MATH 4502 - Statistics for Process Control
Homework 3 - Modeling Process Quality

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```r
library(knitr)
opts_chunk$set(cache = T)
```

3.1

```r
n <- length(data.3.1)
mean.sample <- sum(data.3.1) / n
print(paste0('Sample Average: ', mean.sample))
```

```
## [1] "Sample Average: 16.0291666666667"
```

```r
var.sample <- sum( (data.3.1 - mean.sample)^2 ) / (n-1)
sd.sample <- sqrt(var.sample)
print(paste0('Sample Standard Deviation: ', sd.sample))
```

```
## [1] "Sample Standard Deviation: 0.0202072594216368"
```

3.2

```r
n <- length(data.3.2)
mean.sample <- sum(data.3.2) / n
print(paste0('Sample Average: ', mean.sample))
```

```
## [1] "Sample Average: 50.001875"
```

```r
var.sample <- sum( (data.3.2 - mean.sample)^2 ) / (n-1)
sd.sample <- sqrt(var.sample)
print(paste0('Sample Standard Deviation: ', sd.sample))
```

```
## [1] "Sample Standard Deviation: 0.00344082631271714"
```

3.8

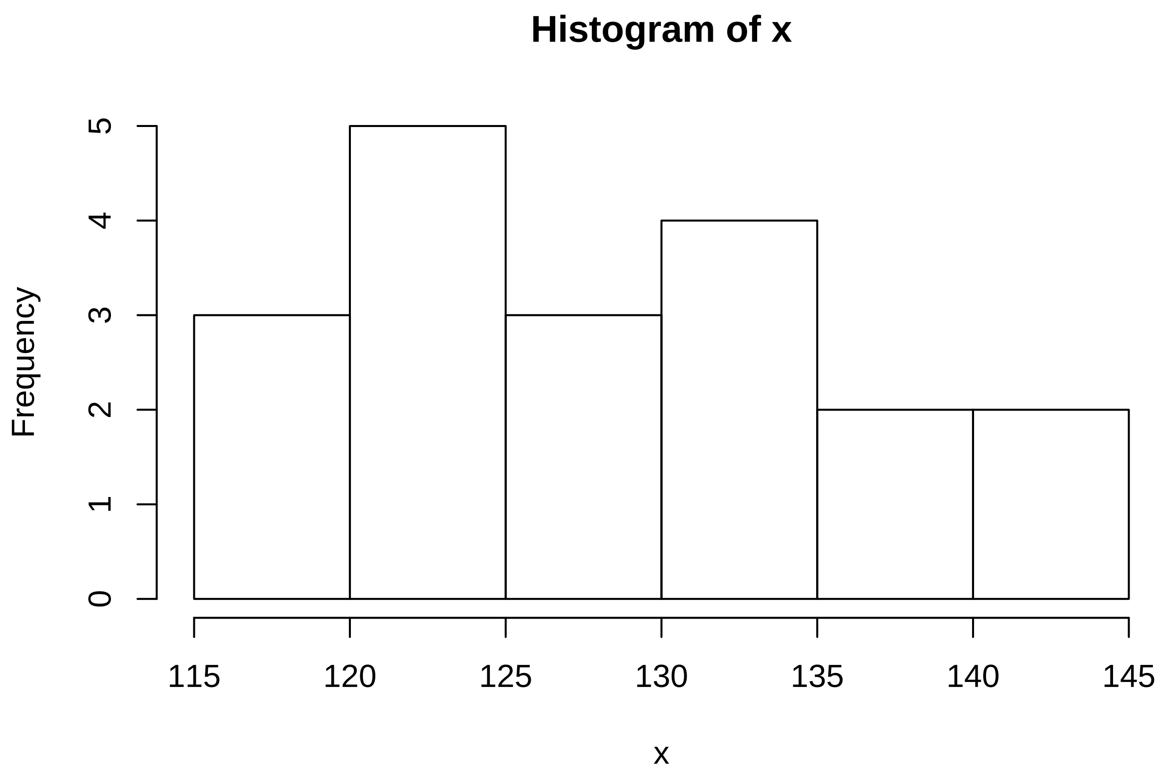
```r
x <- data.3.8$Failure.Time
n <- length(x)
mean.sample <- sum(x) / n
print(paste0('Sample Average: ', mean.sample))
```

```
## [1] "Sample Average: 128.842105263158"
```

```r
var.sample <- sum( (x - mean.sample)^2 ) / (n-1)
sd.sample <- sqrt(var.sample)
print(paste0('Sample Standard Deviation: ', sd.sample))
```

