SMDM PROJECT

ASHWANI KUMAR – June 13, 2021

In this Project, I have submitted all the answer to the entire question in a sequential manner with the detailed explanation of the approach used, insights, inferences, all outputs of codes along with graphs and tables.

Problem 1 :

A wholesale distributor operating in different regions of Portugal has information on annual spending of several items in their stores across different regions and channels. The data consists of 440 large retailers' annual spending on 6 different varieties of products in 3 different regions (Lisbon, Oporto, Other) and across different sales channel (Hotel, Retail).

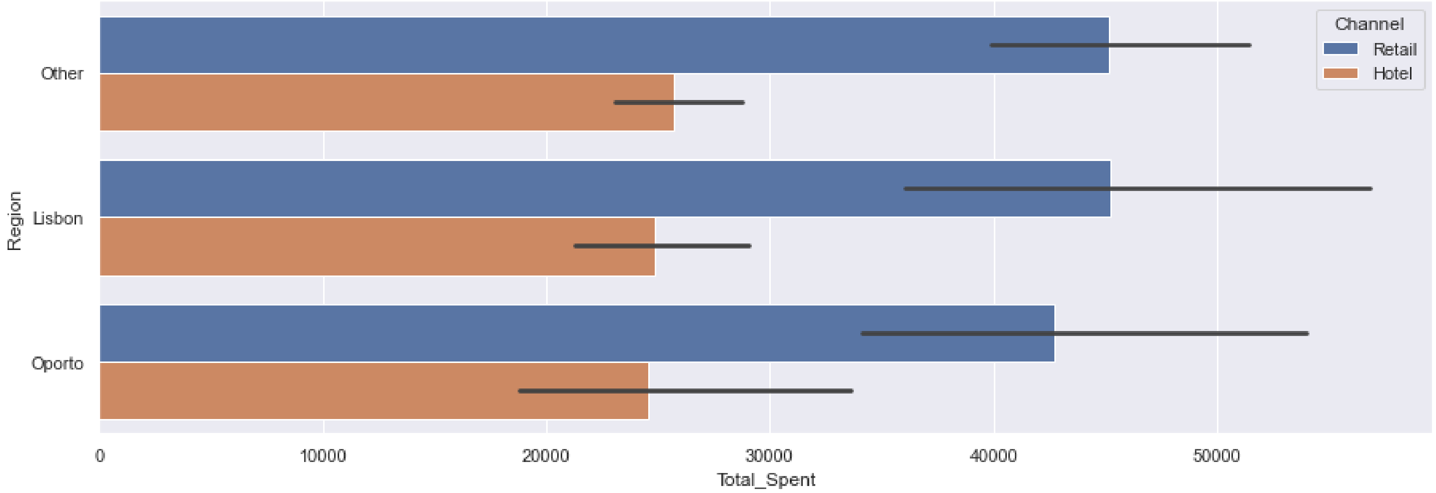
Overview:

	count	unique	top	freq	mean	std	min	25%	50%	75%	max
Buyer/Spender	440	NaN	NaN	NaN	220.5	127.161	1	110.75	220.5	330.25	440
Channel	440	2	Hotel	298	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Region	440	3	Other	316	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Fresh	440	NaN	NaN	NaN	12000.3	12647.3	3	3127.75	8504	16933.8	112151
Milk	440	NaN	NaN	NaN	5796.27	7380.38	55	1533	3627	7190.25	73498
Grocery	440	NaN	NaN	NaN	7951.28	9503.16	3	2153	4755.5	10655.8	92780
Frozen	440	NaN	NaN	NaN	3071.93	4854.67	25	742.25	1526	3554.25	60869
Detergents_Paper	440	NaN	NaN	NaN	2881.49	4767.85	3	256.75	816.5	3922	40827
Delicatessen	440	NaN	NaN	NaN	1524.87	2820.11	3	408.25	965.5	1820.25	47943

1.1). Use methods of descriptive statistics to summarize data. Which Region and which Channel spent the most? Which Region and which Channel spent the least?

