STATISTICAL METHODS FOR DECISION MAKING

An Internship Project Report

Submitted in partial fulfillment of the requirement for the award of the

Degree of Bachelor of Science in Mathematics

Submitted by

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(Affiliated to Bharathiyar University, Coimbatore)

ACCREDITED AT 'A+' GRADE WITH CGPA 3.27 BY NAAC

AN ISO 9001:2008 CERTIFIED INSTITUTION

UDUMALPET-642 128

March-2021

CERTIFICATE:

This is to certify that the Internship project work entitled **"STATISTICAL METHODS FOR DECISION MAKING"** is a bonafied record work done by **M.HEMALATHA (18BM7450)** submitted in partial fulfillment of the requirements for the award of the Degree of Bachelor of Science in Mathematics at Sri G.V.G Visalakshi college for women (Autonomous), Udumalpet during the academic year 2020-2021.

Signature of the Guide **Signature of the HOD**

E-CERTIFIATE

INTRODUCTION:

The Internship training program was organized in **GREAT LEARNING** application launched by Mohan lakhamraju in 2013. **Great Learning** is one of India's leading ed-tech companies for professional and higher education. This is the no. 1 ranked online classroom course on Artificial Intelligence, Machine Learning, Data Science Engineering and Deep learning for college students professionally. The trainer Dr.Abhinanda Sarkar taught us about "**STATISTICAL METHODS FOR DECISION MAKING**." In this he tells about sampling, normal distribution, hypothesis testing, chi-square test and Anova.

DIGITAL TOOL:

Dr.Abhinanda Sarkar Professor of Statistics gave us training under the topic "STATISTICAL METHODS FOR DECISION MAKING."

1. Sampling
2. Normal distribution
3. Hypothesis testing
4. Type 1 and Type 2 errors
5. Types of hypothesis tests
6. Confidence intervals
7. Examples of Hypothesis testing
8. Chi-Square test
9. ANOVA

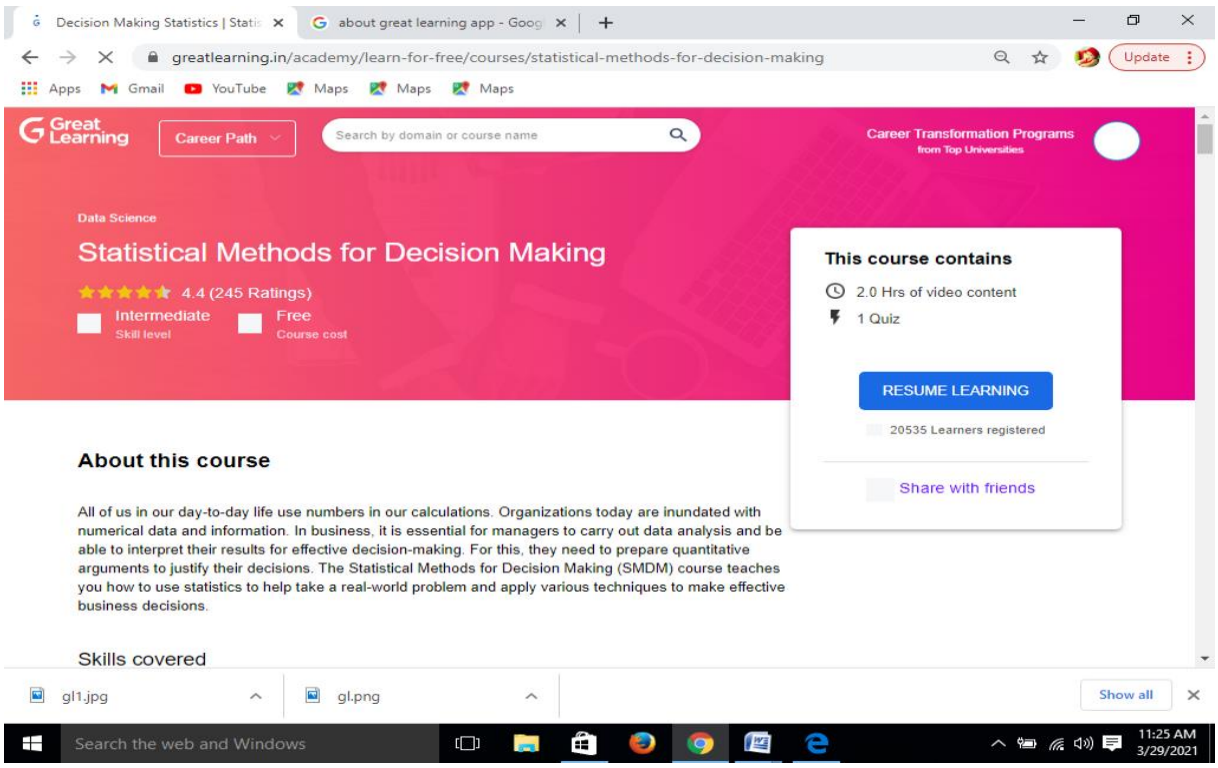
PG Programs Overview

10. Data Science and Business Analytic(DSBA)

11. Artifical Intelligence & Machine Learning

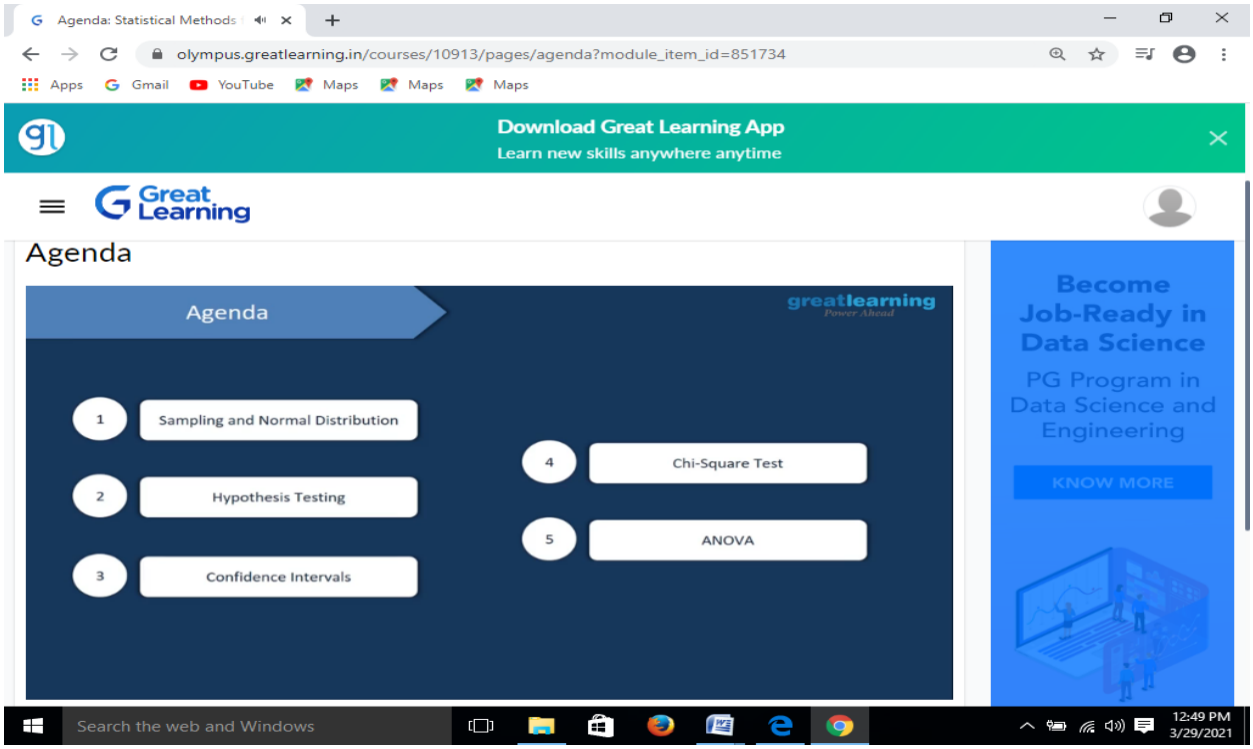
Uses of Statistical methods for decision making:

- **Statistics** can also aid the **decision making process** by enabling us to establish numerical benchmarks and monitor and evaluate the progress of our policy or program.
- **Statistics** can be **used** to inform **decision making** throughout the different stages of the policy-**making process**.



1. AGENDA

1. Sampling
2. Normal distribution
3. Hypothesis testing
4. Confidence interval
5. Chi-Square Test
6. ANOVA

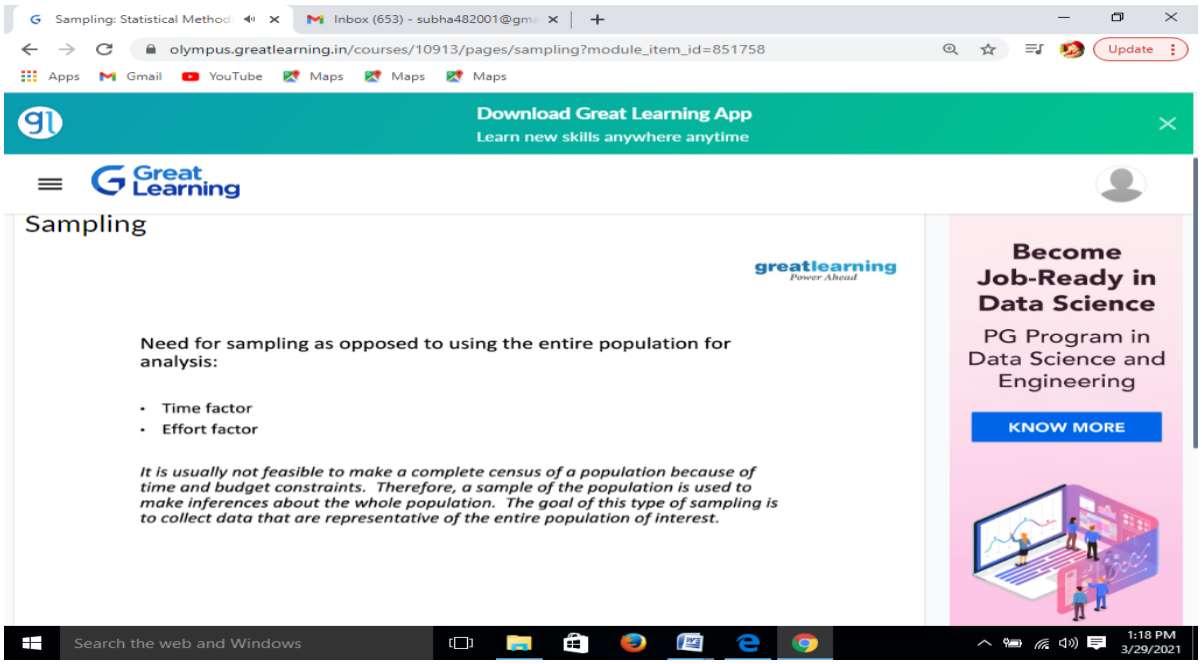


2. SAMPLING:

Need for sampling as opposed to using the entire population for analysis:

- Time factor
- Effort factor

It is usually not feasible to make a complete census of a population because of time and budget constraints. Therefore, a sample of the population is used to make inferences about the whole population. The goal of this type of sampling is to collect data that are representative of the entire population of interest.



3. NORMAL DISTRIBUTION-2

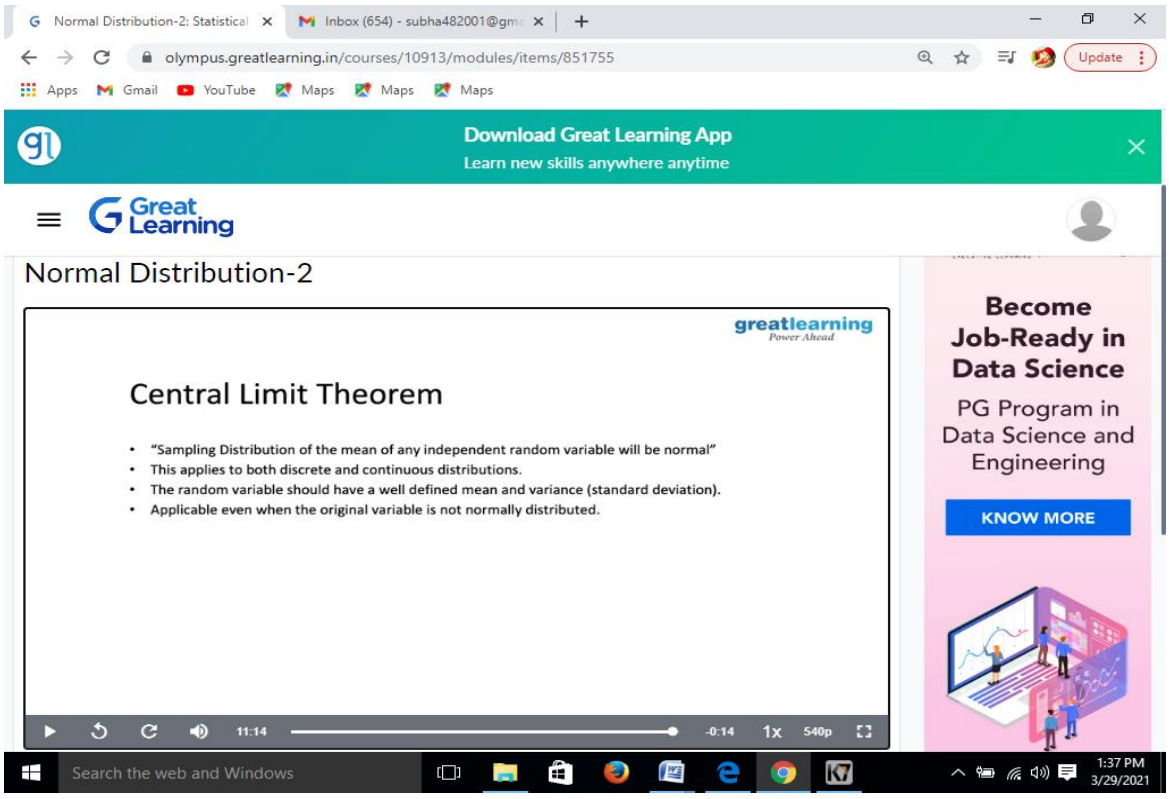
Central Limit Theorem

• Sampling Distribution of the mean of any independent random variable will be normal.

