Inferential Statistics

Non-parametric Statistics

What We Will Cover in This Section

- Introduction
- Correlational Techniques
  - Spearman
  - Point Biserial
- Chi Square

What Is/Are It?

Statistical techniques applied to a set of variables when one cannot assume that the data are normally distributed or the data do not meet the requirements for an interval scale.

Correlational Techniques

Technique	Variable 1	Variable 2
Spearman Correlation (r_s)	Ordinal data	Ordinal data
Point Biserial (r_{pb})	Interval or Ratio	Dichotomous

Spearman Correlation (r_s)

- The Null Hypothesis is
  $H_o: \rho_s = 0$
- The Alternative Hypothesis is
  $H_1: \rho_s \neq 0$

When Used

1. Both sets of data are ordinal.
   or…
2. One set is interval/ratio and the other is ordinal.
   or…
3. The data are interval or ratio but are not normally distributed.

Spearman Correlation Example

A researcher wanted to know if there was a relationship between leadership skill and aggressiveness. The investigator first had ten supervisors rank ordered on their leadership skill, and then had them rank ordered on their aggressiveness.

Spearman Correlation Example

Subject	R_{agg}	R_{lead}	|d|	d^2
1	2	3	1	1
2	3	1	2	4
3	7	5	2	4
4	6	9	3	9
5	1	2	1	1
6	5	6	1	1
7	10	8	2	4
8	8	10	2	4
9	9	7	2	4
10	4	4	0	0

Formula and Computation

$$r_s = 1 - \frac{6(\Sigma d^2)}{N(N^2 - 1)}$$

$$r_s = 1 - \frac{6(32)}{10(100 - 1)}$$

$$r_s = 1 - \frac{192}{990}$$

$$r_s = .806$$

Assumptions

1. The sample has been randomly selected from the population.
2. The relationship between the variables is linear.

Kool Facts Regarding r_s

1. Given no tied ranks r_s and r give the same result.
2. Pearson r is more sensitive.
3. Pearson r is a more powerful statistic.

Point-Biserial (r_{pb})

- Used when
  - One variable is ordinal, interval, or ratio.
  - The second variable has only two values.
- The Null Hypothesis is
  H_o: $\rho_{pb} = 0$
- The Alternative Hypothesis is
  H_1: $\rho_{pb} \neq 0$

Examples of r_{pb}

- You want to correlate gender to GPA.
- You want to correlated drivers training to number of traffic accidents.
- You want to correlate marital status to depression.

Example

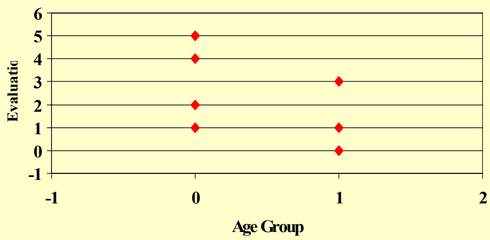
Z.Z. Bottoms wanted to know if there were differences in attitudes toward rap-country-soul music. Z. Z. got a group of eight volunteers and divided them into two groups: those under 30 years old and those over 30 years old. Bottoms then had them rate their feelings about the music.

These data are summarized on the following page.

Summary

Attitude	Age Group	Age Category
5	Over 30	0
0	Under 30	1
4	Over 30	0
1	Over 30	0
1	Under 30	1
2	Over 30	0
3	Under 30	1
0	Under 30	1

Age Group by Evaluation (r_{pb}=-.577)



Kool Facts Regarding r_{pb}

- When the dichotomous variable is coded 0 and 1, r_{pb} is equal to the Pearson r.
- Point-biserial and t-test are closely related.
  - r_{pb} looks at strength and uses all data.
  - t looks at differences between means.

Chi-Square (χ^2)

One Way Chi-Square (χ^2) Goodness of Fit

- One group.
  - Group is grouped categorically (nominal scale).
- Null hypothesis.
  - There is no difference in the distribution of the scores across the group.
- Alternative hypothesis.
  - There is a difference in the scores across the group.

Chi-square Example

The noted statistician, Dr. Anne Nova, was interested in academic preferences. She got a sample of 100 students and asked them to select the school activity they liked best from the following list.

Statistics
Psychological Testing
Experimental Psychology
Recess

Hypotheses

- If there is no specific prediction.
  - Null Hypothesis.
    $H_o: f_{stat} = f_{experimental} = f_{testing} = f_{recess}$
  - Alternative Hypothesis.
    $H_A: f_{stat} \neq f_{experimental} \neq f_{testing} \neq f_{recess}$
- Note: The researcher may specify the proportion of cases in H_A.

