`— title: “ExamPrep” output: pdf_document —

От упражнение 1

```
#1.
#create a vector
vect <- c(8,3,8,7,15,9,12,4,9,10,5,1)
#create a 4x3 matrix
m <- matrix(vect, nrow = 4, ncol = 3)
#adding a column
m1 <- cbind(m, c(1,3,5,7))

#indexes of the first column
ordered <- order(m1[,1], decreasing = FALSE)
#ordered matrix
ordered_by_first_column <- m1[ordered,]

#indexes of the first two columns
ordered2 <- order(m1[,1], m1[,2], decreasing = FALSE)
#ordered matrix
ordered_by_two_columns <- m1[ordered2, ]

#2.
#most and least expensive in 2000
most <- which.max(homedata$y2000)
least <- which.min(homedata$y2000)

#prices in 1970
homedata$y1970[most]
```

```
## [1] 198900
```

```
homedata$y1970[least]
```

```
## [1] 10000
```

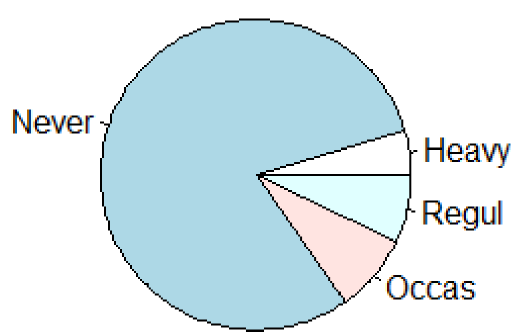
```
#top five most expensive houses in 2000
ordered_five <- homedata$y2000[order(homedata$y2000, decreasing = T)]

top_five <- head(ordered_five ,5)

#средната цена на 5те най-скъпи от 2000, но на техните цени от 1970
mean_top_five <- mean(head(homedata$y1970[order(homedata$y2000, decreasing =
T)], 5))

#къщите, чийто цена е намаляла през 2000г.
lowered <- homedata$y2000[which(homedata$y2000 < homedata$y1970)]

percent_increase <- head(order(((homedata$y2000 - homedata$y1970) /
homedata$y1970),
```

```
                                  decreasing = T), 10)

top_ten_increase <- homedata$y2000[percent_increase]

#3.
#number of men
num_men <- nrow(survey[survey$Sex == 'Male', ])

#number of men smokers
num_men_smokers <- nrow(survey[survey$Sex == 'Male' & survey$Smoke !=
'Never', ])

#mean height of all men
mean(survey$Height[survey$Sex == 'Male'], na.rm = T)

## [1] 178.826

#height and sex of the top 6 youngest students
youngest <- head(order(survey$Age), 6)

survey$Sex[youngest]

## [1] Male   Male   Female Female Female Female
## Levels: Female Male

survey$Height[youngest]

## [1]     NA     NA     NA 160.00 172.00 170.18
```

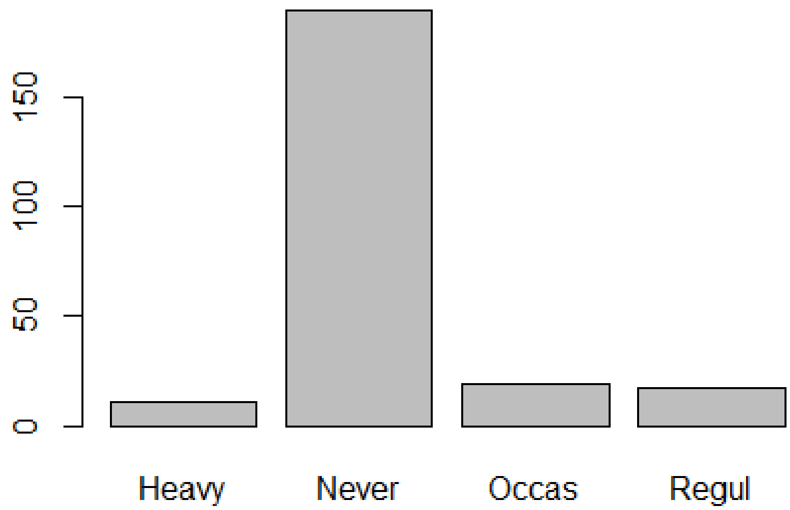
От упражнение 2

```
#1.
#случайно избран човек да се окаже пушач
survey$Smoke %>% table() %>% prop.table()

## .
##      Heavy      Never      Occas      Regul
## 0.04661017 0.80084746 0.08050847 0.07203390

#случайно избран мъж да се окаже редовно пушещ
table(survey$Smoke, survey$Sex) %>% prop.table()

##
##             Female       Male
##   Heavy 0.02127660 0.02553191
##   Never 0.42127660 0.37872340
##   Occas 0.03829787 0.04255319
##   Regul 0.02127660 0.05106383

#the same as
smoking_men <- nrow(survey[survey$Sex == 'Male' & survey$Smoke == 'Regul', ])
smoking_men / nrow(survey)
```

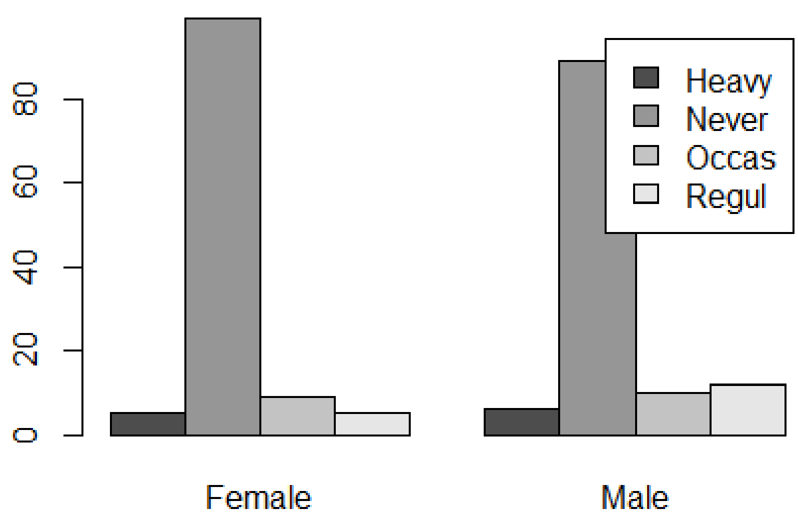
```
## [1] 0.05485232

#случаен мъж да се окаже редовен пушач.Стойността на всяка клетка се дели на
сумата
#от редовете
prop.table(table(survey$Sex, survey$Smoke), 1)

##
##                Heavy      Never      Occas      Regul
##   Female 0.04237288 0.83898305 0.07627119 0.04237288
##   Male   0.05128205 0.76068376 0.08547009 0.10256410

#случаен редовен пушач да се окаже мъж. Клетката се дели на сумата от
колоните
prop.table(table(survey$Sex, survey$Smoke), 2)

##
##               Heavy     Never     Occas     Regul
##   Female 0.4545455 0.5265957 0.4736842 0.2941176
##   Male   0.5454545 0.4734043 0.5263158 0.7058824

#2.
#направете графики за пушачите и за пола

#графики за пушенето
pie(table(survey$Smoke))
```



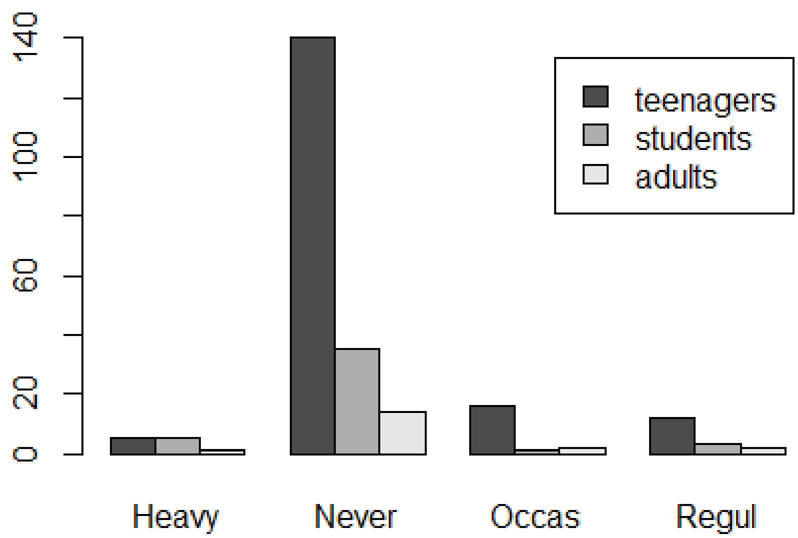

```
barplot(table(survey$Smoke))
```




```
#графика за пушенето и пола
barplot(table(survey$Smoke, survey$Sex), beside = T, legend = T)
```



```r
#3.
#за да разделим някаква информация на интервали, които ние искаме ползваме
cut
groups <- cut(survey$Age, c(0, 20, 25, 100), c('teenagers', 'students',
'adults'))

#правим го на графика
table(groups, survey$Smoke) %>%
  barplot(legend = T, beside = T)
```

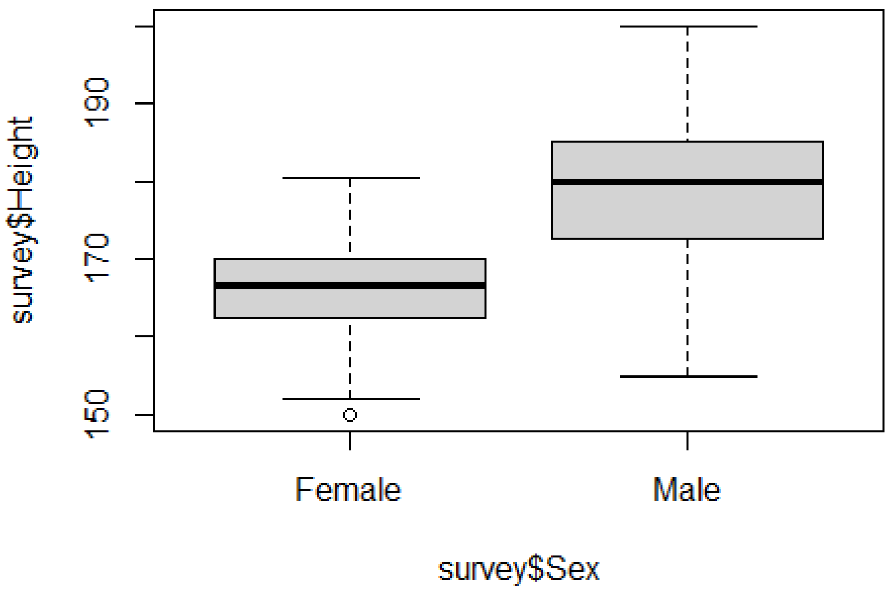



```r
#4.
s <- sd(survey$Height, na.rm = T)

med <- median(survey$Height,na.rm = T)

m <- mean(survey$Height, na.rm = T)

quantile(survey$Height, na.rm = T)

##   0%   25%   50%   75% 100%
##  150   165   171   180   200

#брой различаващи се от средната височина с неповече от 2 стандартни
отклонения
cut(survey$Height, c(0, m - s, m + s, 300)) %>%
  table()
```

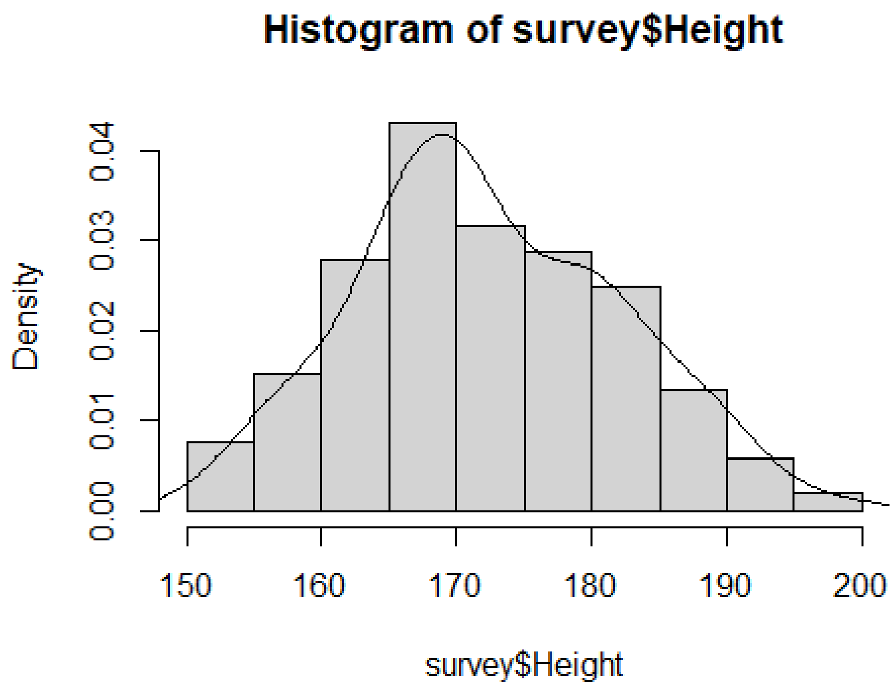
```
## .
##   (0,163] (163,182] (182,300]
##        28       143        38
```

От упражение 3

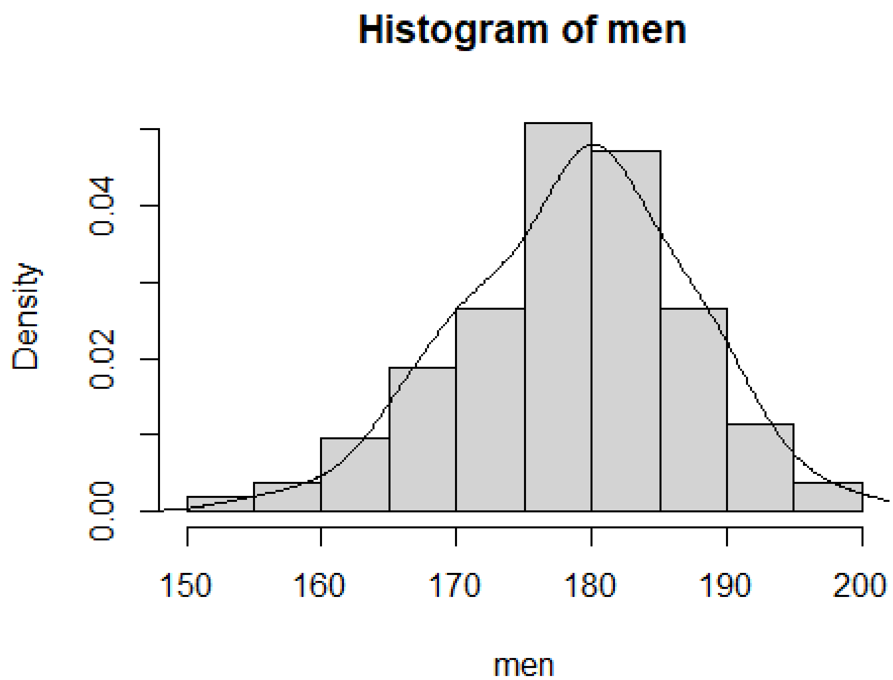
```
#1.
#графика според височината и пола
boxplot(survey$Height ~ survey$Sex)
```