	Buyer/Spender	Channel	Region	Fresh	Milk	Grocery	Frozen	Detergents_Paper	Delicatessen	Total_Spent
0	1	Retail	Other	12669	9656	7561	214	2674	1338	32774
1	2	Retail	Other	7057	9810	9568	1762	3293	1776	31490
2	3	Retail	Other	6353	8808	7684	2405	3516	7844	28766
3	4	Hotel	Other	13265	1196	4221	6404	507	1788	25593
4	5	Retail	Other	22615	5410	7198	3915	1777	5185	40915

```
Other     316
Lisbon     77
Oporto     47
Name: Region, dtype: int64
```



Observation:

So, as per observation we found that "Retail" Channel of "Lisbon" Region spent the most and "Hotel" Channel of "Oporto" Region spent the least.

1.2). There are 6 different varieties of items that are considered. Describe and comment/explain all the varieties across Region and Channel? Provide a detailed justification for your answer.

		Delicatessen	Detergents_Paper	Fresh	Frozen	Grocery	Milk
Channel	Region						
Hotel	Lisbon	1197.15	950.53	12902.25	3127.32	4026.14	3870.20
	Oporto	1105.89	482.71	11650.54	5745.04	4395.50	2304.25
	Other	1518.28	786.68	13878.05	3656.90	3886.73	3486.98
Retail	Lisbon	1871.94	8225.28	5200.00	2584.11	18471.94	10784.00
	Oporto	1239.00	8410.26	7289.79	1540.58	16326.32	9190.79
	Other	1826.21	6899.24	9831.50	1513.20	15953.81	10981.01

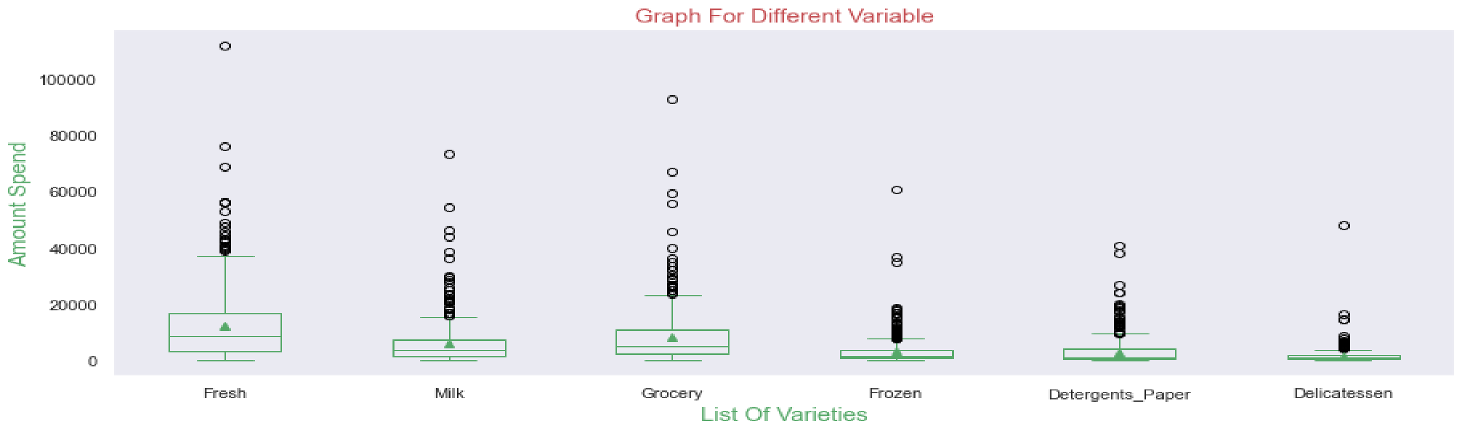
	count	unique	top	freq	mean	std	min	25%	50%	75%	max
Buyer/Spender	440	NaN	NaN	NaN	220.5	127.161	1	110.75	220.5	330.25	440
Channel	440	2	Hotel	298	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Region	440	3	Other	316	NaN	NaN	NaN	NaN	NaN	NaN	NaN
Fresh	440	NaN	NaN	NaN	12000.3	12647.3	3	3127.75	8504	16933.8	112151
Milk	440	NaN	NaN	NaN	5796.27	7380.38	55	1533	3627	7190.25	73498
Grocery	440	NaN	NaN	NaN	7951.28	9503.16	3	2153	4755.5	10655.8	92780
Frozen	440	NaN	NaN	NaN	3071.93	4854.67	25	742.25	1526	3554.25	60869
Detergents_Paper	440	NaN	NaN	NaN	2881.49	4767.85	3	256.75	816.5	3922	40827
Delicatessen	440	NaN	NaN	NaN	1524.87	2820.11	3	408.25	965.5	1820.25	47943
Total_Spent	440	NaN	NaN	NaN	31701.3	25074.9	896	16547	26496	39404	196947

