out[66]: [['shrimp',
          'almonds',
          'avocado',
          'vegetables mix',
```

'green grapes',  
'whole weat flour',  
'yams',  
'cottage cheese',  
'energy drink',  
'tomato juice',  
'low fat yogurt',  
'green tea',  
'honey',  
'salad',  
'mineral water',  
'salmon',  
'antioxydant juice',  
'frozen smoothie',  
'spinach',  
'olive oil'],  
['burgers', 'meatballs', 'eggs'],  
['chutney'],  
['turkey', 'avocado'],  
['mineral water', 'milk', 'energy bar', 'whole wheat rice', 'green tea'],  
['low fat yogurt'],  
['whole wheat pasta', 'french fries'],  
['soup', 'light cream', 'shallot'],  
['frozen vegetables', 'spaghetti', 'green tea'],  
['french fries'],  
['eggs', 'pet food'],  
['cookies'],  
['turkey', 'burgers', 'mineral water', 'eggs', 'cooking oil'],  
['spaghetti', 'champagne', 'cookies'],  
['mineral water', 'salmon'],  
['mineral water'],  
['shrimp',  
'chocolate',  
'chicken',  
'honey',  
'oil',  
'cooking oil',  
'low fat yogurt'],  
['turkey', 'eggs'],  
['turkey',  
'fresh tuna',  
'tomatoes',  
'spaghetti',  
'mineral water',  
'black tea',  
'salmon',  
'eggs',  
'chicken',  
'extra dark chocolate'],  
['meatballs', 'milk', 'honey', 'french fries', 'protein bar'],  
['red wine', 'shrimp', 'pasta', 'pepper', 'eggs', 'chocolate', 'shampoo'],  
['rice', 'sparkling water'],  
['spaghetti', 'mineral water', 'ham', 'body spray', 'pancakes', 'green tea'],  
['burgers',  
'grated cheese',  
'shrimp',  
'pasta',  
'avocado',  
'honey',  
'white wine',  
'toothpaste'],  
['eggs'],  
['parmesan cheese', 'spaghetti', 'soup', 'avocado', 'milk', 'fresh bread'],  
['ground beef',  
'spaghetti',  
'mineral water',  
'milk',  
'energy bar',  
'black tea',

'salmon',  
'frozen smoothie',  
'escalope'],  
['sparkling water'],  
['mineral water', 'eggs', 'chicken', 'chocolate', 'french fries'],  
['frozen vegetables', 'spaghetti', 'yams', 'mineral water'],  
['herb & pepper', 'tomato sauce', 'light cream', 'magazines'],  
['mineral water', 'chocolate', 'avocado', 'eggs'],  
['turkey', 'french fries', 'strawberries'],  
['frozen vegetables', 'strong cheese', 'chocolate'],  
['cookies'],  
['pickles', 'spaghetti', 'salmon', 'escalope'],  
['energy bar', 'french fries'],  
['red wine', 'ground beef', 'mineral water'],  
['mineral water', 'cake', 'cottage cheese'],  
['pickles', 'champagne', 'green tea'],  
['spaghetti'],  
['fresh tuna',  
'frozen vegetables',  
'spaghetti',  
'mineral water',  
'honey',  
'whole wheat rice',  
'frozen smoothie',  
'escalope'],  
['spaghetti'],  
['soup', 'meatballs', 'hot dogs', 'sparkling water'],  
['escalope'],  
['soup',  
'avocado',  
'french fries',  
'hot dogs',  
'brownies',  
'body spray',  
'pancakes',  
'green tea'],  
['mineral water', 'chicken', 'cereals', 'clothes accessories'],  
['mineral water', 'bug spray'],  
['avocado', 'muffins'],  
['burgers', 'black tea', 'green tea'],  
['spaghetti', 'chocolate', 'brownies', 'white wine', 'green tea'],  
['fresh tuna', 'mineral water', 'eggs'],  
['spaghetti', 'muffins'],  
['spaghetti', 'chocolate'],  
['french fries', 'escalope', 'champagne'],  
['tomato sauce', 'light mayo'],  
['turkey',  
'fresh tuna',  
'frozen vegetables',  
'tomatoes',  
'ground beef',  
'spaghetti',  
'mineral water',  
'chocolate',  
'soup',  
'milk',  
'olive oil'],  
['eggs', 'cookies'],  
['soup',  
'chicken',  
'gums',  
'soda',  
'body spray',  
'energy drink',  
'green tea'],  
['turkey',  
'frozen vegetables',  
'mineral water',  
'cider',

'cooking oil',  
'green tea'],  
['spaghetti'],  
['clothes accessories'],  
['energy drink'],  
['soup', 'bug spray', 'shallot', 'protein bar', 'green tea'],  
['turkey', 'eggs'],  
['french fries'],  
['chocolate', 'milk'],  
['herb & pepper',  
'whole wheat pasta',  
'ground beef',  
'mineral water',  
'avocado',  
'cider',  
'whole wheat rice'],  
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In [67]: `print(len(l))`

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```
In [68]: #One Hot Encoding
from mlxtend.preprocessing import TransactionEncoder
ohe = TransactionEncoder()
ohe_rec = ohe.fit(l).transform(l)
df = pd.DataFrame(ohe_rec, columns=ohe.columns_)
df
```

