STAT 461: Homework 3

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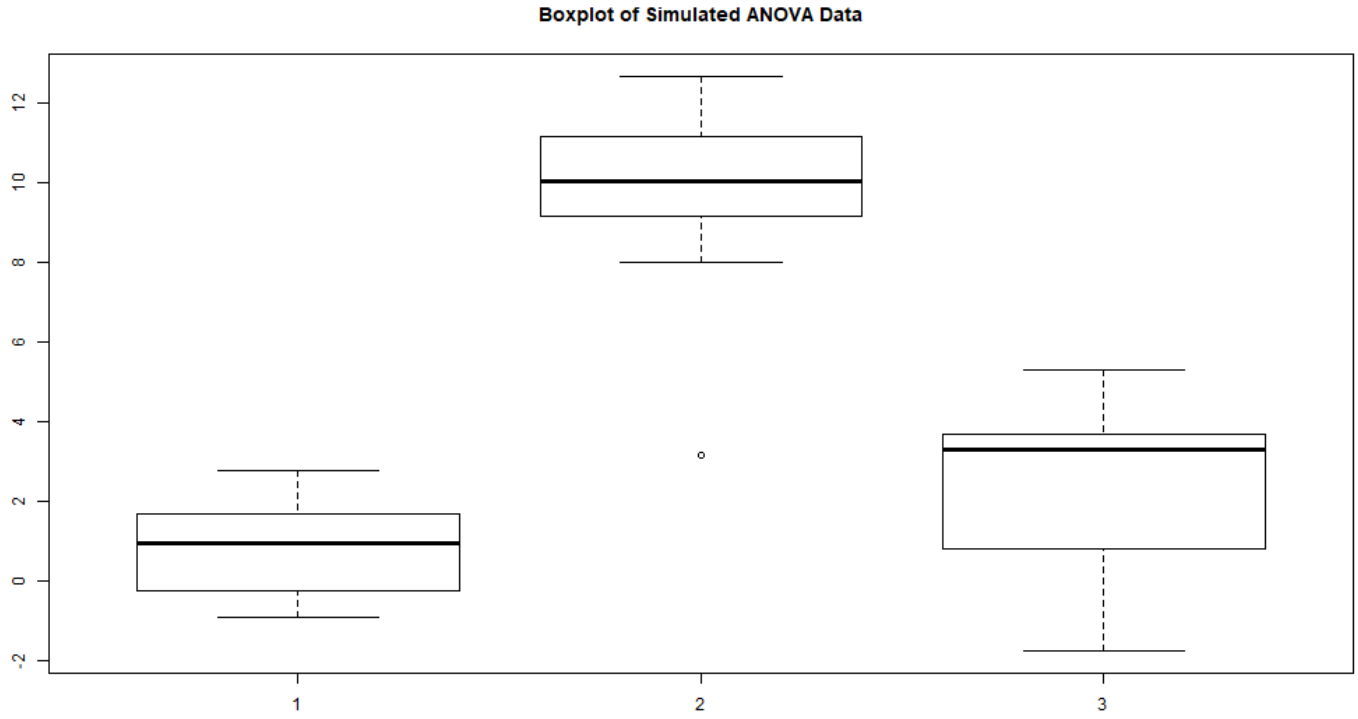
September 10, 2018