	count	unique	top	freq
Channel	440	2	Hotel	298
Region	440	3	Other	316

Observation:

As per observation, we found that there are 6 different varieties of item in which both Channel such as Hotel & Retail. 'Other' Category Region is spending more as comparision of 'Lisbon' & 'Oporto'.

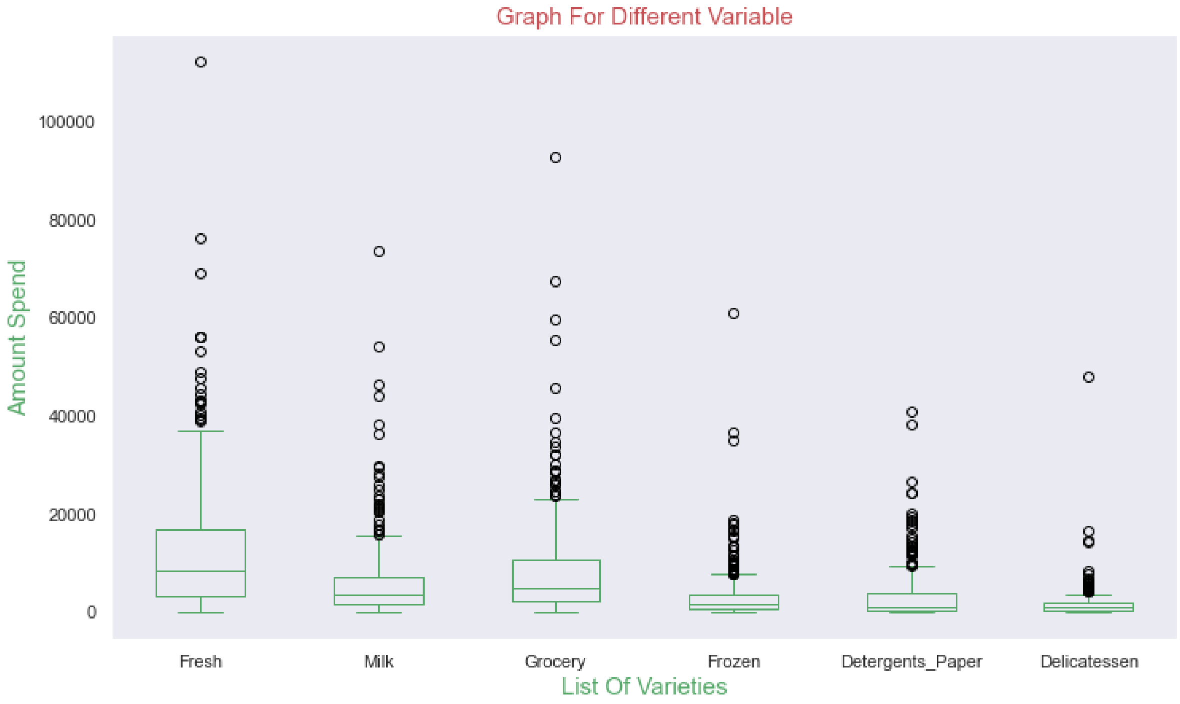
1.3). On the basis of a descriptive measure of variability, which item shows the most inconsistent behaviour? Which items show the least inconsistent behaviour?



