Statistical Inference Project Part 1

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Github repo : Statistical Inference

Instructions

1. Indicate sample mean and compare to the theoretical mean..
2. Indicate variable the sample is and compare to the theoretical variance..
3. Indicate approximately normal distribution.

Libraries

```
library("data.table")
```

```
## Warning: package 'data.table' was built under R version 4.1.1
```

```
library("ggplot2")
```

Task

```
set.seed(31)
lambda <- 0.2
n <- 40
simulations <- 1000
# simulate
simulated_exponentials <- replicate(simulations, rexp(n, lambda))

# calculate mean of exponentials
means_exponentials <- apply(simulated_exponentials, 2, mean)
```

Q.1

Show where the distribution is centered at and compare it to the theoretical center of the distribution.

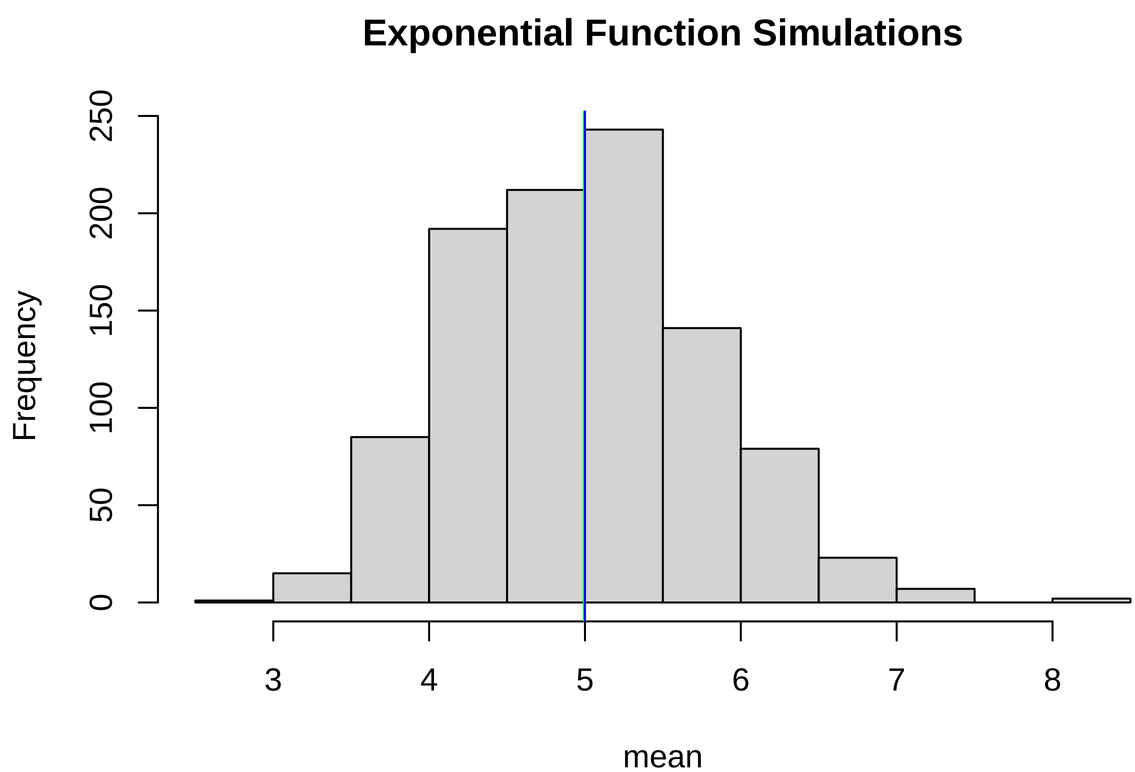
```
analytical_mean <- mean(means_exponentials)
analytical_mean
```

```
## [1] 4.993867
```

```r
# analytical mean
theory_mean <- 1/lambda
theory_mean
```

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

```r
# visualization
hist(means_exponentials, xlab = "mean", main = "Exponential Function Simulations")
abline(v = analytical_mean, col = "green")
abline(v = theory_mean, col = "blue")
```



The mean is 4.99 the theoretical mean 5. The center of distribution of averages of 40 exponentials is close to the theoretical center..