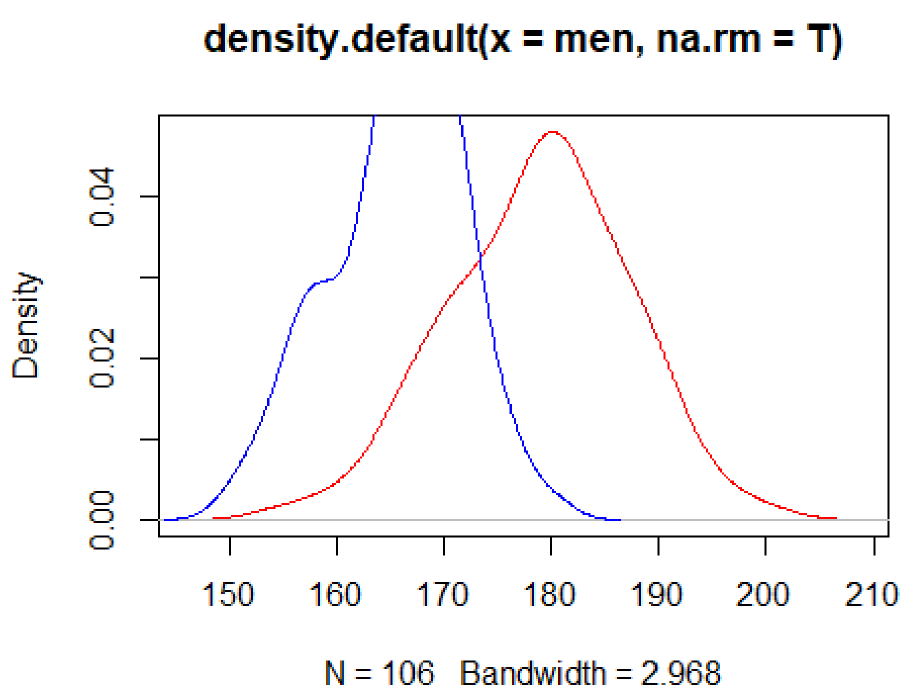

```
#хистограма според височината и имаме плътността
hist(survey$Height, probability = T)
  lines(density(survey$Height, na.rm = T))
```



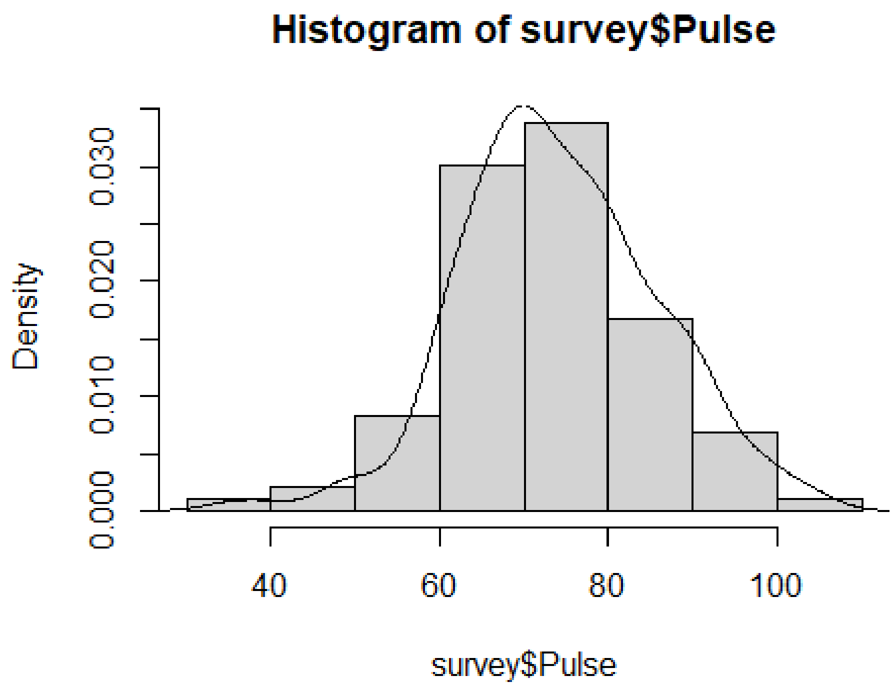

```r
#хистограма според височината на мъжете и имаме линия за плътност
men <- survey$Height[survey$Sex == 'Male']
women <- survey$Height[survey$Sex == 'Female']

hist(men, probability = T)
  lines(density(men, na.rm = T))
```



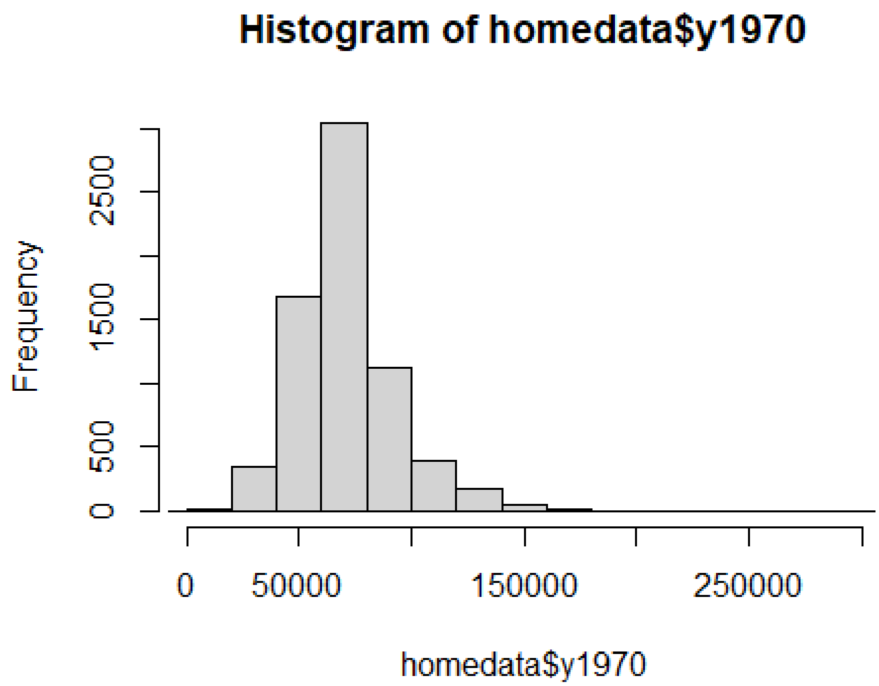

```r
#графика за плътностите на височините на двата пола
plot(density(men, na.rm = T), col='red')
lines(density(women, na.rm = T), col='blue')
```



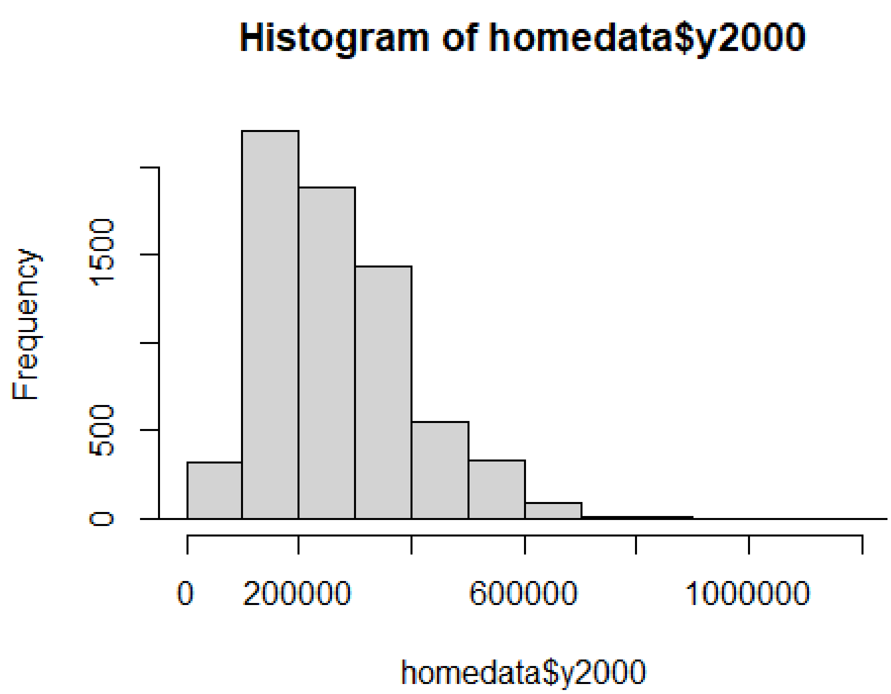
```r
#2.Histogram for the pulse of the students including the density
hist(survey$Pulse, probability = T)
lines(density(survey$Pulse, na.rm = T))
```



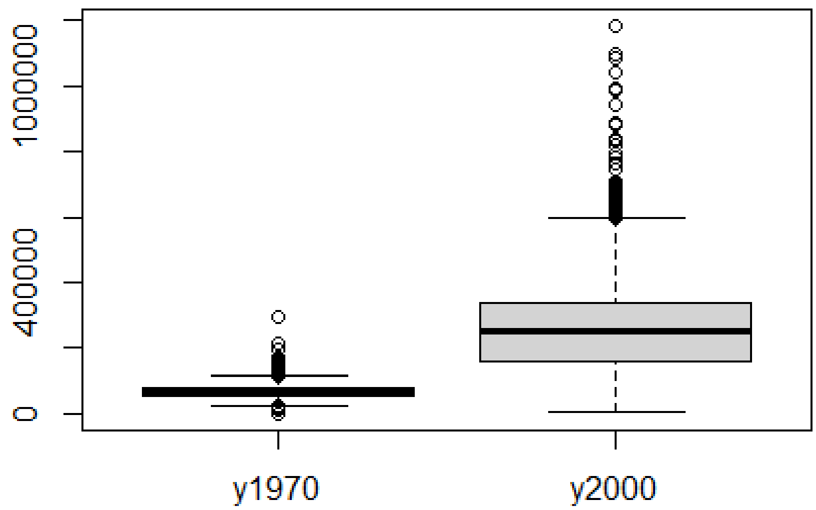

```r
#3.
#графиките за къщите от 1970 и 2000г.
hist(homedata$y1970)
lines(density(homedata$y1970, na.rm = T))
```




```
hist(homedata$y2000)
lines(density(homedata$y2000, na.rm = T))
```



```r
#сравняваме цените на къщите през 1970 и 2000г. и тяхната корелация
boxplot(homedata)
```




```r
correlation <- cor(homedata$y1970, homedata$y2000)

#4.
#View(anscombe)

#boxplot(anscombe)
```

От упражнение 4

```r
dice = function(N = 100){
  samples <- sample(1:6, size = 100, replace = TRUE)

  result <- sum(samples == 6)

  result
}

#емпирична вероятност
dice() / 100

## [1] 0.15

birthdays = function(p = 0.5){
```

```r
  prob = 1
  for(i in 1:365){
    prob = prob * (366 - i) / 365

    if(prob <  1 - p) break
  }
      return(i)
}

birthdays()

## [1] 23

game_one = function(father, mother){

  wins = 0

  for(i in 1:1000){
      vs_mom <- sample(0:1, 2, replace = T, prob = c(1 - mother, mother))
      vs_dad <- sample(0:1, 1, replace = T, prob = c(1- father, father))

      if(vs_mom[1] == 1 & vs_dad == 1 | vs_mom[2] == 1 & vs_dad == 1){
        wins = wins + 1
      }

  }
  return(wins/1000)
}

game_one(0.3, 0.4)

## [1] 0.184

#4.

presents = function(n = 20){

  for(j in 1:10000){
      counter = 1

       x <- sample(1:n, n, replace = FALSE)

      for(i in 1:20){

      if(i == x[i]){
        counter = counter + 1
        break
        }
      }
      return(n - counter)
```

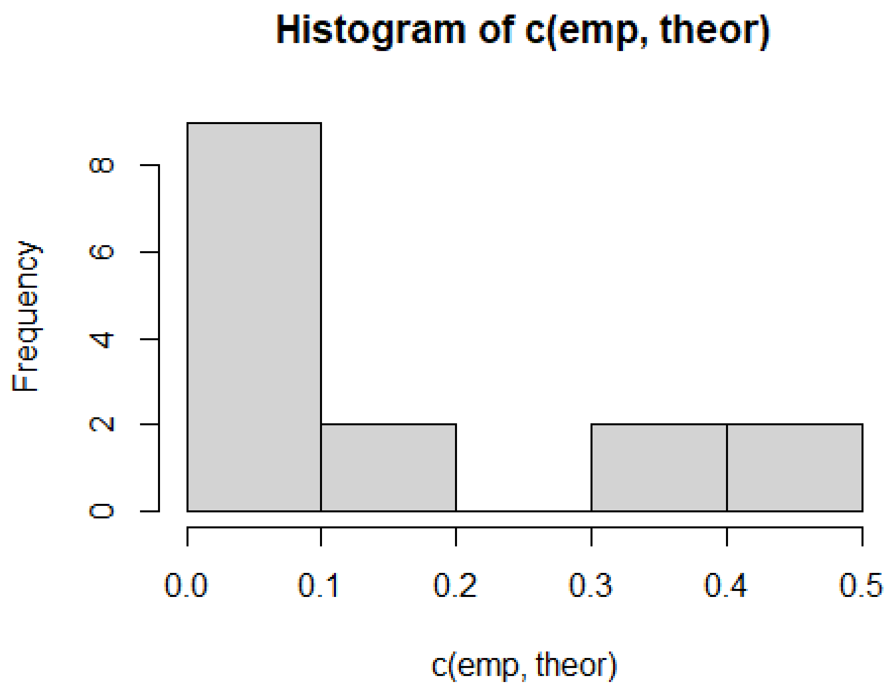
```
  }
}

presents() / 10000

## [1] 0.0019

#5.

coins = function(){
  for(i in 1:10000){

    x <- sample(0:1, 5, replace = T)

    if(x[1] == 1 & x[2] == 1 & x[3] == 0 & x[4] == 1 & x[5] == 0){
      break
    }
  }
  return(i)
}

coins()

## [1] 88
```

От упражнение 5

```
#вероятността да се паднат по-малко от 5 шестици при хвърляне на 30 зара
pbinom(q = 4, size = 30, prob = 1/6)

## [1] 0.4243389

#взимаме извадка от 10000 по 30 хвърляния на зар и го правим на таблица -
това е емп. вер.
thrown_dices <- rbinom(n = 10000, size = 30, prob = 1/6)

thrown_dices %>% table() %>% prop.table()

## .
##      0      1      2      3      4      5      6      7      8      9
10
## 0.0045 0.0280 0.0722 0.1370 0.1852 0.1828 0.1612 0.1090 0.0672 0.0330
0.0135
##     11     12     13     16
## 0.0044 0.0014 0.0005 0.0001

#това е теоритичната вероятност
dbinom(0:6, size = 30, prob = 1/6)

## [1] 0.00421272 0.02527632 0.07330133 0.13682915 0.18471936 0.19210813
0.16009011
```

```r
#с вероятност 0,75 да се паднат повече от колко шестици
#понеже нямаме ф-я за повече от ние ще променим твърдението с неговото обратно
#понеже qbinom показва колко най-много шестици ще се паднат за някаква вероятност
#тоест ние го променяме колко най-много ще се паднат за 0.25 вероятност
qbinom(p = 0.25, size = 30, prob = 1/6)

## [1] 4

qbinom(p = 0.75, size = 30, prob = 1/6, lower.tail = FALSE)

## [1] 4

#2.

#имаме пет неуспеха преди 3тия успех като вероятността за успех е 0.2
# x е квантил
dnbinom(x = 5, size = 3, prob = 0.2)

## [1] 0.05505024

#вероятност да са му нужни повече от 6 изстрела
#q е бр. неуспехи
pnbinom(q = 3, size = 3, prob = 0.2, lower.tail = FALSE)

## [1] 0.90112

#вероятност да му трябват между 5 и 8 изстрела вкл.
pnbinom(q = 5, size = 3, prob = 0.2) - pnbinom(1,3,0.2)

## [1] 0.1758822

#3.
balls = function(){

  total = 13
  white_balls = 7
  black_balls = 6

  num_white = 0

  for(i in 1:8){

    white_p = white_balls / total
    black_p = black_balls / total

    x <- sample(c(0,1), size = 1, prob = c(black_p, white_p))

    if(x == 0){
      black_balls = black_balls - 1
```

