hw.R

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2021-11-11

```
# Exercise 1

#a)
control = c(4.302, 4.017, 4.049, 4.176)
p1 = c(2.021, 3.19, 3.25, 3.276, 3.292, 3.267)
p2 = c(3.397, 3.552, 3.63, 3.578, 3.612)


treat = c(rep("control",length(control)), rep("p1", length(p1)), rep("p2", length(p2)))

outcome = c(control, p1, p2)

n1 = sum((treat=="control") + 0)
n2 = sum((treat=="p1") + 0)
n3 = sum((treat=="p2") + 0)

n = n1+n2+n3

nbar = n/3

ssxobs = n1*mean(outcome[treat=="control"])**2 + n2*mean(outcome[treat=="p1"])**2 + n3*mean(out
come[treat=="p2"])**2
sstobs = ssxobs - n*mean(outcome)**2
sseobs = (n-1)*var(outcome)-sstobs
fobs = (sstobs/2)/(sseobs/(n-3))
ranks = rank(outcome)
a = 12/(n*(n+1))
b=(n+1)/2

kwobs = a*((n1*mean(ranks[treat=="control"])-b)**2) + (n2*(mean(ranks[treat=="p1"]) - b)**2) +
 (n3*(mean(ranks[treat=="p2"])-b)**2)

tot = 10000

d=c()
perm1 = c()
perm2 = c()
perm3 = c()
f = c()
kw = c()
q = c()

for( i in 1:tot){
  permut = sample(outcome)
  ranks = rank(permut)
  d[i] = n1*(mean(permut[treat=="control"])**2) + n2*(mean(permut[treat=="p1"])**2) + n3*(mean
(permut[treat=="p2"])**2)

  ssx = n1*(mean(permut[treat=="control"])**2) + n2*(mean(permut[treat=="p1"])**2) + n3*(mean(p
ermut[treat=="p2"])**2)
  sst=ssx-n*mean(permut)**2
  sse = ssx-n*mean(permut)**2
  sse = (n-1)*var(permut)-sst
  mse = sse/(n-3)
  f[i] = (sst/2)/(sse/(n-3))
  kw[i] = a*((n1*(mean(ranks[treat=="control"])-b)**2) + (n2*(mean(ranks[treat=="p1"])-b)**2) +
(n3*(mean(ranks[treat=="p2"])-b)**2))
```

```
  perm1[i] = (d[i] >= ssxobs)+0
  perm2[i] = (f[i] >= fobs) +0
  perm3[i] = (kw[i] >= kwobs) +0
  maxmean = max(mean(permut[treat=="control"]), mean(permut[treat=="p1"]), mean(permut[treat==
"p2"]))
  minmean = min(mean(permut[treat=="control"]), mean(permut[treat=='p1']), mean(permut[treat==
"p2"]))
  q[i] = ((maxmean-minmean))/(((2/nbar)*mse)**0.5)
}

pvalue1 = sum(perm1)/tot
pvalue2=  sum(perm2)/tot
pvalue3 = sum(perm3)/tot

tkhsdq = quantile(q, .95)

ranks = rank(outcome)
rmean1 = mean(ranks[treat=="control"])
rmean2 = mean(ranks[treat=="p1"])
rmean3 = mean(ranks[treat=="p2"])

mseranks = n*(n+1)/12

pvalue1
```

```
## [1] 0
```

```
pvalue2
```

```
## [1] 0
```

```
pvalue3
```

```
## [1] 0
```

```
#b)
# One way analysis of variance
#.libPaths('C:/Users/pumad/STA104')


#install.packages("ImPerm")
library(ImPerm)
```

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

```
summary(aov(outcome~treat))
```

```
##             Df Sum Sq Mean Sq F value  Pr(>F)
## treat        2   2.85  1.4251   12.57 0.00114 **
## Residuals   12   1.36  0.1134
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(aov(outcome~ treat))
```

```
##             Df Sum Sq Mean Sq F value  Pr(>F)
## treat        2   2.85  1.4251   12.57 0.00114 **
## Residuals   12   1.36  0.1134
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(aovp(outcome~treat))
```

```
## [1] "Settings:  unique SS "
```

```
## Component 1 :
##             Df R Sum Sq R Mean Sq Iter  Pr(Prob)
## treat1       2   2.8503   1.42513 5000 < 2.2e-16 ***
## Residuals   12   1.3604   0.11337
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
kruskal.test(outcome~treat)
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  outcome by treat
## Kruskal-Wallis chi-squared = 12.375, df = 2, p-value = 0.002055
```

```
# Exercise 2

# Permutation F test
weight1 = c(574, 926, 789, 805, 361, 529)
weight2 = c(791, 394, 667, 1385, 1021, 2073, 1263, 1016, 1101, 945, 139)
weight3 = c(865, 775, 729, 1721, 820, 1613, 1202, 1201, 205, 1380, 580, 1803)
weight4 = c(998, 1049, 736, 782, 742, 1219, 705, 1260, 611, 1350, 1657)
weight5 = c(406, 1529, 1132, 767, 1224, 314, 1728)

outcome = c(weight1, weight2, weight3, weight4, weight5)
treat = c(rep("code1",length(weight1)), rep("code2", length(weight2)), rep("code3", length(weig
ht3)),
          rep("code4", length(weight4)), rep("code5", length(weight5)))


n1 = sum((treat=="code1") + 0)
n2 = sum((treat=="code2") + 0)
n3 = sum((treat=="code3") + 0)
n4 = sum((treat=="code4") + 0)
n5 = sum((treat=="code5") + 0)

n = n1+n2+n3+n4+n5

nbar = n/5

ssxobs = n1*mean(outcome[treat=="code1"])**2 + n2*mean(outcome[treat=="code2"])**2 + n3*mean(ou
tcome[treat=="code3"])**2 +
  n4*mean(outcome[treat=="code4"])**2 + n5*mean(outcome[treat=="code5"])**2
sstobs = ssxobs - n*mean(outcome)**2
sseobs = (n-1)*var(outcome)-sstobs
fobs = (sstobs/4)/(sseobs/(n-5))
ranks = rank(outcome)
a = 12/(n*(n+1))
b=(n+1)/2

kwobs = a*((n1*mean(ranks[treat=="code1"])-b)**2) + (n2*(mean(ranks[treat=="code2"]) - b)**2) +
(n3*(mean(ranks[treat=="code3"])-b)**2) +
  (n4*(mean(ranks[treat=="code4"])-b)**2) + (n5*(mean(ranks[treat=="code5"])-b)**2)

tot = 10000

d=c()
perm1 = c()
perm2 = c()
perm3 = c()
f = c()
kw = c()
q = c()

for( i in 1:tot){
  permut = sample(outcome)
  ranks = rank(permut)
  d[i] = n1*(mean(permut[treat=="code1"])**2) + n2*(mean(permut[treat=="code2"])**2) + n3*(mean
(permut[treat=="code3"])**2) +
    n4*(mean(permut[treat=="code3"])**2) +  n5*(mean(permut[treat=="code3"])**2)

  ssx = n1*(mean(permut[treat=="code1"])**2) + n2*(mean(permut[treat=="code2"])**2) + n3*(mean
```

```
(permut[treat=="code3"])**2) +
    n4*(mean(permut[treat=="code4"])**2) + n5*(mean(permut[treat=="code5"])**2)
  sst=ssx-n*mean(permut)**2
  sse = ssx-n*mean(permut)**2
  sse = (n-1)*var(permut)-sst
  mse = sse/(n-5)
  f[i] = (sst/4)/(sse/(n-5))
  kw[i] = a*((n1*(mean(ranks[treat=="code1"])-b)**2) + (n2*(mean(ranks[treat=="code2"])-b)**2)
 + (n3*(mean(ranks[treat=="code3"])-b)**2) +
    (n4*(mean(ranks[treat=="code4"])-b)**2) + (n5*(mean(ranks[treat=="code5"])-b)**2))
  perm1[i] = (d[i] >= ssxobs)+0
  perm2[i] = (f[i] >= fobs) +0
  perm3[i] = (kw[i] >= kwobs) +0
  maxmean = max(mean(permut[treat=="code1"]), mean(permut[treat=="code2"]), mean(permut[treat==
"code3"]), mean(permut[treat=="code4"]), mean(permut[treat=="code5"]))
  minmean = min(mean(permut[treat=="code1"]), mean(permut[treat=='code2']), mean(permut[treat==
"code3"]), mean(permut[treat=="code4"]), mean(permut[treat=="code5"]))
  q[i] = ((maxmean-minmean))/(((2/nbar)*mse)**0.5)
}

pvalue1 = sum(perm1)/tot
pvalue2=  sum(perm2)/tot
pvalue3 = sum(perm3)/tot

tkhsdq = quantile(q, .95)

ranks = rank(outcome)
rmean1 = mean(ranks[treat=="code1"])
rmean2 = mean(ranks[treat=="code2"])
rmean3 = mean(ranks[treat=="code3"])
rmean4 = mean(ranks[treat=="code4"])
rmean5 = mean(ranks[treat=="code5"])


mseranks = n*(n+1)/12

pvalue1
```

```
## [1] 0.4711
```

```
pvalue2
```

```
## [1] 0.467
```

```
pvalue3
```

```
## [1] 0
```

```
# ANOVA F-test

summary(aov(outcome~treat))
```

```
##             Df  Sum Sq Mean Sq F value Pr(>F)
## treat        4  723714  180928   0.905   0.47
## Residuals   42 8393656  199849
```

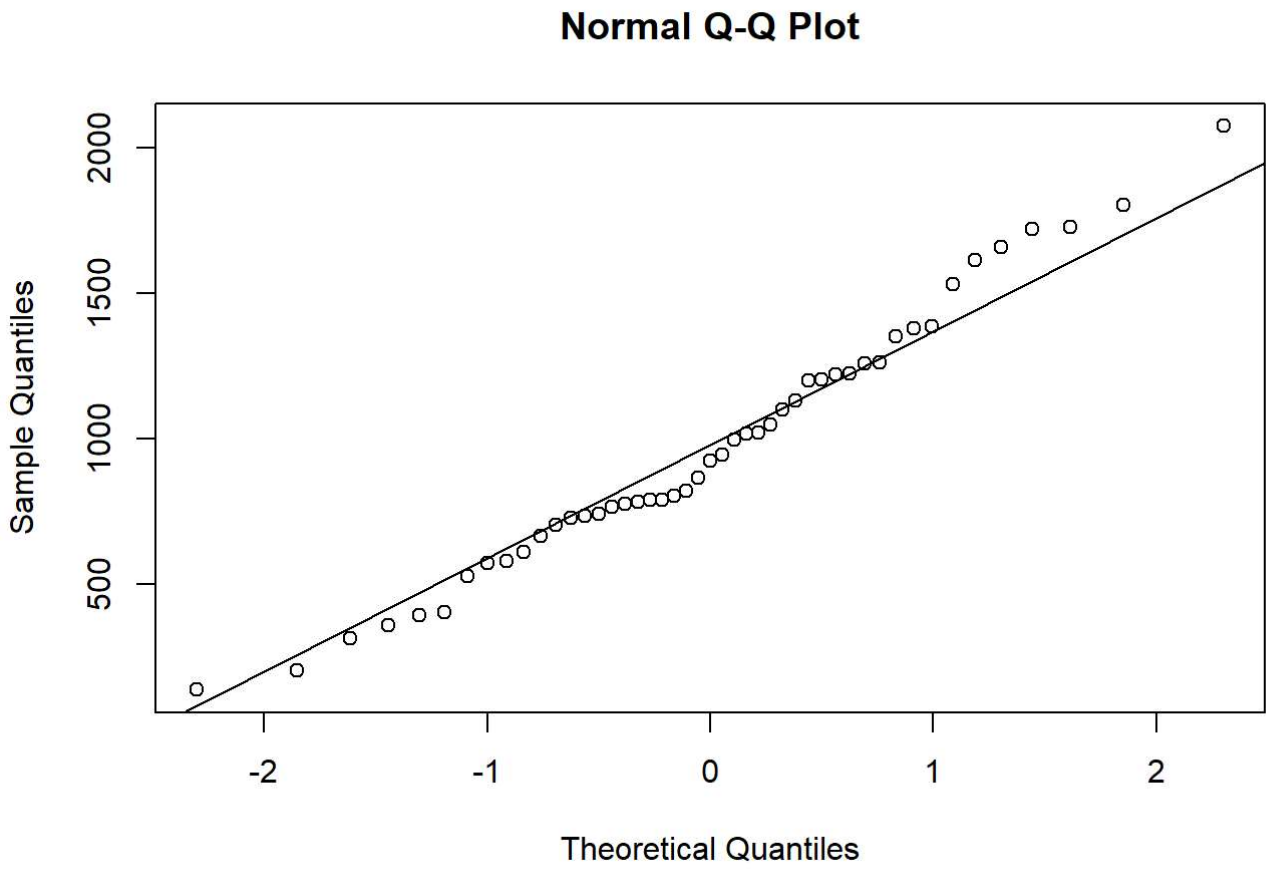
```
#install.packages("ggpubr")
library(ggpubr)
```

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

```
## Loading required package: ggplot2
```

```
## Warning: package 'ggplot2' was built under R version 4.0.5
```

```
qqnorm(outcome)
qqline(outcome)
```




```
# Exercise 3
kruskal.test(outcome~treat)
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  outcome by treat
## Kruskal-Wallis chi-squared = 3.9549, df = 4, p-value = 0.4121
```

```
# Exercise 4

compact = c(791, 846, 1024, 1007, 1399, 1279, 1407, 656, 1036, 226)
heavy = c(423, 541, 517, 328, 1471, 533, 863, 786, 451, 1068)
light = c(551, 1068, 757, 1114, 920, 809, 1238, 1918, 1339, 1603)
medium = c(712, 435, 1298, 1733, 300, 701, 707, 790, 1800, 480)
mpv = c(1345, 1269, 1077, 1458, 996, 1306, 968, 943, 1026, 1564)
pickup = c(903, 949, 1183, 1051, 1342, 1184, 977, 1465, 892, 1074)
van = c(985, 1074, 742, 985, 805, 2613, 1387, 1320, 1434, 1603)

outcome = c(compact, heavy, light, medium, mpv, pickup, van)
treat = c(rep('compact',length(compact)), rep('heavy', length(heavy)), rep('light', length(ligh
t)),
          rep('medium', length(medium)), rep('mpv', length(mpv)),  rep('pickup', length(picku
p)),  rep('length', length(van)))

model = kruskal.test(outcome~treat)
ks = model[1][1]
ks
```

```
## $statistic
## Kruskal-Wallis chi-squared
##                   14.80486
```

```
fit = aov(outcome~treat)
fit
```

```
## Call:
##    aov(formula = outcome ~ treat)
##
## Terms:
##                    treat Residuals
## Sum of Squares  2443215   9789649
## Deg. of Freedom       6        63
##
## Residual standard error: 394.197
## Estimated effects may be unbalanced
```