Part 1: Simulation Exercise Instructions

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23/10/2020

In this project I will investigate the exponential distribution in R and compare it with the Central Limit Theorem. The exponential distribution can be simulated in R with rexp(n, lambda) where lambda is the rate parameter. The mean of exponential distribution is 1/lambda and the standard deviation is also 1/lambda

```r
set.seed(1)
lambda= 0.2
n= 40
mns = NULL
for (i in 1 : 1000) {
  mns= c(mns, mean( rexp(n, lambda)))
}
```

1. Show the sample mean and compare it to the theoretical mean of the distribution.

```r
# Sample Mean:
SampleMean <- mean(mns)
SampleMean
```

```
## [1] 4.990025
```

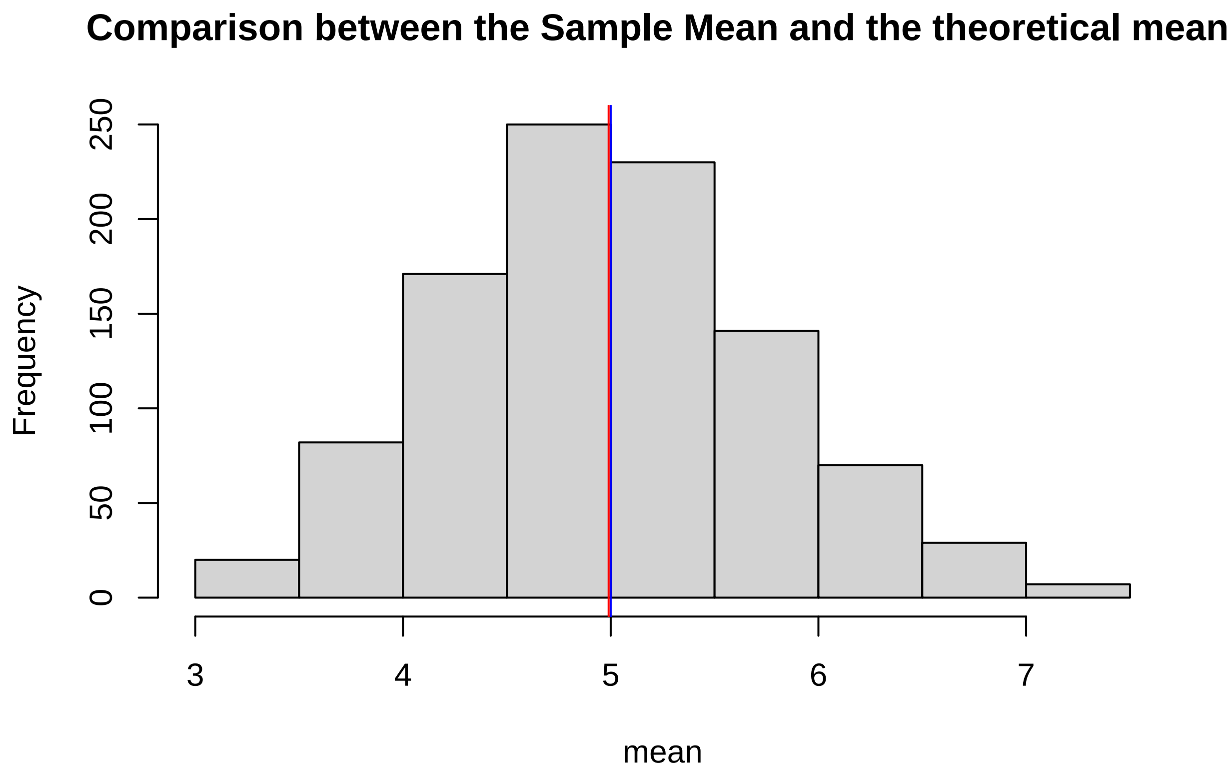
```r
# Theoretical Mean:
TheoreticalMean<- 1/lambda
TheoreticalMean
```

```
## [1] 5
```

```r
# Difference between theoretical and sample mean:
TheoreticalMean - SampleMean
```

```
## [1] 0.009974799
```

```r
# Visualization:
hist(mns, xlab = "mean", main = "Comparison between the Sample Mean and the theoretical mean ")
abline(v= TheoreticalMean, col= "blue" )
abline(v= SampleMean, col= "red")
```



