Chi-Square

Exercise

Steps in Test of Hypothesis

1. Determine the appropriate test
2. Establish the level of significance:α
3. Formulate the statistical hypothesis
4. Calculate the test statistic
5. Determine the degree of freedom
6. Compare computed test statistic against a tabled/critical value

1. Determine Appropriate Test

- Chi Square is used when both variables are measured on a nominal scale.
- It can be applied to interval or ratio data that have been categorized into a small number of groups.
- It assumes that the observations are randomly sampled from the population.
- All observations are independent (an individual can appear only once in a table and there are no overlapping categories).
- It does not make any assumptions about the shape of the distribution nor about the homogeneity of variances.

2. Establish Level of Significance

- α is a predetermined value
- The convention
  - $\alpha = .05$
  - $\alpha = .01$
  - $\alpha = .001$

3. Determine The Hypothesis: Whether There is an Association or Not

- H_o : The two variables are independent
- H_a : The two variables are associated

4. Calculating Test Statistics

- Contrasts observed frequencies in each cell of a contingency table with expected frequencies.
- The expected frequencies represent the number of cases that would be found in each cell if the null hypothesis were true (i.e. the nominal variables are unrelated).
- Expected frequency of two unrelated events is product of the row and column frequency divided by number of cases.

$$F_e = F_r F_c / N$$

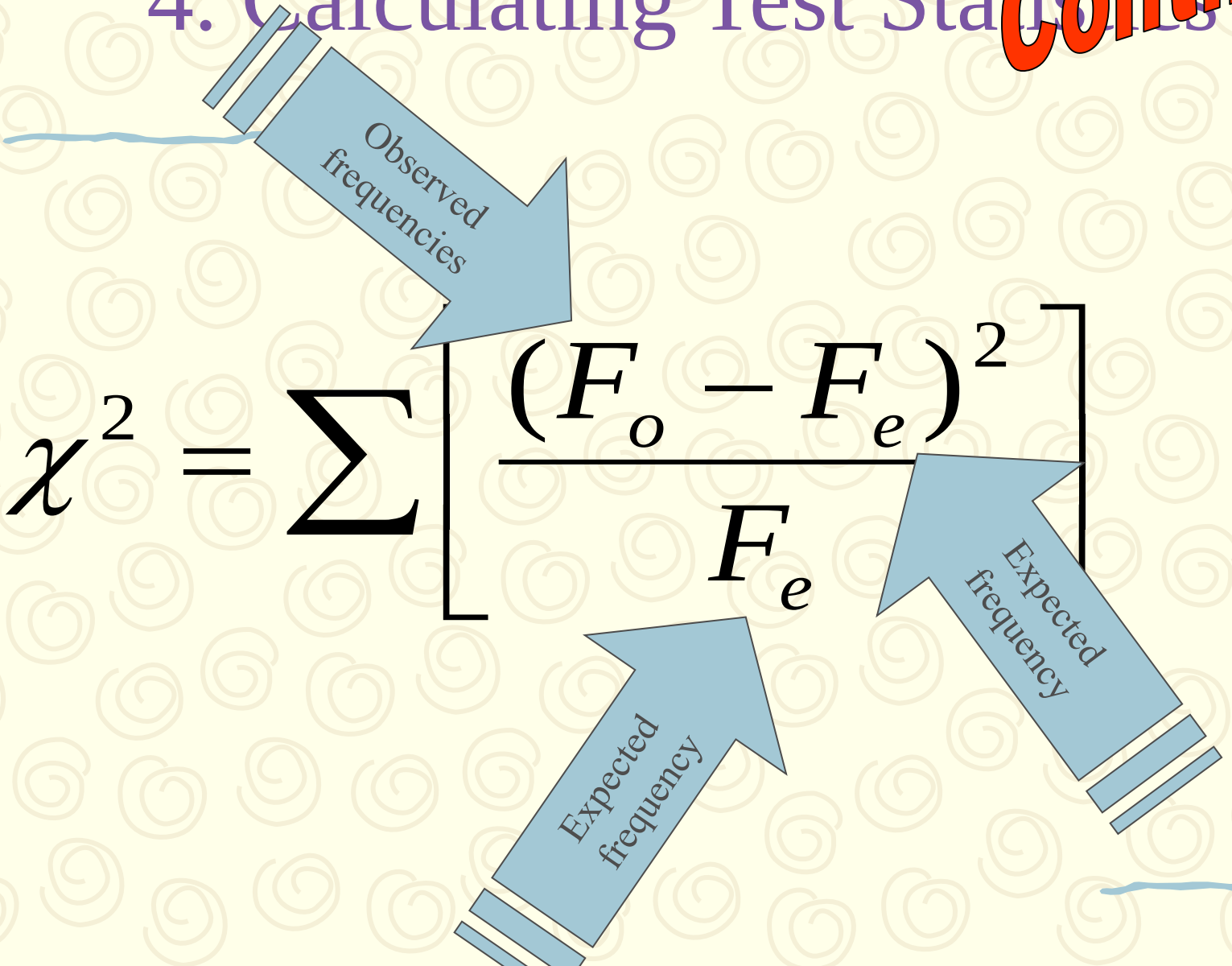
4. Calculating Test Statistics

Continued

$$\chi^2 = \sum \left[\frac{(F_o - F_e)^2}{F_e} \right]$$

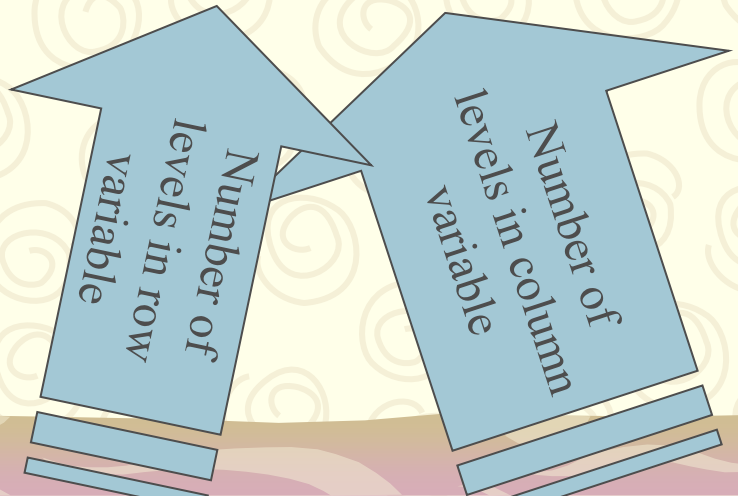
4. Calculating Test Statistics

Continued



5. Determine Degrees of Freedom

$$df = (R-1)(C-1)$$



6. Compare computed test statistic against a tabled/critical value

- The computed value of the Pearson chi-square statistic is compared with the critical value to determine if the computed value is *improbable*
- The critical tabled values are based on sampling distributions of the Pearson chi-square statistic
- If calculated χ^2 is greater than χ^2 table value, reject H_o

Example

- Suppose a researcher is interested in voting preferences on gun control issues.
- A questionnaire was developed and sent to a random sample of 90 voters.
- The researcher also collects information about the political party membership of the sample of 90 respondents.

Bivariate Frequency Table or Contingency Table

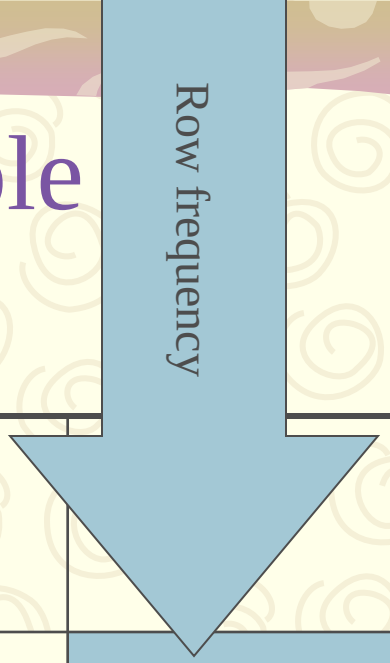
	Favor	Neutral	Oppose	f_{row}
Democrat	10	10	30	50
Republican	15	15	10	40
f_{column}	25	25	40	n = 90

Bivariate Frequency Table or Contingency Table

	Favor	Neutral	Oppose	f_{row}
Democrat	10	10	30	50
Republican	15	15	10	40
f_{column}		25	40	n = 90

Observed frequencies

Bivariate Frequency Table
Contingency Table



	Favor	Neutral	Oppose	
Democrat	10	10	30	50
Republican	15	15	10	40
f_{column}	25	25	40	n = 90

Bivariate Frequency Table or Contingency Table

	Favor	Neutral	Oppose	f_{row}
Democrat	10	10	30	50
Republican	15	15	10	40
	25	25	40	n = 90

Column frequency

1. Determine Appropriate Test

1. Party Membership (2 levels) and Nominal
2. Voting Preference (3 levels) and Nominal

2. Establish Level of Significance

Alpha of .05

3. Determine The Hypothesis

- Ho : There is no difference between D & R in their opinion on gun control issue.
- Ha : There is an association between responses to the gun control survey and the party membership in the population.

4. Calculating Test Statistics

	Favor	Neutral	Oppose	f_{row}
Democrat	f_o =10 f_e =13.9	f_o =10 f_e =13.9	f_o =30 f_e=22.2	50
Republican	f_o =15 f_e =11.1	f_o =15 f_e =11.1	f_o =10 f_e =17.8	40
f_{column}	25	25	40	n = 90

4. Calculating Test Statistics

Continued

	Favor	Neutral	Oppose	f_{row}
Democrat	f_o =10 f_e =**13.9**	f_o =10 f_e =13.9	f_o =30 f_e=22.2	50
Republican	f_o =15 f_e =11.1	f_o =15 f_e =11.1	f_o =10 f_e =17.8	40
f_{column}	25	25	40	n = 90

= 50*25/90

4. Calculating Test Statistics

Continued

	Favor	Neutral	Oppose	f_{row}
Democrat	f_o =10 f_e =13.9	f_o =10 f_e =13.9	f_o =30 f_e =22.2	50
Republican	f_o =15 f_e =**11.1**	f_o =10 f_e =11.1	f_o =10 f_e =17.8	40
f_{column}	25	25	40	n = 90

= 40* 25/90

4. Calculating Test Statistics

Continued

$$\chi^2 = \frac{(10-13.89)^2}{13.89} + \frac{(10-13.89)^2}{13.89} + \frac{(30-22.2)^2}{22.2} +$$

$$\frac{(15-11.11)^2}{11.11} + \frac{(15-11.11)^2}{11.11} + \frac{(10-17.8)^2}{17.8}$$

$$= 11.03$$

5. Determine Degrees of Freedom

$$df = (R-1)(C-1) =$$
$$(2-1)(3-1) = 2$$

6. Compare computed test statistic against a tabled/critical value

- $\alpha = 0.05$
- df = 2
- Critical tabled value = 5.991
- Test statistic, 11.03, exceeds critical value
- Null hypothesis is rejected
- Democrats & Republicans differ significantly in their opinions on gun control issues