Impact of Covid-19 on Aviation

AE102 Project

Team Aero-Souls (Group 9)

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Video Link - Click Here!

Contents

Data Sources: Please click on them to view

- Source 1
- Source 2
- Source 3
- Source 4

1 Introduction:

The Covid-19-19 pandemic had a massive impact on the Indian aviation sector in 2020 and major airlines facing losses and challenging times laid off employees, sent them on leave without pay, or cut their salaries.

The aim of this project is to further analyse this impact and find out statistically how much the impact of Covid-19-19 really is on the Indian aviation industry.

About Data: The data used is the Number of Passengers and the Number of Aircrafts travelling domestically in the year 2019 and 2020. The aim of this analysis is to compare the data from the year 2019 (before Covid-19-19) and 2020 (after Covid-19-19) to analyse the effect of Covid-19 19 on the aviation industry in India

This is how our data looks like:

- 2019

Month	No. of Passengers	No. of Aircrafts	No. of International passengers	No. of International Aircrafts
Jan	125.08	189.23	59.3	40.29
Feb	113.49	165.21	50.9	35.62
Mar	115.96	175.40	49.6	37.74
Apr	109.95	166.83	51.0	34.33
May	121.87	177.94	51.9	35.00
June	120.25	176.25	52.7	34.59
July	119.05	179.22	55.4	36.62
Aug	117.93	179.50	52.0	37.62
Sep	115.33	176.02	49.8	37.20
Oct	123.16	192.25	53.2	38.67
Nov	129.47	189.22	54.0	38.71
Dec	130.18	184.20	57.6	40.35

- 2020

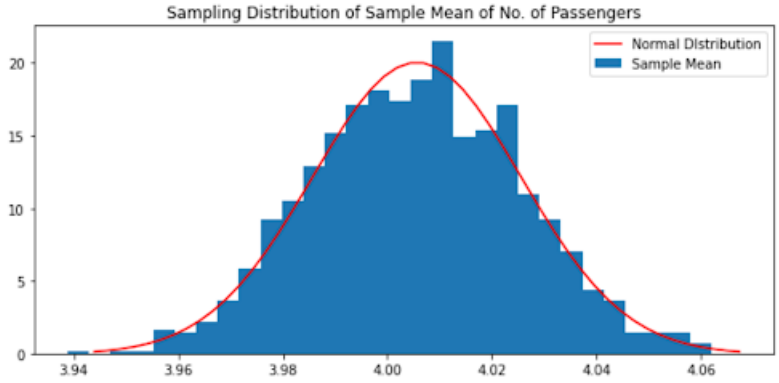
Month	No. of Passengers	No. of Aircrafts	No. of International passengers	No. of International Aircrafts
Jan	127.83	195.21	64.9	40.07
Feb	123.68	185.93	54.1	36.55
Mar	77.62	142.07	25.7	22.00
Apr	0.10	2.92	0.5	2.60
May	2.81	12.40	1.1	4.63
June	19.84	50.50	3.9	8.45
July	21.07	56.45	5.5	10.10
Aug	28.32	64.53	5.9	10.30
Sep	39.43	86.01	6.6	11.12
Oct	52.71	106.45	8.5	12.08
Nov	63.54	115.60	10.4	13.06
Dec	73.27	136.05	13.5	14.80

2 Sampling Distributions

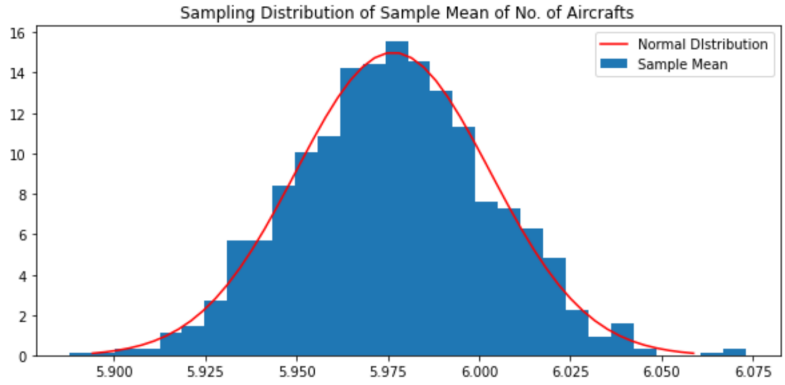
Following are the distributions:

1.Sample Mean:

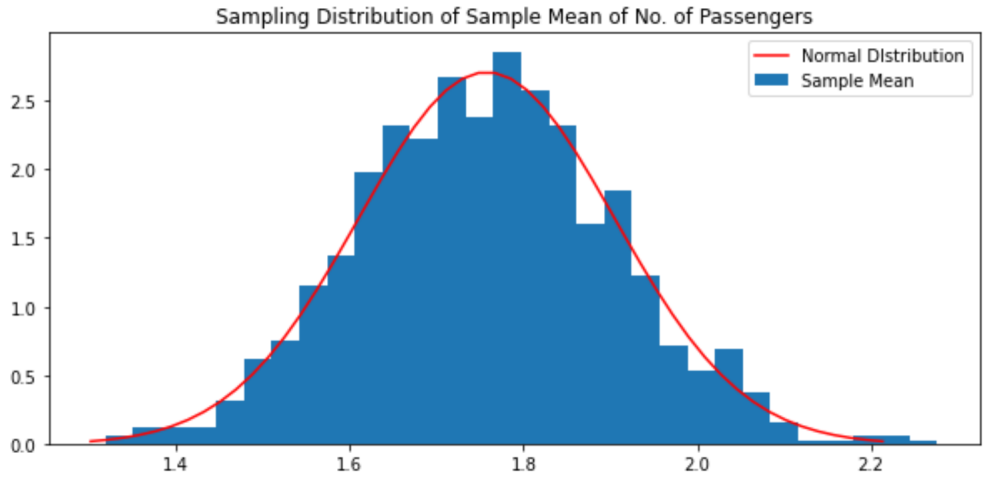
- 2019:Number of Passengers



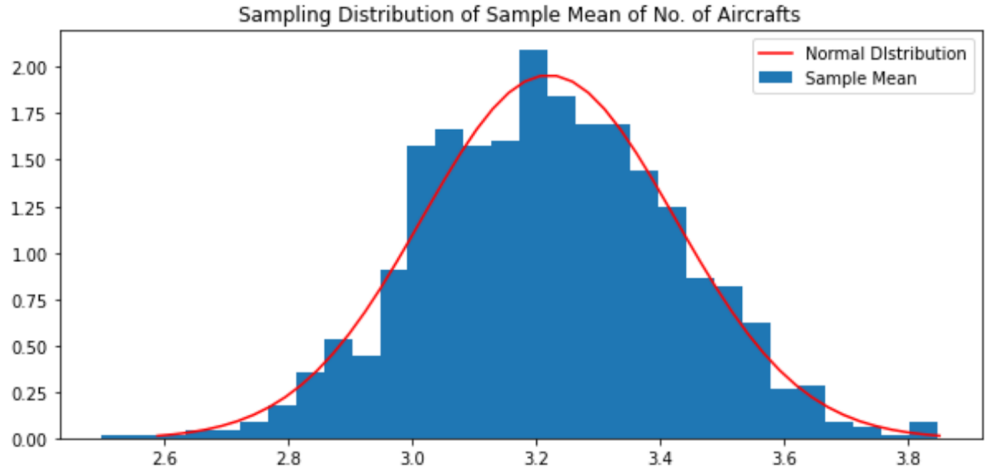
- 2019:Number of Aircrafts



- 2020:Number of Passengers



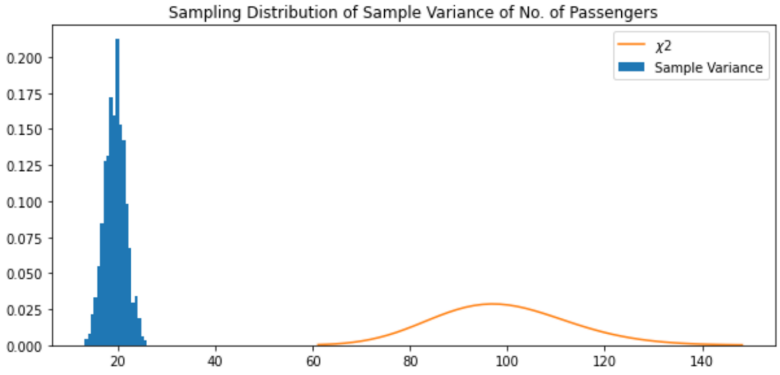
- 2019:Number of Aircrafts



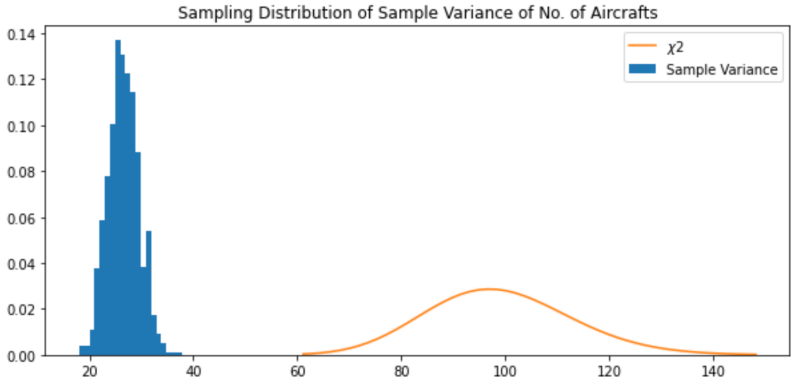
These graphs also prove the **Central Limit Theorem**.

2.Sample Variance:

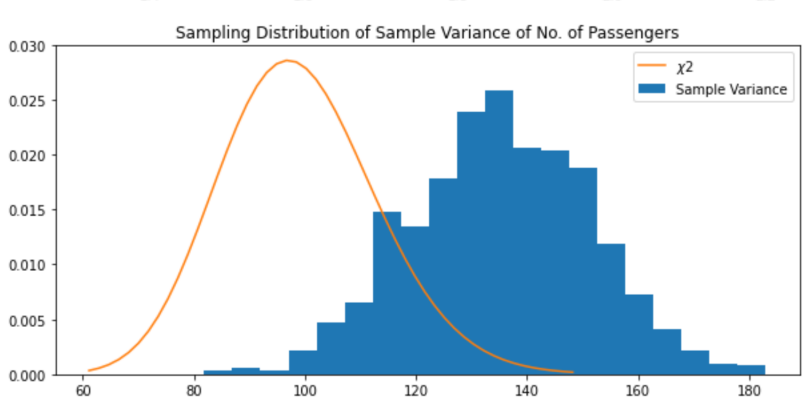
- 2019:Number of Passengers



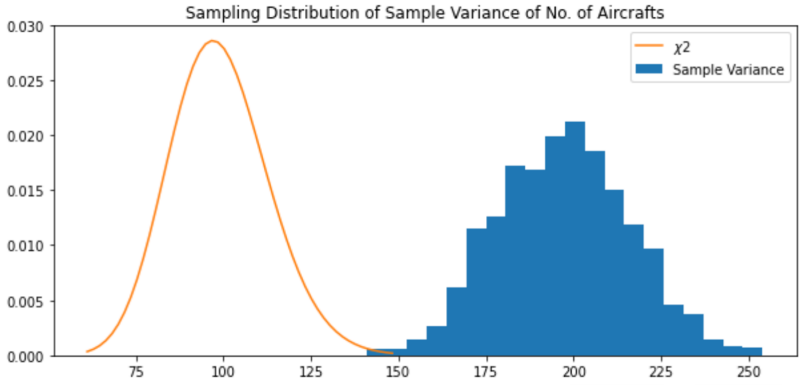
- 2019:Number of Aircrafts



- 2020:Number of Passengers



- 2020:Number of Aircrafts



The sampling distribution of the sample variance does not fit the χ^2 distribution. This is because the data set used is not normally distributed.

