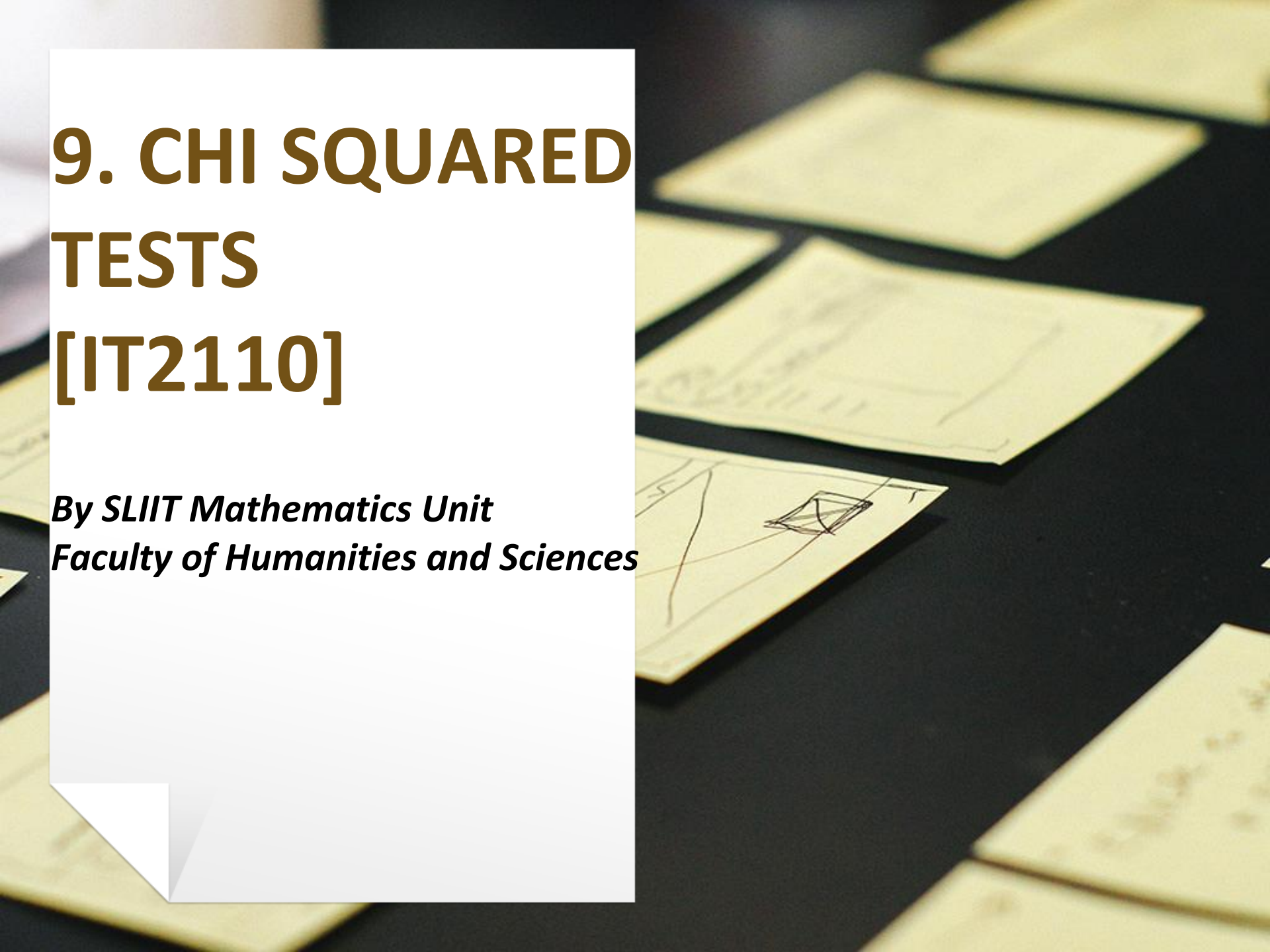