• This applies to both discrete and continuous distribution.

• The random variable should have a well defined mean and variance (standard deviation).

• Application even when the original variable is not normally distributed.

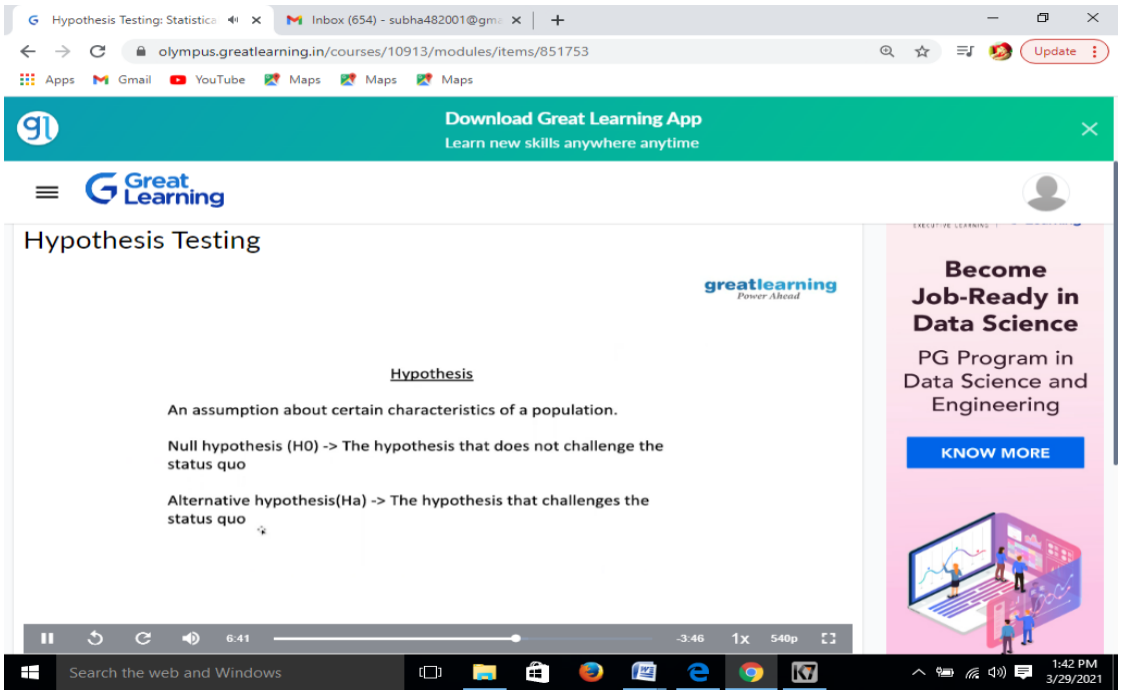


4. HYPOTHESIS TESTING:

An assumption about certain characteristics of a population.

Null hypothesis (H0)-> The hypothesis that does not challenge the status quo

Alternative hypothesis (Ha)->The hypothesis that challenge the status quo



5.TYPE 1 AND TYPE 2 ERRORS:

Type I Errors :

- Rejection of null hypothesis when it should not have been rejected

• Incorrectly rejecting the null hypothesis.

Type II Errors:

• Failure to reject the null hypothesis ,when it should have been rejected.

• Incorrectly not rejecting the null hypothesis.

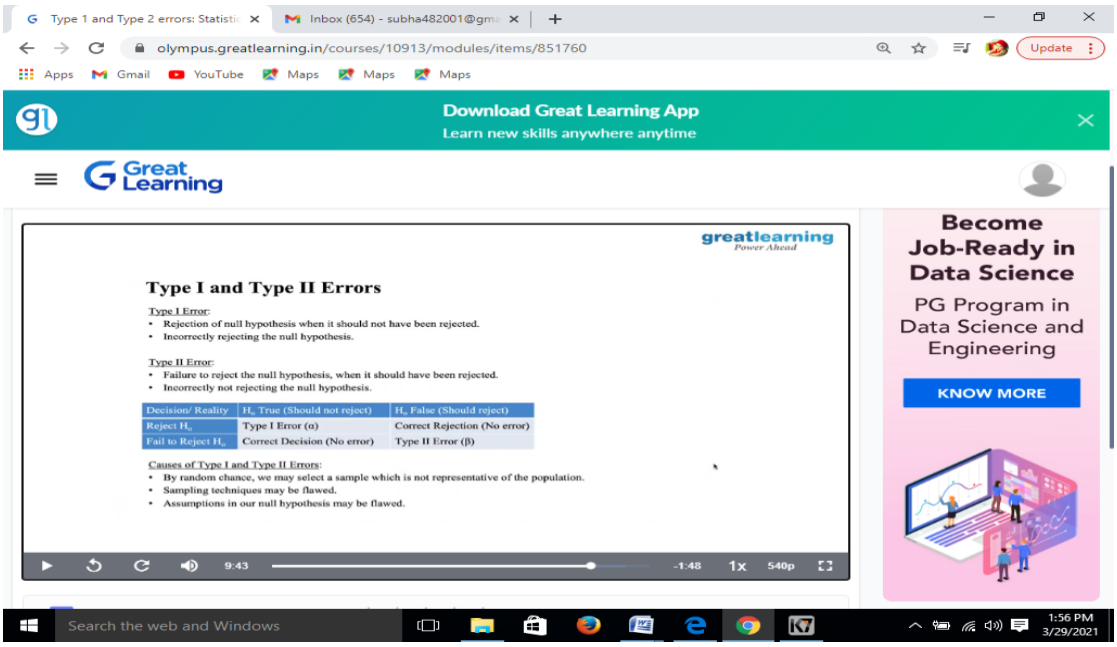
Decision/Reality	H_o True (Should not reject)	H_o False (should reject)
Reject H_o	Type I Errors (α)	Correct Rejection (No error)
Fail to Reject H_o	Correct Decision (No error)	Type II Errors (β)

Causes ofType I Errors and Type II Errors :

• By random chance ,we may select a sample which is not representative of the population.

