# Importing libraries

In [1]:
```
import scipy.stats as stats
import statsmodels.api as sm
import numpy as np
import pandas as pd
import warnings
warnings.filterwarnings("ignore")
from PIL import ImageGrab
import matplotlib.pyplot as plt
import seaborn as sns
```

# Question 1

In [16]:
```
ImageGrab.grabclipboard()
```

Out[16]:

# Hypothesis Testing Exercise

A F&B manager wants to determine whether there is any significant difference in the diameter of the cutlet between two units. A randomly selected sample of cutlets was collected from both units and measured? Analyze the data and draw inferences at 5% significance level. Please state the assumptions and tests that you carried out to check validity of the assumptions.

## We are going to conduct a 2 tailed t-Test on 2 Independent samples with Numerical Data

### We need to check whether the mean of both samples are different and

### Is there any significance difference between the two samples?

## Step 1

### Make two Hypothesis one contradicting to other

### Null Hypothesis is want we want to prove

- **Null Hypothesis:** $\mu_1 = \mu_2$
- **Alternative Hypthosis:** $\mu_1 \neq \mu_2$

## Step 2

## Decide a cut-off value

- **Significance 5%**
- **alpha = 0.05**

## As it is a two-tailed test

- **alpha/2 = 0.025**

# Step 3

## Collect evidence

## Importing Files

In [3]:
```
cutlets = pd.read_csv('Cutlets.csv')
cutlets.head(10)
```

Out[3]:

| | Unit A | Unit B |
|---|---|---|
| **0** | 6.8090 | 6.7703 |
| **1** | 6.4376 | 7.5093 |
| **2** | 6.9157 | 6.7300 |
| **3** | 7.3012 | 6.7878 |
| **4** | 7.4488 | 7.1522 |
| **5** | 7.3871 | 6.8110 |
| **6** | 6.8755 | 7.2212 |
| **7** | 7.0621 | 6.6606 |
| **8** | 6.6840 | 7.2402 |
| **9** | 6.8236 | 7.0503 |

## Applying Descriptive Statistics

In [4]:
```
cutlets.describe()
```

Out[4]:

| | Unit A | Unit B |
|---|---|---|
| **count** | 35.000000 | 35.000000 |
| **mean** | 7.019091 | 6.964297 |
| **std** | 0.288408 | 0.343401 |
| **min** | 6.437600 | 6.038000 |
| **25%** | 6.831500 | 6.753600 |
| **50%** | 6.943800 | 6.939900 |
| **75%** | 7.280550 | 7.195000 |
| **max** | 7.516900 | 7.545900 |

## Checking for Null Values

In [5]:
```
cutlets.isnull().sum()
```

Out[5]:
```
Unit A    0
Unit B    0
dtype: int64
```

## Checking for Duplicate Values

In [6]:
```
cutlets[cutlets.duplicated()].shape
```

Out[6]:
```
(0, 2)
```

In [7]:
```
cutlets[cutlets.duplicated()]
```

Out[7]:

| Unit A | Unit B |
|---|---|

## Checking the data type

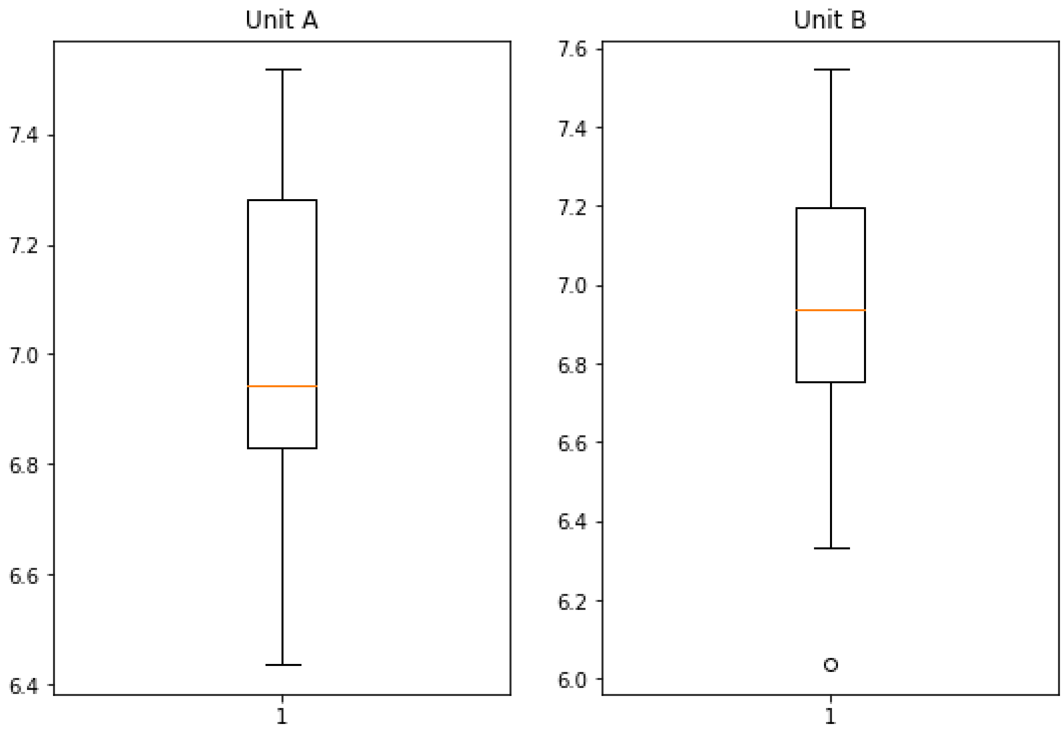
In [8]:
```
cutlets.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 35 entries, 0 to 34
Data columns (total 2 columns):
 #   Column  Non-Null Count  Dtype  
---  ------  --------------  -----  
 0   Unit A  35 non-null     float64
 1   Unit B  35 non-null     float64
dtypes: float64(2)
memory usage: 688.0 bytes
```

