Stat 5309 Lab 3

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1. Data: Casting of High Temperature Alloys-

A metal alloy is produced by a high temperature casting process. The tensile strength of the alloy is critical for its future use. The casting process is designed produce bars of alloy with an average tensile strength above minimum requirement. An experiment was planned to isolate the variation in tensile strength due to the effects of different castings. 30 bars or alloy were produced using the 3 casting methods.

(a)

Set up the data frame. There are 30 observations. Form a factor vector "casting". Form a vector of response "strength" Form a data named "alloy".

```r
tensile <- data.frame(type = rep(c("1","2","3"),each=10),
                      strength = c(88.0, 88.0, 94.8, 90.8, 93.0, 89.0, 86.0, 92.9, 89.0, 93.0,
                                   85.9, 88.6, 90.0, 87.1, 85.6, 86.0, 91.0, 89.6, 93.0, 87.5,
                                   94.2, 91.5, 92.0, 96.5, 95.6, 93.8, 92.5, 93.2, 96.2, 92.5))
tensile %>% kable()
```

type	strength
1	88.0
1	88.0
1	94.8
1	90.8
1	93.0
1	89.0
1	86.0
1	92.9
1	89.0
1	93.0
2	85.9
2	88.6
2	90.0
2	87.1
2	85.6
2	86.0
2	91.0
2	89.6
2	93.0
2	87.5
3	94.2
3	91.5
3	92.0
3	96.5
3	95.6
3	93.8

type	strength
3	92.5
3	93.2
3	96.2
3	92.5

(b)

Find the treatment means, treatment vars, treatment standard deviations

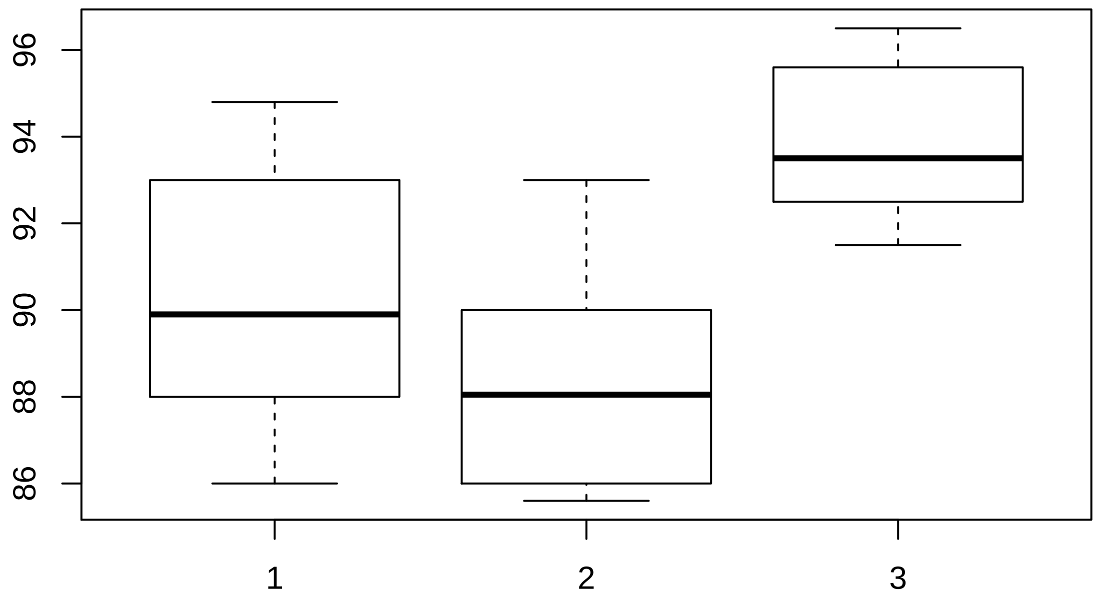
```
tensile %>%
  group_by(type) %>%
  summarise(treatment_mean = mean(strength),
            treatment_var = var(strength),
            treatment_sd = sd(strength)
            ) %>%
  kable()
```

type	treatment_mean	treatment_var	treatment_sd
1	90.45	8.229444	2.868701
2	88.43	6.033444	2.456307
3	93.80	3.191111	1.786368

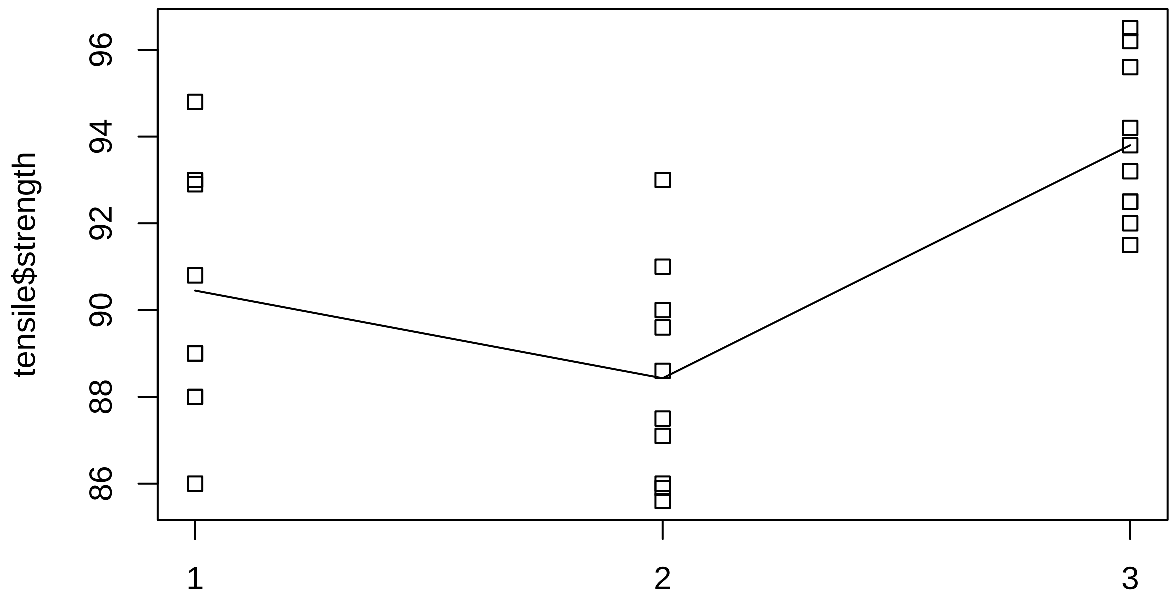
(c)

Do a boxplot, stripchart.

```
boxplot(tensile$strength~tensile$type)
```




```
stripchart(tensile$strength~tensile$type,vertical = TRUE)
lines(tapply(tensile$strength,tensile$type , mean))
```



(d)

Build a linear model, using aov(). Do a summary.lm() and a summary.aov()

```
tensile_model <- aov(tensile$strength~tensile$type)
summary.aov(tensile_model)
```

```
##               Df Sum Sq Mean Sq F value   Pr(>F)
## tensile$type  2  147.1   73.57   12.64 0.000133 ***
## Residuals    27  157.1    5.82
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary.lm(tensile_model)
```

```
##
## Call:
## aov(formula = tensile$strength ~ tensile$type)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -4.450 -1.712 -0.300  2.250  4.570
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)     90.4500     0.7628 118.583  < 2e-16 ***
```

```
## tensile$type2  -2.0200     1.0787  -1.873  0.07199 .
## tensile$type3   3.3500     1.0787   3.106  0.00443 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.412 on 27 degrees of freedom
## Multiple R-squared:  0.4836, Adjusted R-squared:  0.4454
## F-statistic: 12.64 on 2 and 27 DF,  p-value: 0.0001333
```

(e)

Perform a Pairwise.t.test(p.adj="bonf")

```r
pairwise.t.test(tensile$strength,tensile$type, p.adj = "bonf")
```

```
##
##  Pairwise comparisons using t tests with pooled SD
##
## data:  tensile$strength and tensile$type
##
##   1     2
## 2 0.216 -
## 3 0.013 9.7e-05
##
## P value adjustment method: bonferroni
```

(f)

Perform TukeyHSD(). Plot the TukeyHSD result.

(g)

Calculate the power of the F-test in the aov model.

2. Data: Detection of Phlebitis on Rabits.

Rabbits are used as the test animals, randomly assigned to 3 treatment groups. Intravenous needles are inserted in a vein of one ear. Three (3) intravenous treatments are administered to test animals. (a) Amiodarone with a vehicle solution (b) Vehicle solution alone (c) Saline solution.

An increase in temperature of the two ears (treated minus untreated) was used as the response

(a)

Set up the data frame. There are 23 observations. Create a vector "trt" of 3 levels Create a data frame named rabbits.

```r
rabbits <- data.frame(type = c(rep("Amiodarone",9),rep("Vehicle",6),rep("Saline",8)),
                      temp_difference = c( 2.2, 1.6, 0.8, 1.8, 1.4, 0.4, 0.6,1.5, 0.5,
                                           0.3, 0.0, 0.6, 0.0, -0.3, 0.2,
                                           0.1, 0.1, 0.2, -0.4, 0.3, 0.1, 0.1,-0.5)
```

```
                              )
rabbits %>% kable()
```

type	temp_difference
Amiodarone	2.2
Amiodarone	1.6
Amiodarone	0.8
Amiodarone	1.8
Amiodarone	1.4
Amiodarone	0.4
Amiodarone	0.6
Amiodarone	1.5
Amiodarone	0.5
Vehicle	0.3
Vehicle	0.0
Vehicle	0.6
Vehicle	0.0
Vehicle	-0.3
Vehicle	0.2
Saline	0.1
Saline	0.1
Saline	0.2
Saline	-0.4
Saline	0.3
Saline	0.1
Saline	0.1
Saline	-0.5

(b)

Perfom treatment means, treatment variances, treatment standard deviations

(c)

Boxplot. Strip chart.

(d)

Build a linear model,using aov(). Summary

(e)

Perform pairwise t -test.

(f)

Perform TukeyHSD. Plot the TukeyHSD result.

3

The response time in milliseconds was determined for three different types of circuits taht could be used in an automatic valve shutoff mechanism. The results are shown in the following table:

```
circuit <- data.frame(type = rep(c(1,2,3),each=5),
                      response_time = c(9,12,10,8,15,
                                        20,21,23,17,30,
                                        6,5,8,16,7)
                      )
circuit %>% kable()
```

type	response_time
1	9
1	12
1	10
1	8
1	15
2	20
2	21
2	23
2	17
2	30
3	6
3	5
3	8
3	16
3	7

a

Test the hypothesis taht the three circuit types have the same response time. use $\alpha = 0.01$

b

Use Tukey's test to compare pairs of treatment means. Use $\alpha = 0.01$.

c

Use the graphcial procedure in Section 3-5.3 to compare the treatment means. What conclusions can you draw? How do they compare with the conclusions from part (b).

d

Constuct a set of othagonal contrasts, asssuming that at the outset of the experiment you suspected the response time of circuit type 2 to be different from the other two.

e

If you were the design engineer an you wished to minimize the response time, which circuit type would you select?

f

Analyse the residuals from this experiment. Are the basic analysis of variance assumptions satisfied?