Statistical Inference: Programming Assignment 1

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Sunday, May 24, 2015

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

switch on libraries

```
library('ggplot2')
```

terms of the problem

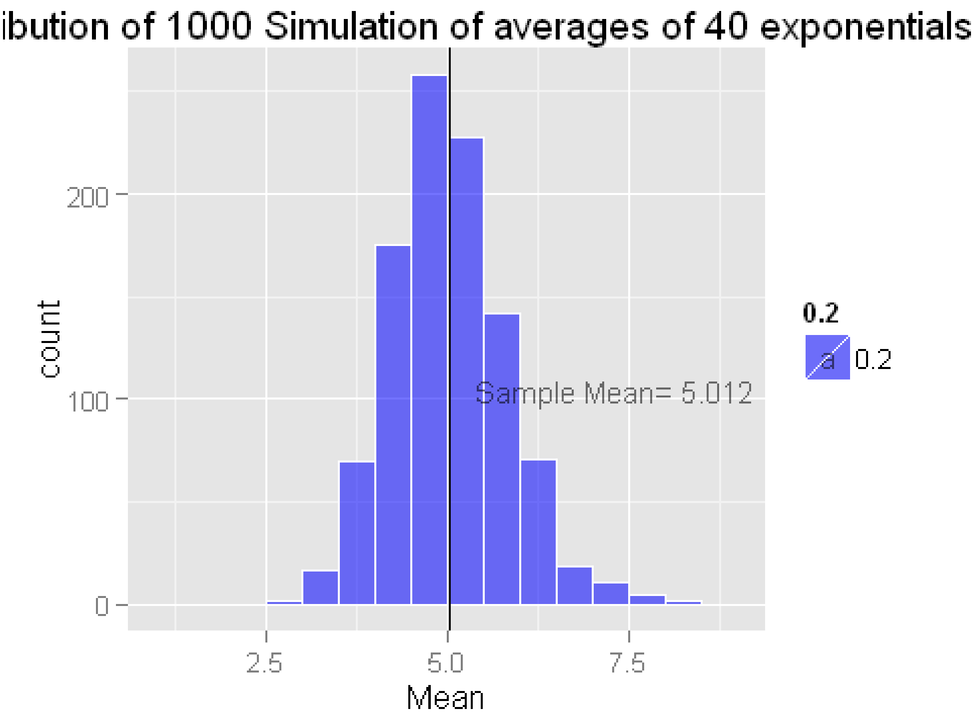
```
simulations_number <- 1000
n <- 40
lambda <- 0.2
```

simulations

```
mn = NULL
variance = NULL
for (i in 1 : simulations_number) {
    expd <- rexp(n, lambda)   #Exponential Distribution
    mn  <- c(mn, mean(expd)) #mean
    variance <- c(variance, var(expd)) #Variance
}
sample_mean <- mean(mn) # Sample Mean
mean_theoretical <- 1/lambda # Theoritical Mean
sample_mean

## [1] 5.011928

mean_theoretical

## [1] 5
```

create graphics

```
plot1 <- qplot(mn,  fill = I("blue"), color = I("white"), geom = "histogram",
               xlab = "Mean", binwidth = 0.5, xlim = c(1,9), alpha = 0.2,
               main = "Distribution of 1000 Simulation of averages of 40
exponentials")
plot1 <- plot1 + geom_vline(xintercept = sample_mean, color = "black")
plot1 <- plot1 + geom_text(mapping = aes(x = sample_mean, y = 110,
                                         label = paste("Sample Mean=",
                                                       round(sample_mean,
3))),
                           size = 4, vjust = 1, hjust = -0.1)
plot1
```