• Sampling techniques may be flawed.

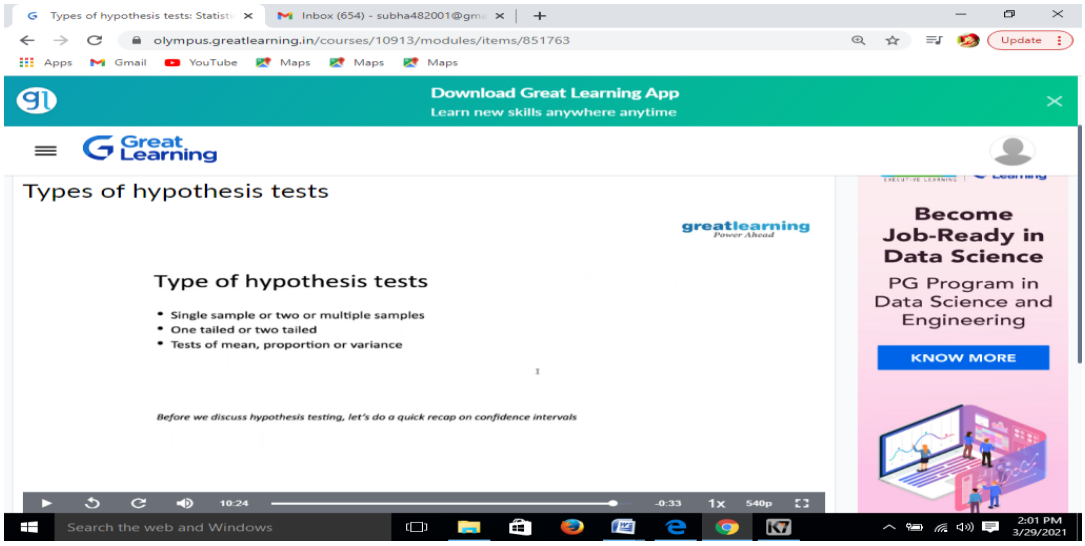
• Assumptions in our null hypothesis may be flawed.



Types of hypothesis tests

- Single sample or two or multiple samples
- One tailed or two tailed
- Tests of mean, proportion or variance

Before we discuss hypothesis testing ,let’s do a quick recab on confidence intervals.



6.CONFIDENCE INTERVAL:

• 95% of all sample means ($\overline{x}$)are hypothesized to be in this region

=> This is called confidence interval.

• If sample mean is in the blue region ,we fail reject the null hypothesis

• If sample mean is in the white region ,we reject the null hypothesis .

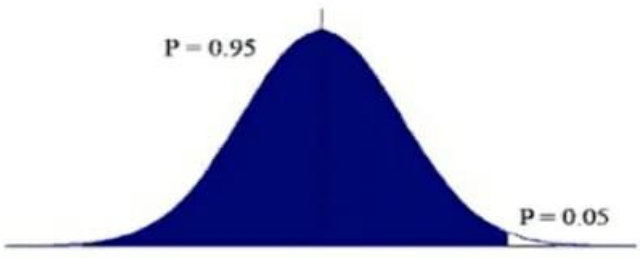
• Here,α=0.05

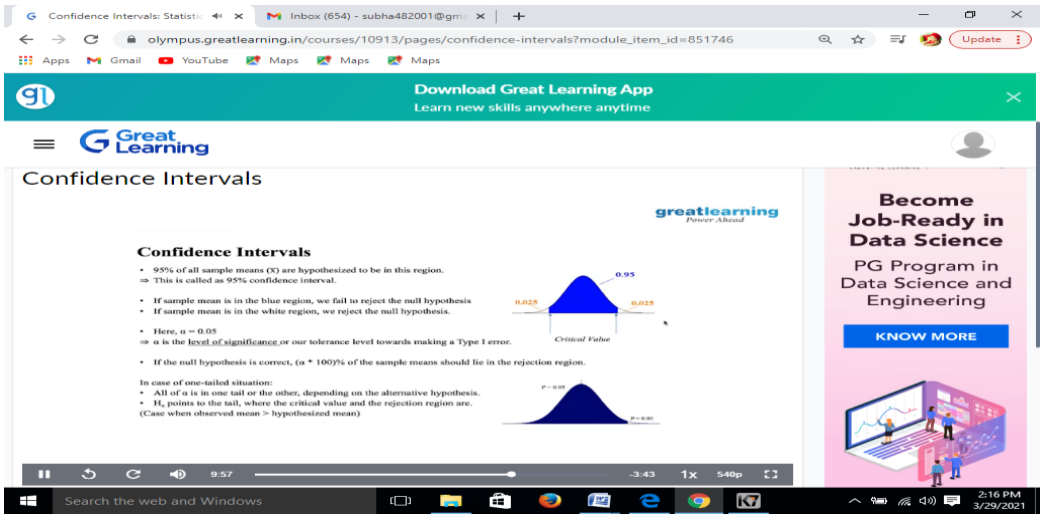
=>α is the null hypothesis is correct ,(α*100)% of the sample means should lie in the rejection region

In case of one-tailed situation:

• All of α is in one tail or the other ,depending on the alternative hypothesis

• H_a points to the tail ,where the critical value and the rejection region are(case when observed mean> hypothesis mean)





Example scenario to perform an hypothesis test

A study was done to see the effect of presence of dogs as pets on kids (ages 10 to 18).Two groups of teenagers ,One groupe with teenagengers who owned a dog for minimum 5 years and another groupe of kids who never owned a dog ,were presented a questionnaries and score were computed .High score corresponds to higher cheerfulness and low score corresponds to lower cheerfulness.

Do dogs have a significant effect (either positive or negative)on the cheerfulness of kids?

Dog : 6.6,7.8,4.6,7.8,7,8,8.8,9.9,8.5,7.7,8.6,8,7,5.8,7.4

No - Dog : 9.8,8.3,7.1,7.2,8.1,8.9,6,7,7.5,7.8,7.6,7.3,6.4,6.8,7,6.4,7.9

What are the null and alternative hypothesis?

Is it a right tailed or a left tailed test ?

Is it a one sample or a two sample test ?

Is it a test of mean ,proporation or variance?

Which statistical test do you think is appropriate?

Let's perform a two sample t-test to check if there is a significant difference in mean of the two sample

Avg-score of kids with dogs ,m1,s1=7.73,1.24

Avg-score of kids without dogs ,m2,s2=7.58,1.23

|A-B|=0.10

Is the difference sigificant at 5% significance level?

