In [1]:
```
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import scipy.stats as stats
%matplotlib inline
```

In [2]:
```
import os
os.chdir("C:\\Users\kpriyadh\\Documents\\PGP-DSBA\Module II - Statistical Methods for Decision Making\\Project")
df=pd.read_csv("Wholesale+Customers+Data.csv")
```

In [3]:
```
df.head()
```

Out[3]:

	Buyer/Spender	Channel	Region	Fresh	Milk	Grocery	Frozen	Detergents_Paper	Delicatess
0	1	Retail	Other	12669	9656	7561	214	2674	13
1	2	Retail	Other	7057	9810	9568	1762	3293	17
2	3	Retail	Other	6353	8808	7684	2405	3516	78
3	4	Hotel	Other	13265	1196	4221	6404	507	17
4	5	Retail	Other	22615	5410	7198	3915	1777	51

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).

1.1 Use methods of descriptive statistics to summarize data.

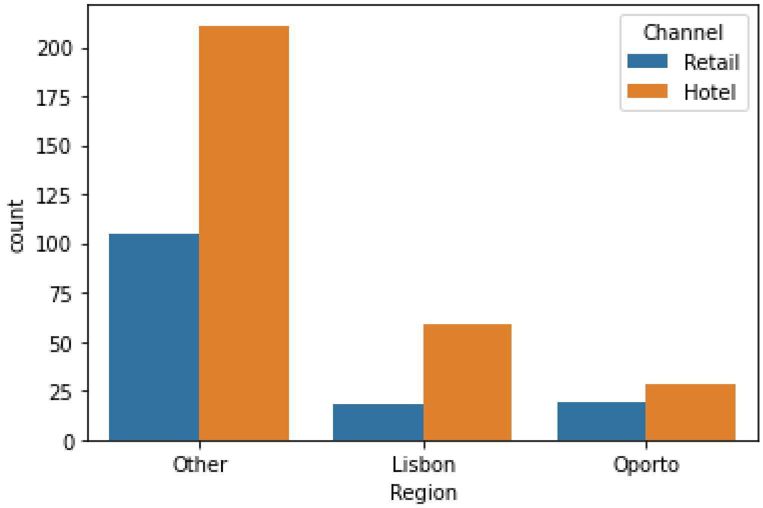
Which Region and which Channel seems to spend more?

Which Region and which Channel seems to spend less?

In [5]:
```
df["Total"]=df["Fresh"]+df["Milk"]+df["Grocery"]+df["Frozen"]+df["Detergents_P
aper"]+df["Delicatessen"]
```

In [6]:
```
#df.hist(by='Region',column = 'Total', figsize=(20,30))
sns.countplot(x="Region", hue="Channel", data=df)
```

