JMP Defects

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Part 1

Defects Split by Day

```
library("reshape2")
acast(dat, dat$Sample~dat$Day, value.var="Defects")
```

```
##           1   2   3   4   5   6   7   8   9  10
## 08:15  12  17   7  11   7  13  10  10  11   9
## 08:30   8  12  11  11   8   9   8  11  12  18
## 08:45   9   7   9   8   7  14  15  11  10  17
## 09:00  11  11  16  12  11  10   3  11  12  16
## 09:15   9   7   8  12   7   7   8  14  14  10
## 09:30  10   6  12  11  17   7  12  12  13  12
## 09:45  12  10  14  12   7  11   5  15   6   8
## 10:00   9  11   5  13   8  12   5  10   8   9
## 10:15  12  12  13  10  11   9  14   6   9  11
## 10:30   4   7  14  15   3  11  12  13  13  13
## 10:45  11  11   6  12  14  13  16  14   5  11
## 11:00   8   6   4   6   7  11   9  10  11   8
## 11:15  12  12  14   7  10  12  10  11   6   9
## 11:30  12  13   8   5   3   6  10  10   8  14
## 11:45   9   1  11   3  11  14  12   9  11   9
## 12:00   8  12  10  13  14  12   4   9  14   4
## 12:15   9  13   6   9  10  10  13  12  11  12
## 12:30  10   8  10  11  13   9   9  12  12  13
## 12:45  15  14   5   9  16   9  11   3  16  11
## 13:00  11  12   9  15  12   5  12  10  11   9
## 13:15  14   8  12  12  10  11  12   9   7  10
## 13:30  11  12  12   6  11  17   7   9   5   8
## 13:45   9  12  10   8  11  13   8   9  16  10
## 14:00   7  10  13  11  13  10  15   5   7   9
## 14:15  15  10   4  14   9   7  11  11  11  14
## 14:30  11  15   6   7   9   5  14   8   5  11
## 14:45  13   6  13   7   9  12  13  14   8   8
## 15:00   9  12   9  16  13   6   7  17  14  15
## 15:15  15  13  17   3  12  12  10   7  10  10
## 15:30   8   7  15  13  14   4  16  14   9   8
## 15:45   7   7  14  16  14  10  10  12  11   9
## 16:00  11  11  12   9   8  14   7   6  12  13
```

Distribution of Defects

```
library("ggplot2")
library("egg")
```
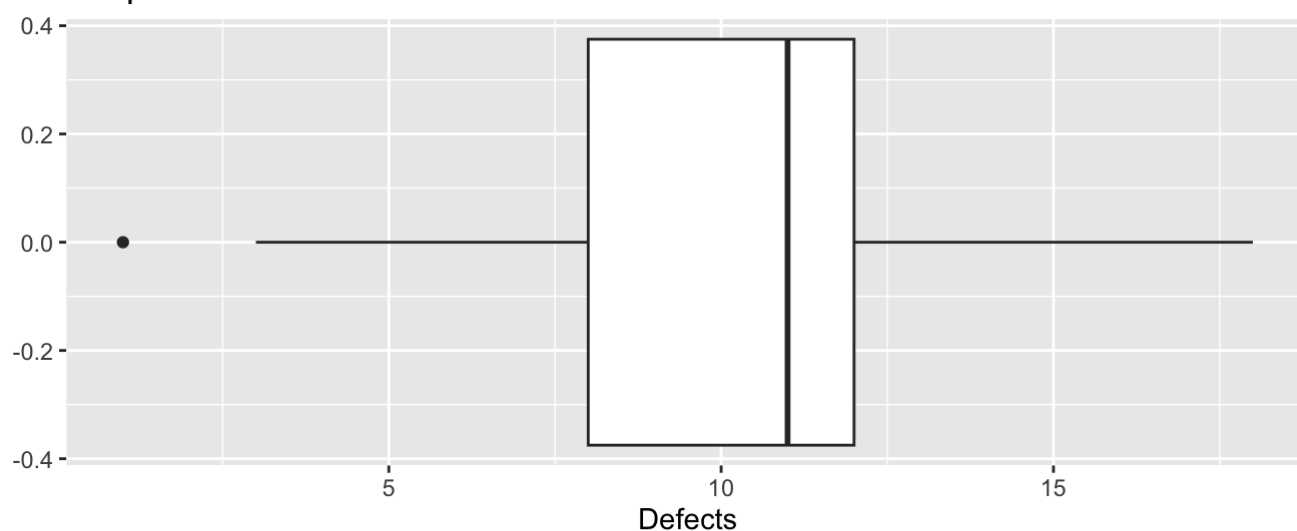
```
## Loading required package: gridExtra
```

```
hist<- ggplot(dat, aes(x = Defects)) + geom_histogram(binwidth=1, color = "black", fill
= "turquoise") + ggtitle("Histogram of Defects") + scale_x_continuous(breaks = seq(0, 2
0, 2))

box <- ggplot(dat, aes(x=Defects)) + geom_boxplot() + ggtitle("Boxplot of Defects")

egg::ggarrange(box, hist, heights = 2:1)
```
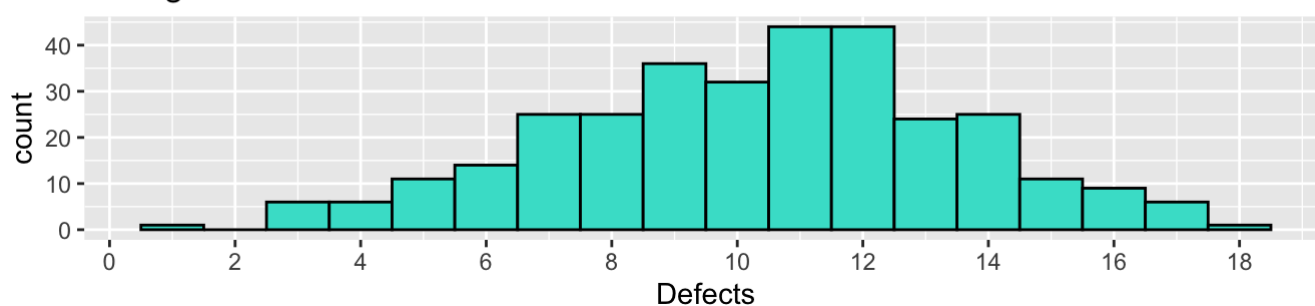


```
summary(dat$Defects)
```

```
##     Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##     1.00    8.00   11.00   10.32   12.00   18.00
```

```
xbar <- mean(dat$Defects)
xbar
```

```
## [1] 10.325
```

```
sd <- sd(dat$Defects)
sd
```

```
## [1] 3.172274
```

```
n = 320
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.1773355
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 9.976105
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 10.67389
```

#Summay of Defects by Day

```
library("dplyr")
```

```
##
## Attaching package: 'dplyr'
```

```
## The following object is masked from 'package:gridExtra':
##
##     combine
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library("lubridate")
```

```
##
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
subdat <-
  dat %>%
  group_by(Day) %>%
  summarize(mean_Defects = mean(Defects))

subdat
```

```
## # A tibble: 10 × 2
##       Day mean_Defects
##     <int>        <dbl>
##  1     1         10.3
##  2     2         10.2
##  3     3         10.3
##  4     4         10.2
##  5     5         10.3
##  6     6         10.2
##  7     7         10.2
##  8     8         10.4
##  9     9         10.2
## 10    10         10.9
```

```
library("dplyr")

dat1 <- dat %>% dplyr::group_by(Day) %>% summarise(mean(Defects))
dat1$n <- c(32,32,32,32,32,32,32,32,32,32)
dat1
```

```
## # A tibble: 10 × 3
##      Day `mean(Defects)`     n
##    <int>           <dbl> <dbl>
##  1     1            10.3    32
##  2     2            10.2    32
##  3     3            10.3    32
##  4     4            10.2    32
##  5     5            10.3    32
##  6     6            10.2    32
##  7     7            10.2    32
##  8     8            10.4    32
##  9     9            10.2    32
## 10    10            10.9    32
```

Sample Once Per Day

```
library("dplyr")
library("ggplot2")
library("egg")

dat2 <- filter(dat, Sample == '09:30')
dat2 <- subset(dat2, select = -Sample)
dat2$n <- c(1,1,1,1,1,1,1,1,1,1)
dat2
```

```
##     Day Defects n
## 1     1      10 1
## 2     2       6 1
## 3     3      12 1
## 4     4      11 1
## 5     5      17 1
## 6     6       7 1
## 7     7      12 1
## 8     8      12 1
## 9     9      13 1
## 10   10      12 1
```
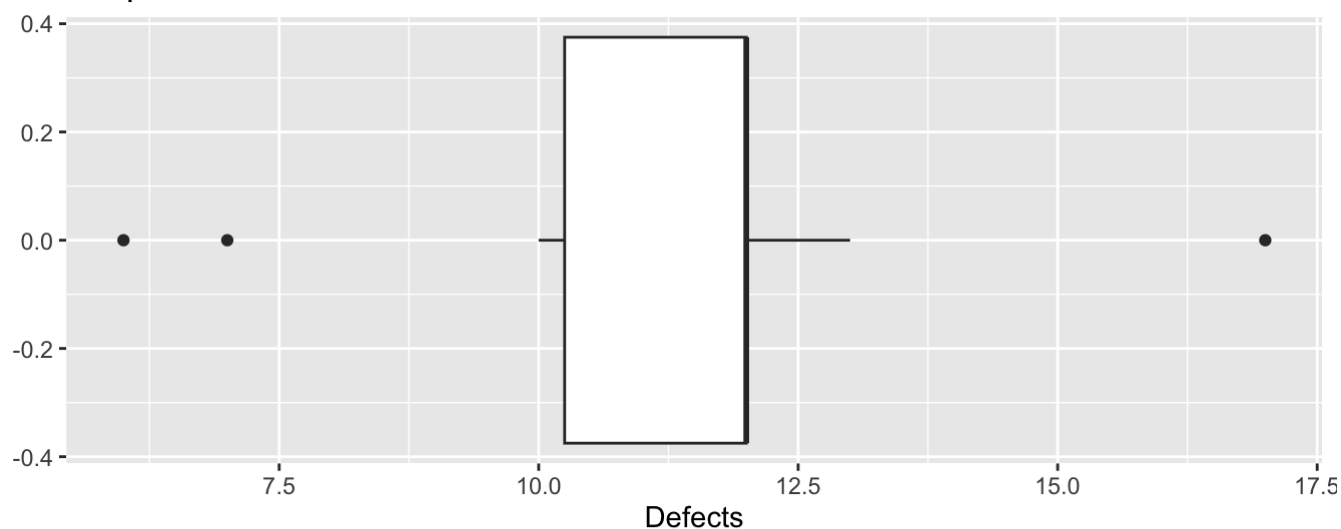
```
hist <- ggplot(dat2, aes(x = Defects)) + geom_histogram(bins=8, color = "black", fill =
"violet") + ggtitle("Histogram of Defects at 9:30") + scale_x_continuous(limits = c(4,2
0))

box<- ggplot(dat2, aes(x=Defects)) + geom_boxplot() + ggtitle("Boxplot of Defects at 9:3
0")

egg::ggarrange(box, hist, heights = 2:1)
```
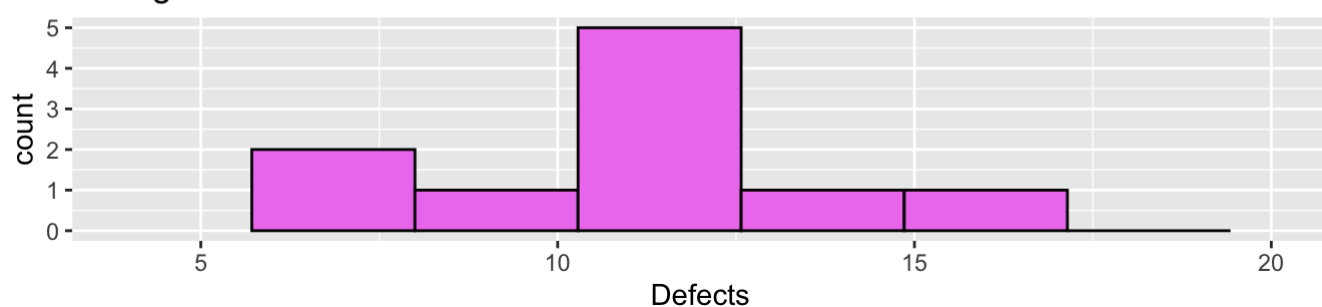
```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Boxplot of Defects at 9:30

Histogram of Defects at 9:30