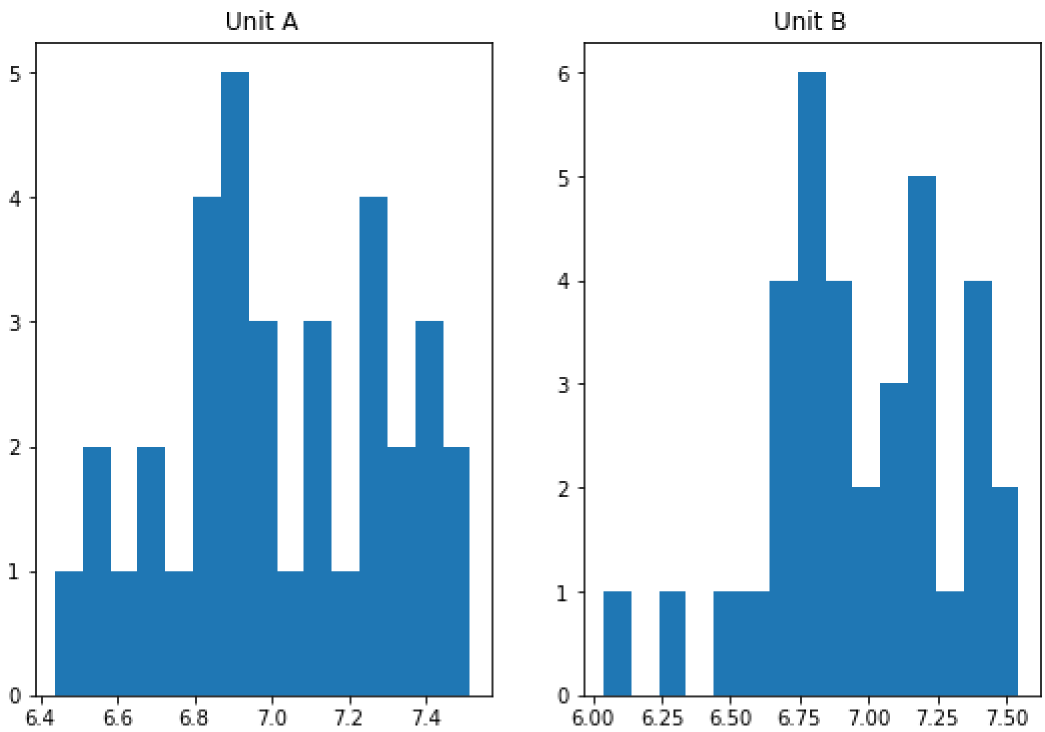
## Plotting the data

In [9]:
```
plt.subplots(figsize = (9,6))
plt.subplot(121)
plt.boxplot(cutlets['Unit A'])
plt.title('Unit A')
plt.subplot(122)
plt.boxplot(cutlets['Unit B'])
```

```
plt.title('Unit B')
plt.show()
```



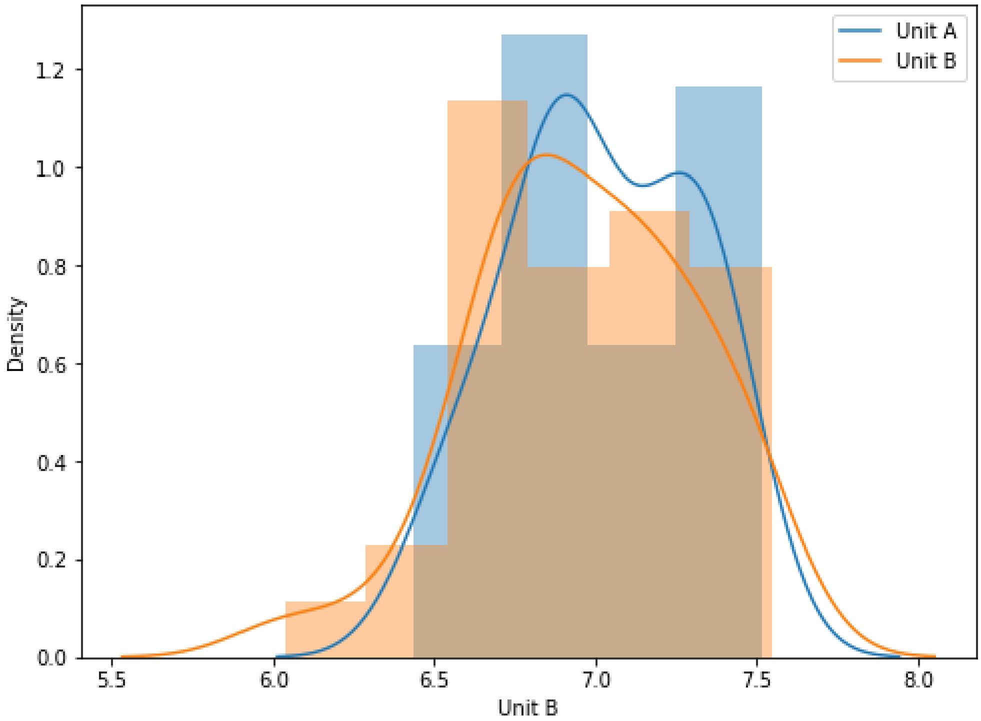

In [10]:
```
plt.subplots(figsize = (9,6))
plt.subplot(121)
plt.hist(cutlets['Unit A'], bins = 15)
plt.title('Unit A')
plt.subplot(122)
plt.hist(cutlets['Unit B'], bins = 15)
plt.title('Unit B')
plt.show()
```




In [11]:
```
plt.figure(figsize = (8,6))
labels = ['Unit A', 'Unit B']
sns.distplot(cutlets['Unit A'], kde = True)
```

