**Problem 1**

**(i)**

> pbinom(8, 30, .35)

[1] 0.2246957

> pbinom(8, 60, .35)

[1] 0.000146853

> pbinom(8, 90, .35)

[1] 9.635798e-09

> pbinom(8, 120, .35)

[1] 2.41666e-13

**(ii)**

> pnorm(8.05, 30\*.35, sqrt(30\*.35\*(1-.35)))

[1] 0.1741711

> pnorm(8.05, 60\*.35, sqrt(60\*.35\*(1-.35)))

[1] 0.0002281969

> pnorm(8.05, 90\*.35, sqrt(90\*.35\*(1-.35)))

[1] 1.095247e-07

> pnorm(8.05, 120\*.35, sqrt(120\*.35\*(1-.35)))

[1] 4.078348e-11

**(iii)**

> abs(pbinom(8, 30, .35) - pnorm(8.05, 30\*.35, sqrt(30\*.35\*(1-.35))))

[1] 0.05052456

> abs(pbinom(8, 60, .35) - pnorm(8.05, 60\*.35, sqrt(60\*.35\*(1-.35))))

[1] 8.134398e-05

> abs(pbinom(8, 90, .35) - pnorm(8.05, 90\*.35, sqrt(90\*.35\*(1-.35))))

[1] 9.988888e-08

> abs(pbinom(8, 120, .35) - pnorm(8.05, 120\*.35,

sqrt(120\*.35\*(1-.35))))

[1] 4.054182e-11

**(iv)**

> n <- c(30, 60, 90, 120)

> abs\_errors <- c(abs(pbinom(8, 30, .35) - pnorm(8.05, 30\*.35, sqrt(30\*.35\*(1-.35)))),

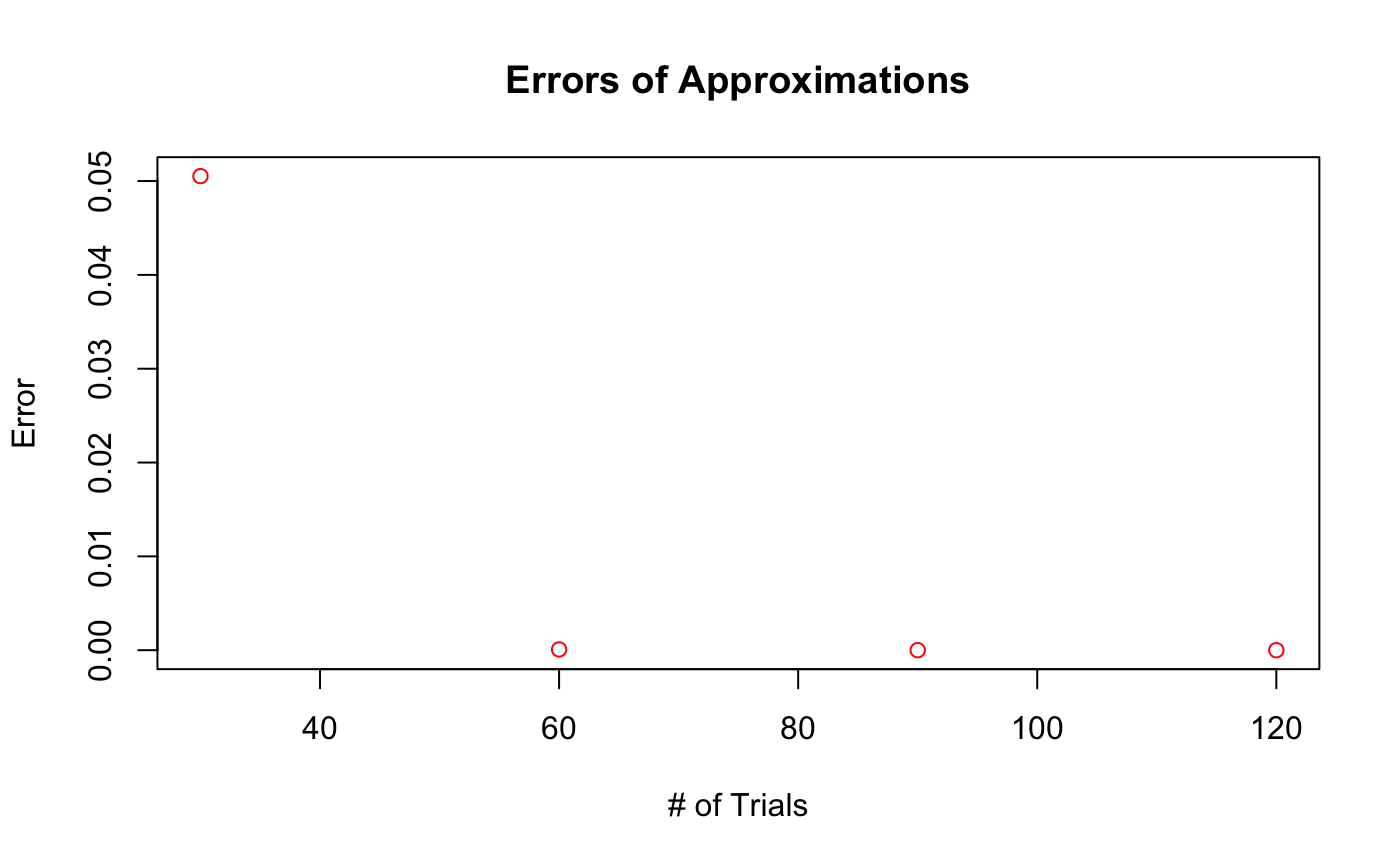
+ abs(pbinom(8, 60, .35) - pnorm(8.05, 60\*.35, sqrt(60\*.35\*(1-.35)))),

+ abs(pbinom(8, 90, .35) - pnorm(8.05, 90\*.35, sqrt(90\*.35\*(1-.35)))),

+ abs(pbinom(8, 120, .35) - pnorm(8.05, 120\*.35, sqrt(120\*.35\*(1-.35)))))

>

> plot(n, abs\_errors, col="red", xlab="# of Trials", ylab = "Error", main = "Errors of Approximations")



After 30 trials the errors tend to basically zero, so the more trials the less errors.