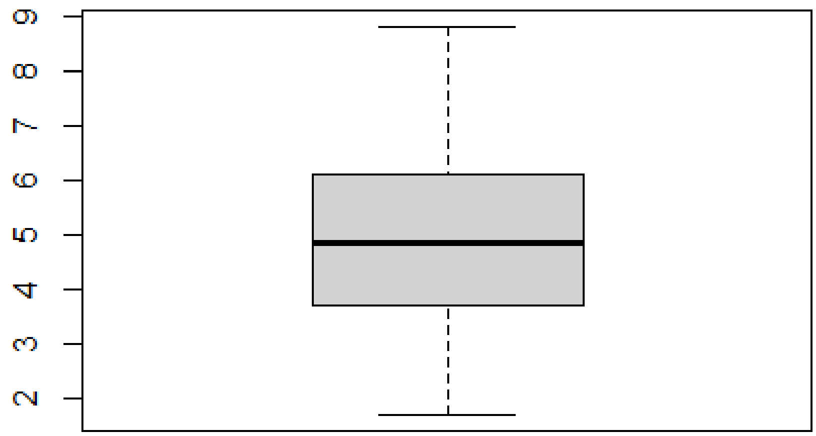
```r
    }
    else{
      white_balls = white_balls - 1
      num_white = num_white + 1
    }

    total = total - 1
  }
  num_white
}

replicated <- replicate(1000, balls())


mean(replicated)

## [1] 4.269

sd(replicated)

## [1] 0.9140429

min(replicated)

## [1] 2

max(replicated)

## [1] 7

sum(replicated == 3) / 1000

## [1] 0.175

#емпирична вероятност
emp <- replicated %>% table() %>% prop.table()

#теоритична вероятност
theor <- dhyper(0:8, 7, 6, 8)

hist(c(emp, theor) , beside = T)

## Warning in plot.window(xlim, ylim, "", ...): "beside" is not a graphical
## parameter

## Warning in title(main = main, sub = sub, xlab = xlab, ylab = ylab, ...):
## "beside" is not a graphical parameter

## Warning in axis(1, ...): "beside" is not a graphical parameter

## Warning in axis(2, ...): "beside" is not a graphical parameter
```




```
#4.
n = 100

dbinom(2, size = n, prob = 5/(2*n))

## [1] 0.2587841
```

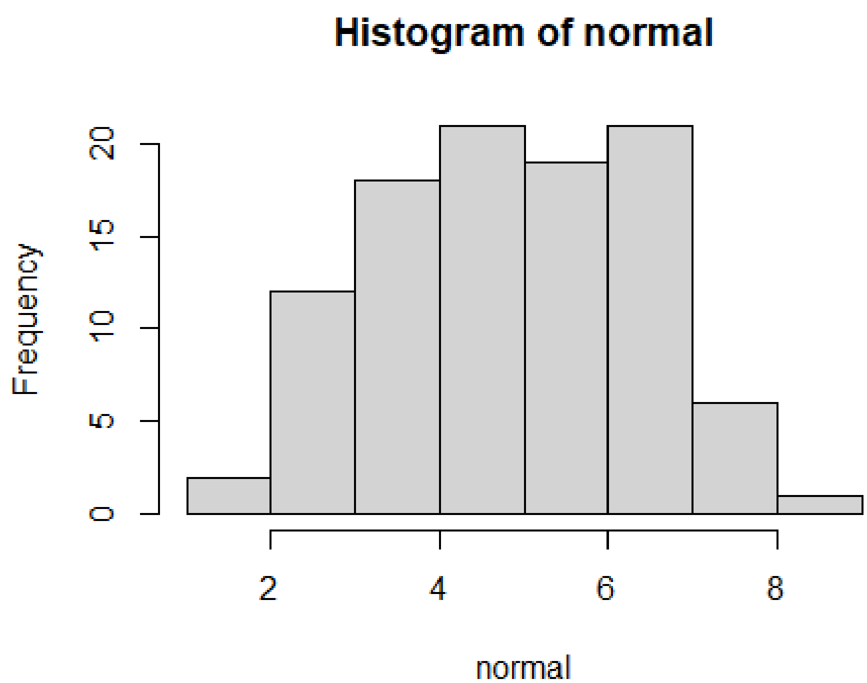
От упражнение 6

```
#нормално разпр с боксплот и хистограма
normal <- rnorm(100, 5, sqrt(2))

boxplot(normal)
```



2
3
4
5
6
7
8
9


```
hist(normal)
```

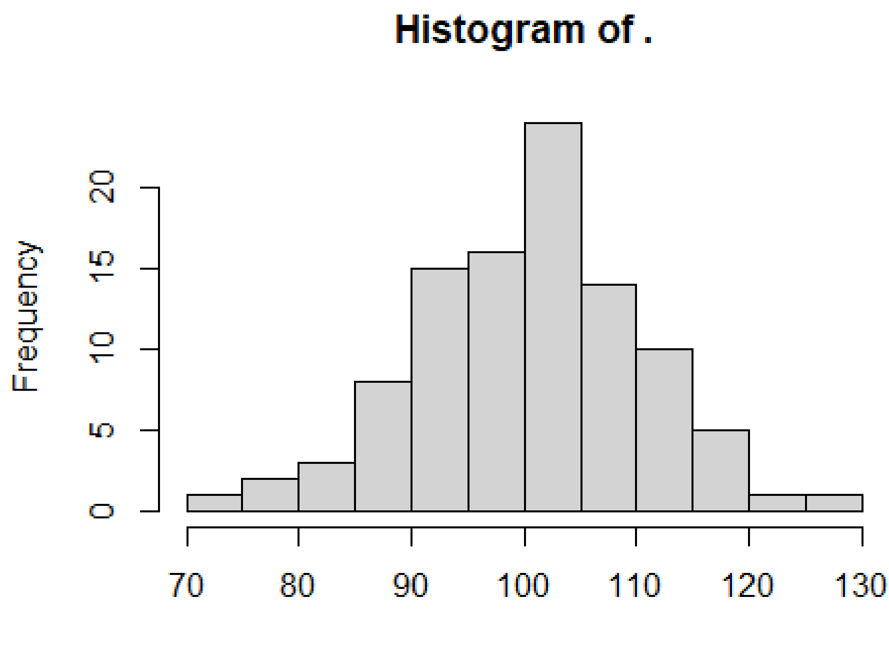


Histogram of normal
Frequency
0
5
10
15
20
2
4
6
8
normal

```r
#правим някаква извадка
  s <- seq(1, 8, 0.2)

#теоритична вероятност
dnorm(s, 5, sqrt(2))
```

```
##  [1] 0.005166746 0.007631185 0.011047931 0.015677760 0.021807265
0.029732572
##  [7] 0.039735427 0.052051997 0.066836087 0.084119899 0.103776874
0.125492144
## [13] 0.148746447 0.172818715 0.196810858 0.219695645 0.240385325
0.257815227
## [19] 0.271033697 0.279287902 0.282094792 0.279287902 0.271033697
0.257815227
## [25] 0.240385325 0.219695645 0.196810858 0.172818715 0.148746447
0.125492144
## [31] 0.103776874 0.084119899 0.066836087 0.052051997 0.039735427
0.029732572
```

```r
#2.
#n - брой сл. в
#k - брой стойности, които ни дава всяко разпределение
# fn - distribution function and ... is her arguments

xsim <- function(n, k, fn, ...){

  #вектор пълен с нули. В него се събират стойностите поиндексно на всяко
разпределение
  s <- rep(0, k)
  for (i in 1:n) {
    s <- s + fn(k, ... )
  }
  #връща се вектор със сумата поиндексно на всички разпределения
  s
}

xsim(100, 100, rexp) %>% hist()
```

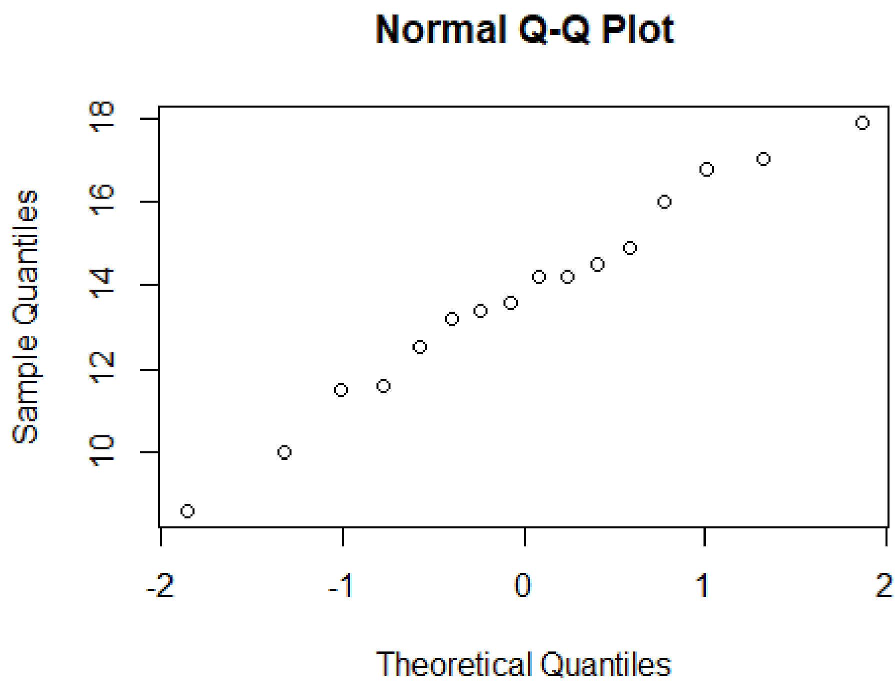



```
#това ни показва граничната теор - т.е при сумиране на независими еднакво
разпр сл.в
#че се получава нормално разпределение

#4.
#пъпеши по-малки от 20 т.е трето качество
small <- pnorm(20, 25, 6)

#първата половина от по-големите
medium <- (1 - small) / 2

big <- medium

#колко да е голям за да бъде трето качество
qnorm(big + medium, 25, 6)

## [1] 30
```

От упражнение 7

```
#1. а)ако ни е известно станд отклонение
n <- 20
sd <- 2

x <- rnorm(n, 3, sd)

q <- qnorm(0.975, 3, 2)
```

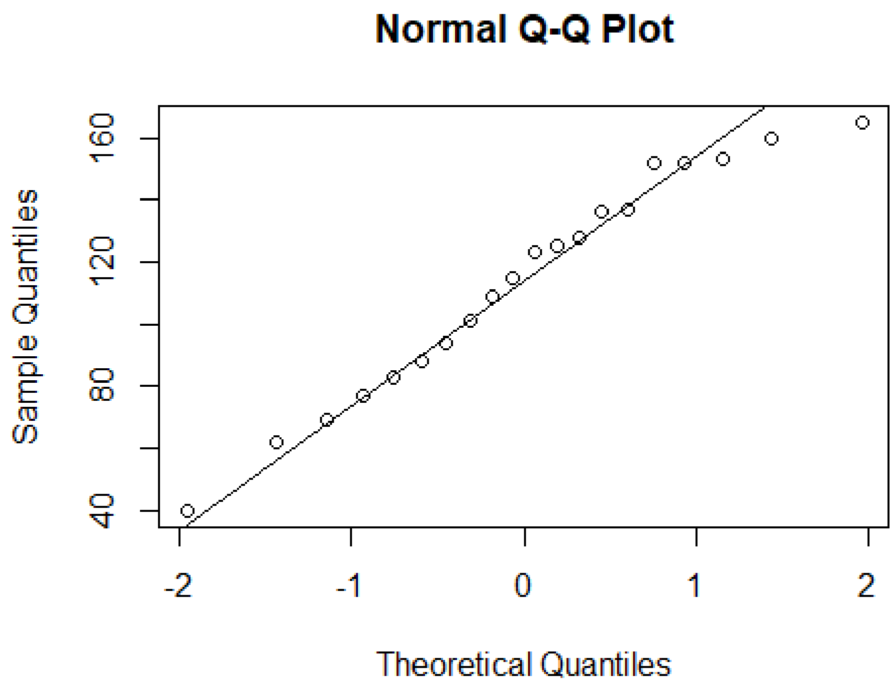
```r
left_interval <- mean(x) - q * (sd / sqrt(n))

right_interval <- mean(x) + q * (sd / sqrt(n))

#b)ако не ни е известно станд отклонение

n <- 20

theor_mean <- 3
theor_sd <- 2

x <- rnorm(n, theor_mean, theor_sd)

m <- mean(x)

sd <- sd(x)

q <- qt(p = 0.975, df = n - 1)

left_interval <- m - q * sd / sqrt(n)

right_interval <- m + q * sd / sqrt(n)

#можем и така да намерим доверителния интервал ако знаем че x е нормално
разпределено
t.test(x)

##
##  One Sample t-test
##
## data:  x
## t = 6.8338, df = 19, p-value = 1.6e-06
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  2.276277 4.286187
## sample estimates:
## mean of x
##  3.281232

#2.
data1 <- c(10.0, 13.6, 13.2, 11.6, 12.5, 14.2, 14.9, 14.5, 13.4, 8.6, 11.5,
16.0, 14.2, 16.8, 17.9, 17.0)

#проверяваме дали е нормално разпределена
qqnorm(data1)
```




```
#правим доверителните интервали
t.test(data1)

##
##  One Sample t-test
##
## data:  data1
## t = 21.65, df = 15, p-value = 9.976e-13
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  12.39066 15.09684
## sample estimates:
## mean of x
##  13.74375

t.test(data1, conf.level = 0.90)

##
##  One Sample t-test
##
## data:  data1
## t = 21.65, df = 15, p-value = 9.976e-13
## alternative hypothesis: true mean is not equal to 0
## 90 percent confidence interval:
##  12.63088 14.85662
## sample estimates:
```

```
## mean of x
##  13.74375
```