```
## [1] "Sample Standard Deviation: 7.37309793095244"
```

```r
hist(x)
```




```r
stem(x)
```

```
##
##   The decimal point is 1 digit(s) to the right of the |
##
##   11 | 89
##   12 | 0334
##   12 | 55689
##   13 | 1133
##   13 | 7
##   14 | 012
```

```r
print(paste0('Sample median: ', quantile(x, .5)))
```

```
## [1] "Sample median: 128"
```

```r
print(paste0('Sample lower quartile: ', quantile(x, .25)))
```

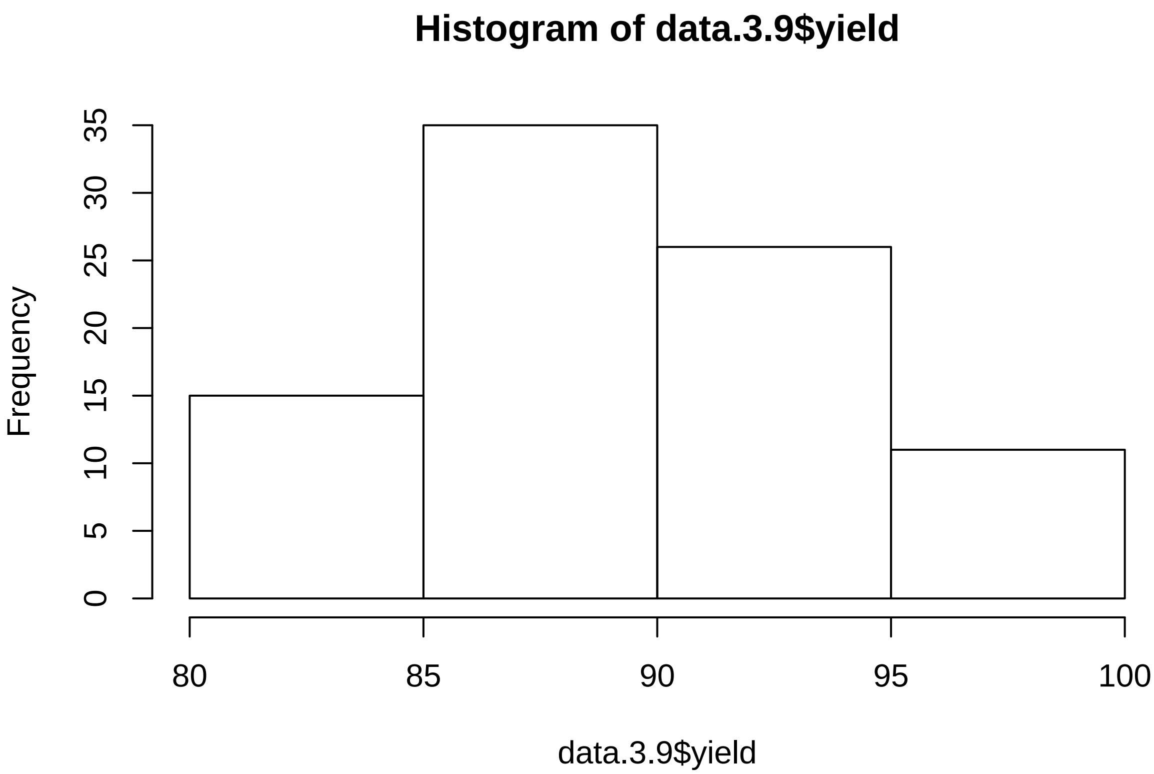
```
## [1] "Sample lower quartile: 123.5"
```