3 True Parameters of our Distribution

True mean and True variance are represented by μ and σ^2 respectively.

- 2019:Number of Passengers

  μ=120.14

  σ^2=34.92

- 2019:Number of Aircrafts

  μ=179.2725

  σ^2=64.9925

- 2020:Number of Passengers

  μ=52.518

  σ^2=1662.533

- 2020:Number of Aircrafts

  μ=96.17

  σ^2=3543.91

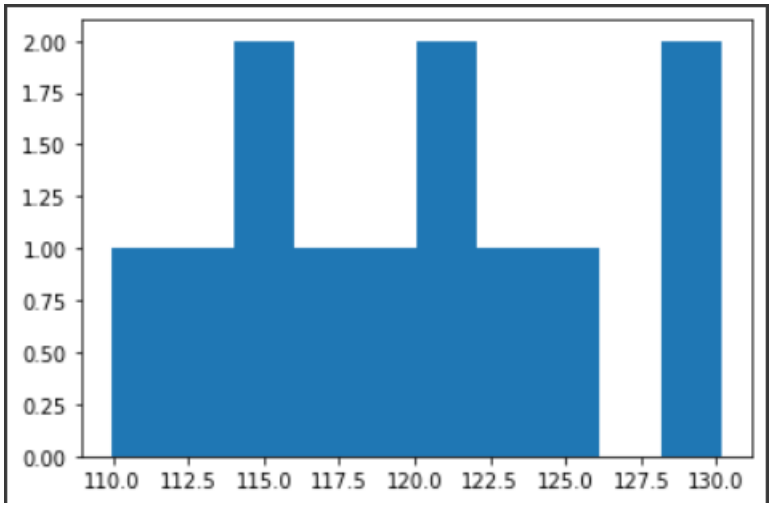
We can clearly see that the mean for both our random variables, number of passengers and number of aircrafts is significantly lesser in the year 2020 as compared to the year 2019.

What we also notice is that the variance is significantly greater in the year 2020 as compared to 2019. This could be because of the change in the impact of Covid-19-19 on our country and the changing travel restrictions throughout the year 2020.

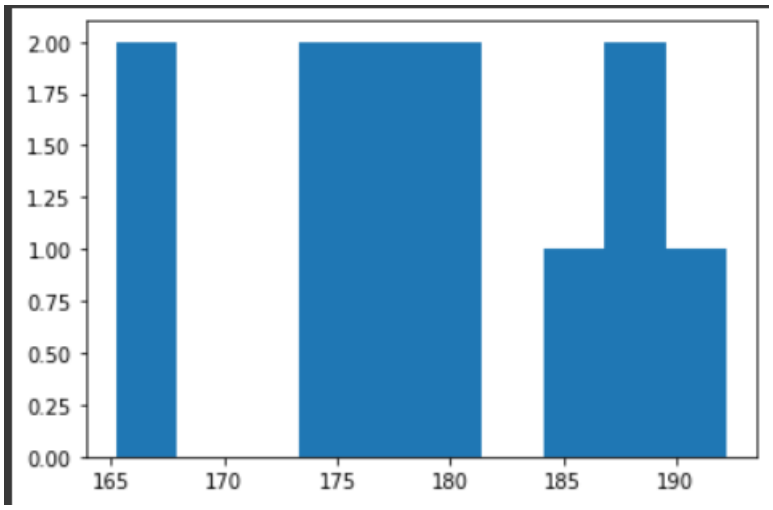
4 True Parameter Distribution

Since we have only 12 data points for each Variable in our data we weren't able to figure out the distribution.

