Homework 3

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Problem 1

========== Part 1 ==========

```
water = read.table(file = "~/Documents/Math189/water.txt", header = TRUE)

# we test if the concentration of Zinc in bottom water(m1)
# and concentration of Zinc in surface water is the same(m2)
# H0: m1 = m2
# H1: m1 not= m2

# checking the summary statistics first
summary(water)
```

```
##      bottom          surface
##  Min.   :0.2660   Min.   :0.2380
##  1st Qu.:0.4845   1st Qu.:0.4103
##  Median :0.5780   Median :0.4690
##  Mean   :0.5649   Mean   :0.4845
##  3rd Qu.:0.6930   3rd Qu.:0.6080
##  Max.   :0.7230   Max.   :0.6320
```

```
t.test(water$bottom, water$surface, paired = TRUE)
```

```
##
##  Paired t-test
##
## data:  water$bottom and water$surface
## t = 4.8638, df = 9, p-value = 0.0008911
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  0.043006 0.117794
## sample estimates:
## mean of the differences
##                  0.0804
```

========== Part 2 ==========

```
# I'm going to chose if out assumption failed the practice of
# normality. Assumptions for ANOVA is considered a good and rigorous
# rigoroust test against the normality of assumption. This means
# if our assumption was violated in practice of normality,
# meaning that this will tolerates the violations to its normality
# assumption rather well. As regard with the normality of group data,
# the Assumption for ANOVA can tolerate data that is-non normal or skewed
# with only a small efect on the Type of I error in statistics.
```

Problem 2

========== Part 1 ==========

```
#install.packages('HSAUR3')
library("HSAUR3")
```

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

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

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

```
data("pottery")
class(pottery)
```

```
## [1] "data.frame"
```

```
v1 = data.frame(pottery[c(1)], pottery[c(10)])
v2 = data.frame(pottery[c(2)], pottery[c(10)])
v3 = data.frame(pottery[c(3)], pottery[c(10)])
v4 = data.frame(pottery[c(4)], pottery[c(10)])
v5 = data.frame(pottery[c(5)], pottery[c(10)])
v6 = data.frame(pottery[c(6)], pottery[c(10)])
v7 = data.frame(pottery[c(7)], pottery[c(10)])
v8 = data.frame(pottery[c(8)], pottery[c(10)])
v9 = data.frame(pottery[c(9)], pottery[c(10)])


anova1 = aov(Al2O3~kiln, data = v1)
anova2 = aov(Fe2O3~kiln, data = v2)
anova3 = aov(MgO~kiln, data = v3)
anova4 = aov(CaO~kiln, data = v4)
anova5 = aov(Na2O~kiln, data = v5)
anova6 = aov(K2O~kiln, data = v6)
anova7 = aov(TiO2~kiln, data = v7)
anova8 = aov(MnO~kiln, data = v8)
anova9 = aov(BaO~kiln, data = v9)
```

========== Part 2 ==========

```
p.adjust(anova1$residuals, method = "bonferroni")
```

```
##           1           2           3           4           5
##   1.0000000  -0.8571429   1.0000000  -0.8571429   1.0000000
##           6           7           8           9          10
##   1.0000000 -18.8571429   1.0000000 -50.3571429 -104.3571429
##          11          12          13          14          15
## -144.8571429 -104.3571429 -95.3571429   1.0000000  -5.3571429
##          16          17          18          19          20
##  -50.3571429   1.0000000  -0.8571429   1.0000000   1.0000000
##          21          22          23          24          25
##   1.0000000   1.0000000   1.0000000   1.0000000 -47.6250000
##          26          27          28          29          30
##   1.0000000 -74.6250000 -110.6250000 -43.1250000 -65.6250000
```

```
##           31           32           33           34           35
##    1.0000000   -7.1250000    1.0000000   -4.5000000    1.0000000
##           36           37           38           39           40
##    1.0000000 -107.1000000   -8.1000000   -8.1000000    1.0000000
##           41           42           43           44           45
##    1.0000000    1.0000000  -27.9000000 -113.4000000    1.0000000
```

```
p.adjust(anova2$residuals, method = "bonferroni")
```

```