Out[6]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x13cbf58e8b0>
```



From the above bar graph, it is evident that,

'Other' Region and 'Hotel' Channel seems to spend more ;

'Lisbon' Region and 'Retail' Channel seems to spend less

1.2 There are 6 different varieties of items are considered.

Do all varieties show similar behaviour across Region and Channel? Provide justification for your answer

In [8]:
```
pd.pivot_table(df, index=['Region'],
                              columns=['Channel'])
```

Out[8]:

	Buyer/Spender		Delicatessen		Detergents_Paper		Fresh
Channel	**Hotel**	**Retail**	**Hotel**	**Retail**	**Hotel**	**Retail**	**Hotel**
Region							
Lisbon	237.728814	226.055556	1197.152542	1871.944444	950.525424	8225.277778	12902.2542
Oporto	321.000000	311.105263	1105.892857	1239.000000	482.714286	8410.263158	11650.5357
Other	227.582938	152.438095	1518.284360	1826.209524	786.682464	6899.238095	13878.0521

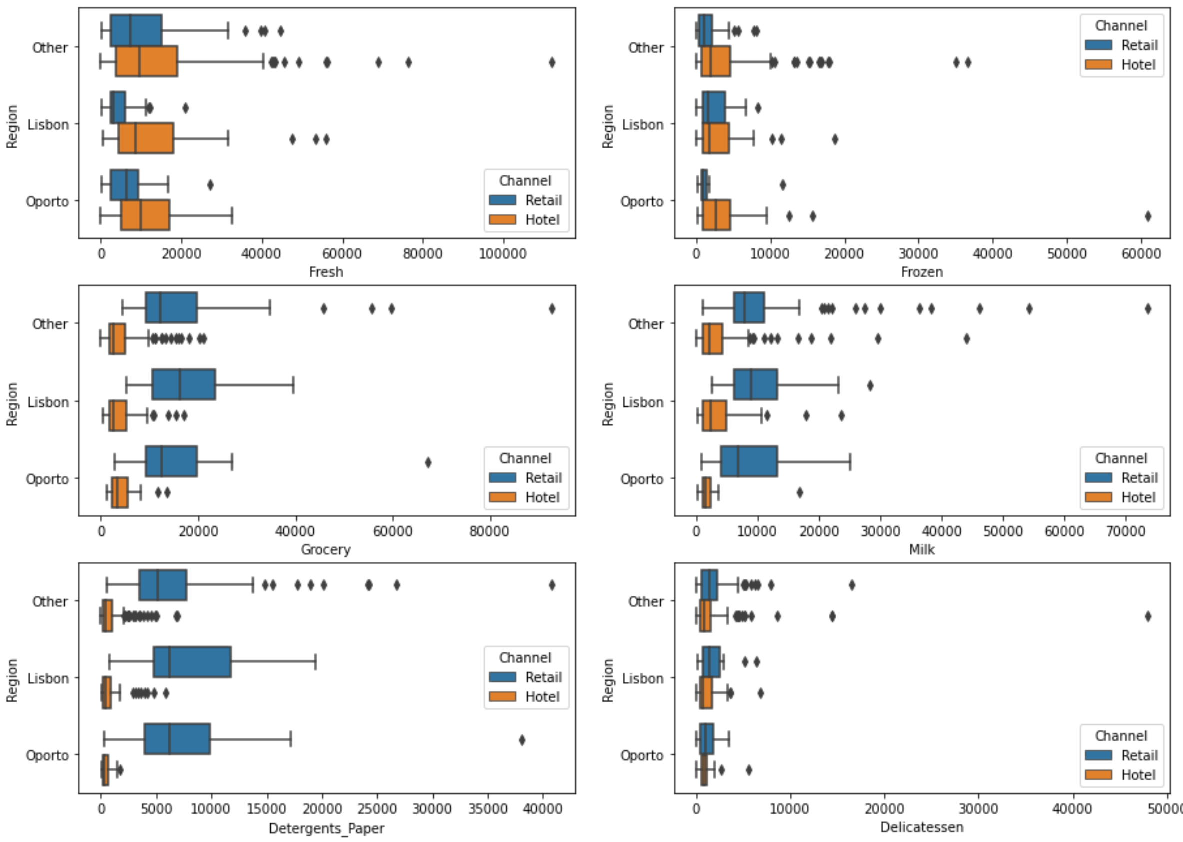
From the pivot table, minimum & maximum for, Item Fresh: Lisbon(Retail) & Other(Hotel) Item Frozen: Other(Retail) & Oporto(Hotel) Item Grocery: Lisbon(Hotel) & Lisbon(Retail) Item Milk: Oporto(Hotel) & Other(Retail) Item Detergents_Paper: Oporto(Hotel) & Lisbon(Retail) Item Delicatessen: Oporto(Hotel) & Lisbon(Retail)

Hence it is clear that all varieties DO NOT show similar behaviour across Region and Channel respectively.

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?

In [78]:
```
plt.figure(figsize= (15,15))
plt.subplot(4,2,1)
sns.boxplot(x= df.Fresh, y=df.Region,hue=df.Channel)

