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MAT 222

Fall 2019

Chapter 9 Worksheet

“[Clouseau] It’s amazing how he fell perfectly into the chalk outline on the floor. [Ponton] I think they drew the outline after he was shot.

[Clouseau] Ah! We must be working with some kind of mastermind!”

– Inspector Clouseau & Gilbert Ponton, *The Pink Panther*

Problem 1: A group of researchers is trying to determine if there is a relationship between ones education level and whether one has found employment. They survey a group of individuals, asking whether they are employed full–time, part–time, or are unemployed. They also ask the individuals whether they have a high school education, some college education (Associates), a B.A., a masters, or a Ph.D.. The results are summarized in the first table below. Complete the missing entries in the tables below.

Table of Counts

	High School	Associates	B.A.	Masters	Ph.D.	Total
Full–Time	33	48	59	55	59	254
Part–Time	22	37	36	37	28	160
Unemployed	15	26	12	13	9	75
Total	70	111	107	105	96	489

Table of Expected Values

	High School	Associates	B.A.	Masters	Ph.D.
Full–Time	36.36	57.66	55.58	54.54	49.87
Part–Time	22.90	36.32	35.01	34.36	31.41
Unemployed	10.74	17.02	16.41	16.10	14.72

Table of Chi–Squared Contributions

	High School	Associates	B.A.	Masters	Ph.D.
Full–Time	0.3105	1.6173	0.2106	0.0039	1.6735
Part–Time	0.0354	0.0128	0.0280	0.2035	0.3704
Unemployed	1.6933	4.7380	1.1856	0.5984	2.2252

Perform a chi-squared analysis to determine if there is a relationship between ones employment and education level. Be sure to state your H_0, H_a in the context of the problem, the degrees of freedom, your p -value, and your conclusion in the context of the problem. [Use $\alpha = 0.10$.]

Solution.

$X^2 = \text{sum of the entries of the last table} = 14.9064$
degrees of freedom = $(5 - 1)(3 - 1) = 8$

$\left\{ \begin{array}{l} H_0 : \text{there is no assoc. between Ed. \& Employ.} \\ H_a : \text{there is an assoc. between Ed. \& Employ.} \end{array} \right.$

Then we have $0.05 < p < 0.10$. Therefore, we reject the null hypothesis. There is an association between ones education level and their employment status.

Problem 2: Cornaught University is investigating whether they are admitting under-represented groups 'fairly' or if income may have some influence in admittance. They collect family income data on all African-American students at the University. The breakdown of the students' income levels is given in the table below. Given that 22% of African-Americans make under 15K, 27% make between 15K and 35K, 38% make between 35K and 100K, 11% make between 100K and 200K, and 2% make over 200K, determine whether the students are being admitted 'fairly'. [Use $\alpha = 0.01$.]

Income Level	<15K	15K-35K	35K-100K	100K-200K	>200K
Number of Students	213	312	425	200	100

Solution. A total of 1,250 students were examined. This gives us an expected table of...

Income Level	<15K	15K - 35K	35K - 100K	100K - 200K	>200K
Expected Number of Students	275	337.5	475	137.5	25

For example, the expected value in the second column is computed via $1250 \cdot 0.27 = 337.5$. This gives a contribution to χ^2 -table of...

Income Level	<15K	15K-35K	35K-100K	100K-200K	>200K
χ^2 -Contribution	13.98	1.93	5.26	28.41	225.00

We have null and alternative hypotheses:

$$\begin{cases} H_0 : \text{The data is consistent with the given percentages.} \\ H_a : \text{The data is not consistent with the given percentages.} \end{cases}$$

We have test statistic $X^2 = 13.98 + 1.93 + 5.26 + 28.41 + 225 = 275.58$ with degrees of freedom $5 - 1 = 4$. This gives p value of $p \approx 0.000$. Therefore, we reject the null hypothesis. The rate of admittance of African-American students is not consistent with the known percentages of wealth rates of African-Americans.