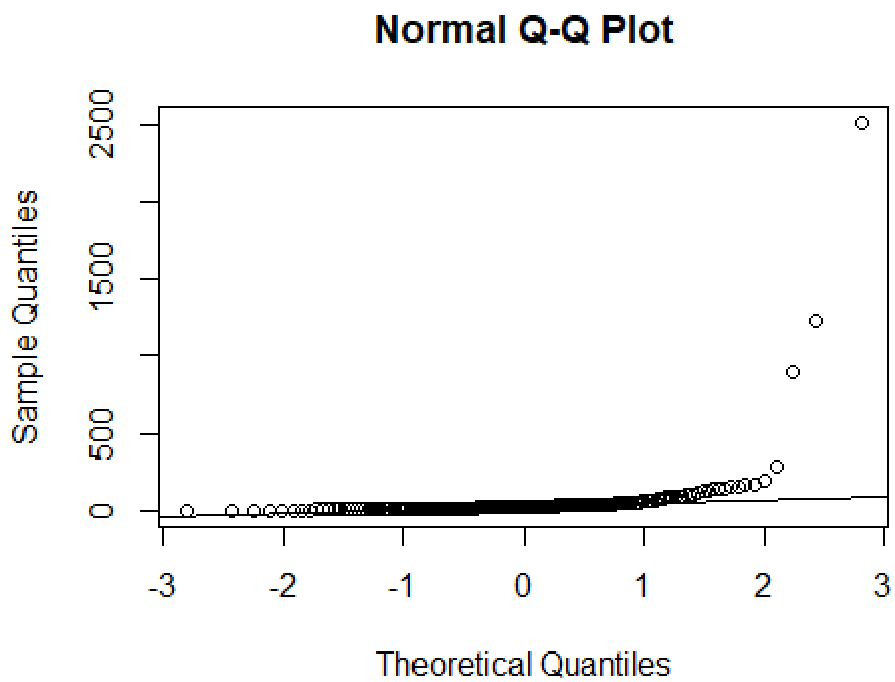
```
#3.a)
qqnorm(rat)
qqline(rat)
```




```
t.test(rat, conf.level = 0.96)
```

```
##
##  One Sample t-test
##
## data:  rat
## t = 14.176, df = 19, p-value = 1.48e-11
## alternative hypothesis: true mean is not equal to 0
## 96 percent confidence interval:
##   95.80624 131.09376
## sample estimates:
## mean of x
##    113.45
```

```
#b)
#данните не са нормално разпределени затова ползваме wilcox.test
qqnorm(exec.pay)
qqline(exec.pay)
```




```
wilcox.test(exec.pay, conf.int = T, conf.level = 0.96)

##
##  Wilcoxon signed rank test with continuity correction
##
## data:  exec.pay
## V = 19306, p-value < 2.2e-16
## alternative hypothesis: true location is not equal to 0
## 96 percent confidence interval:
##  25.99996 33.00003
## sample estimates:
## (pseudo)median
##       29.00002

#v)

#4.когато имаме пропорции ползваме това
prop.test(87, 150, conf.level = 0.92)

##
##  1-sample proportions test with continuity correction
##
## data:  87 out of 150, null probability 0.5
## X-squared = 3.5267, df = 1, p-value = 0.06039
## alternative hypothesis: true p is not equal to 0.5
## 92 percent confidence interval:
##  0.5051991 0.6514474
```

```
## sample estimates:
##    p
## 0.58
```

```
#6.
smoke_men <- nrow(survey[survey$Sex == 'Male' & survey$Smoke == 'Never', ])

all_men <- nrow(survey[survey$Sex == 'Male', ])

prop.test(smoke_men, all_men, conf.level = 0.90)
```

```
##
##  1-sample proportions test with continuity correction
##
## data:  smoke_men out of all_men, null probability 0.5
## X-squared = 32.303, df = 1, p-value = 1.319e-08
## alternative hypothesis: true p is not equal to 0.5
## 90 percent confidence interval:
##  0.6908187 0.8260629
## sample estimates:
##         p
## 0.7647059
```

От упражнение 8

```
#1.check for norm distr
# H0 - EX = 3
data2 <- rnorm(100, mean = 2, sd = 2)

#p-value< 0.05 отхвърляме хипотезата
t.test(data2, mu = 3, alternative = 'two.sided')
```

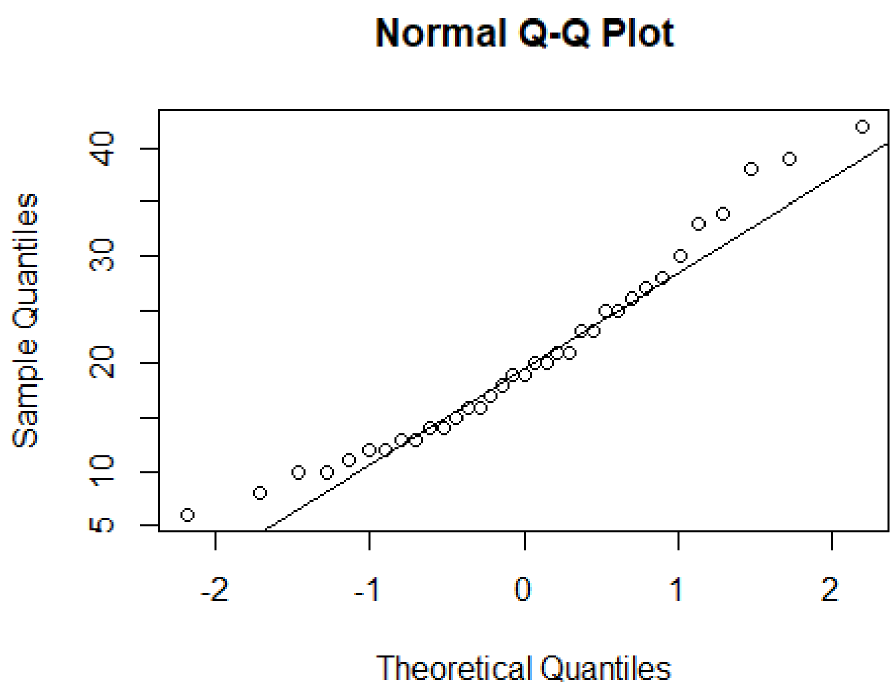
```
##
##  One Sample t-test
##
## data:  data2
## t = -4.4363, df = 99, p-value = 2.376e-05
## alternative hypothesis: true mean is not equal to 3
## 95 percent confidence interval:
##  1.646252 2.482987
## sample estimates:
## mean of x
##   2.06462
```

```
t.test(data2, mu = 5, alternative = 'two.sided')
```

```
##
##  One Sample t-test
##
## data:  data2
## t = -13.922, df = 99, p-value < 2.2e-16
```

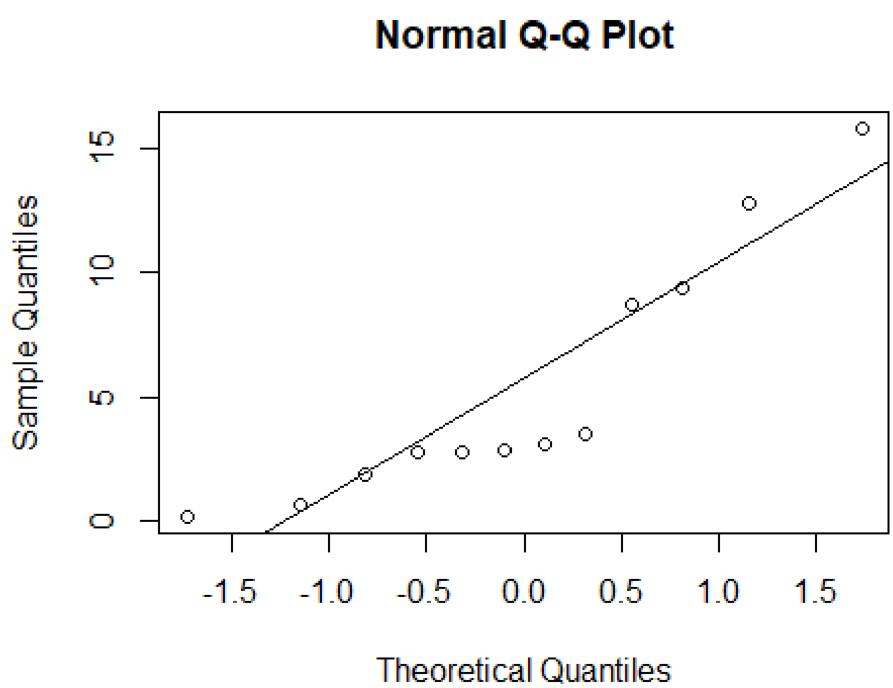
```
## alternative hypothesis: true mean is not equal to 5
## 95 percent confidence interval:
##  1.646252 2.482987
## sample estimates:
## mean of x
##   2.06462
```

```
#2.H0: дните за почивка да са 24 при п-жалуе > 0.2
data3 <- vacation

#seems normal distributed
qqnorm(data3)
qqline(data3)
```

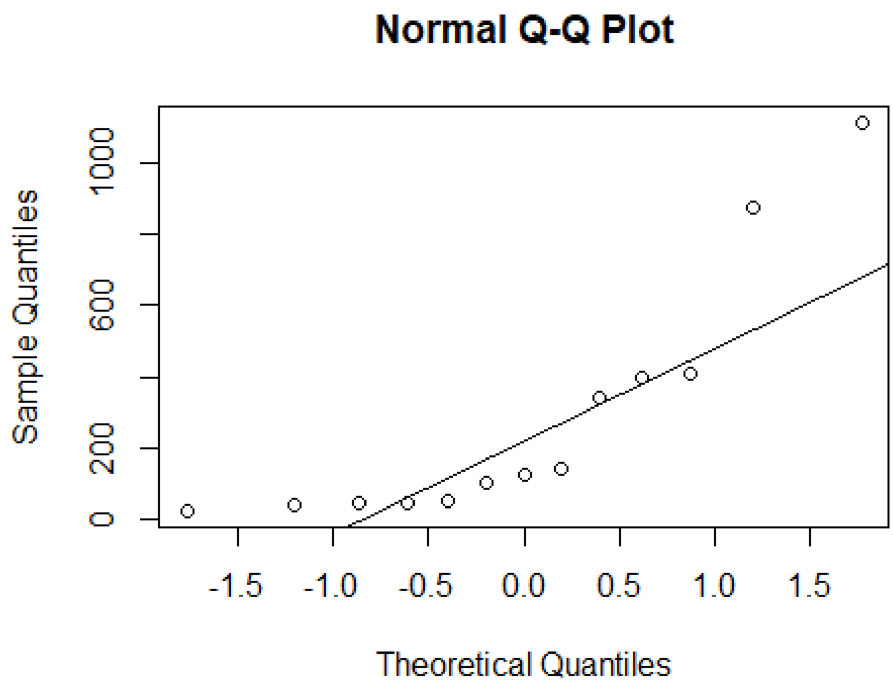



```
#p-value < 0,2 отхвърляме нулевата хипотеза
t.test(vacation, mu = 24, alternative = 'two.sided')

##
##  One Sample t-test
##
## data:  vacation
## t = -2.2584, df = 34, p-value = 0.03045
## alternative hypothesis: true mean is not equal to 24
## 95 percent confidence interval:
##  17.37768 23.65089
## sample estimates:
```

```
## mean of x
##  20.51429

#3.H0 - 50 процента са доволни
# H1 - < 50 процента са доволни

prop.test(42, 100, p = 0.5, alternative = 'less')

##
##  1-sample proportions test with continuity correction
##
## data:  42 out of 100, null probability 0.5
## X-squared = 2.25, df = 1, p-value = 0.06681
## alternative hypothesis: true p is less than 0.5
## 95 percent confidence interval:
##  0.0000000 0.5072341
## sample estimates:
##    p
## 0.42

#4.H0 - 5 minutes on the phone H1 - more than 5 mins
data4 <- c(12.8, 3.5, 2.9, 9.4, 8.7, 0.7, 0.2, 2.8, 1.9, 2.8, 3.1, 15.8)

qqnorm(data4)
qqline(data4)
```



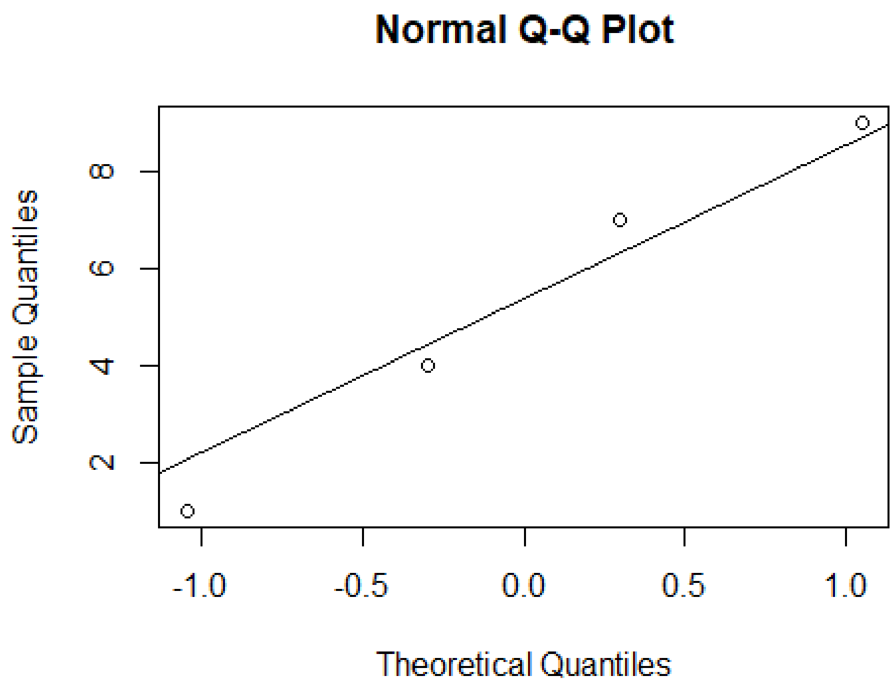
```r
#not normal distribution
shapiro.test(data4)

##
##  Shapiro-Wilk normality test
##
## data:  data4
## W = 0.83988, p-value = 0.0276

#we accept h0
wilcox.test(data4, mu = 5, alternative = 'greater')

## Warning in wilcox.test.default(data4, mu = 5, alternative = "greater"):
cannot
## compute exact p-value with ties

##
##  Wilcoxon signed rank test with continuity correction
##
## data:  data4
## V = 39, p-value = 0.5156
## alternative hypothesis: true location is greater than 5

#5.h0 - live more than 100 days h1- less than 100 days
data5 <- cancer$stomach

qqnorm(data5)
qqline(data5)
```



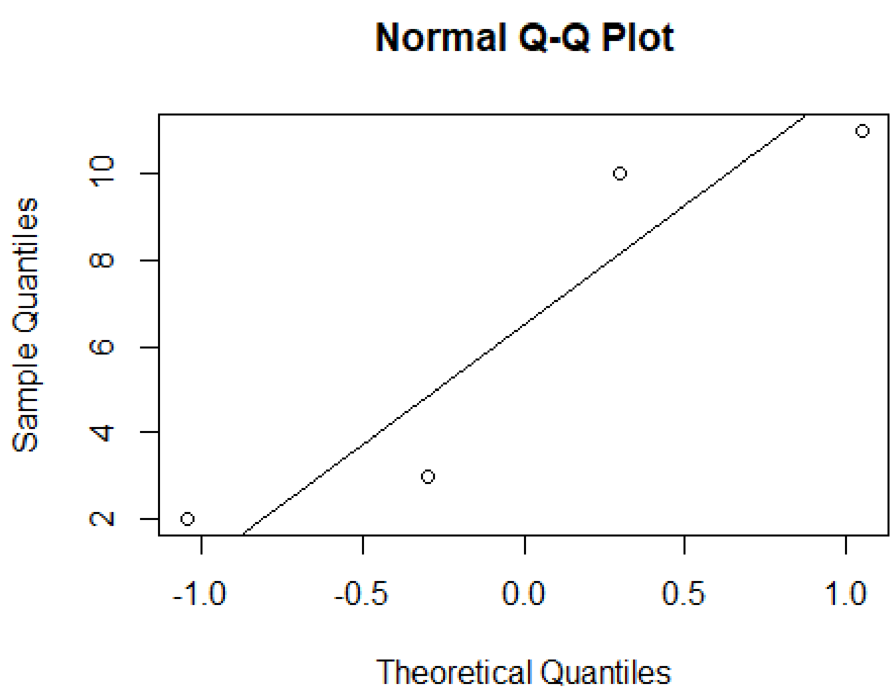

```
#not normal distr
shapiro.test(data5)

##
##  Shapiro-Wilk normality test
##
## data:  data5
## W = 0.75473, p-value = 0.002075

#we accept h0
wilcox.test(data5, mu = 100, alternative = 'less')

##
##  Wilcoxon signed rank exact test
##
## data:  data5
## V = 61, p-value = 0.8633
## alternative hypothesis: true location is less than 100
```