plt.subplot(4,2,2)
sns.boxplot(x= df.Frozen, y=df.Region,hue=df.Channel)

plt.subplot(4,2,3)
sns.boxplot(x= df.Grocery, y=df.Region,hue=df.Channel)

plt.subplot(4,2,4)
sns.boxplot(x= df.Milk, y=df.Region,hue=df.Channel)

plt.subplot(4,2,5)
sns.boxplot(x= df.Detergents_Paper, y=df.Region,hue=df.Channel)

plt.subplot(4,2,6)
sns.boxplot(x= df.Delicatessen, y=df.Region,hue=df.Channel)

plt.show()
```



From the above box plot it is clear that, Item 'Fresh' is almost normally distributed and hence it shows most consistent behaviour Item 'Detergents_Paper' is highly right skewed and hence it shows least consistent behaviour

1.4 Are there any outliers in the data?

Yes - there are outliers in all the items as shown by the above box plot

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? Answer from the business perspective

1. Spending on Hotel Channel is more than spending on Retail Channel
2. Items 'Fresh' is consistently purchased in Lisbon, Oporto whereas there is so much inconsistency in purchase of items like 'Detergents_Paper'
3. Business can focus on minimizing the amount spent on 'Milk,Frozen,Detergents_Paper,Fresh' in 'Other' Region as it has extreme outliers.
4. Retain Spend in Lisbon region for item Fresh can serve as benchmark for other items.

Question 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).

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

In [14]:
```
mydata = pd.read_csv("Survey-1.csv")
mydata.head()
```

Out[14]:

	ID	Gender	Age	Class	Major	Grad Intention	GPA	Employment	Salary	Social Networking	Sa
0	1	Female	20	Junior	Other	Yes	2.9	Full-Time	50.0	1	
1	2	Male	23	Senior	Management	Yes	3.6	Part-Time	25.0	1	
2	3	Male	21	Junior	Other	Yes	2.5	Part-Time	45.0	2	
3	4	Male	21	Junior	CIS	Yes	2.5	Full-Time	40.0	4	
4	5	Male	23	Senior	Other	Undecided	2.8	Unemployed	40.0	2	

2.1.1. Gender and Major

In [16]:
```
pd.crosstab(mydata['Gender'],mydata['Major'] )
```

Out[16]:

Major	Accounting	CIS	Economics/Finance	International Business	Management	Other	Retailing/Market
Gender							
Female	3	3	7	4	4	3	
Male	4	1	4	2	6	4	

2.1.2. Gender and Grad Intention

In [18]:
```
pd.crosstab(mydata['Gender'],mydata['Grad Intention'] )
```

Out[18]:

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

2.1.3. Gender and Employment

In [20]:
```
pd.crosstab(mydata['Gender'],mydata['Employment'] )
```

Out[20]:

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

2.1.4. Gender and Computer

In [22]:
```
pd.crosstab(mydata['Gender'],mydata['Computer'] )
```

Out[22]:

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

2.2. Assume that the sample is a 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?

In [24]:
```
mydata["Gender"].value_counts()
```

Out[24]:
```
Female    33
Male      29
Name: Gender, dtype: int64
```

In [25]:
```
print("The probability that a randomly selected CMSU student will be male is {}".format(round(29/62,2)))
```

```
The probability that a randomly selected CMSU student will be male is 0.47
```

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

In [27]:
```
print("The probability that a randomly selected CMSU student will be male is {}".format(round(33/62,2)))
```

```
The probability that a randomly selected CMSU student will be male is 0.53
```

2.3. Assume that the sample is a 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.

In [29]:
```
pd.crosstab(mydata['Gender'],mydata['Major'] )
```

Out[29]:

Major Gender	Accounting	CIS	Economics/Finance	International Business	Management	Other	Retailing/Market
Female	3	3	7	4	4	3	
Male	4	1	4	2	6	4	

In [30]:
```
print("The conditional probability of different majors among the male students in CMSU is {}".format(round(7/29,2)))
```