2. show how variable the sample is (via variance) and compare it to the theoretical variance of the distribution.

```
# Sample Variance:
SampleVar <- var(mns)
SampleVar
```

```
## [1] 0.6111165
```

```
# Theoretical Variance:
TheoreticalVar <- (1/lambda^2)/n
TheoreticalVar
```

```
## [1] 0.625
```

```
# Difference between sample and theoretical variance:
TheoreticalVar - SampleVar
```

```
## [1] 0.01388353
```

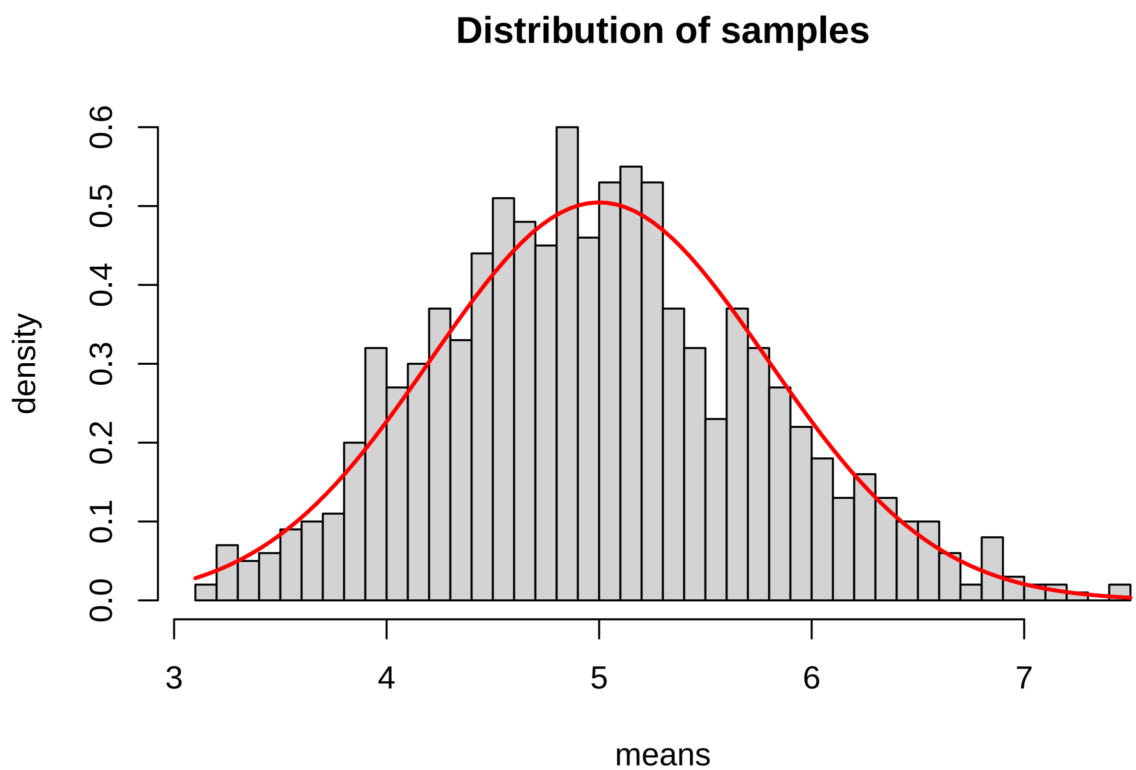
3. Show that the distribution is approximately normal.

I used three methods:

1. Histogram: there is a very little devition of the sample distribution (gray) from the theoretical bell curve of the normal distribution (red).
2. Box Plot: The symmetry indicates normal distribution.
3. QQ Plot: The quantiles of the variable are in line with the theoretical normal quantiles making a straight line, this is telling us we have a normal distribution.