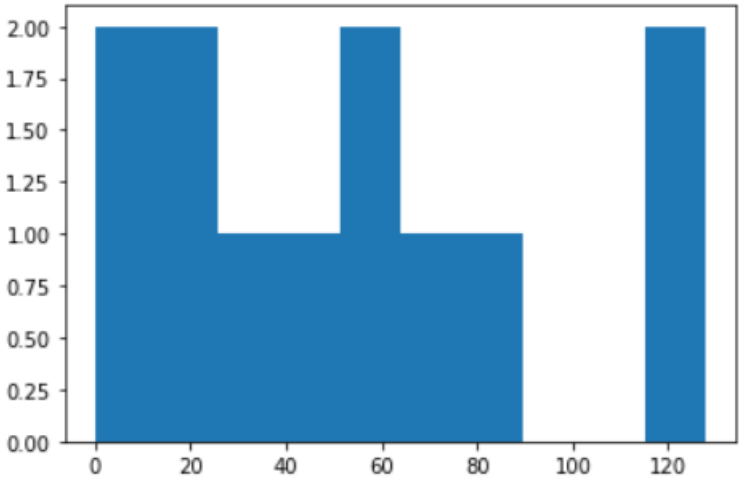
- 2019
  - Number of Passengers



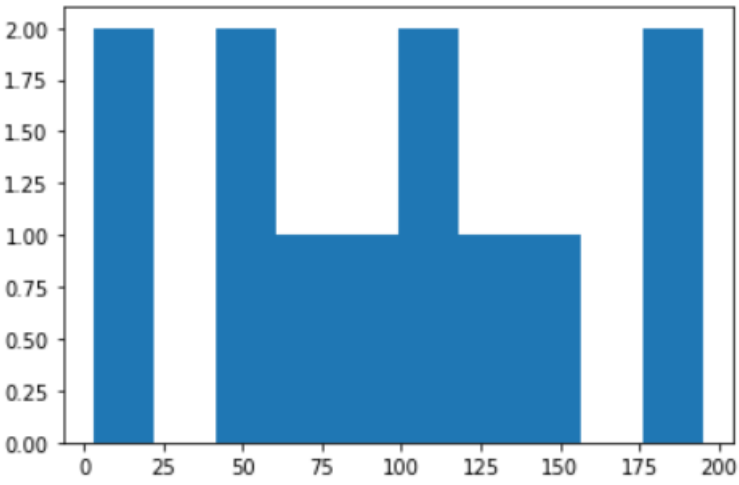
  - Number of Aircrafts



- 2020
  - Number of Passengers

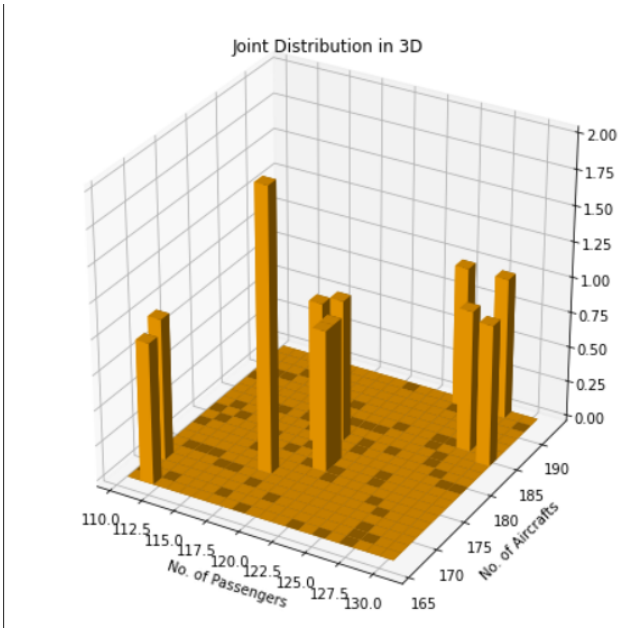


  - Number of Aircrafts

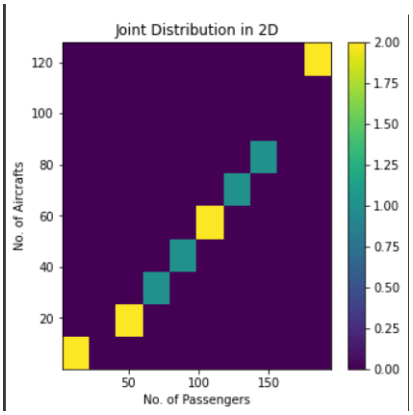


5 Joint Distribution

- 3D



- 2D



6 Computing Point Estimates (Sample Mean and Sample Variance):

If we choose a sample size of 10, our observations are:

Sample Mean and Sample Variance are represented by $\bar{X}$ and S^2 respectively.

- 2019:Number of Passengers

  $\bar{X}$=120.04

  μ=120.14

  S^2=46.58

  σ^2=34.92

- 2019:Number of Aircrafts

  $\bar{X}$=179.3769

  μ=179.2725

  S^2=86.6567

  σ^2=64.9925

- 2020:Number of Passengers

  $\bar{X}$=52.768

  μ=52.518

  S^2=2216.711

  σ^2=1662.533

- 2020:Number of Aircrafts

  $\bar{X}$=96.18

  μ=96.17

  S^2=4725.21

  σ^2=3543.91

Also as the sample size is increased, the results are more and more accurate.

Example:

- **Sample size=3**

  2020:Number of Aircrafts

  $\bar{X}$=97.23

  μ=96.17

  S^2=21263.46

  σ^2=3543.91

- **Sample size=12**

  2020:Number of Aircrafts

  $\bar{X}$=95.98

  μ=96.17

  S^2=3866.08

  σ^2=3543.91

7 Computing Interval Estimates

Finding interval estimates with 95 % confidence,

- 2019:
  - Number of passengers: (in lakhs)
    - 95% Confidence Intervals for Sample Mean is 120.475 - 126.9788
    - 95% Confidence Intervals for Sample Variance is 12.050 - 60.654
  - Number of aircrafts: (in thousands)
    - 95% Confidence Intervals for Sample Mean is 171.94 - 180.13
    - 95% Confidence Intervals for Sample Variance is 23.80 - 113.05
- 2020:
  - Number of passengers: (in lakhs)
    - 95% Confidence Intervals for Sample Mean is 30.62 - 88.12
    - 95% Confidence Intervals for Sample Variance is 530.55- 2836.87
  - Number of aircrafts: (in thousands)
    - 95% Confidence Intervals for Sample Mean is 72.46 - 149.01
    - 95% Confidence Intervals for Sample Variance is 1270.27 - 5993.74

8 Hypothesis Testing

Idea : Idea is to compare the distribution of passengers and aircrafts of both the years (i.e. 2019 2020) on quarterly basis.

- **Jan - Mar** : This quarter is the pre-Covid-19 quarter of 2020 and should be the least impacted quarter of the aviation industry.
- **Apr - Jun** : This is the Covid-19 quarter of 2020 and should be the most impacted quarter of the aviation industry.
- **Jul - Sep** : This is the post-Covid-19 quarter of 2020 and should show slight recovery.
- **Oct - Dec** : This is also the post-Covid-19 quarter of 2020 and should show slight recovery compared to the previous quarter.

