Solutions

STAT 217: Quiz 27

1. Crab Claw Force and Size: As part of a study of the relationship between predatory intertidal crab species and snail populations, researchers measured the average closing forces (newtons) and propodus heights (mm) of the claws on several crabs of three species. They collected data on 14 crabs from the species Hemigrapsus nudus, 12 from Lophphanopeus bells, and 12 from Cancer productus. (Data read from Figure 3 in Yamada & Boulding, Claw morphology, prey size selection, and foraging efficiency in generalist and specialist shell-breaking crabs, Journal of Experimental Marine Biology and Ecology, 220, pp. 191 – 211.)

```
##
## Call:
## lm(formula = Force ~ Height * Species, data = crab.data)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -7.146 -2.100 -0.501  1.841 13.094
##
## Coefficients:
##                          Estimate Std. Error t value Pr(>|t|)
## (Intercept)               -17.252      6.096   -2.83   0.0080
## Height                      3.849      0.723    5.32  7.8e-06
## Speciesnudus               20.413      7.794    2.62   0.0134
## Speciesproductus            8.248      9.394    0.88   0.3865
## Height:Speciesnudus        -3.704      0.936   -3.96   0.0004
## Height:Speciesproductus    -1.169      0.989   -1.18   0.2459
##
## Residual standard error: 4.45 on 32 degrees of freedom
## Multiple R-squared:  0.788,Adjusted R-squared:  0.755
## F-statistic: 23.8 on 5 and 32 DF,  p-value: 6.42e-10
## Analysis of Variance Table
##
## Response: Force
##                Df Sum Sq Mean Sq F value  Pr(>F)
## Height          1   1273    1273   64.43 3.7e-09
## Species         2    736     368   18.62 4.3e-06
## Height:Species  2    342     171    8.64   0.001
## Residuals      32    632      20
```

(a) Write out the response variable and the explanatory variable(s). Identify each as categorical or quantitative.

response - average closing force (newtons)
explanatory - propodus height (mm) and species
quantitative categorical

(b) Is this multiple linear regression or simple linear regression? Briefly justify.

MLR because there are two predictor variables

(c) Write out the model that was fit above.

$M\{\text{Force} \mid ht, species\} = \beta_0 + \beta_1 height + \beta_2 I_{nudus} + \beta_3 I_{prod} + \beta_4 height \cdot I_{nudus} + \beta_5 height \cdot I_{prod}$

$I_{nudus} = \begin{cases} 1 \text{ if species=nudus} \\ 0 \text{ if else} \end{cases}$ $I_{prod} = \begin{cases} 1 \text{ if species=productus} \\ 0 \text{ if else} \end{cases}$

(d) What is the reference level? Lophphanopeus bells

(e) Would you allow different slopes for each species? Write a conclusion to answer this question.

There is strong evidence that the ~~mean average closing~~ linear relationship between height and mean average closing force depends on species (p-value = 0.001 from F-stat=8.64 on 2 + 32 df

2. Now let's look at the same question using AIC-based model comparisons.

```
lm.add <- lm(Force~Height+Species, data=crab.data)
lm.int <- lm(Force~Height+Species+Height*Species, data=crab.data)
AIC(lm.add,lm.int)
```

```
##        df AIC
## lm.add  5 241
## lm.int  7 229
```

(a) According to the AIC, which model would you choose and why?

I would choose the interaction model because the AIC is much lower.

(b) Is this consistent with the answer you gave in 1e? Briefly justify.

Yes. If we choose the interaction model, this is equivalent to saying that we need different slopes for each species.