```r
print(paste0('Sample lower upper: ', quantile(x, .75)))
```

```
## [1] "Sample lower upper: 133"
```

3.9

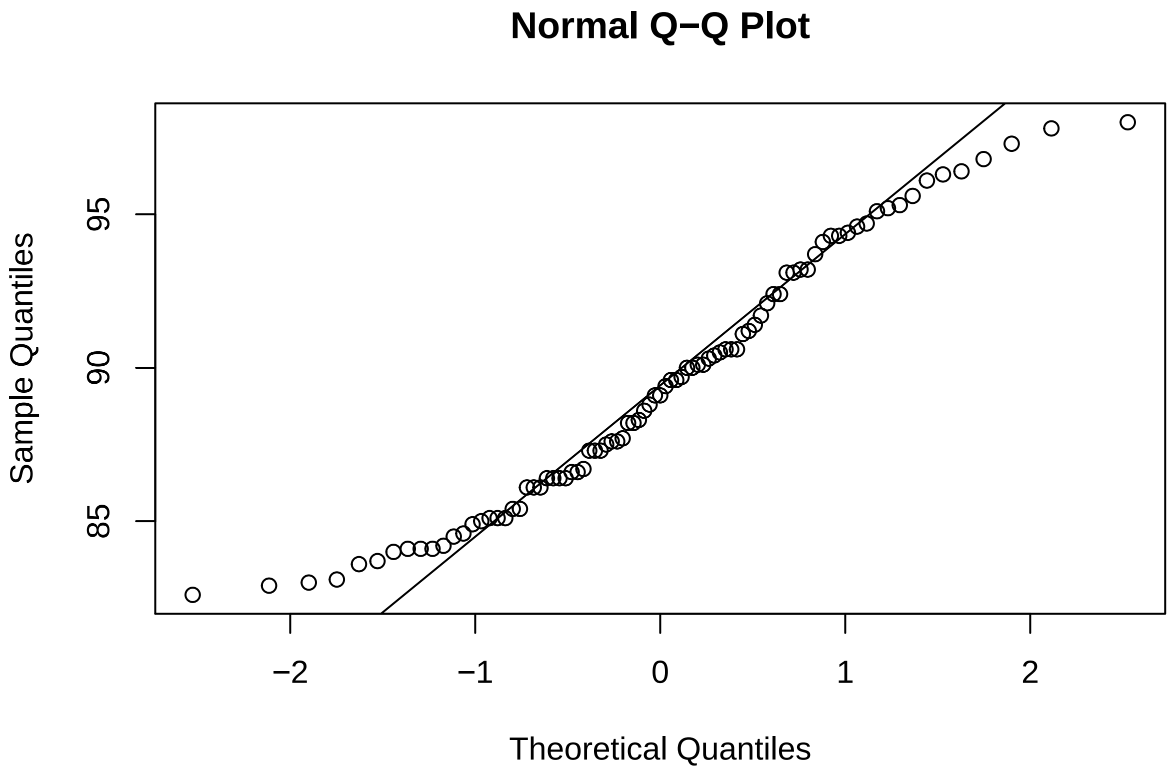
```r
hist(data.3.9$yield, breaks = 'Scott')
```



The histogram's shape resembles a bimodal distribution formed as a mixture of two normal distributions with means of approximately 87 and 95.

3.13

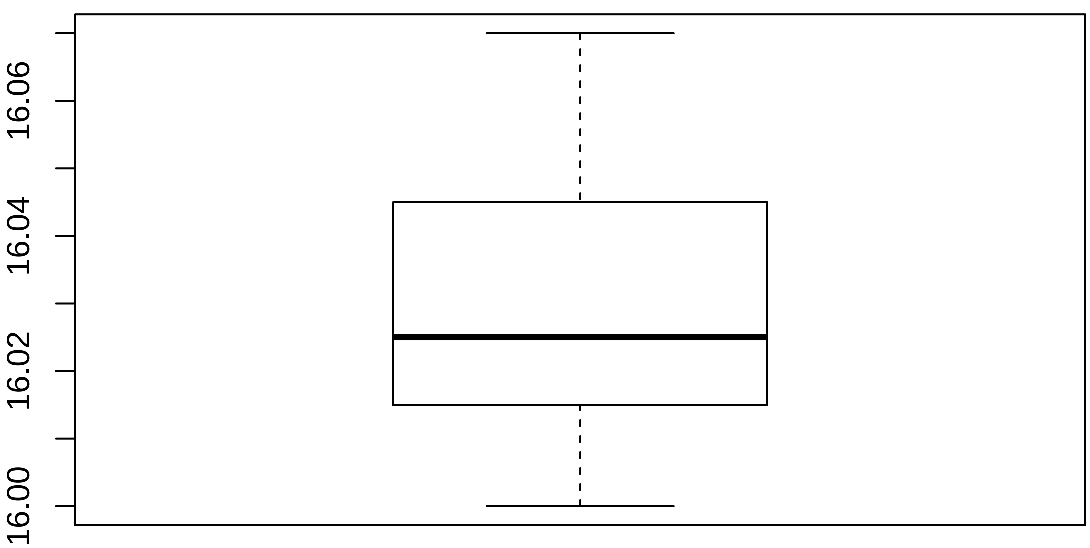
```r
qqnorm(data.3.9$yield)
qqline(data.3.9$yield)
```



The normal probability plot above doesn't show any signficant or systematic deviations from the assumption that the failure time for the component follows a normal distribution. So the assumption seems reasonable.

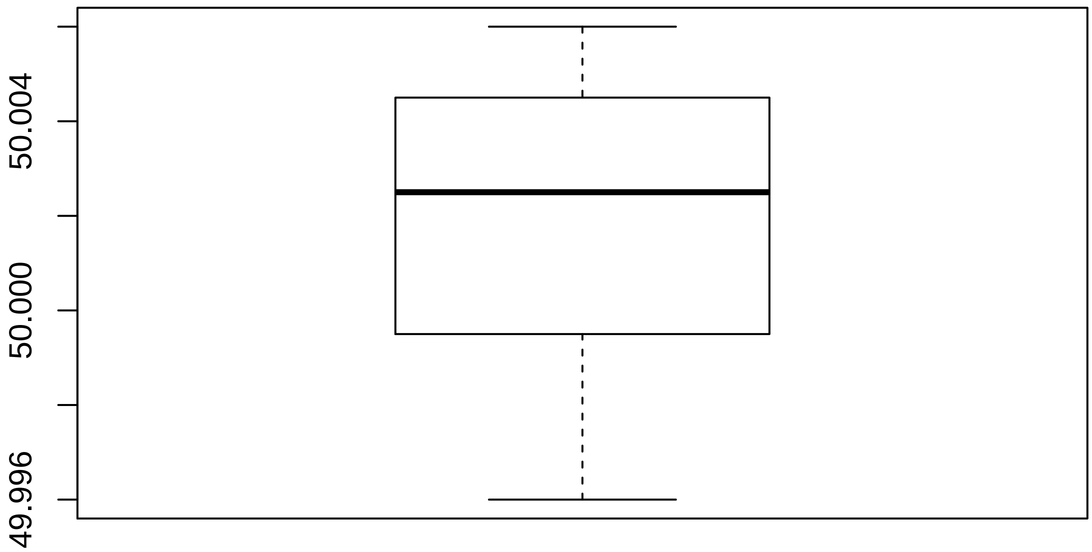
3.25