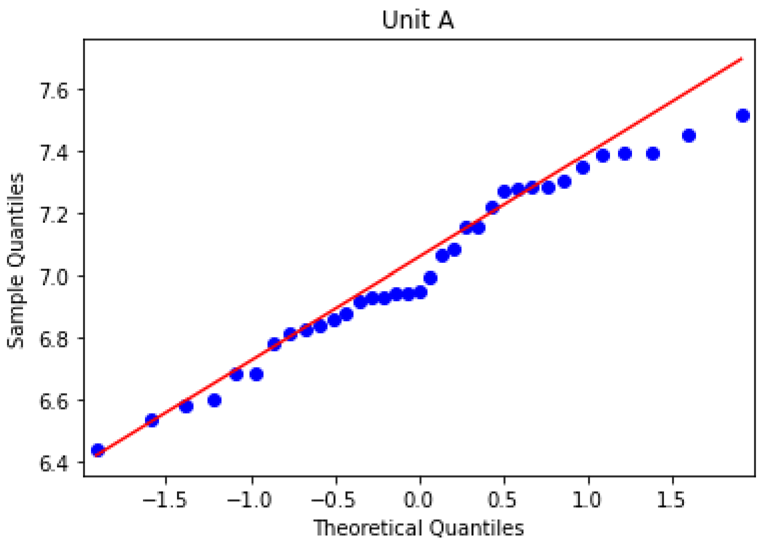
```
sns.distplot(cutlets['Unit B'],hist = True)
plt.legend(labels)
```

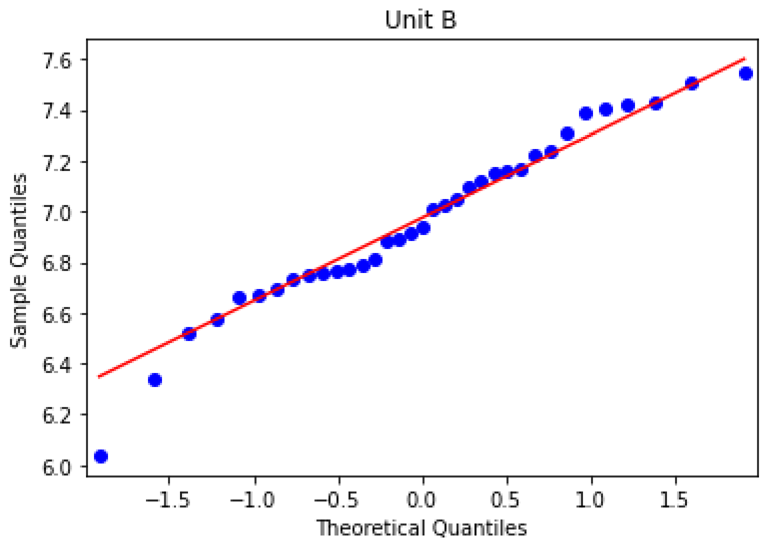
Out[11]: <matplotlib.legend.Legend at 0x1c51067ed90>




## Plotting Q-Q plot to check whether the distribution follows normal distribution or not

In [12]:
```
sm.qqplot(cutlets["Unit A"], line = 'q')
plt.title('Unit A')
sm.qqplot(cutlets["Unit B"], line = 'q')
plt.title('Unit B')
plt.show()
```






# Step 4

## Compare Evidences with Hypothesis using t-statistics

In [13]:
```
statistic , p_value = stats.ttest_ind(cutlets['Unit A'],cutlets['Unit B'], alterna
print('p_value=',p_value)
```

```
p_value= 0.4722394724599501
```

## Compare p_value with '$\alpha$ '(Significane Level)

## If p_value is $\neq$ '$\alpha$ ' we failed to reject Null Hypothesis because of lack of evidence

## If p_value is = '$\alpha$ ' we reject Null Hypothesis

## interpreting p-value

In [14]:
```
alpha = 0.025
print('Significnace=%.3f, p=%.3f' % (alpha, p_value))
if p_value <= alpha:
    print('We reject Null Hypothesis there is a significance difference between two
else:
    print('We fail to reject Null hypothesis')
```

```
Significnace=0.025, p=0.472
We fail to reject Null hypothesis
```

# Hence, We fail to reject Null Hypothesis because of lack of evidence, there is no significant difference between the two samples

# Question 2

In [17]:
```
ImageGrab.grabclipboard()
```

Out[17]:

# Hypothesis Testing Exercise

A hospital wants to determine whether there is any difference in the average Turn Around Time (TAT) of reports of the laboratories on their preferred list. They collected a random sample and recorded TAT for reports of 4 laboratories. TAT is defined as sample collected to report dispatch.

Analyze the data and determine whether there is any difference in average TAT among the different laboratories at 5% significance level.

## We are going to conduct a ANOVA Test on 4 Independent samples with Numerical Data

### We need to check whether the mean of any of these samples are different or the same?

## Step 1

### Make two Hypothesis one contradicting to other

### Null Hypothesis is want we want to prove

- **Null Hypothesis:** $\mu_1 = \mu_2 = \mu_3 = \mu_4$
- **Alternative Hypthosis:** Atleast One of them is Differente

## Step 2

### Decide a cut-off value

- **Significance 5%**
- **alpha = 0.05**

## Step 3

### Collect evidence

### Importing Files

In [18]:
```
labtat = pd.read_csv('LabTAT.csv')
labtat.head()
```

Out[18]:

| | Laboratory 1 | Laboratory 2 | Laboratory 3 | Laboratory 4 |
|---|---|---|---|---|
| **0** | 185.35 | 165.53 | 176.70 | 166.13 |
| **1** | 170.49 | 185.91 | 198.45 | 160.79 |
| **2** | 192.77 | 194.92 | 201.23 | 185.18 |
| **3** | 177.33 | 183.00 | 199.61 | 176.42 |
| **4** | 193.41 | 169.57 | 204.63 | 152.60 |