```
xbar <- mean(dat2$Defects)
xbar
```

```
## [1] 11.2
```

```
sd <- sd(dat2$Defects)
sd
```

```
## [1] 3.084009
```

```
n = 10
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.9752493
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 8.993833
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 13.40617
```

Sample Twice Per Day

```
library("dplyr")
library("ggplot2")
library("egg")

dat3 <- filter(dat, Sample == '09:30' | Sample == '14:30')
dat3 <- subset(dat3, select = -Sample)
subdat3 <-
  dat3 %>%
  group_by(Day) %>%
  summarize(mean_Defects = mean(Defects))
subdat3$n <- c(2,2,2,2,2,2,2,2,2,2)
subdat3
```

```
## # A tibble: 10 × 3
##       Day mean_Defects     n
##     <int>        <dbl> <dbl>
## 1     1          10.5     2
## 2     2          10.5     2
## 3     3           9       2
## 4     4           9       2
## 5     5          13       2
## 6     6           6       2
## 7     7          13       2
## 8     8          10       2
## 9     9           9       2
## 10    10         11.5     2
```
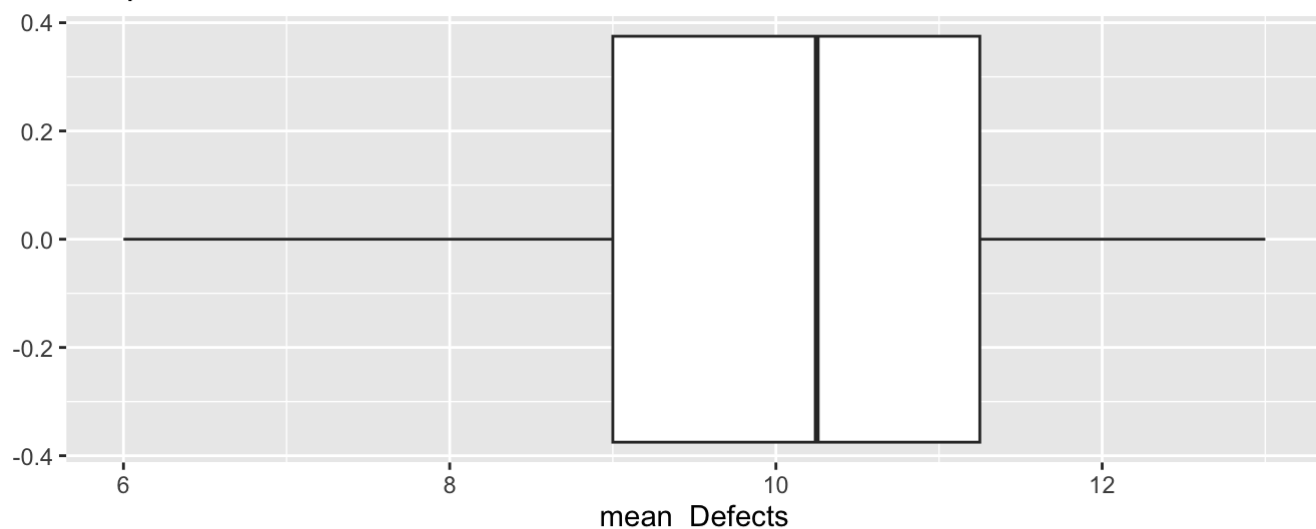
```
hist <- ggplot(subdat3, aes(x = mean_Defects)) + geom_histogram(bins = 9, color = "blac
k", fill = "green", ) + ggtitle("Histogram of Defects at 9:30 and 14:30")
scale_x_continuous(limits = c(5,14))
```

```
## <ScaleContinuousPosition>
##  Range:
##  Limits:    5 --   14
```

```
box<- ggplot(subdat3, aes(x= mean_Defects)) + geom_boxplot() + ggtitle("Boxplot of Defec
ts at 9:30 and 14:30")

egg::ggarrange(box, hist, heights = 2:1)
```

Boxplot of Defects at 9:30 and 14:30

Histogram of Defects at 9:30 and 14:30
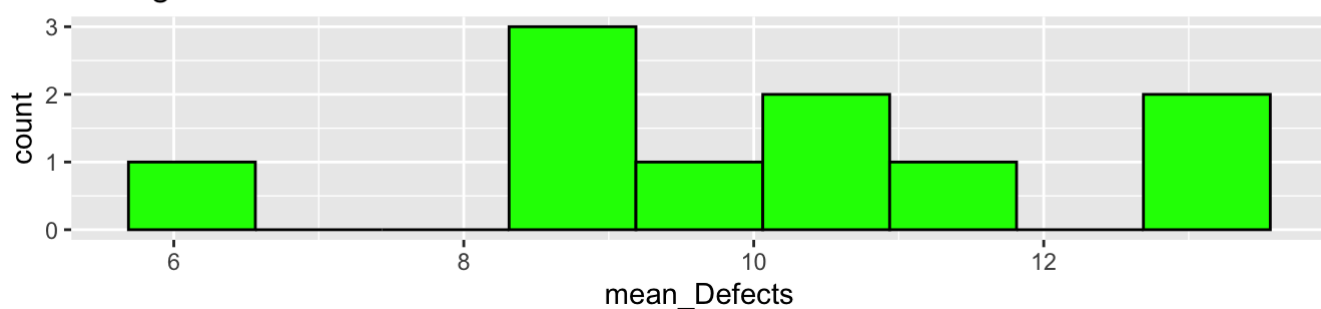
```
xbar <- mean(subdat3$mean_Defects)
xbar
```

```
## [1] 10.15
```

```
sd <- sd(subdat3$mean_Defects)
sd
```

```
## [1] 2.09563
```

```
n = 10
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.6626965
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 8.650876
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 11.64912
```

Five Sampling Schemes

```
# 9:30
dat2 <- filter(dat, Sample == '09:30')
dat2 <- subset(dat2, select = -Sample)
dat2$n <- c(1,1,1,1,1,1,1,1,1,1)
ggplot(dat2, aes(x = Defects)) +
geom_histogram(bins = 32, color = "turquoise", fill = "white") + ggtitle("Histogram of D
efects at 9:30") +
scale_x_continuous(limits = c(4,20), breaks = 4:20)
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Histogram of Defects at 9:30
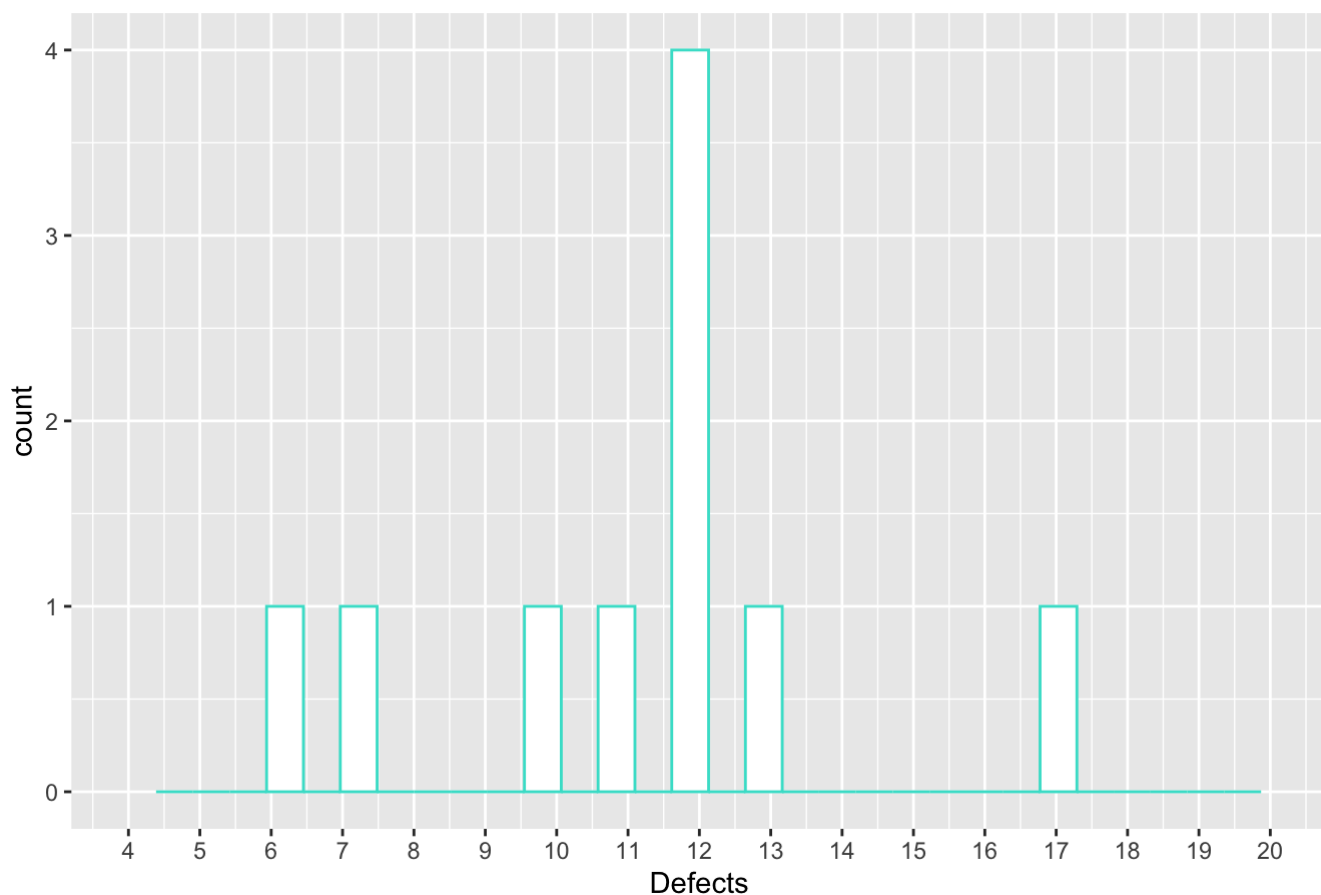

```
# 9:30 and 14:30
dat3 <- filter(dat, Sample == '09:30' | Sample == '14:30')
dat3 <- subset(dat3, select = -Sample)
subdat3 <-
  dat3 %>%
  group_by(Day) %>%
  summarize(mean_Defects = mean(Defects))
subdat3$n <- c(2,2,2,2,2,2,2,2,2,2)
ggplot(subdat3, aes(x = mean_Defects)) +
geom_histogram(bins = 32, color = "turquoise", fill = "white") + ggtitle("Histogram of D
efects at 9:30 and 14:30") +
scale_x_continuous(limits = c(4,20), breaks = 4:20)
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Histogram of Defects at 9:30 and 14:30


