Semester : IV Subject : Statistics for AIDS Academic Year: 2022-2023

CHI-SQUARE TEST :

A chi-squared test is a statistical hypothesis test used in the analysis of contigency tables when the sample sizes are large. In simpler terms, this test is primarily used to examine whether two categorical variables are independent in influencing the test statistic.

Chi-Square Test Algorithm :

Step 1 : Decide null and alternate hypothesis.

Step 2 : Calculate Expected Value.

$$E = \left(\frac{\text{Row Total} \times \text{Column Total}}{\text{Grand Total}} \right)$$

Step 3 : Calculate Chi-Square value.

$$\chi^2 = \sum \left(\frac{(\text{Observed value} - \text{Expected value})^2}{\text{Expected Value}} \right)$$

Step 4 : Calculate the Degree of Freedom

$$DOF = (\text{Column} - 1) \times (\text{row} - 1)$$

Step 5 : Find the Critical value.

Step 6 : If $\chi^2 >$ critical value then null hypothesis is rejected else null hypothesis is accepted.

Semester: V Subject: Statistics for AIDS Academic Year: 2023-2024

Example:

In an Antimalarial campaign in India, Quinine was administered to 500 persons out of total population of 2000. The no. of fever cases is shown below:

Treatment	Fever	No Fever	Total
Quinine	20	480	500
No Quinine	100	1400	1500
Total	120	1880	2000

Discuss the usefulness of Quinine in checking malaria.

Solution:

H_0: Quinine is not effective in checking malaria.

H_a: Quine is effective in checking malaria.

$E = \frac{RT \times CT}{GT}$, $GT = 2000$

$E_1 = \frac{500 \times 120}{2000} = 30$, $E_2 = \frac{1500 \times 120}{2000} = 90$

$E_3 = \frac{500 \times 1880}{2000} = 470$, $E_4 = \frac{1500 \times 1880}{2000} = 1410$.

Expected value

Treatment	Fever	No Fever
Quinine	30	470
No Quinine	90	1410

Calculation of χ^2

O	E	(O-E)	$(O-E)^2$	$(O-E)^2/E$
20	30	-10	100	3.33
100	90	+10	100	1.11
480	470	+10	100	0.21
1400	1410	-10	100	0.07
				$\chi^2 = 4.72$

Calculate dof:

$dof = (r-1)(c-1)$

$= (2-1)(2-1)$

$dof = 1$

Critical value $\chi^2_{0.05} = 3.84$.

$\chi^2 = 4.72 > 3.84$

H_0 is failed and rejected.

Hence Quinine is useful in checking the malaria.

Semester V Subject Statistics for AI&DS Academic Year 2023-2024

Example:

A drug X claimed to be effective in curing colds. In an experiment on 500 persons with cold, half of them were given the drug X and half were given placebo (sugar pills). The patients reactions to the treatment are recorded in the following table:

Treatment	Helped	Reaction	No Effect	Total
Drug	150	30	70	250
Placebo	130	40	80	250
Total	280	70	150	500

On the basis of the data, can it be concluded that there is a significant difference in the effect of drug X and placebo. (Critical value $\chi^2_{0.05} = 5.99$)

Solution:

H_0: Drug = Placebo

H_a: Drug ≠ Placebo.

Calculate expected value: $E = \frac{RT \times CT}{GT}$

$E_1 = \frac{250 \times 280}{500} = 140$, $E_2 = \frac{250 \times 70}{500} = 35$, $E_3 = \frac{250 \times 150}{500} = 75$

$E_4 = \frac{250 \times 280}{500} = 140$, $E_5 = \frac{250 \times 70}{500} = 35$, $E_6 = \frac{250 \times 150}{500} = 75$

Expected Value

	H	R	NE
Drug	140	35	75
Placebo	140	35	75

Calculation of χ^2:

O	E	(O-E)	$(O-E)^2$	$(O-E)^2/E$
150	140	+10	100	0.714
130	140	-10	100	0.714
30	35	-5	25	0.714
40	35	+5	25	0.714
70	75	-5	25	0.333
80	75	+5	25	0.333
				$\chi^2 = 3.522$

Calculate df:

$df = (C-1)(R-1) = (3-1)(2-1)$

$= 2 \times 1 = 2$

Critical value:

$\chi^2_{0.05} = 5.99$

Since $\chi^2 = 3.522 < 5.99$

Null hypothesis is accepted.

Hence there is no significant difference in the effect of drug X and placebo.