

Name:

AP Statistics - Chapter 11: The Chi-Square Distributions

Multiple Choice

Identify the choice that best completes the statement or answers the question.

1. A chi-square goodness of fit test is used to test whether a 0 to 9 spinner is “fair” (that is, the outcomes are all equally likely). The spinner is spun 100 times, and the results are recorded. What are the degrees of freedom for this test?
- 8
 - 9
 - 10
 - 99
 - 100
2. A study of accident records at a large engineering company in England reported the following number of injuries on each shift for 1 year:

| Shift: | Morning | Afternoon | Night |
|---------------------|---------|-----------|-------|
| Number of injuries: | 1372 | 1578 | 1686 |

Is there sufficient evidence to say that the numbers of accidents on the three shifts are not the same? Test at the 0.05, 0.01, and 0.001 levels.

- There is sufficient evidence at all three levels to say that the numbers of accidents on each shift are not the same.
- There is sufficient evidence at the 0.05 and 0.01 levels but not at the 0.001 level.
- There is sufficient evidence at the 0.05 level but not at the 0.01 or 0.001 levels.
- There is sufficient evidence at the 0.001 level but not at the 0.01 or 0.05 levels.
- There is insufficient evidence at any of these levels.

Questions 3 to 10 refer to the following situation.

In the paper “Color Association of Male and Female Fourth-Grade School Children” (*Journal of Psychology*, 1988, 383–388), reported on a study in which children were asked to indicate what emotion they associated with the color red. The response and the sex of the child are noted and summarized below. The first number in each cell is the count; the second number is the row percent.

| | Anger | Happy | Love | Pain | Total |
|--------|-------------|-------------|-------------|-------------|-------|
| Female | 27 26.47 | 19 18.63 | 39 38.24 | 17 16.67 | 102 |
| Male | 34 30.36 | 12 10.71 | 38 33.93 | 28 25.00 | 112 |
| Total | 61 | 31 | 77 | 45 | 214 |

3. The null hypothesis is
- emotional association with red is independent of gender.
 - gender is dependent upon the emotional association with red.
 - the probability of associating a specific emotion with red is related to gender.
 - the number of children in each cell does not depend upon gender or upon emotion.
 - the color red is independent of the emotion associated with it and with gender.
4. Under a suitable null hypothesis, the expected frequency for the cell corresponding to Anger and Males is
- 15.9
 - 55.7

- c. 30.4
- d. 31.9
- e. 29.1

5. The null hypothesis will be rejected at $\alpha = 0.05$ if the test statistic exceeds

- a. 3.84
- b. 5.99
- c. 7.81
- d. 9.49
- e. 14.07

6. The approximate P -value is

- a. between 0.100 and 0.900.
- b. between 0.050 and 0.100.
- c. between 0.025 and 0.050.
- d. between 0.010 and 0.025.
- e. between 0.005 and 0.010.

7. Which of the following is NOT CORRECT?

- a. The children were classified by sex and emotion associated with red. Each child was counted in one and only one cell.
- b. The null hypothesis is that the type of emotion associated with red is independent of the sex of the child.
- c. The null hypothesis is that the proportion of emotions associated with red is the same for both sexes.
- d. All expected cell counts should be greater than 5 in order that the distribution of the test statistic is an approximate chi-square distribution.
- e. If we reject the null hypothesis, then we have proven that the two sexes associate red with emotions in different ways.

8. Which of the following is NOT CORRECT?

- a. A lower percent of female students associate the emotion "anger" with the color red than do male students.
- b. More students associate the color red with the emotion "love" than with the emotion "anger."
- c. There is insufficient evidence of an association between gender and emotion associated with the color red.
- d. We will be unable to compute a correlation for these data because the variables are both categorical.
- e. We compute row or column percents by dividing the cell count by the table total (214).

9. A Type I error would be committed if

- a. we conclude that the sex of the child and the emotion associated with red are independent when in fact they are not independent.
- b. we conclude that the sex of the child and the emotion associated with red are not independent when in fact they are not independent.
- c. we conclude that the proportion of emotions associated with red differs between males and females when in fact they are the same.
- d. we conclude that the proportion of emotions associated with red is the same for males and females when in fact they are the same.
- e. we fail to find any association between the color red and emotions for either sex.

10. The test statistic and approximate P -value are

- a. 4.661 0.1983
- b. 4.661 0.3966
- c. 4.629 0.2011
- d. 4.629 0.4022
- e. 4.629 0.1006

AP Statistics – Chapter 11 Practice Test: The Chi-Square Distributions

Part II, Free Response – Show all work and communicate completely and clearly.

- Computer software generated 500 random numbers that should look like they are from the uniform distribution on the interval 0 to 1. They are categorized into five groups: (1) less than or equal to 0.2 (2) greater than 0.2 and less than or equal to 0.4, (3) greater than 0.4 and less than or equal to 0.6, (4) greater than 0.6 and less than or equal to 0.8, and (5) greater than 0.8. The counts in the five groups are 113, 95, 108, 99, and 85, respectively.
 - The probabilities for these five intervals are all the same. What is this probability?
 - Compute the expected count for each interval for a sample of 500.
 - Perform the goodness of fit test and summarize your results. Report the χ^2 statistic, the P-value and write an appropriate conclusion.
- For 1000 shoppers donating blood at a mall, the frequencies of blood types were as shown in the table below. Consider this an SRS of all mall shoppers.

| Blood Type | O | A | B | AB | Total |
|------------|-----|-----|----|----|-------|
| Frequency | 465 | 394 | 96 | 45 | 1000 |

In the general population, the blood type distribution is as follows:

Type O = 45%, Type A = 40%, Type B = 10%, Type AB = 5%,.

Here are the hypotheses we will test:

Ho: Mall shoppers have the same blood type proportions as the general public

Ha: Mall shoppers DO NOT have the same blood type proportions as the general public

- Compute the expected counts for this table.
 - Use the results of part (a) to compute the chi-square statistic – show the entire calculation from the chi-square formula.
 - What is the p-value of this test?
 - What is the conclusion of this test (write a sentence or two in context of the problem).
- A study of the career plans of young women and men sent questionnaires to all 390 members of the senior class in the College of Business Administration at the University of Illinois. One question asked which major within the business program the student had chosen. Here are the data from the students who responded:

| Major/Gender | Female | Male |
|----------------|--------|------|
| Accounting | 68 | 56 |
| Administration | 91 | 40 |
| Economics | 7 | 8 |
| Finance | 61 | 59 |

This is an example of a single sample classified according to two categorical variables (gender and major).

- Verify that the expected cell counts satisfy the requirement for use of chi-square.
- Compute the expected count for the female economics cell of the table. **SHOW WORK.**
- Test the null hypothesis that there is no relationship between the gender of students and their choice of major. Give the χ^2 statistic and the P-value.
- State your conclusion in a sentence or two.

Name:

Score: 0 / 10 points (0%)

AP Statistics - Chapter 11: The Chi-Square Distributions

Multiple Choice

Identify the choice that best completes the statement or answers the question.

1. A chi-square goodness of fit test is used to test whether a 0 to 9 spinner is “fair” (that is, the outcomes are all equally likely). The spinner is spun 100 times, and the results are recorded. What are the degrees of freedom for this test?
- a. 8
 - b. 9
 - c. 10
 - d. 99
 - e. 100

ANSWER: B

Since there are 10 “categories” on the spinner (0-9), we have $10 - 1 = 9$ degrees of freedom for this χ^2 test.

POINTS: 0 / 1

2. A study of accident records at a large engineering company in England reported the following number of injuries on each shift for 1 year:

| Shift: | Morning | Afternoon | Night | |
|---------------------|---------|-----------|-------|--|
| Number of injuries: | 1372 | 1578 | 1686 | |

Is there sufficient evidence to say that the numbers of accidents on the three shifts are not the same? Test at the 0.05, 0.01, and 0.001 levels.

- a. There is sufficient evidence at all three levels to say that the numbers of accidents on each shift are not the same.
- b. There is sufficient evidence at the 0.05 and 0.01 levels but not at the 0.001 level.
- c. There is sufficient evidence at the 0.05 level but not at the 0.01 or 0.001 levels.
- d. There is sufficient evidence at the 0.001 level but not at the 0.01 or 0.05 levels.
- e. There is insufficient evidence at any of these levels.

ANSWER: A


Since this test is assuming that accidents will be equal in all 3 shifts, the expected counts are found by taking the sum of all accidents and dividing by 3 which gives $(1372 + 1578 + 1686) / 3 =$

POINTS: 0 / 1

Questions 3 to 10 refer to the following situation.


In the paper “Color Association of Male and Female Fourth-Grade School Children” (*Journal of Psychology*, 1988, 383–388), reported on a study in which children were asked to indicate what emotion they associated with the color red. The response and the sex of the child are noted and summarized below. The first number in each cell is the count; the second number is the row percent.

| | Anger | Happy | Love | Pain | Total |
|--------|-------------|-------------|-------------|-------------|------------|
| Female | 27 26.47 | 19 18.63 | 39 38.24 | 17 16.67 | 102 |
| Male | 34 30.36 | 12 10.71 | 38 33.93 | 28 25.00 | 112 |
| Total | 61 | 31 | 77 | 45 | 214 |

-  — 3. The null hypothesis is
- emotional association with red is independent of gender.
 - gender is dependent upon the emotional association with red.
 - the probability of associating a specific emotion with red is related to gender.
 - the number of children in each cell does not depend upon gender or upon emotion.
 - the color red is independent of the emotion associated with it and with gender.


ANSWER: A

POINTS: 0 / 1

-  — 4. Under a suitable null hypothesis, the expected frequency for the cell corresponding to Anger and Males is
- 15.9
 - 55.7
 - 30.4
 - 31.9
 - 29.1


ANSWER: D

POINTS: 0 / 1

-  — 5. The null hypothesis will be rejected at $\alpha = 0.05$ if the test statistic exceeds
- 3.84
 - 5.99
 - 7.81
 - 9.49
 - 14.07


ANSWER: C

POINTS: 0 / 1

-  — 6. The approximate P -value is
- between 0.100 and 0.900.
 - between 0.050 and 0.100.
 - between 0.025 and 0.050.
 - between 0.010 and 0.025.
 - between 0.005 and 0.010.


ANSWER: A

POINTS: 0 / 1

-  — 7. Which of the following is NOT CORRECT?
- The children were classified by sex and emotion associated with red. Each child was counted in one and only one cell.
 - The null hypothesis is that the type of emotion associated with red is independent of the sex of the child.
 - The null hypothesis is that the proportion of emotions associated with red is the same for both sexes.
 - All expected cell counts should be greater than 5 in order that the distribution of the test statistic is an approximate chi-square distribution.
 - If we reject the null hypothesis, then we have proven that the two sexes associate red with emotions in different ways.

ANSWER: E


POINTS: 0 / 1

-  — 8. Which of the following is NOT CORRECT?
- A lower percent of female students associate the emotion “anger” with the color red than do male students.

- b. More students associate the color red with the emotion “love” than with the emotion “anger.”
- c. There is insufficient evidence of an association between gender and emotion associated with the color red.
- d. We will be unable to compute a correlation for these data because the variables are both categorical.
- e. We compute row or column percents by dividing the cell count by the table total (214).


ANSWER: E

POINTS: 0 / 1

-  — 9. A Type I error would be committed if
- a. we conclude that the sex of the child and the emotion associated with red are independent when in fact they are not independent.
 - b. we conclude that the sex of the child and the emotion associated with red are not independent when in fact they are not independent.
 - c. we conclude that the proportion of emotions associated with red differs between males and females when in fact they are the same.
 - d. we conclude that the proportion of emotions associated with red is the same for males and females when in fact they are the same.
 - e. we fail to find any association between the color red and emotions for either sex.

ANSWER: C

POINTS: 0 / 1

-  — 10. The test statistic and approximate P -value are
- a. 4.661 0.1983
 - b. 4.661 0.3966
 - c. 4.629 0.2011
 - d. 4.629 0.4022
 - e. 4.629 0.1006

ANSWER: C

POINTS: 0 / 1

AP Statistics – Chapter 11 Practice FR Solutions

1. Goodness of Fit Test – Equal Proportions

- Since there are 5 groups, the probability is $1/5 = 0.2$
- Since there are 500 numbers generated, expected counts are $500(0.2) = 500/5 = 100$
- The χ^2 statistic is 4.84. There are 4 degrees of freedom here, so the p-value is .3041.

Conclusion: Since the p-value is high ($p > .05$), we fail to reject the null hypothesis. So we can conclude that the random numbers are uniformly distributed among the 5 groups.

2. Goodness of Fit Test – Unequal Proportions

- Using the percentages given and multiplying them by the sample size (1000), we get the following expected counts:

$$\text{Type O} = 450, \text{Type A} = 400, \text{Type B} = 100, \text{Type AB} = 50,$$

- The formula for χ^2 statistic is $\chi^2 = \sum \frac{(\text{obs} - \text{exp})^2}{\text{exp}}$. For this data, the calculation is

$$\frac{(465 - 450)^2}{450} + \frac{(394 - 400)^2}{400} + \frac{(96 - 100)^2}{100} + \frac{(45 - 50)^2}{50} = 1.25$$

- There are 3 degrees of freedom here, so the p-value is .7410.
- Since the p-value is high ($p > .05$), we fail to reject the null hypothesis. We can conclude that the blood types for mall shoppers are consistent with the population blood type distribution.

3. Test of Association Between Categorical Variables – Two-Way Table

- All of the expected counts are more than 5 (See Matrix B after running the test). So we are OK to use the chi-square test.
- Expected counts are found by

$$\frac{(\text{row tot})(\text{col tot})}{\text{table tot}} = \frac{(15)(227)}{390} = 8.731$$

- There are 3 degrees of freedom here, so $\chi^2 = 10.907$ and the p-value is .0122
- Since the p-value is less than .05, we reject the null hypothesis. So we can conclude that there is a relationship between gender and their choice of business major. Stated another way, men and women are different in their choices of business majors.