Q.2

Show how variable it is and compare it to the theoretical variance of the distribution:

```r
# standard deviation of distribution
standard_deviation_dist <- sd(means_exponentials)
standard_deviation_dist
```

```
## [1] 0.7931608
```

```
# standard deviation from analytical expression
standard_deviation_theory <- (1/lambda)/sqrt(n)
standard_deviation_theory
```

```
## [1] 0.7905694
```

```
# istribution
variance_dist <- standard_deviation_dist^2
variance_dist
```

```
## [1] 0.6291041
```

```
# analytical expression
variance_theory <- ((1/lambda)*(1/sqrt(n)))^2
variance_theory
```

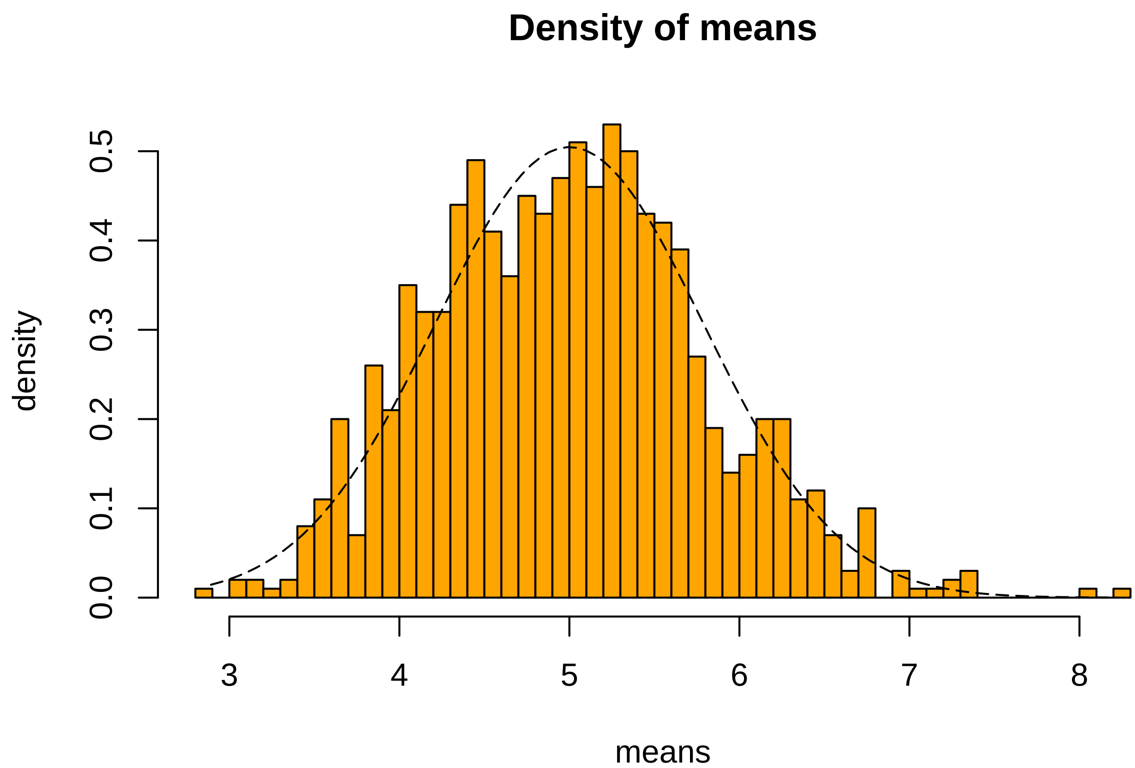
```
## [1] 0.625
```

Standard Deviation of the distribution is 0.7931608 with the theoretical SD calculated as 0.7905694. The Theoretical variance is calculated as ((1 / ??) * (1/???n))2 = 0.625. The actual variance of the distribution is 0.6291041