```
# Every hour starting at 8:30
dat4 <- filter(dat, Sample == '08:30' | Sample == '09:30' | Sample == '10:30' | Sample =
= '11:30' | Sample == '12:30' | Sample == '13:30' | Sample == '14:30' | Sample == '15:3
0')
dat4 <- subset(dat4, select = -Sample)
subdat4 <-
  dat4 %>%
  group_by(Day) %>%
  summarize(mean_Defects = mean(Defects))
ggplot(subdat4, aes(x = mean_Defects)) +
geom_histogram(bins = 32, color = "turquoise", fill = "white") + ggtitle("Histogram of D
efects every hour starting at 8:30") +
scale_x_continuous(limits = c(4,20), breaks = 4:20)
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```
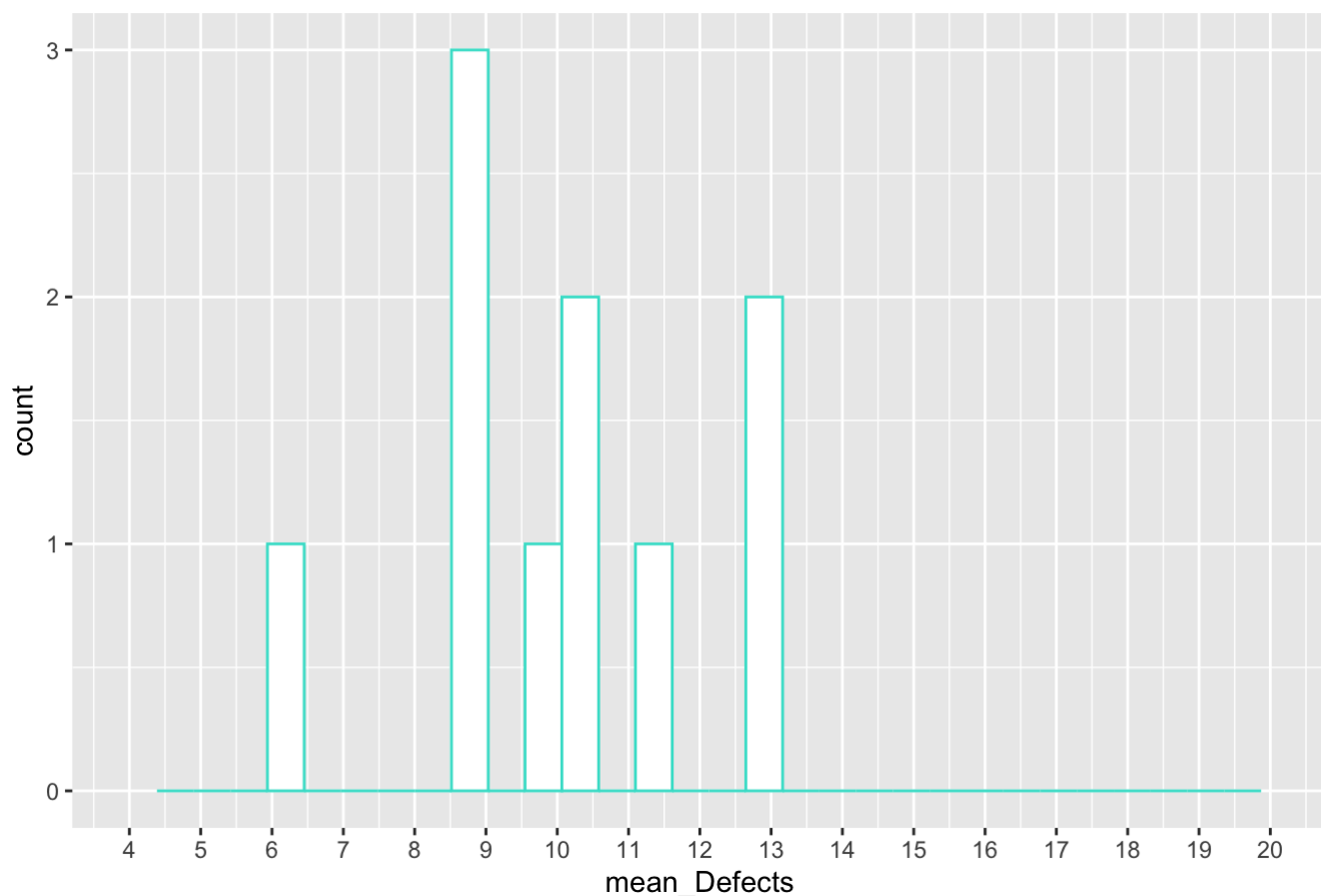
Histogram of Defects every hour starting at 8:30


```
# Every half-hour starting at 8:30
dat5 <- filter(dat, Sample == '08:30' | Sample == '09:30' | Sample =
= '11:30' | Sample == '12:30' | Sample == '13:30' | Sample == '14:30' | Sample == '15:3
0' | Sample == '09:00' | Sample == '10:00' | Sample == '11:00' | Sample == '12:00' | Sam
ple == '13:00' | Sample == '14:00' | Sample == '15:00' | Sample == '16:00')
dat5 <- subset(dat5, select = -Sample)
subdat5 <-
  dat5 %>%
  group_by(Day) %>%
  summarize(mean_Defects = mean(Defects))
ggplot(subdat5, aes(x = mean_Defects)) +
geom_histogram(bins = 32, color = "turquoise", fill = "white") + ggtitle("Histogram of D
efects every half-hour starting at 8:30") +
scale_x_continuous(limits = c(4,20), breaks = 4:20)
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```
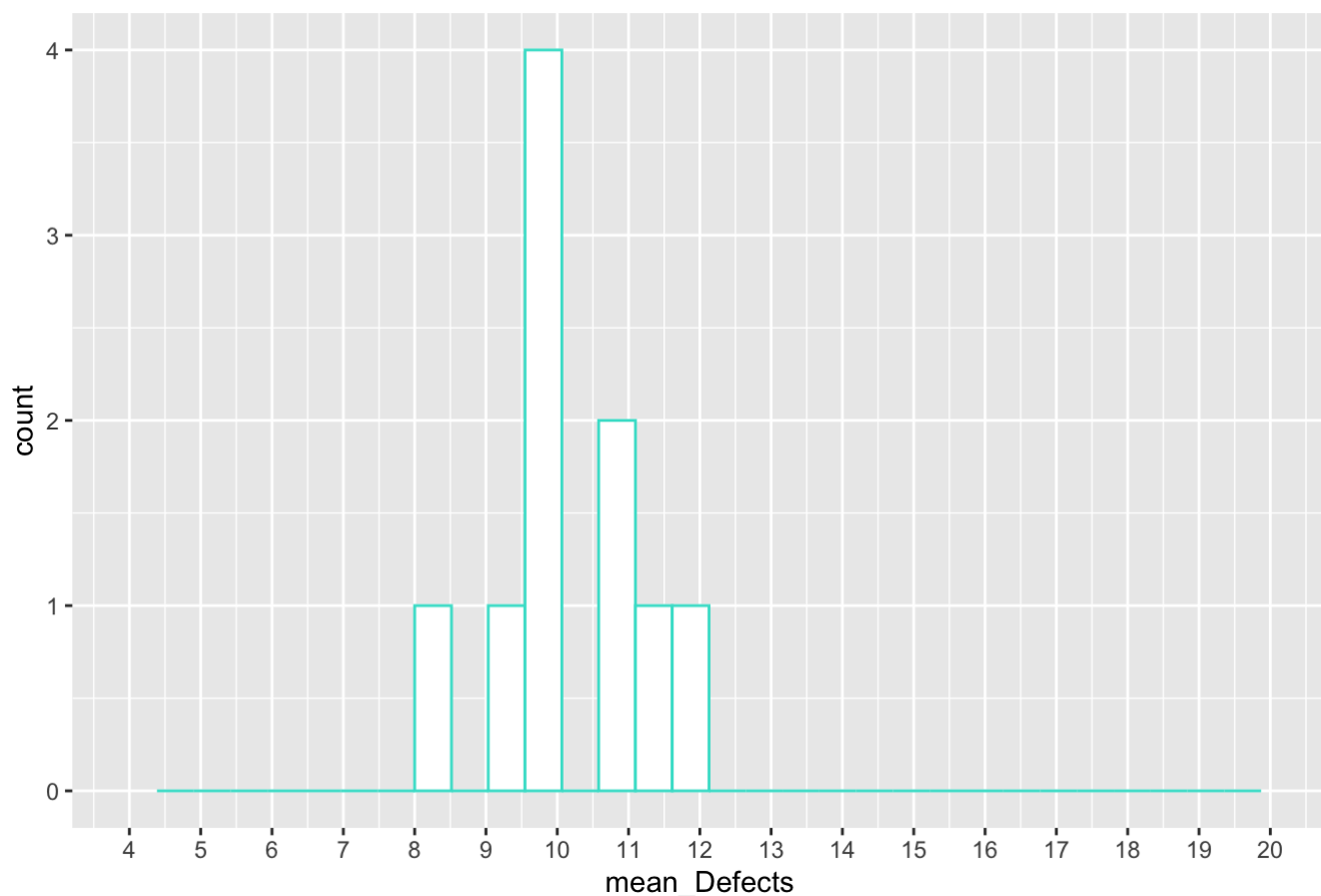
Histogram of Defects every half-hour starting at 8:30
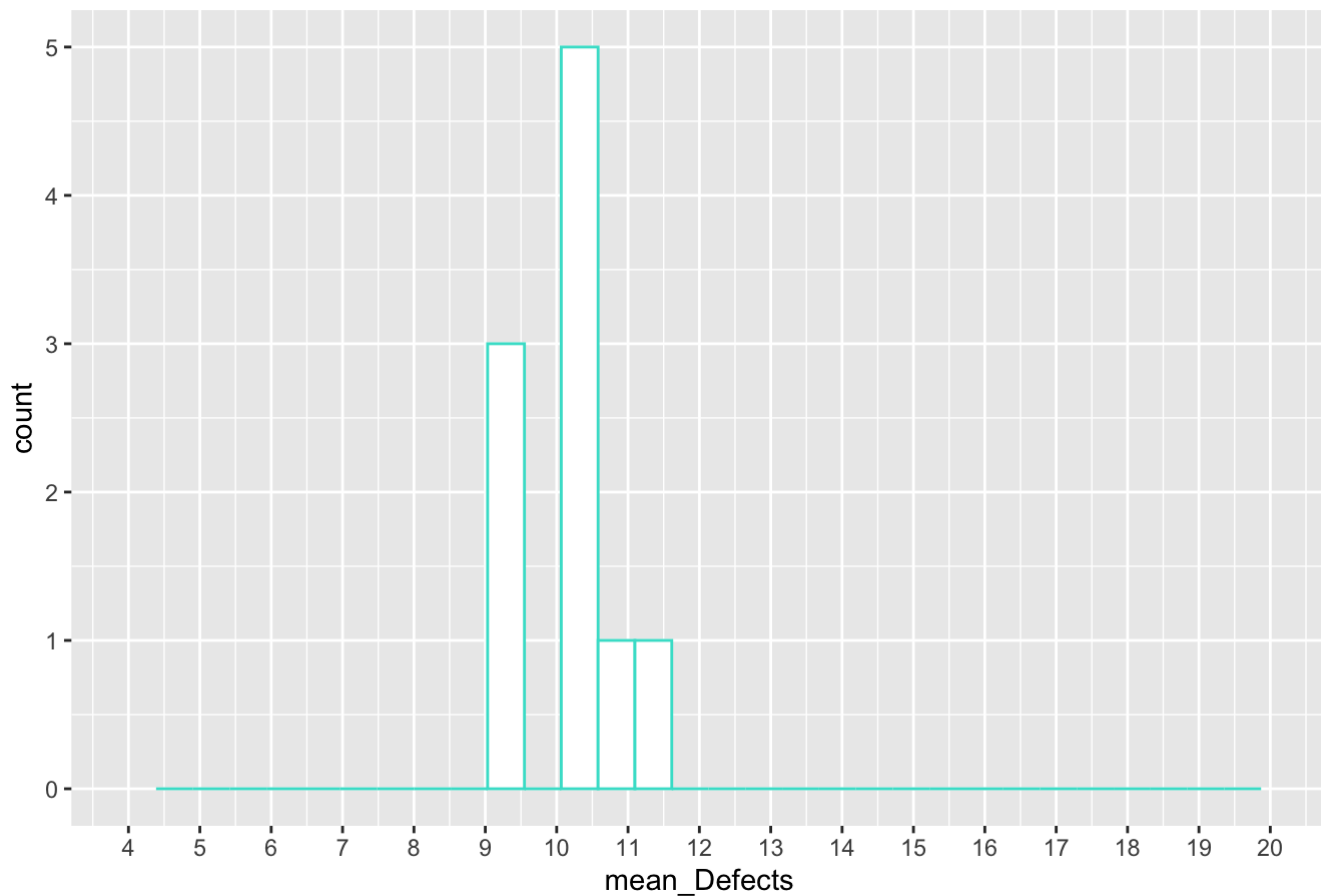

