Applied Statistics for the Behavioral Sciences

Chapter 11:
One-Way Analysis of Variance (ANOVA)

1

Topical Outline

- Purpose of ANOVA
- Steps
- Logic of ANOVA
- An example
- Group comparisons
- Presenting results (summary tables)

2

Purpose of ANOVA

- more than 2 treatment levels
- these designs differ from those in t chapter by # of levels of the IV
- with a three level IV
  H_0: $\mu_1 = \mu_2 = \mu_3$

  H_1: not($\mu_1 = \mu_2 = \mu_3$)
- multiple t-tests, not a good idea
- probability of making a type I error rises
- 4 groups= 6 tests, p(at least 1 type I error) 6 x 0.05 = 0.30
- common in outcomes research
  - evaluate the relative efficacy of treatments
  - clinical trials, compare new drug with "old-standard" and a placebo control

3

ANOVA ANalysis Of Variance steps

- One-way ANOVA allows comparisons among two or more sample means
- Steps in hypothesis testing with ANOVA
- 1. identify H_0 and H_1
- 2. assume tentatively the equality hypothesis is true
  - deviations among the sample means within the bounds expected due to sampling error
- 3. choose sampling distribution
  - t distribution worked for two sample means
  - will use the F distribution

4

ANOVA hypothesis testing steps (cont.)

- 4. obtain data from the populations you are interested in and calculate an F statistic
- 5. compare F observed to F critical (Table F, Pgs. 404-7)
- 6. reach a conclusion about the status of the null
  - **if $p \leq .05$ reject the null**
  - **if $p > .05$ retain null and alternative as possibilities.**
- 7. tell the story in terms of the constructs being investigated
- same process we followed with t test

5

ANOVA logic / DF

- variance in a set of observations can be partitioned into within groups and between groups variance
- F statistic - ratio of between groups variance and within groups variance
- if no differences between group means, between and within groups variance will be about the same, resulting in an f ratio of around one
- F statistic has two degrees of freedom
- first is the between groups df which = k(ngroups)-1
- second is the within groups df which = n – k(ngroups)

6

ANOVA example

- exercise program example
- enter data into SPSS
- write paragraph summarizing findings
- hired by a large corporation to implement a “wellness program.”
- encouraging good dietary habits and exercise will decrease sick days, productivity will increase and have reduced health insurance benefit costs due to lower utilization of medical services
- best way to present the program, in terms of scheduling?

7

ANOVA example (cont.)

- you have the freedom to schedule it at any time you wish, and attendance will be mandatory for all employees, so you want to find out which type of presentation people will prefer
- more satisfied with the program = receptive and attentive to the information presented
- group of 30 employees randomly assigned to one of the three conditions
- at the conclusion of the program (identical for all 3 groups) assess satisfaction with the program

8

The data

Condition	Satisfaction	Cond.	Satis.	Cond.	Satis.
days	5	nights	5	Saturday	5
days	5	nights	4	Saturday	5
days	5	nights	4	Saturday	5
days	5	nights	3	Saturday	4
days	4	nights	3	Saturday	4
days	4	nights	2	Saturday	4
days	4	nights	2	Saturday	3
days	4	nights	2	Saturday	3
days	3	nights	1	Saturday	3
days	2	nights	0	Saturday	2

9

Components of F statistic

- two different estimates of the pop.variance (σ^2)
- the numerator of the F statistic represents a reasonable estimate of σ^2 only when null is true
- when the null is not true, estimate is too large
- If this variance, as estimated by the variance of the means is large relative to the average of the variances we reject the null hypothesis that there is no difference between treatment means
- expected value of F is 1.00 if null is true

10

Conclusions from ANOVA

- we can conclude that the three schedules do not result in equal satisfaction
- unsure about specifically where these significant differences lie
- probably a safe bet that the days mean is higher than the nights mean
- is days significantly higher than Saturday?
- is Saturday significantly higher than nights?

11

Multiple comparisons (HSD)

- Tukey's HSD (Honestly Significant Difference) test (Table G, pg. 408-9)
- a priori or post hoc
- a priori have selected some small number of comparisons
- post hoc - comparing all of the group means
- lots of different test options

12

ANOVA summary table

Source	SS	df	MS - Mean Square	F	p (sig.)
Condition (Between Groups)	12.60	2	6.30	4.373	.023
Error (Within Groups)	38.90	27	1.441		
Total	51.50	29			
Total N = total df+1		30			
N of groups = condition df+1		3			

13