Out[68]:

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...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7496	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
7497	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
7498	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
7499	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
7500	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	True	False

7501 rows × 120 columns

Applying apriori with various confidence and minimum supports

We see that the total number of individual transactions is 7501. If we consider a minimum support of 0.01, 0.05, and 0.08, with confidence being either 0.15, 0.2, 0.25 we get 9 combinations of min\_support and confidence. Here, I have considered 3 out of those 9 possible combinations.

NOTE:

The minimum support is considered so small since the total number of records is 7501, and thus 0.01, 0.05 and 0.1 would correspond to a frequency of 75, 375, and 600 records, which is adequate.

The dataset supports only low confidence values, and for higher values of confidence, no association rules are formed at all.

```
In [69]: import time
#Applying apriori algo with min_suport = 0.01 and confidence 0.25
start = time.process_time()
freq_items=apriori(df, min_support=0.01, use_colnames=True)
time_taken=time.process_time() - start
print(f'Time taken for mining the dataset is {time_taken}')
freq_items
```

Time taken for mining the dataset is 0.2891317820000001

Out[69]:

	support	itemsets
0	0.020397	(almonds)
1	0.033329	(avocado)
2	0.010799	(barbecue sauce)
3	0.014265	(black tea)

	support	itemsets
4	0.011465	(body spray)
...	...	...
252	0.011065	(mineral water, milk, ground beef)
253	0.017064	(spaghetti, mineral water, ground beef)
254	0.015731	(spaghetti, mineral water, milk)
255	0.010265	(spaghetti, mineral water, olive oil)
256	0.011465	(spaghetti, mineral water, pancakes)

257 rows × 2 columns

```
In [70]: #Forming association rules using FIS
start = time.process_time()
rules = association_rules(freq_items, metric="confidence", min_threshold=0.25)
time_taken=time.process_time() - start
print(f'Time taken for forming the association rules with the above frequent itemset is {time_taken}')
```

Time taken for forming the association rules with the above frequent itemset is 0.008022588000001107

	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction
0	(avocado)	(mineral water)	0.033329	0.238368	0.011598	0.348000	1.459926	0.003654	1.168147
1	(burgers)	(eggs)	0.087188	0.179709	0.028796	0.330275	1.837830	0.013128	1.224818
2	(burgers)	(french fries)	0.087188	0.170911	0.021997	0.252294	1.476173	0.007096	1.108844
3	(burgers)	(mineral water)	0.087188	0.238368	0.024397	0.279817	1.173883	0.003614	1.057552
4	(cake)	(mineral water)	0.081056	0.238368	0.027463	0.338816	1.421397	0.008142	1.151921
...	...	...	...	...	...	...	...	...	...
90	(mineral water, milk)	(spaghetti)	0.047994	0.174110	0.015731	0.327778	1.882589	0.007375	1.228597
91	(spaghetti, olive oil)	(mineral water)	0.022930	0.238368	0.010265	0.447674	1.878079	0.004799	1.378954
92	(mineral water, olive oil)	(spaghetti)	0.027596	0.174110	0.010265	0.371981	2.136468	0.005460	1.315071
93	(spaghetti, pancakes)	(mineral water)	0.025197	0.238368	0.011465	0.455026	1.908923	0.005459	1.397557
94	(mineral water, pancakes)	(spaghetti)	0.033729	0.174110	0.011465	0.339921	1.952333	0.005593	1.251198