8.1 Analysis for Number of passengers:

Let X be the distribution for year 2019 (before Covid) and Y be for the year 2020 (after Covid)

- $H_0 : \mu_x = \mu_y$
- $H_1 : \mu_x > \mu_y$

DISTRIBUTION :

Case of distribution is known variance - $\frac{\bar{X} - \bar{Y}}{\sqrt{(\frac{(\sigma^2)x}{n} + \frac{(\sigma^2)y}{m})}}$

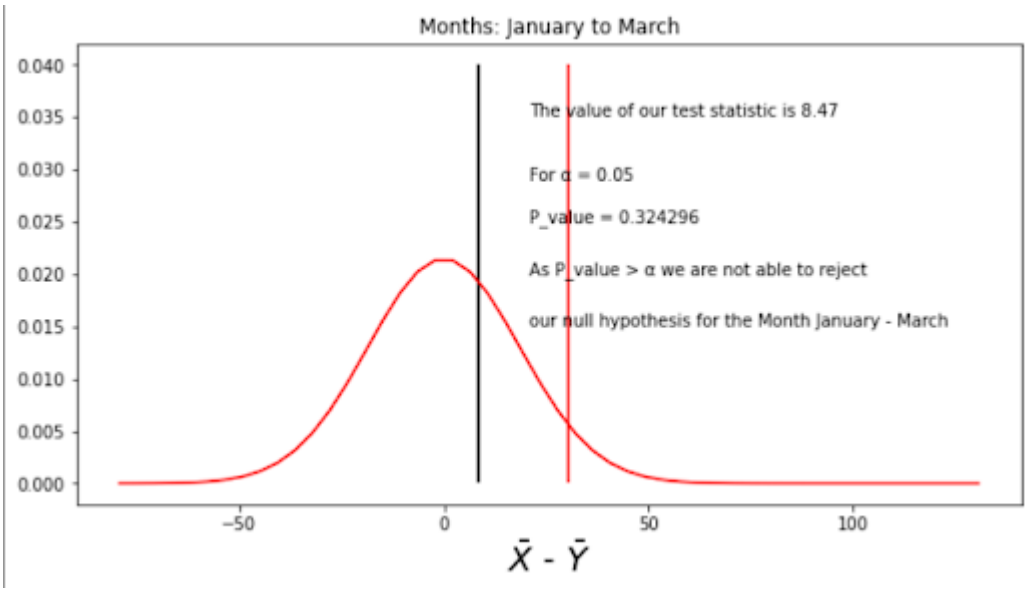
Therefore test statics is :$\bar{X}$ - $\bar{Y}$

α= 0.05

If $\alpha >$ p-value : Reject Hypothesis

Else : Fail to reject Hypothesis

- **JAN - MAR**



From the graph it is clearly seen that

$\bar{X}$ - $\bar{Y}$= **8.47**

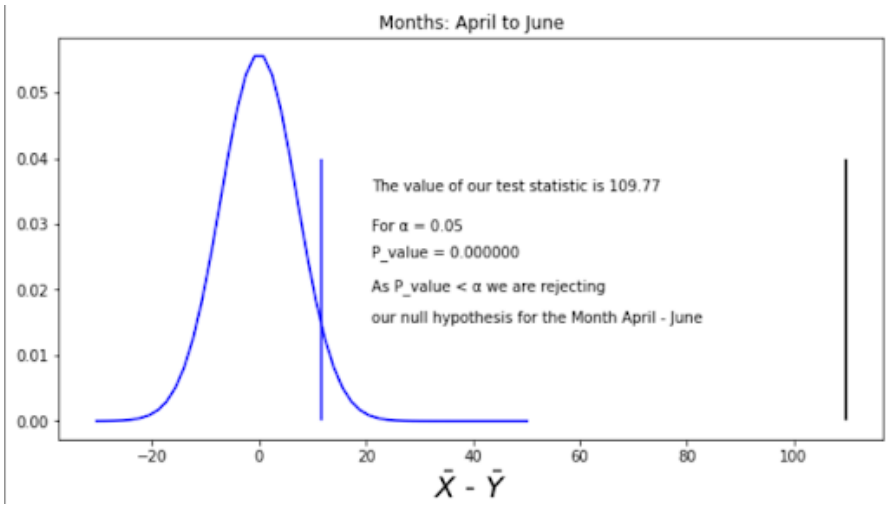
p - value = 0.208

Clearly, **p - value** $> \alpha$

Therefore, we fail to reject Null Hypothesis

CONCLUSION: Clearly, this quarter has not been impacted due to Covid-19.

- **APR - JUN**



From the graph it is clearly seen that

$\bar{X}$ - $\bar{Y}$= **109.77**

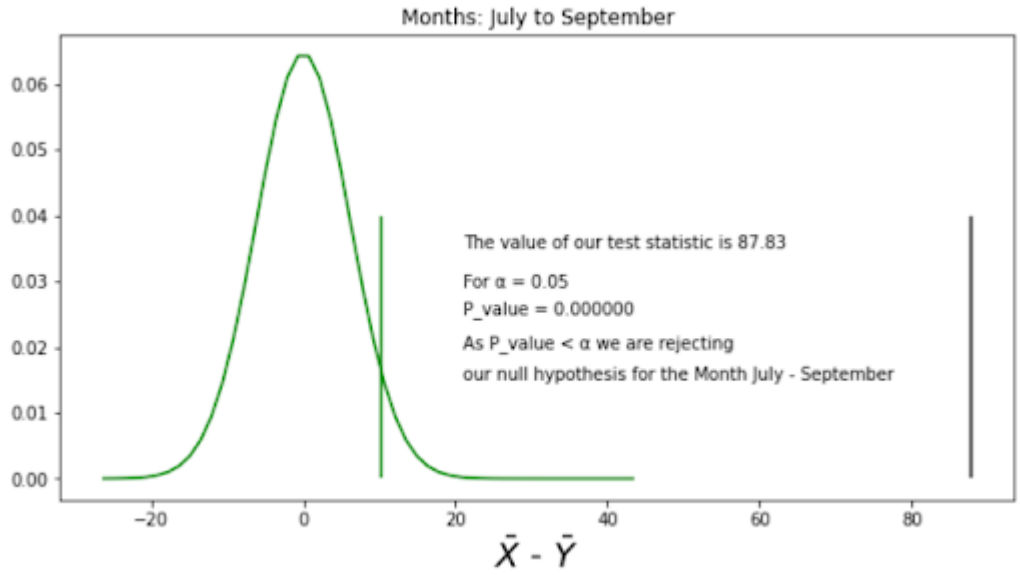
p - value = nearly zero

Clearly, **p - value** $< \alpha$

Therefore, Null Hypothesis is rejected.