```
The conditional probability of different majors among the male students in CM
SU is 0.24
```

In [31]:
```
print("The conditional probability of different majors among the female students in CMSU is {}".format(round(7/33,2)))
```

```
The conditional probability of different majors among the female students in
CMSU is 0.21
```

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.

In [33]:
```
pd.crosstab(mydata['Gender'],mydata['Grad Intention'] )
```

Out[33]:

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

In [34]:
```
print("The probability That a randomly chosen student is a male and intends to
graduate is {}".format(round(17/29,2)))
```

```
The probability That a randomly chosen student is a male and intends to gradu
ate is 0.59
```

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

In [36]:
```
pd.crosstab(mydata['Gender'],mydata['Computer'] )
```

Out[36]:

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

In [142]:
```
print("The probability that a randomly chosen student is a female and does not
have a laptop is {}".format(round(4/33,2)))
```

```
The probability that a randomly chosen student is a female and does not have
a laptop is 0.12
```

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 either a male or has a full-time employment

In [39]:
```
pd.crosstab(mydata['Gender'],mydata['Employment'] )
```

Out[39]:

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

In [40]:
```
#P(MUFE)=P(M)+P(FE)-[P(M) n P(FE)]
```

In [41]:
```
P_M=29/62
```

In [42]:
```
P_F=33/62
```

In [43]:
```
P_FE=10/62
```

In [44]:
```
P_MIP_F=7/62
```

In [45]:
```
print("The probability that a randomly chosen student is either a male or has
 a full-time employment {}".format(round((29/62)+(10/62)-(7/62),2)))
```

```
The probability that a randomly chosen student is either a male or has a full
-time employment 0.52
```

2.5.2 Find the conditional probability that given a female student is randomly chosen,

she is majoring in international business or management.

In [47]:
```
pd.crosstab(mydata['Gender'],mydata['Major'] )
```

Out[47]:

Major	Accounting	CIS	Economics/Finance	International Business	Management	Other	Retailing/Market
Gender							
Female	3	3	7	4	4	3	
Male	4	1	4	2	6	4	

In [143]:
```
print("The probability that given a female student is randomly chosen,she is m
ajoring in international business or management.{}".format(round(8/33,2)))
```

```
The probability that given a female student is randomly chosen,she is majorin
g in international business or management.0.24
```

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 graduate intention and being female are independent events?

In [50]:
```
gg=pd.crosstab(mydata['Gender'],mydata['Grad Intention'] )
gg
```

Out[50]:

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

In [51]:
```
gg.drop(columns="Undecided")
```

Out[51]:

Grad Intention	No	Yes
Gender		
Female	9	11
Male	3	17

Graduate intention and being female are NOT independent events. In fact graduate intention is more in Males than Females, though more than 50% female have grad intention

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?

In [53]:
```
print('GPA mean {}'.format(round(mydata['GPA'].mean(),4)))
```

```
GPA mean 3.129
```

In [54]:
```
print('GPA standard deviation {}'.format(round(mydata['GPA'].std(),4)))
```

```
GPA standard deviation 0.3774
```

In [55]:
```
print('z value is {}'.format(round((-0.129)/0.3774,2)))
```

```
z value is -0.34
```

In [56]:
```
print('The probability that his/her GPA is less than 3 is {}'.format(round(17/
62,4)))
```

```
The probability that his/her GPA is less than 3 is 0.2742
```

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

Find conditional probability that a randomly selected female earns 50 or more

In [58]:
```
print('Mean Salary {}'.format(round(mydata['Salary'].mean(),4)))
```

```
Mean Salary 48.5484
```

In [59]:
```
print('Standard Deviation of Salary {}'.format(round(mydata['Salary'].std(),4
)))
```

```
Standard Deviation of Salary 12.0809
```

In [60]:
```
print('Z value {}'.format(round((50-48.5484)/12.0809,4)))
```

