STAT 222 Spring 2022 HW12

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```
## Warning: package 'knitr' was built under R version 4.0.5
```

Q1

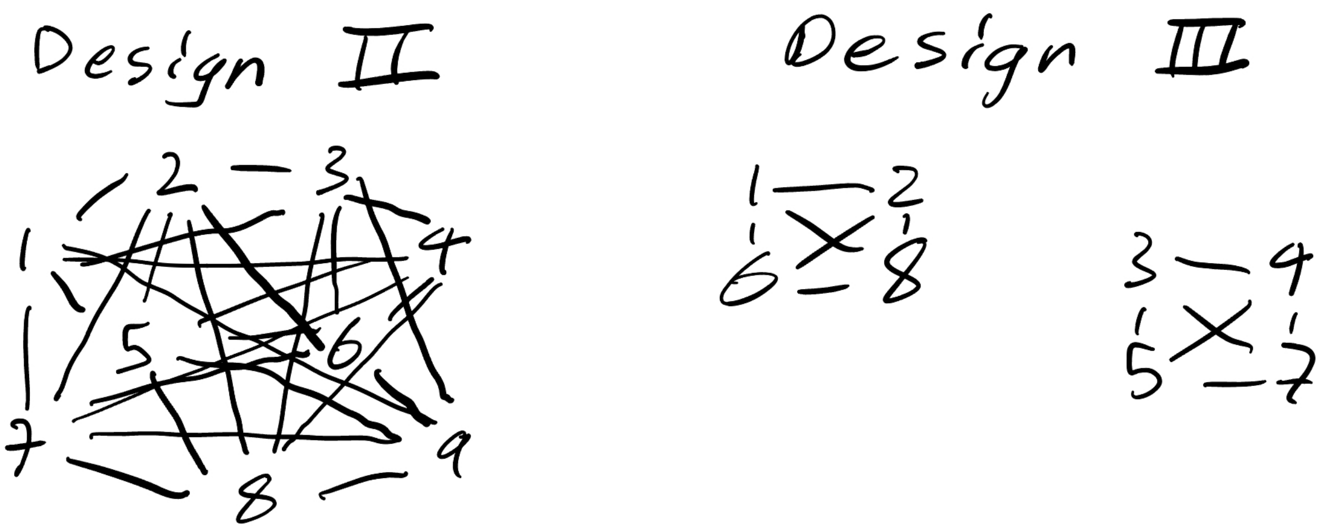


Figure 1: Connectivity Graphs

a) Design II is connected but Design III is not.

b) For Design II, $\tau_1 - \tau_5$ is estimable because there is a direct connection between treatment 1 and 5. $\tau_1 - \tau_6$ is also estimable indirectly. For Design III, $\tau_1 - \tau_6$ since they are connected but not $\tau_1 - \tau_5$.

Q2

a) Bonferroni: $\hat{C} \pm t_{\alpha/2/m,\text{df MSE}} \times \text{SE}(\hat{\text{C}})$

$\hat{C}_1 = -4.125 - (-8.125) = 4$

$\text{SE}(\hat{C}) = \sqrt{\text{MSE} \times (\frac{2k}{\lambda g})}$

```
mse <- 44.155
se <- sqrt(mse*((2*5)/(4*6)))
var <- qt(0.02/2/2,df = 19, lower.tail = F) * se

c(4-var,4+var)
## [1] -8.271348 16.271348
```

$\hat{C}_2 = 18.875 - (-11.375) = 30.25$

```
mse <- 44.155
se <- sqrt(mse*((2*5)/(4*6)))
var <- qt(0.02/2/2,df = 19, lower.tail = F) * se

c(30.25-var,30.25+var)
## [1] 17.97865 42.52135
```

For the first CI, we can conclude that the effect on pulse rate of changing step frequency from 28 steps per minute to 14 at a step height of 5.75in is between -8.271348 and 16.271348 bpm. For the second CI, we can conclude that the effect on pulse rate of changing step frequency from 28 steps per minute to 14 at a step height of 11.5in is between 17.97865 and 42.52135 bpm. Since 0 falls within the first CIs, we cannot say if there is an effect. However, the second CI is strictly positive so we can say there is an effect.

b) $\hat{C} = 18.875 - 2 * 12.375 + (-11.375) = -17.25$

```
est <- -17.25; est
## [1] -17.25
se <- sqrt(mse*((2*5)/(4*6))); se
## [1] 4.289279

tstat <- est/se; tstat
## [1] -4.021655
df <- 19; df
## [1] 19
2*pt(tstat,df)
## [1] 0.0007292155
```

Since $p<0.05$, we can reject the null that the contrast is zero i.e. we can conclude that heart rate increases linearly with step frequency.

Q3

```
abrasive = read.table("http://www.stat.uchicago.edu/~yibi/s222/abrasive.wear.txt", h=T)
```

a) $C_B = -y_{111} - y_{112} + y_{121} + y_{122} - y_{211} - y_{212} + y_{221} + y_{222}$

$\hat{C}_B = -0.049 - 0.041 + 0.220 + 0.358 - 0.044 - 0.030 + 0.133 + 0.192 = 0.739$

$c_{ijk}^{AC} = c_{ijk}^{A} c_{ijk}^{C} \Rightarrow$

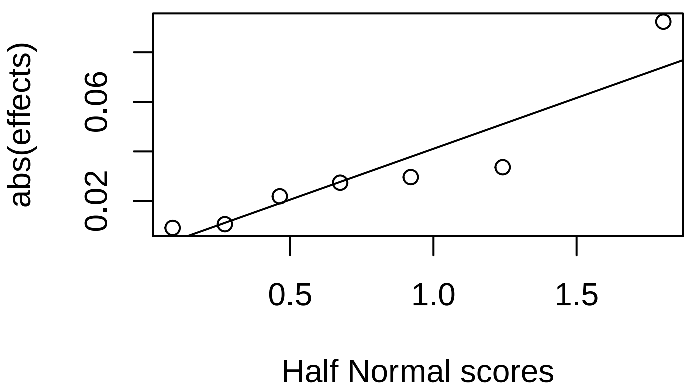
$\hat{C}_{AC} = y_{111} - y_{112} + y_{121} - y_{122} - y_{211} + y_{212} - y_{221} + y_{222} = 0.049 - 0.041 + 0.220 - 0.358 - 0.044 + 0.030 - 0.133 + 0.192 = -0.085$

b) Loading library and setting zero sum constraints.

```
library(daewr)
```

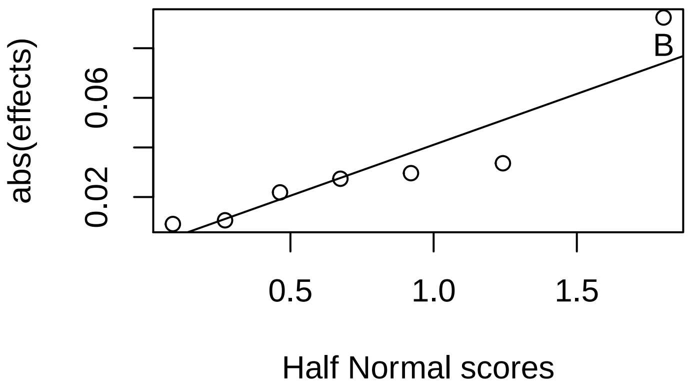
```
abrasive$A = as.factor(abrasive$A)
abrasive$B = as.factor(abrasive$B)
abrasive$C = as.factor(abrasive$C)
contrasts(abrasive$A) = contr.sum(2)
contrasts(abrasive$B) = contr.sum(2)
contrasts(abrasive$C) = contr.sum(2)
lm1 = lm(y ~ A*B*C, data=abrasive)
lm1$coef[-1]
##        A1        B1        C1     A1:B1     A1:C1     B1:C1  A1:B1:C1
##  0.033625 -0.092375 -0.021875 -0.029625 -0.010625  0.027375  0.009125
```

```
halfnorm(lm1$coef[-1], alpha=0.05)
```




```
## zscore= 0.08964235 0.27188 0.4637078 0.6744898 0.920823 1.241867 1.802743effp= 0.009125 0
```

```
halfnorm(lm1$coef[-1], alpha=0.2)
```




```
## zscore= 0.08964235 0.27188 0.4637078 0.6744898 0.920823 1.241867 1.802743effp= 0.009125 0
```

At a significance level of 0.05, we do not find any of the effects to be significantly different than zero. Once we increase the level to 0.2, we find that B is significant, meaning that the B main effect could be nonzero.