Math189 HW3

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CONTRIBUTIONS All 3 team members worked on each question together, and helped to format the final RMarkdown Document. Work was done in the library collectively with equal contribution from each member.

Question 1 Here we test H0: mu1-mu2=0 vs H1: mu1-mu2!=0

```
bottom = c(.43, .266,.567,.531,.707,.716,.651,.589,.469,.723)
surface = c(.415,.238,.39,.41,.605,.609,.632,.523,.411,.612)
water = c(bottom,surface)
water = matrix(water,nrow =10,ncol = 2)
mu_y = colMeans(water)[1]-colMeans(water)[2]
diff = water[,1]-water[,2]
# t.test uses .95 confidence level by default
t.test(diff, mu = 0)
```

```
##
##  One Sample t-test
##
## data:  diff
## t = 4.8638, df = 9, p-value = 0.0008911
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  0.043006 0.117794
## sample estimates:
## mean of x
##    0.0804
```

We use the difference between the bottom water data and the surface water data to turn this two sample paired data into one sample data. To test if the means are equivalent, we test if the difference between the two samples has an average equal to 0.

So using t.test to perform a one sample t test with 0.05, we find that we should reject the null hypothesis in favor of the alternative hypothesis, which means that, on average, the amount of trace metals in surface water does not equal the amount of trace metals in bottom water.

Question 2

```
library("HSAUR3")
```

```
## Loading required package: tools
```

```
##
## Attaching package: 'HSAUR3'
```

```
## The following object is masked _by_ '.GlobalEnv':
##
##     water
```

```
data("pottery")
pottery = subset(pottery,pottery$kiln!=3)
result = manova(as.matrix(pottery[, 1:9]) ~ kiln, data = pottery)
summary.aov(result)
```

```
##  Response Al2O3 :
##             Df  Sum Sq Mean Sq F value    Pr(>F)
## kiln         3 191.882  63.961  26.001 2.083e-09 ***
## Residuals   39  95.938   2.460
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response Fe2O3 :
##             Df  Sum Sq Mean Sq F value    Pr(>F)
## kiln         3 234.656  78.219  154.32 < 2.2e-16 ***
## Residuals   39  19.768   0.507
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response MgO :
##             Df  Sum Sq Mean Sq F value    Pr(>F)
## kiln         3 114.403  38.134  97.767 < 2.2e-16 ***
## Residuals   39  15.212   0.390
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response CaO :
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## kiln         3 7.2247 2.40824  53.502 6.88e-14 ***
## Residuals   39 1.7555 0.04501
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response Na2O :
##             Df  Sum Sq  Mean Sq F value   Pr(>F)
## kiln         3 0.58864 0.196212  10.465 3.48e-05 ***
## Residuals   39 0.73121 0.018749
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response K2O :
##             Df  Sum Sq Mean Sq F value    Pr(>F)
## kiln         3 24.1835  8.0612  81.762 < 2.2e-16 ***
## Residuals   39  3.8451  0.0986
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response TiO2 :
##             Df  Sum Sq  Mean Sq F value    Pr(>F)
## kiln         3 0.65277 0.217589  14.659 1.525e-06 ***
## Residuals   39 0.57891 0.014844
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response MnO :
##             Df   Sum Sq   Mean Sq F value    Pr(>F)
## kiln         3 0.075848 0.0252827  52.756 8.562e-14 ***
## Residuals   39 0.018690 0.0004792
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
##  Response BaO :
##             Df     Sum Sq    Mean Sq F value Pr(>F)
## kiln         3 0.00001283 4.2750e-06   0.459 0.7125
## Residuals   39 0.00036322 9.3134e-06
```

For Part A

We simply take the F statistics calculated by the manova test. So the values under F value in the above summary are our F Statistics.

For Part B

We use the Bonferroni correction to find that new alpha = alpha/m where m is the number of variables we observe.

```
anew = 0.05/9
```

Then we compare this new alpha to the Pr(>F) values found by our manova test. We can see that, for example, Pr(>F) of Al2O3 is 2.083e-09 which is less than our new alpha. Therefore we can reject the null hypothesis and say that all the means are not all equal.

For Part C

We simply use the result of our manova test above, comparing the Pr(>F) values to our significance level of 0.05. We find multiple values are less than 0.05, which means that we reject the null hypothesis in favor of the alternative hypothesis. So, on average, the mean values of each chemical from each of the four sites are not equal, so we reject the null hypothesis in favor of the alternative hypothesis.