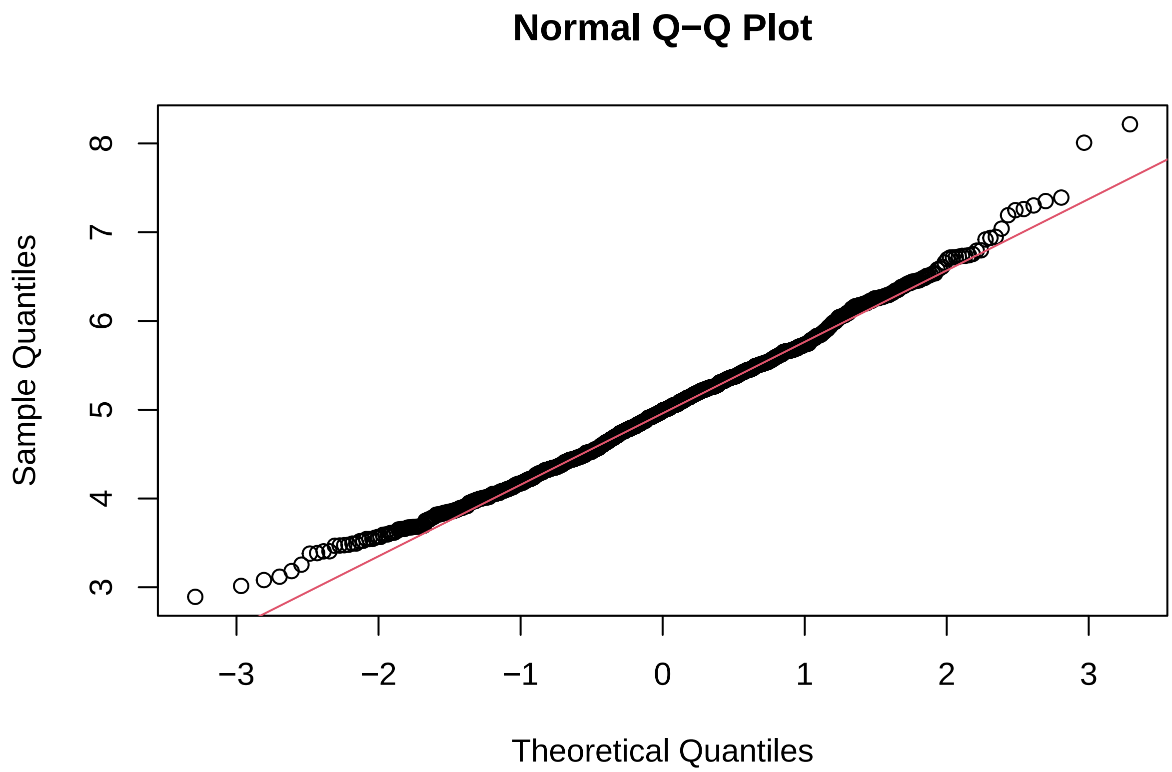
Q3

Show that the distribution is approximately normal.

```
xfit <- seq(min(means_exponentials), max(means_exponentials), length=100)
yfit <- dnorm(xfit, mean=1/lambda, sd=(1/lambda/sqrt(n)))
hist(means_exponentials,breaks=n,prob=T,col="orange",xlab = "means",main="Density of means",ylab="densi
lines(xfit, yfit, pch=22, col="black", lty=5)
```




```r
# compare the distribution of averages of 40 exponentials to a normal distribution
qqnorm(means_exponentials)
qqline(means_exponentials, col = 2)
```



Due to Due to the central limit theorem (CLT), the distribution of averages of 40 exponentials is very close to a normal distribution.