##           1           2           3           4           5           6
##   1.0000000  -4.4357143   1.0000000  -6.2357143  -8.4857143   0.9642857
##           7           8           9          10          11          12
## -17.0357143  -0.3857143 -12.5357143 -25.1357143 -71.9357143 -30.0857143
##          13          14          15          16          17          18
## -16.1357143   1.0000000   1.0000000   1.0000000   1.0000000   1.0000000
##          19          20          21          22          23          24
##   1.0000000   1.0000000  -6.6857143   1.0000000   1.0000000   1.0000000
##          25          26          27          28          29          30
##   1.0000000   1.0000000  -3.6000000 -93.6000000 -25.2000000 -38.2500000
##          31          32          33          34          35          36
##   1.0000000  -9.4500000   1.0000000  -1.1250000   1.0000000 -19.4400000
##          37          38          39          40          41          42
##   1.0000000  -9.5400000   1.0000000  -9.0900000 -17.6400000 -16.7400000
##          43          44          45
## -26.6400000   1.0000000   1.0000000
```

```
p.adjust(anova3$residuals, method = "bonferroni")
```

```
##           1           2           3           4           5           6
##   1.0000000  -8.6571429  -1.0071429 -12.7071429  -0.5571429   1.0000000
##           7           8           9          10          11          12
##  -1.4571429   1.0000000 -10.0071429  -7.7571429 -15.4071429  -9.5571429
##          13          14          15          16          17          18
## -10.0071429   1.0000000   0.7928571   1.0000000   1.0000000  -0.5571429
##          19          20          21          22          23          24
##   1.0000000   1.0000000   1.0000000 -28.4250000 -67.5750000 -47.3250000
##          25          26          27          28          29          30
##   1.0000000   1.0000000 -65.7750000 -30.2250000   1.0000000 -18.5250000
##          31          32          33          34          35          36
##   1.0000000   1.0000000   1.0000000  -3.8250000   1.0000000  -0.1800000
##          37          38          39          40          41          42
##  -1.9800000  -0.1800000   0.2700000   1.0000000  -2.0700000   1.0000000
##          43          44          45
##  -3.4200000   1.0000000  -0.2700000
```

```
p.adjust(anova4$residuals, method = "bonferroni")
```

```
##           1           2           3           4           5           6
##  -6.7071429  -4.4571429  -7.6071429  -8.0571429  -0.8571429  -3.1071429
##           7           8           9          10          11          12
##   1.0000000   1.0000000 -10.3071429  -8.0571429 -12.5571429   1.0000000
##          13          14          15          16          17          18
##   1.0000000  -4.9071429  -4.4571429  -5.8071429  -3.1071429   1.0000000
##          19          20          21          22          23          24
##  -4.9071429 -11.2071429  -5.8071429  -2.2875000  -3.6375000  -3.1875000
##          25          26          27          28          29          30
```

```
##  -1.8375000  -0.0375000  -1.3875000  -0.0375000  -0.9375000   1.0000000
##          31          32          33          34          35          36
##   1.0000000   0.8625000   1.0000000  -0.2250000   0.2250000   0.1800000
##          37          38          39          40          41          42
##  -0.7200000  -0.7200000  -0.7200000   1.0000000   0.3600000   0.3600000
##          43          44          45
##  -1.8900000  -0.9900000   1.0000000
```

```
p.adjust(anova5$residuals, method = "bonferroni")
```

```
##           1           2           3           4           5           6
##   1.0000000   1.0000000   1.0000000   1.0000000   1.0000000  -4.3071429
##           7           8           9          10          11          12
##  -0.7071429  -2.9571429   1.0000000  -0.7071429  -9.7071429  -6.5571429
##          13          14          15          16          17          18
##  -4.7571429   1.0000000   1.0000000   1.0000000   1.0000000   1.0000000
##          19          20          21          22          23          24
##  -9.7071429 -10.1571429  -7.4571429   1.0000000  -3.8250000  -2.4750000
##          25          26          27          28          29          30
##  -5.1750000  -2.4750000  -1.5750000  -3.3750000  -4.2750000   1.0000000
##          31          32          33          34          35          36
##  -2.4750000   1.0000000  -0.6750000   0.4500000  -0.4500000  -1.0800000
##          37          38          39          40          41          42
##  -0.6300000   0.2700000  -0.6300000   1.0000000   0.5400000   0.0900000
##          43          44          45
##   0.0900000   0.0900000  -0.8100000
```

