Investigate the exponential distribution in R

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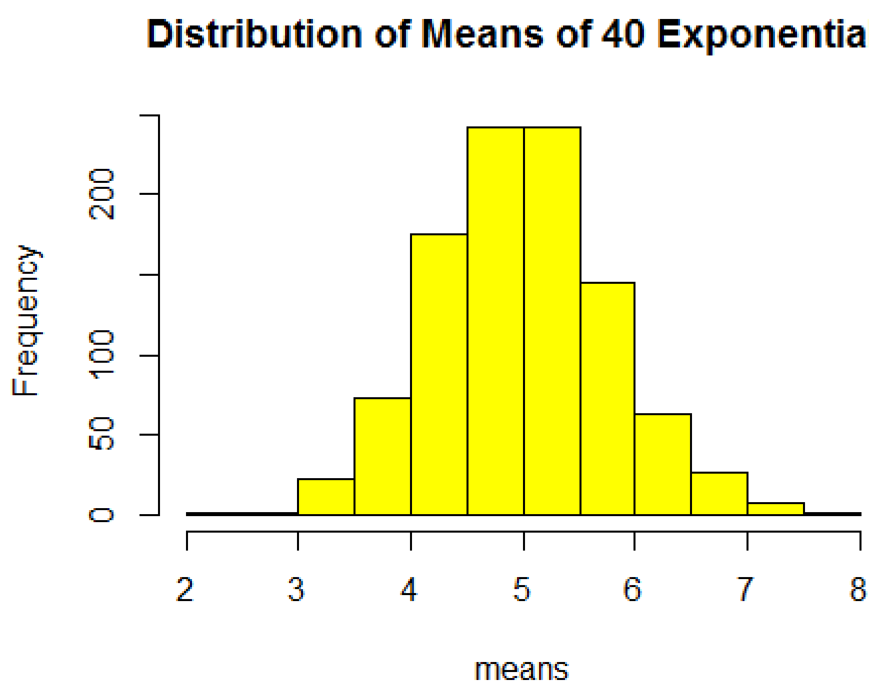
[1]. Show the sample mean and compare it to the theoretical mean of the distribution.

```
library(ggplot2)
library(knitr)
#Simulating exponential distribution
set.seed(876)
nsim=1000;n=40;lambda=0.2
means=NULL
for(i in 1:nsim) means=c(means,mean(rexp(n,lambda)))
hist(means,col="yellow",main="Distribution of Means of 40 Exponentials")
```




```
#Sample means vs Theoretical means
Sample_mean=mean(means);Theoretical_mean=1/lambda
print(c(Sample_mean,Theoretical_mean))

## [1] 4.991893 5.000000
```

According to the result, sample mean derived from simulation is quite near to theoretical mean.

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

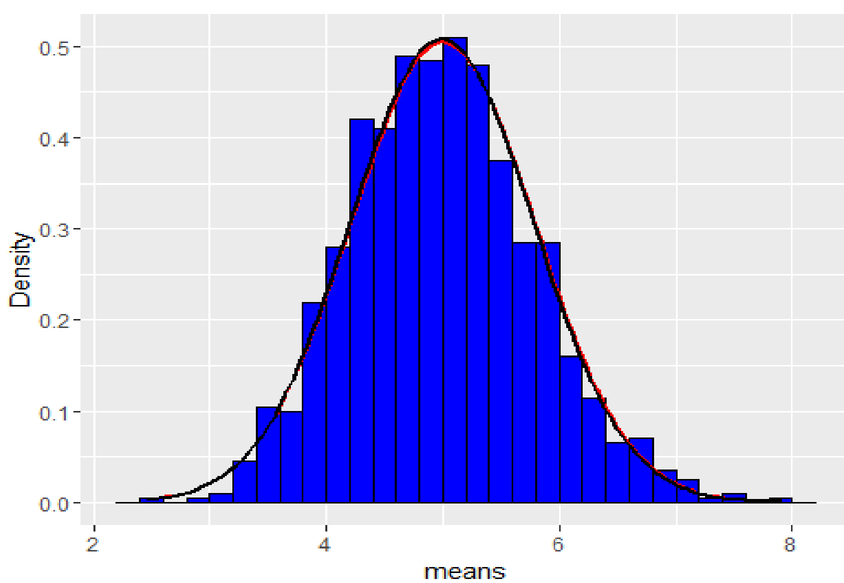
```
Sample_variance=var(means)
Theoretical_variance=((1/lambda)^2)/n
print(c(Sample_variance,Theoretical_variance))

## [1] 0.6168217 0.6250000
```

According to the above result, sample variance and theoretical variance are nearly equal.

