

## STAT502 Homework #4b

due Monday, 7/24

4. A soft drink distributor is studying the effectiveness of delivery methods. Three different types of hand trucks have been developed, and an experiment is performed in the company's methods engineering laboratory. The variable of interest is the delivery time in minutes ( $Y$ ). However, delivery time is also strongly related to the case volume delivered ( $x$ ). The data can be read with the following commands.

```
data = read.table('softdrink.dat',header=T)
y = data[,1]
x = data[,2]
type = as.factor(data[,3])
```

- (a) Create a scatterplot of delivery time versus case volume using different symbols to distinguish the truck types. Refer to Lab 8 with the `pch=1` option substituted for the `col='blue'` option. Does it appear that we need separate regression lines for each truck type? Should the regression lines also have different slopes? Explain.
- (b) Obtain the residuals for the ANCOVA model

$$Y_{ij} = \mu. + \tau_i + \gamma(X_{ij} - \bar{X}_{..}) + \varepsilon_{ij}$$

Plot the residuals against the fitted values; also include a normal probability plot of the residuals. Comment on the assumptions of the ANCOVA model.

- (c) Fit the full and reduced regression models to test for treatment (truck type) effects. Use  $\alpha = 0.05$ . State the hypotheses and conclusion.
- (d) Using the same full model as in part (b), write the reduced model for testing whether the slope is significant. Carry out the test, and state the conclusion using  $\alpha = 0.05$ .
- (e) State the full model to be employed for testing whether or not the treatment regression lines have the same slope. Conduct this test using  $\alpha = .05$ . State the hypotheses, test statistic, and conclusion. What is the P-value of the test?