```
p.adjust(anova6$residuals, method = "bonferroni")
```

```
##           1           2           3           4           5           6
##   1.0000000  -2.3785714  -1.4785714  -2.3785714   0.7714286   1.0000000
##           7           8           9          10          11          12
##   1.0000000   1.0000000   1.0000000  -1.9285714 -38.3785714  -3.7285714
##          13          14          15          16          17          18
##  -3.2785714   1.0000000  -7.7785714   1.0000000   1.0000000  -0.5785714
##          19          20          21          22          23          24
##   1.0000000   1.0000000   1.0000000   1.0000000   0.7500000   1.0000000
##          25          26          27          28          29          30
## -10.5000000   1.0000000 -32.5500000 -36.1500000 -19.0500000  -4.2000000
##          31          32          33          34          35          36
##   1.0000000   1.0000000   1.0000000  -2.9250000   1.0000000  -5.2200000
##          37          38          39          40          41          42
##  -6.1200000   1.0000000  -3.4200000   1.0000000   1.0000000   1.0000000
##          43          44          45
##  -9.2700000   1.0000000  -9.7200000
```

```
p.adjust(anova7$residuals, method = "bonferroni")
```

```
##           1           2           3           4           5           6
##   1.0000000   1.0000000   1.0000000   1.0000000  -0.3428571   1.0000000
##           7           8           9          10          11          12
##   0.5571429   1.0000000  -0.3428571  -1.2428571  -8.4428571  -3.0428571
##          13          14          15          16          17          18
##  -3.4928571  -0.3428571   0.1071429   1.0000000   1.0000000   0.5571429
##          19          20          21          22          23          24
##   1.0000000  -0.3428571  -1.6928571   1.0000000   1.0000000   1.0000000
```

```
##          25          26          27          28          29          30
##  -0.4875000   0.4125000  -1.8375000  -4.9875000  -2.2875000  -3.1875000
##          31          32          33          34          35          36
##  -0.4875000  -0.0375000   0.8625000  -0.6750000   0.6750000 -17.8200000
##          37          38          39          40          41          42
##   1.0000000  -5.6700000   1.0000000   1.0000000  -9.1800000  -4.6800000
##          43          44          45
##  -3.7800000   1.0000000   1.0000000
```

```
p.adjust(anova8$residuals, method = "bonferroni")
```

```
##           1           2           3           4           5           6
##  0.26357143 -0.18642857  0.71357143 -0.36642857 -0.45642857  0.03857143
##           7           8           9          10          11          12
## -0.23142857  0.03857143 -0.41142857 -0.72642857 -1.67142857 -0.72642857
##          13          14          15          16          17          18
##  0.39857143  0.84857143  1.00000000  1.00000000  0.44357143  0.93857143
##          19          20          21          22          23          24
##  0.03857143 -1.62642857 -0.18642857  1.00000000  1.00000000  0.13500000
##          25          26          27          28          29          30
## -1.53000000 -0.90000000 -0.54000000  1.00000000 -1.75500000 -1.84500000
##          31          32          33          34          35          36
##  1.00000000  1.00000000 -1.21500000  0.56250000 -0.56250000 -0.05400000
##          37          38          39          40          41          42
## -0.05400000 -0.05400000  0.17100000 -0.00900000 -0.14400000  0.08100000
##          43          44          45
## -0.00900000 -0.05400000  0.12600000
```

```
p.adjust(anova9$residuals, method = "bonferroni")
```

```
##            1            2            3            4            5
## -0.096428571  0.038571429 -0.141428571  0.083571429  0.083571429
##            6            7            8            9           10
## -0.006428571  0.083571429 -0.006428571 -0.006428571 -0.231428571
##           11           12           13           14           15
## -0.231428571 -0.051428571 -0.051428571  0.128571429  0.128571429
##           16           17           18           19           20
##  0.083571429  0.038571429  0.263571429 -0.096428571 -0.006428571
##           21           22           23           24           25
## -0.006428571  0.123750000  0.168750000  0.123750000 -0.326250000
##           26           27           28           29           30
##  0.213750000 -0.281250000  0.033750000 -0.056250000 -0.011250000
##           31           32           33           34           35
##  0.033750000 -0.056250000  0.033750000  0.045000000 -0.045000000
##           36           37           38           39           40
## -0.108000000 -0.108000000 -0.018000000  0.252000000 -0.018000000
##           41           42           43           44           45
## -0.117000000  0.153000000 -0.117000000 -0.027000000  0.108000000
```

========== Part 3 ==========

```
p.adjust(anova1$residuals, method = "hochberg")
```

```
##           1           2           3           4           5
##   1.0000000  -0.4761905   1.0000000  -0.4571429   1.0000000
##           6           7           8           9          10
##   1.0000000 -12.9904762   1.0000000 -39.1666667 -92.7619048
```

```
##          11          12          13          14          15
## -144.8571429  -95.0809524  -82.6428571    1.0000000   -3.2142857
##          16          17          18          19          20
##  -40.2857143    1.0000000   -0.4380952    1.0000000    1.0000000
##          21          22          23          24          25
##    1.0000000    1.0000000    1.0000000    1.0000000  -35.9833333
##          26          27          28          29          30
##    1.0000000  -63.0166667 -105.7083333  -31.6250000  -53.9583333
##          31          32          33          34          35
##    1.0000000   -4.4333333    1.0000000   -2.6000000    1.0000000
##          36          37          38          39          40
##    1.0000000  -99.9600000   -5.2200000   -5.4000000    1.0000000
##          41          42          43          44          45
##    1.0000000    1.0000000  -19.8400000 -110.8800000    1.0000000
```

```
p.adjust(anova2$residuals, method = "hochberg")
```

```
##          1          2          3          4          5          6
##   1.0000000  -2.5628571   1.0000000  -3.7414286  -5.4685714   0.4714286
##          7          8          9         10         11         12
## -13.6285714  -0.1971429  -9.1928571 -21.7842857 -70.3371429 -28.0800000
##         13         14         15         16         17         18
## -12.1914286   1.0000000   1.0000000   1.0000000   1.0000000   1.0000000
##         19         20         21         22         23         24
##   1.0000000   1.0000000  -4.1600000   1.0000000   1.0000000   1.0000000
##         25         26         27         28         29         30
##   0.6000000   1.0000000  -2.0000000 -93.6000000 -22.4000000 -36.5500000
##         31         32         33         34         35         36
##   1.0000000  -6.5100000   1.0000000  -0.6000000   0.5250000 -16.4160000
##         37         38         39         40         41         42
##   1.0000000  -6.7840000   1.0000000  -6.0600000 -14.5040000 -13.0200000
##         43         44         45
## -24.2720000   1.0000000   1.0000000
```

```
p.adjust(anova3$residuals, method = "hochberg")
```

```
##          1          2          3          4          5          6
##   1.0000000  -6.5409524  -0.6042857 -10.7304762  -0.3219048   1.0000000
##          7          8          9         10         11         12
##  -0.9066667   1.0000000  -8.0057143  -5.6885714 -13.3528571  -7.4333333
##         13         14         15         16         17         18
##  -8.2280952   1.0000000   0.3523810   1.0000000   1.0000000  -0.3095238
##         19         20         21         22         23         24
##   1.0000000   1.0000000   1.0000000 -25.8983333 -67.5750000 -45.2216667
##         25         26         27         28         29         30
##   1.0000000   1.0000000 -64.3133333 -28.2100000   1.0000000 -16.4666667
##         31         32         33         34         35         36
##   1.0000000   1.0000000   1.0000000  -2.7200000   1.0000000  -0.0880000
##         37         38         39         40         41         42
##  -1.2760000  -0.0920000   0.1260000   0.8740000  -1.3800000   1.0000000
##         43         44         45
##  -2.3560000   1.0000000  -0.1440000
```

```
p.adjust(anova4$residuals, method = "hochberg")
```

```
##           1           2           3           4           5
```

```
##  -5.81285714  -3.36761905  -6.76190476  -7.52000000  -0.41904762
##            6            7            8            9           10
##  -2.00238095   0.79095238   0.48761905  -9.84904762  -7.34095238
##           11           12           13           14           15
## -12.55714286   0.79095238   0.79095238  -3.81666667  -3.26857143
##           16           17           18           19           20
##  -4.77476190  -2.07142857   0.79095238  -3.92571429 -10.95809524
##           21           22           23           24           25
##  -4.90380952  -1.42333333  -2.58666667  -2.19583333  -1.06166667
##           26           27           28           29           30
##  -0.01333333  -0.77083333  -0.01416667  -0.47916667   0.53500000
##           31           32           33           34           35
##   0.53500000   0.21083333   0.54583333  -0.09000000   0.07000000
##           36           37           38           39           40
##   0.06000000  -0.30400000  -0.32000000  -0.33600000   0.43200000
##           41           42           43           44           45
##   0.09600000   0.09600000  -1.13400000  -0.52800000   0.43200000
```

```
p.adjust(anova5$residuals, method = "hochberg")
```

```
##           1           2           3           4           5           6
##   0.4342857   0.4342857   0.4342857   0.4342857   0.4842857  -3.6371429
##           7           8           9          10          11          12
##  -0.4085714  -2.2342857   0.4342857  -0.4242857  -9.2757143  -5.9742857
##          13          14          15          16          17          18
##  -4.1228571   0.4842857   0.4842857   0.4842857   0.4342857   0.4842857
##          19          20          21          22          23          24
##  -9.4914286 -10.1571429  -6.9600000   0.4842857  -3.0600000  -1.7050000
##          25          26          27          28          29          30
##  -4.6000000  -1.7600000  -1.0500000  -2.6250000  -3.5150000   0.4342857
##          31          32          33          34          35          36
##  -1.8150000   0.4842857  -0.3750000   0.1700000  -0.2200000  -0.6960000
##          37          38          39          40          41          42
##  -0.3220000   0.1080000  -0.3360000   0.4342857   0.1920000   0.0380000
##          43          44          45
##   0.0380000   0.0380000  -0.5040000
```

```
p.adjust(anova6$residuals, method = "hochberg")
```

```
##           1           2           3           4           5           6
##   0.7666667  -1.5328571  -0.8871429  -1.5857143   0.4114286   0.7666667
##           7           8           9          10          11          12
##   0.7666667   0.7666667   0.7666667  -1.2000000 -38.3785714  -2.8171429
##          13          14          15          16          17          18
##  -2.3314286   0.6242857  -6.5685714   0.7666667   0.7666667  -0.3342857
##          19          20          21          22          23          24
##   0.7666667   0.7666667   0.7666667   0.7666667   0.4114286   0.7666667
##          25          26          27          28          29          30
##  -9.5666667   0.7666667 -31.1033333 -35.3466667 -17.7800000  -3.2666667
##          31          32          33          34          35          36
##   0.7666667   0.7666667   0.7666667  -2.0150000   0.7666667  -4.1760000
##          37          38          39          40          41          42
##  -5.0320000   0.7480000  -2.5080000   0.7666667   0.7666667   0.7666667
##          43          44          45
##  -8.0340000   0.7666667  -8.6400000
```

```r
p.adjust(anova7$residuals, method = "hochberg")
```

```
##           1           2           3           4           5           6
##   0.3460000   0.3460000   0.3460000   0.3460000  -0.2133333   0.3460000
##           7           8           9          10          11          12
##   0.2476190   0.3460000  -0.1904762  -0.8838095  -8.0676190  -2.4342857
##          13          14          15          16          17          18
##  -2.9495238  -0.1980952   0.0547619   0.3460000   0.3460000   0.2476190
##          19          20          21          22          23          24
##   0.3460000  -0.2057143  -1.2414286   0.3460000   0.3460000   0.3460000
##          25          26          27          28          29          30
##  -0.3141667   0.2016667  -1.3883333  -4.5441667  -1.7791667  -2.6208333
##          31          32          33          34          35          36
##  -0.3250000  -0.0200000   0.3450000  -0.4650000   0.2850000 -17.8200000
##          37          38          39          40          41          42
##   0.3460000  -5.2920000   0.3460000   0.3460000  -8.9760000  -4.1600000
##          43          44          45
##  -3.2760000   0.3460000   0.3460000
```

```r
p.adjust(anova8$residuals, method = "hochberg")
```

```
##           1           2           3           4           5           6
##  0.04200000 -0.12014286  0.04200000 -0.26057143 -0.34485714  0.01628571
##           7           8           9          10          11          12
## -0.15942857  0.01628571 -0.30171429 -0.59728571 -1.59714286 -0.61342857
##          13          14          15          16          17          18
##  0.04200000  0.04200000  0.04200000  0.04200000  0.04200000  0.04200000
##          19          20          21          22          23          24
##  0.01628571 -1.51800000 -0.12428571  0.04200000  0.04200000  0.04200000
##          25          26          27          28          29          30
## -1.39400000 -0.78000000 -0.42000000  0.04200000 -1.71600000 -1.84500000
##          31          32          33          34          35          36
##  0.04200000  0.04200000 -1.08000000  0.04200000 -0.45000000 -0.02880000
##          37          38          39          40          41          42
## -0.03000000 -0.03120000  0.04200000 -0.00440000 -0.08960000  0.03240000
##          43          44          45
## -0.00460000 -0.03240000  0.04200000
```

```r
p.adjust(anova9$residuals, method = "hochberg")
```

```
##           1           2           3           4           5
## -0.077142857  0.005857143 -0.128857143  0.005857143  0.005857143
##           6           7           8           9          10
## -0.003000000  0.005857143 -0.003142857 -0.003285714 -0.216000000
##          11          12          13          14          15
## -0.221142857 -0.035428571 -0.036571429  0.005857143  0.005857143
##          16          17          18          19          20
##  0.005857143  0.005857143  0.005857143 -0.075000000 -0.003428571
##          21          22          23          24          25
## -0.003571429  0.005857143  0.005857143  0.005857143 -0.326250000
##          26          27          28          29          30
##  0.005857143 -0.275000000  0.005857143 -0.041250000 -0.006500000
##          31          32          33          34          35
##  0.005857143 -0.042500000  0.005857143  0.005857143 -0.030000000
##          36          37          38          39          40
```

```
## -0.088800000 -0.091200000 -0.010800000  0.005857143 -0.011200000
##           41           42           43           44           45
## -0.101400000  0.005857143 -0.104000000 -0.017400000  0.005857143
```