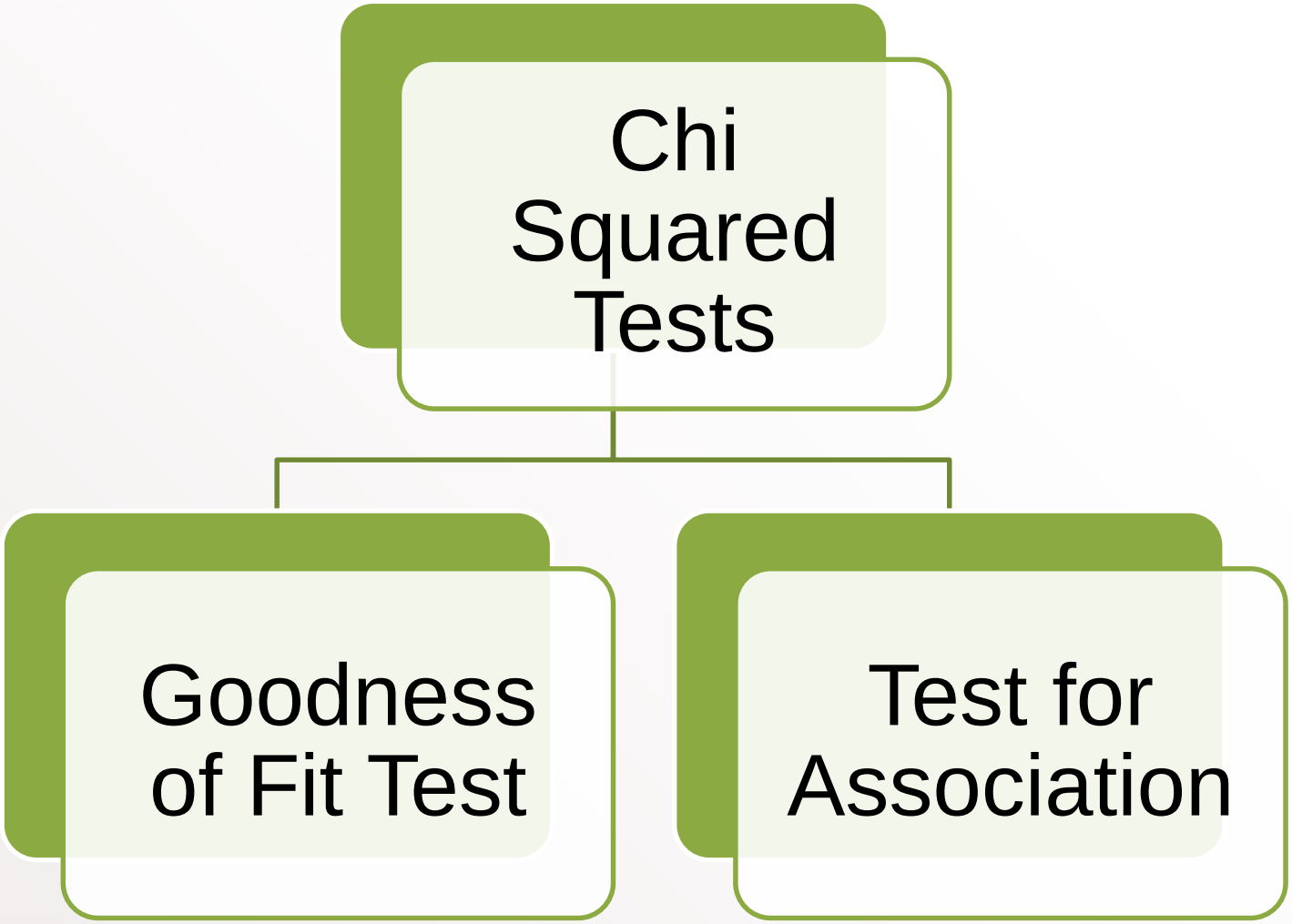