95 rows × 9 columns

```
In [71]: #Applying apriori algo with min_suport = 0.05 and confidence 0.2
start = time.process_time()
freq_items=apriori(df, min_support=0.05, use_colnames=True)
time_taken=time.process_time() - start
print(f'Time taken for mining the dataset is {time_taken}')
```

Time taken for mining the dataset is 0.035435861999999993

	support	itemsets
0	0.087188	(burgers)
1	0.081056	(cake)
2	0.059992	(chicken)

	support	itemsets
3	0.163845	(chocolate)
4	0.080389	(cookies)
5	0.051060	(cooking oil)
6	0.179709	(eggs)
7	0.079323	(escalope)
8	0.170911	(french fries)
9	0.063325	(frozen smoothie)
10	0.095321	(frozen vegetables)
11	0.052393	(grated cheese)
12	0.132116	(green tea)
13	0.098254	(ground beef)
14	0.076523	(low fat yogurt)
15	0.129583	(milk)
16	0.238368	(mineral water)
17	0.065858	(olive oil)
18	0.095054	(pancakes)
19	0.071457	(shrimp)
20	0.050527	(soup)
21	0.174110	(spaghetti)
22	0.068391	(tomatoes)
23	0.062525	(turkey)
24	0.058526	(whole wheat rice)
25	0.052660	(chocolate, mineral water)
26	0.050927	(mineral water, eggs)
27	0.059725	(spaghetti, mineral water)

```
In [72]: #Forming association rules using FIS
start = time.process_time()
rules = association_rules(freq_items, metric="confidence", min_threshold=0.2)
time_taken=time.process_time() - start
print(f'Time taken for forming the association rules with the above frequent itemset is {time_taken}')
rules
```

Time taken for forming the association rules with the above frequent itemset is 0.006733691000000874

Out[72]:	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction
0	(chocolate)	(mineral water)	0.163845	0.238368	0.052660	0.321400	1.348332	0.013604	1.122357
1	(mineral water)	(chocolate)	0.238368	0.163845	0.052660	0.220917	1.348332	0.013604	1.073256
2	(mineral water)	(eggs)	0.238368	0.179709	0.050927	0.213647	1.188845	0.008090	1.043158
3	(eggs)	(mineral water)	0.179709	0.238368	0.050927	0.283383	1.188845	0.008090	1.062815
4	(spaghetti)	(mineral water)	0.174110	0.238368	0.059725	0.343032	1.439085	0.018223	1.159314
5	(mineral water)	(spaghetti)	0.238368	0.174110	0.059725	0.250559	1.439085	0.018223	1.102008

```
In [73]: #Applying apriori algo with min_suport = 0.08 and confidence 0.13
start = time.process_time()
freq_items=apriori(df, min_support=0.08, use_colnames=True)
time_taken=time.process_time() - start
print(f'Time taken for mining the dataset is {time_taken}')
freq_items
```

Time taken for mining the dataset is 0.010052458000000541

Out[73]:

	support	itemsets
0	0.087188	(burgers)
1	0.081056	(cake)
2	0.163845	(chocolate)
3	0.080389	(cookies)
4	0.179709	(eggs)
5	0.170911	(french fries)
6	0.095321	(frozen vegetables)
7	0.132116	(green tea)
8	0.098254	(ground beef)
9	0.129583	(milk)
10	0.238368	(mineral water)
11	0.095054	(pancakes)
12	0.174110	(spaghetti)

```
In [74]: #Forming association rules using FIS
start = time.process_time()
rules = association_rules(freq_items, metric="confidence", min_threshold=0.13)
time_taken=time.process_time() - start
print(f'Time taken for forming the association rules with the above frequent itemset is {time_taken}')
rules
```

Time taken for forming the association rules with the above frequent itemset is 0.0029888709999999449

Out[74]:

antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction
-------------	-------------	--------------------	--------------------	---------	------------	------	----------	------------

NOTE :

We see that for the last combination of support and confidence values, no association rules have been formed. This also proves to the fact that the dataset inherently supports only low confidence values for mining.