## Applying Descriptive Statistics

In [19]:
```
labtat.describe()
```

Out[19]:

| | Laboratory 1 | Laboratory 2 | Laboratory 3 | Laboratory 4 |
|---|---|---|---|---|
| **count** | 120.000000 | 120.000000 | 120.000000 | 120.00000 |
| **mean** | 178.361583 | 178.902917 | 199.913250 | 163.68275 |
| **std** | 13.173594 | 14.957114 | 16.539033 | 15.08508 |
| **min** | 138.300000 | 140.550000 | 159.690000 | 124.06000 |
| **25%** | 170.335000 | 168.025000 | 188.232500 | 154.05000 |
| **50%** | 178.530000 | 178.870000 | 199.805000 | 164.42500 |
| **75%** | 186.535000 | 189.112500 | 211.332500 | 172.88250 |
| **max** | 216.390000 | 217.860000 | 238.700000 | 205.18000 |

## Checking for Null Values

In [20]:
```
labtat.isnull().sum()
```

Out[20]:
```
Laboratory 1    0
Laboratory 2    0
Laboratory 3    0
Laboratory 4    0
dtype: int64
```

## Checking for Duplicate Values

In [21]:
```
labtat[labtat.duplicated()].shape
```

Out[21]:
```
(0, 4)
```

In [22]:
```
labtat[labtat.duplicated()]
```

Out[22]:

| Laboratory 1 | Laboratory 2 | Laboratory 3 | Laboratory 4 |
|---|---|---|---|

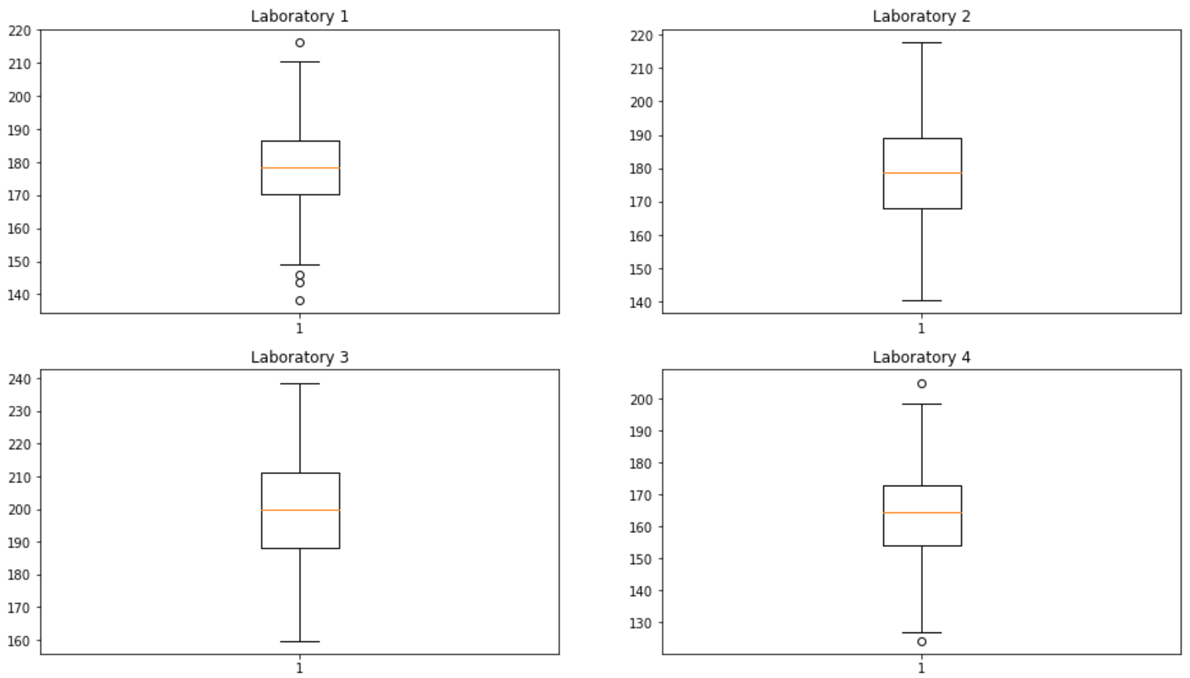
## Checking the data type

In [23]:
```
labtat.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 120 entries, 0 to 119
Data columns (total 4 columns):
 #   Column        Non-Null Count  Dtype  
---  ------        --------------  -----  
 0   Laboratory 1  120 non-null    float64
 1   Laboratory 2  120 non-null    float64
 2   Laboratory 3  120 non-null    float64
 3   Laboratory 4  120 non-null    float64
dtypes: float64(4)
memory usage: 3.9 KB
```

