Chi-Square Test for Association

Ho: The two qualitative variables are independent (not related)
Ha: The two qualitative variables are dependent (related)

Example:
$E(n_{1s}) = n * p_1 * p_s$

n = sample size
p_1=probability of the first row
p_s=probability of the s^{th} column
$E(n_{1s})$=expected value

Chi-Square test statistic:

$$\chi^2 = \frac{\left(n_{1s} - E(n_{1s})\right)^2}{E(n_{1s})} + \frac{\left(n_{2s} - E(n_{2s})\right)^2}{E(n_{2s})} + \cdots + \frac{\left(n_{xs} - E(n_{xs})\right)^2}{E(n_{xs})}$$

OR

$$\chi^2 = \frac{(Observed\ value - Espected\ value)^2}{Expected\ value} + \cdots + \frac{(Observed\ value - Espected\ value)^2}{Expected\ value}$$

Degrees of freedom = (number of rows – 1)*(number of columns – 1)

Rejection Region:

Reject Ho if $\chi^2 > \chi^2$ critical value

Chi-Square Test for Goodness of Fit

Chi-Square distribution

$$\frac{(n-1)s^2}{\sigma^2}$$

n = sample size
s^2=sample variance
σ^2=population variance

Degrees of Freedom = n-1

Example:
$E(n_1) = n * p_1$

Chi-Square test statistic:

$$\chi^2 = \frac{\left(n_1 - E(n_1)\right)^2}{E(n_1)} + \frac{\left(n_2 - E(n_2)\right)^2}{E(n_2)} + \cdots + \frac{\left(n_x - E(n_x)\right)^2}{E(n_x)}$$

$$\chi^2 = \frac{(Observed\ value - Espected\ value)^2}{Expected\ value} + \cdots + \frac{(Observed\ value - Espected\ value)^2}{Expected\ value}$$

Degrees of Freedom = (rows – 1) or (columns – 1)

If n is large enough = $E(n_i) \geq 5$

Rejection Region:

Reject Ho if $\chi^2 \geq \chi^2\ critical$ with alpha and (rows – 1) or (columns – 1) degrees of freedom

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