[3].Show that the distribution is approximately normal

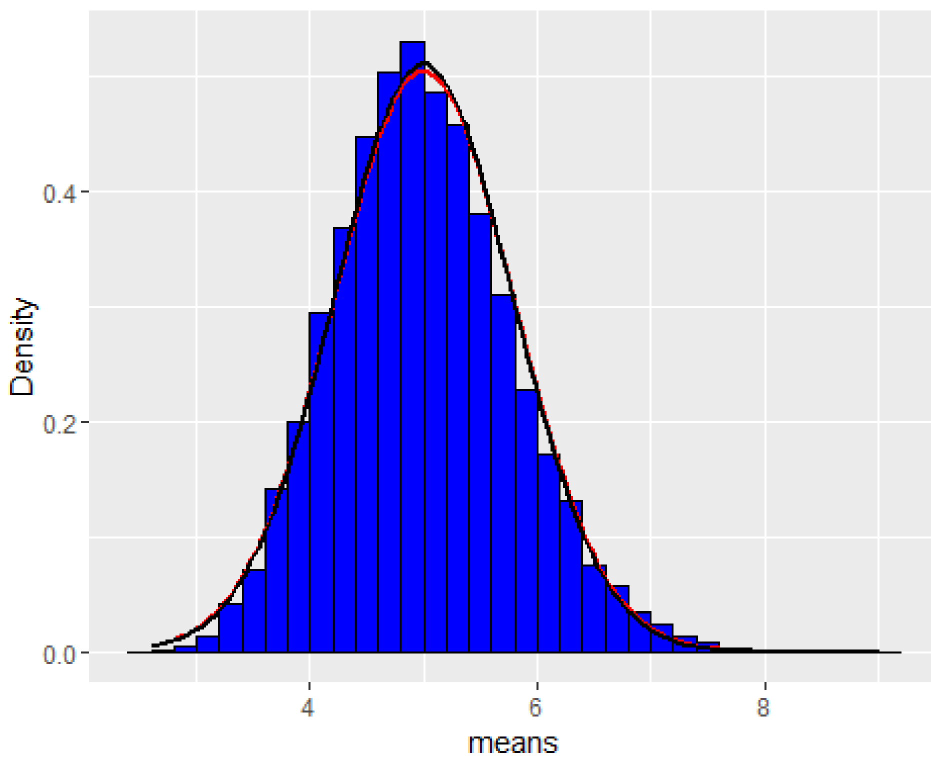
```
g<-ggplot(data.frame(means),aes(x=means))
g<-g+geom_histogram(binwidth=0.2,aes(y=..density..),colour="black",fill
="blue")
g<-g+labs(x="means",y="Density")
g<-g+stat_function(fun=dnorm,args=list(mean=Theoretical_mean, sd=sqrt(T
heoretical_variance)),color = "red", size = 1.0)
g<-g+stat_function(fun=dnorm,args=list(mean=Sample_mean,sd=sqrt(Sample_
variance)),color="black",size=1.0)
g
```



Red line indicates the normal distribution of theoretical means, black line indicates the normal distribution of simulating 40 expontentials.

In order to show that the distribution is approximately normal, we could increase our simulating numbers to a large number (10,000).

```
set.seed(12345)
nsim=10000;n=40;lambda=0.2
#Recalculate
means=NULL
for(i in 1:nsim) means=c(means,mean(rexp(n,lambda)))
Sample_mean=mean(means);Theoretical_mean=1/lambda
Sample_variance=var(means)
Theoretical_variance=((1/lambda)^2)/n
g<-ggplot(data.frame(means),aes(x=means))
g<-g+geom_histogram(binwidth=0.2,aes(y=..density..),colour="black",fill
="blue")
g<-g+labs(x="means",y="Density")
g<-g+stat_function(fun=dnorm,args=list(mean=Theoretical_mean, sd=sqrt(T
heoretical_variance)),color = "red", size = 1.0)
g<-g+stat_function(fun=dnorm,args=list(mean=Sample_mean,sd=sqrt(Sample_
variance)),color="black",size=1.0)
g
```



As shown above, the simulating exponential distribution becomes quite close to normal distribution.