STAT 461: Project

Name: Kyle Salitrik | ***ID#:*** *997543474* | ***PSU ID:*** *kps168*

December 2, 2018

Gathering Data

The following table outlines the factors that were considered, their levels, and how they are associated. Originally tray position was not considered as a factor, however, when putting the trays into the oven, only one tray would fit on the top rack so the difference in top and bottom racks was added after the fact.

Factor	**Levels**	**Fixed?**	**Nested/Crossed**
Butter (b)	Melted (M), Creamed (C)	Fixed	Nested in Dough
Dough Temp (d)	Refrigerated (R), NOT Refrigerated (N)	Fixed	Nested in Tray
Tray Position (t)	Top (T), Bottom (B)	Fixed	Crossed with Butter

Using the possible combinations of butter and dough temperature, R was used draw 2 samples for position assignment for each tray. The following is the output from this procedure.

```
> tray1
[1] "CN" "CN" "MR" "CN" "MR" "CR" "CR" "MR" "MN" "MN" "CR" "MN"
> tray2
[1] "CN" "CN" "CR" "CR" "MR" "MN" "CN" "MN" "MR" "MR" "MN" "CR"
```

Listing 1: Randomized Tray Locations

Model

$$Y_{b,d,t,c} = \alpha_b + \beta d(b) + \gamma_{t(d,b} + \epsilon_{b,d,t,c}$$
$$\epsilon_{b,d,t,c} \sim N(0, \sigma^2)$$