Results

	Statistics	Experimental	Testing	Recess
f_e	25	25	25	25
f_o	40	30	20	10
$f_o - f_e$	15	5	-5	-15
$(f_o - f_e)^2$	225	25	25	225
$\frac{(f_o - f_e)^2}{f_e}$	9	1	1	9

225/25

Chi-Square Evaluation

$$\chi^2 = \Sigma\left(\frac{(f_o - f_e)^2}{f_e}\right)$$

$$\chi^2 = 20$$

Degrees of freedom = k-1

Critical value (page 490)

$$\chi^2_{crit} = 7.81, p < .05$$

Two-Way Chi-Square Test of Independence

- Two variables.
  - People are grouped categorically (nominal scale).
- Null hypothesis.
  - There is no difference in the distribution of the scores across the variables.
- Alternative hypothesis.
  - There is a difference in the distribution of the scores across the variables.

Chi-Square (r x c) Example

The noted statistician, Dr. Polly Nomial, wanted to repeat Anne Nova's study but was interested if there was an effect on the basis of gender. So she asked a sample of students to select their preference for academic activity then broke the group into male and female respondents.

Nomial's Data

	Statistics	Experimental	Testing	Recess	Total
Male	15	10	10	15	50
Female	20	10	5	5	40
	35	20	15	20	90

1. Compute the expected values.

	Statistics	Experimental	Testing	Recess	Total
Male	15 f_e=19.44	10 f_e= 11.11	10 f_e= 8.33	15 f_e= 11.11	50
Female	20 f_e= 15.56	10 f_e= 8.89	5 f_e= 6.67	5 f_e= 8.89	40
	35	20	15	20	90

$$f_e = \frac{Row\,Total\; x\; Column\,Total}{Grand\,Total}$$

2. Compute $(f_e - f_o)^2$

	Statistics	Experimental	Testing	Recess	Total
Male	15 f_e=19.44 $(f_e-f_o)^2$=19.71	10 f_e= 11.11 $(f_e-f_o)^2$=1.21	10 f_e= 8.33 $(f_e-f_o)^2$= 2.79	15 f_e= 11.11 $(f_e-f_o)^2$=15.13	50
Female	20 f_e= 15.56 $(f_e-f_o)^2$=19.71	10 f_e= 8.89 $(f_e-f_o)^2$=1.23	5 f_e= 6.67 $(f_e-f_o)^2$=2.79	5 f_e= 8.89 $(f_e-f_o)^2$=15.13	40
	35	20	15	20	90

3. Compute $\frac{(f_e - f_o)^2}{f_e}$

	Statistics	Experimental	Testing	Recess	Total
Male	15 f_e=19.44 $(f_e-f_o)^2$=19.71 1.014	10 f_e= 11.11 $(f_e-f_o)^2$=1.21 .109	10 f_e= 8.33 $(f_e-f_o)^2$= 2.79 .335	15 f_e= 11.11 $(f_e-f_o)^2$=15.13 1.362	50
Female	20 f_e= 15.56 $(f_e-f_o)^2$=19.71 1.267	10 f_e= 8.89 $(f_e-f_o)^2$=1.23 .138	5 f_e= 6.67 $(f_e-f_o)^2$=2.79 .418	5 f_e= 8.89 $(f_e-f_o)^2$=15.13 1.702	40
	35	20	15	20	90

4. Compute $\chi^2 = \Sigma\left(\frac{(f_e - f_o)^2}{f_e}\right)$

$\chi^2 = 6.363$

df = (r-1)(c-1)

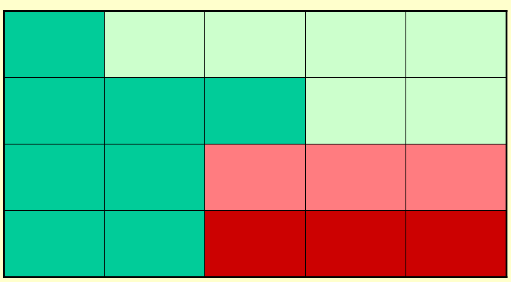
What is the critical value?

What is your conclusion?

Kool Facts About Chi-Square

- χ^2 values range from a low of 0, no difference, to higher values as the difference between f_o and f_e become larger.
- Degrees of freedom are based on the number of cells, not number of people.
- For complex contingency tables χ^2 does not indicate which cells are highly different. *Post hoc* tests have to be done to identify the differences.
- χ^2 does not give an indication as to how strong a relationship is.

5 x 4 Contingency Table



Types of Chi-square

1. *Goodness of fit* (One way).
   - Single variable with multiple categories.
     - Preference for car models.
     - Choice of computer models.
   - Compares the distribution of scores against a standard.
     - Equal distribution of scores.
     - A priori distribution of scores.
   - Similar to the One-way ANOVA.

Types of Chi-square

2. *Test of Independence* (Independent Samples)
   - Two or more variables.
     - School dropouts by ethnic group.
     - Gender of rider by order of finish in a horse race.
   - Similar to factorial ANOVA.

χ^2 Assumptions

1. The observations are independent; each observed frequency is generated by a different subject.
2. The observed cell frequencies are greater than 5.

THE END!!!!!

Thank God!
Its all over.