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Course : Statistical Inference - Project

Title : Analysis of distribution of averages of 40 exponentials

Overview :

In this project you 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. Set lambda = 0.2 for all of the simulations. You will investigate the distribution of averages of 40 exponentials. Note that you will need to do a thousand simulations. Illustrate via simulation and associated explanatory text the properties of the distribution of the mean of 40 exponentials.

Simulations : Generate a data set of 1000 sample data which is average 40 exponentials, then once we have the data set calculate mean and sd

```
lambda<-0.2
x <- NULL
num_exponentials <- 40
set.seed(1000)

for(i in 1:1000) {
   x <- c(x, mean(rexp(num_exponentials, lambda)))
}
```

1. Show the sample mean and compare it to the theoretical mean of the distribution. Mean (Thoertrical)

```
1/lambda
```

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

```
#5
```

Calculate the mean of distribution of averages of 40 exponentials (sample)

```
mean(x)
```

```
## [1] 4.986963
```

Calculate the Standard Deviation of distribution of averages of 40 exponentials (Sample)

```
sd(x)
```

```
## [1] 0.8089147
```

Expected standard deviation (Theoretrical)

```
(1/lambda)/(sqrt(num_exponentials))
```

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

Conclusion : Sample mean/standard deviation is closer to Theoretrical mean/standard deviation

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

Variance of distribution of averages of 40 exponentials (Sample)

```
var(x)
```

```
## [1] 0.654343
```

Expected variance (Theoretrical)

```
((1/lambda)/(sqrt(num_exponentials)))^2
```

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

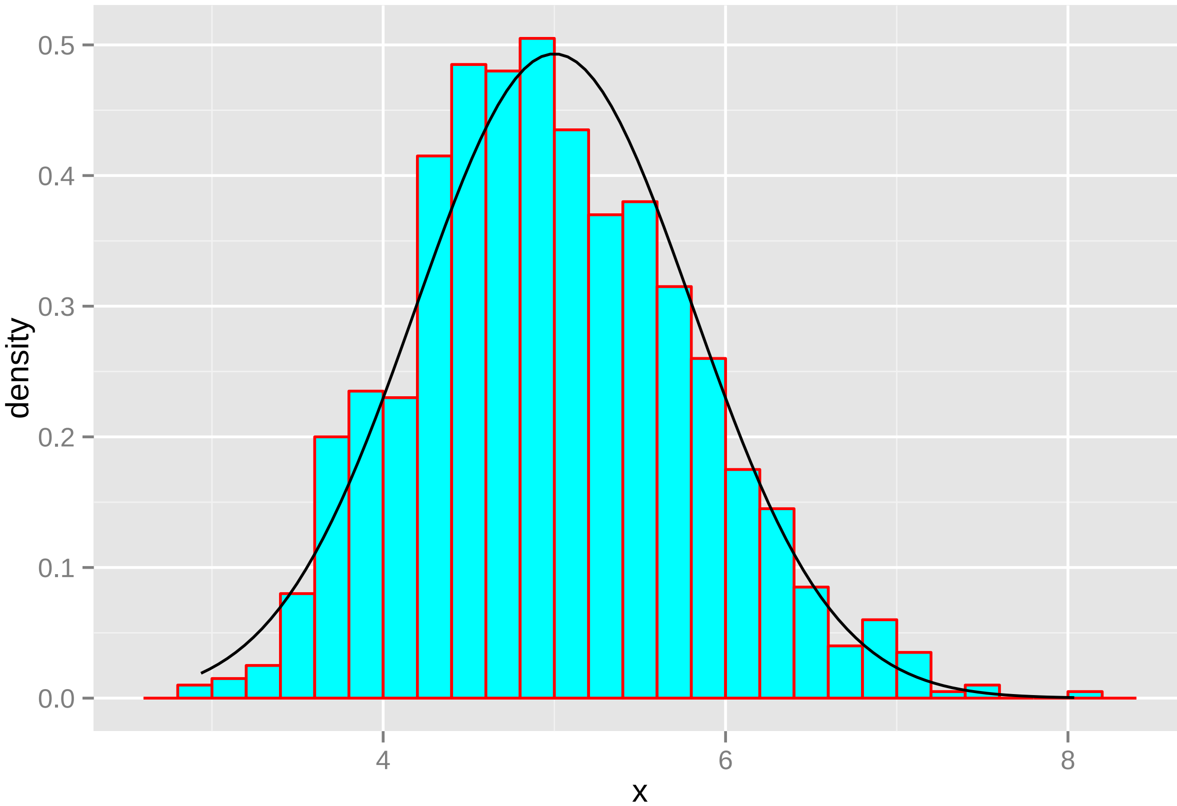
Conclusion : Theoretrical/Expected variance is closer to the Sample distribution variance.

3. Show that the distribution is approximately normal.

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.1.3
```

```
xdata <- as.data.frame(x)
ggplot(data = xdata, aes(x = x)) + geom_histogram(aes(y = ..density..), fill = I("cyan"),
    binwidth = 0.2, color = I("red")) + stat_function(fun = dnorm, arg = list(mean = 5,
    sd = sd(x)))
```



Conclusion : As shown in the distribution is approximately normal with mean = 5, sd = 0.7909

Lets look at the 95% confidence interval for 1/lambda:

```
mean(x) + c(-1, 1) * 1.96 * sd(x)/sqrt(nrow(xdata))
```

```
## [1] 4.936826 5.037100
```