Statistical Inference Project - Part 1

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Overview

This part of the project aims to compare the exponential distribution and the central limit theorem. The comparisons are between mean, variance and distribution (is this distribution near to normal?).

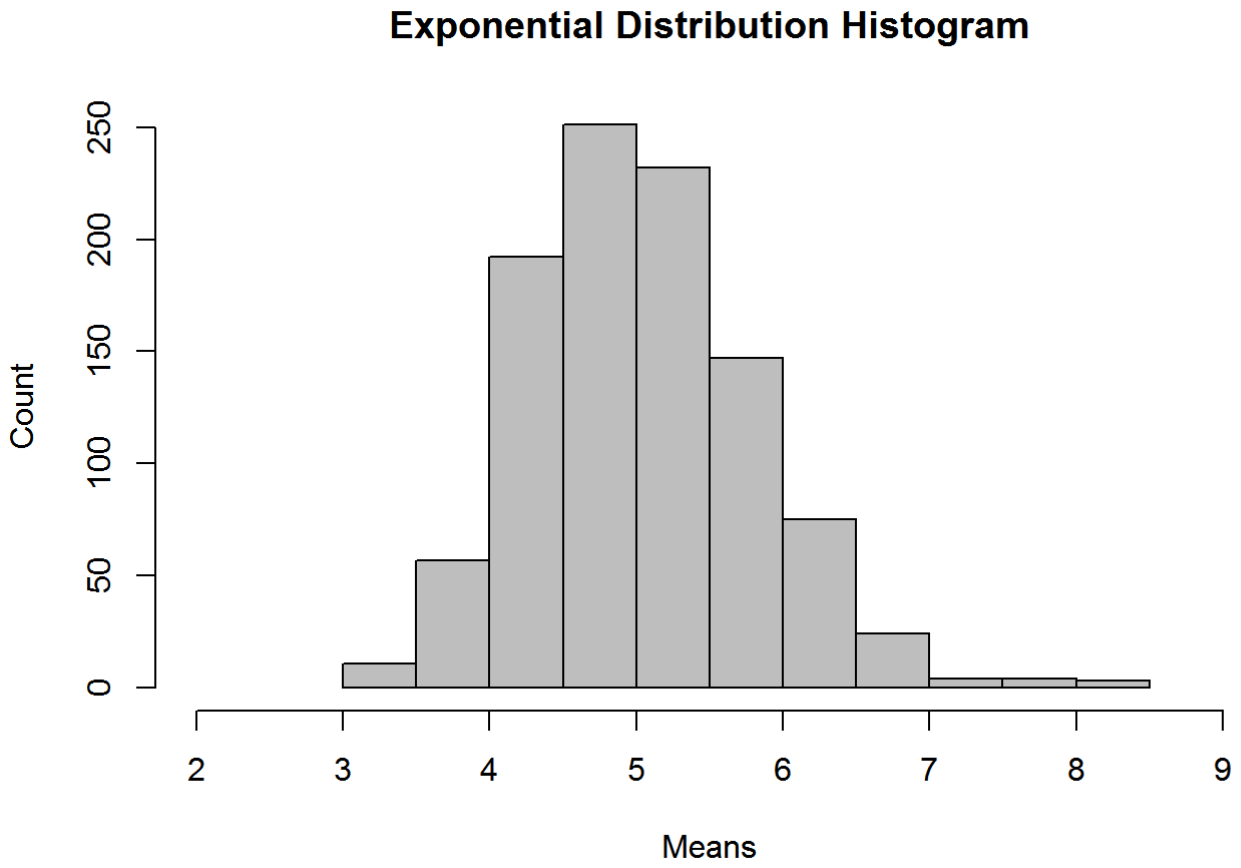
Simulations

First we will load the needed libraries to make the comparisons:

```
# load all needed libraries
library(ggplot2, quietly = TRUE)
library(knitr, quietly = TRUE)
```

Creating 40 random exponential distribution values for 1000 simulations. The instructions give the lambda = 0.2:

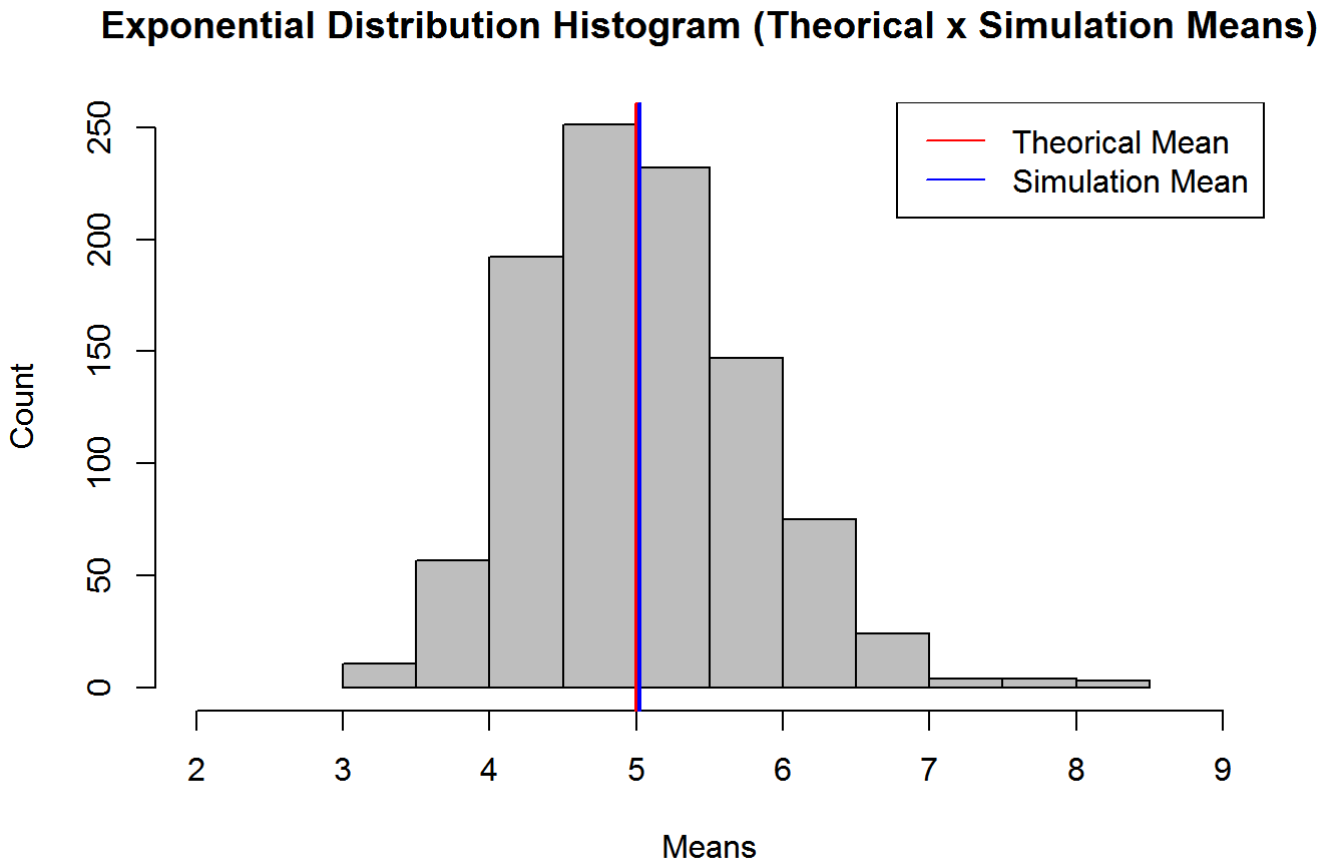
```
# set the seed to make the work reproducible
set.seed(1010)
# set the variables as the instructions tell
simulations <- 1000
n <- 40
lambda <- 0.2
# create the exponential distribution simulation
simu <- data.frame(matrix(rexp(simulations * n, rate = lambda), simulations, n))
means <- apply(simu, 1, mean)
# create a histogram to show the results of the simulation
hist(means, main = "Exponential Distribution Histogram",
     xlab = "Means", ylab = "Count", col = "gray",
     xlim = c(2,9))
```




```
# Calculate the theorical mean and variance and the simulation mean and variance
theorical_mean <- round(1 / lambda, 3)
theorical_sd <- round((1/lambda)/sqrt(n), 3)
theorical_variance <- round(theorical_sd ^ 2, 3)
simu_mean <- round(mean(means), 3)
simu_sd <- round(sd(means), 3)
simu_variance <- round(var(means), 3)
```