CONCLUSION: Clearly, this quarter is heavily impacted by Covid-19.

- **JULY - SEP**



From the graph it is clearly seen that

$\bar{X}$ - $\bar{Y}$= **87.83**

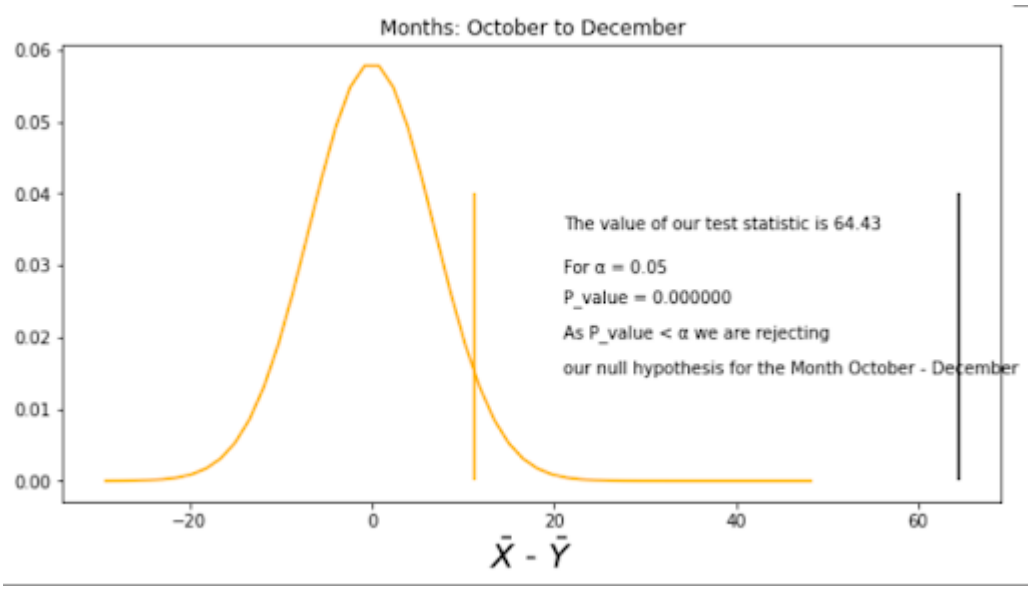
p - value = nearly zero

Clearly, **p - value** $< \alpha$

Therefore, Null Hypothesis is rejected.

CONCLUSION: Clearly, this quarter is also heavily impacted by Covid-19, $\bar{X}$ - $\bar{Y}$ is also large but smaller than that of 2nd quarter.

- **OCT - DEC**



From the graph it is clearly seen that

$\bar{X}$ **-** $\bar{Y}$**= 64.43**

p - value = nearly zero

Clearly, **p - value** $< \alpha$

Therefore, Null Hypothesis is rejected.

CONCLUSION: Clearly, this quarter is also heavily impacted by Covid-19, $\bar{X}$ - $\bar{Y}$ is also large but smaller than that of 3rd quarter.

8.2 Analysis for number of Aircrafts:

Let X be the distribution for year 2019 (before Covid) and Y be for the year 2020 (after Covid)

- $H_0 : \mu_x = \mu_y$

- $H_1 : \mu_x > \mu_y$

DISTRIBUTION :

Case of distribution is equal variance - $\frac{\bar{X}-\bar{Y}}{\sqrt{(\frac{(\sigma^2)x}{n}+\frac{(\sigma^2)y}{m})}}$

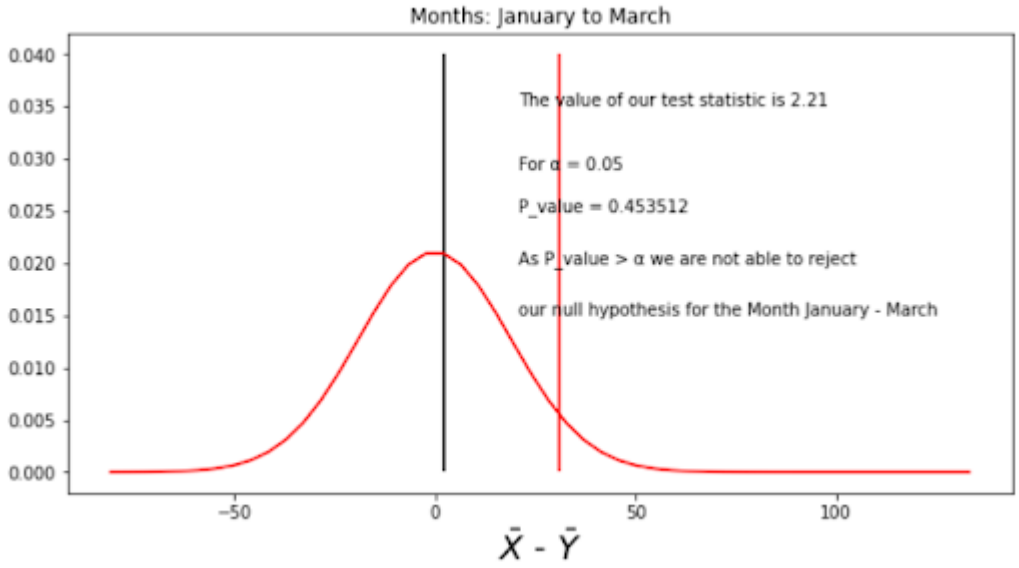
Therefore test statics is : $\bar{X}$ - $\bar{Y}$