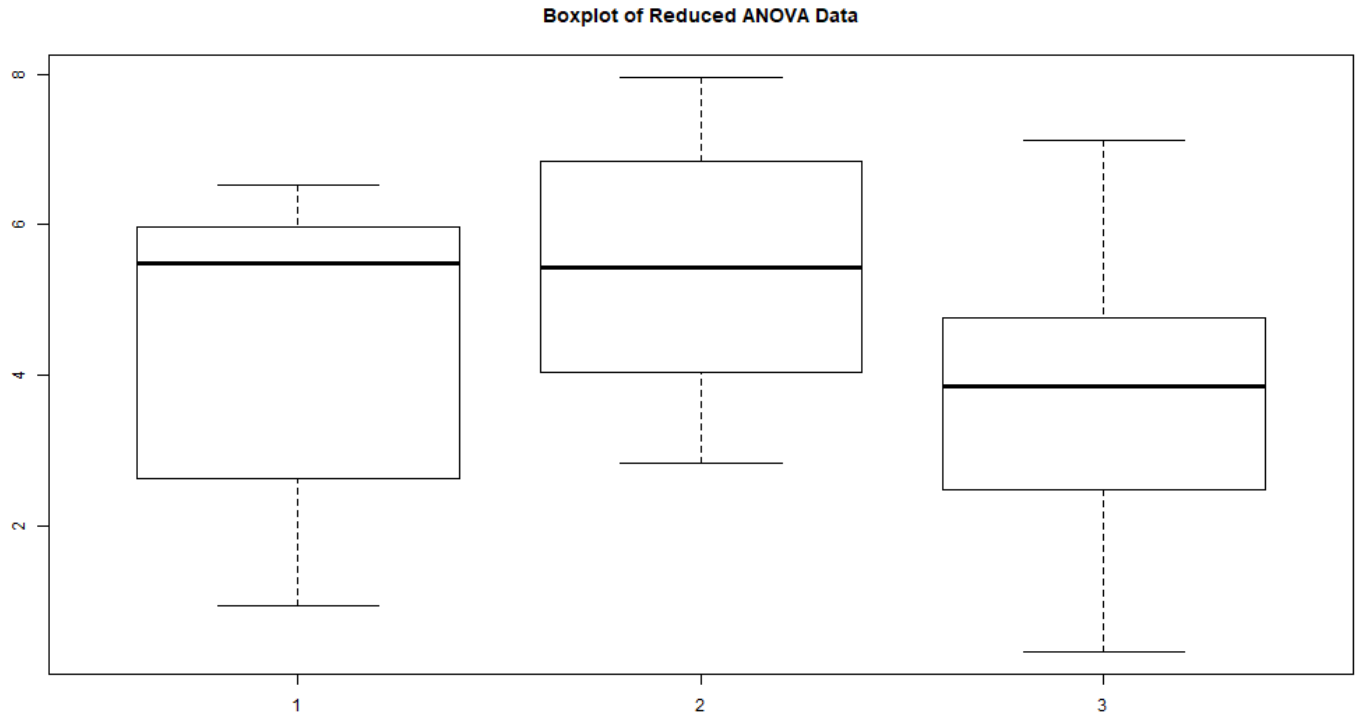
PROBLEM 1

Below is a plot of the simulated ANOVA distribution:



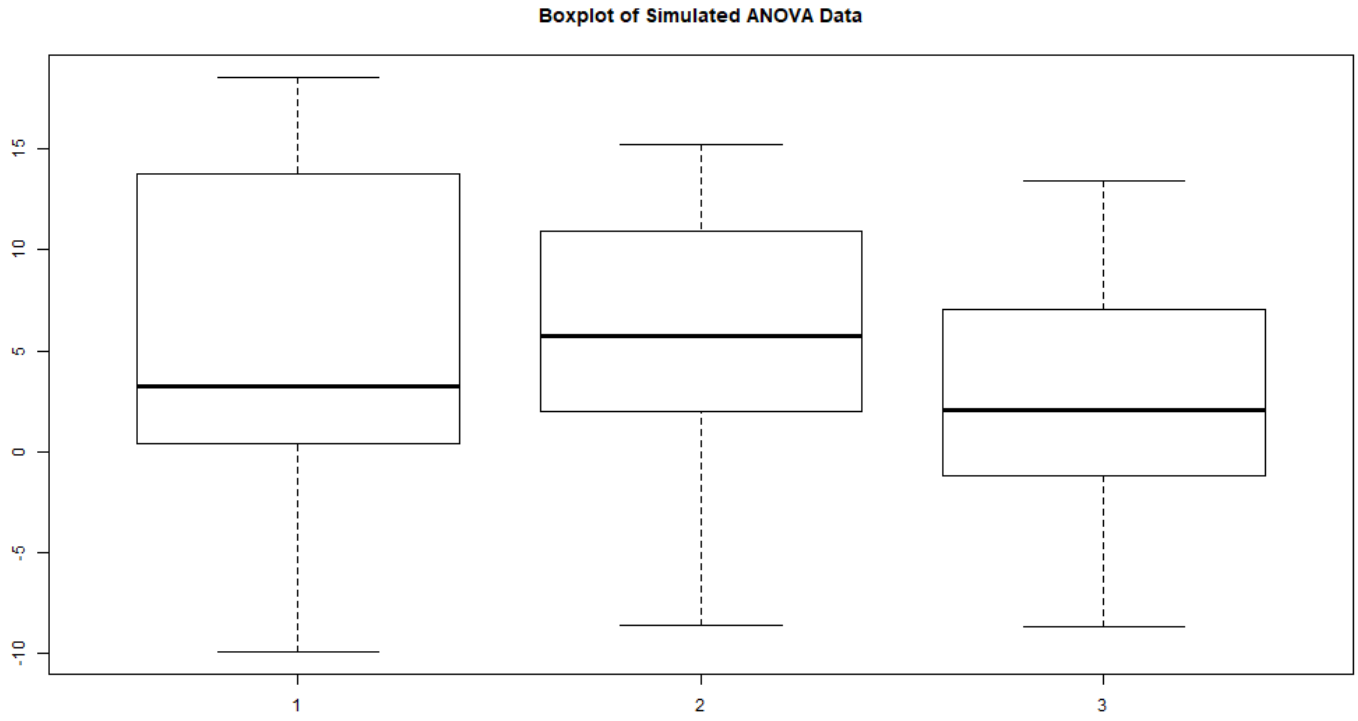
PROBLEM 2

Below is a plot of the simulated reduced ANOVA distribution:



PROBLEM 3

Below is a plot of the simulated ANOVA distribution with an extremely large variance:



PROBLEM 4

$$Y_{23} = Y_{2t} = \mu + \tau_1 + \epsilon_{it}; \quad \epsilon_{it} \overset{iid}{\sim} N(0,4)$$
$$Y_{2t} = 4.7 + 5 + N(0,4)$$
$$Y_{2t} \sim N(9.7,4)$$

PROBLEM 5

$$\hat{Y_{2\cdot}} = \frac{1}{r_2}\sum_{t=1}^{r_2} Y_{2t}; \quad r_2 = 10$$
$$\sum_{t=1}^{r_2} Y_{2t} \sim N(9.7,4) + \overset{8}{\cdots} + N(9.7,4)$$
$$\sum_{t=1}^{r_2} Y_{2t} \sim N(97,40)$$
$$\frac{1}{10} Y_{2t} \sim \frac{1}{10} N(97,40) = N\left(\frac{1}{10} * 97, \left(\frac{1}{10}\right)^2 40\right)$$
$$\frac{1}{10} Y_{2t} \sim N(9.7,0.4)$$

PROBLEM 6

$Y_{1t} \sim 4.7 - 3 + N(0,4)$

$Y_{1t} \sim N(1.7,4)$

$Y_{2t} \sim N(9.7,4)$

$Y_{1t} - Y_{2t} \sim N(1.7,4) - N(9.7,4)$

$Y_{1t} - Y_{2t} \sim N(1.7,4) + -1 * N(9.7,4)$

$Y_{1t} - Y_{2t} \sim N(1.7,4) + N(-1 * 9.7, (-1)^2 * 4)$

$Y_{1t} - Y_{2t} \sim N(1.7,4) + N(-9.7,4)$

$Y_{1t} - Y_{2t} \sim N(1.7 - 9.7, 4 + 4)$

$Y_{1t} - Y_{2t} \sim N(-8,8)$

Code Appendix

```r
######################################################################
#### Setup
######################################################################
## Install and load libraries
# ipak function taken from: https://gist.github.com/stevenworthington/3178163
# ipak <- function(pkg) {
#   new.pkg <- pkg[!(pkg %in% installed.packages()[, "Package"])]
#   if (length(new.pkg))
#     install.packages(new.pkg, dependencies = TRUE)
#   sapply(pkg, require, character.only = TRUE)
# }
#
# packages <- c("ggplot2", "reshape2", "gridExtra", "TSA", "astsa", "orcutt",
#               "nlme", "fGarch", "vars")
# ipak(packages)



######################################################################
#### Problem 1
######################################################################
# Set up treatment distribution and experimental units
n=30
treatments = c(rep("1", 10), rep("2", 10), rep("3", 10))
exp_units = 1:n

# Randomize treatments
p1_randomized = sample(treatments)

# Set treatment parameters
mu_1 = 4.7
var_1 = 4
tao_1 = -3
tao_2 = 5
tao_3 = -2

# Generate treatment means
means_1 = rep(NA, n)
means_1[p1_randomized=="1"] = mu_1 + tao_1
means_1[p1_randomized=="2"] = mu_1 + tao_2
means_1[p1_randomized=="3"] = mu_1 + tao_3

# Simulate ANOVA model
p1_sim = means_1 + rnorm(n, mean = 0, sd = sqrt(var_1))

# Plot Data
p1_data = data.frame(exp_units, p1_randomized, p1_sim)

png("./figures/p1.png", width = 1024, height = 576)
  boxplot(p1_sim ~ p1_randomized, main="Boxplot of Simulated ANOVA Data")
dev.off()


######################################################################
#### Problem 2
######################################################################
p2_randomized = sample(treatments)

# Generate treatment means
means_2 = rep(mu_1, n)

# Simulate ANOVA model
p2_sim = means_2 + rnorm(n, mean = 0, sd = sqrt(var_1))

```

```r
# Plot Data
p2_data = data.frame(exp_units, p2_randomized, p2_sim)

png("./figures/p2.png", width = 1024, height = 576)
  boxplot(p2_sim ~ p2_randomized, main="Boxplot of Reduced ANOVA Data")
dev.off()

######################################################################
#### Problem 3
######################################################################
p3_randomized = sample(treatments)

# Set treatment parameters
var_3 = 50

# Simulate ANOVA model
p3_sim = means_1 + rnorm(n, mean = 0, sd = sqrt(var_3))

# Plot Data
p3_data = data.frame(exp_units, p3_randomized, p3_sim)

png("./figures/p3.png", width = 1024, height = 576)
  boxplot(p3_sim ~ p3_randomized, main="Boxplot of Simulated ANOVA Data")
dev.off()
```