От упражение 9

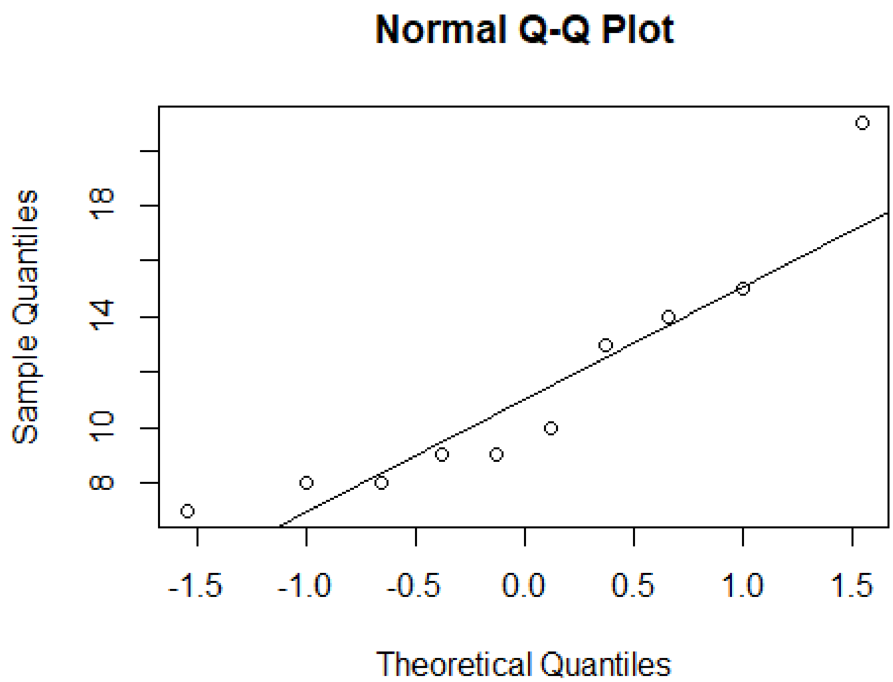
```
#1. H0 - equal h1 - not equal
x <- c(4, 1, 7, 9)
y <- c(10, 3, 2, 11)

#не са норм разпр
qqnorm(x)
qqline(x)
```



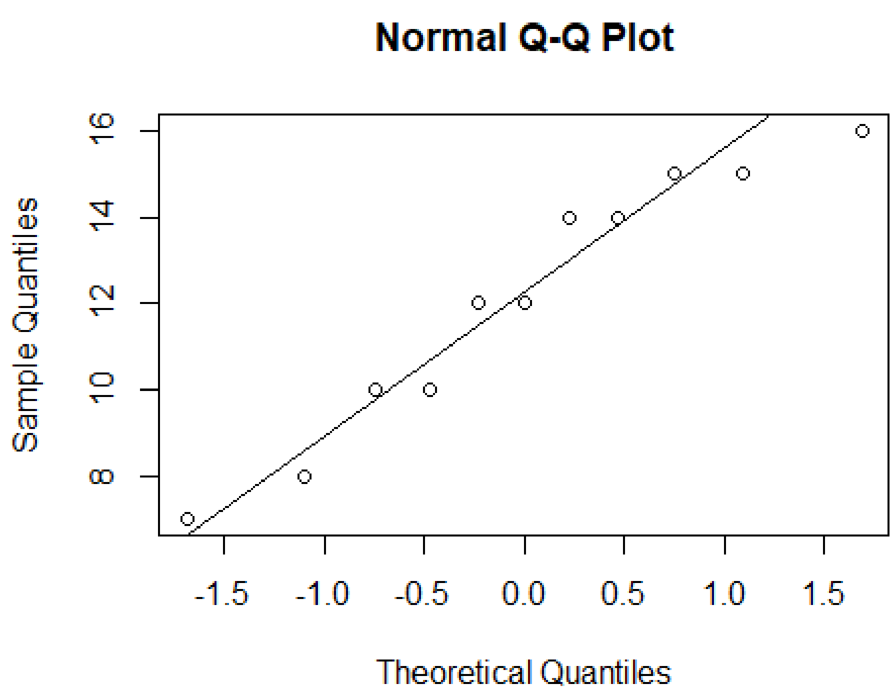

```
qqnorm(y)
qqline(y)
```



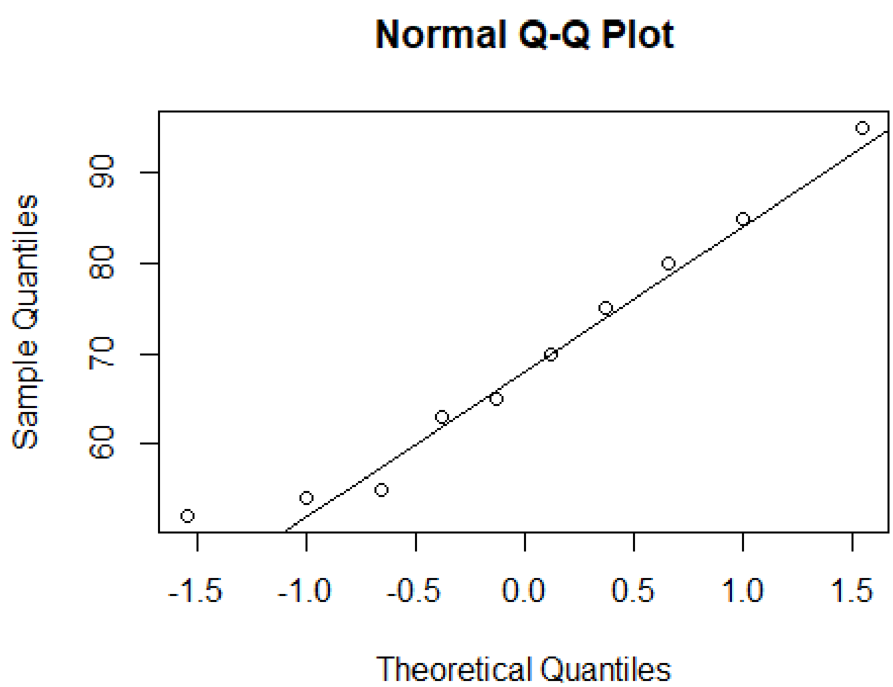
```r
#приемаме нулевата хипотеза
wilcox.test(x, y, alternative = 'two.sided')

##
##  Wilcoxon rank sum exact test
##
## data:  x and y
## W = 6, p-value = 0.6857
## alternative hypothesis: true location shift is not equal to 0

#2.H0 - equal H1 - greater

#we accept h1
prop.test(c(351, 71), c(605, 195), alternative = 'greater')

##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(351, 71) out of c(605, 195)
## X-squared = 26.761, df = 1, p-value = 1.151e-07
## alternative hypothesis: greater
## 95 percent confidence interval:
##  0.1470851 1.0000000
## sample estimates:
##    prop 1    prop 2
## 0.5801653 0.3641026

#3.H0 - less H1 - more

before <- c( 15, 10, 13, 7, 9, 8, 21, 9, 14, 8)
after <- c(15, 14, 12, 8, 14, 10, 7, 16, 10, 15, 12)

#normal distr
qqnorm(before)
qqline(before)
```



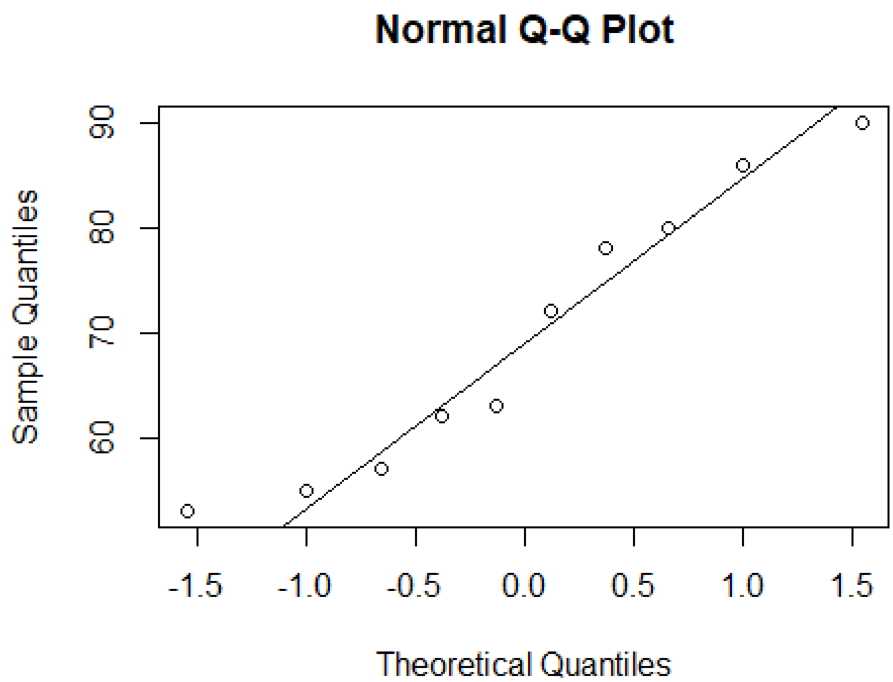

```
qqnorm(after)
qqline(after)
```



```
t.test(before, after, alternative = 'greater')

##
##  Welch Two Sample t-test
##
## data:  before and after
## t = -0.41894, df = 15.853, p-value = 0.6596
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  -3.571812       Inf
## sample estimates:
## mean of x mean of y
##  11.40000  12.09091

#4.X0 - че са равни X1 - че са различни

radar1 <- c(70, 85, 63, 54, 65, 80, 75, 95, 52, 55)

radar2 <- c(72, 86, 62, 55, 63, 80, 78, 90, 53, 57)

#they are normally distributed
qqnorm(radar1)
qqline(radar1)
```




```
qqnorm(radar2)
qqline(radar2)
```




```
t.test(radar1, radar2, alternative = 'two.sided', paired = T)

##
##  Paired t-test
##
## data:  radar1 and radar2
## t = -0.26941, df = 9, p-value = 0.7937
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -1.879354  1.479354
## sample estimates:
## mean of the differences
##                    -0.2
```

От упражнение 10

```
#1.H0 - data elements are equal H1- they are not

data6 <- c(125, 410, 310, 300, 318, 298, 148)

#we cant accept H0
chisq.test(data6)

##
##  Chi-squared test for given probabilities
##
```

```
## data:  data6
## X-squared = 223.84, df = 6, p-value < 2.2e-16

#2.H0 - all digits have the same prob H1 - they don't

#взимаме първите 200 цифри и виждаме колко често всяка една се среща
data7 <- pi2000[1:200] %>% table()

#правим хи-квадрат теста
#можем да приемем нулевата хипотеза
chisq.test(data7)

##
##  Chi-squared test for given probabilities
##
## data:  data7
## X-squared = 7.2, df = 9, p-value = 0.6163

#3.
#теоритичните вероятности за срещането на буквите в англ език
probs <- c(0.1270, 0.0956, 0.0817, 0.0751, 0.0697, 0.0675, 0.4834)

#срещането на буквите от нашия текст
letters <- c(102, 108, 90, 95, 82, 40, 519)

#правим проверка дали са равни
chisq.test(letters, p = probs)

##
##  Chi-squared test for given probabilities
##
## data:  letters
## X-squared = 26.396, df = 6, p-value = 0.0001878

#p-value е много малко затова отхвърляме хипотезата

#4.искаме да видим дали колан / без колан са независими сл.в Това става като
подадед
#на ф-ята матрица и тя прави проверката, т.е нулевата хипотеза е, че данните
са независими
# иначе са зависими

belt <- c(12813, 647, 359, 42)

nobelt <- c(65963, 4000, 2642, 303)

data8 <- matrix(belt, nrow = 1, ncol = 4)

data9 <- rbind(data8, nobelt)
```

```r
#p-value е много малко следователно отхвърляме нулевата хипотеза, т.е са зависими
#колан влияе на нараняването при катастрофа
chisq.test(data9)
```

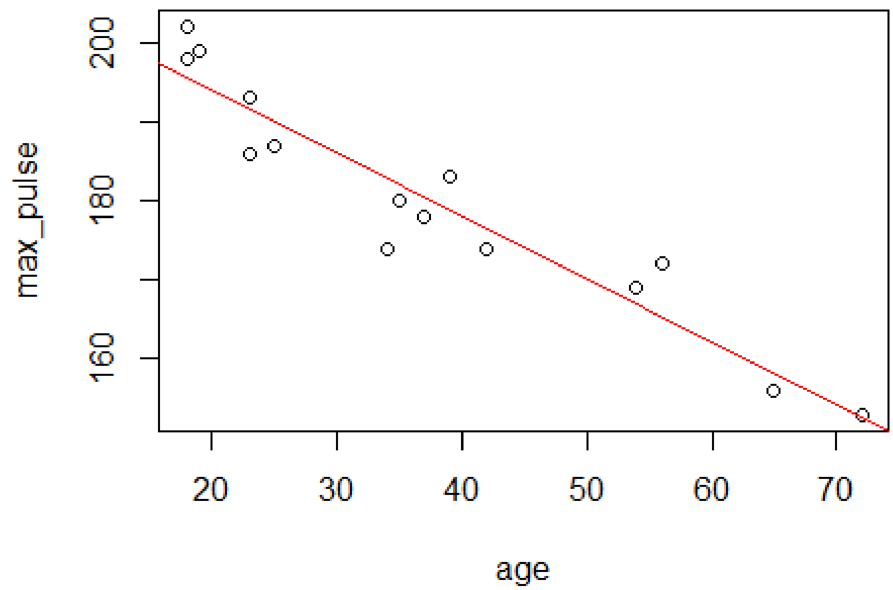
```
##
##  Pearson's Chi-squared test
##
## data:  data9
## X-squared = 59.224, df = 3, p-value = 8.61e-13
```

```r
#5.

mon <- c(44, 14, 15, 3)
tues <- c(74, 25, 20, 5)
wed <- c(79, 27, 20, 5)
thurs <- c(72, 24, 23, 0)
fri <- c(31, 10, 9, 0)

final <- matrix(c(mon, tues, wed, thurs, fri), nrow = 5)

#отхвърляме нулевата хипотеза че са независими , т.е има връзка между деня и качеството на стоката
chisq.test(final)
```

```
##
##  Pearson's Chi-squared test
##
## data:  final
## X-squared = 350.71, df = 12, p-value < 2.2e-16
```

От упражнение 11

```r
#1.Създаваме дата фрейм за данните
patients_df <- data.frame(
  age = c(18, 23, 25, 35, 65, 54, 34, 56, 72, 19, 23, 42, 18, 39, 37),
  max_pulse = c(202, 186, 187, 180, 156, 169, 174, 172, 153, 199, 193, 174, 198, 183, 178)
)

#това е за модел на линейната регресия
model1 <- lm(patients_df$max_pulse ~ patients_df$age, data = patients_df)


plot(patients_df)
abline(model1, col = "red")
```




```
summ_lm <- summary(model1)

n <- nrow(patients_df)

# Тестване на хипотезата, че бета1 = -1
# H0 :- "бета_1 = -1"

# Стандартно отклонение(грешка) на оценката за бета1
std_b1 <- summ_lm$coefficients[2, 2]

# оценката за бета1
est_b1 <- summ_lm$coefficients[2, 1]


# Параметър за бета1 под нулева хипотеза
b1_null_hyp <- -1

# Изграждане на т-статистика
t_statistic <- (est_b1 - b1_null_hyp) / std_b1

# Вероятност да наблюдваме тази т-статистика (или по-крайна) при положение,
че е вярна нулевата хипотеза
pval <- 2 * pt(t_statistic, n - 2, lower.tail = FALSE)


# Прогнозиране за възрасти 30, 40 и 50
```

```
predict.lm(
  model1,
  newdata = data.frame(age = c(30, 40, 50)),
  interval = "confidence",
  level = 0.9
)
```