```
Z value 0.1202
```

In [61]:
```
print('The conditional probability that a randomly selected male earns 50 or m
ore is {}'.format(round(14/29,2)))
```

```
The conditional probability that a randomly selected male earns 50 or more is
0.48
```

In [62]:
```
print('The conditional probability that a randomly selected female earns 50 or
more is {}'.format(round(18/33,2)))
```

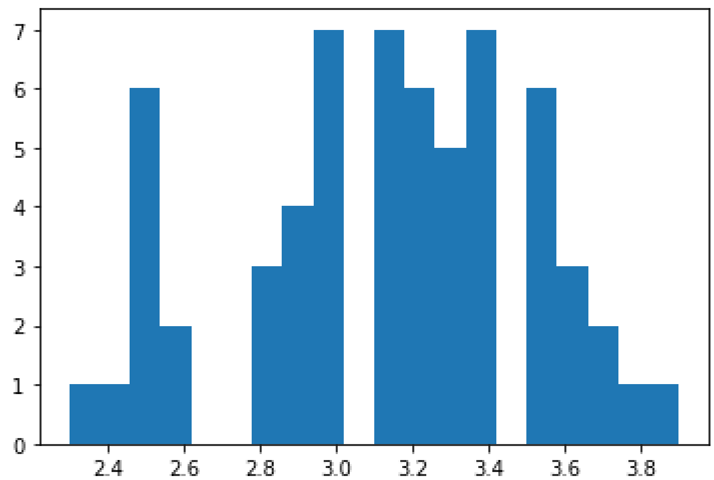
```
The conditional probability that a randomly selected female earns 50 or more
is 0.55
```

2.8.1 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.

In [64]:
```
plt.hist(mydata['GPA'], bins=20)
```

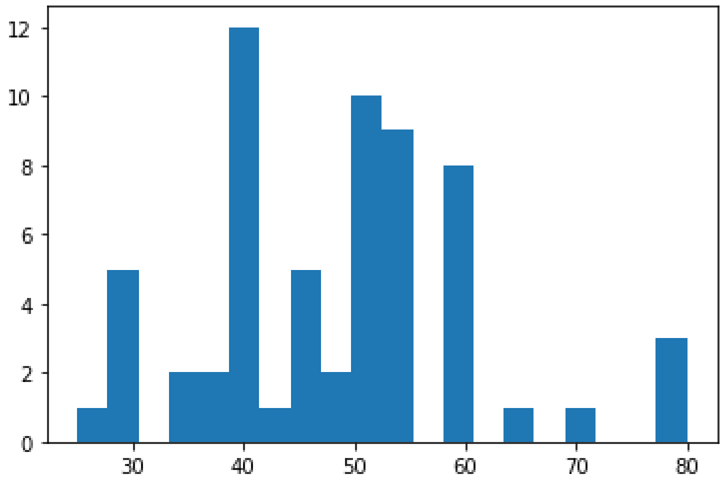
Out[64]:
```
(array([1., 1., 6., 2., 0., 0., 3., 4., 7., 0., 7., 6., 5., 7., 0., 6., 3.,
        2., 1., 1.]),
 array([2.3 , 2.38, 2.46, 2.54, 2.62, 2.7 , 2.78, 2.86, 2.94, 3.02, 3.1 ,
        3.18, 3.26, 3.34, 3.42, 3.5 , 3.58, 3.66, 3.74, 3.82, 3.9 ]),
 <a list of 20 Patch objects>)
```



GPA does not follow normal distribution curve

In [65]:
```
plt.hist(mydata['Salary'], bins=20)
```

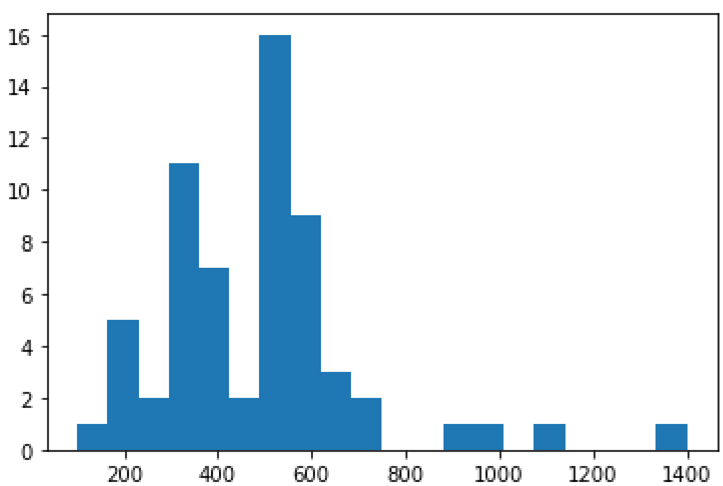
Out[65]:
```
(array([ 1.,  5.,  0.,  2.,  2., 12.,  1.,  5.,  2., 10.,  9.,  0.,  8.,
         0.,  1.,  0.,  1.,  0.,  0.,  3.]),
 array([25.  , 27.75, 30.5 , 33.25, 36.  , 38.75, 41.5 , 44.25, 47.  ,
        49.75, 52.5 , 55.25, 58.  , 60.75, 63.5 , 66.25, 69.  , 71.75,
        74.5 , 77.25, 80.  ]),
 <a list of 20 Patch objects>)
```



Salary does not follow normal distribution curve

In [66]:
```
plt.hist(mydata['Spending'], bins=20)
```

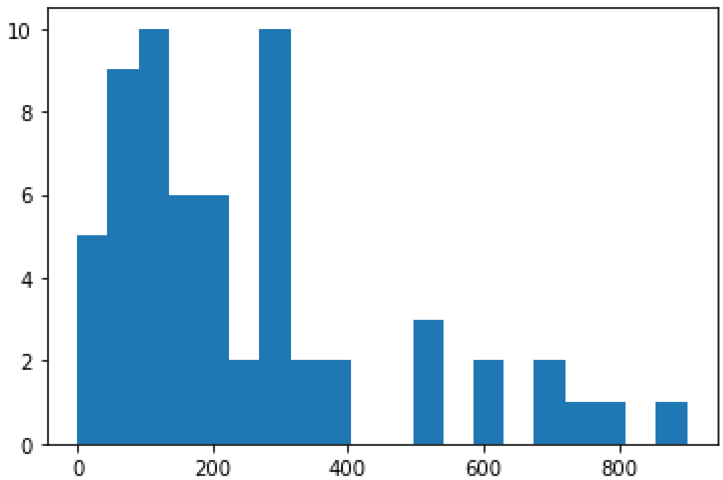
Out[66]:
```
(array([ 1.,  5.,  2., 11.,  7.,  2., 16.,  9.,  3.,  2.,  0.,  0.,  1.,
         1.,  0.,  1.,  0.,  0.,  0.,  1.]),
 array([ 100.,  165.,  230.,  295.,  360.,  425.,  490.,  555.,  620.,
         685.,  750.,  815.,  880.,  945., 1010., 1075., 1140., 1205.,
        1270., 1335., 1400.]),
 <a list of 20 Patch objects>)
```



