STAT 217: Worksheet 4 Two-Way Anova Tests 2-20 SOLUTIONS

Suppose a statistics teacher gave an essay final to his class. He randomly divides the classes in half such that half the class writes the final with a blue-book and half with notebook computers. In addition the students are partitioned into three groups, no typing ability, some typing ability, and highly skilled at typing. Answers written in blue-books will be transcribed to word processors and scoring will be done blindly. Not with a blindfold, but the instructor will not know the method or skill level of the student when scoring the final. The dependent measure will be the score on the essay part of the final exam.

Use the following R output to answer these questions.

```
## Analysis of Variance Table
##
## Response: y
##                Df Sum Sq Mean Sq F value  Pr(>F)
## ability         2  300.1   150.1   15.43 0.00048
## method          1   34.7    34.7    3.57 0.08318
## ability:method  2   18.8     9.4    0.97 0.40843
## Residuals      12  116.7     9.7
```

1. First, test for an interaction.

   (a) Write the hypotheses to test for an interaction in this example.

   H_0 : There is no interaction between method and ability
   H_A : There is an interaction between method and ability

   OR

   $H_0 : \omega_{CN} = \omega_{CS} = \omega_{CL} = \omega_{BN} = \omega_{BS} = \omega_{BL} = 0$
   H_A : At least one $\omega_{jk} \neq 0$

   (b) Report the test statistic and the distribution it follows under the null hypothesis.

   F-stat = 0.97. The test statistic follows an F-distribution on 2 and 12 df.

   (c) Report the p-value and your decision (Hint: Decision=reject or fail to reject).

   p-value=0.408
   Decision: Fail to Reject H_0

   (d) What is your conclusion?

   There is no evidence of an interaction between method and ability (p-value= 0.408 from F-stat=0.97 on 2 and 12 df).

(e) Would you choose an additive model or an interaction model for inference?

Because there is no evidence of an interaction, I would choose an additive model.

2. Now test for the effect of `method`.

```
lm.add <- lm(y~ability+method)
Anova(lm.add)


## Anova Table (Type II tests)
##
## Response: y
##           Sum Sq Df F value  Pr(>F)
## ability    300.1  2   15.51 0.00028
## method      34.7  1    3.59 0.07901
## Residuals  135.4 14
```

(a) Write the hypotheses to test for the effect of `method`.

H_0: There is no difference in the true mean test scores across method after accounting for ability.
H_A: There is at least one difference in the true mean test scores across method after accounting for ability.

(b) Report the test statistic and the distribution it follows under the null hypothesis.

F-stat=3.59. The test statistic follows an F-distribution on 1 and 14 df.

(c) Report the p-value and your decision.

p-value=0.079 decision: fail to reject H_0 at $\alpha = 0.05$

(d) What is your conclusion?

There is moderate evidence of at least one difference in the true mean test scores across method after accounting for ability (p-value=0.079 from F-stat=3.59 on 1 and 14 df).