α= 0.05

If $\alpha >$ p-value : Reject Hypothesis

Else : Fail to reject Hypothesis

- **JAN-MAR**



From the graph it is clearly seen that

$\bar{X}$ - $\bar{Y}$= **2.21**

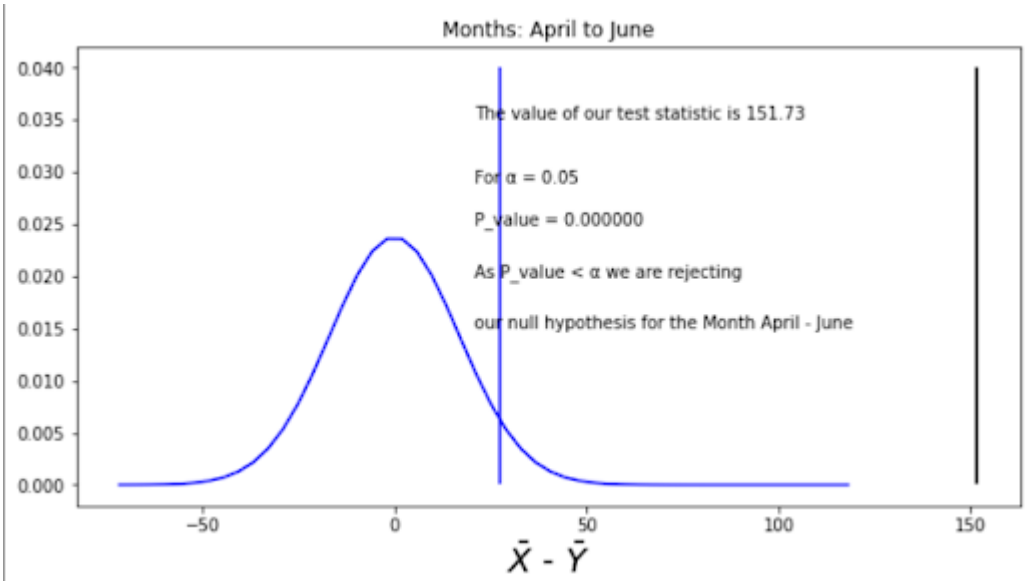
p - value = 0.422

Clearly, **p - value** $> \alpha$

Therefore, we fail to reject Null Hypothesis

CONCLUSION: Clearly, this quarter has not been impacted majorly due to Covid-19.

- **APR - JUN**



From the graph it is clearly seen that

$\bar{X}$ - $\bar{Y}$= **151.73**

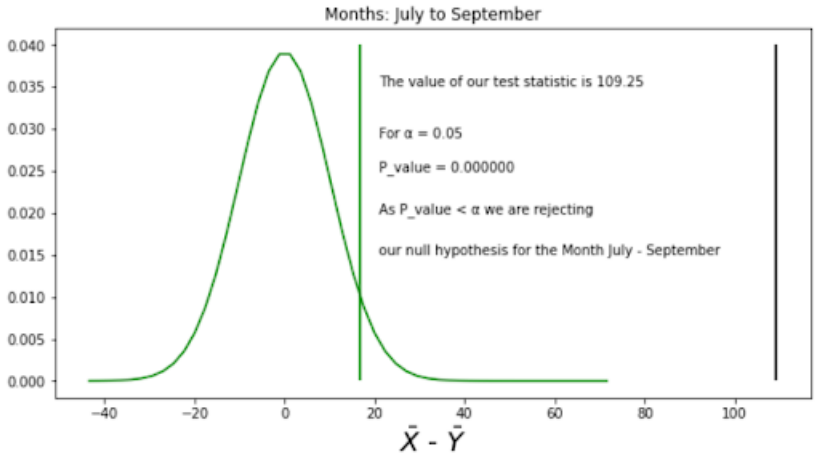
p - value = nearly zero

Clearly, **p - value** $< \alpha$

Therefore, Null Hypothesis is rejected

CONCLUSION: Clearly, this quarter is heavily impacted by Covid-19,

- **JULY-SEP**



From the graph it is clearly seen that

$\bar{X}$ - $\bar{Y}$= **109.25**

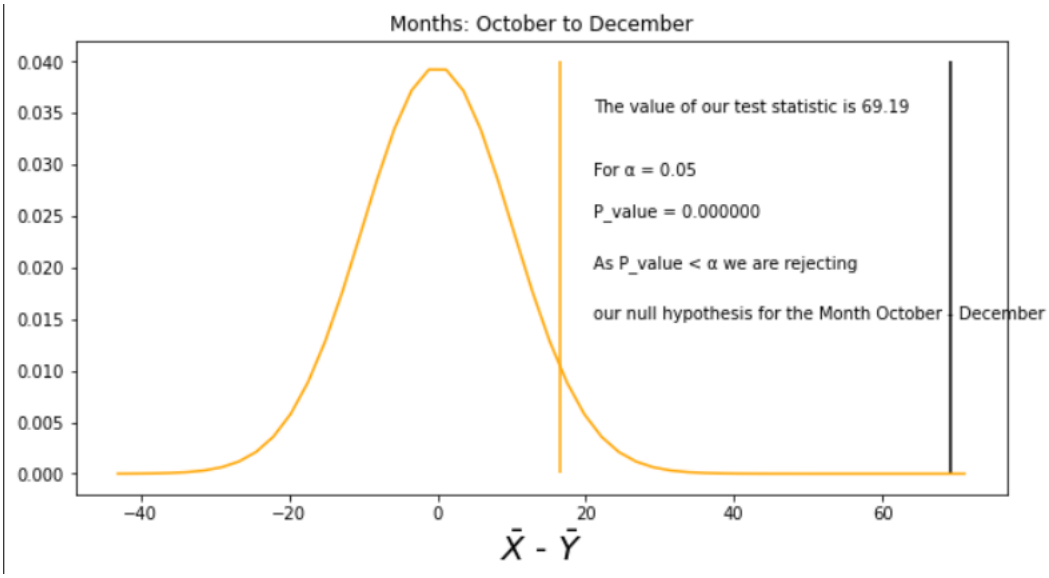
p - value = nearly zero

Clearly, **p - value** $< \alpha$

Therefore, Null Hypothesis is rejected

CONCLUSION: Clearly, this quarter is also heavily impacted by Covid-19, $\bar{X}$ - $\bar{Y}$ is also large but smaller than that of 2nd quarter.