Spending does not follow normal distribution curve

In [67]:
```
plt.hist(mydata['Text Messages'], bins=20)
```

Out[67]:
```
(array([ 5.,  9., 10.,  6.,  6.,  2., 10.,  2.,  2.,  0.,  0.,  3.,  0.,
         2.,  0.,  2.,  1.,  1.,  0.,  1.]),
 array([  0.,  45.,  90., 135., 180., 225., 270., 315., 360., 405., 450.,
        495., 540., 585., 630., 675., 720., 765., 810., 855., 900.]),
 <a list of 20 Patch objects>)
```



Text Messages does not follow normal distribution curve

2.8.2 Write a note summarizing your conclusions.

1. Range of age for CMSU students lie between 18 to 26, where maximum students enroll at the age of 20,21,22.

1. Number of senior students are more than the junior students ; No of students in Sophomore are least

1. Female students network socially over the Male students

1. Graduate intention is more in Males than Females, though more than 50% female have grad intention

1. Around 70 % of students are employed in a Part Time job and less than 15 % of students are unemployed.

1. Retailing/Marketing is the most prefered major and CIS is the least prefered major

1. Around 88 % of the students use Laptop compared to preference in desktop and tablet

1. More than 70 % students score more than GPA 3.0

Question # 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.

The file (A & B shingles.csv) includes 36 measurements (in pounds per 100 square feet) for A shingles and 31 for B shingles.

Do you think there is evidence that mean moisture contents in both types of shingles are within the permissible limits?

State your conclusions clearly showing all steps.

In [118]:
```
data = pd.read_csv('A+&+B+shingles.csv')
data.head()
mean_A = data['A'].mean()
mean_B = data['B'].mean()
std_A =  data['A'].std()
std_B =  data['B'].std()
n_A=36
n_B=31
print('Mean of A {}'.format(mean_A))
print('Mean of B {}'.format(mean_B))
print('Std of A {}'.format(std_A))
print('Std of B {}'.format(std_A))
```

