Biology 4605 / 7220 Name Key
Exam #2b 1 November 2019

1. Wadley (1946 *Journal of Economic Entomology* 38:651) reported percentage of flower buds attacked by boll weevils in 16 plots each treated with a different type of arsenical insecticide. The experiment was repeated in 5 different fields for a total of 80 plots. Are some insecticides more effective than others, after controlling for differences in location?

Define variables in a tabular format, as in the box. [3]

scale = nominal, ordinal, or cardinal
cardinal = interval or ratio scale.

A. name	symbol	scale
% Buds	%B	cardinal
IType	IT	nominal
Field	F	nominal

Using the symbols, write a general linear model relating the response variable to explanatory variable(s) and interaction terms (if appropriate).
List degrees of freedom beneath each term in the model,
Assume 1 measure of flower bud % per plot. ← 60 df cannot estimate

$$\underset{79}{\%B} = \underset{15}{\beta_0 + \beta_{IT} \cdot IT} + \underset{4}{\beta_F \cdot F} + \underset{60}{\beta_{IT \cdot F} \cdot IT \cdot F} + \varepsilon$$ [3] [4]

State the name of the analysis, from the following list. [1]

t-test, one-way ANOVA, two-way ANOVA,
three-way ANOVA
paired comparisons, randomized blocks,
hierarchical (nested) ANOVA
regression, multiple regression,
ANCOVA (at least one nominal and at least 1 cardinal scale explanatory variable)
none of the above.

Using the same symbols, write a general linear model given 2 measurements per plot.
List degrees of freedom beneath each term in the model.

$$\underset{160-1}{\%B} = \underset{15}{\beta_0 + \beta_{IT} \cdot IT} + \underset{4}{\beta_F \cdot F} + \underset{60}{\beta_{IT \cdot F} \cdot IT \cdot F} + \underset{80}{\varepsilon}$$ [4] [5]

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2. J. Neter, W. Wasserman, and M.H. Kutner 1985 *Applied Linear Statistical Models* reported muscle mass in 8 women, in the 43-58 year age range.
Does muscle mass M (kg) decrease with age A in this range? (H_o testing)
The question can also be phrased as:
How good is the evidence for a decrease in muscle mass with age in this range ?

Using the symbols above write a GLM to address this question.

$$M = \beta_0 + \beta_A \cdot A + \varepsilon$$
$$kg = kg + \frac{kg}{yr} \cdot yr + kg$$

[2]

Show units below each symbol in your GLM. [5]

Write the null hypothesis.

H_o $\beta_A = 0$ or $var(\beta_A) = 0$ or $var(\beta_A \cdot A) = 0$ [1]

Complete the ANOVA table [6]

age	Source	df	SS	MS	F	p
43-58	regr	1	70.64	70.64	10.228	0.02
	residual	6	41.44	6.91		
	total	7	112.08			

Calculate the explained variance R^2 = $\frac{70.64}{112.08} = 0.63$ [1]

Calculate the likelihood ratio. LR = $(1 - 0.63)^{-8/2} = 54$ [1]

Declare a decision about H_o against a 5% tolerance for statistical significance. [1]

H_o : Reject the null at $\alpha = 5\%$

Choose one of the following methods of reporting statistical conclusions. (circle it). [1]

Report the likelihood ratio as relative evidence:
"change with age was (__) times more likely than no change"
Report Type I error with a decision.
"the null hypothesis was (or was not) rejected at $\alpha = 5\%$."

Give a reason for your choice. [2]

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3. Cochran and Cox (1957 *Experimental Designs* Table 4.4) reported the breaking strength of cotton fibers from 5 blocks, each with 5 plots treated with a different level of potash (36, 54, 72, 108, or 144 lbs K_2O / acre). Does cotton property (breaking strength) depend on level of potash, controlled for soil pH ?

Define variables in a tabular format, as in the box. [3]

scale = nominal, ordinal, or cardinal
cardinal = interval or ratio scale.

A. name	symbol	scale
Br Strength	BStr	cardinal
Potash	P	nominal
pH	pH	cardinal
Block	B	nominal

Using the symbols, write a general linear model relating the response variable to explanatory variables and interaction term.

$BStr = \beta_0 + \beta_P \cdot P + \beta_{pH} \cdot pH + \beta_{P \cdot pH} \cdot P \cdot pH + \varepsilon$ [4]

Assume 2 measures of breaking strength and one measure of pH per plot.
Show how to calculate the total degrees of freedom. $2 \times 5 \times 5 - 1 = 49$ [1]

Complete the source column. [1]
Complete the df column [5]
of the ANOVA table.

C. source	df
P	4
pH	1
P×pH	4
residual	40
total	49

P	4
pH	1
B	4
P×pH	4
res	36
total	49

State the name of the analysis, from the following list.

t-test, one-way ANOVA, two-way ANOVA, three-way ANOVA
paired comparisons, randomized blocks, hierarchical (nested) ANOVA
regression, multiple regression,
(ANCOVA) (at least one nominal and at least 1 cardinal scale explanatory variable)
none of the above.

[1]

P	4
pH	1
B	4
P×B	16
res	24
total	49

15