**Problem 2**

**(i, ii, iii, iv)**  
```{r}

generate\_plots <- function(n) {

X\_values <- c()

S\_values <- c()

for (i in 1:100) {

x <- rnorm(n, mean=2, sd=3)

X\_bar <- mean(x)

s\_squared <- var(x)

X\_values <- c(X\_values, (X\_bar - 2) / sqrt(9/n))

S\_values <- c(S\_values, ((n-1) \* s\_squared) / 9)

}

plot(density(X\_values), main=paste("Density curve of (X\_bar - 2) / sqrt(9/n) where n =", n))

plot(density(S\_values), main=paste("Density curve of (n-1)S^2 / 9 where n =", n))

plot(X\_values, S\_values, main=paste("Scatterplot for both equations where n =", n), xlab = "(X\_bar - 2) / sqrt(9/n)", ylab="(n-1)S^2 / 9")

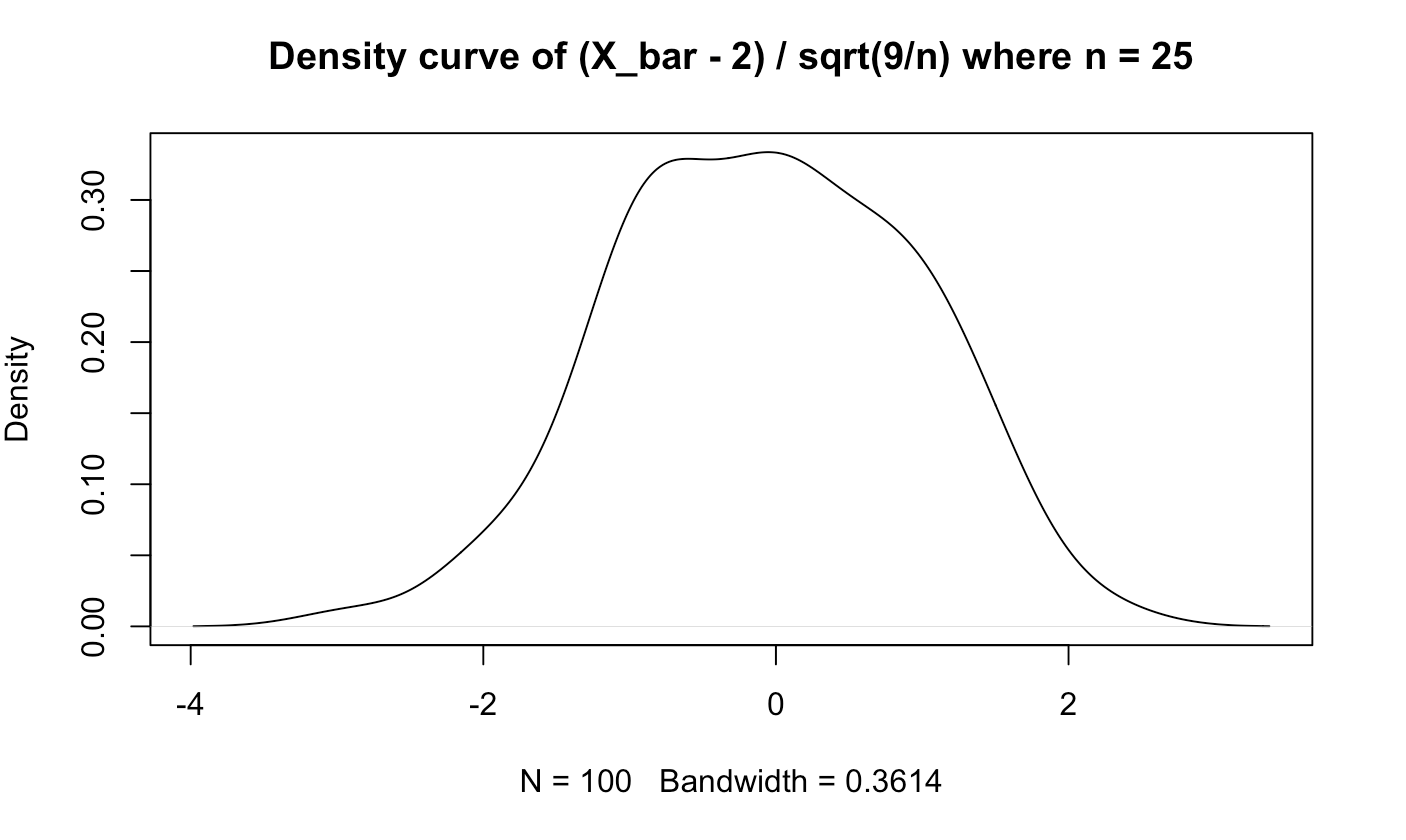
}

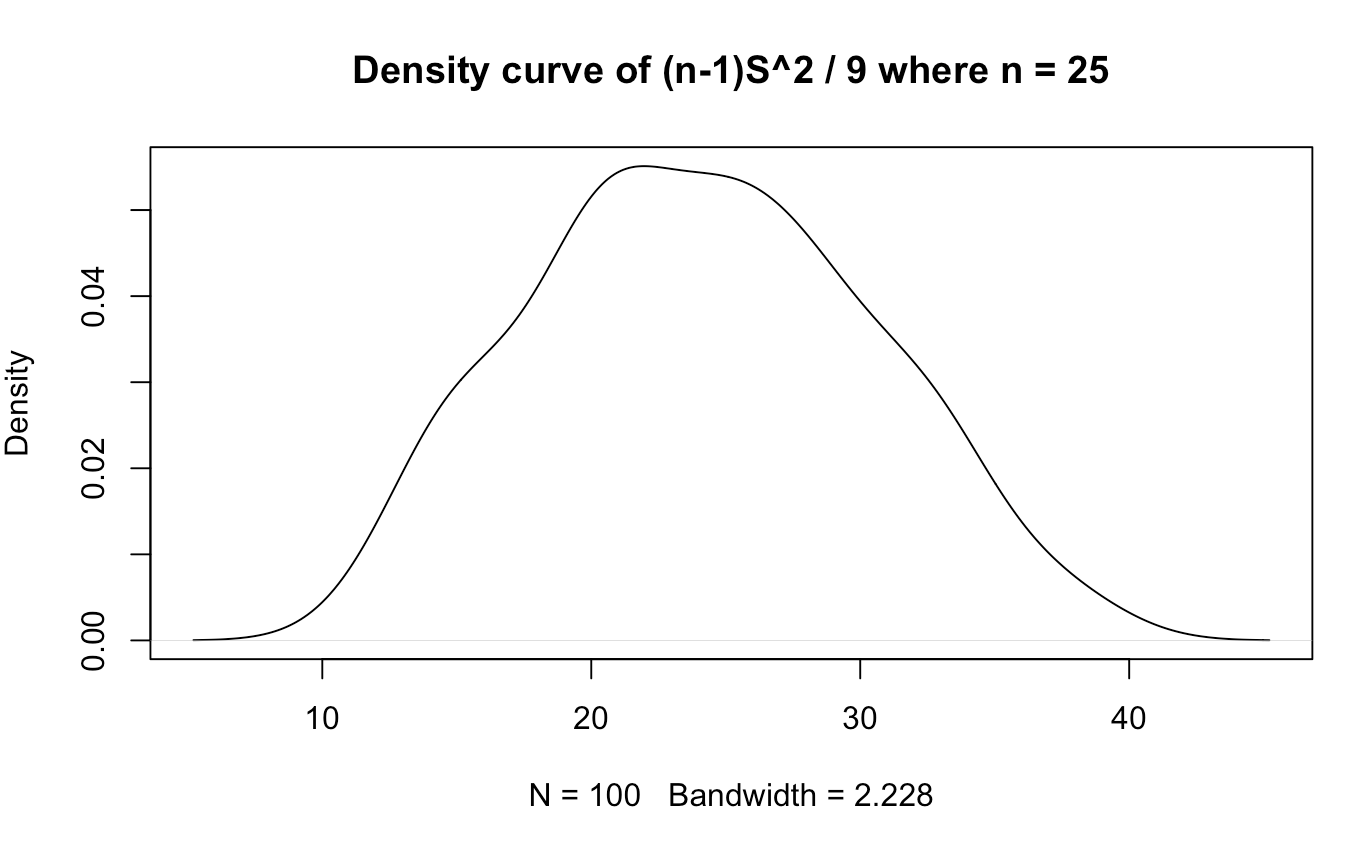
for (n in c(25, 50, 75, 100)) {

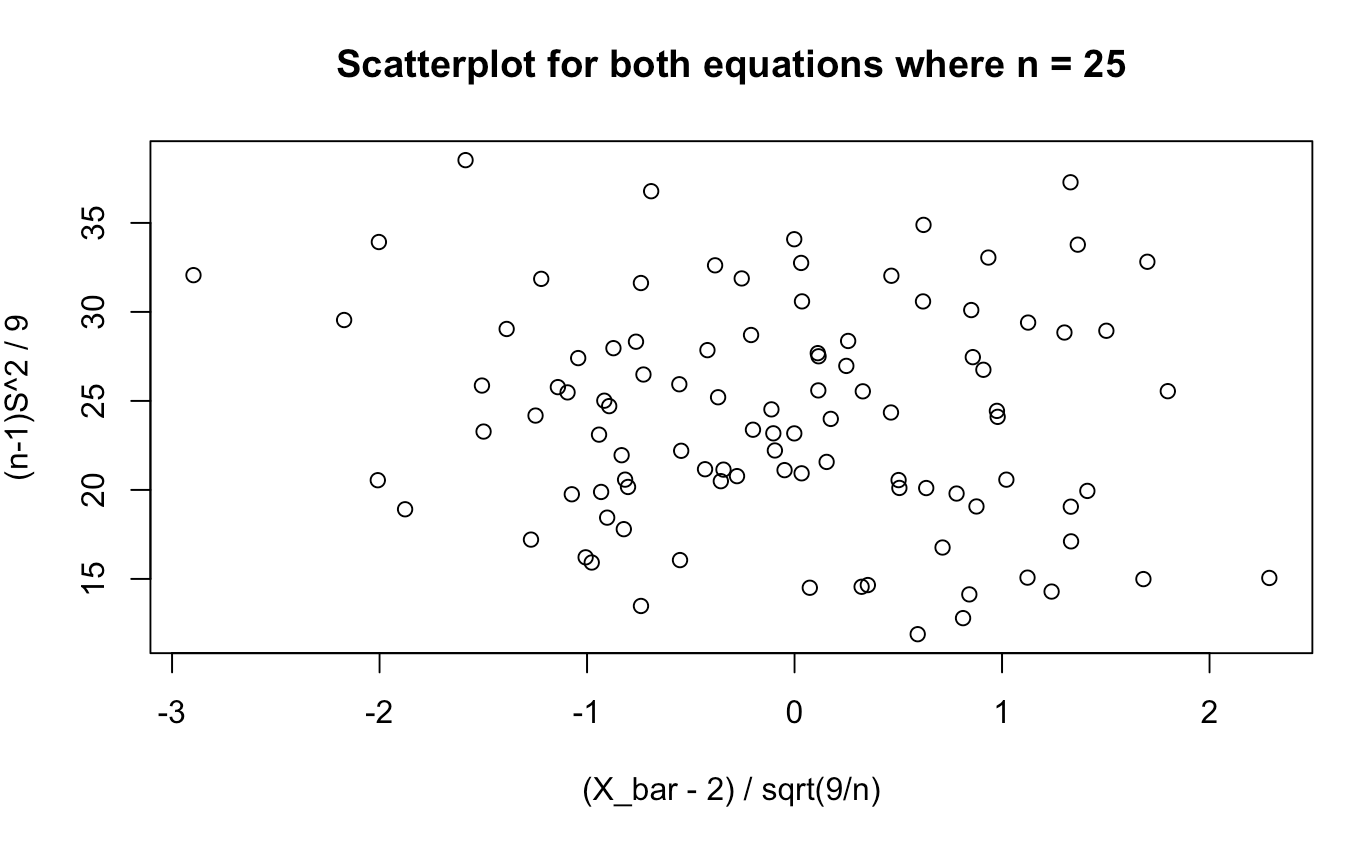
generate\_plots(n)

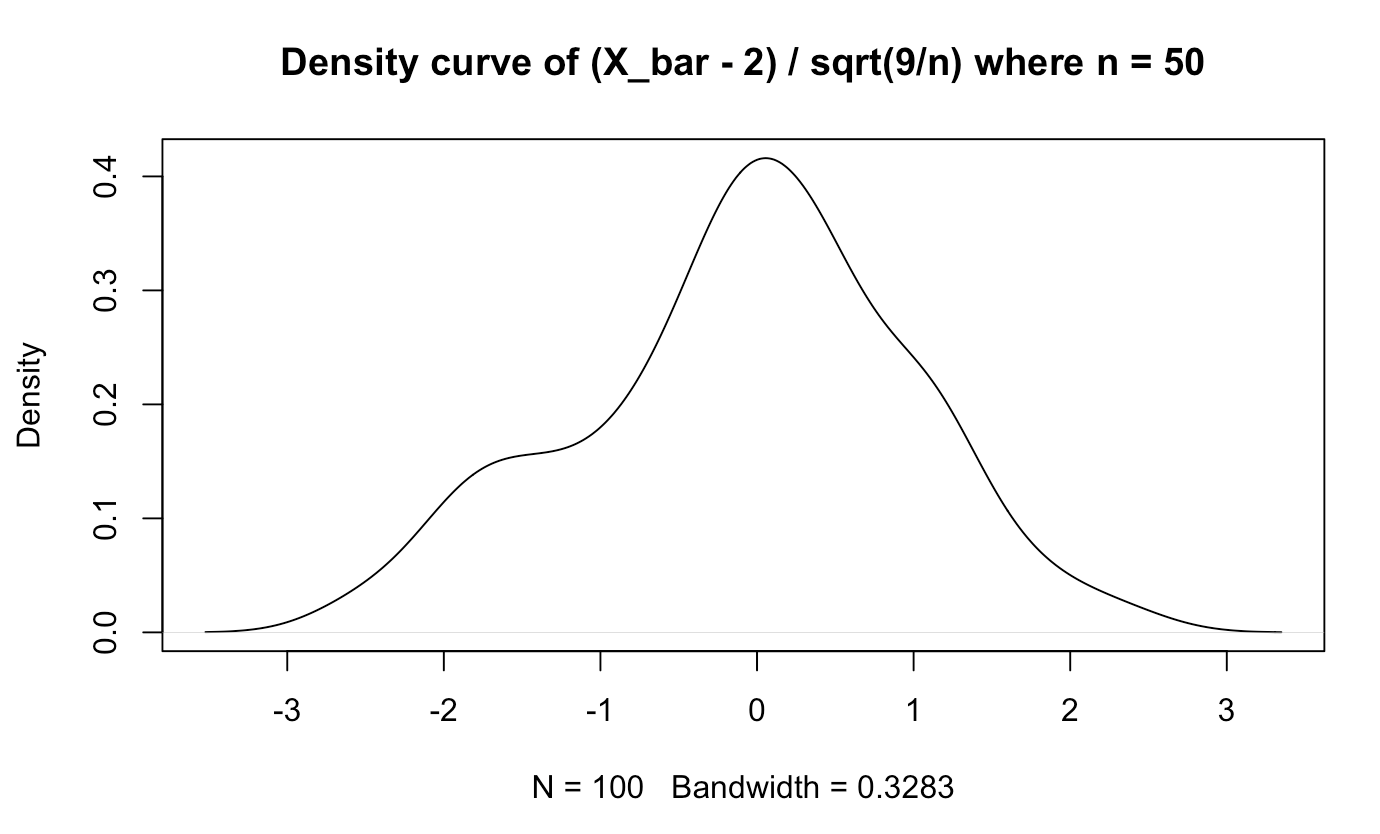
}

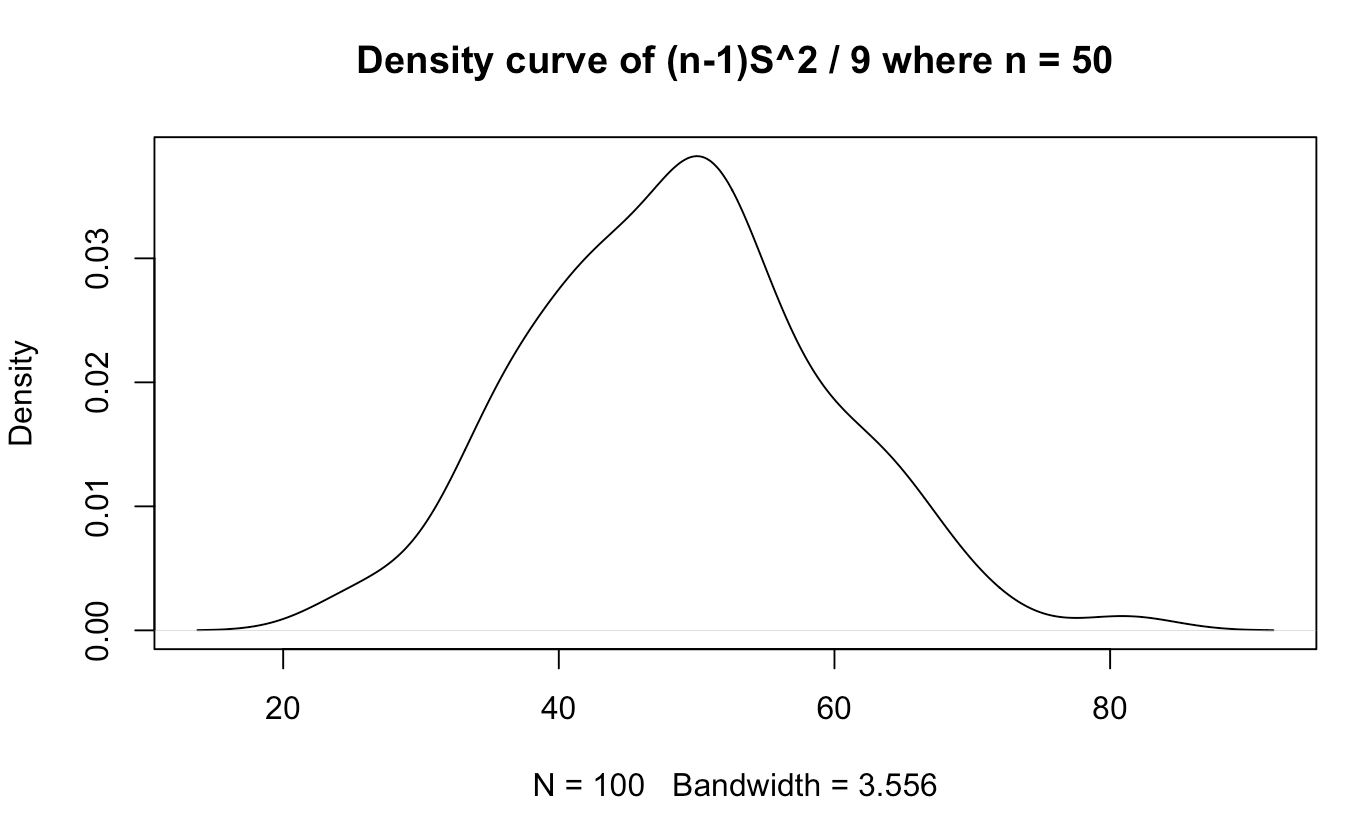
```

