Simulation Exercise

Dipanshu

08/12/2020

Synosis

In this project we 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. lambda = 0.2 for all of the simulations. We will investigate the distribution of averages of 40 exponentials.

Simulations

Setting the simulation variables.

```
set.seed(99)
lambda = 0.2
exponentials = 40
simulatedmeans = c()
for (i in 1 : 1000) simulatedmeans = c(simulatedmeans, mean(rexp(exponentials, lambda)))
```

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

```
samplemean <- mean(simulatedmeans)
samplemean
```

```
## [1] 5.014808
```

Theoretical Mean

```
theoreticalmean <- lambda^(-1)
theoreticalmean
```

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

Comparision

```
abs(samplemean-theoreticalmean)
```

```
## [1] 0.01480849
```

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

```
samplevar <- var(simulatedmeans)
samplevar
```

```
## [1] 0.5929536
```

Theoretical Variance

```
theoreticalvar <- (lambda * sqrt(exponentials))^-2
theoreticalvar
```

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

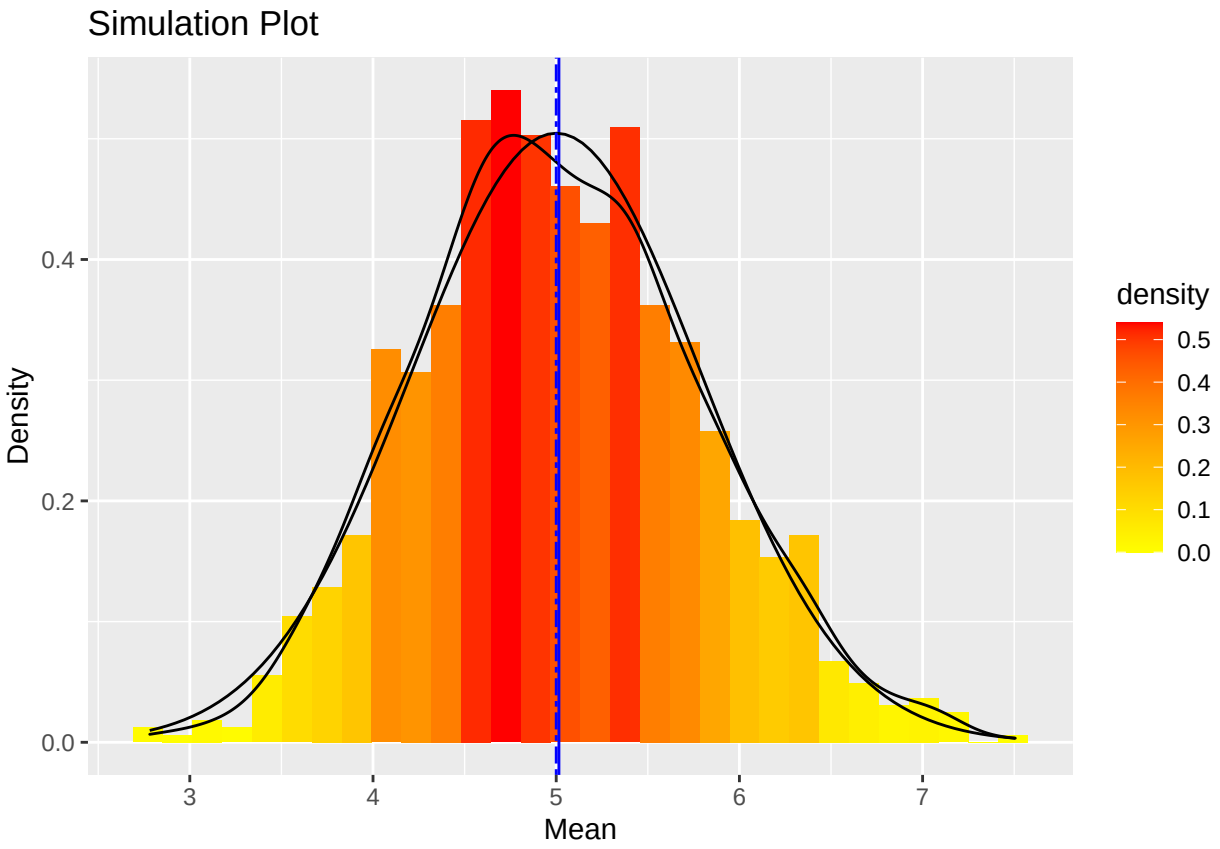
Comparision

```
abs(samplevar-theoreticalvar)
```

```
## [1] 0.03204639
```

3. Show that the distribution is approximately normal. ## Distribution

```
library(ggplot2)
ggplot(data.frame(y=simulatedmeans), aes(x=y)) +
geom_histogram(aes(y=..density.., fill=..density..), bins = 30) +
scale_fill_gradient(low = "yellow",high = "red") +
labs(title="Simulation Plot", y="Density", x="Mean") +
geom_density(colour="black") +
geom_vline(xintercept=samplemean, colour="blue", linetype="solid") +
stat_function(fun=dnorm,args=list( mean=theoreticalmean, sd=sqrt(theoreticalvar)),color = "black") +
geom_vline(xintercept=theoreticalmean, colour="blue", linetype="twodash")
```


Simulation Plot
Density
0.4
0.2
0.0
3
4
5
6
7
Mean
density
0.5
0.4
0.3
0.2
0.1
0.0