H_o:m1 =m2(pets have no effect on the cheerfulness of kids)

H_a:m1≠m2(pets have an effect on the cheerfulness of kids)

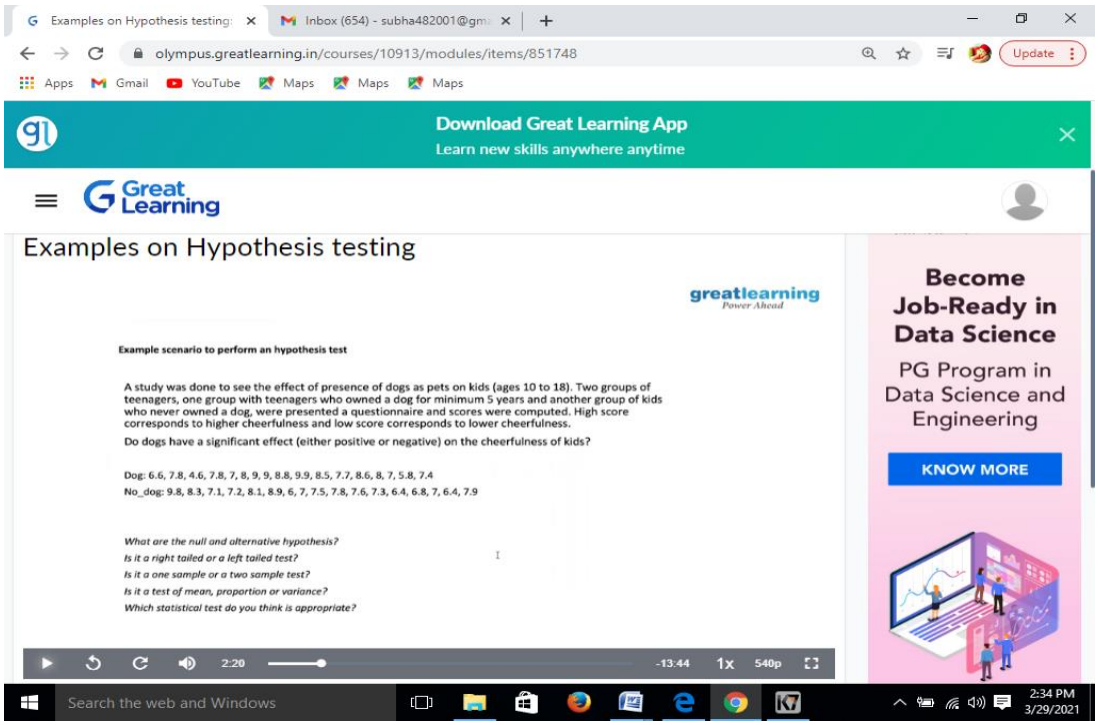
Alpha=0.05

t -critical = ± 2.11 (for a dot of 16, and a confidence of 95% in case of a two tailed test)

$$t = \frac{m1-m2}{\frac{s1^2}{n1}+\frac{s2^2}{n2}}$$

t - statistic = 0.35

It is well inside the critical level .we could not prove that pets either increase or decrease the cheerfulness of kids We fail to reject the null hypothesis.

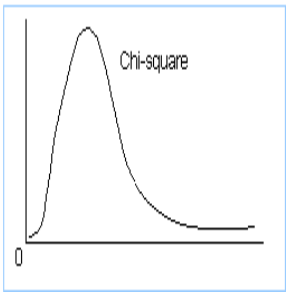


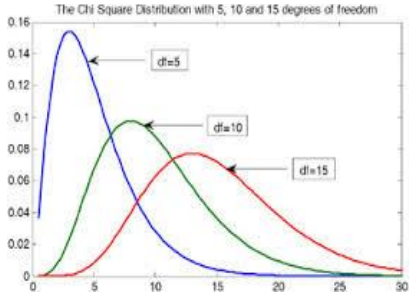
- The test we performed is called a 2-sample t-test or independent samples t-test or student's t-test.
- We perform this test to see if there is a statistically significant difference between means of two independent groups.
- The null hypothesis will be that there is no difference in means.
- The alternative hypothesis will be that there is a significant difference in means.
- To perform this test, we will need one independent qualitative variable with two levels and one dependent qualitative variable.

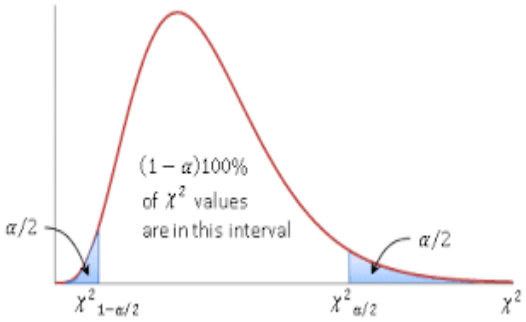
7. CHI-SQUARE TEST:

When we take many samples of the same size from a normal population and find the sample means, they follow a normal distribution.

When we take many samples of the same size from a normal population and find the sample variances, they DO NOT follow a normal distribution; instead they follow a chi-square(χ^2) distribution, which is dependent on the degrees of freedom.







- Area under the curve is always 1
- Cumulative Probability runs from right to left; 1 is towards the left end, while 0 is towards the right.

Pop: m1, v1 = 100,16.11
Lori's: m2, v2 = 104.06, 40.99
N = 15
Dof = 15 – 1= 14

Ho: v2 = v1 (Variance in income of Lori's is same as the population)
Ha: v2 > v1 (Variance in income of Lori's is higher than the population)

alpha = 0.05
Chi_critical = 23.68 (any value beyond 23.68 falls in the rejection region)

$$\text{Chi\_statistic} \Rightarrow x^2 = \text{dof}\left(\frac{v2}{v1}\right)$$

$$x^2 = 35.62$$

$$x^2 > 23.68$$

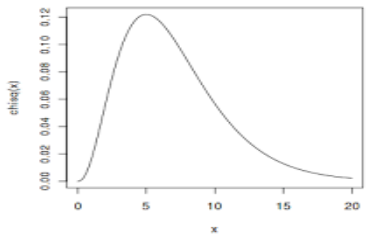
It is well beyond the critical value. The variation in income of blue collar workers at Lori's is significantly higher than the population variance.

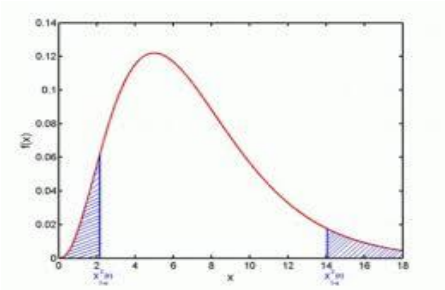
Chi-square (χ^2) test compares the population variance, with the hypothesized variance.