Data Examination

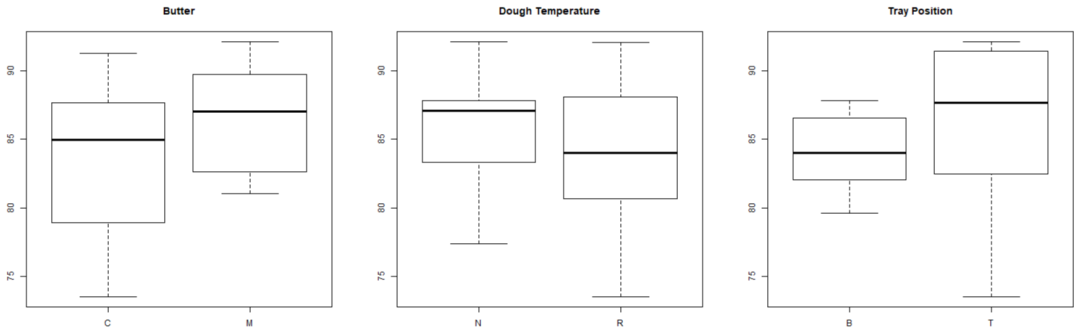

Figure 1: Individual Factor Effects on Cookie Size

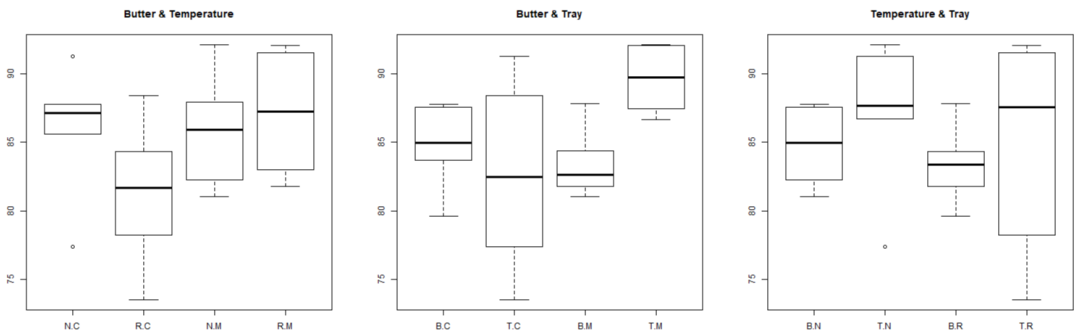

Figure 2: Pairwise Factor Effects on Cookie Size

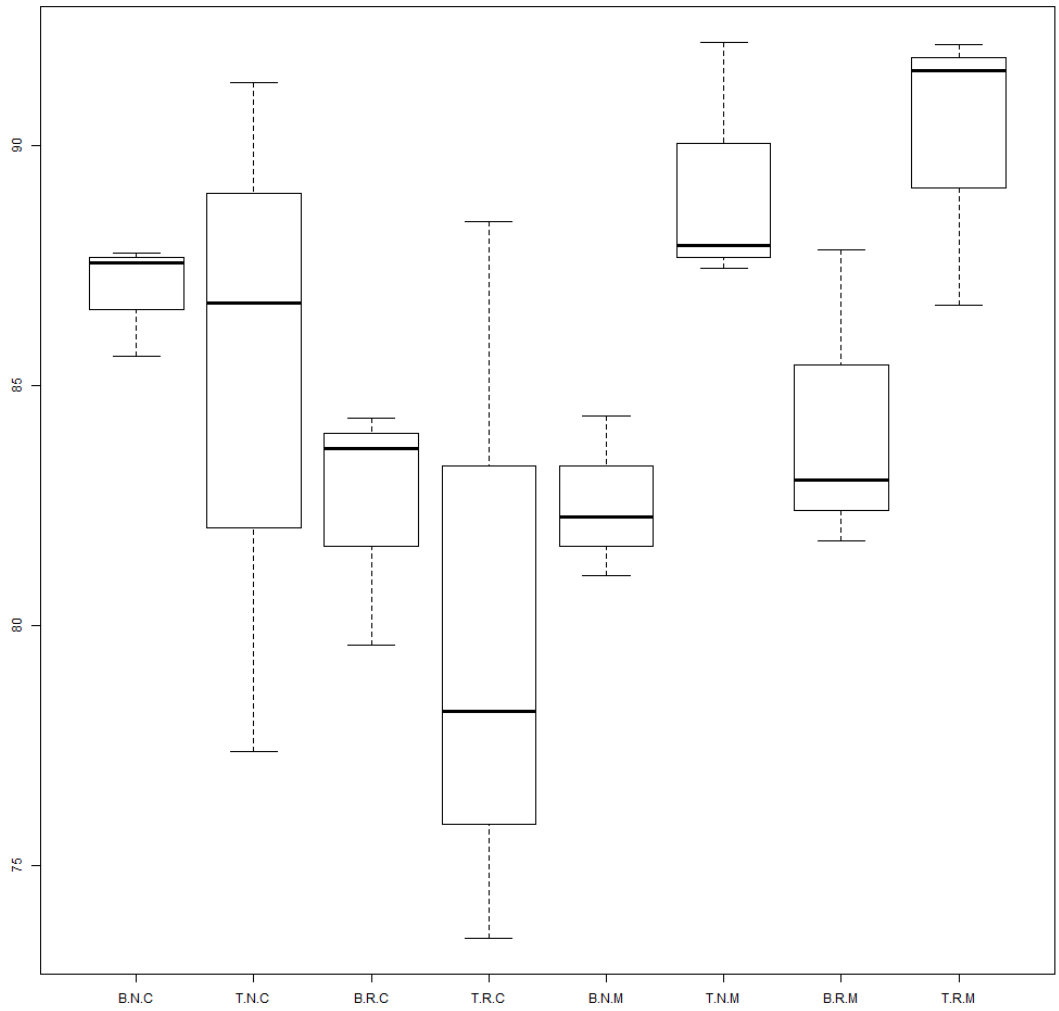

Figure 3: Full Factor Effects on Cookie Size

Code Appendix

```
################################################################################
#### 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","ggplotify", "reshape2", "gridExtra", "TSA", "astsa",
             "orcutt", "nlme", "fGarch", "vars", "lsmeans", "multcompView",
             "base2grob", "lme4", "lmerTest")
ipak(packages)

################################################################################
#### Randomly assign 3 of each pair of treatments to spots on the tray
################################################################################
options = c(rep("MR",3),rep("MN",3),rep("CR",3),rep("CN",3))
tray1 = sample(options)
tray2 = sample(options)
tray1
tray2

################################################################################
## Read in Data
################################################################################
cookies=read.table("cookies.txt",header=TRUE)

################################################################################
## Plot Data in Boxplots
################################################################################
plotWidth=512;
plotHeight=512;

######################
## Individual Plots
######################

png("./figures/boxplots/boxplot-1-butter.png", width = plotWidth, height = plotHeight
    )
  boxplot(size ~ butter, data=cookies, main = "Butter")
dev.off()

png("./figures/boxplots/boxplot-1-chilled.png", width = plotWidth, height =
    plotHeight)
  boxplot(size ~ chilled, data=cookies, main = "Dough Temperature")
dev.off()

png("./figures/boxplots/boxplot-1-tray.png", width = plotWidth, height = plotHeight)
  boxplot(size ~ tray, data=cookies, main = "Tray Position")
dev.off()

######################
## Pair Plots
######################
png("./figures/boxplots/boxplot-2-butter-chilled.png", width = plotWidth, height =
    plotHeight)
  boxplot(size ~ chilled + butter, data=cookies, main = "Butter & Temperature")
dev.off()

png("./figures/boxplots/boxplot-2-butter-tray.png", width = plotWidth, height =
    plotHeight)
```

```
  boxplot(size ~ tray + butter, data=cookies, main = "Butter & Tray")
dev.off()

png("./figures/boxplots/boxplot-2-chilled-tray.png", width = plotWidth, height =
    plotHeight)
  boxplot(size ~ tray + chilled, data=cookies, main = "Temperature & Tray")
dev.off()

######################
## Full Plot
######################
png("./figures/boxplot_full.png", width = 2*plotWidth, height = 2*plotHeight)
  boxplot(size ~ tray + chilled + butter, data=cookies)
dev.off()

######################
## Compile Plots
######################
singleBoxplots = lapply(sprintf("./figures/boxplots/boxplot-1-%s.png", c("butter","
    chilled","tray")), png::readPNG)
singleBoxGrid = lapply(singleBoxplots, grid::rasterGrob)

doubleBoxPlots = lapply(sprintf("./figures/boxplots/boxplot-2-%s.png", c("butter-
    chilled","butter-tray","chilled-tray")), png::readPNG)
doubleBoxGrid = lapply(doubleBoxPlots, grid::rasterGrob)

png("./figures/boxplot_individuals.png", width = 3*plotWidth, height = plotHeight)
  gridExtra::grid.arrange(ncol=3, grobs=singleBoxGrid)
dev.off()

png("./figures/boxplot_pairs.png", width = 3*plotWidth, height = plotHeight)
  gridExtra::grid.arrange(ncol=3, grobs=doubleBoxGrid)
dev.off()

#############################################################################
## Create Model
#############################################################################
```