```
Mean of A 0.3166666666666666
Mean of B 0.2735483870967742
Std of A 0.13573082605973166
Std of B 0.13573082605973166
```

Step 1: Define null and alternative hypotheses

In [111]:
```
#Ho>=0.35
#Ha<0.35
```

Step 2: Decide the significance level

In [126]:
```
alpha = 0.05
df=36+31-2
```

Step 3: Identify the test statistic

In [120]:
```
Numerator = mean_A - mean_B
Denominator = np.sqrt(((std_A**2)/n_A)+((std_B**2)/n_B))
t_statistic = Numerator/Denominator
print('test statistics is {}'.format(t_statistic))
```

```
test statistics is 1.2885080295255011
```

Step 4: Calculate the p - value and test statistic

In [128]:
```
pvalue = ('P_Value is T.DIST(test statistics,df,1) {}',0.8989/2)
pvalue
```

Out[128]:
```
('P_Value is T.DIST(test statistics,df,1) {}', 0.44945)
```

Step 5: Decide to reject or accept null hypothesis

In [144]:
```
# p_value > 0.05 => Null hypothesis:
print (" The mean moisture content is NOT less than 0.35 pound per 100 square
 feet")
```

```
The mean moisture content is NOT less than 0.35 pound per 100 square feet
```

3.2 Do you think that the population means 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?

In [132]:
```
from scipy.stats import ttest_ind
from scipy.stats import chi2_contingency
data.head()
```

Out[132]:

	A	B
0	0.44	0.14
1	0.61	0.15
2	0.47	0.31
3	0.30	0.16
4	0.15	0.37

Step 1: Define null and alternative hypotheses

In [146]:
```
# Ho = Population means of shingles A & B are NOT equal
# Ha = Population means of shingles A & B are equal
# Ho = E(A) = E(B)
# Ha = E(A) not equal E(B)
```

Step 2: Decide the significance level

In [90]:
```
alpha = 0.05
```

Step 3: Identify the test statistic

Before the test for equality of means is performed, it is assumed that the populations have identical variances. This is a two-sided test for the null hypothesis that 2 independent samples have identical average (expected) values.

Step 4: Calculate the p - value and test statistic

In [140]:
```
pvalue = ('P_Value is T.DIST(test statistics,df,1) {}',0.8989/2)
pvalue
```

Out[140]:
```
('P_Value is T.DIST(test statistics,df,1) {}', 0.44945)
```

Step 5: Decide to reject or accept null hypothesis

In [145]:
```
# p_value > 0.05 => Null hypothesis:
print ("The population means for shingles A and B are NOT equal")
```

```
The population means for shingles A and B are NOT equal
```

In [ ]: