STA 135 - Homework 2

Gianni Spiga

4/20/2022

Problem 3

a.)

```
scores <- read.table("~/GitHub/STA135/Homework/HW2/T5-2.dat")

meanalt <- c(500, 50, 30)

library(DescTools)
```

```
## Warning: package 'DescTools' was built under R version 4.1.3
```

```
HotellingsT2Test(scores, mu = meanalt, test = 'chi')
```

```
##
##  Hotelling's one sample T2-test
##
## data:  scores
## T.2 = 223.31, df = 3, p-value < 2.2e-16
## alternative hypothesis: true location is not equal to c(500,50,30)
```

```
#Finding the critical point

n = nrow(scores)
p = ncol(scores)

Fstat = qf(0.05, p, n - p, lower.tail =  FALSE)
critval <- ((n -1) * p) / (n - p) * Fstat
```

Given that our T^2 value is much larger than our critical value as well as our p-value is extremely close to zero, we reject H_0. We have reason to believe that students are scoring differently than the reported average scores.

b.)

```
S <- cov(scores)
eigVal <- eigen(S)$values
eigVec <- eigen(S)$vectors
```

```r
cat("The directions of the corresponding axis are \n")
```

```
## The directions of the corresponding axis are
```

```r
eigVec
```

```
##             [,1]         [,2]         [,3]
## [1,] 0.99390539  0.103731534 -0.037307396
## [2,] 0.10344339 -0.994589227 -0.009577815
## [3,] 0.03809906 -0.005660238  0.999257936
```

```r
cat("\n")
```

```r
cat("The lengths of the axis are \n")
```

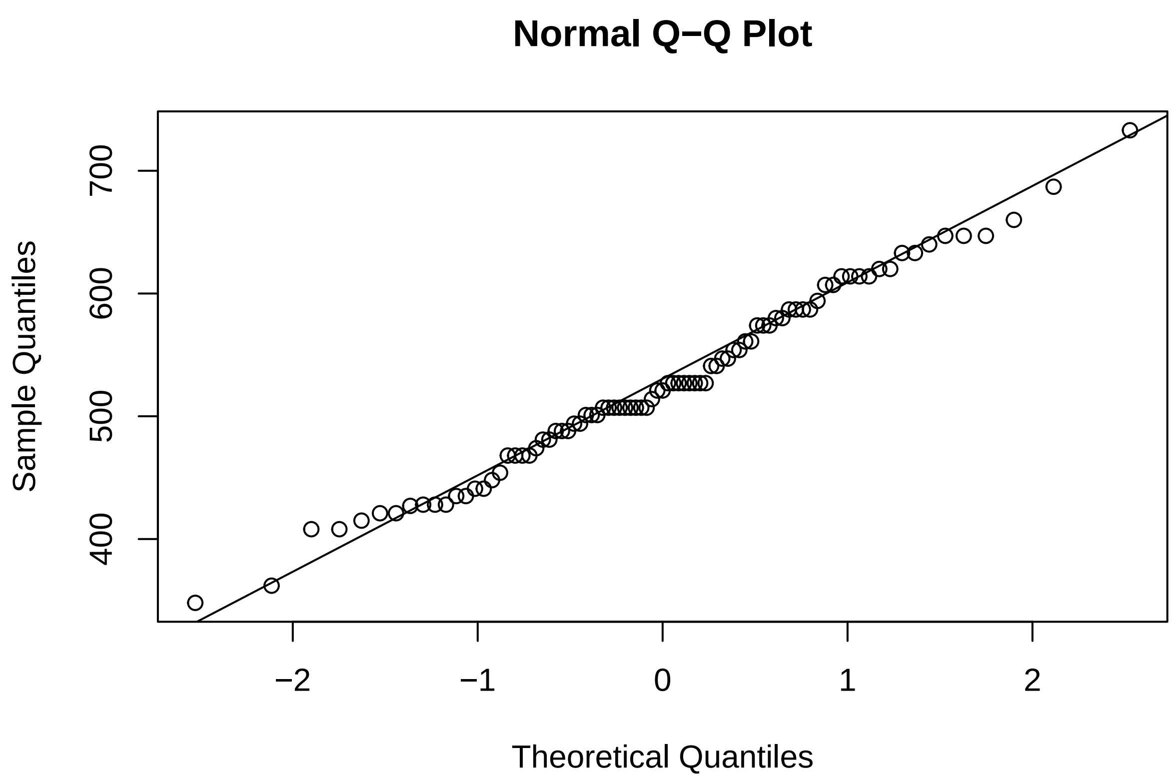
```
## The lengths of the axis are
```

```r
sqrt(eigVal) * sqrt((1/n) * critval)
```

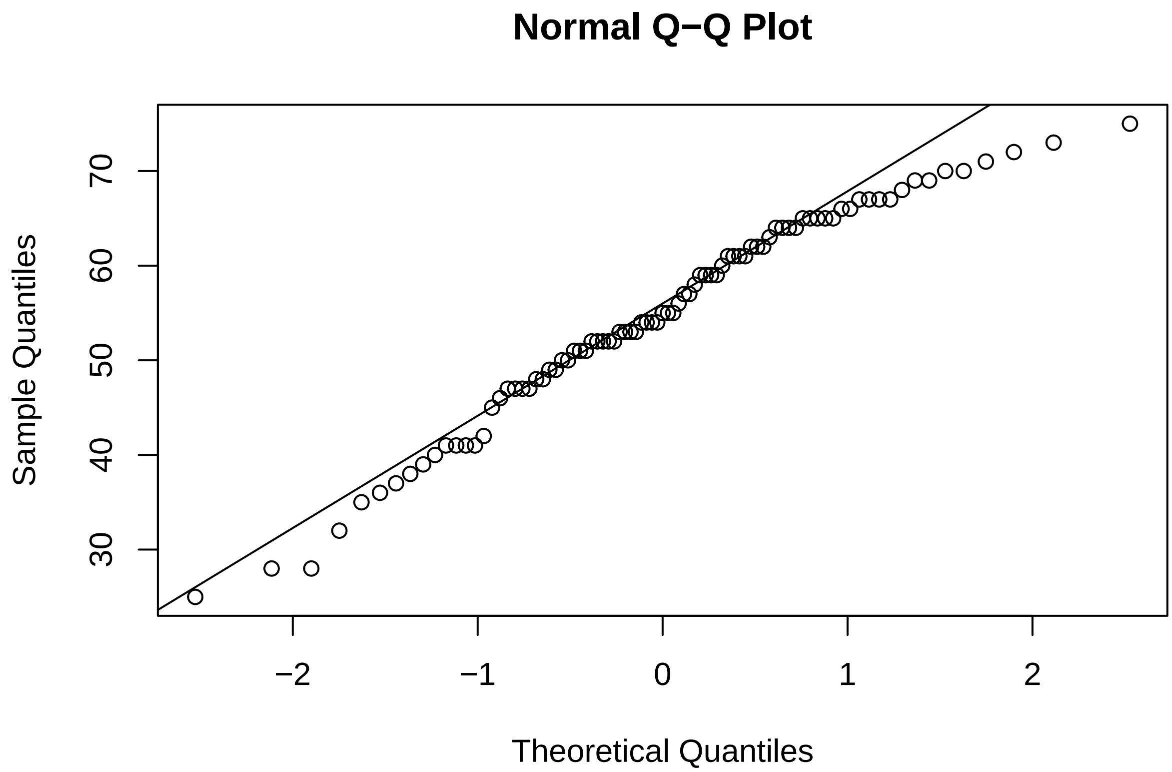
```
## [1] 23.729998  2.472768  1.182500
```

c.)

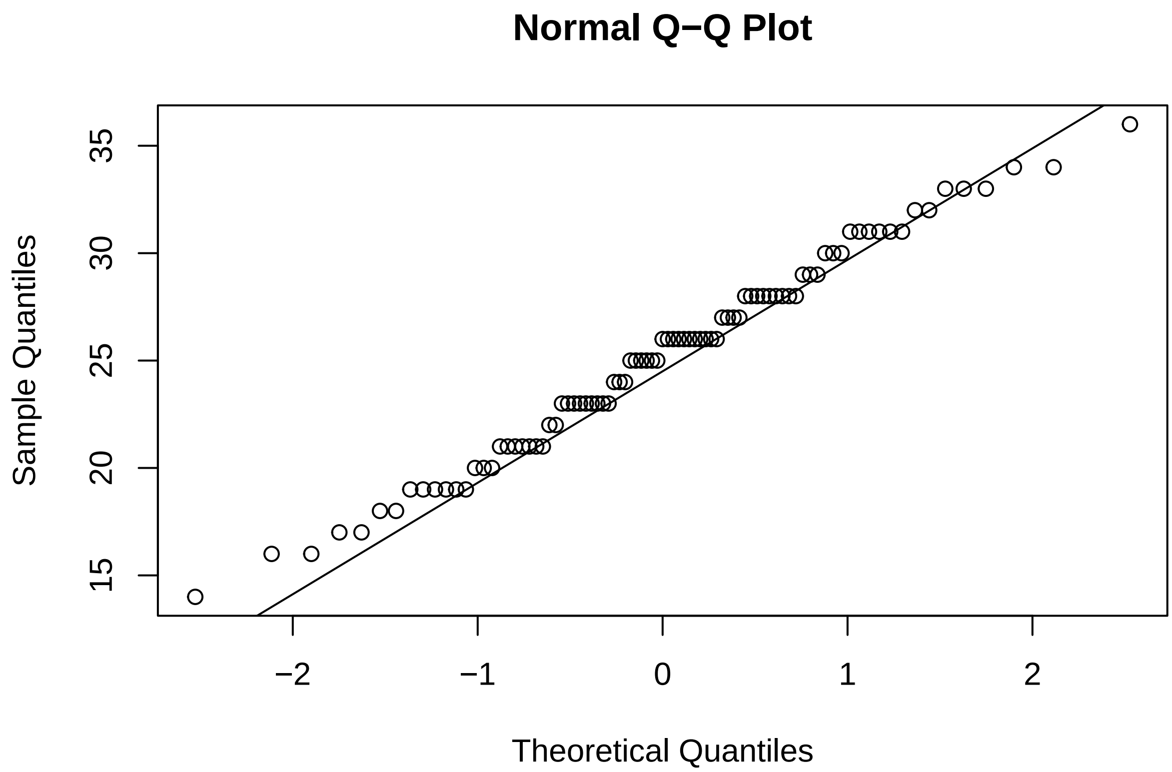
```r
qqnorm(scores[,1]); qqline(scores[,1])
```



```
qqnorm(scores[,2]); qqline(scores[,2])
```




```
qqnorm(scores[,3]); qqline(scores[,3])
```




```
library(ggplot2)
library(ggExtra)
```

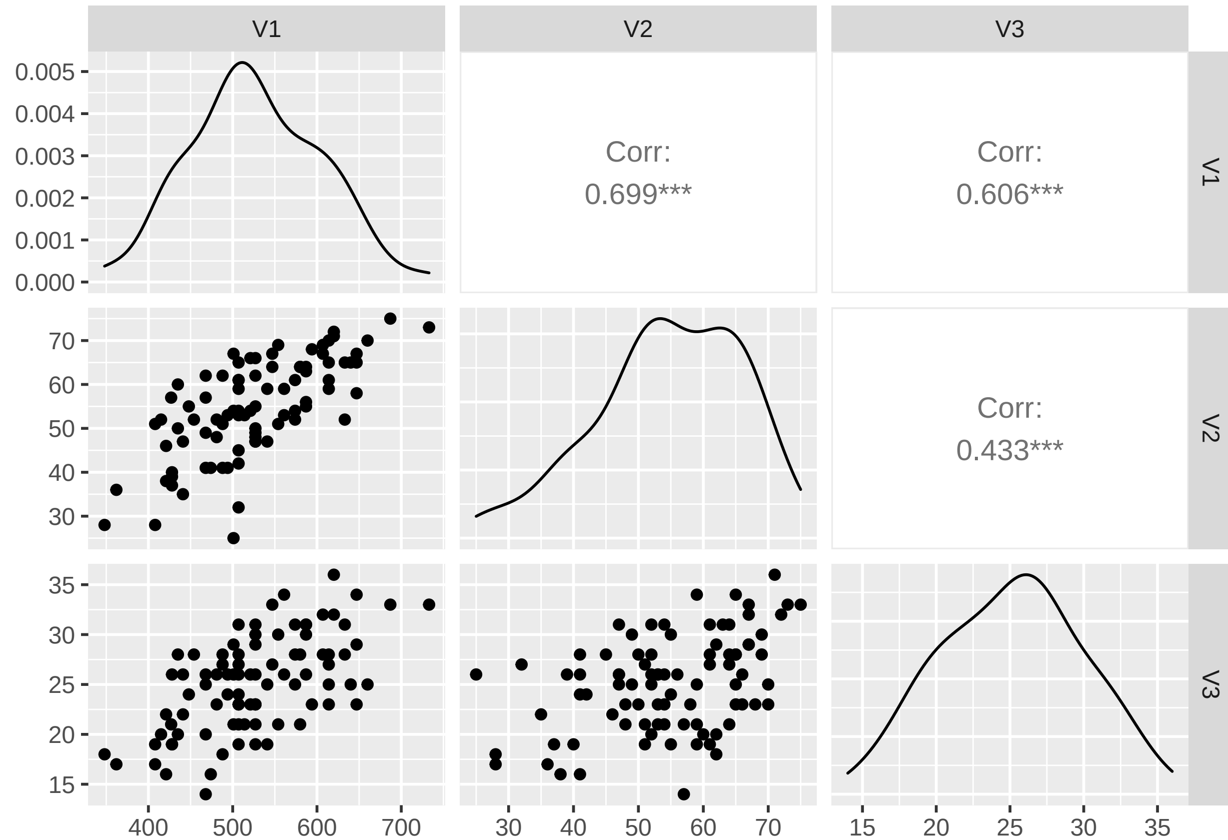
```
## Warning: package 'ggExtra' was built under R version 4.1.3
```

```
library(GGally)
```

```
## Warning: package 'GGally' was built under R version 4.1.3
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```
#Pairwise plots
ggpairs(scores)
```



Problem 4

P 5.21

```
bone <- read.table("~/GitHub/STA135/Homework/HW2/T1-8.dat")
bone
```

```
##       V1    V2    V3    V4    V5    V6
## 1  1.103 1.052 2.139 2.238 0.873 0.872
## 2  0.842 0.859 1.873 1.741 0.590 0.744
## 3  0.925 0.873 1.887 1.809 0.767 0.713
## 4  0.857 0.744 1.739 1.547 0.706 0.674
## 5  0.795 0.809 1.734 1.715 0.549 0.654
## 6  0.787 0.779 1.509 1.474 0.782 0.571
## 7  0.933 0.880 1.695 1.656 0.737 0.803
## 8  0.799 0.851 1.740 1.777 0.618 0.682
## 9  0.945 0.876 1.811 1.759 0.853 0.777
## 10 0.921 0.906 1.954 2.009 0.823 0.765
## 11 0.792 0.825 1.624 1.657 0.686 0.668
## 12 0.815 0.751 2.204 1.846 0.678 0.546
## 13 0.755 0.724 1.508 1.458 0.662 0.595
## 14 0.880 0.866 1.786 1.811 0.810 0.819
## 15 0.900 0.838 1.902 1.606 0.723 0.677
```

```
## 16 0.764 0.757 1.743 1.794 0.586 0.541
## 17 0.733 0.748 1.863 1.869 0.672 0.752
## 18 0.932 0.898 2.028 2.032 0.836 0.805
## 19 0.856 0.786 1.390 1.324 0.578 0.610
## 20 0.890 0.950 2.187 2.087 0.758 0.718
## 21 0.688 0.532 1.650 1.378 0.533 0.482
## 22 0.940 0.850 2.334 2.225 0.757 0.731
## 23 0.493 0.616 1.037 1.268 0.546 0.615
## 24 0.835 0.752 1.509 1.422 0.618 0.664
## 25 0.915 0.936 1.971 1.869 0.869 0.868
```

```
#Bonferroni
tstat <- qt(0.05/(2*ncol(bone)), nrow(bone) - 1)
tstat
```

```
## [1] -2.875094
```

```
upperBon <- colMeans(bone) - tstat * sqrt(diag(var(bone))/nrow(bone))
lowerBon <- colMeans(bone) + tstat * sqrt(diag(var(bone))/nrow(bone))

bonf <- matrix(c(lowerBon, upperBon), nrow= 6, ncol = 2)
bonf
```

```
##           [,1]      [,2]
## [1,] 0.7782338 0.9093662
## [2,] 0.7568766 0.8797634
## [3,] 1.6296774 1.9556826
## [4,] 1.5832656 1.8864144
## [5,] 0.6425529 0.7662471
## [6,] 0.6346406 0.7530394
```

```
n <- nrow(bone)
p <- ncol(bone)

# T^2 Interval
T2stat <- sqrt((p * (n- 1))/(n- p) * qf(0.05, p, n - p, lower.tail = FALSE))

lowerT2 <- colMeans(bone) - T2stat * sqrt(diag(var(bone))/nrow(bone))
upperT2 <- colMeans(bone) + T2stat * sqrt(diag(var(bone))/nrow(bone))

T2int <- matrix(c(lowerT2, upperT2), nrow= 6, ncol = 2)
T2int
```

```
##           [,1]      [,2]
## [1,] 0.7420179 0.9455821
## [2,] 0.7229380 0.9137020
## [3,] 1.5396419 2.0457181
## [4,] 1.4995425 1.9701375
## [5,] 0.6083914 0.8004086
## [6,] 0.6019414 0.7857386
```

We can see in this example, that the intervals for our simultaneous Bonferroni intervals are more narrow than the simulataneous T^2 intervals.