- **OCT-DEC**



From the graph it is clearly seen that

$\bar{X}$ - $\bar{Y}$= **69.19**

p - value = nearly zero

Clearly, **p - value** $< \alpha$

Therefore, Null Hypothesis is rejected

CONCLUSION: Clearly, this quarter is also heavily impacted by Covid-19, $\bar{X}$ - $\bar{Y}$ is also large but smaller than that of 3rd quarter.

8.3 Final Conclusion:

1st quarter was not impacted and the rest 3 were heavily impacted but if $\bar{X}$ - $\bar{Y}$ is observed of each quarter ,it is seen that $\bar{X}$ - $\bar{Y}$ continuously decreases for the last three quarters which means aviation industry is on the path of recovery.

9 Correlation between our Random variables

Calculating the correlation coefficient for our 2 random variables for the year 2019 and 2020, The result is as expected.

- **For 2019**

	No. of Passengers	No. of Aircrafts
No. of Passengers	1.000000	0.839063
No. of Aircrafts	0.839063	1.000000

Planes flew with less number of passengers and the number of planes was closely related to the number of passengers.

- **For 2020**

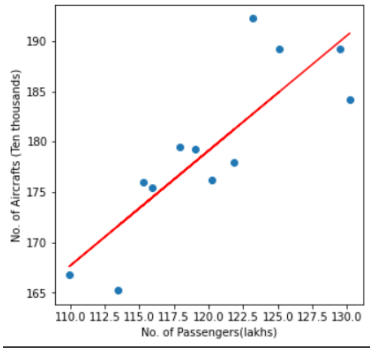
	No. of Passengers	No. of Aircrafts
No. of Passengers	1.000000	0.986495
No. of Aircrafts	0.986495	1.000000

In the above cell the correlation is lesser than that in 2020 as in 2019 there were approximately 200-300 passengers in each flight on an average while lesser in some flights while in 2020 almost all the flights had similar number of passengers.

10 Regression

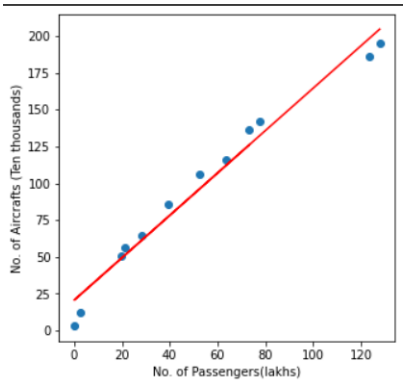
Even though we don't have sufficient data we can compute the number of aircrafts required for a particular number of passengers using linear regression.

- 2019:



In this graph we can see that the approximation for the number of aircrafts according to the number of passengers for the year 2019 will not be accurate as the data is not that linear. The R^2 value is 0.97.

- 2020



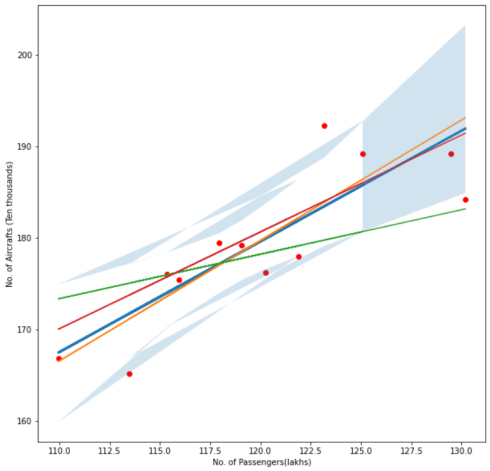
In the above graph we can see that the approximation for the number of aircrafts according

to the number of passengers for the year 2020 will be accurate as the data is almost linear and we are applying linear regression. The R^2 value is 0.70.

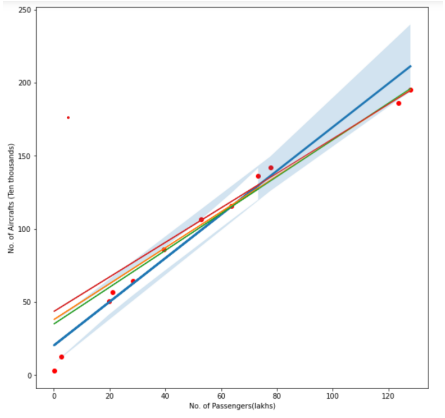
11 Confidence Intervals for Regression

We will be taking the 90% confidence intervals in this case. This will show us the region of the graph in between which the perfect fit line lies.

- 2019



- 2020



12 Conclusion

Concluding our project, we created the sampling distributions of sample mean and sample variance, computed point and interval estimates for mean and variance and also showed the joint and marginal distributions for our parameters. We analysed the relationship between our random variables and found that the number of aircrafts and the number of passengers were mostly correlated with a better correlation in 2020 rather than 2019. We tested our hypothesis of covid affecting the aviation industry and found out that 1st quarter of 2020 (January- March) was not impacted by covid-19 and had normal expected values as compared to 2019, but the last 3 quarters of 2020 were heavily impacted by covid-19 with the impact decreasing from 2nd to the last quarter as the industry slowly recovered from the pandemic.