```
# Every 15 minutes
dat6 <- subset(dat, select = -Sample)
subdat6 <-
  dat %>%
  group_by(Day) %>%
  summarize(mean_Defects = mean(Defects))
ggplot(subdat6, aes(x = mean_Defects)) +
geom_histogram(bins = 32, boundary = 4, color = "turquoise", fill = "white") + ggtitle
("Histogram of Defects every 15 minutes") +
scale_x_continuous(limits = c(4,20), breaks = 4:20)
```

Histogram of Defects every 15 minutes
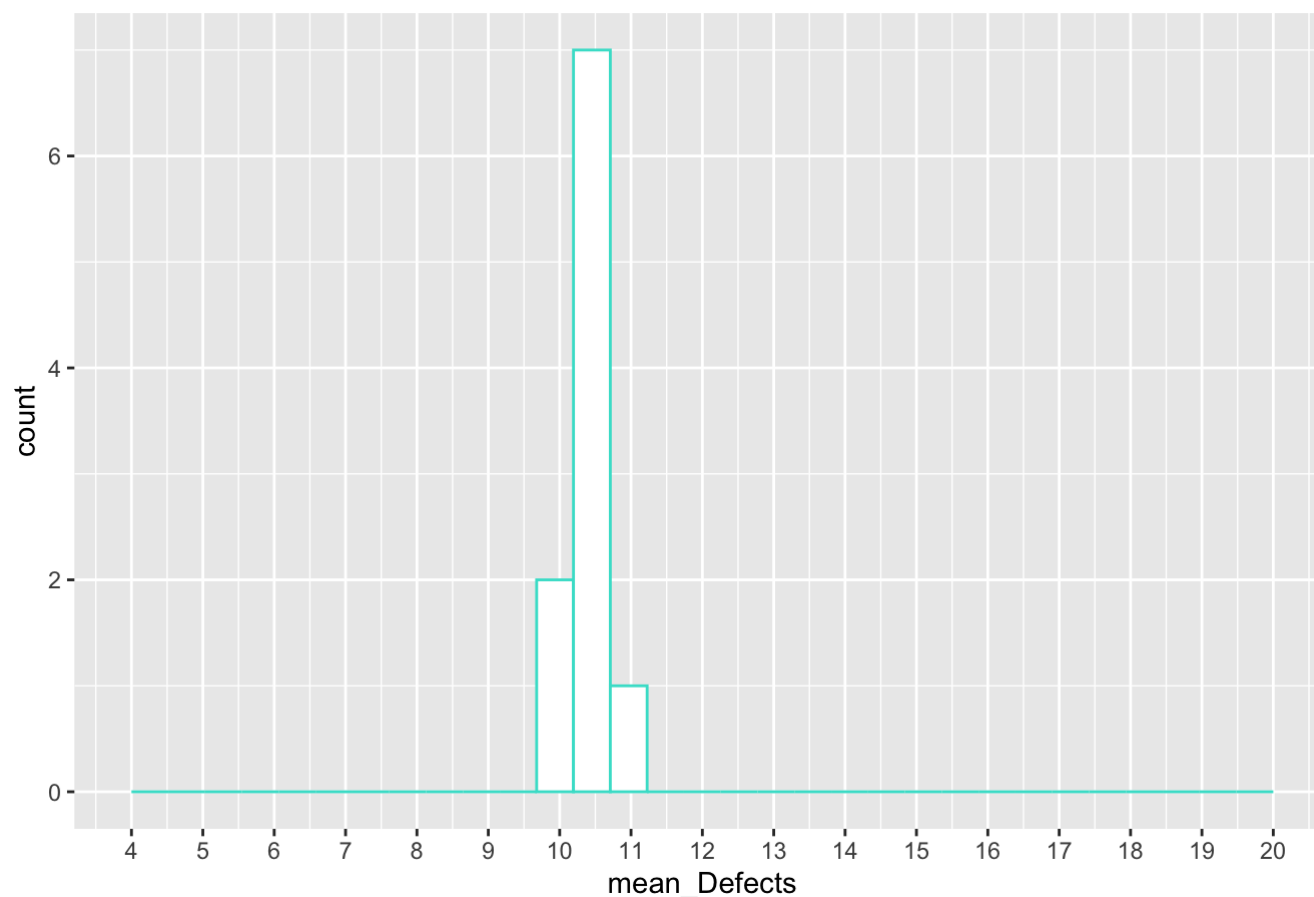
Average Defects Plotted Over Time

```
# 9:30
dat2 <- filter(dat, Sample == '09:30')
dat2 <- subset(dat2, select = -Sample)
dat2$n <- c(1,1,1,1,1,1,1,1,1,1)
ggplot(data=dat2, aes(x=Day, y=Defects)) +
  geom_line(color="red")+
  geom_point()
```
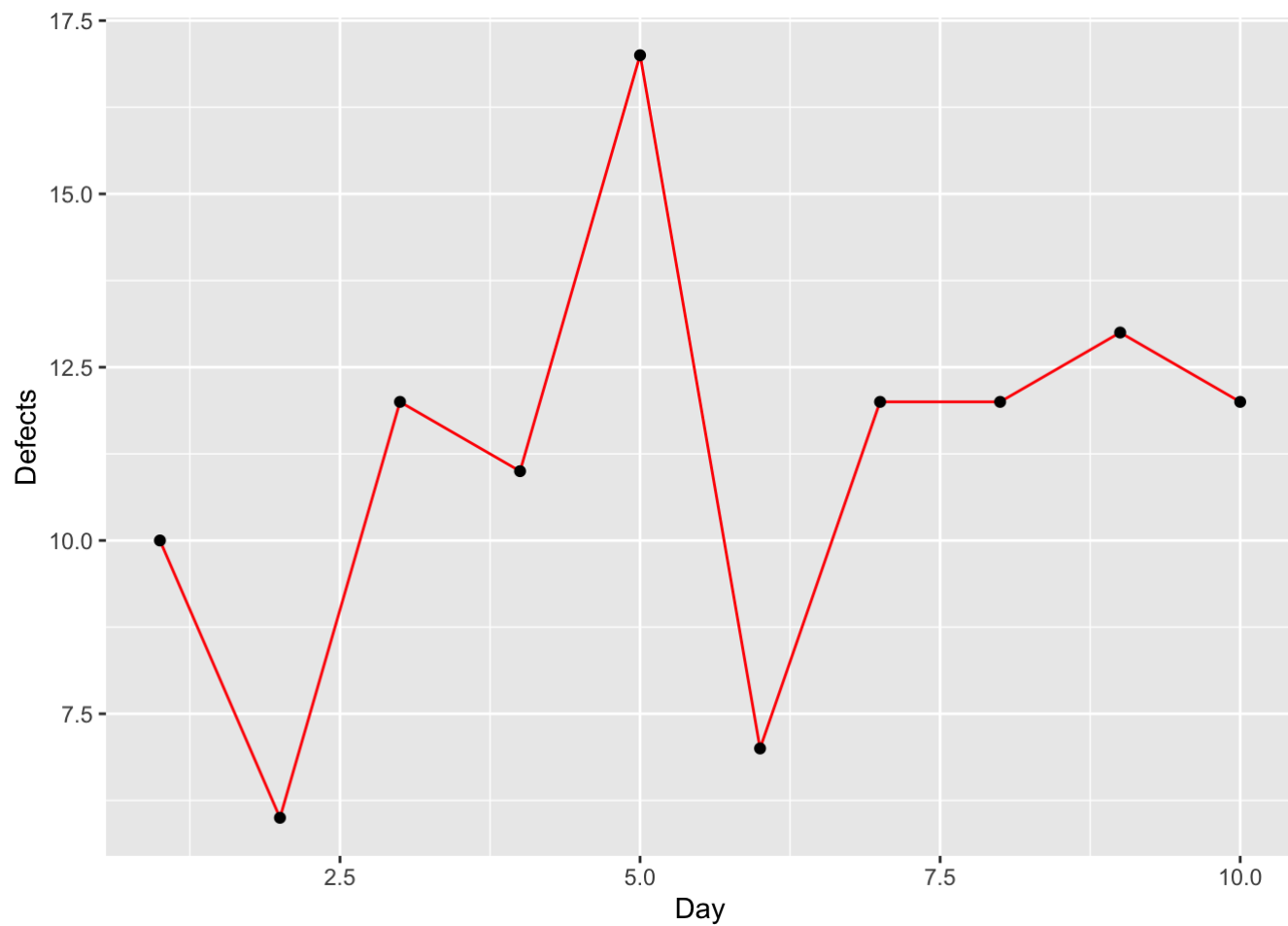
```r
# every hour starting at 8:30
dat4 <- filter(dat, Sample == '08:30' | Sample == '09:30' | Sample == '10:30' | Sample =
= '11:30' | Sample == '12:30' | Sample == '13:30' | Sample == '14:30' | Sample == '15:3
0')
dat4 <- subset(dat4, select = -Sample)
subdat4 <-
  dat4 %>%
  group_by(Day) %>%
  summarize(mean_Defects = mean(Defects))
ggplot(data=subdat4, aes(x=Day, y=mean_Defects)) +
  geom_line(color="red")+
  geom_point()
```
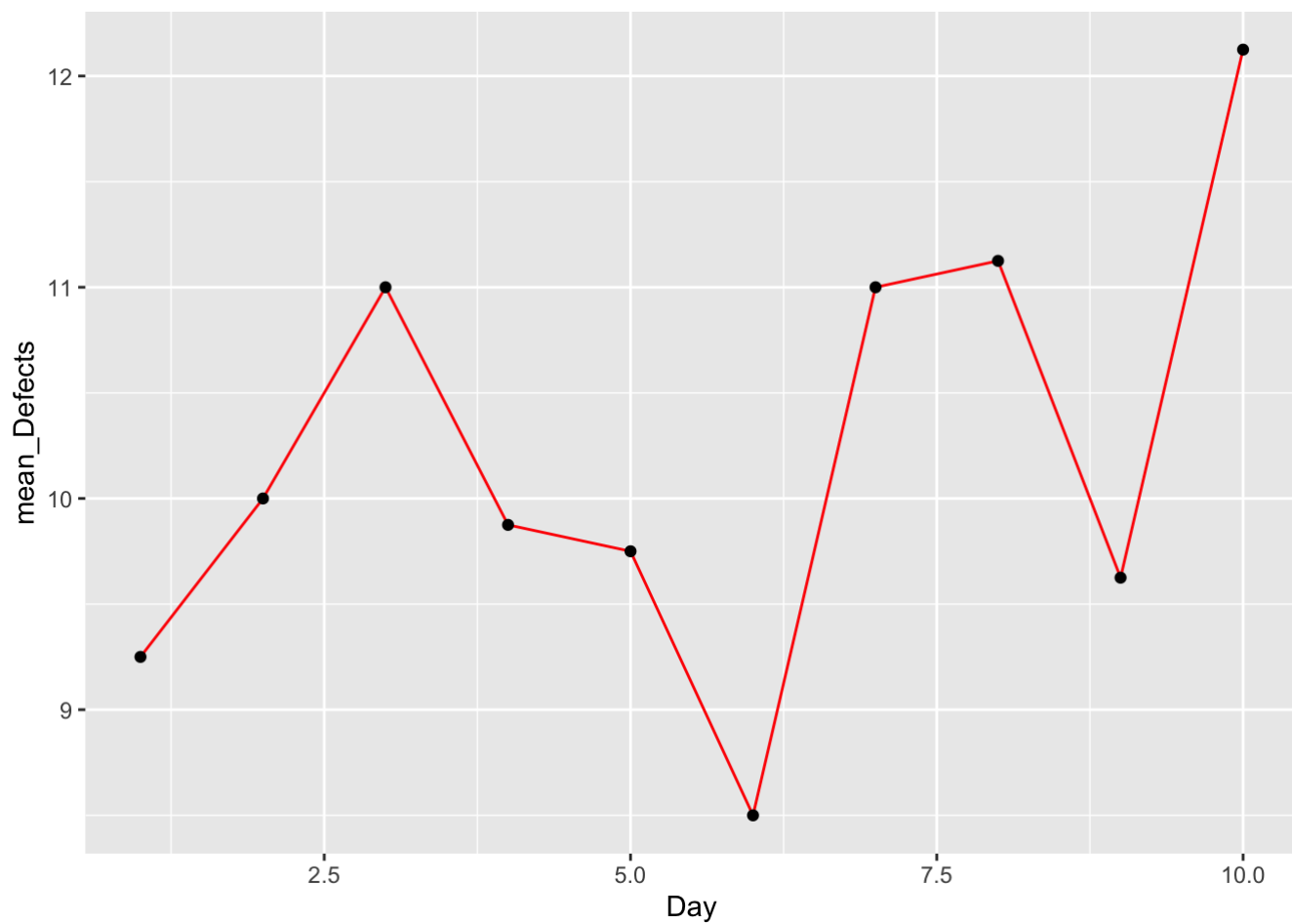
```
# every 15 minutes
dat6 <- subset(dat, select = -Sample)
subdat6 <-
  dat %>%
  group_by(Day) %>%
  summarize(mean_Defects = mean(Defects))
ggplot(data=subdat6, aes(x=Day, y=mean_Defects)) +
  geom_line(color="red")+
  geom_point()
```

Part 2

8-10
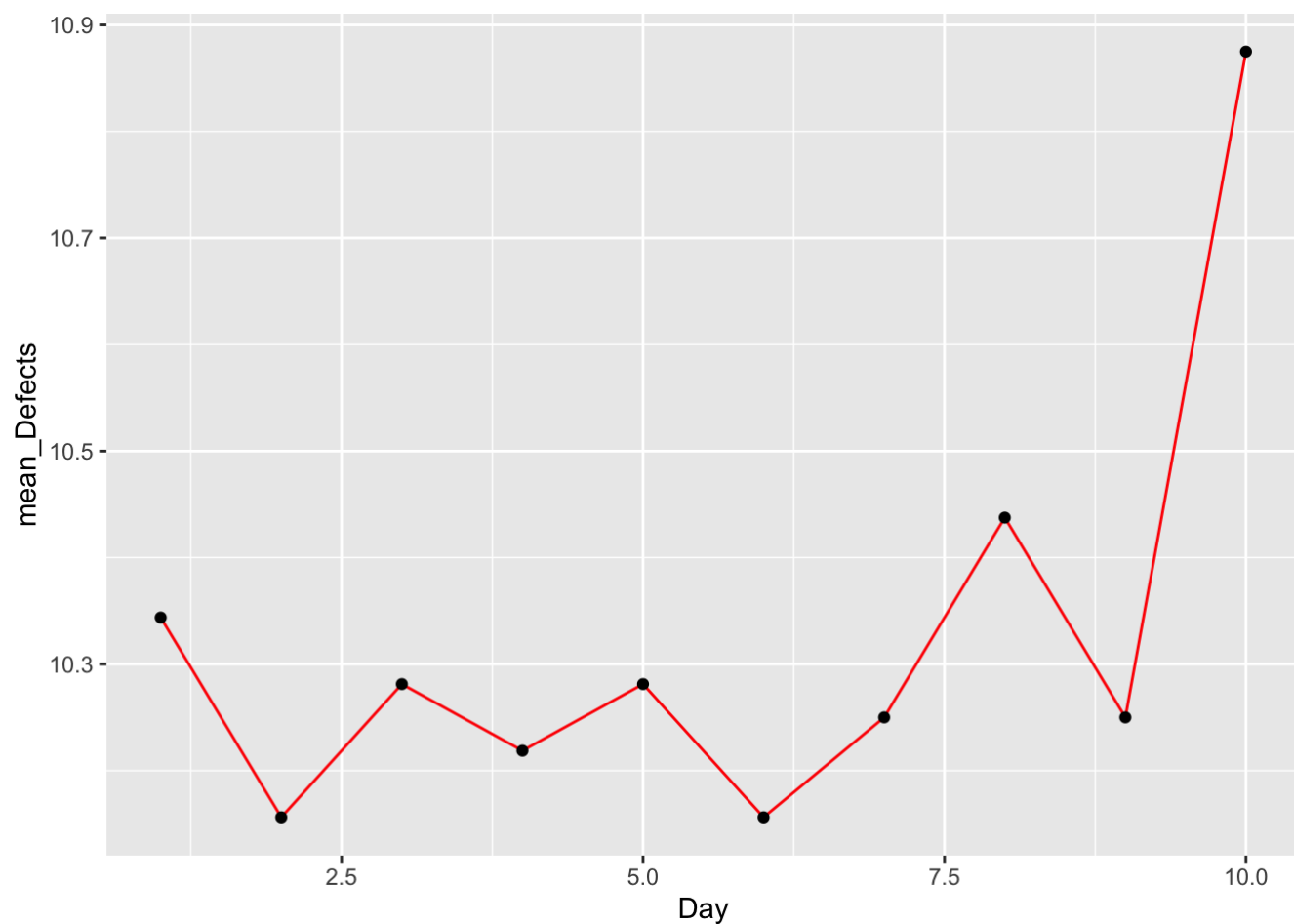
```r
library("dplyr")
library("ggplot2")
library("egg")