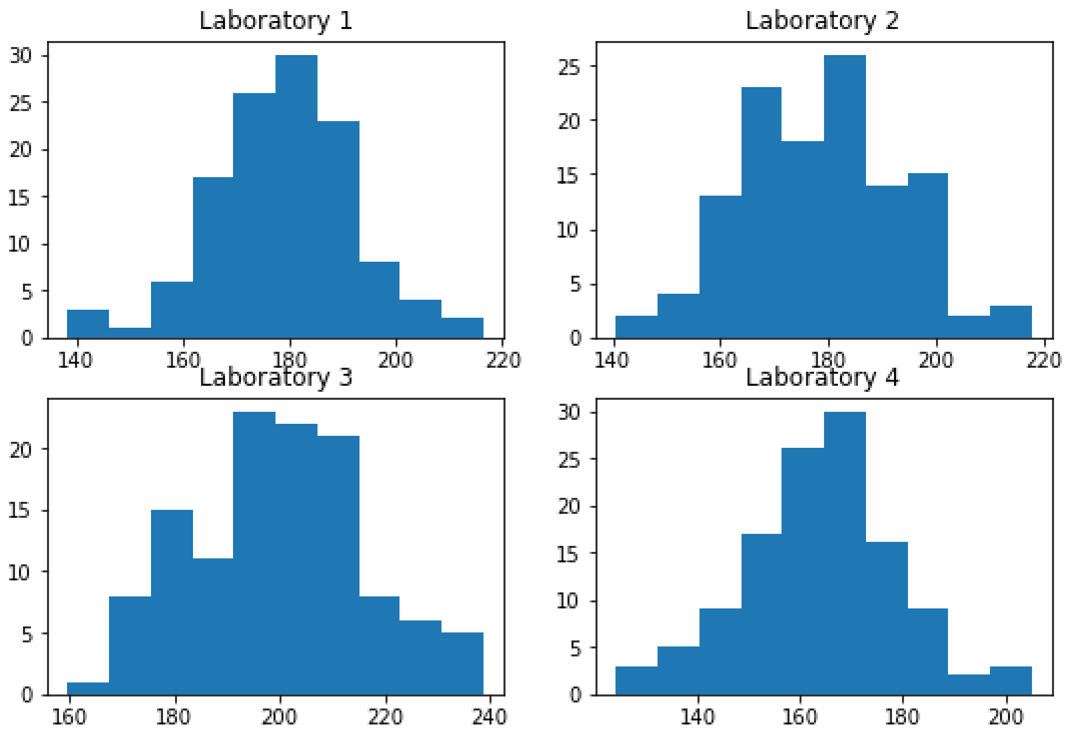
## Plotting the data

In [24]:
```
plt.subplots(figsize = (16,9))
plt.subplot(221)
plt.boxplot(labtat['Laboratory 1'])
plt.title('Laboratory 1')
plt.subplot(222)
plt.boxplot(labtat['Laboratory 2'])
plt.title('Laboratory 2')
plt.subplot(223)
plt.boxplot(labtat['Laboratory 3'])
plt.title('Laboratory 3')
plt.subplot(224)
plt.boxplot(labtat['Laboratory 4'])
plt.title('Laboratory 4')
plt.show()
```




In [25]:
```
plt.subplots(figsize = (9,6))
plt.subplot(221)
plt.hist(labtat['Laboratory 1'])
plt.title('Laboratory 1')
plt.subplot(222)
plt.hist(labtat['Laboratory 2'])
plt.title('Laboratory 2')
plt.subplot(223)
plt.hist(labtat['Laboratory 3'])
plt.title('Laboratory 3')
```

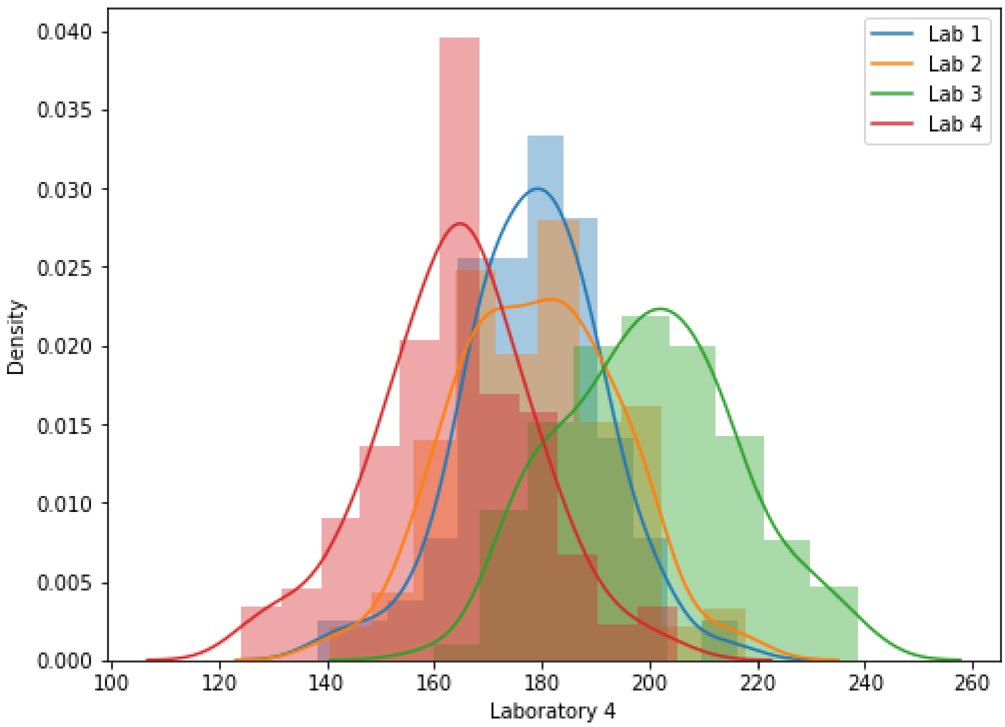
```
plt.subplot(224)
plt.hist(labtat['Laboratory 4'])
plt.title('Laboratory 4')
plt.show()
```




In [26]:

```
plt.figure(figsize = (8,6))
labels = ['Lab 1', 'Lab 2','Lab 3', 'Lab 4']
sns.distplot(labtat['Laboratory 1'], kde = True)
sns.distplot(labtat['Laboratory 2'],hist = True)
sns.distplot(labtat['Laboratory 3'],hist = True)
sns.distplot(labtat['Laboratory 4'],hist = True)
plt.legend(labels)
```

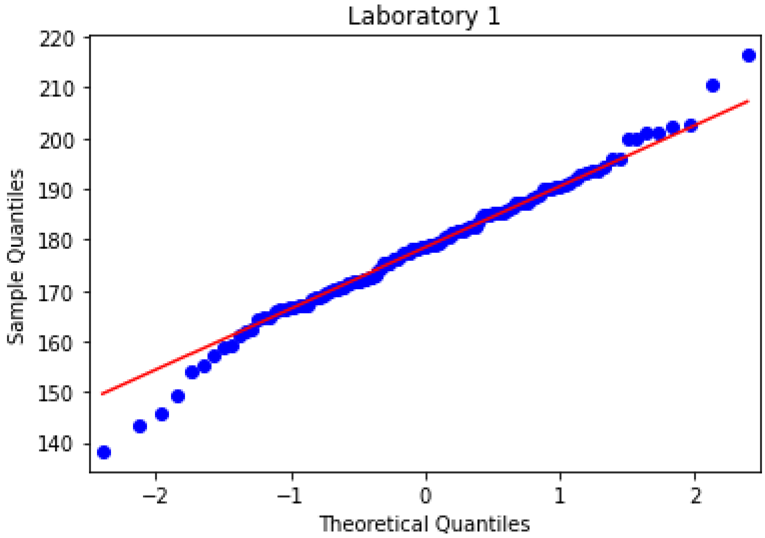
Out[26]: <matplotlib.legend.Legend at 0x1c51081e910>