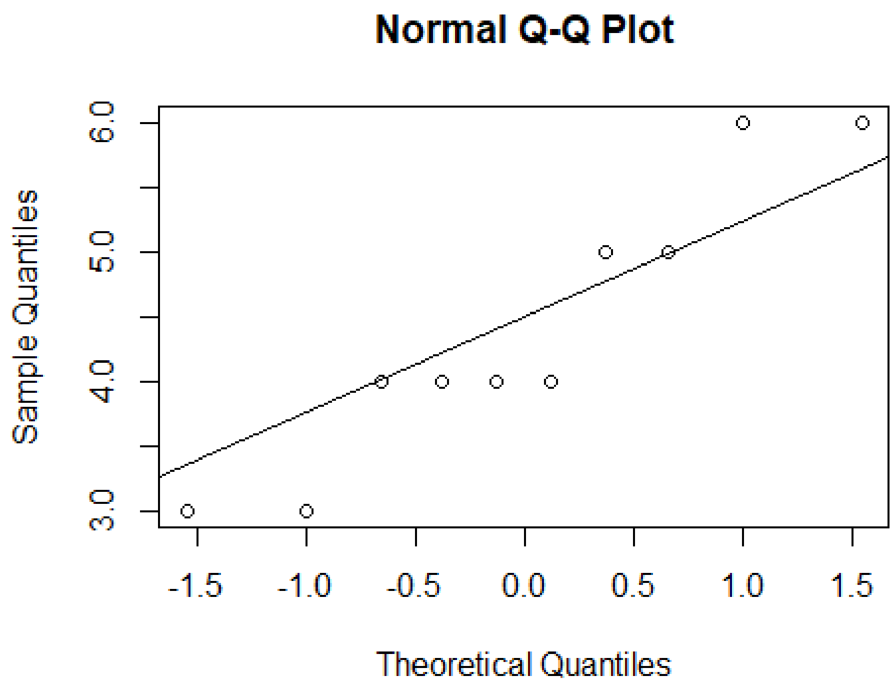
```
## Warning: 'newdata' had 3 rows but variables found have 15 rows
```

```
##         fit      lwr      upr
## 1  195.6894 192.5083 198.8705
## 2  191.7007 188.9557 194.4458
## 3  190.1053 187.5137 192.6969
## 4  182.1280 180.0149 184.2411
## 5  158.1962 154.1798 162.2127
## 6  166.9712 164.0309 169.9116
## 7  182.9258 180.7922 185.0593
## 8  165.3758 162.2564 168.4952
## 9  152.6121 147.8341 157.3902
## 10 194.8917 191.8028 197.9805
## 11 191.7007 188.9557 194.4458
## 12 176.5439 174.3723 178.7155
## 13 195.6894 192.5083 198.8705
## 14 178.9371 176.8337 181.0405
## 15 180.5326 178.4390 182.6262
```

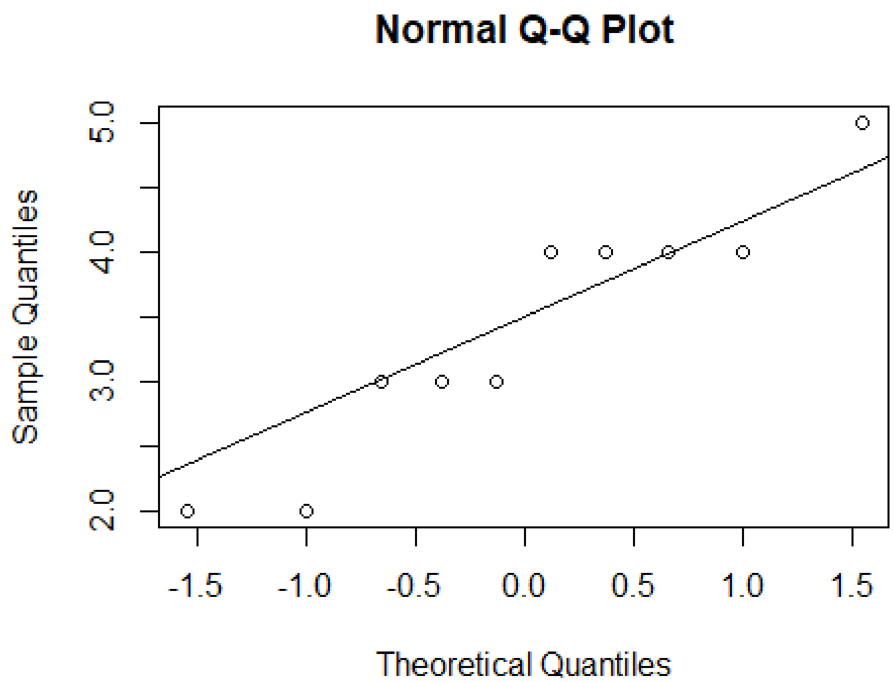
От упражнение 12

От упражнение 13

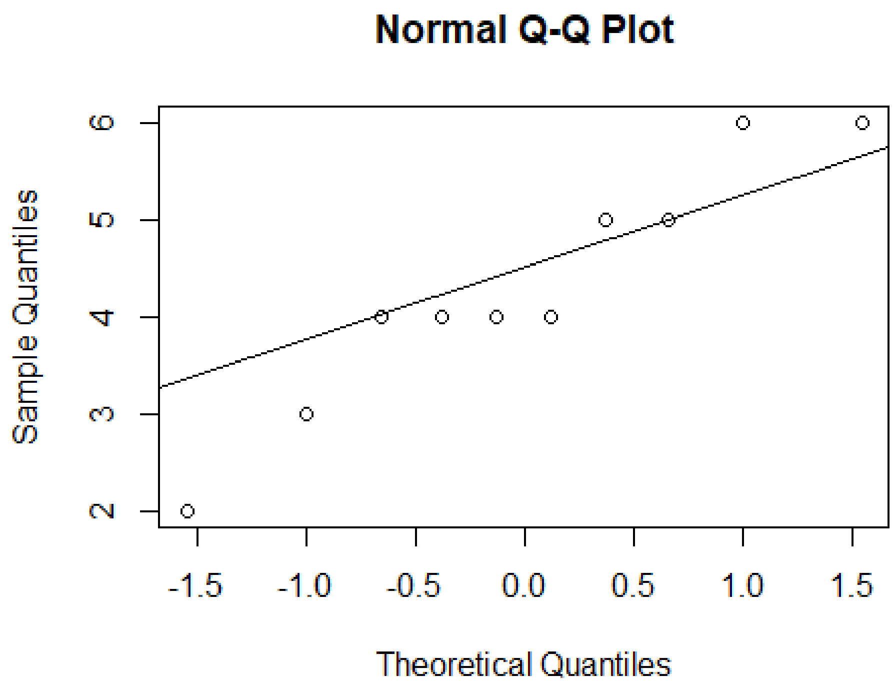
```
#нулевата хипотеза е че имат равни средни трите извадки от данни
#правим дата фрейм с данните от задачата
  exams_df <- data.frame(
examinor1 = c(5, 4, 4, 6, 4, 6, 3, 3, 4, 5),
examinor2 = c(3, 2, 4, 5, 3, 4, 3, 4, 2, 4),
examinor3 = c(4 ,6 ,4 ,2 ,4 ,5 ,5 ,3 ,6 ,4)
)

 stacked_exam_df <- stack(exams_df)

#гледаме дали са нормално разпределени данните

qqnorm(exams_df$examinor1)
qqline(exams_df$examinor1)
```




```
shapiro.test(exams_df$examinor1)

##
##  Shapiro-Wilk normality test
##
## data:  exams_df$examinor1
## W = 0.89165, p-value = 0.177

qqnorm(exams_df$examinor2)
qqline(exams_df$examinor2)
```



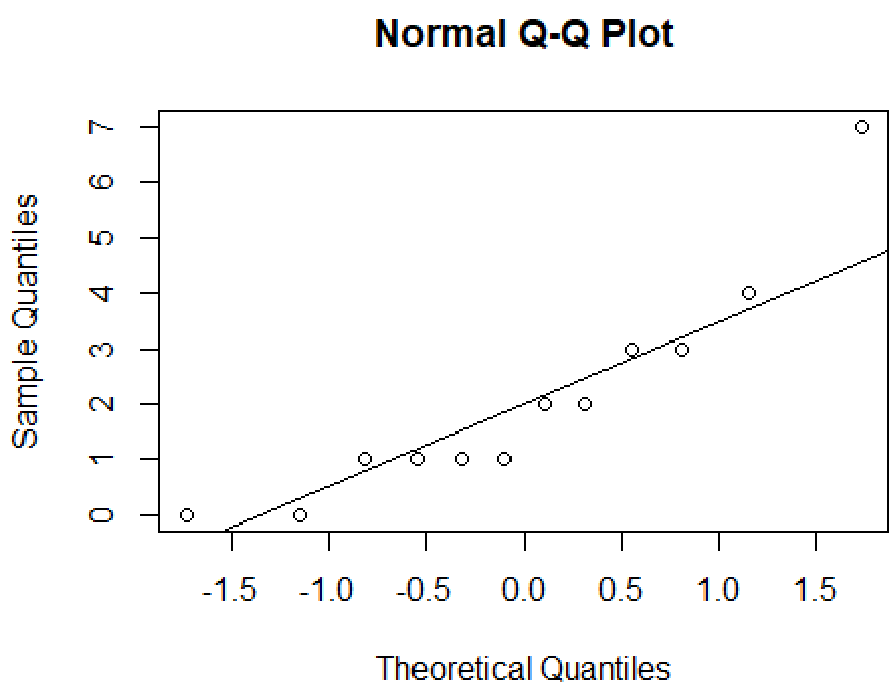

```
shapiro.test(exams_df$examinor2)

##
##  Shapiro-Wilk normality test
##
## data:  exams_df$examinor2
## W = 0.90444, p-value = 0.2449

qqnorm(exams_df$examinor3)
qqline(exams_df$examinor3)
```



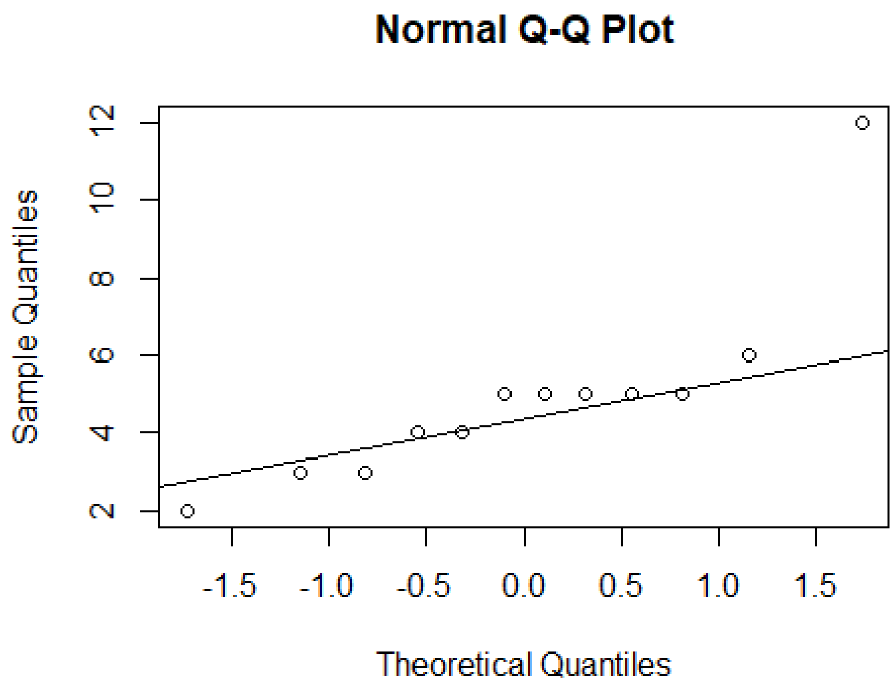

```
shapiro.test(exams_df$examinor3)

##
##  Shapiro-Wilk normality test
##
## data:  exams_df$examinor3
## W = 0.92883, p-value = 0.4365

#и трите са нормално  разпределени тоест можем да направим тест дали имат
еднакво средно ако са норм разпр

oneway.test(values ~ ind, data = stacked_exam_df)

##
##  One-way analysis of means (not assuming equal variances)
##
## data:  values and ind
## F = 2.7825, num df = 2.000, denom df = 17.811, p-value = 0.0888

#Не можем да отхвърлим хипотезата че имат равни средни
#друг начин да се провери същата хипотеза

anova(lm(values ~ ind, data = stacked_exam_df))

## Analysis of Variance Table
##
## Response: values
```

```
##           Df Sum Sq Mean Sq F value Pr(>F)
## ind        2  6.067  3.0333  2.4894 0.1018
## Residuals 27 32.900  1.2185
```

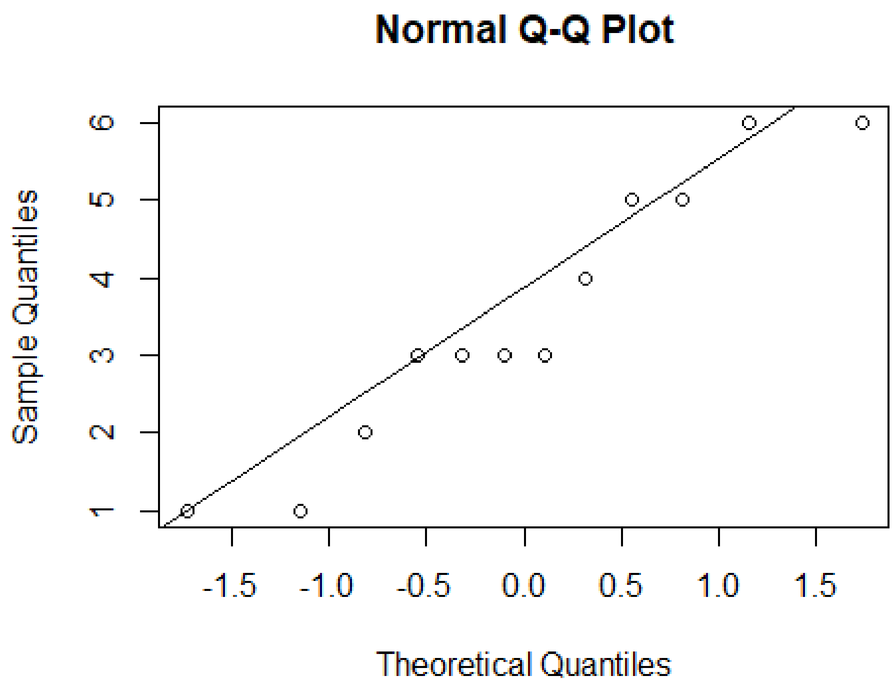
```
#2.

groupC <- InsectSprays$count[InsectSprays$spray == 'C']

groupD <- InsectSprays$count[InsectSprays$spray == 'D']

groupE <- InsectSprays$count[InsectSprays$spray == 'E']

#изглежда ми сравнително нормално разпределени
qqnorm(groupC)
qqline(groupC)
```




```
shapiro.test(groupC)

##
##  Shapiro-Wilk normality test
##
## data:  groupC
## W = 0.85907, p-value = 0.04759

qqnorm(groupD)
qqline(groupD)
```




```
shapiro.test(groupD)

##
##  Shapiro-Wilk normality test
##
## data:  groupD
## W = 0.75063, p-value = 0.002713

qqnorm(groupE)
qqline(groupE)
```




```
shapiro.test(groupE)

##
##  Shapiro-Wilk normality test
##
## data:  groupE
## W = 0.92128, p-value = 0.2967

#p-value-то е много малко следователно можем да твърдим че някои от
препаратите действат по-добре от други
oneway.test(count ~ spray, data = InsectSprays)

##
##  One-way analysis of means (not assuming equal variances)
##
## data:  count and spray
## F = 36.065, num df = 5.000, denom df = 30.043, p-value = 7.999e-12

#3.взимаме данните от файла
drug_df <- read.csv("./data.txt")

#тъй като имаме сдвоени данни, т.е даваме лекартво на един и същ пациент
ползваме aov
aov(response ~ drug + Error(patient), data = drug_df) %>% summary()

##
## Error: patient
##             Df Sum Sq Mean Sq F value Pr(>F)
```

```
## Residuals  1   72.9    72.9
##
## Error: Within
##            Df Sum Sq Mean Sq F value Pr(>F)
## drug        1     36   36.00   0.565  0.462
## Residuals 17   1082   63.66
```

```
#не можем да отхвърлим хопотезата, че имаме лекарствата действат еднакво

#4.
iris
```