# 9. CHI SQUARED TESTS [IT2110]

*By SLIIT Mathematics Unit*
*Faculty of Humanities and Sciences*

- Chi-squared tests are used for,
  - ***Discrete data***
  - ***Categorical data***


Chi Squared Tests
Goodness of Fit Test
Test for Association

# Test for Association

“

*Used to find whether* ***two factors*** *are* ***independent***.

- The hypothesis for the test is,

  $\boldsymbol{H_0}$: *The factors are independent.*

  $\boldsymbol{H_1}$: *The factors are not independent.*

- Test Statistic,

  ***Under*** $\boldsymbol{H_0}$***,***

$$\boldsymbol{X^2 = \sum_{i=1}^{n} \sum_{j=1}^{m} \frac{(O_{ij} - E_{ij})^2}{E_{ij}} \sim X^2_{d.f.}}$$

  - $O_{ij}$ - Observed frequency for cell ij
  - $E_{ij}$ - Expected frequency for cell ij
  - $df = (No\ of\ rows - 1)(No\ of\ columns - 1)$

- ***Reject $H_0$, if $X^2_{cal} > X^2_{df,\alpha\%}$*** (critical value)

- Test:
  - *Find the **expected frequencies** for each cell.*
  - *Calculate **test statistic value**.*

- Conclusion:

  ***Compare*** calculated ***test statistic value*** with ***critical value*** and give the conclusion.

# Important

**Rule 01**

- ***All expected counts*** should be ***greater than 5***.

**Rule 02**

- ***All expected counts*** should be ***greater than 1 & at least 80% of the cells*** should have ***expected count*** which is ***greater than or equal to 5***.
- If not, categories can be joined.

# Example

The following table gives a classification according to religious affiliation and marital status for 500 randomly selected individuals. For $\alpha = 1\%$, test the null hypothesis that marital status and religious affiliation are independent.

| | | Religious Affiliation | | | | |
|---|---|---|---|---|---|---|
| | | **A** | **B** | **C** | **D** | **None** |
| **Marital Status** | **Single** | 39 | 19 | 12 | 28 | 18 |
| | **Married** | 172 | 61 | 44 | 70 | 37 |

# Goodness of Fit Test

*“Used to find whether a set of discrete or categorical data* ***follows a specified distribution****.*

- The hypothesis for the test is,

  $\boldsymbol{H_0}$: *The data are consistent with the specified distribution.*

  $\boldsymbol{H_1}$: *At least one category deviates from the specified distribution.*

- Test Statistic,

  ***Under*** $\boldsymbol{H_0}$***,***

$$\boldsymbol{X^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i} \sim X^2_{d.f.}}$$

  - $O_{ij}$ - Observed frequency for cell ij
  - $E_{ij}$ - Expected frequency for cell ij

- ***d.f.** = No of classes – No of parameters estimated - 1*
- ***Reject $H_0$, if $X^2_{cal} > X^2_{df,\alpha\%}$*** (critical value)
- Test:
  - *Find the **expected frequencies** for each category.*
  - *Calculate **test statistic value**.*
- Conclusion:

  ***Compare*** calculated ***test statistic value*** with ***critical value*** and give the conclusion.

# Example

1) A die is rolled 60 times and the face values are recorded. The results are as follows.

| Up Face | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Frequency | 8 | 11 | 5 | 12 | 15 | 9 |

Is the die balanced? Test using $\alpha = 0.05$.

# Example

2) The number of accidents in a month observed over a period of 10 years is given below.

| **No of accidents** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | ≥7 |
|---|---|---|---|---|---|---|---|---|
| **Frequency** | 41 | 40 | 22 | 10 | 6 | 0 | 1 | 0 |

Is the data following a Poisson distribution? Test using $\alpha = 0.05$.

# Example

3) The grades of students in a class of 51 are given in the following table. Test the hypothesis that the grades are normally distributed with a mean of 75 and a standard deviation of 8. Use $\alpha = 0.05$.

| **Range** | 0-59.5 | 59.5-69.5 | 69.5-79.5 | 79.5-89.5 | 89.5-100 |
|---|---|---|---|---|---|
| **No of students** | 8 | 11 | 5 | 12 | 15 |

# Thanks!

## Any questions?