$\chi^2 = \frac{(n-1)x^2}{\sigma^2}$ where n = sample size

x^2 = sample variance and σ^2 = population variance

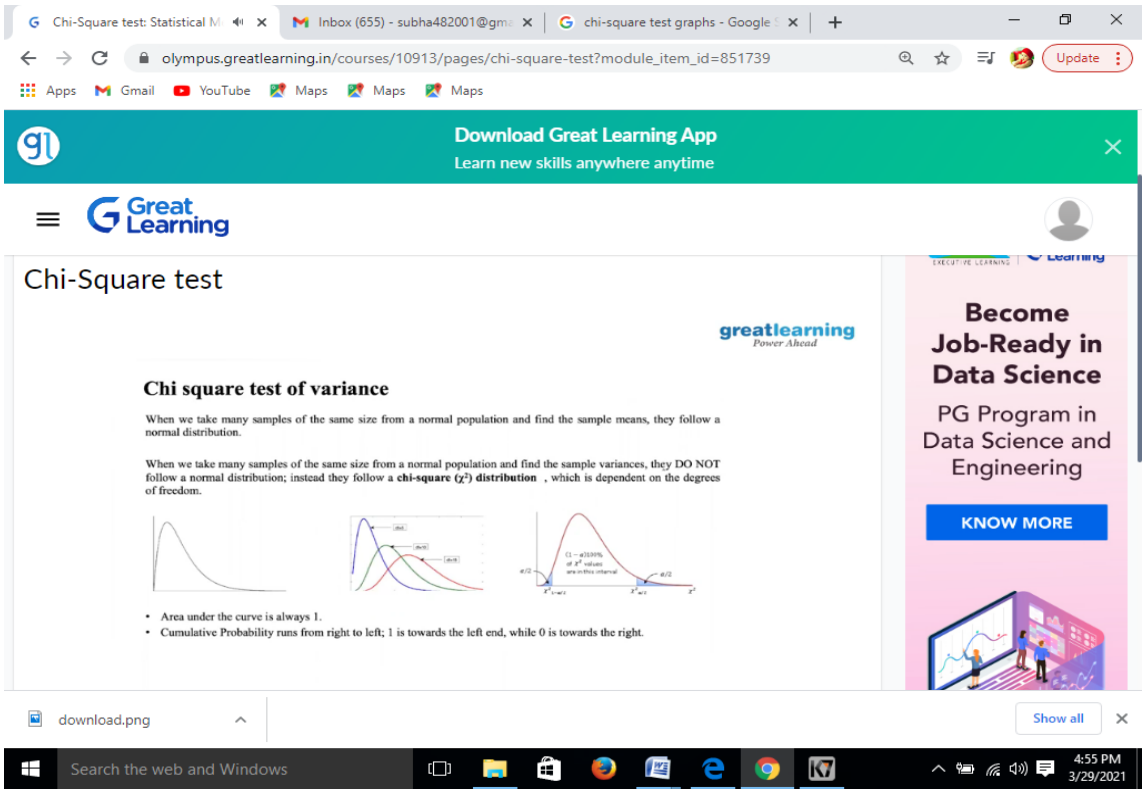
At α = 0.05 and n= 5 (df = 4)





p-value: How much of the area is above the test – statistic?

If it is less than the specific α, we reject the null hypothesis.



8.ANOVA:

Hypothesis of One-Way ANOVA

H_0:μ_1=μ_2=μ_3=$\mu_{4=....=}\mu_k$

All population means are equal

H_a: Not all of the population means are equal

For at least one pair ,the population means are unequal.

One Way ANOVA:

• The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant difference between the means of two or more inpendent (unrelated) groups

• For one -way ANOVA ,the ratio of the between -group variability to the within-group variability follows an F-distribution when the null hypothesis is true .when you perform a one -way ANOVA for a single study ,you obtain a single F-value.

Example

Three groups of samples of factory emissions of different plants of the same company were collected. The score is computed based on the composition of the emissions. We want to find out if there is any inconsistency or difference across the three groups.

A = 57,56,58,58,56,59,56,55,53,54,53,42,44,34,54,54,34,64,84,24

B = 49,47,49,47,49,46,45,46,41,42,42,42,14,14,34

C = 49,48,46,45,46,45,55,61,45,55,54,44,74,54,84,39

Dof(between) = k-1 = 3-1 = 2

Dof(within) = N – k = 59 – 3 = 56

Dof(total) = 56 +2 = 58

For the above degrees of freedom,

$F_{critical} = 3.161$

Mean(A) = 52.45

Mean(B) =41.36

Mean(C) = 51.45

Overall Mean = 2864/59 = 48.54

$SS_{total} = \sum(x_i - overall\_mean)^2 = 8548.64$

$SS_{within} = \sum(a_i - mean(A))^2 + \sum(b_i - mean(B))^2 + \sum(c_i - mean(c))^2 = 7096.32$

$SS_{between} = SS_{total} - SS_{within} = 1452.32$

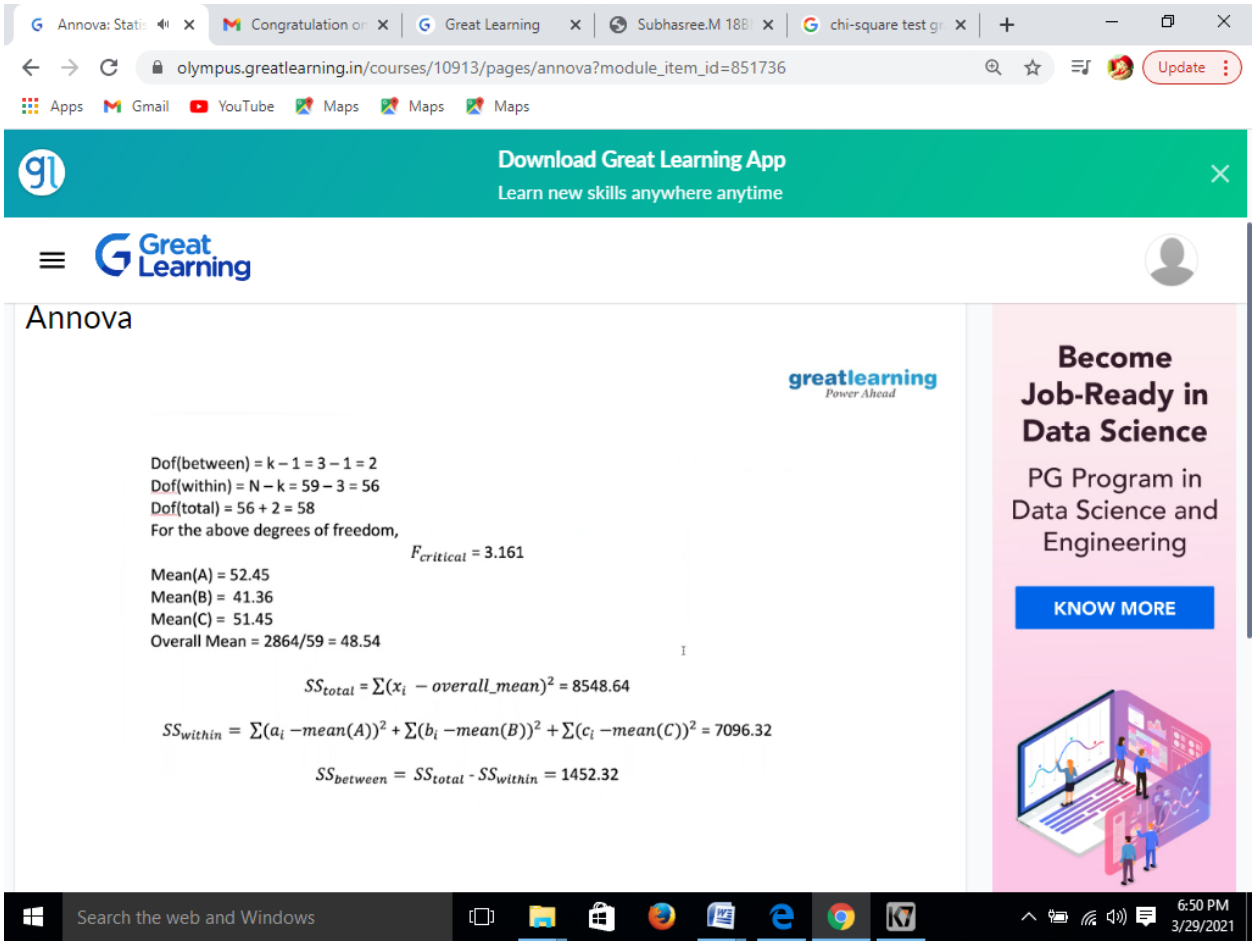
$MS_{between} = \frac{SS(between)}{dof(between)} = 726.16$

