

How do you perform a Chi-Square Test by hand step-by-step?

Authored by
stats writer

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A Chi-Square Test is a statistical analysis that compares expected and observed frequencies in a categorical data set. This test is commonly used to determine if there is a significant relationship between two variables. Performing a Chi-Square Test by hand involves several steps:

1. Define the null and alternative hypotheses: The null hypothesis states that there is no significant relationship between the two variables, while the alternative hypothesis states that there is a significant relationship.
2. Create a contingency table: A contingency table is a table that displays the observed frequencies of the variables being compared. It should have rows and columns representing the categories of each variable.
3. Calculate the expected frequencies: Using the contingency table, calculate the expected frequencies under the assumption that the null hypothesis is true. This can be done by multiplying the row total and column total and dividing by the total number of observations.
4. Calculate the Chi-Square statistic: The Chi-Square statistic is calculated by taking the sum of for each cell in the contingency table.
5. Determine the degrees of freedom: Degrees of freedom refer to the number of categories minus 1 for each variable. In a contingency table, it can be calculated by $(\text{number of rows} - 1) \times (\text{number of columns} - 1)$.
6. Consult a Chi-Square table: Using the calculated Chi-Square statistic and degrees of freedom, consult a Chi-Square table to find the critical value for a given significance level (usually 0.05).
7. Compare the critical value and Chi-Square statistic: If the Chi-Square statistic is greater than the critical value, the null hypothesis can be rejected, and it can be concluded that there is a significant relationship between the variables.
8. Interpret the results: Finally, interpret the results in the context of the study and the research question being investigated.

Performing a Chi-Square Test by hand can be time-consuming, and it is recommended to use statistical software for more efficient and accurate results. However, understanding the step-by-step process can help in understanding the concept and interpreting the results accurately.

Perform a Chi-Square Test by Hand (Step-by-Step)

A Chi-Square goodness of fit test is used to determine

whether or not a follows a hypothesized distribution.

The following step-by-step example shows how to perform a Chi-Square goodness of fit test by hand.

Chi-Square Goodness of Fit Test By Hand

Suppose we believe that a certain dice is fair. In other words, we believe the dice is equally likely to land on a 1, 2, 3, 4, 5, or 6 on a given roll.

To test this, we we roll it 60 times and record the number that it lands on each time. The results are as follows:

1: 8 times 2: 12 times 3: 18 times 4: 9 times 5: 7 times 6: 6 times

Use the following steps to perform a Chi-Square goodness of fit test to determine if the dice is fair.

Step 1: Define the Null and Alternative Hypotheses

H₀ (null): The dice is equally likely to land on each number. H₁ (alternative) : The dice is not equally likely to land on each number.

Step 2: Calculate the Observed and Expected Frequencies

Next, let's create a table of observed and expected frequencies for each number on the dice:

	1	2	3	4	5	6
O	8	12	18	9	7	6
E	10	10	10	10	10	10

Note: If we believe the dice is fair, this means we expect it to land on each number an equal amount of times - in this case, 10 times each.

Step 3: Calculate the Test Statistic

The Chi-Square test statistic, X^2 , is calculated as:

$$X^2 = \sum(O-E)^2 / E$$

The following table shows how to calculate this test statistic:

	1	2	3	4	5	6
O	8	12	18	9	7	6
E	10	10	10	10	10	10
$(O-E)^2 / E$	0.4	0.4	6.4	0.1	0.9	1.6

$\Sigma = 9.8$

In this case, X² turns out to be 9.8.

Step 4: Find the Critical Value

Next, we need to find the critical value in the that corresponds to $\alpha = .05$ and $df = (\#categories - 1)$.

In this case, there are 6 categories, so we will use $df = 6 - 1 = 5$.

We can see that the critical value is 11.07.

DF	P										
	0.995	0.975	0.2	0.1	0.05	0.025	0.02	0.01	0.005	0.002	0.001
1	.0004	.00016	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.55	10.828
2	0.01	0.0506	3.219	4.605	5.991	7.378	7.824	9.21	10.597	12.429	13.816
3	0.0717	0.216	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	5.989	7.779	9.488	11.143	11.668	13.277	14.86	16.924	18.467
5	0.412	0.831	7.289	9.236	11.07	12.833	13.388	15.086	16.75	18.907	20.515
6	0.676	1.237	8.558	10.645	12.592	14.449	15.033	16.812	18.548	20.791	22.458
7	0.989	1.69	9.803	12.017	14.067	16.013	16.622	18.475	20.278	22.601	24.322
8	1.344	2.18	11.03	13.362	15.507	17.535	18.168	20.09	21.955	24.352	26.124
9	1.735	2.7	12.242	14.684	16.919	19.023	19.679	21.666	23.589	26.056	27.877
10	2.156	3.247	13.442	15.987	18.307	20.483	21.161	23.209	25.188	27.722	29.588
11	2.603	3.816	14.631	17.275	19.675	21.92	22.618	24.725	26.757	29.354	31.264
12	3.074	4.404	15.812	18.549	21.026	23.337	24.054	26.217	28.3	30.957	32.909
13	3.565	5.009	16.985	19.812	22.362	24.736	25.472	27.688	29.819	32.535	34.528
14	4.075	5.629	18.151	21.064	23.685	26.119	26.873	29.141	31.319	34.091	36.123
15	4.601	6.262	19.311	22.307	24.996	27.488	28.259	30.578	32.801	35.628	37.697
16	5.142	6.908	20.465	23.542	26.296	28.845	29.633	32	34.267	37.146	39.252
17	5.697	7.564	21.615	24.769	27.587	30.191	30.995	33.409	35.718	38.648	40.79
18	6.265	8.231	22.76	25.989	28.869	31.526	32.346	34.805	37.156	40.136	42.312

Step 5: Reject or Fail to Reject the Null Hypothesis

Since our test statistic is less than the critical value, we fail to reject the null hypothesis. This means we do not

have sufficient evidence to say that the dice is unfair.

The following resources offer additional information on the Chi-Square goodness of fit test:

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