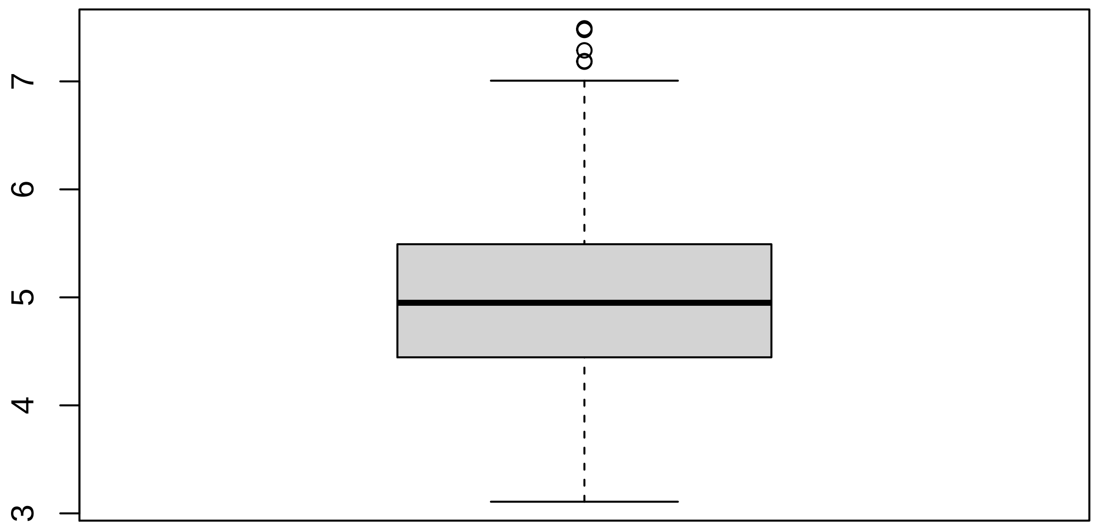
```
#Histogram:

hist(mns, main = "Distribution of samples", xlab = "means", ylab = "density", probability = TRUE, break
x <- seq(min(mns), max(mns), length=100)
curve(dnorm(x, mean=1/lambda, sd=(1/lambda/sqrt(n)) ), col="red", lwd=2, add=TRUE, yaxt="n")
```



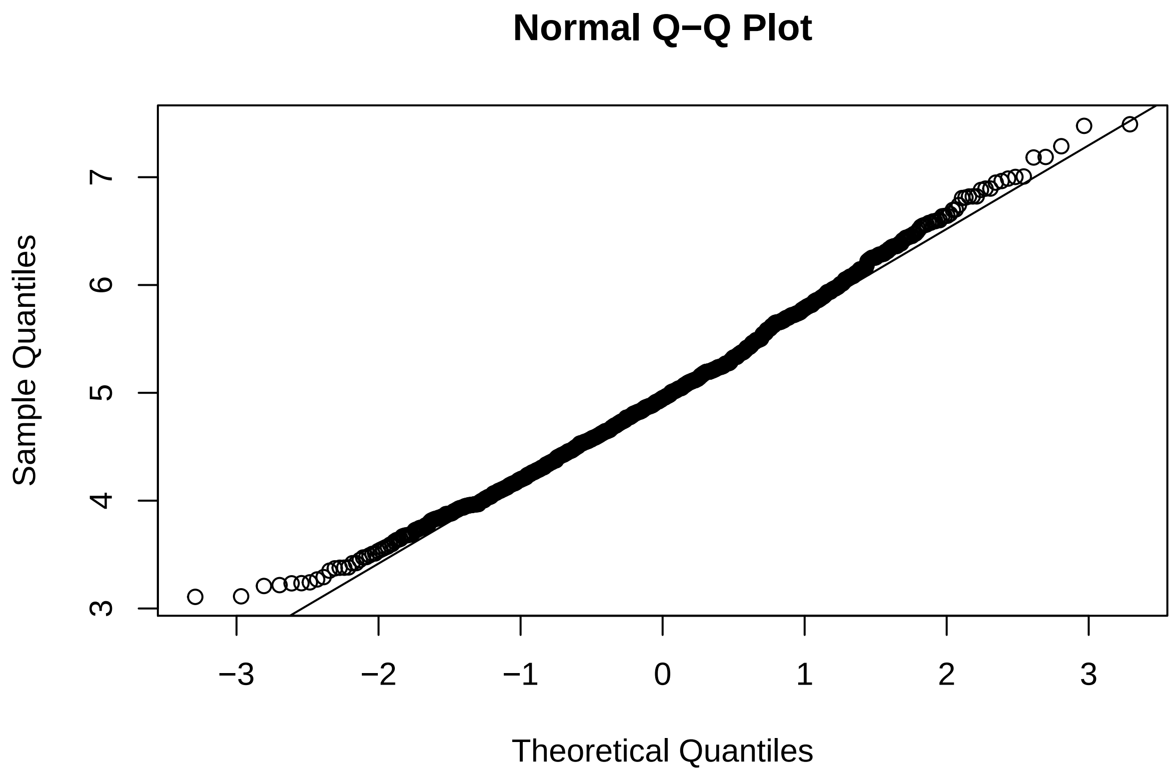

```
#Box Plot:

boxplot(mns)
```




```r
#QQ Plot:

qqnorm(mns)
qqline(mns)
```



Normal Q−Q Plot
Sample Quantiles
3
4
5
6
7
−3
−2
−1
0
1
2
3
Theoretical Quantiles