Observation:

In the Graph, we are able to descripe measures of vaiability like IQR, Variance, Outlier and means. Looking at the problem objective we have computed that, variable "Fresh" has the most inconsistent behaviour and variable "Detergents_Paper" has the leat inconsistent behaviour among all

1.4). Are there any outliers in the data? Back up your answer with a suitable plot/technique with the help of detailed comments.



Observation:

Yes, there area outliers in the data which we can observe from the graph.

1.5). On the basis of your analysis, what are your recommendations for the business? How can your analysis help the business to solve its problem?

Observation:

As per observation, we have found that in Hotel the 'Fresh' Varieble is consumed more and in Retail ('Grocery' and 'Millk') are the product which is consumed in most. So, as conclusion it will be more profitable to invest more in these mentioned variable, according to their mentioned Channel.

Problem 2

The Student News Service at Clear Mountain State University (CMSU) has decided to gather data about the undergraduate students that attend CMSU. CMSU creates and distributes a survey of 14 questions and receives responses from 62 undergraduates (stored in the Survey data set).

Overview:

	count	mean	std	min	25%	50%	75%	max
ID	62.0	31.500000	18.041619	1.0	16.25	31.50	46.75	62.0
Age	62.0	21.129032	1.431311	18.0	20.00	21.00	22.00	26.0
GPA	62.0	3.129032	0.377388	2.3	2.90	3.15	3.40	3.9
Salary	62.0	48.548387	12.080912	25.0	40.00	50.00	55.00	80.0
Social Networking	62.0	1.516129	0.844305	0.0	1.00	1.00	2.00	4.0
Satisfaction	62.0	3.741935	1.213793	1.0	3.00	4.00	4.00	6.0
Spending	62.0	482.016129	221.953805	100.0	312.50	500.00	600.00	1400.0
Text Messages	62.0	246.209677	214.465950	0.0	100.00	200.00	300.00	900.0

2.1.). For this data, construct the following contingency tables (Keep Gender as row variable)

	Age	GPA	Salary	Satisfaction	Social Networking	Spending	Text Messages
Gender							
Female	696	104.6	1610.0	116	47	14920	7835
Male	614	89.4	1400.0	116	47	14965	7430

2.1.1.). Gender and Major

Major	Accounting	CIS	Economics/Finance	International Business	Management	Other	Retailing/Marketing	Undecided
Gender								
Female	3	3	7	4	4	3	9	0
Male	4	1	4	2	6	4	5	3

2.1.2.). Gender and Grad Intention

Grad Intention	No	Undecided	Yes
Gender			
Female	9	13	11
Male	3	9	17

2.1.3.). Gender and Employment

Employment	Full-Time	Part-Time	Unemployed
Gender			
Female	3	24	6
Male	7	19	3

2.1.4.). Gender and Computer

Computer	Desktop	Laptop	Tablet
Gender			
Female	2	29	2
Male	3	26	0

2.2.). Assume that the sample is representative of the population of CMSU. Based on the data, answer the following question:

2.2.1.). What is the probability that a randomly selected CMSU student will be male?

```
Female    33
Male      29
Name: Gender, dtype: int64

Total number of students are 62

P(Male)= Number of Males/Total Number of Students

P(Male)= 0.46774193548387094
```

Observation:

So, the probability that a randomly selected CMSU student of being male is 0.46774193548387094

2.2.2.). What is the probability that a randomly selected CMSU student will be female?

```
Female    33
Male      29
Name: Gender, dtype: int64

Total number of students are 62

P(Female)= Number of Females/Total Number of Students

P(Female)= 0.532258064516129
```

Observation:

So, the probability that a randomly selected CMSU student of being female is 0.532258064516129

2.3.). Assume that the sample is representative of the population of CMSU. Based on the data, answer the following question:

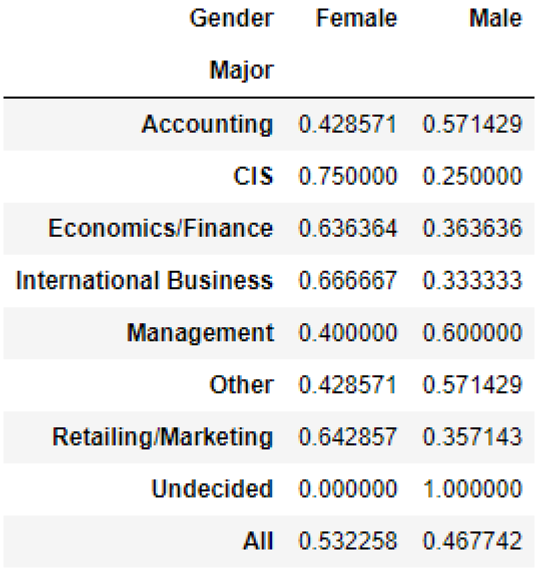
2.3.1.). Find the conditional probability of different majors among the male students in CMSU.

Gender	Female	Male
Major		
Accounting	0.428571	0.571429
CIS	0.750000	0.250000
Economics/Finance	0.636364	0.363636
International Business	0.666667	0.333333
Management	0.400000	0.600000
Other	0.428571	0.571429
Retailing/Marketing	0.642857	0.357143
Undecided	0.000000	1.000000
All	0.532258	0.467742

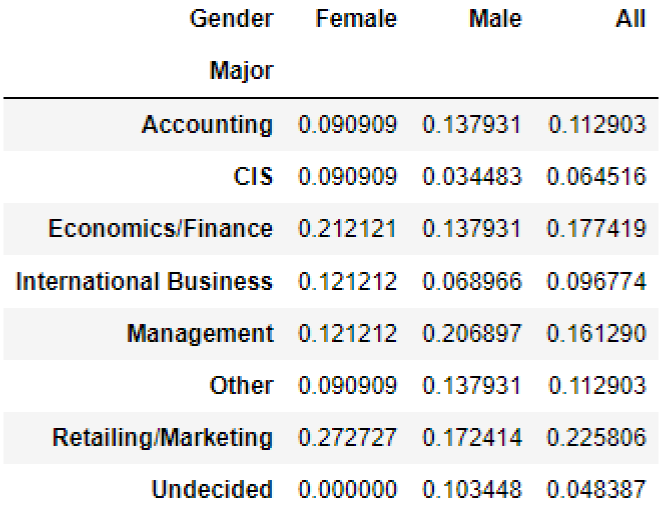
Gender	Female	Male	All
Major			
Accounting	0.090909	0.137931	0.112903
CIS	0.090909	0.034483	0.064516
Economics/Finance	0.212121	0.137931	0.177419
International Business	0.121212	0.068966	0.096774
Management	0.121212	0.206897	0.161290
Other	0.090909	0.137931	0.112903
Retailing/Marketing	0.272727	0.172414	0.225806
Undecided	0.000000	0.103448	0.048387

Ans: So, as per above table we can see the probability of male students in different majors along with total probability.

2.3.2.). Find the conditional probability of different majors among the female students of CMSU.



Gender	Female	Male
Major		
Accounting	0.428571	0.571429
CIS	0.750000	0.250000
Economics/Finance	0.636364	0.363636
International Business	0.666667	0.333333
Management	0.400000	0.600000
Other	0.428571	0.571429
Retailing/Marketing	0.642857	0.357143
Undecided	0.000000	1.000000
All	0.532258	0.467742



Gender	Female	Male	All
Major			
Accounting	0.090909	0.137931	0.112903
CIS	0.090909	0.034483	0.064516
Economics/Finance	0.212121	0.137931	0.177419
International Business	0.121212	0.068966	0.096774
Management	0.121212	0.206897	0.161290
Other	0.090909	0.137931	0.112903
Retailing/Marketing	0.272727	0.172414	0.225806
Undecided	0.000000	0.103448	0.048387

Ans: So, as per above table we can see the probability of female students in different majors along with total probability.