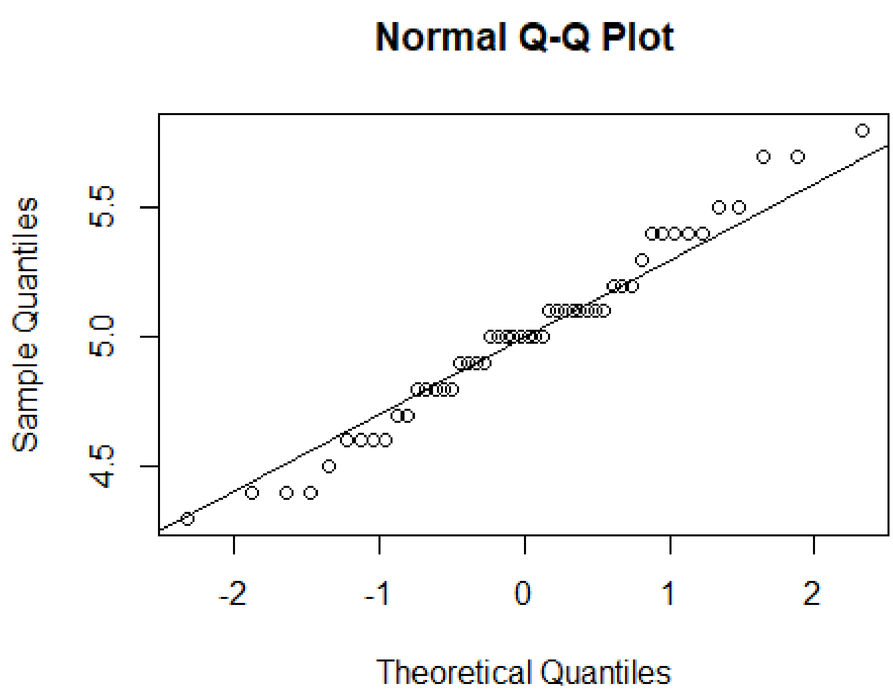
```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1            5.1         3.5          1.4         0.2     setosa
## 2            4.9         3.0          1.4         0.2     setosa
## 3            4.7         3.2          1.3         0.2     setosa
## 4            4.6         3.1          1.5         0.2     setosa
## 5            5.0         3.6          1.4         0.2     setosa
## 6            5.4         3.9          1.7         0.4     setosa
## 7            4.6         3.4          1.4         0.3     setosa
## 8            5.0         3.4          1.5         0.2     setosa
## 9            4.4         2.9          1.4         0.2     setosa
## 10           4.9         3.1          1.5         0.1     setosa
## 11           5.4         3.7          1.5         0.2     setosa
## 12           4.8         3.4          1.6         0.2     setosa
## 13           4.8         3.0          1.4         0.1     setosa
## 14           4.3         3.0          1.1         0.1     setosa
## 15           5.8         4.0          1.2         0.2     setosa
## 16           5.7         4.4          1.5         0.4     setosa
## 17           5.4         3.9          1.3         0.4     setosa
## 18           5.1         3.5          1.4         0.3     setosa
## 19           5.7         3.8          1.7         0.3     setosa
## 20           5.1         3.8          1.5         0.3     setosa
## 21           5.4         3.4          1.7         0.2     setosa
## 22           5.1         3.7          1.5         0.4     setosa
## 23           4.6         3.6          1.0         0.2     setosa
## 24           5.1         3.3          1.7         0.5     setosa
## 25           4.8         3.4          1.9         0.2     setosa
## 26           5.0         3.0          1.6         0.2     setosa
## 27           5.0         3.4          1.6         0.4     setosa
## 28           5.2         3.5          1.5         0.2     setosa
## 29           5.2         3.4          1.4         0.2     setosa
## 30           4.7         3.2          1.6         0.2     setosa
## 31           4.8         3.1          1.6         0.2     setosa
## 32           5.4         3.4          1.5         0.4     setosa
## 33           5.2         4.1          1.5         0.1     setosa
## 34           5.5         4.2          1.4         0.2     setosa
## 35           4.9         3.1          1.5         0.2     setosa
## 36           5.0         3.2          1.2         0.2     setosa
## 37           5.5         3.5          1.3         0.2     setosa
```

```
## 38          4.9         3.6          1.4         0.1     setosa
## 39          4.4         3.0          1.3         0.2     setosa
## 40          5.1         3.4          1.5         0.2     setosa
## 41          5.0         3.5          1.3         0.3     setosa
## 42          4.5         2.3          1.3         0.3     setosa
## 43          4.4         3.2          1.3         0.2     setosa
## 44          5.0         3.5          1.6         0.6     setosa
## 45          5.1         3.8          1.9         0.4     setosa
## 46          4.8         3.0          1.4         0.3     setosa
## 47          5.1         3.8          1.6         0.2     setosa
## 48          4.6         3.2          1.4         0.2     setosa
## 49          5.3         3.7          1.5         0.2     setosa
## 50          5.0         3.3          1.4         0.2     setosa
## 51          7.0         3.2          4.7         1.4 versicolor
## 52          6.4         3.2          4.5         1.5 versicolor
## 53          6.9         3.1          4.9         1.5 versicolor
## 54          5.5         2.3          4.0         1.3 versicolor
## 55          6.5         2.8          4.6         1.5 versicolor
## 56          5.7         2.8          4.5         1.3 versicolor
## 57          6.3         3.3          4.7         1.6 versicolor
## 58          4.9         2.4          3.3         1.0 versicolor
## 59          6.6         2.9          4.6         1.3 versicolor
## 60          5.2         2.7          3.9         1.4 versicolor
## 61          5.0         2.0          3.5         1.0 versicolor
## 62          5.9         3.0          4.2         1.5 versicolor
## 63          6.0         2.2          4.0         1.0 versicolor
## 64          6.1         2.9          4.7         1.4 versicolor
## 65          5.6         2.9          3.6         1.3 versicolor
## 66          6.7         3.1          4.4         1.4 versicolor
## 67          5.6         3.0          4.5         1.5 versicolor
## 68          5.8         2.7          4.1         1.0 versicolor
## 69          6.2         2.2          4.5         1.5 versicolor
## 70          5.6         2.5          3.9         1.1 versicolor
## 71          5.9         3.2          4.8         1.8 versicolor
## 72          6.1         2.8          4.0         1.3 versicolor
## 73          6.3         2.5          4.9         1.5 versicolor
## 74          6.1         2.8          4.7         1.2 versicolor
## 75          6.4         2.9          4.3         1.3 versicolor
## 76          6.6         3.0          4.4         1.4 versicolor
## 77          6.8         2.8          4.8         1.4 versicolor
## 78          6.7         3.0          5.0         1.7 versicolor
## 79          6.0         2.9          4.5         1.5 versicolor
## 80          5.7         2.6          3.5         1.0 versicolor
## 81          5.5         2.4          3.8         1.1 versicolor
## 82          5.5         2.4          3.7         1.0 versicolor
## 83          5.8         2.7          3.9         1.2 versicolor
## 84          6.0         2.7          5.1         1.6 versicolor
## 85          5.4         3.0          4.5         1.5 versicolor
## 86          6.0         3.4          4.5         1.6 versicolor
## 87          6.7         3.1          4.7         1.5 versicolor
```

```
## 88           6.3         2.3          4.4         1.3 versicolor
## 89           5.6         3.0          4.1         1.3 versicolor
## 90           5.5         2.5          4.0         1.3 versicolor
## 91           5.5         2.6          4.4         1.2 versicolor
## 92           6.1         3.0          4.6         1.4 versicolor
## 93           5.8         2.6          4.0         1.2 versicolor
## 94           5.0         2.3          3.3         1.0 versicolor
## 95           5.6         2.7          4.2         1.3 versicolor
## 96           5.7         3.0          4.2         1.2 versicolor
## 97           5.7         2.9          4.2         1.3 versicolor
## 98           6.2         2.9          4.3         1.3 versicolor
## 99           5.1         2.5          3.0         1.1 versicolor
## 100          5.7         2.8          4.1         1.3 versicolor
## 101          6.3         3.3          6.0         2.5  virginica
## 102          5.8         2.7          5.1         1.9  virginica
## 103          7.1         3.0          5.9         2.1  virginica
## 104          6.3         2.9          5.6         1.8  virginica
## 105          6.5         3.0          5.8         2.2  virginica
## 106          7.6         3.0          6.6         2.1  virginica
## 107          4.9         2.5          4.5         1.7  virginica
## 108          7.3         2.9          6.3         1.8  virginica
## 109          6.7         2.5          5.8         1.8  virginica
## 110          7.2         3.6          6.1         2.5  virginica
## 111          6.5         3.2          5.1         2.0  virginica
## 112          6.4         2.7          5.3         1.9  virginica
## 113          6.8         3.0          5.5         2.1  virginica
## 114          5.7         2.5          5.0         2.0  virginica
## 115          5.8         2.8          5.1         2.4  virginica
## 116          6.4         3.2          5.3         2.3  virginica
## 117          6.5         3.0          5.5         1.8  virginica
## 118          7.7         3.8          6.7         2.2  virginica
## 119          7.7         2.6          6.9         2.3  virginica
## 120          6.0         2.2          5.0         1.5  virginica
## 121          6.9         3.2          5.7         2.3  virginica
## 122          5.6         2.8          4.9         2.0  virginica
## 123          7.7         2.8          6.7         2.0  virginica
## 124          6.3         2.7          4.9         1.8  virginica
## 125          6.7         3.3          5.7         2.1  virginica
## 126          7.2         3.2          6.0         1.8  virginica
## 127          6.2         2.8          4.8         1.8  virginica
## 128          6.1         3.0          4.9         1.8  virginica
## 129          6.4         2.8          5.6         2.1  virginica
## 130          7.2         3.0          5.8         1.6  virginica
## 131          7.4         2.8          6.1         1.9  virginica
## 132          7.9         3.8          6.4         2.0  virginica
## 133          6.4         2.8          5.6         2.2  virginica
## 134          6.3         2.8          5.1         1.5  virginica
## 135          6.1         2.6          5.6         1.4  virginica
## 136          7.7         3.0          6.1         2.3  virginica
## 137          6.3         3.4          5.6         2.4  virginica
```

```
## 138          6.4         3.1          5.5         1.8  virginica
## 139          6.0         3.0          4.8         1.8  virginica
## 140          6.9         3.1          5.4         2.1  virginica
## 141          6.7         3.1          5.6         2.4  virginica
## 142          6.9         3.1          5.1         2.3  virginica
## 143          5.8         2.7          5.1         1.9  virginica
## 144          6.8         3.2          5.9         2.3  virginica
## 145          6.7         3.3          5.7         2.5  virginica
## 146          6.7         3.0          5.2         2.3  virginica
## 147          6.3         2.5          5.0         1.9  virginica
## 148          6.5         3.0          5.2         2.0  virginica
## 149          6.2         3.4          5.4         2.3  virginica
## 150          5.9         3.0          5.1         1.8  virginica
```

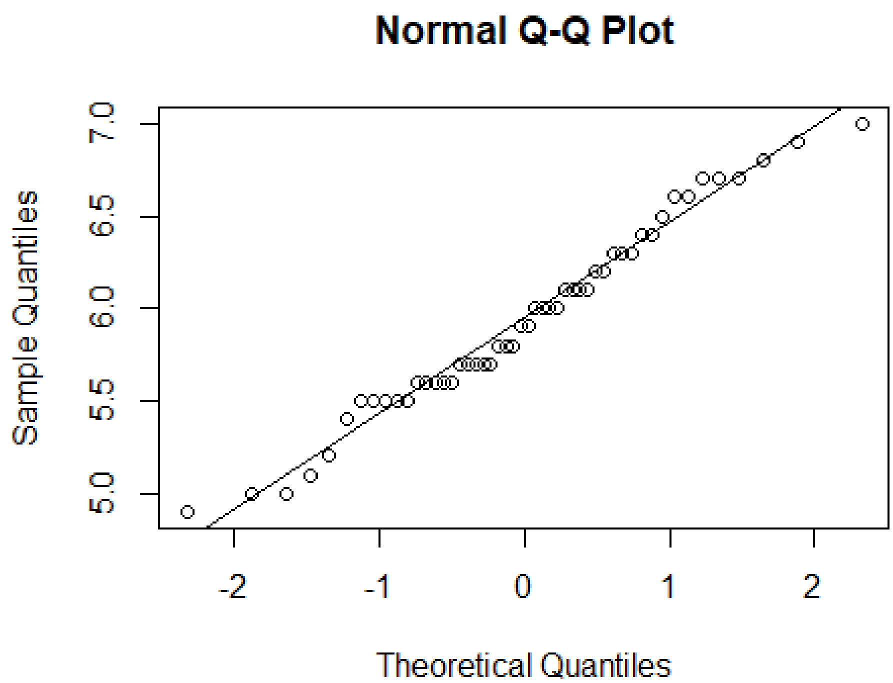
```
sort1 <- iris$Sepal.Length[iris$Species == 'setosa']

sort2 <- iris$Sepal.Length[iris$Species == 'versicolor']

sort3 <- iris$Sepal.Length[iris$Species == 'virginica']

#checking whether the data is normal distributed
qqnorm(sort1)
qqline(sort1)
```




```
shapiro.test(sort1)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  sort1
## W = 0.9777, p-value = 0.4595
```

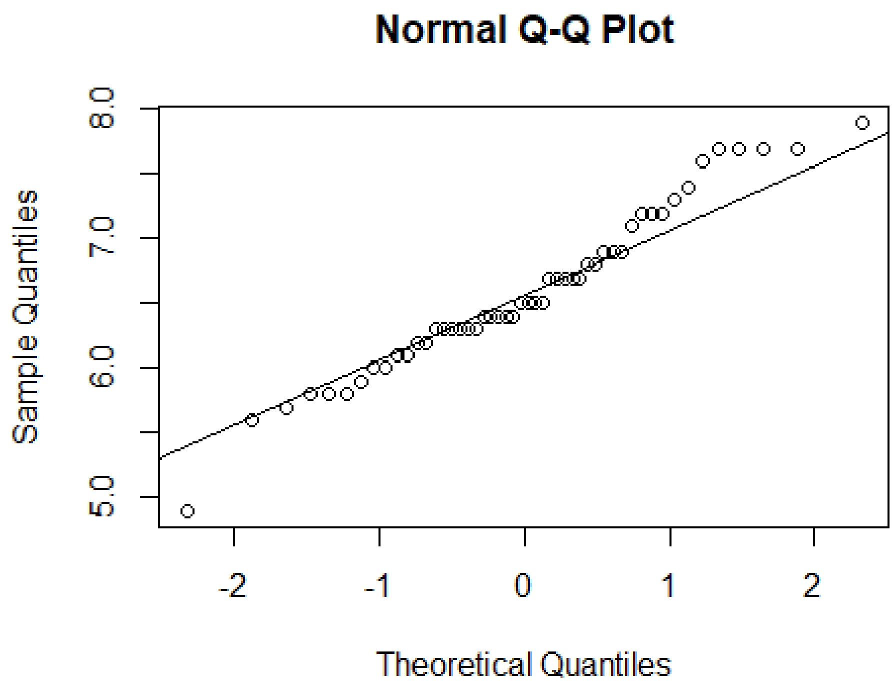
```
qqnorm(sort2)
qqline(sort2)
```




```
shapiro.test(sort2)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  sort2
## W = 0.97784, p-value = 0.4647
```

