Homework 5

ANOVA

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1 Six Orthogonal Contrasts

```
p_1 <- 0.047
p_2 <- 0.001
p_3 <- 0.009
p_4 <- 0.030
p_5 <- 0.012
p_6 <- 0.036

cat("\nAlphas:", .05/1, .05/2, 0.05/3, .05/4, .05/5, .05/6)
```

```
Alphas: 0.05 0.025 0.01666667 0.0125 0.01 0.008333333
```

Controlling the family-wise error rate at 0.05, different methods will impact results.

The Bonferroni procedure is the most conservative. It results in only 1 significant contrast (contrast 2). This means we only have one significant finding.

The Holm procedure is at least as powerful as Bonferroni and does not require any additional assumptions. Using the Holm procedure, we start with the lowest p-value and reject ($\alpha = 0.05$) the null hypothesis associated with the second contrast. We continue to the next smallest p-value (contrast 3), which is also significant ($\alpha = 0.025$). Contrast 5 is also significant ($\alpha = 0.0167$). The fourth smallest p-value, associated with the 4th contrast, is not significant ($\alpha = 0.0125$), so we stop. This procedure results in 3 significant contrasts, for contrasts 2, 3, and 5.

The Hochberg procedure is similar to the Holm procedure but may be more powerful. We reject the largest p-value (contrast 1). We reject all smaller p-values, which results in all 6 contrasts being significant.

2 Food/Water Deprivation

```r
means <- c(18, 24, 8, 12, 10)
ms_within <- 5.6
ms_between <- 214
se <- sqrt(5.6)/sqrt(5)
cv <- qtukey(p=0.95, nmeans=5, df=20)/sqrt(2)
cat("Critical Value:", cv)
```

```
Critical Value: 2.992375
```

```r
cat("Confidence Interval:", cv*se)
```

```
Confidence Interval: 3.166832
```

```r
sapply(means, "-", means)
```

```
     [,1] [,2] [,3] [,4] [,5]
[1,]    0    6  -10   -6   -8
[2,]   -6    0  -16  -12  -14
[3,]   10   16    0    4    2
[4,]    6   12   -4    0   -2
[5,]    8   14   -2    2    0
```

2.1 Common SE

The common standard standard error is given by $\frac{\sqrt{MS_w}}{\sqrt{n}}$. Since all groups have $n = 5$, the SE is common to all groups, $\frac{\sqrt{5.6}}{\sqrt{5}} = 1.058301$

2.2 Ten pairwise differences

The confidence interval is the same for all groups and is given by $q_{5,20,0.05}(SE)$, which is 3.167.

Contrast	Confidence Interval	Significant
$u_1 - u_2$	6 ± 3.167	Yes
$u_1 - u_3$	10 ± 3.167	Yes
$u_1 - u_4$	6 ± 3.167	Yes
$u_1 - u_5$	8 ± 3.167	Yes
$u_2 - u_3$	16 ± 3.167	Yes
$u_2 - u_4$	12 ± 3.167	Yes
$u_2 - u_5$	14 ± 3.167	Yes
$u_3 - u_4$	-4 ± 3.167	Yes
$u_3 - u_5$	-2 ± 3.167	No
$u_4 - u_5$	2 ± 3.167	No

3 Family of five contrasts

```
qt(p=0.01,36,lower.tail=FALSE)
```

```
[1] 2.434494
```

```
qt(p=0.005,36,lower.tail=FALSE)
```

```
[1] 2.719485
```

The Bonferroni-corrected alpha value for 5 contrasts is 0.01 (0.05/5). The degrees of freedom is $N - k$, or 36.

The critical values are $t_{0.01,36} = 2.43$ (one-sided) and $t_{0.005,36} = 2.72$ (two-sided).