2.4.). Assume that the sample is a representative of the population of CMSU. Based on the data, answer the following question:

2.4.1.). Find the probability That a randomly chosen student is a male and intends to graduate.

```
Yes          28
Undecided    22
No           12
Name: Grad Intention, dtype: int64

The probability that a randomly selected CMSU student of being male is 0.46774193548387094
and the probability of intend to graduate is 0.45161290322580644
So, based on independent Mutiplication Rule
P(Int. to Grad)*P(Male)

= 0.21123829344432882
```

Observation:

So the probability that a randomly chosen student is a male who intend to graduate is 0.21123829344432882

2.4.2.). Find the probability that a randomly selected student is a female and does NOT have a laptop.

```
Laptop     55
Desktop     5
Tablet      2
Name: Computer, dtype: int64

The probability that a randomly selected CMSU student of being female is 0.532258064516129
Probability of not having Laptop is 0.11290322580645161
So, based on independent Mutiplication Rule
P(Not Having Laptop)*P(Female)

= 0.060093652445369405
```

Observation:

So the probability that a randomly chosen student is a female who don't have Laptop is 0.060093652445369405

2.5.). Assume that the sample is a representative of the population of CMSU. Based on the data, answer the following question:

2.5.1.) Find the probability that a randomly chosen student is a male or has a full-time employment

```
Part-Time     43
Full-Time     10
Unemployed     9
Name: Employment, dtype: int64

The probability that a randomly selected CMSU student of being male is 0.46774193548387094
Probability of having Full-Time employment is 0.16129032258064516
So Based on Addition Rule
P(Male)+P(Full-Time Employment)

=  0.6290322580645161
```

Observation:

So the probability that a radnomly chosen student is a male or has a full time employment is 0.6290322580645161

2.5.2.). Find the conditional probability that given a female student is randomly chosen, she is majoring in international business or management.

```
Retailing/Marketing       14
Economics/Finance         11
Management                10
Other                      7
Accounting                 7
International Business     6
CIS                        4
Undecided                  3
Name: Major, dtype: int64

The probability that a randomly selected CMSU student of being female is 0.532258064516129
Probability of internation business is 0.0967741935483871
Probability of management is 0.16129032258064516
P(Internation Business|Female)+P(Management|Female)
      0.48484848484848486
      0.3998044965786901
So, the conditional probability of a female student of being randomly chosen as international business or management is 0.48484
848484848486
```

2.6.). Construct a contingency table of Gender and Intent to Graduate at 2 levels (Yes/No). The Undecided students are not considered now and the table is a 2x2 table. Do you think the graduate intention and being female are independent events?

```
Yes, the graduate intention and being female are independent events.
and to check the probability we will be using Multiplication Rule, which is

       P(Female or Yes) = P(Female)*P(Yes)

So the probability of Graduate intention and being female is  0.35
```

Grad Intention	No	Yes
Gender		
Female	9	11
Male	3	17

2.7. Note that there are four numerical (continuous) variables in the data set, GPA, Salary, Spending, and Text Messages.

Answer the following questions based on the data

2.7.1.). If a student is chosen randomly, what is the probability that his/her GPA is less than 3?

GPA	False	True	All
Gender			
Female	25	8	33
Male	20	9	29
All	45	17	62

The probability of GPA less than 3 is:

$$P(GPA < 3) = 17/62$$

Observation"

So, the probability of GPA less than 3 is 0.27419354838709675

2.7.2. Find the conditional probability that a randomly selected male earns 50 or more. Find the conditional probability that a randomly selected female earns 50 or more.

Salary	False	True	All
Gender			
Female	15	18	33
Male	15	14	29
All	30	32	62

The probability of randomly selected male earns 50 or more is"

$$P(Selected.male.earns.50.or.more) = 14/29$$

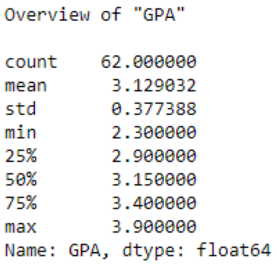
$$P(Selected.female.earns.50.or.more) = 18/33$$

Observation:

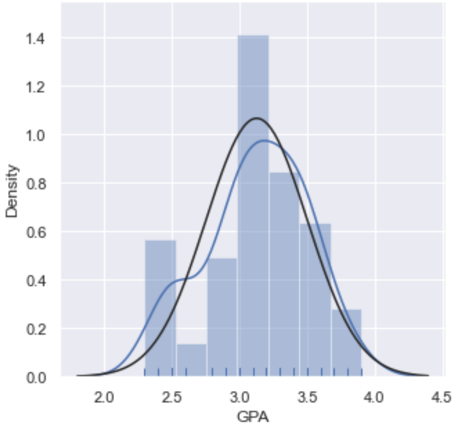
So, the probability of randomly selected male earns 50 or more is 0.4827586206896552 .