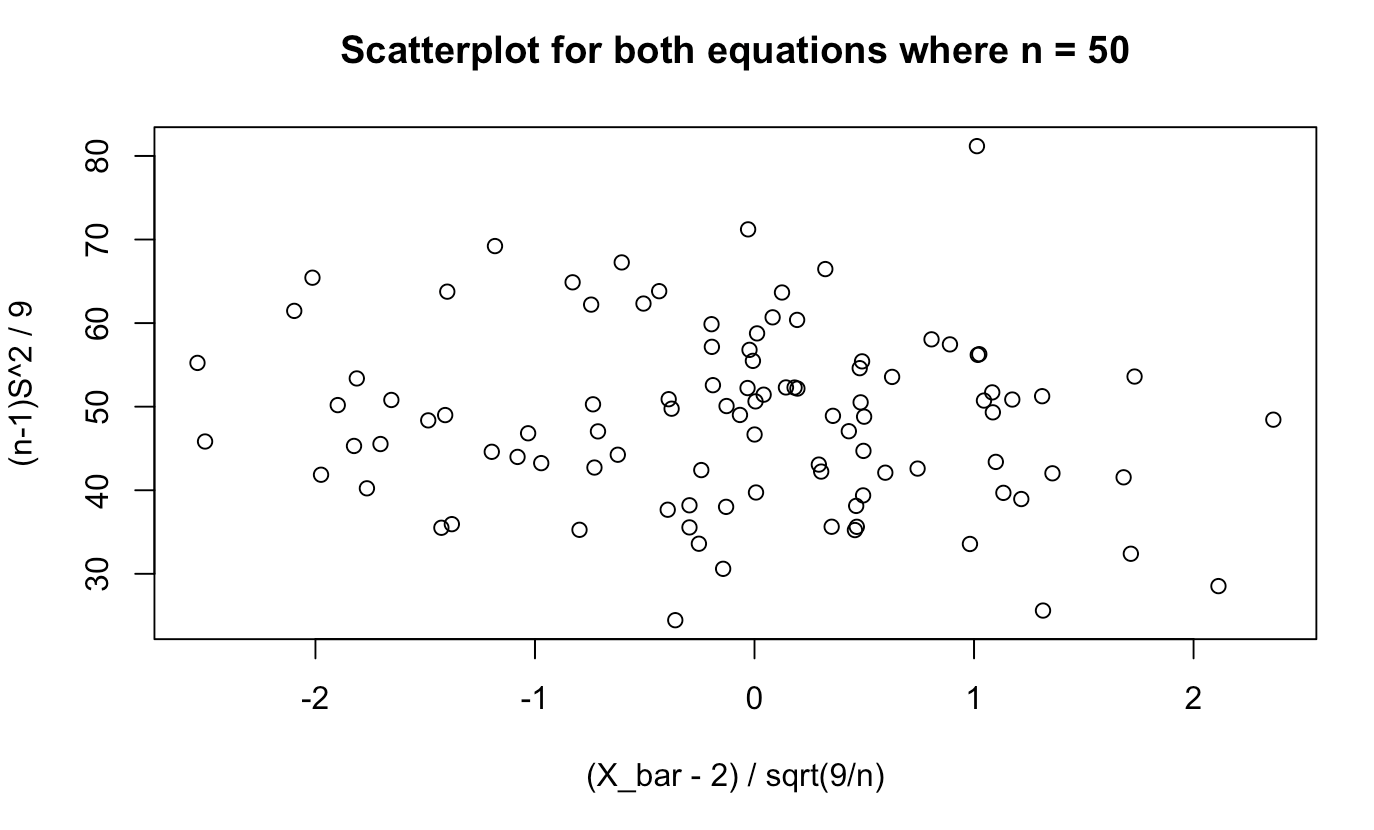


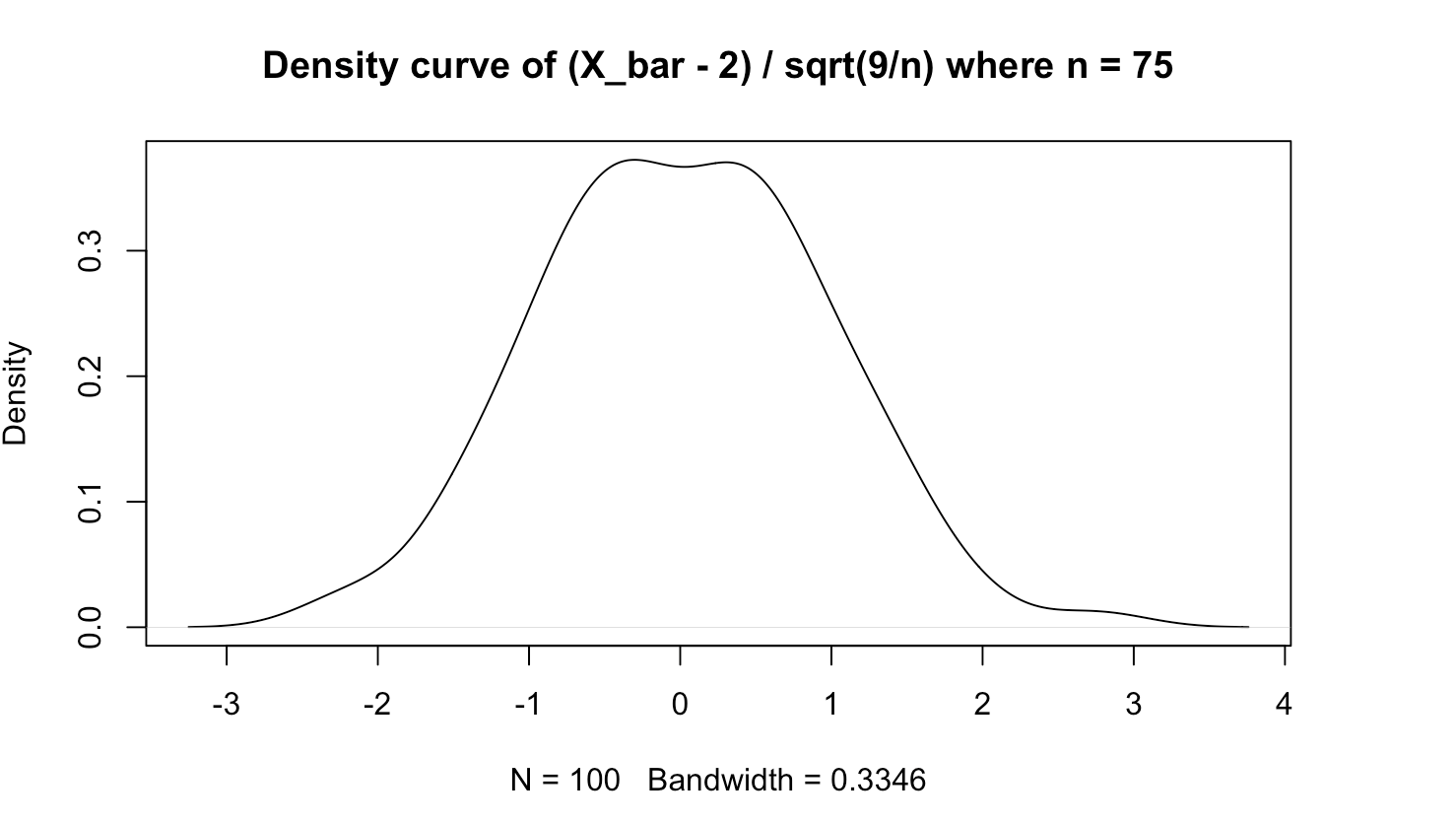


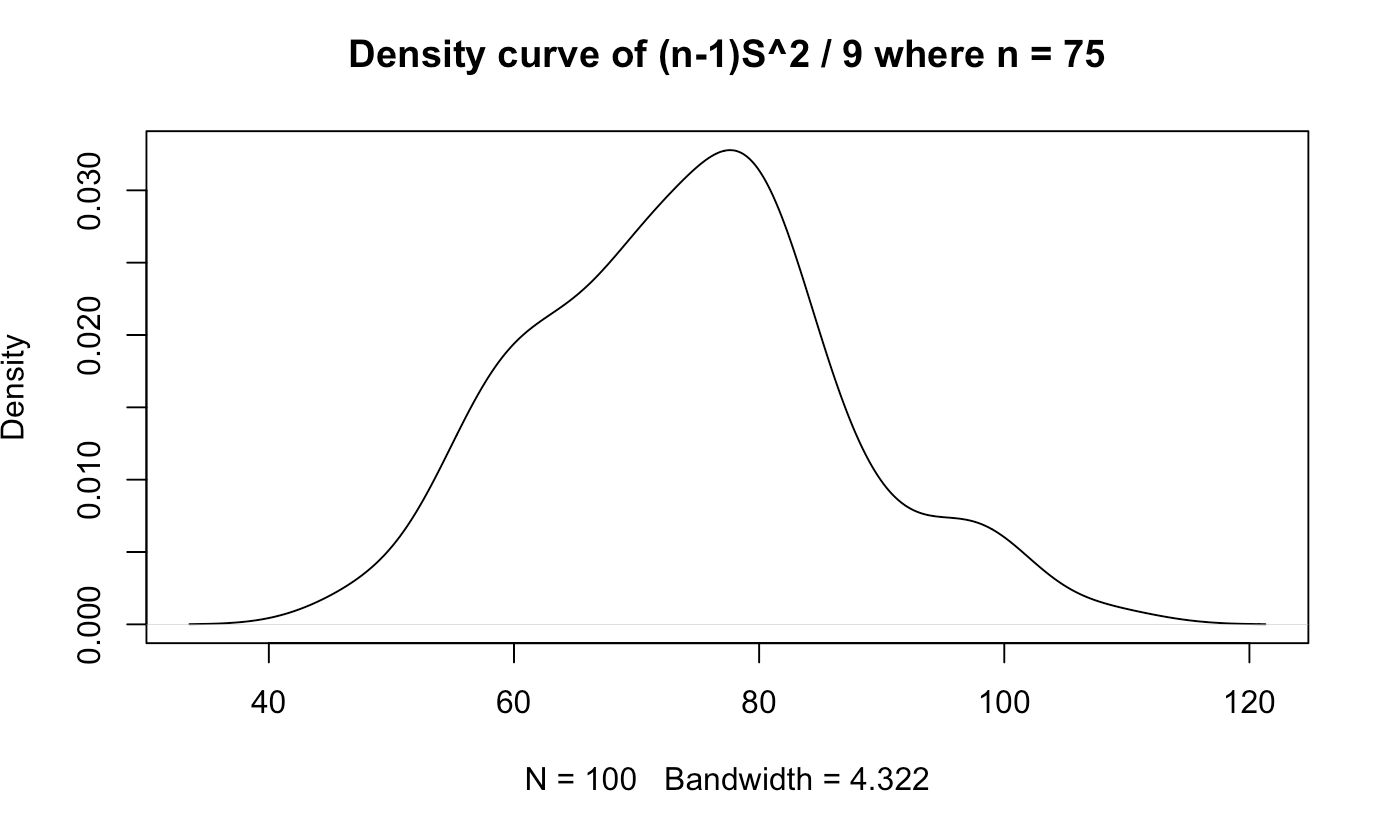


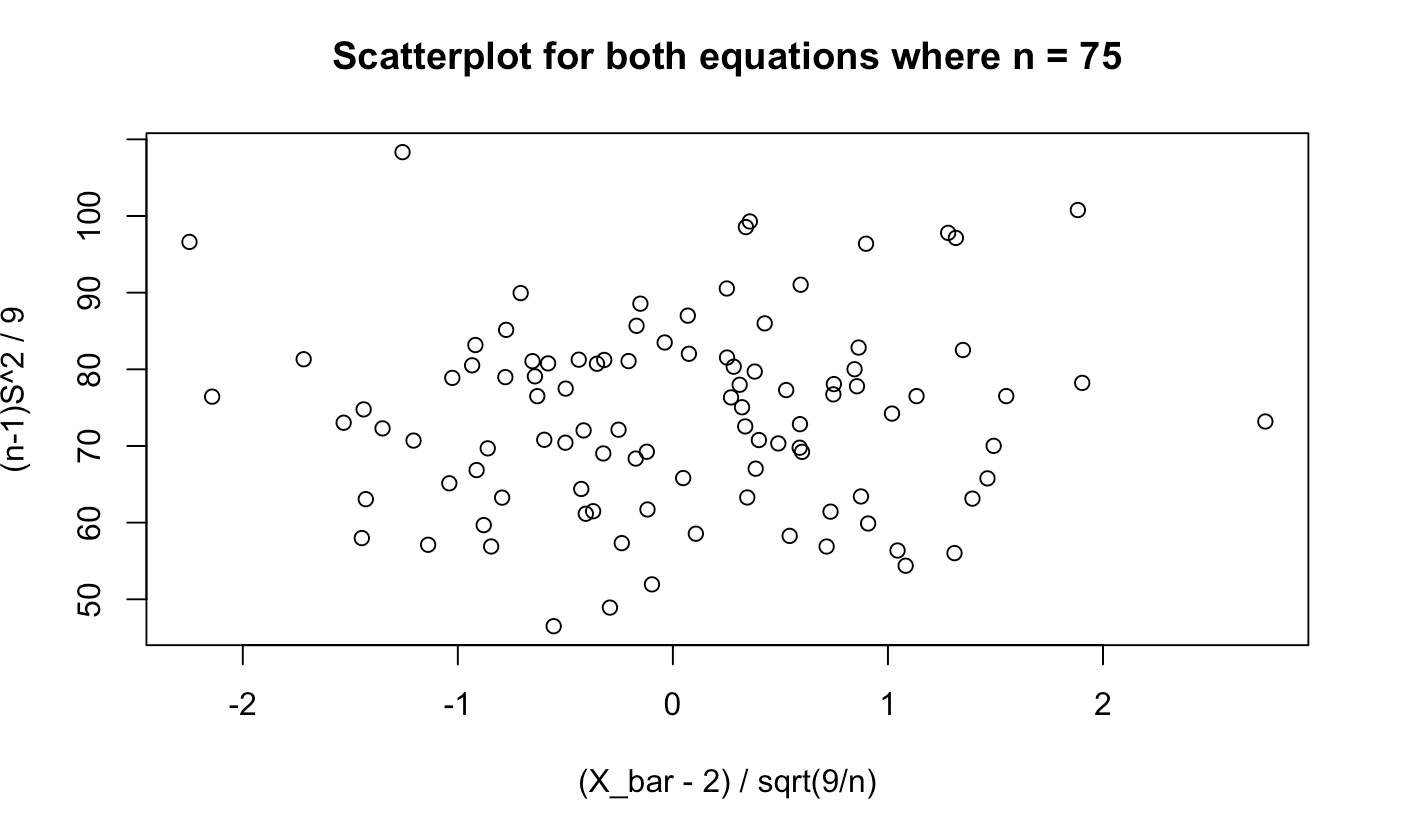


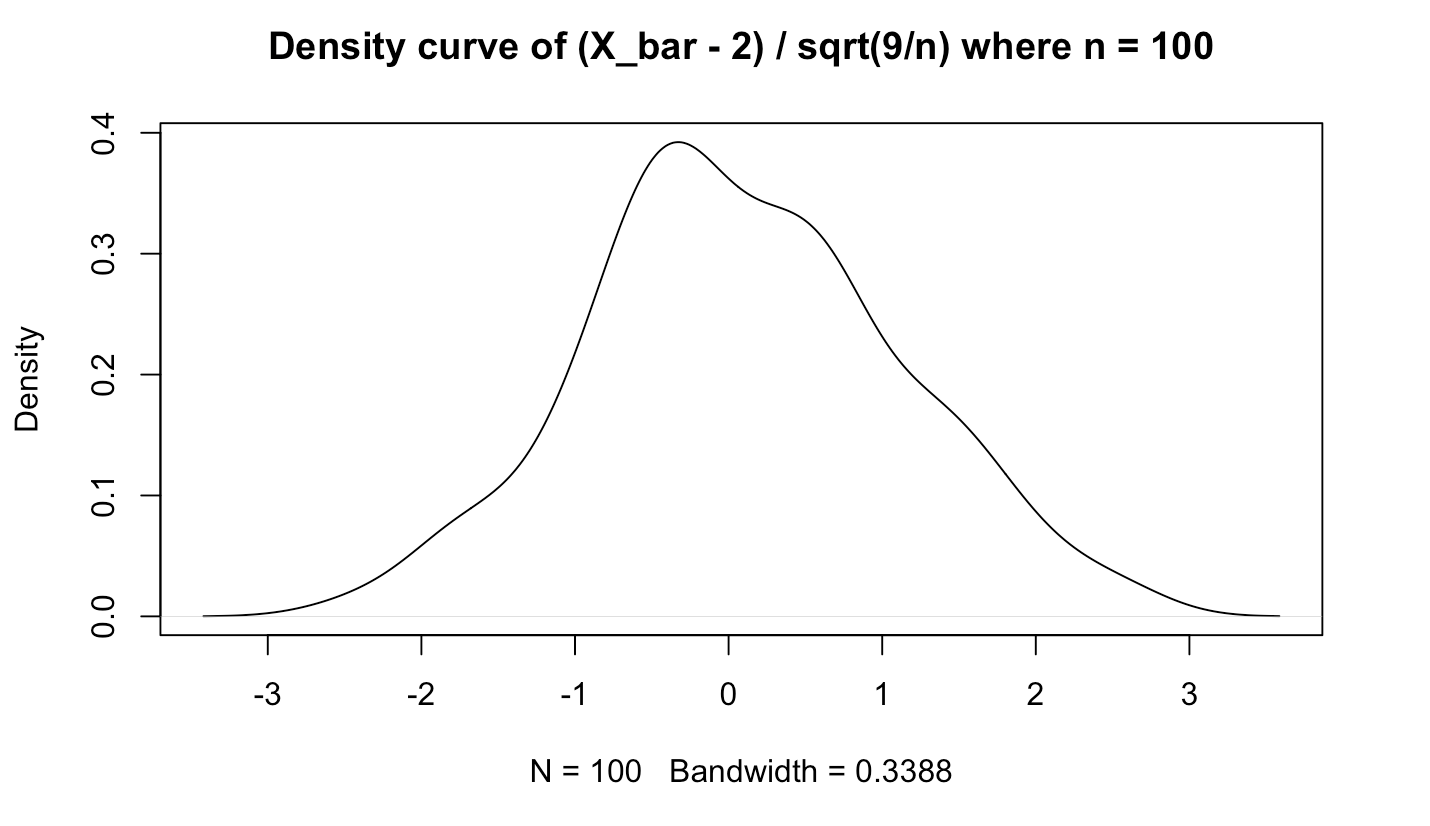


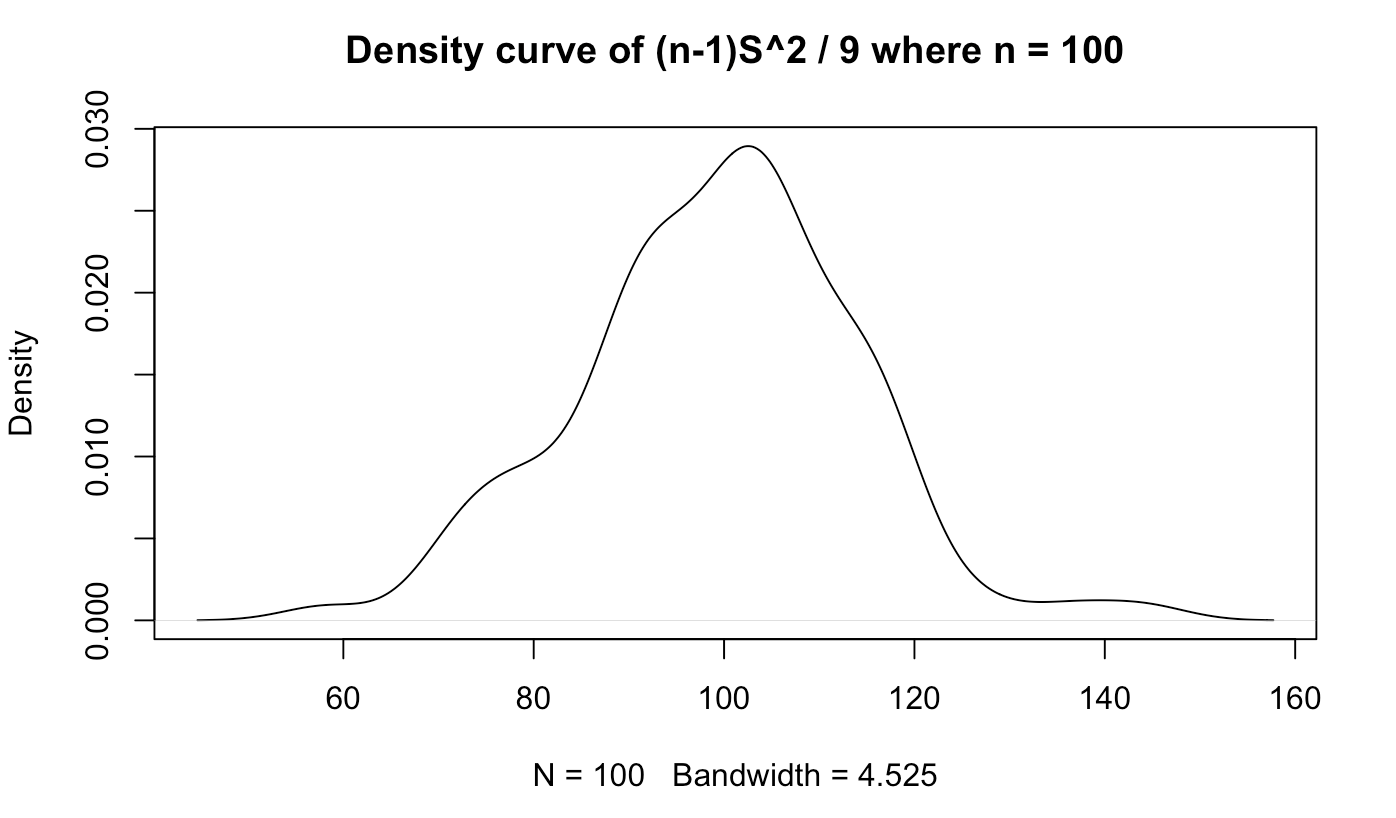


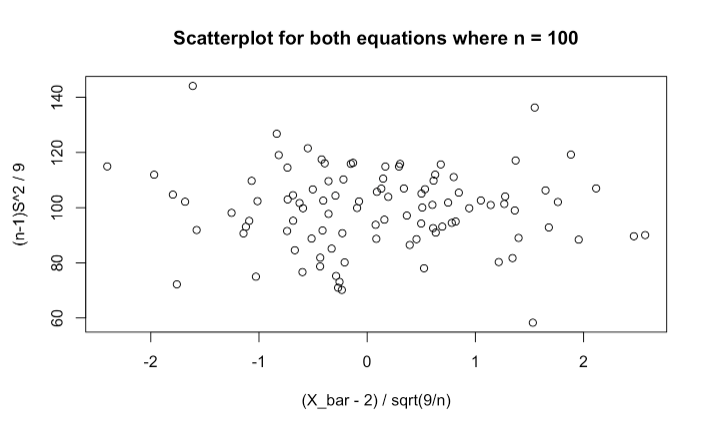












**(v)**

The higher the n, the closer the distribution of (x\_bar - 2) / sqrt(9 / n) was to normal while conversely, the distribution for the other equation became less normal.

**(vi)**

As the scatterplots reveal no certain correlation, we can assume the values are independent.

**Problem 3**

**(i)**

> X <- c(-0.4, 0.15, 0.5, -1.2, -0.5, 0.9, 1.5, -0.7, 1.5, -1, 2.25, 3.5, -1.45, 0.2, 2.75)