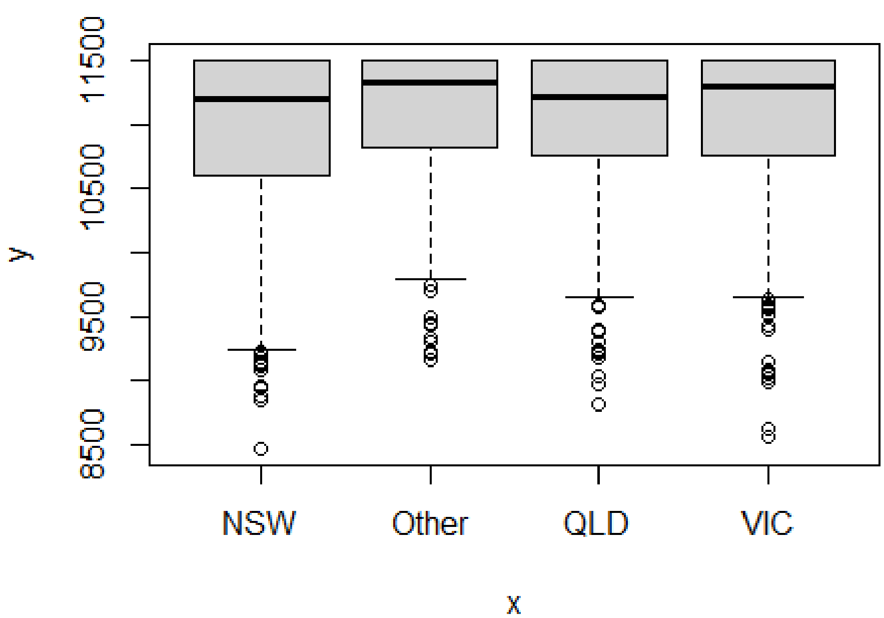
```
qqnorm(sort3)
qqline(sort3)
```



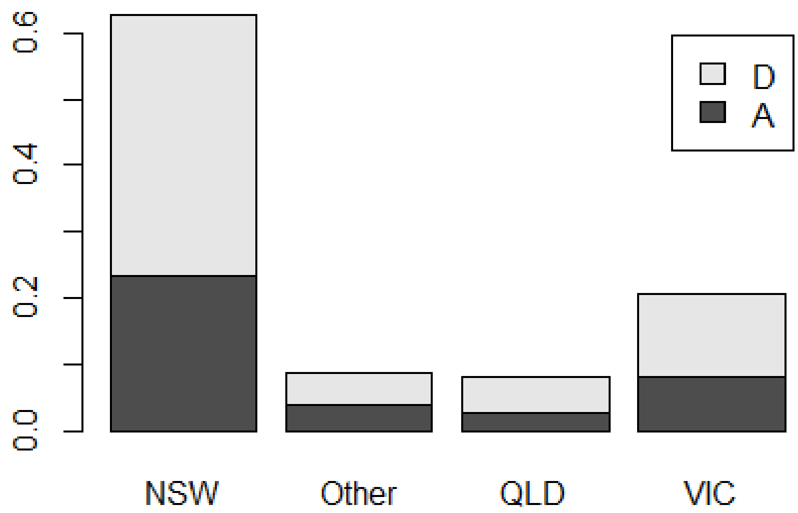

```
shapiro.test(sort3)

##
##  Shapiro-Wilk normality test
##
## data:  sort3
## W = 0.97118, p-value = 0.2583

#all three are normally dirstributed

# формула на модела (имаме два отклика)
(cbind(iris$Sepal.Length, iris$Sepal.Width) ~ Species) %>%
  # изпълнение на anova с много y променливи
  manova(data = iris) %>%
  # Обобщение
  summary()

##             Df  Pillai approx F num Df den Df    Pr(>F)
## Species      2 0.94531   65.878      4    294 < 2.2e-16 ***
## Residuals 147
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

  # Извод: Различните сортове играят роля за размера на чашелистчетата
  # някоя от групите има значително различно средно от останалите
```

От изпит 2017

```r
#1.
#number of people younger than 20 yrs
length(Aids2$age[Aids2$age < 20])

## [1] 39

#sex of the patients with earliest diagnosis
Aids2$sex[head(order(Aids2$diag), 5)]

## [1] M M M M M
## Levels: F M

#men who got aids from blood
men_blood <- sum(Aids2$sex[Aids2$T.categ == 'blood'] == 'M')

all_men <- sum(Aids2$sex == 'M')

men_blood / all_men

## [1] 0.02069717

#графика за щатът на пациента и смъртността
plot(Aids2$state, Aids2$death, na.rm = T)
```

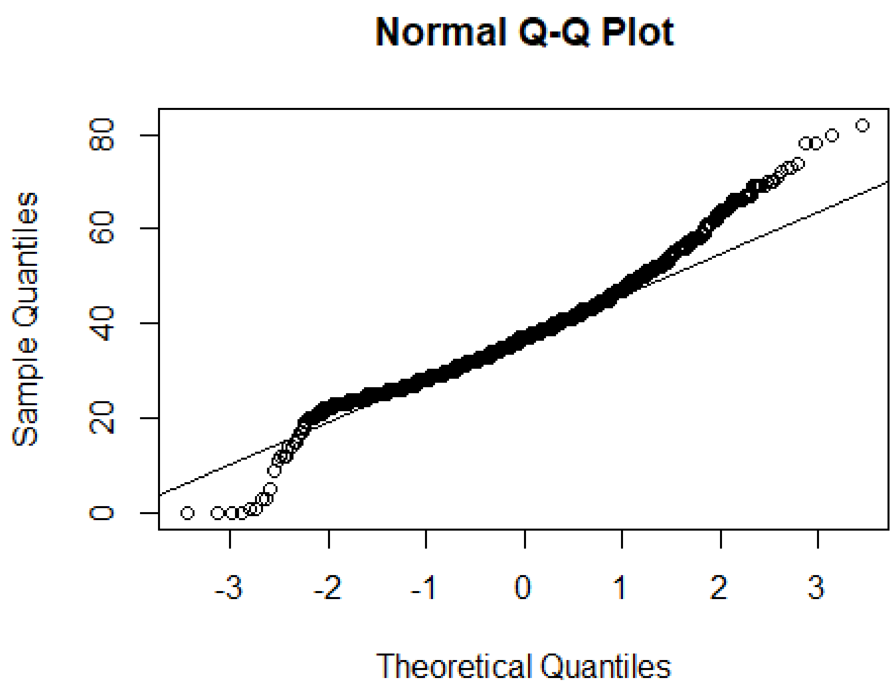



```r
table(Aids2$status, Aids2$state) %>% prop.table() %>% barplot(legend.text =
T)
```



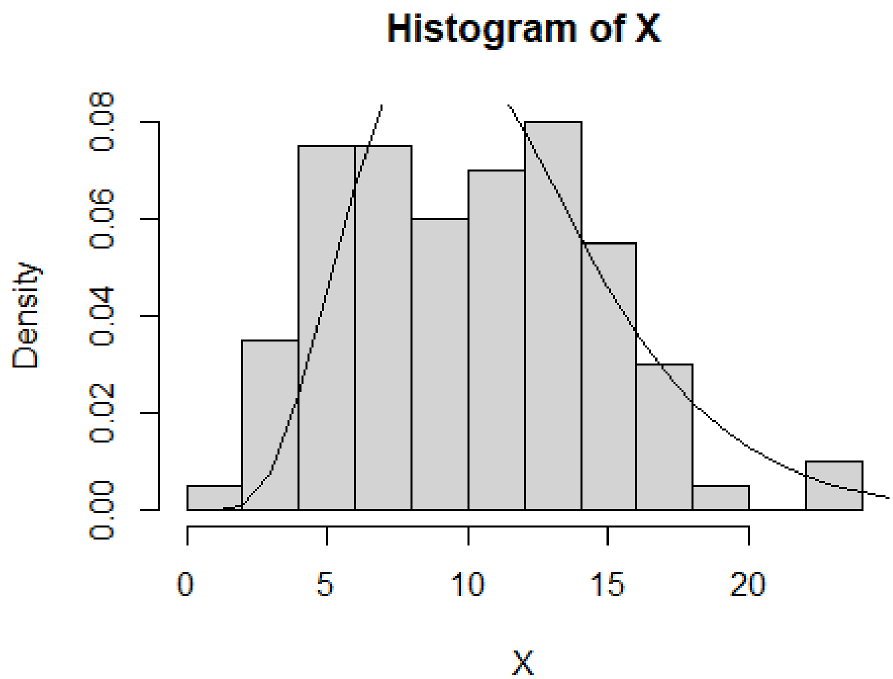

```r
?Aids2

## starting httpd help server ... done

#2.
#total women and women that died
women <- sum(Aids2$sex == 'F')
dead_women <- sum(Aids2$status[Aids2$sex == 'F'] == 'D')

men <- sum(Aids2$sex == 'M')
dead_men <- sum(Aids2$status[Aids2$sex == 'M'] == 'D')

#X0 - жените умират по-малко X1 - умират повече
prop.test(c(dead_women, dead_men), c(women, men), alternative = 'greater')

##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(dead_women, dead_men) out of c(women, men)
## X-squared = 0.13041, df = 1, p-value = 0.641
## alternative hypothesis: greater
## 95 percent confidence interval:
##  -0.1173963  1.0000000
## sample estimates:
##    prop 1    prop 2
## 0.5955056 0.6201888
```

```r
#можем да приемем нулевата хипотеза

number_dead <- Aids2$age[Aids2$status == 'D']

qqnorm(number_dead)
qqline(number_dead)
```




```r
shapiro.test(number_dead)

##
##  Shapiro-Wilk normality test
##
## data:  number_dead
## W = 0.96911, p-value < 2.2e-16

#not normally distributed

#X0 - средната възраст е 38 X1 - не е
#приемаме h1 хипотеза
wilcox.test(number_dead, mu = 38, alternative = 'two.sided')

##
##  Wilcoxon signed rank test with continuity correction
##
## data:  number_dead
## V = 649726, p-value = 0.00164
## alternative hypothesis: true location is not equal to 38
```

```r
#4.
X <- rchisq(100, df = 10)

hist(X, probability = T)

lines(dchisq(0:30, df = 10))
```

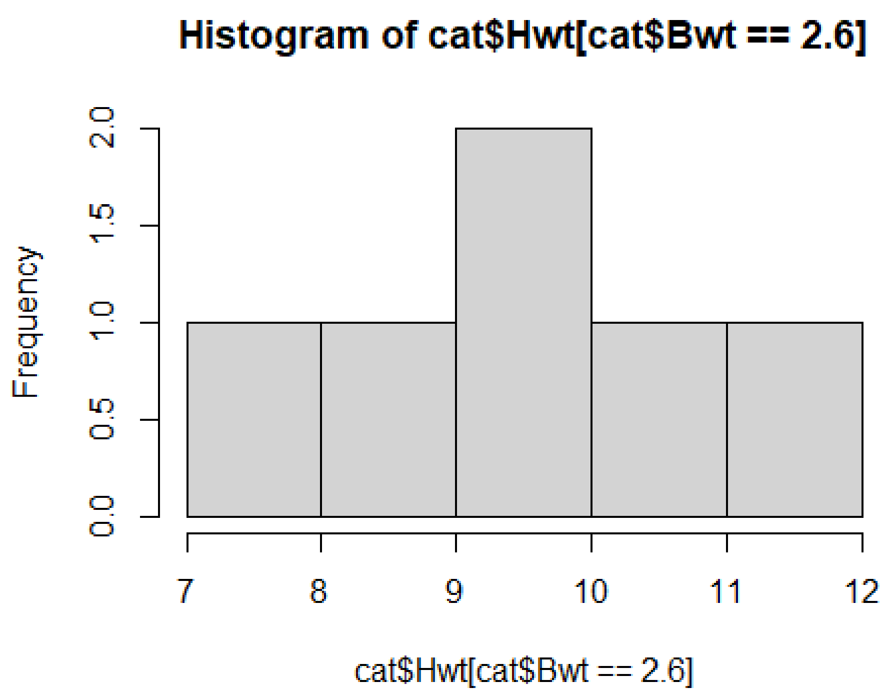



```r
#5.
cat <- cats[cats$Sex == 'M', ]

#create the model
s <- lm(Hwt ~ Bwt, data = cat) %>% summary()
#based on the model we get that the heart and body weight are not independant
#демек са зависими и сърцето се повлиява от теглото на котката

t <- (s$coefficients[2, 1] - 5) / s$coefficients[2, 2]
#t is negative => we calculate p-value like this:
#df is equal to: numOfObservations - numOfEvaluatedParameters - 1
#             so: 97 - 2 - 1 = 94
#Вярно ли е, че при котки по тежки с 1 кг сърцето е по тежко с 5 гр - H0
pval = 2 * pt(t, df = 94)
#тук имаме p-value < 0.05 което значи че отхвърляме нулевата хипотеза, т.е
горното не е вярно

# pval = 2 * pt(t, df = 94, lower.tail = F) if t > 0 only lower tail
```

```r
#we test if the distribution is normal so we can do t.test to get the conf.interval
shapiro.test(cat$Hwt[cat$Bwt == 2.6])
```

```
##
##  Shapiro-Wilk normality test
##
## data:  cat$Hwt[cat$Bwt == 2.6]
## W = 0.96653, p-value = 0.8683
```

```r
hist(cat$Hwt[cat$Bwt == 2.6])
```




```r
#it is norm dist so we use t.test else we use wilcox.test()
t.test(cat$Hwt[cat$Bwt == 2.6], conf.level = 0.95)
```

```
##
##  One Sample t-test
##
## data:  cat$Hwt[cat$Bwt == 2.6]
## t = 16.654, df = 5, p-value = 1.426e-05
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##   8.005474 10.927859
## sample estimates:
## mean of x
##  9.466667
```

От примерен тест 2017

```r
#1.
qnorm(p = 0.05)

## [1] -1.644854

#2.
nrow(state.x77)

## [1] 50

#подреждаме щатите по ниво на необразованост
dumb_states <- head(order(state.x77[,3], decreasing = T), 5)
#взимаме ги според индексите на първите 5 щата
state.x77[dumb_states, 3]

##      Louisiana    Mississippi South Carolina     New Mexico          Texas
##            2.8            2.4            2.3            2.2            2.2

#states with life expectancy over 70
old_states <- state.x77[1:50, 4] > 70
length(state.x77[old_states, 4])

## [1] 41

#щат с най-голяма гъстота на населението
pop <- state.x77[1:50,1]

land <- state.x77[1:50, 8]

density <- pop / land

density[head(order(density, decreasing = T), 1)]

## New Jersey
##  0.9750033

#общото население на петте най-големи щати
biggest_states <- head(order(state.x77[1:50, 8], decreasing = T), 5)
sum(state.x77[biggest_states, 1])

## [1] 35690

#3.ho - има по-малко подобрили се жени h1- има повече подобрили се мъже
women <- 200
men <- 100

not_accepted_women <- women * 38 / 100
not_accepted_men <- men * 50 / 100

#приемаме хипотезата че е по-ефективно при жените отколкото при мъжете
prop.test(c(not_accepted_women, not_accepted_men), c(women, men), alternative
= 'greater' )
```

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(not_accepted_women, not_accepted_men) out of c(women, men)
## X-squared = 3.4637, df = 1, p-value = 0.9686
## alternative hypothesis: greater
## 95 percent confidence interval:
##  -0.2272546  1.0000000
## sample estimates:
## prop 1 prop 2
##   0.38   0.50
```

```
#4.
 data <- data.frame(
anscombe$x3,
anscombe$x4)

l <- lm(data$anscombe.x3 ~ data$anscombe.x4, data = data)

plot(data$anscombe.x3, data$anscombe.x4)
abline(l, col = "red ", lwd = 2)
```