$MS_{within} = \frac{SS(within)}{dof(within)} = 126.72$

$F_{statistic} = \frac{MS(between)}{MS(within)} = 5.73$

$F_{statistic} > F_{critical}$

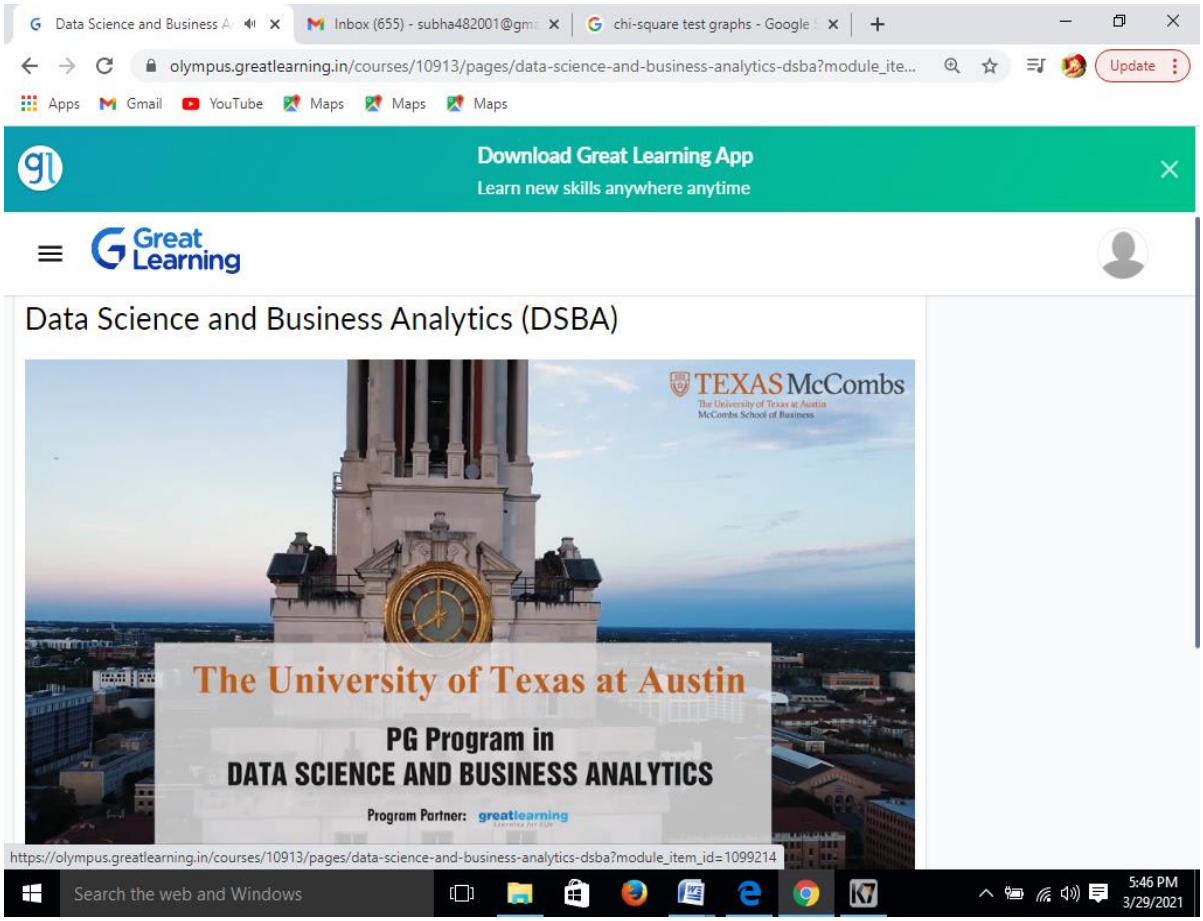
Since our f-statistic is beyond the critical value, we reject the null.