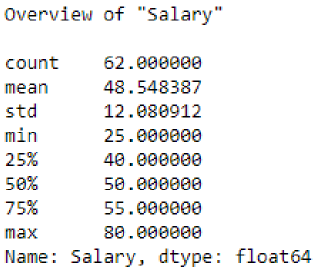
So, the probability of randomly selected female earns 50 or more is 0.5454545454545454 .

2.8. Note that there are four numerical (continuous) variables in the data set, GPA, Salary, Spending, and Text Messages. For each of them comment whether they follow a normal distribution. Write a note summarizing your conclusions for this whole Problem 2.

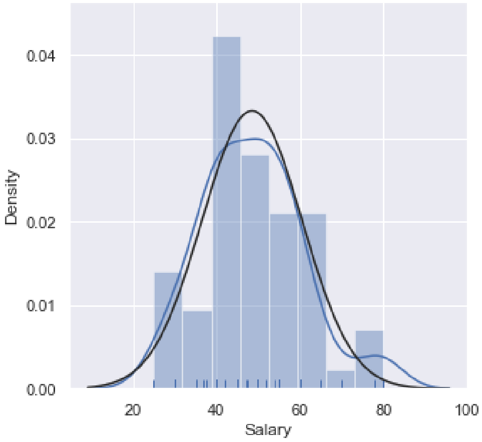


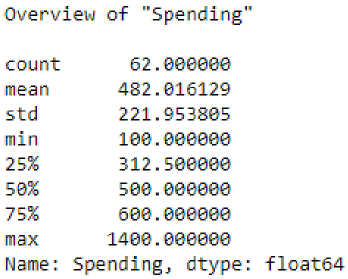
```
Overview of "GPA"

count    62.000000
mean      3.129032
std       0.377388
min       2.300000
25%       2.900000
50%       3.150000
75%       3.400000
max       3.900000
Name: GPA, dtype: float64
```



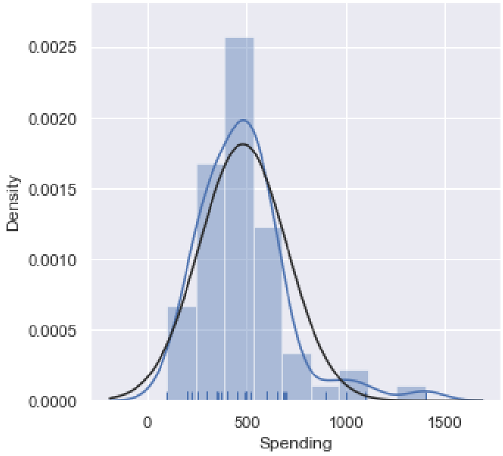


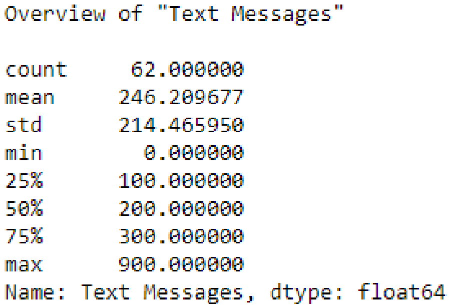
```
Overview of "Salary"

count    62.000000
mean     48.548387
std      12.080912
min      25.000000
25%      40.000000
50%      50.000000
75%      55.000000
max      80.000000
Name: Salary, dtype: float64
```