```
boxplot(data.3.1)
```



3.26

```r
boxplot(data.3.2)
```



3.29

```r
prob.1.defect <- ppois(1, .02) - ppois(0, .02) # a
prob.atleast.1.defects <- ppois(1, .02, lower.tail = F) # b
```

(c) Lowering the occurrence rate of defects will lower the probability that an assembly will have one or more defects.

```r
prob.atleast.1.defects <- ppois(1, .01, lower.tail = F) # c
```

3.34

```r
f <- function(x) {
  if ((11.75 <= x) & (x <= 12.25))
    4*(x-11.75)
  else if ((12.25 < x) & (x <= 12.75))
    4*(12.75-x)
  else
    0
}
# Answer:
integrate(Vectorize(f), 11.75, 12)
```

```
## 0.125 with absolute error < 1.4e-15
```

```r
# Verify it's a true probability distribution:
integrate(Vectorize(f), 11.75, 12.75)
```

```
## 1 with absolute error < 1.1e-14
```

3.35

```r
prob.atleast.1.defect.per.sample <- 1 - (1-.01)^25
```

3.39

```r
prob.exactly.1.prediabetic <- .9^3 * (1-.9)^1
prob.none.prediabetic <- .9^4
prob.atleast.1.prediabetic <- 1 - prob.none.prediabetic
```

The probability that exactly one of the four participants is prediabetic is 0.0729. The probability that at least one of the four participants is prediabetic is 0.3439.

3.44

```r
p <- 3 / 50
prob.exactly.1 <- p * (1-p)^4
prob.none <- (1-p)^5
prob.atleast.1 <- 1 - prob.none
```

The probability that the sample contains exactly one nonconforming unit is 0.0468449. The probability that it contains at least one nonconforming unit is 0.266096.

3.46(Poisson)

```r
ppois(1, .1, lower.tail = F)
```

```
## [1] 0.00467884
```

3.51

```r
n <- 50000
mu <- 40
sd <- 5
p.less.than.35 <- pnorm(35, mu, sd)
p.more.than.48 <- pnorm(48, mu, sd, lower.tail = F)

num.expected.less.than.35 <- n * p.less.than.35
num.expected.less.than.35
```

```
## [1] 7932.763
```

```r
num.expected.more.than.48 <- n * p.more.than.48
num.expected.more.than.48
```

```
## [1] 2739.965
```

3.52

```r
mu <- 5
sd <- .02
pnorm(5.05, mu, sd) - pnorm(4.95, mu, sd)
```

```
## [1] 0.9875807
```