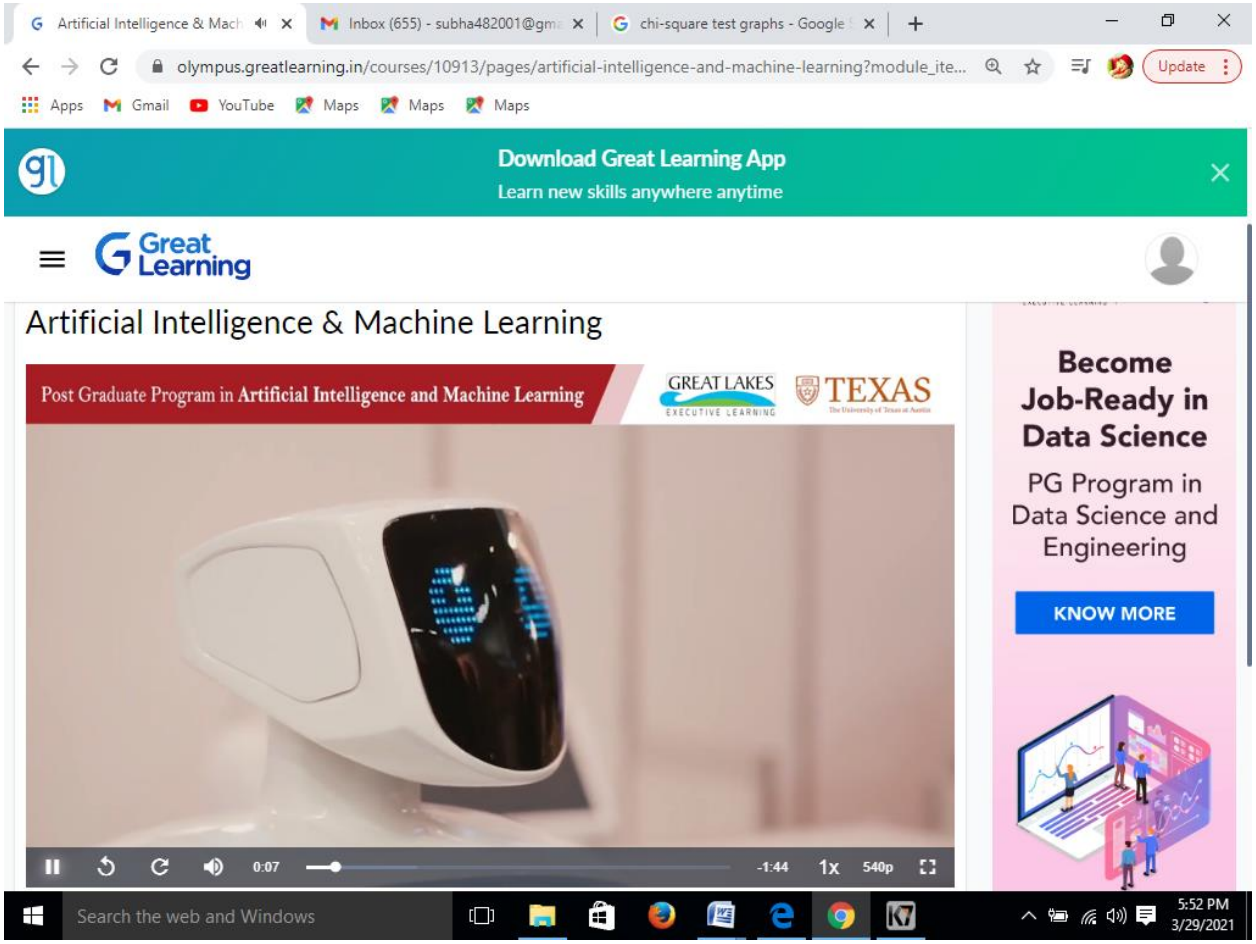
PG PROGRAMS OVERVIEW:

Kumar Muthuraman, Faculty director,Centre for Analytics and Transformative Technologies, PGP-AIML introduced that post graduate programs in

1. Data Science and Business Analytics (DSBA) in Great learning,

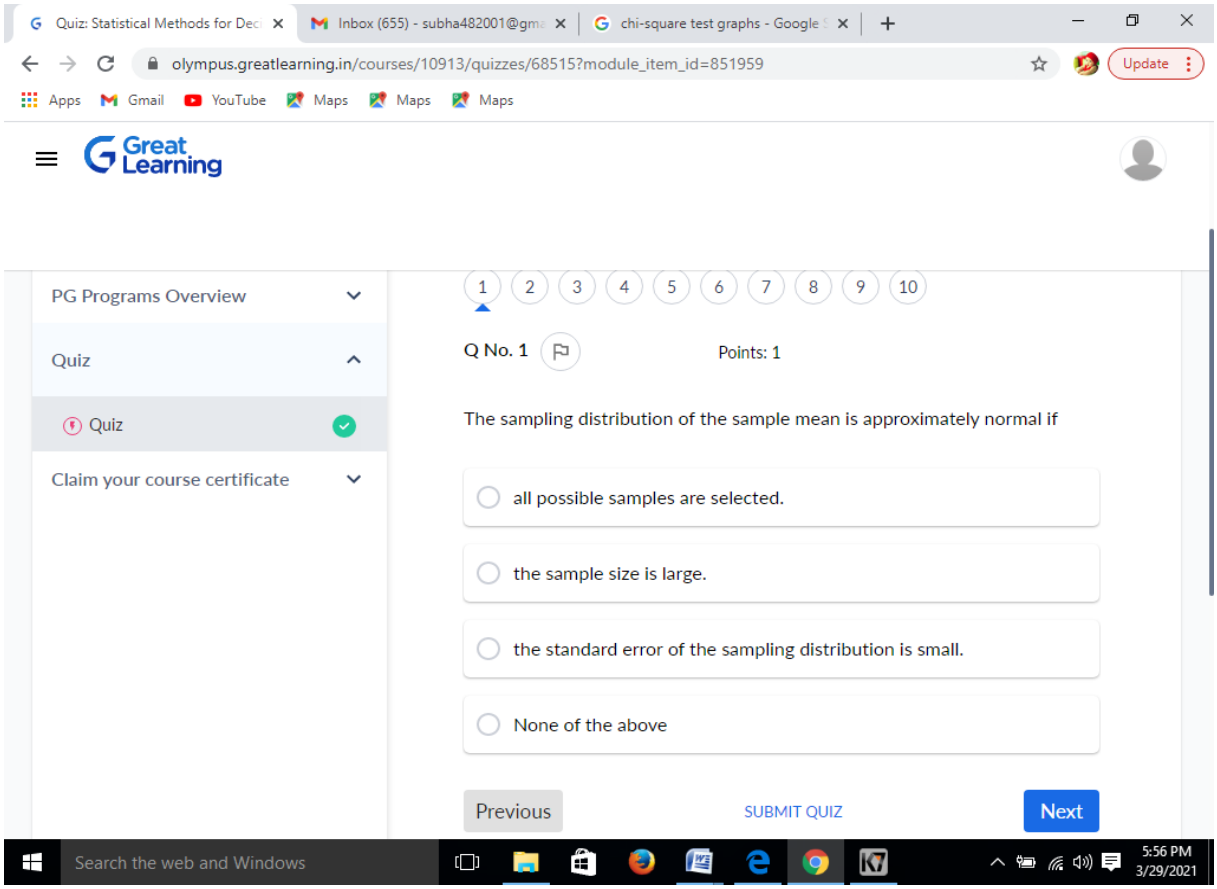


2.Artificial Science and Machine Learning



QUIZ

Checkpoint questions were provided to check our understandability of the concepts and to increase the real life application of probability. The quiz answers were checked and the correct answers were provided for our reference.



CONCLUSION:

The internship was a useful experience. It helped to gain new knowledge and skills. It provides a path to achieve several of our learning goals. This internship

programme was not one sided, but it was a way of sharing knowledge, ideas and opinions. The new insights and motivation to pursue one’s career using mathematics is gained through this internship programme.