datearly <- filter(dat, Sample == '08:00' | Sample == '08:15' | Sample == '08:30' | Samp
le == '08:45' | Sample == '09:00' | Sample == '09:15' | Sample == '09:30' | Sample == '0
9:45' | Sample == '10:00')
datearly <- subset(datearly, select = -Sample)
datearly$n <- c(1,1,1,1,1,1,1,1,1,1)
datearly
```

```
##     Day Defects n
## 1    1       12 1
## 2    1        8 1
## 3    1        9 1
## 4    1       11 1
## 5    1        9 1
## 6    1       10 1
## 7    1       12 1
## 8    1        9 1
## 9    2       17 1
## 10   2       12 1
## 11   2        7 1
## 12   2       11 1
## 13   2        7 1
## 14   2        6 1
## 15   2       10 1
## 16   2       11 1
## 17   3        7 1
## 18   3       11 1
## 19   3        9 1
## 20   3       16 1
## 21   3        8 1
## 22   3       12 1
## 23   3       14 1
## 24   3        5 1
## 25   4       11 1
## 26   4       11 1
## 27   4        8 1
## 28   4       12 1
## 29   4       12 1
## 30   4       11 1
## 31   4       12 1
## 32   4       13 1
## 33   5        7 1
## 34   5        8 1
## 35   5        7 1
## 36   5       11 1
## 37   5        7 1
## 38   5       17 1
## 39   5        7 1
## 40   5        8 1
## 41   6       13 1
## 42   6        9 1
## 43   6       14 1
## 44   6       10 1
## 45   6        7 1
## 46   6        7 1
## 47   6       11 1
## 48   6       12 1
## 49   7       10 1
## 50   7        8 1
## 51   7       15 1
```

```
## 52    7        3 1
## 53    7        8 1
## 54    7       12 1
## 55    7        5 1
## 56    7        5 1
## 57    8       10 1
## 58    8       11 1
## 59    8       11 1
## 60    8       11 1
## 61    8       14 1
## 62    8       12 1
## 63    8       15 1
## 64    8       10 1
## 65    9       11 1
## 66    9       12 1
## 67    9       10 1
## 68    9       12 1
## 69    9       14 1
## 70    9       13 1
## 71    9        6 1
## 72    9        8 1
## 73   10        9 1
## 74   10       18 1
## 75   10       17 1
## 76   10       16 1
## 77   10       10 1
## 78   10       12 1
## 79   10        8 1
## 80   10        9 1
```

```
hist <- ggplot(datearly, aes(x = Defects)) + geom_histogram(bins=8, color = "black", fil
l = "violet") + ggtitle("Histogram of Defects from 8-10") + scale_x_continuous(limits =
c(4,20))

box<- ggplot(datearly, aes(x=Defects)) + geom_boxplot() + ggtitle("Boxplot of Defects fr
om 8-10")

egg::ggarrange(box, hist, heights = 2:1)
```

```
## Warning: Removed 1 rows containing non-finite values (`stat_bin()`).
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Boxplot of Defects from 8-10
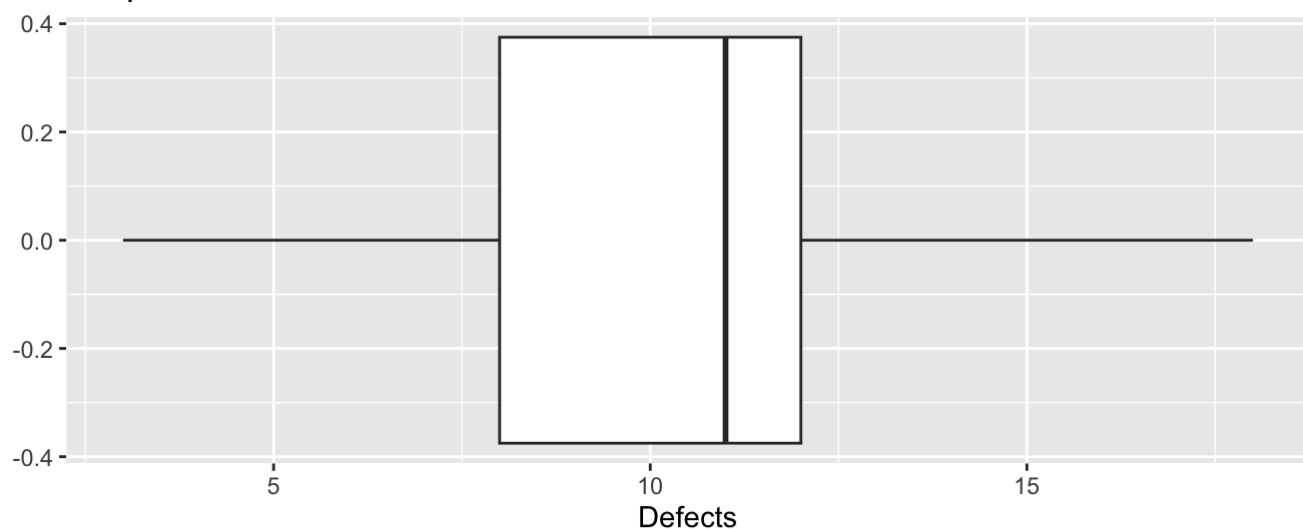
Histogram of Defects from 8-10
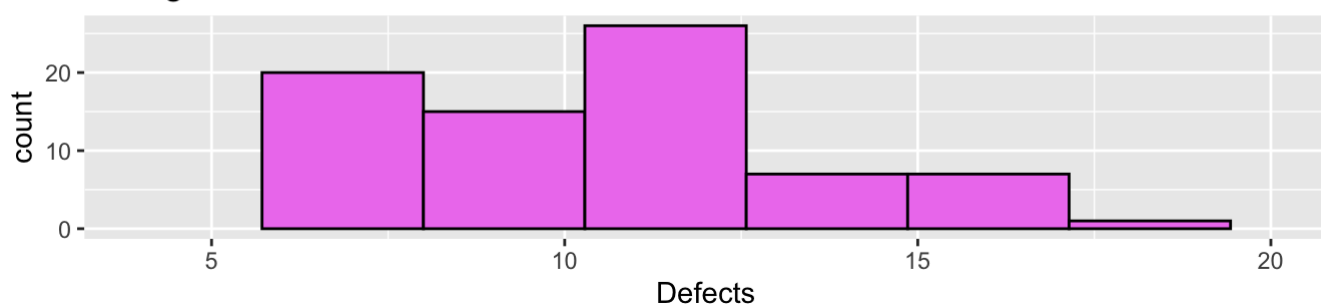
```
xbar <- mean(datearly$Defects)
xbar
```

```
## [1] 10.4125
```

```
sd <- sd(datearly$Defects)
sd
```

```
## [1] 3.092227
```

```
n = 80
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.3457215
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 9.724359
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 11.10064
```

