**CHI-SQUARE TEST**

To analyze the association between device type and customer satisfaction using the Chi-Square test for independence, we need to follow these steps:

1. **State the Hypotheses**:
   * **Null Hypothesis (H0)**: There is no significant association between the type of device purchased and the customer satisfaction level. The satisfaction levels are independent of the type of device.
   * **Alternative Hypothesis (H1)**: There is a significant association between the type of device purchased and the customer satisfaction level. The satisfaction levels are not independent of the type of device.
2. **Compute the Chi-Square Statistic**:

We will use the formula for the Chi-Square statistic:

χ2=∑(Oi−Ei)2Ei\chi^2 = \sum \frac{(O\_i - E\_i)^2}{E\_i}χ2=∑Ei​(Oi​−Ei​)2​

where OiO\_iOi​ represents the observed frequency, and EiE\_iEi​ represents the expected frequency.

**Step-by-Step Calculation**:

* + **Step 1**: Calculate the expected frequencies for each cell.

The formula for the expected frequency EiE\_iEi​ is:

Ei=(Row Total×Column Total)Grand TotalE\_i = \frac{( \text{Row Total} \times \text{Column Total} )}{\text{Grand Total}}Ei​=Grand Total(Row Total×Column Total)​

* + **Step 2**: Compute the Chi-Square statistic using the observed and expected frequencies.

**Python Implementation**:

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import numpy as np

from scipy.stats import chi2

# Observed frequency table

observed = np.array([[50, 70],

[80, 100],

[60, 90],

[30, 50],

[20, 50]])

# Totals

row\_totals = observed.sum(axis=1)

col\_totals = observed.sum(axis=0)

grand\_total = observed.sum()

# Expected frequency table

expected = np.outer(row\_totals, col\_totals) / grand\_total

# Chi-Square statistic calculation

chi2\_stat = ((observed - expected) \*\* 2 / expected).sum()

chi2\_stat

1. **Determine the Critical Value**:
   * **Degrees of Freedom (df)**: Calculated as (Number of Rows−1)×(Number of Columns−1)(\text{Number of Rows} - 1) \times (\text{Number of Columns} - 1)(Number of Rows−1)×(Number of Columns−1).
     + Number of Rows = 5 (satisfaction levels)
     + Number of Columns = 2 (device types)
     + Degrees of Freedom = (5 - 1) \* (2 - 1) = 4
   * **Significance Level (α)**: 0.05

Use the chi-square distribution to find the critical value.

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# Critical value for alpha = 0.05 and df = 4

alpha = 0.05

df = 4

critical\_value = chi2.ppf(1 - alpha, df)

critical\_value

1. **Make a Decision**:

Compare the Chi-Square statistic with the critical value:

* + If χstat2>critical value\chi^2\_{\text{stat}} > \text{critical value}χstat2​>critical value, reject the null hypothesis.
  + If χstat2≤critical value\chi^2\_{\text{stat}} \leq \text{critical value}χstat2​≤critical value, fail to reject the null hypothesis.

**Python Implementation**:

python

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if chi2\_stat > critical\_value:

decision = "Reject the null hypothesis"

else:

decision = "Fail to reject the null hypothesis"

decision

**Complete Python Code**

python

Copy code

import numpy as np

from scipy.stats import chi2

# Observed frequency table

observed = np.array([[50, 70],

[80, 100],

[60, 90],

[30, 50],

[20, 50]])

# Totals

row\_totals = observed.sum(axis=1)

col\_totals = observed.sum(axis=0)

grand\_total = observed.sum()

# Expected frequency table

expected = np.outer(row\_totals, col\_totals) / grand\_total

# Chi-Square statistic calculation

chi2\_stat = ((observed - expected) \*\* 2 / expected).sum()

# Degrees of Freedom

df = (observed.shape[0] - 1) \* (observed.shape[1] - 1)

# Critical value for alpha = 0.05 and df = 4

alpha = 0.05

critical\_value = chi2.ppf(1 - alpha, df)

# Make a decision

decision = "Reject the null hypothesis" if chi2\_stat > critical\_value else "Fail to reject the null hypothesis"

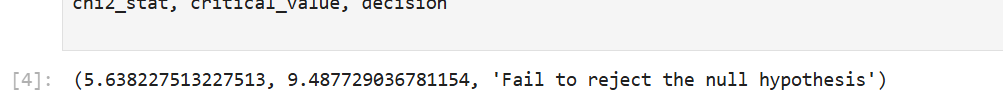
chi2\_stat, critical\_value, decision

**Explanation**

* **Chi-Square Statistic**: The calculated value tells us how much the observed frequencies differ from the expected frequencies.
* **Critical Value**: The value from the chi-square distribution table that corresponds to the given significance level and degrees of freedom.
* **Decision**: Based on the comparison of the chi-square statistic with the critical value, determine whether there is a significant association between the type of device and customer satisfaction.

With the above code, you can run the Chi-Square test for independence and interpret the results to make your decision.

**OUTPUT**

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