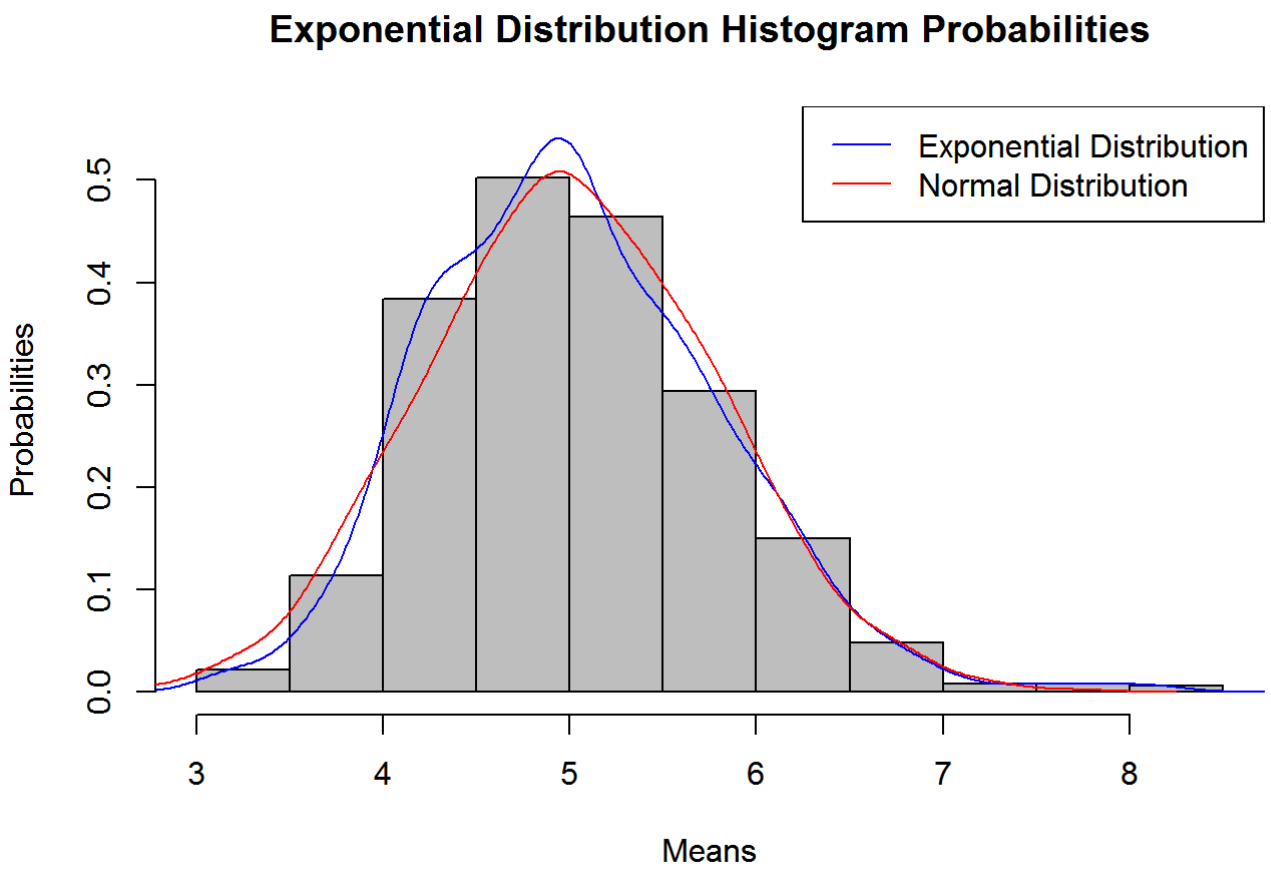
After the simulation we can compare:
The theorical mean is : **5** The simulation mean is: **5.025**
The theorical standard deviation is : **0.791** The simulation standard deviation is: **0.773**
The theorical variance is : **0.626** The simulation variance is: **0.597**
As we can see, all the values are pretty close to each other, concluding that the central limit theorem is valid.

```
# Make a plot to visually compare the differences:
hist(means, main = "Exponential Distribution Histogram (Theorical x Simulation Means)", xlab
= "Means", ylab = "Count", col = "gray", xlim = c(2,9))
abline(v = theorical_mean, lwd = 2, col = "red")
abline(v = simu_mean, lwd = 2, col = "blue")
legend("topright", legend = c("Theorical Mean","Simulation Mean"),
       col = c("red","blue"), lty = c(1,1))
```



Now we can compare the normal distribution to the exponential distribution:

```
set.seed(1010)
# Make the histogram with probabilities
hist(means, main = "Exponential Distribution Histogram Probabilities",
     xlab = "Means", ylab = "Probabilities", col = "gray", prob = TRUE,
     ylim = c(0.0, 0.55))
lines(density(means), col = "blue")
# Create 1000 normal random values and plot the line
normal_values <- rnorm(n = 1000, sd = simu_sd, mean = simu_mean)
lines(density(normal_values), col = "red")
legend("topright", legend = c("Exponential Distribution", "Normal Distribution"),
       col = c("blue","red"), lty=c(1,1))
```



As we can see, the exponential distribution is pretty close to the normal distribution.