10:15-12:00

```
library("dplyr")
library("ggplot2")
library("egg")

datmid <- filter(dat, Sample == '10:15' | Sample == '10:30' | Sample == '10:45' | Sample
== '11:00' | Sample == '11:15' | Sample == '11:30' | Sample == '11:45' | Sample == '12:0
0')
datmid <- subset(datmid, select = -Sample)
datmid$n <- c(1,1,1,1,1,1,1,1,1,1)
datmid
```

```
##     Day Defects n
## 1     1      12 1
## 2     1       4 1
## 3     1      11 1
## 4     1       8 1
## 5     1      12 1
## 6     1      12 1
## 7     1       9 1
## 8     1       8 1
## 9     2      12 1
## 10    2       7 1
## 11    2      11 1
## 12    2       6 1
## 13    2      12 1
## 14    2      13 1
## 15    2       1 1
## 16    2      12 1
## 17    3      13 1
## 18    3      14 1
## 19    3       6 1
## 20    3       4 1
## 21    3      14 1
## 22    3       8 1
## 23    3      11 1
## 24    3      10 1
## 25    4      10 1
## 26    4      15 1
## 27    4      12 1
## 28    4       6 1
## 29    4       7 1
## 30    4       5 1
## 31    4       3 1
## 32    4      13 1
## 33    5      11 1
## 34    5       3 1
## 35    5      14 1
## 36    5       7 1
## 37    5      10 1
## 38    5       3 1
## 39    5      11 1
## 40    5      14 1
## 41    6       9 1
## 42    6      11 1
## 43    6      13 1
## 44    6      11 1
## 45    6      12 1
## 46    6       6 1
## 47    6      14 1
## 48    6      12 1
## 49    7      14 1
## 50    7      12 1
## 51    7      16 1
```

```
## 52    7        9 1
## 53    7       10 1
## 54    7       10 1
## 55    7       12 1
## 56    7        4 1
## 57    8        6 1
## 58    8       13 1
## 59    8       14 1
## 60    8       10 1
## 61    8       11 1
## 62    8       10 1
## 63    8        9 1
## 64    8        9 1
## 65    9        9 1
## 66    9       13 1
## 67    9        5 1
## 68    9       11 1
## 69    9        6 1
## 70    9        8 1
## 71    9       11 1
## 72    9       14 1
## 73   10       11 1
## 74   10       13 1
## 75   10       11 1
## 76   10        8 1
## 77   10        9 1
## 78   10       14 1
## 79   10        9 1
## 80   10        4 1
```

```
hist <- ggplot(datmid, aes(x = Defects)) + geom_histogram(bins=8, color = "black", fill
= "violet") + ggtitle("Histogram of Defects from 10:15-12") + scale_x_continuous(limits
= c(4,20))

box<- ggplot(datmid, aes(x=Defects)) + geom_boxplot() + ggtitle("Boxplot of Defects from
10:15-12")

egg::ggarrange(box, hist, heights = 2:1)
```

```
## Warning: Removed 4 rows containing non-finite values (`stat_bin()`).
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Boxplot of Defects from 10:15-12
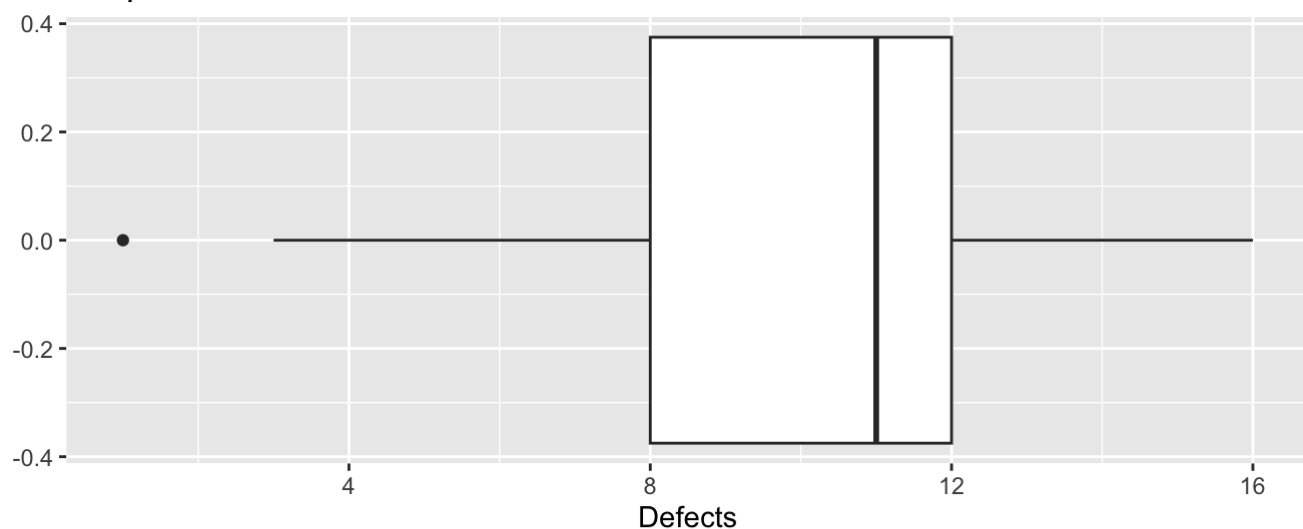
Histogram of Defects from 10:15-12
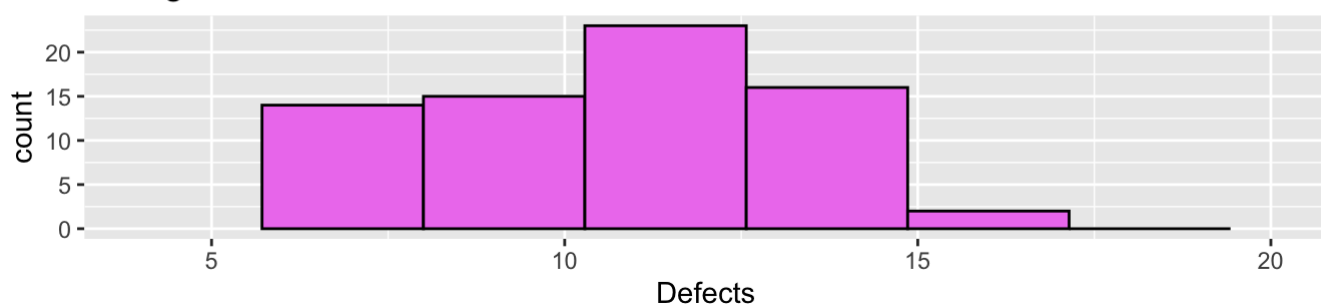

```
xbar <- mean(datmid$Defects)
xbar
```

```
## [1] 9.8375
```

```
sd <- sd(datmid$Defects)
sd
```

```
## [1] 3.365663
```

```
n = 80
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.3762926
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 9.088508
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 10.58649
```

12:15-14:00

```
library("dplyr")
library("ggplot2")
library("egg")

dataft <- filter(dat, Sample == '12:15' | Sample == '12:30' | Sample == '12:45' | Sample
== '13:00' | Sample == '13:15' | Sample == '13:30' | Sample == '13:45' | Sample == '14:0
0')
dataft <- subset(dataft, select = -Sample)
dataft$n <- c(1,1,1,1,1,1,1,1,1,1)
dataft
```

```
##      Day Defects n
## 1     1        9 1
## 2     1       10 1
## 3     1       15 1
## 4     1       11 1
## 5     1       14 1
## 6     1       11 1
## 7     1        9 1
## 8     1        7 1
## 9     2       13 1
## 10    2        8 1
## 11    2       14 1
## 12    2       12 1
## 13    2        8 1
## 14    2       12 1
## 15    2       12 1
## 16    2       10 1
## 17    3        6 1
## 18    3       10 1
## 19    3        5 1
## 20    3        9 1
## 21    3       12 1
## 22    3       12 1
## 23    3       10 1
## 24    3       13 1
## 25    4        9 1
## 26    4       11 1
## 27    4        9 1
## 28    4       15 1
## 29    4       12 1
## 30    4        6 1
## 31    4        8 1
## 32    4       11 1
## 33    5       10 1
## 34    5       13 1
## 35    5       16 1
## 36    5       12 1
## 37    5       10 1
## 38    5       11 1
## 39    5       11 1
## 40    5       13 1
## 41    6       10 1
## 42    6        9 1
## 43    6        9 1
## 44    6        5 1
## 45    6       11 1
## 46    6       17 1
## 47    6       13 1
## 48    6       10 1
## 49    7       13 1
## 50    7        9 1
## 51    7       11 1
```

```
## 52    7       12 1
## 53    7       12 1
## 54    7        7 1
## 55    7        8 1
## 56    7       15 1
## 57    8       12 1
## 58    8       12 1
## 59    8        3 1
## 60    8       10 1
## 61    8        9 1
## 62    8        9 1
## 63    8        9 1
## 64    8        5 1
## 65    9       11 1
## 66    9       12 1
## 67    9       16 1
## 68    9       11 1
## 69    9        7 1
## 70    9        5 1
## 71    9       16 1
## 72    9        7 1
## 73   10       12 1
## 74   10       13 1
## 75   10       11 1
## 76   10        9 1
## 77   10       10 1
## 78   10        8 1
## 79   10       10 1
## 80   10        9 1
```

```
hist <- ggplot(dataft, aes(x = Defects)) + geom_histogram(bins=8, color = "black", fill
= "violet") + ggtitle("Histogram of Defects from 12:15-2") + scale_x_continuous(limits =
c(4,20))

box<- ggplot(dataft, aes(x=Defects)) + geom_boxplot() + ggtitle("Boxplot of Defects from
12:15-2")

egg::ggarrange(box, hist, heights = 2:1)
```

```
## Warning: Removed 1 rows containing non-finite values (`stat_bin()`).
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Boxplot of Defects from 12:15-2
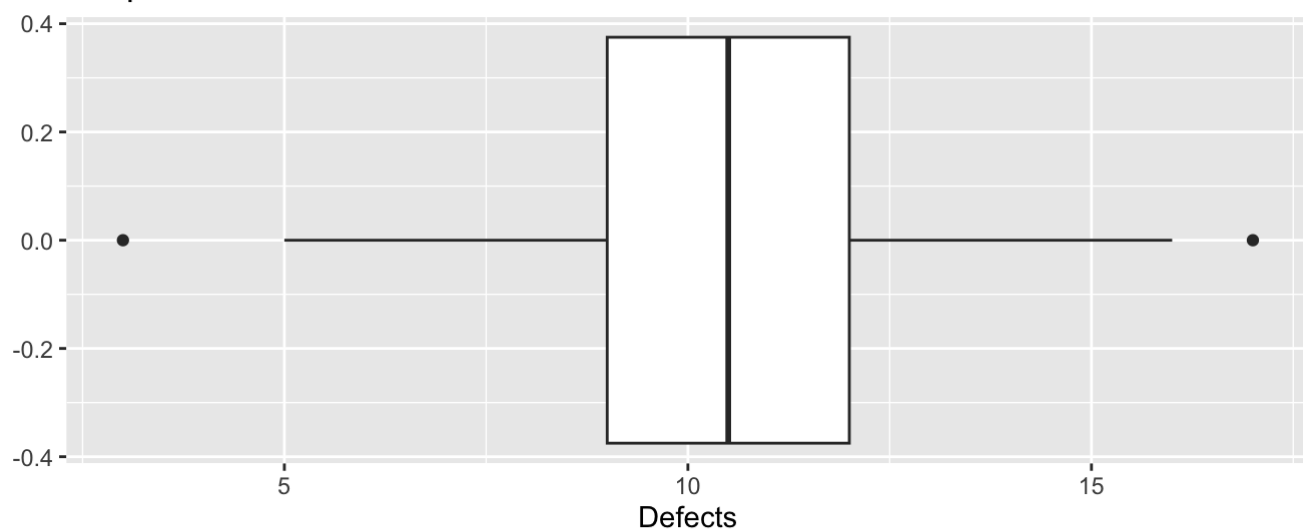
Histogram of Defects from 12:15-2
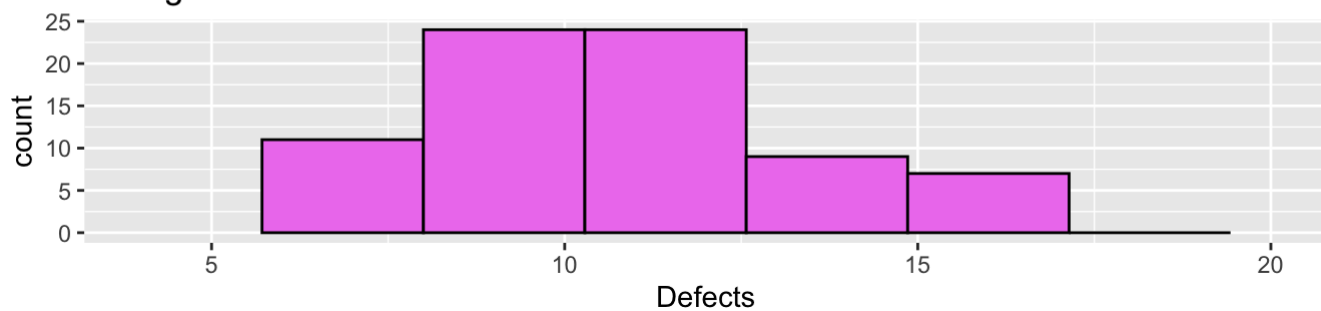

```
xbar <- mean(dataft$Defects)
xbar
```

```
## [1] 10.45
```

```
sd <- sd(dataft$Defects)
sd
```

```
## [1] 2.810018
```

```
n = 80
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.3141696
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 9.824661
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 11.07534
```

14:15-16:00

```
library("dplyr")
library("ggplot2")
library("egg")

datlat <- filter(dat, Sample == '14:15' | Sample == '14:30' | Sample == '14:45' | Sample
== '15:00' | Sample == '15:15' | Sample == '15:30' | Sample == '15:45' | Sample == '16:0
0')
datlat <- subset(datlat, select = -Sample)
datlat$n <- c(1,1,1,1,1,1,1,1,1,1)
datlat
```

```
##      Day Defects n
## 1      1      15 1
## 2      1      11 1
## 3      1      13 1
## 4      1       9 1
## 5      1      15 1
## 6      1       8 1
## 7      1       7 1
## 8      1      11 1
## 9      2      10 1
## 10     2      15 1
## 11     2       6 1
## 12     2      12 1
## 13     2      13 1
## 14     2       7 1
## 15     2       7 1
## 16     2      11 1
## 17     3       4 1
## 18     3       6 1
## 19     3      13 1
## 20     3       9 1
## 21     3      17 1
## 22     3      15 1
## 23     3      14 1
## 24     3      12 1
## 25     4      14 1
## 26     4       7 1
## 27     4       7 1
## 28     4      16 1
## 29     4       3 1
## 30     4      13 1
## 31     4      16 1
## 32     4       9 1
## 33     5       9 1
## 34     5       9 1
## 35     5       9 1
## 36     5      13 1
## 37     5      12 1
## 38     5      14 1
## 39     5      14 1
## 40     5       8 1
## 41     6       7 1
## 42     6       5 1
## 43     6      12 1
## 44     6       6 1
## 45     6      12 1
## 46     6       4 1
## 47     6      10 1
## 48     6      14 1
## 49     7      11 1
## 50     7      14 1
## 51     7      13 1
```

```
## 52    7        7 1
## 53    7       10 1
## 54    7       16 1
## 55    7       10 1
## 56    7        7 1
## 57    8       11 1
## 58    8        8 1
## 59    8       14 1
## 60    8       17 1
## 61    8        7 1
## 62    8       14 1
## 63    8       12 1
## 64    8        6 1
## 65    9       11 1
## 66    9        5 1
## 67    9        8 1
## 68    9       14 1
## 69    9       10 1
## 70    9        9 1
## 71    9       11 1
## 72    9       12 1
## 73   10       14 1
## 74   10       11 1
## 75   10        8 1
## 76   10       15 1
## 77   10       10 1
## 78   10        8 1
## 79   10        9 1
## 80   10       13 1
```

```
hist <- ggplot(datlat, aes(x = Defects)) + geom_histogram(bins=8, color = "black", fill
= "violet") + ggtitle("Histogram of Defects from 2:15-4") + scale_x_continuous(limits =
c(4,20))

box<- ggplot(datmid, aes(x=Defects)) + geom_boxplot() + ggtitle("Boxplot of Defects from
2:15-4")

egg::ggarrange(box, hist, heights = 2:1)
```

```
## Warning: Removed 1 rows containing non-finite values (`stat_bin()`).
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Boxplot of Defects from 2:15-4
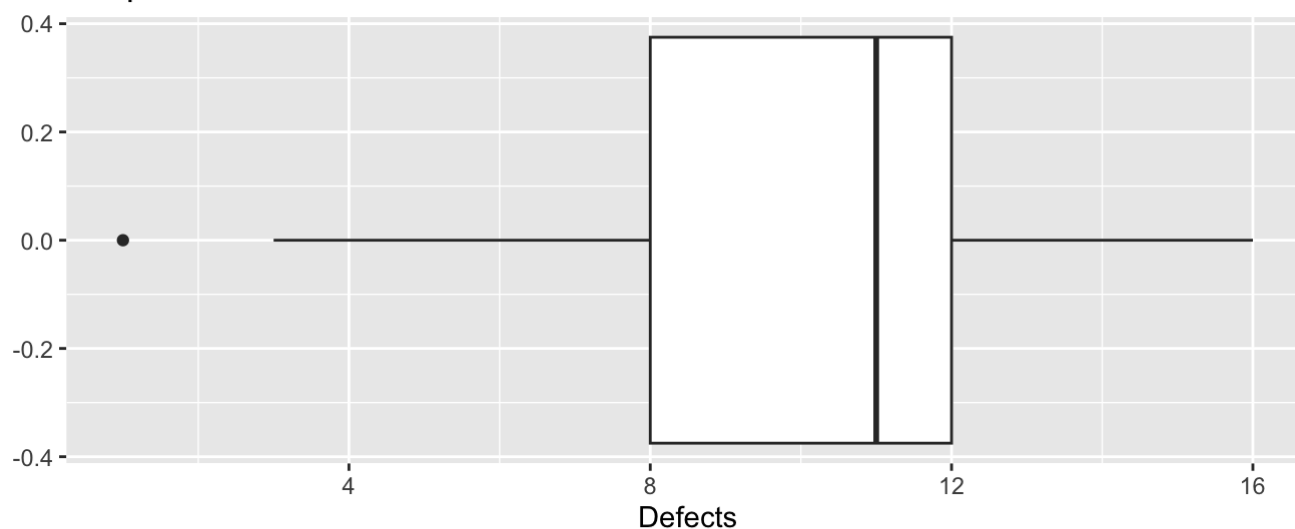
Histogram of Defects from 2:15-4
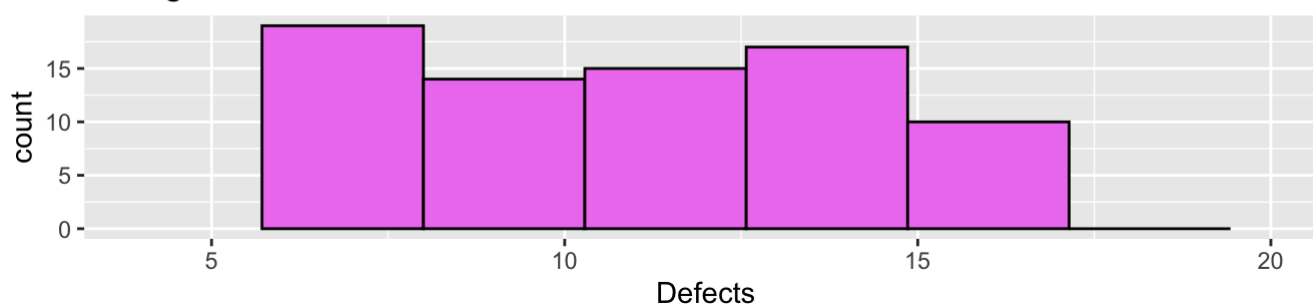
```
xbar <- mean(datlat$Defects)
xbar
```

```
## [1] 10.6
```

```
sd <- sd(datlat$Defects)
sd
```

```
## [1] 3.392471
```

```
n = 80
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.3792898
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 9.845043
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 11.35496
```

Part 3

First Half

```
library("dplyr")
library("ggplot2")
library("egg")

datfirst <- filter(dat, Day == '1' | Day == '2' | Day == '6' | Day == '7')
datfirst <- subset(datfirst, select = -Day)
datfirst
```

```
##       Sample Defects
## 1      08:15      12
## 2      08:30       8
## 3      08:45       9
## 4      09:00      11
## 5      09:15       9
## 6      09:30      10
## 7      09:45      12
## 8      10:00       9
## 9      10:15      12
## 10     10:30       4
## 11     10:45      11
## 12     11:00       8
## 13     11:15      12
## 14     11:30      12
## 15     11:45       9
## 16     12:00       8
## 17     12:15       9
## 18     12:30      10
## 19     12:45      15
## 20     13:00      11
## 21     13:15      14
## 22     13:30      11
## 23     13:45       9
## 24     14:00       7
## 25     14:15      15
## 26     14:30      11
## 27     14:45      13
## 28     15:00       9
## 29     15:15      15
## 30     15:30       8
## 31     15:45       7
## 32     16:00      11
## 33     08:15      17
## 34     08:30      12
## 35     08:45       7
## 36     09:00      11
## 37     09:15       7
## 38     09:30       6
## 39     09:45      10
## 40     10:00      11
## 41     10:15      12
## 42     10:30       7
## 43     10:45      11
## 44     11:00       6
## 45     11:15      12
## 46     11:30      13
## 47     11:45       1
## 48     12:00      12
## 49     12:15      13
## 50     12:30       8
## 51     12:45      14
```

```
## 52    13:00      12
## 53    13:15       8
## 54    13:30      12
## 55    13:45      12
## 56    14:00      10
## 57    14:15      10
## 58    14:30      15
## 59    14:45       6
## 60    15:00      12
## 61    15:15      13
## 62    15:30       7
## 63    15:45       7
## 64    16:00      11
## 65    08:15      13
## 66    08:30       9
## 67    08:45      14
## 68    09:00      10
## 69    09:15       7
## 70    09:30       7
## 71    09:45      11
## 72    10:00      12
## 73    10:15       9
## 74    10:30      11
## 75    10:45      13
## 76    11:00      11
## 77    11:15      12
## 78    11:30       6
## 79    11:45      14
## 80    12:00      12
## 81    12:15      10
## 82    12:30       9
## 83    12:45       9
## 84    13:00       5
## 85    13:15      11
## 86    13:30      17
## 87    13:45      13
## 88    14:00      10
## 89    14:15       7
## 90    14:30       5
## 91    14:45      12
## 92    15:00       6
## 93    15:15      12
## 94    15:30       4
## 95    15:45      10
## 96    16:00      14
## 97    08:15      10
## 98    08:30       8
## 99    08:45      15
## 100   09:00       3
## 101   09:15       8
## 102   09:30      12
## 103   09:45       5
```

```
## 104   10:00        5
## 105   10:15       14
## 106   10:30       12
## 107   10:45       16
## 108   11:00        9
## 109   11:15       10
## 110   11:30       10
## 111   11:45       12
## 112   12:00        4
## 113   12:15       13
## 114   12:30        9
## 115   12:45       11
## 116   13:00       12
## 117   13:15       12
## 118   13:30        7
## 119   13:45        8
## 120   14:00       15
## 121   14:15       11
## 122   14:30       14
## 123   14:45       13
## 124   15:00        7
## 125   15:15       10
## 126   15:30       16
## 127   15:45       10
## 128   16:00        7
```

```
hist <- ggplot(datfirst, aes(x = Defects)) + geom_histogram(bins=8, color = "black", fil
l = "violet") + ggtitle("Histogram of Defects on Day 1, 2, 6, and 7") + scale_x_continuo
us(limits = c(4,20))

box<- ggplot(datfirst, aes(x=Defects)) + geom_boxplot() + ggtitle("Boxplot of Defects on
Day 1, 2, 6, and 7")

egg::ggarrange(box, hist, heights = 2:1)
```
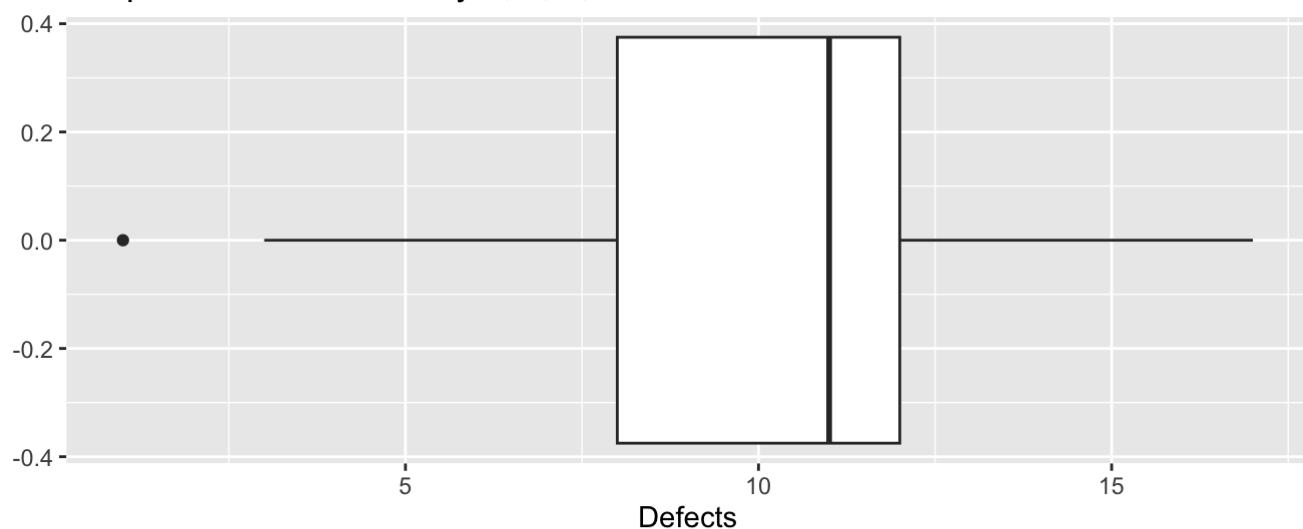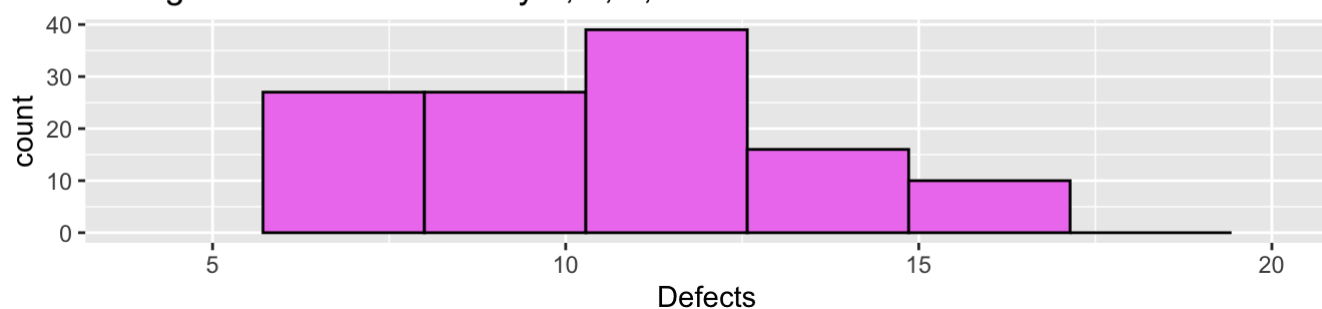
```
## Warning: Removed 2 rows containing non-finite values (`stat_bin()`).
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Boxplot of Defects on Day 1, 2, 6, and 7

Histogram of Defects on Day 1, 2, 6, and 7


```
xbar <- mean(datfirst$Defects)
xbar
```

```
## [1] 10.22656
```

```
sd <- sd(datfirst$Defects)
sd
```

```
## [1] 3.071881
```

```
n = 80
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.3434468
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 9.542949
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 10.91018
```

Second Half

```
library("dplyr")
library("ggplot2")
library("egg")

datsecond <- filter(dat, Day == '4' | Day == '5' | Day == '9' | Day == '10')
datsecond <- subset(datsecond, select = -Day)
datsecond
```

```
##      Sample Defects
## 1    08:15      11
## 2    08:30      11
## 3    08:45       8
## 4    09:00      12
## 5    09:15      12
## 6    09:30      11
## 7    09:45      12
## 8    10:00      13
## 9    10:15      10
## 10   10:30      15
## 11   10:45      12
## 12   11:00       6
## 13   11:15       7
## 14   11:30       5
## 15   11:45       3
## 16   12:00      13
## 17   12:15       9
## 18   12:30      11
## 19   12:45       9
## 20   13:00      15
## 21   13:15      12
## 22   13:30       6
## 23   13:45       8
## 24   14:00      11
## 25   14:15      14
## 26   14:30       7
## 27   14:45       7
## 28   15:00      16
## 29   15:15       3
## 30   15:30      13
## 31   15:45      16
## 32   16:00       9
## 33   08:15       7
## 34   08:30       8
## 35   08:45       7
## 36   09:00      11
## 37   09:15       7
## 38   09:30      17
## 39   09:45       7
## 40   10:00       8
## 41   10:15      11
## 42   10:30       3
## 43   10:45      14
## 44   11:00       7
## 45   11:15      10
## 46   11:30       3
## 47   11:45      11
## 48   12:00      14
## 49   12:15      10
## 50   12:30      13
## 51   12:45      16
```

```
## 52    13:00       12
## 53    13:15       10
## 54    13:30       11
## 55    13:45       11
## 56    14:00       13
## 57    14:15        9
## 58    14:30        9
## 59    14:45        9
## 60    15:00       13
## 61    15:15       12
## 62    15:30       14
## 63    15:45       14
## 64    16:00        8
## 65    08:15       11
## 66    08:30       12
## 67    08:45       10
## 68    09:00       12
## 69    09:15       14
## 70    09:30       13
## 71    09:45        6
## 72    10:00        8
## 73    10:15        9
## 74    10:30       13
## 75    10:45        5
## 76    11:00       11
## 77    11:15        6
## 78    11:30        8
## 79    11:45       11
## 80    12:00       14
## 81    12:15       11
## 82    12:30       12
## 83    12:45       16
## 84    13:00       11
## 85    13:15        7
## 86    13:30        5
## 87    13:45       16
## 88    14:00        7
## 89    14:15       11
## 90    14:30        5
## 91    14:45        8
## 92    15:00       14
## 93    15:15       10
## 94    15:30        9
## 95    15:45       11
## 96    16:00       12
## 97    08:15        9
## 98    08:30       18
## 99    08:45       17
## 100   09:00       16
## 101   09:15       10
## 102   09:30       12
## 103   09:45        8
```

```
## 104    10:00          9
## 105    10:15         11
## 106    10:30         13
## 107    10:45         11
## 108    11:00          8
## 109    11:15          9
## 110    11:30         14
## 111    11:45          9
## 112    12:00          4
## 113    12:15         12
## 114    12:30         13
## 115    12:45         11
## 116    13:00          9
## 117    13:15         10
## 118    13:30          8
## 119    13:45         10
## 120    14:00          9
## 121    14:15         14
## 122    14:30         11
## 123    14:45          8
## 124    15:00         15
## 125    15:15         10
## 126    15:30          8
## 127    15:45          9
## 128    16:00         13
```

```
hist <- ggplot(datsecond, aes(x = Defects)) + geom_histogram(bins=8, color = "black", fi
ll = "violet") + ggtitle("Histogram of Defects on Day 4, 5, 9, and 10") + scale_x_contin
uous(limits = c(4,20))

box<- ggplot(datsecond, aes(x=Defects)) + geom_boxplot() + ggtitle("Boxplot of Defects o
n Day 4, 5, 9, and 10")

egg::ggarrange(box, hist, heights = 2:1)
```
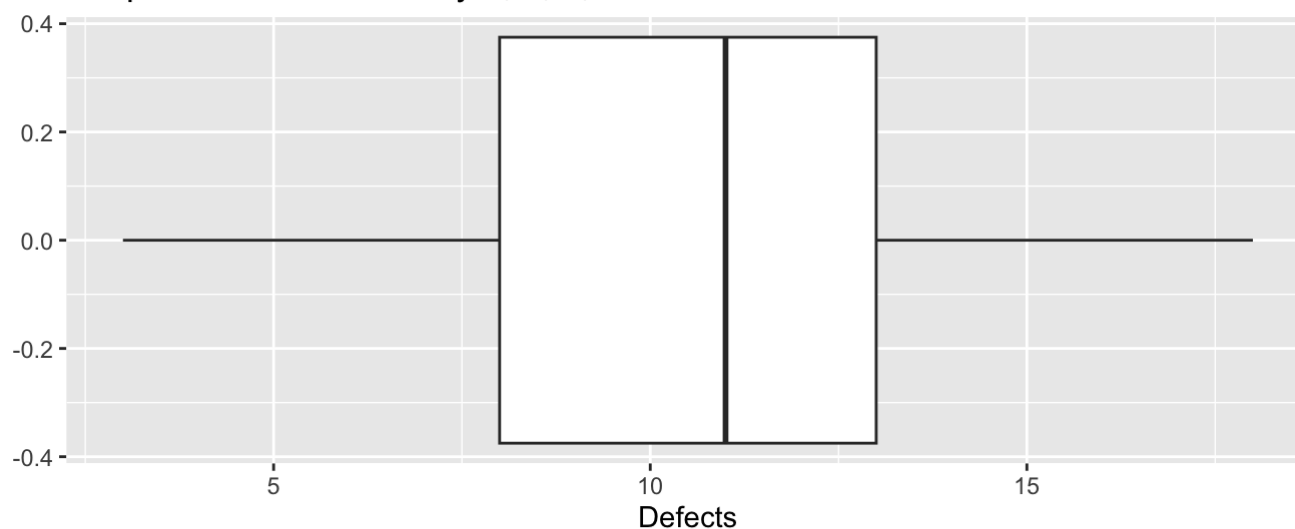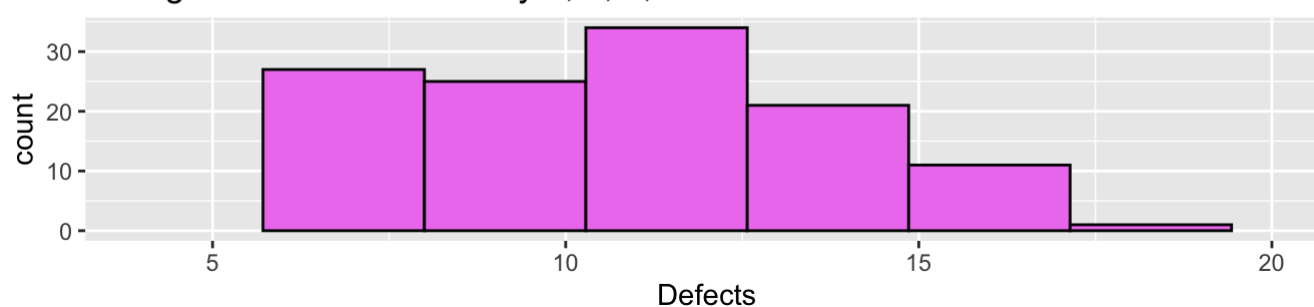
```
## Warning: Removed 4 rows containing non-finite values (`stat_bin()`).
```

```
## Warning: Removed 2 rows containing missing values (`geom_bar()`).
```

Boxplot of Defects on Day 4, 5, 9, and 10

Histogram of Defects on Day 4, 5, 9, and 10

```
xbar <- mean(datsecond$Defects)
xbar
```

```
## [1] 10.40625
```

```
sd <- sd(datsecond$Defects)
sd
```

```
## [1] 3.220108
```

```
n = 80
standard_error_mean <- sd/sqrt(n)
standard_error_mean
```

```
## [1] 0.360019
```

```
margin <- qt(0.975,df=n-1)*sd/sqrt(n)
lowerinterval <- xbar - margin
lowerinterval
```

```
## [1] 9.68965
```

```
upperinterval <- xbar + margin
upperinterval
```

```
## [1] 11.12285
```