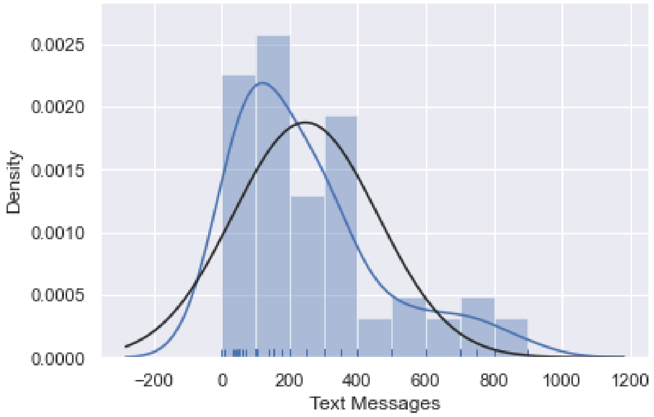


```
Overview of "Spending"

count      62.000000
mean      482.016129
std       221.953805
min       100.000000
25%       312.500000
50%       500.000000
75%       600.000000
max      1400.000000
Name: Spending, dtype: float64
```





```
Overview of "Text Messages"

count     62.000000
mean     246.209677
std      214.465950
min        0.000000
25%      100.000000
50%      200.000000
75%      300.000000
max      900.000000
Name: Text Messages, dtype: float64
```



Observation:

As per observation, we found that all four numerical (continuous) variables in the data set, GPA, Salary, Spending, and Text Messages forms a Normal Distribution Bell Curve.

Problem 3:

An important quality characteristic used by the manufacturers of ABC asphalt shingles is the amount of moisture the shingles contain when they are packaged. Customers may feel that they have purchased a product lacking in quality if they find moisture and wet shingles inside the packaging. In some cases, excessive moisture can cause the granules attached to the shingles for texture and colouring purposes to fall off the shingles resulting in appearance problems. To monitor the amount of moisture present, the company conducts moisture tests. A shingle is weighed and then dried. The shingle is then reweighed, and based on the amount of moisture taken out of the product, the pounds of moisture per 100 square feet is calculated. The company would like to show that the mean moisture content is less than 0.35 pound per 100 square feet.

	count	mean	std	min	25%	50%	75%	max
A	36.0	0.316667	0.135731	0.13	0.2075	0.29	0.3925	0.72
B	31.0	0.273548	0.137296	0.10	0.1600	0.23	0.4000	0.58

3.1 Do you think there is evidence that means moisture contents in both types of shingles are within the permissible limits? State your conclusions clearly showing all steps.

$$H_0 : MeanMoisture = 0.35$$

$$H_a : MeanMoisture > 0.35$$

In this case, lets consider alpha as 0.05 as it is not specified

```
The mean of "A" is  0.3166666666666666 and the mean of "B" is 0.2735483870967742

The Standard Deviation of "A" is  0.13573082605973166 and the Standard Deviation of "B" is 0.13729647694185443

The number (n) of variables in column 'A' is  36 and the number (n) of variables in column 'B' is  31 .


For A :  Ttest_1sampResult(statistic=-1.4735046253382782, pvalue= 0.07477633144907513
For B :  Ttest_1sampResult(statistic=-3.1003313069986995, pvalue= 0.0020904774003191826
```

So, As per review:
For A Shingles : P_value is greater than alpha, So, in this case we have Failed Reject Null Hypothesis.

Whereas :
For B Shingles : P_value is smaller than alpha, So, in this case we have Rejected the Null Hypothesis.

3.2 Do you think that the population mean for shingles A and B are equal? Form the hypothesis and conduct the test of the hypothesis. What assumption do you need to check before the test for equality of means is performed?

```
The mean of "A" is  0.3166666666666666 and the mean of "B" is 0.2735483870967742
The Standard Deviation of "A" is  0.13573082605973166 and the Standard Deviation of "B" is 0.13729647694185443
The number (n) of variables in column 'A' is  36 and the number (n) of variables in column 'B' is  31 .

ShapiroResult(statistic=0.9375598430633545, pvalue=0.042670514434576035)
ShapiroResult(statistic=nan, pvalue=1.0)
LeveneResult(statistic=nan, pvalue=nan)


So, the T_stat is 1.289628271966112З
and the P_Value is 0.2017496571835306
```

Type *Markdown* and LaTeX: α^2

Observation :

P_value is greater than alpha, So, in this case we have Failed to Reject the Null Hypothesis.

THE END