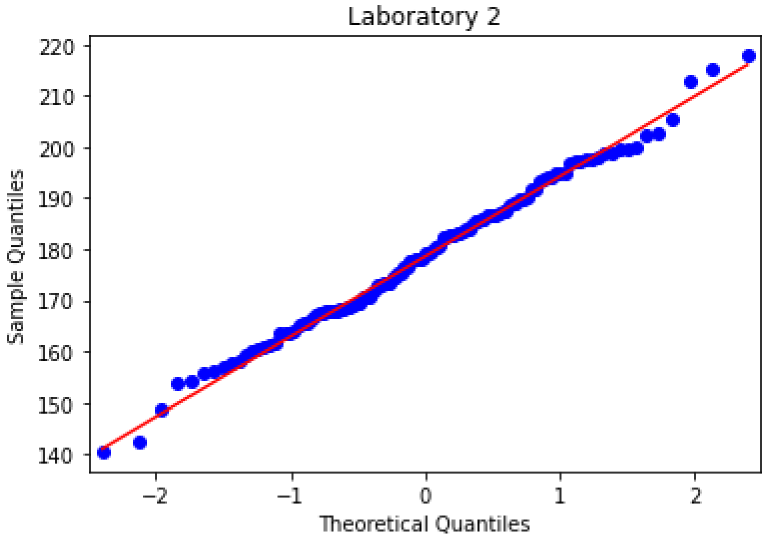


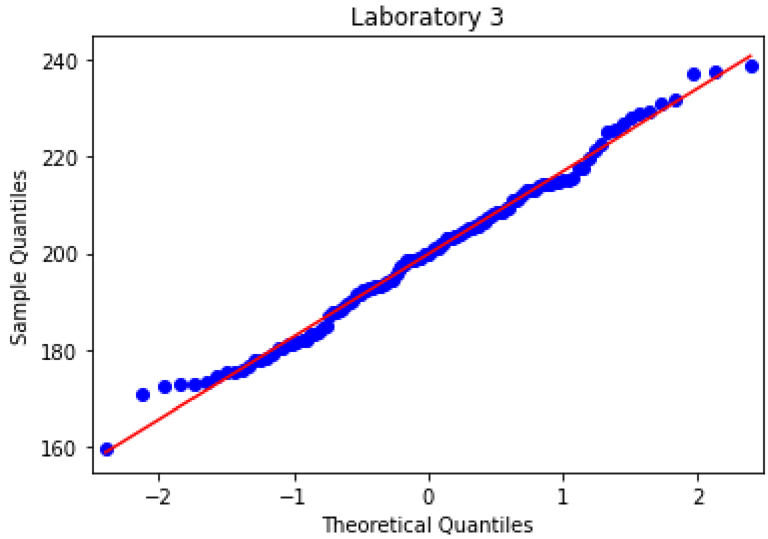

## Plotting Q-Q plot to check whether the distribution follows

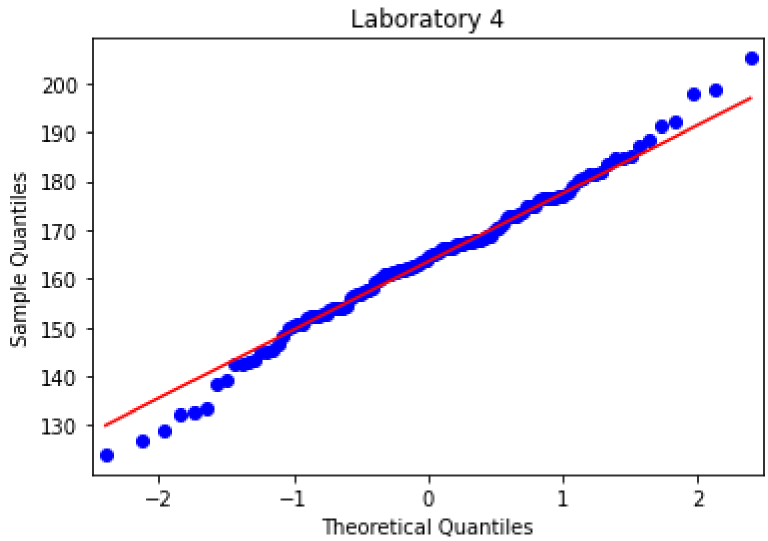
## normal distribution or not

In [27]:
```
sm.qqplot(labtat['Laboratory 1'], line = 'q')
plt.title('Laboratory 1')
sm.qqplot(labtat['Laboratory 2'], line = 'q')
plt.title('Laboratory 2')
sm.qqplot(labtat['Laboratory 3'], line = 'q')
plt.title('Laboratory 3')
sm.qqplot(labtat['Laboratory 4'], line = 'q')
plt.title('Laboratory 4')
plt.show()
```






# Step 4

## Compare Evidences with Hypothesis using t-statictic

In [28]:
```
test_statistic , p_value = stats.f_oneway(labtat.iloc[:,0],labtat.iloc[:,1],labtat
print('p_value =',p_value)
```

```
p_value = 2.1156708949992414e-57
```

## Compare p_value with '$\alpha$ '(Significane Level)

## If p_value is $\neq$ '$\alpha$ ' we failed to reject Null Hypothesis because of lack of evidence

## If p_value is = '$\alpha$ ' we reject Null Hypothesis

## interpreting p-value

In [29]:
```
alpha = 0.05
print('Significnace=%.3f, p=%.3f' % (alpha, p_value))
if p_value <= alpha:
```

```
    print('We reject Null Hypothesis there is a significance difference between TA
else:
    print('We fail to reject Null hypothesis')
```