## Question 12

```
In [76]: from mlxtend.frequent_patterns import fpgrowth
```

```
In [77]: l = [i.strip('\n').split(',') for i in open("store_data.csv").readlines()]
l
```

Out[77]:

```
[[ 'shrimp',
   'almonds',
   'avocado',
   'vegetables mix',
   'green grapes',
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...]

```

```

In [78]: ohe = TransactionEncoder()
ohe_rec = ohe.fit(l).transform(l)

```

```
df = pd.DataFrame(ohe_rec, columns=ohe.columns_)
df
```

Out[78]:

	asparagus	almonds	antioxydant juice	asparagus	avocado	babies food	bacon	barbecue sauce	black tea	blueberries	...	turkey	vegetables mix	water spray	white wine	whole weat flour	whole wheat pasta	whole wheat rice	yams	yogurt cake	zucchini
0	False	True	True	False	True	False	False	False	False	False	...	False	True	False	False	True	False	False	True	False	False
1	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
2	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
3	False	False	False	False	True	False	False	False	False	False	...	True	False	False	False	False	False	False	False	False	False
4	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	True	False	False	False
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7496	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
7497	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
7498	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
7499	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	False	False
7500	False	False	False	False	False	False	False	False	False	False	...	False	False	False	False	False	False	False	False	True	False

7501 rows × 120 columns

Applying fpgrowth with various confidence and minimum supports

We see that the total number of individual transactions is 7501. If we consider a minimum support of 0.01, 0.05, and 0.08, with confidence being either 0.15, 0.2, 0.25 we get 9 combinations of min\_support and confidence. Here, I have considered 3 out of those 9 possible combinations.

NOTE:

The minimum support is considered so small since the total number of records is 7501, and thus 0.01, 0.05 and 0.1 would correspond to a frequency of 75, 375, and 600 records, which is adequate.

The dataset supports only low confidence values, and for higher values of confidence, no association rules are formed at all.

In [79]:

```
#Applying fpgrowth algo with min_suport = 0.01 and confidence 0.25
start = time.process_time()
freq_items=fpgrowth(df, min_support=0.01, use_colnames=True)
time_taken=time.process_time() - start
print(f'Time taken for mining the dataset is {time_taken}')
freq_items
```

Time taken for mining the dataset is 0.20513794100000027

Out[79]:

	support	itemsets
0	0.238368	(mineral water)
1	0.132116	(green tea)
2	0.076523	(low fat yogurt)
3	0.071457	(shrimp)
4	0.065858	(olive oil)
...	...	...
252	0.011465	(burgers, cake)
253	0.014131	(green tea, cake)
254	0.010265	(frozen vegetables, cake)



	support	itemsets
255	0.011865	(pancakes, cake)
256	0.010265	(cereals, mineral water)

257 rows × 2 columns

```
In [80]: #Forming association rules using FIS
start = time.process_time()
rules = association_rules(freq_items, metric="confidence", min_threshold=0.25)
time_taken=time.process_time() - start
print(f'Time taken for forming the association rules with the above frequent itemset is {time_taken}')
rules
```

Time taken for forming the association rules with the above frequent itemset is 0.007909554999999457

Out[80]:

	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction
0	(low fat yogurt)	(mineral water)	0.076523	0.238368	0.023997	0.313589	1.315565	0.005756	1.109585
1	(shrimp)	(mineral water)	0.071457	0.238368	0.023597	0.330224	1.385352	0.006564	1.137144
2	(shrimp)	(chocolate)	0.071457	0.163845	0.017998	0.251866	1.537221	0.006290	1.117654
3	(shrimp)	(spaghetti)	0.071457	0.174110	0.021197	0.296642	1.703760	0.008756	1.174209
4	(olive oil)	(mineral water)	0.065858	0.238368	0.027596	0.419028	1.757904	0.011898	1.310962
...	...	...	...	...	...	...	...	...	...
90	(herb & pepper)	(ground beef)	0.049460	0.098254	0.015998	0.323450	3.291994	0.011138	1.332860
91	(herb & pepper)	(eggs)	0.049460	0.179709	0.012532	0.253369	1.409883	0.003643	1.098656
92	(herb & pepper)	(spaghetti)	0.049460	0.174110	0.016264	0.328841	1.888695	0.007653	1.230543
93	(cake)	(mineral water)	0.081056	0.238368	0.027463	0.338816	1.421397	0.008142	1.151921
94	(cereals)	(mineral water)	0.025730	0.238368	0.010265	0.398964	1.673729	0.004132	1.267198

95 rows × 9 columns

```
In [81]: #Applying fpgrowth algo with min_suport = 0.05 and confidence 0.2
start = time.process_time()
freq_items=fpgrowth(df, min_support=0.05, use_colnames=True)
time_taken=time.process_time() - start
print(f'Time taken for mining the dataset is {time_taken}')
freq_items
```

Time taken for mining the dataset is 0.080070664000000085

Out[81]:

	support	itemsets
0	0.238368	(mineral water)
1	0.132116	(green tea)
2	0.076523	(low fat yogurt)
3	0.071457	(shrimp)
4	0.065858	(olive oil)
5	0.063325	(frozen smoothie)
6	0.179709	(eggs)
7	0.087188	(burgers)

	support	itemsets
8	0.062525	(turkey)
9	0.129583	(milk)
10	0.058526	(whole wheat rice)
11	0.170911	(french fries)
12	0.050527	(soup)
13	0.174110	(spaghetti)
14	0.095321	(frozen vegetables)
15	0.080389	(cookies)
16	0.051060	(cooking oil)
17	0.163845	(chocolate)
18	0.059992	(chicken)
19	0.068391	(tomatoes)
20	0.095054	(pancakes)
21	0.052393	(grated cheese)
22	0.098254	(ground beef)
23	0.079323	(escalope)
24	0.081056	(cake)
25	0.050927	(mineral water, eggs)
26	0.059725	(spaghetti, mineral water)
27	0.052660	(chocolate, mineral water)

```
In [82]: #Forming association rules using FIS
start = time.process_time()
rules = association_rules(freq_items, metric="confidence", min_threshold=0.2)
time_taken=time.process_time() - start
print(f'Time taken for forming the association rules with the above frequent itemset is {time_taken}')
rules
```

Time taken for forming the association rules with the above frequent itemset is 0.006320184999999867

Out[82]:	antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction
0	(mineral water)	(eggs)	0.238368	0.179709	0.050927	0.213647	1.188845	0.008090	1.043158
1	(eggs)	(mineral water)	0.179709	0.238368	0.050927	0.283383	1.188845	0.008090	1.062815
2	(spaghetti)	(mineral water)	0.174110	0.238368	0.059725	0.343032	1.439085	0.018223	1.159314
3	(mineral water)	(spaghetti)	0.238368	0.174110	0.059725	0.250559	1.439085	0.018223	1.102008
4	(chocolate)	(mineral water)	0.163845	0.238368	0.052660	0.321400	1.348332	0.013604	1.122357
5	(mineral water)	(chocolate)	0.238368	0.163845	0.052660	0.220917	1.348332	0.013604	1.073256

```
In [83]: #Applying fpgrowth algo with min_suport = 0.08 and confidence 0.15
start = time.process_time()
freq_items=fpgrowth(df, min_support=0.08, use_colnames=True)
time_taken=time.process_time() - start
print(f'Time taken for mining the dataset is {time_taken}')
freq_items
```

Time taken for mining the dataset is 0.05425885400000041

Out[83]:

	support	itemsets
0	0.238368	(mineral water)
1	0.132116	(green tea)
2	0.179709	(eggs)
3	0.087188	(burgers)
4	0.129583	(milk)
5	0.170911	(french fries)
6	0.174110	(spaghetti)
7	0.095321	(frozen vegetables)
8	0.080389	(cookies)
9	0.163845	(chocolate)
10	0.095054	(pancakes)
11	0.098254	(ground beef)
12	0.081056	(cake)

In [84]:

```
#Forming association rules using FIS
start = time.process_time()
rules = association_rules(freq_items, metric="confidence", min_threshold=0.15)
time_taken=time.process_time() - start
print(f'Time taken for forming the association rules with the above frequent itemset is {time_taken}')
rules
```

Time taken for forming the association rules with the above frequent itemset is 0.006129259999999803

Out[84]:

antecedents	consequents	antecedent support	consequent support	support	confidence	lift	leverage	conviction
-------------	-------------	--------------------	--------------------	---------	------------	------	----------	------------

NOTE :

We see that for the last combination of support and confidence values, no association rules have been formed. This also proves to the fact that the dataset inherently supports only low confidence values for mining.

In [ ]: