

Chi-squared testing cont'd

Group	Alcohol use		Total
	High	Low	
Clergy	32	268	300
Educators	51	199	250
Executives	67	233	300
Retailers	83	267	350
Total	233	967	1,200

- $H_0 : p_1 = p_2 = p_3 = p_4 = p$
- $H_a : \text{at least two of the } p_j \text{ are unequal}$

Word distributions

Word	Book			Total
	1	2	3	
<i>a</i>	147	186	101	434
<i>an</i>	25	26	11	62
<i>this</i>	32	39	15	86
<i>that</i>	94	105	37	236
<i>with</i>	59	74	28	161
<i>without</i>	18	10	10	38
Total	375	440	202	1017

- H_0 : The probabilities of each word are the same for every book
- H_a : At least two are different

Testing independence

	Wife's Rating				
Husband	N	F	V	A	Tot
N	7	7	2	3	19
F	2	8	3	7	20
V	1	5	4	9	19
A	2	8	9	14	33
	12	28	18	33	91

N=never, F=fairly often, V=very often,
A=almost always

- H_0 : H and W ratings are independent
- H_a : not independent
- $P(H = N \ \& \ W = A) = P(H = N)P(W = A)$

Independence cont'd

```
x<-matrix(c(7,7,2,3,  
            2,8,3,7,  
            1,5,4,9,  
            2,8,9,14),4)  
chisq.test(x)
```

$$\sum \frac{(O-E)^2}{E} = 16.96$$

$$df = (4 - 1)(4 - 1) = 9$$

$$p\text{-value} = .049$$

Cell counts are probably too small
to use large sample approximation

Notes

- Equal distribution and independence test yield the same results
- Same test results if
 - ▶ row totals are fixed
 - ▶ column totals are fixed
 - ▶ total ss is fixed
 - ▶ none are fixed(interpretations differ)
- Chi-squared result requires large cell counts
- df is always $(Rows - 1)(Columns - 1)$
- Generalizations of Fishers exact test can be used

Chi-squared goodness of fit

Results from R's RNG

	[0, .25)	[.25, .5)	[.5, .75)	[.75, 1)	Total
Count	254	235	267	244	1000
TP	.25	.25	.25	.25	1

- $H_0 : p_1 = .25, p_2 = .25, p_3 = .25, p_4 = .25$
- $H_a : \text{any } p_i \neq \text{it's hypothesized value}$

Testing Mendel's hypothesis

	Phenotype		
	Yellow	Green	Total
Observed	6022	2001	8023
TP	.75	.25	1
Expected	6017.25	2005.75	8023

- $H_0 : p_1 = .75, p_2 = .25$

Notes on GOF

- Test of whether or not observed counts equal theoretical values
- Test statistic is $\sum \frac{(O-E)^2}{E}$
- TS follows χ^2 distribution for large n
- df is the number of cells minus 1
- Undirected alternative is problematic
- Especially useful for testing RNGs
- Kolmogorov/Smirnov test is an alternative test that does not require discretization