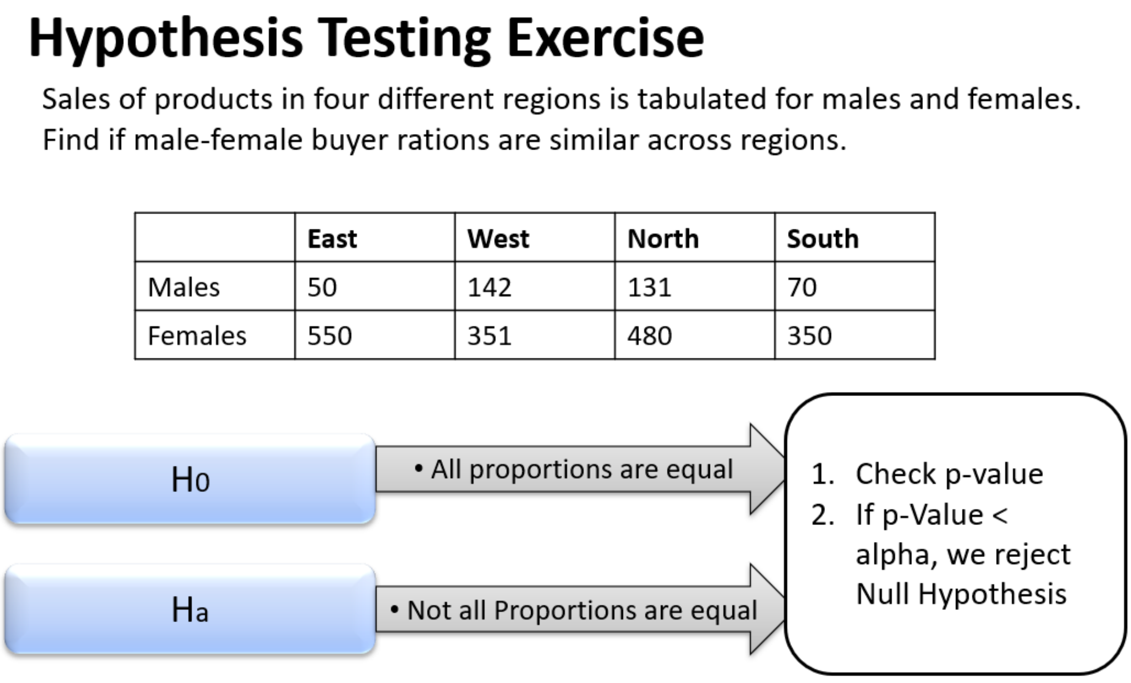
```
Significnace=0.050, p=0.000
We reject Null Hypothesis there is a significance difference between TAT of report
s of the laboratories
```

## Hence, We fail to reject Null Hypothesis because of lack evidence, there is no significant difference between the samples

# Question 3

In [30]:
```
ImageGrab.grabclipboard()
```

Out[30]:




| | East | West | North | South |
|---|---|---|---|---|
| Males | 50 | 142 | 131 | 70 |
| Females | 550 | 351 | 480 | 350 |

## We are going to conduct a Test of Independence using Chi-Square $\chi_2$ test with Contingency table

### We need to check whether the proportion of any of these samples are different or the same?

## Step 1

### Make two Hypothesis one contradicting to other

### Null Hypothesis is want we want to prove

- **Null Hypothesis:** There is no association or dependency between the gender based

buyer rations across regions
- **Alternative Hypthosis:** There is a significant association or dependency between the gender based buyer rations across regions

# Step 2

## Decide a cut-off value

- **Significance 5%**
- **alpha = 0.05**

## As it is a one-tailed test

- **alpha = 1-0.95 = 0.05**

# Step 3

## Collect evidence

## Importing Files

In [32]:
```
buyer = pd.read_csv('BuyerRatio.csv', index_col = 0)
buyer
```

Out[32]:

| | East | West | North | South |
|---|---|---|---|---|
| **Observed Values** | | | | |
| **Males** | 50 | 142 | 131 | 70 |
| **Females** | 435 | 1523 | 1356 | 750 |

In [33]:
```
table = [[50,142,131,70],
         [435,1523,1356,750]]
```

## Applying Chi-Square $\chi_2$ contingency table to convert observed value into expected value

In [34]:
```
stat, p, dof, exp = stats.chi2_contingency(buyer)
print(stat,"\n", p,"\n", dof,"\n", exp)
```

```
1.595945538661058
 0.6603094907091882
 3
 [[  42.76531299  146.81287862  131.11756787   72.30424052]
 [ 442.23468701 1518.18712138 1355.88243213  747.69575948]]
```

In [35]:
```
stats.chi2_contingency(table)
```

Out[35]:
```
(1.595945538661058,
 0.6603094907091882,
 3,
 array([[  42.76531299,  146.81287862,  131.11756787,   72.30424052],
        [ 442.23468701, 1518.18712138, 1355.88243213,  747.69575948]]))
```

In [36]:
```
observed = np.array([50, 142, 131, 70, 435, 1523, 1356, 750])
expected = np.array([42.76531299,  146.81287862,  131.11756787, 72.30424052, 442.2
```

# Step 4

## Comparing Evidence with Hypothesis

In [37]:
```
statistics, p_value = stats.chisquare(observed, expected, ddof = 3)
print("Statistics = ",statistics,"\n",'P_Value = ', p_value)
```

```
Statistics =  1.5959455390914483
 P_Value =  0.8095206646905712
```