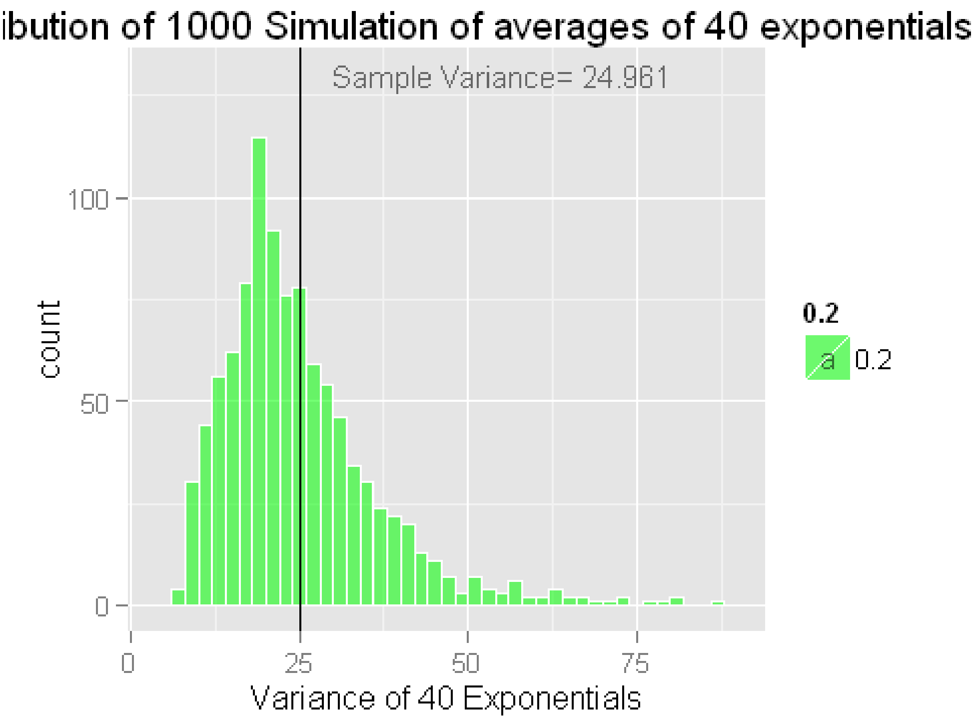


2. Show how variable the sample is (via variance) and compare it to the theoretical variance of the distribution.

```
sample_variance <- mean(variance) # Sample Variance
variance_theoretical <- (1/lambda)^2 # Theoritical Variance
sample_variance

## [1] 24.96057

variance_theoretical

## [1] 25
```

create graphics

```
plot2 <- qplot(variance,  fill = I("green"), color = I("white"),
               geom = "histogram", binwidth = 2,
               xlab = "Variance of 40 Exponentials",
               alpha = 0.2,
               main = "Distribution of 1000 Simulation of averages of 40
exponentials")
plot2 <- plot2 + geom_vline(xintercept = sample_variance, color = "black")
plot2 <- plot2 + geom_text(mapping = aes(x = sample_variance, y = 130,
                                        label = paste("Sample Variance=",
                                                      round(sample_variance,
3))),
                           size=4, hjust= -0.1)
plot2
```

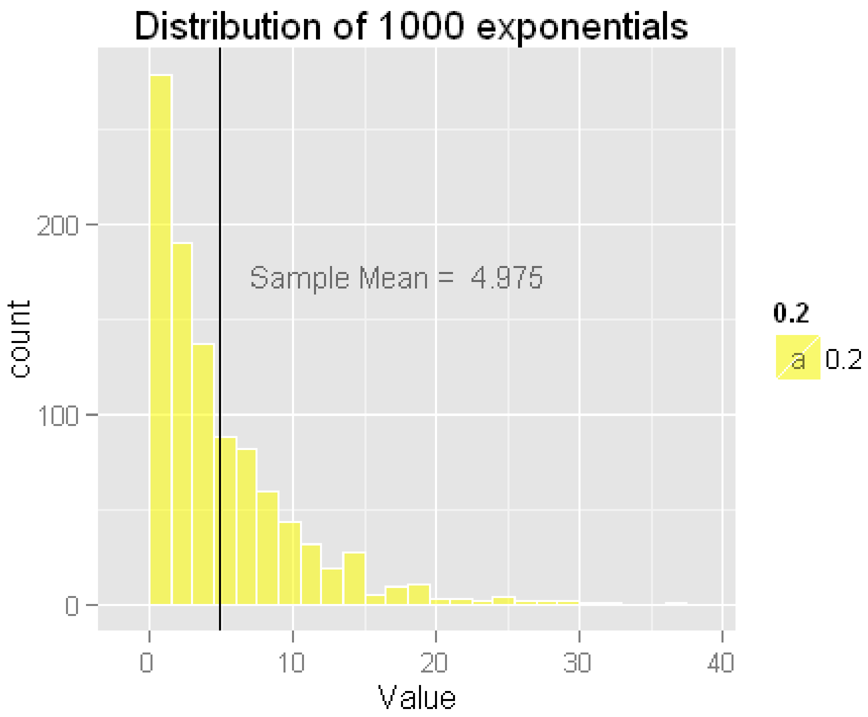


3. Show that the distribution is approximately normal.

```
expdistrib <- rexp(simulations_number, lambda)
expdistrib_mean = mean(expdistrib) #Mean Exponential Distribution
expdistrib_variance = var(expdistrib) #Variance Exponential Distribution
expdistrib_mean

## [1] 4.975025

expdistrib_variance

## [1] 26.64857
```

create graphics

```
plot3 <- qplot(expdistrib,  fill = I("yellow"), color = I("white"),
               alpha = 0.2,
               geom = "histogram", xlab = "Value", binwidth = 1.5,
               main = "Distribution of 1000 exponentials ")
plot3 <- plot3 + geom_vline(xintercept = expdistrib_mean, color = "black")
plot3 <- plot3 + geom_text(mapping = aes(x = expdistrib_mean, y = 180,
                                          label = paste("Sample Mean = ",
                                                        round(expdistrib_mean,
3))),
                            size = 4, hjust = -0.1, vjust = 1)
plot3
```



Conclusions:

- On figure #1: the sample mean is very close to the theoretical mean
- On figure #2: the sample variance is very close to the theoretical variance.
- On figure #3: the exponentional distribution is approximately close to normal.
- Figure 1-3: the sample mean and distribution mean is very close to theoretical values. This is illustrated in Central Limit Theorem, which states that the distribution of averages of IID variables becomes that of a standard normal as the sample size increases.