> n = length(X)

> Xbar = mean(X)

> a1 <- sum((X - 1)^2) / 2

> p1 <- 1 - pchisq(a1, df=n)

> a1 = 17.47

> P(> a2) = 0.2915524

a1 = 17.47 P(Chi-squared > a1) = 0.2915524

**(ii)**

> a2 <- sum((X - Xbar)^2) / 2

> p2 <- 1 - pchisq(a2, df=n-1)

> a2 = 15.83667

> P(> a2) = 0.3234504

a2 = 15.83667 P(Chi-squared > a2) = 0.3234504

**(iii)**

> a3 <- (Xbar - 1) / sqrt(var(X) / n)

> p3 <- 2 \* (1 - pt(abs(a3), df=n-1))

> a3 = -1.201627

> P(> |a3|) = 0.2494416

a3 = -1.201627 P(|T| > |a3|) = 0.2494416

**Problem 4**

**(i)**

P(X ∈ (−1, 2)):

> pnorm(2, mean = -1, sd = 4) - pnorm(-1, mean = -1, sd = 4)

[1] 0.2733726

P(Y ∈ (−1, 2)):

> pchisq(2, 10) - pchisq(-1, 10)

[1] 0.003659847

P(T ∈ (−1, 2)):

> pt(2, 11) - pt(-1, 11)

[1] 0.7951977

P(F ∈ (−1, 2)):

> pf(2, 8, 11) - pf(-1, 8, 11)

[1] 0.8578956

**(ii)**

> qs <- c(0.05/2, 0.05, 1 - 0.05, 1 - 0.05/2)

> qs

[1] 0.025 0.050 0.950 0.975

> qnorm(qs, mean = -1, sd = 4)

[1] -8.839856 -7.579415 5.579415 6.839856

> qchisq(qs, 10)

[1] 3.246973 3.940299 18.307038 20.483177

> qt(qs, 11)

[1] -2.200985 -1.795885 1.795885 2.200985

> qf(qs, 8, 11)

[1] 0.2356594 0.3018457 2.9479903 3.6638190

**Problem 5**

**(i)**

The expected value for a binomial distribution would be the product of each trial's possibilities of succeeding. This would look like . Therefore .

Generally, . For the binomial distribution, .

**(ii)**

According to Slide 20 in slide deck 2, if then . Multiplying standard normal distributions changes the standard deviation but not the expected value, which means that .

**(iii)**

The student T distribution is defined as where and are independent. where . Therefore .

The student T distribution is symmetric about the y-axis, so . We know some such that . Therefore .

**Problem 6**

**(i)**

;

;

;

**(ii)**

Recall W, X, and Y follow normal distributions and are mutually independent.

We already know

**(iii)**

Recall W, X, and Y follow normal distributions and are mutually independent.

because it is of the form .

because it is of the form .

**(iv)**

because it is of the form .

because it is of the form .