## Compare p_value with '$\alpha$ '(Significane Level)

## If p_value is $\neq$ '$\alpha$ ' we failed to reject Null Hypothesis because of lack of evidence

## If p_value is = '$\alpha$ ' we reject Null Hypothesis

## interpreting p-value

In [38]:
```
alpha = 0.05
print('Significnace=%.3f, p=%.3f' % (alpha, p_value))
if p_value <= alpha:
    print('We reject Null Hypothesis there is a significance difference between TA
else:
    print('We fail to reject Null hypothesis')
```

```
Significnace=0.050, p=0.810
We fail to reject Null hypothesis
```

# We fail to reject Null Hypothesis because of lack evidence. Therefore, there is no association or dependency between male-female buyers rations and are similar across regions. Hence, Independent samples

# Question 4

In [39]:
```
ImageGrab.grabclipboard()
```

Out[39]:

# Hypothesis Testing Exercise

TeleCall uses 4 centers around the globe to process customer order forms. They audit a certain % of the customer order forms. Any error in order form renders it defective and has to be reworked before processing. The manager wants to check whether the defective % varies by centre. Please analyze the data at *5%* significance level and help the manager draw appropriate inferences

## We are going to conduct a Test of Independence using Chi-Square $\chi_2$ test with Contingency table

### We need to check whether the mean of any of these samples are different or the same?

## Step 1

### Make two Hypothesis one contradicting to other

### Null Hypothesis is want we want to prove

- **Null Hypothesis:** $\mu_1 = \mu_2 = \mu_3 = \mu_4$
- **Alternative Hypthosis:** Atleast One of them is Differente

## Step 2

## Decide a cut-off value

- **Significance 5%**
- **alpha = 0.05**

## Step 3

## Collect evidence

### Importing Files

In [42]:

```
centers = pd.read_csv('Costomer+OrderForm.csv')
centers.head(10)
```

Out[42]:

| | Phillippines | Indonesia | Malta | India |
|---|---|---|---|---|
| **0** | Error Free | Error Free | Defective | Error Free |
| **1** | Error Free | Error Free | Error Free | Defective |
| **2** | Error Free | Defective | Defective | Error Free |
| **3** | Error Free | Error Free | Error Free | Error Free |
| **4** | Error Free | Error Free | Defective | Error Free |
| **5** | Error Free | Error Free | Error Free | Error Free |
| **6** | Error Free | Defective | Error Free | Error Free |
| **7** | Error Free | Error Free | Error Free | Error Free |
| **8** | Error Free | Error Free | Error Free | Error Free |
| **9** | Error Free | Error Free | Error Free | Error Free |

## Applying Descriptive Statistics

In [43]:
```
centers.describe()
```

Out[43]:

| | Phillippines | Indonesia | Malta | India |
|---|---|---|---|---|
| **count** | 300 | 300 | 300 | 300 |
| **unique** | 2 | 2 | 2 | 2 |
| **top** | Error Free | Error Free | Error Free | Error Free |
| **freq** | 271 | 267 | 269 | 280 |

## Checking for Null Values

In [44]:
```
centers.isnull().sum()
```

Out[44]:
```
Phillippines    0
Indonesia       0
Malta           0
India           0
dtype: int64
```

In [45]:
```
centers[centers.isnull().any(axis=1)]
```

Out[45]:

| Phillippines | Indonesia | Malta | India |
|---|---|---|---|

## Checking the data type

In [46]:
```
centers.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 300 entries, 0 to 299
Data columns (total 4 columns):
 #   Column        Non-Null Count  Dtype 
---  ------        --------------  ----- 
 0   Phillippines  300 non-null    object
 1   Indonesia     300 non-null    object
 2   Malta         300 non-null    object
 3   India         300 non-null    object
dtypes: object(4)
memory usage: 9.5+ KB
```

## Checking value counts in data

In [47]:
```
print(centers['Phillippines'].value_counts(),'\n',centers['Indonesia'].value_count:
```

```
Error Free    271
Defective      29
Name: Phillippines, dtype: int64
 Error Free    267
Defective      33
Name: Indonesia, dtype: int64
 Error Free    269
Defective      31
Name: Malta, dtype: int64
 Error Free    280
Defective      20
Name: India, dtype: int64
```

## Creating Contingency table

In [48]:
```
contingency_table = [[271,267,269,280],
                     [29,33,31,20]]
print(contingency_table)
```

```
[[271, 267, 269, 280], [29, 33, 31, 20]]
```

## Calculating Expected Values for Observed data

In [49]:
```
stat, p, df, exp = stats.chi2_contingency(contingency_table)
print("Statistics = ",stat,"\n",'P_Value = ', p,'\n', 'degree of freedom =', df,'\ı
```

```
Statistics =  3.858960685820355
 P_Value =  0.2771020991233135
 degree of freedom = 3
 Expected Values =  [[271.75 271.75 271.75 271.75]
 [ 28.25  28.25  28.25  28.25]]
```

## Defining Expected values and observed values

In [50]:
```
observed = np.array([271, 267, 269, 280, 29, 33, 31, 20])
expected = np.array([271.75, 271.75, 271.75, 271.75, 28.25, 28.25, 28.25, 28.25])
```

# Step 4

## Compare Evidences with Hypothesis using t-statictic

In [51]:
```
test_statistic , p_value = stats.chisquare(observed, expected, ddof = df)
print("Test Statistic = ",test_statistic,'\n', 'p_value =',p_value)
```

```
Test Statistic =  3.858960685820355
 p_value = 0.4254298144535761
```

### Plotting the data

### Compare p_value with '$\alpha$ '(Significane Level)

### If p_value is $\neq$ '$\alpha$ ' we failed to reject Null Hypothesis because of lack of evidence

### If p_value is = '$\alpha$ ' we reject Null Hypothesis

### interpreting p-value

In [52]:
```
alpha = 0.05
print('Significnace=%.3f, p=%.3f' % (alpha, p_value))
if p_value <= alpha:
    print('We reject Null Hypothesis there is a significance difference between TAT
else:
    print('We fail to reject Null hypothesis')
```

```
Significnace=0.050, p=0.425
We fail to reject Null hypothesis
```

## We fail to reject Null Hypothesis because of lack of evidence.

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: