Statistical Inference Project

Shambhavi Malik

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Simulation Exercise

Overview In this we 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. We investigate the distribution of averages of 40 exponentials. Note that we do a thousand simulations.

Part 1: Show the sample mean and compare it to the theoretical mean distribution

```
n <- 40
Simulations <- 1000
Lambda <- 0.2

SampleMean <- NULL
for(i in 1:Simulations) {
  SampleMean <- c(SampleMean, mean(rexp(n, Lambda)))
}
mean(SampleMean)
```

```
## [1] 4.991318
```

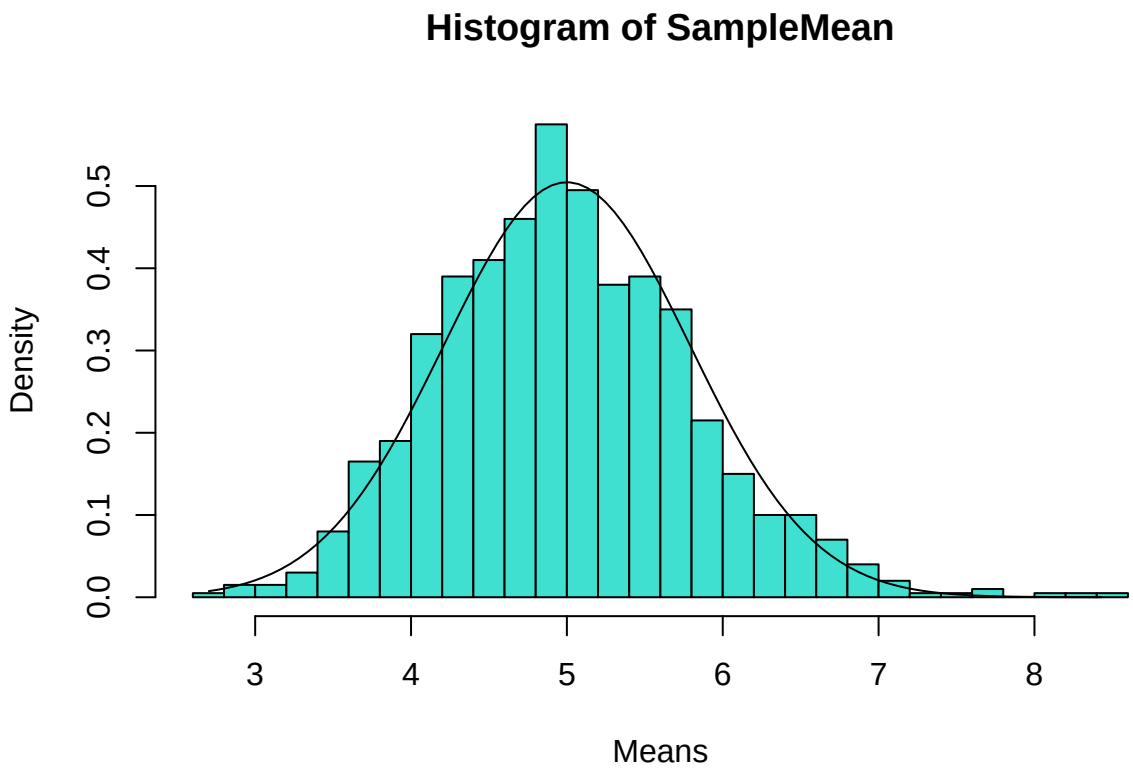
Part 2: Show the sample is (via variance) and compare it to the thoretical variance of the distribtution

```
Variance <- var(SampleMean)
Variance
```

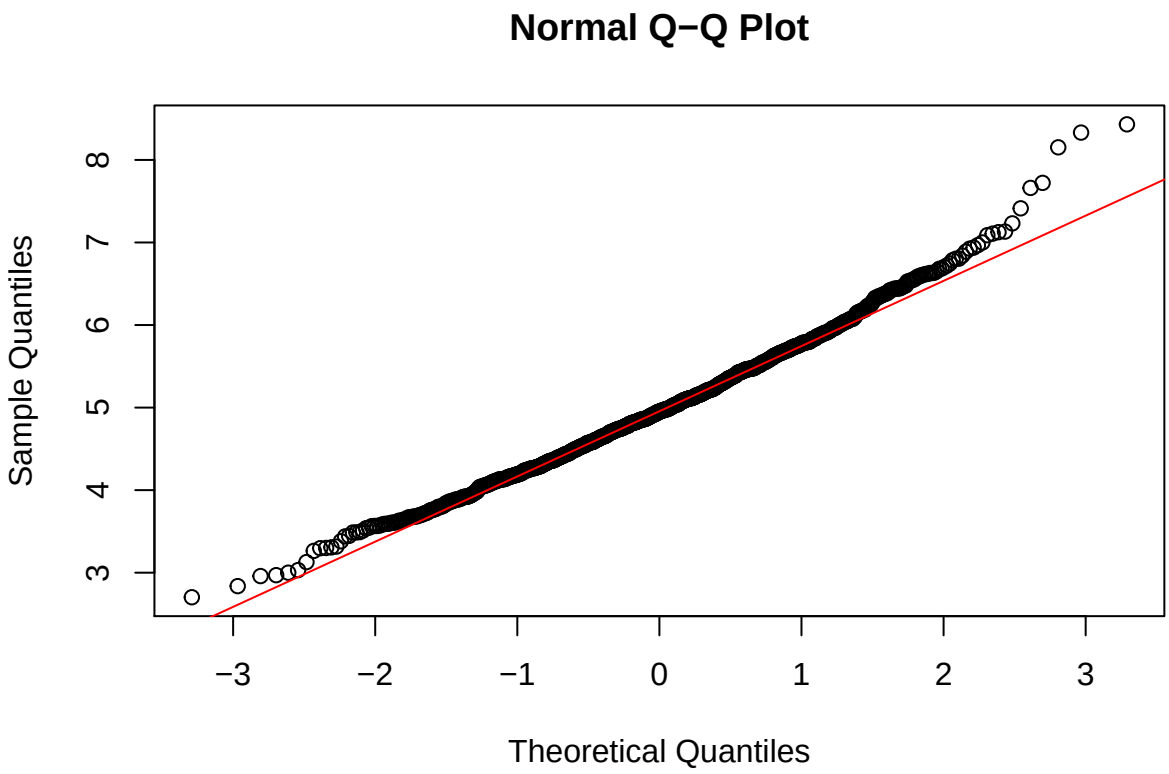
```
## [1] 0.6574795
```

Part 3: Show that the distribution is appoximately normal

```
hist(SampleMean, breaks = n, prob = T, col = "turquoise", xlab = "Means")
x <- seq(min(SampleMean), max(SampleMean), length = 100)
lines(x, dnorm(x, mean = 1/Lambda, sd = (1/Lambda/sqrt(n))), pch = 25, col = "black")
```




```r
qqnorm(SampleMean)
qqline(SampleMean, col = "red")
```



The distribution averages of 40 exponentials is very close to a normal distribution.

Basic Inferential Data Ananlysis

We will analyze the ToothGrowth data in the R datasets package.

1. Load the ToothGrowth data and perform some basic exploratory data analysis

```
library(datasets)
data(ToothGrowth)
library(ggplot2)

str(ToothGrowth)
```

```
## 'data.frame':    60 obs. of  3 variables:
##  $ len : num  4.2 11.5 7.3 5.8 6.4 10 11.2 11.2 5.2 7 ...
##  $ supp: Factor w/ 2 levels "OJ","VC": 2 2 2 2 2 2 2 2 2 2 ...
##  $ dose: num  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

2. Look at the data set

```
head(ToothGrowth)
```

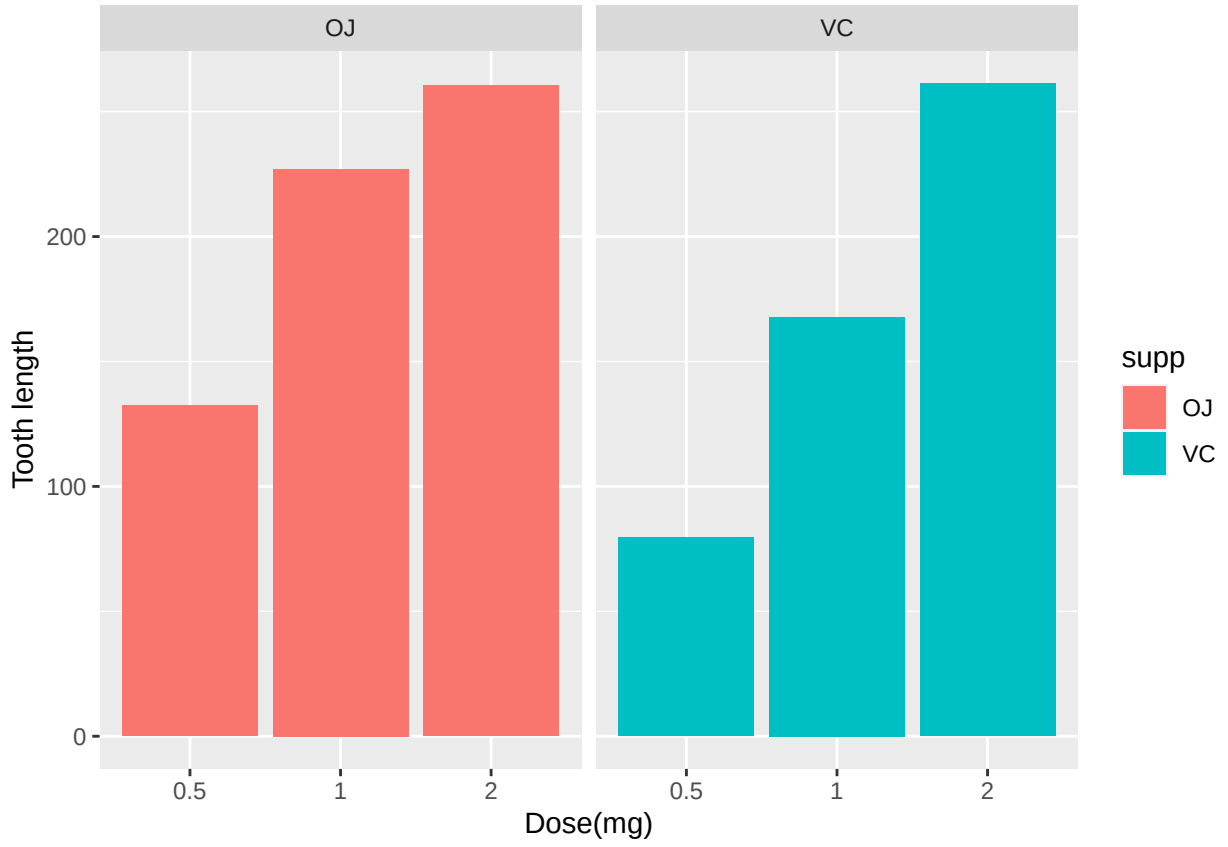
```
##    len supp dose
## 1  4.2   VC  0.5
## 2 11.5   VC  0.5
## 3  7.3   VC  0.5
## 4  5.8   VC  0.5
## 5  6.4   VC  0.5
## 6 10.0   VC  0.5
```

```
summary(ToothGrowth)
```

```
##       len        supp         dose
##  Min.   : 4.20   OJ:30   Min.   :0.500
##  1st Qu.:13.07   VC:30   1st Qu.:0.500
##  Median :19.25           Median :1.000
##  Mean   :18.81           Mean   :1.167
##  3rd Qu.:25.27           3rd Qu.:2.000
##  Max.   :33.90           Max.   :2.000
```

3. Plotting the data

```
ggplot(data=ToothGrowth, aes(x=as.factor(dose), y=len, fill=supp)) +
    geom_bar(stat="identity") +
    facet_grid(. ~ supp) +
    xlab("Dose(mg)") +
    ylab("Tooth length")
```



4. Use confidence intervals and/or hypothesis tests to compare tooth growth by supp and dose.

```
hypoth1 <- t.test(len ~ supp, data = ToothGrowth)
hypoth1$conf.int
```

```
## [1] -0.1710156  7.5710156
## attr(,"conf.level")
## [1] 0.95
```

```
hypoth1$p.value
```

```
## [1] 0.06063451
```

```
hypoth2<-t.test(len ~ supp, data = subset(ToothGrowth, dose == 0.5))
hypoth2$conf.int
```

```
## [1] 1.719057 8.780943
## attr(,"conf.level")
## [1] 0.95
```

```
hypoth2$p.value
```

```
## [1] 0.006358607
```

```
hypoth3<-t.test(len ~ supp, data = subset(ToothGrowth, dose == 1))
hypoth3$conf.int
```

```
## [1] 2.802148 9.057852
## attr(,"conf.level")
## [1] 0.95
```

```
hypoth3$p.value
```

```
## [1] 0.001038376
```

```
hypoth4<-t.test(len ~ supp, data = subset(ToothGrowth, dose == 2))
hypoth4$conf.int
```

```
## [1] -3.79807  3.63807
## attr(,"conf.level")
## [1] 0.95
```

```
hypoth4$p.value
```

```
## [1] 0.9638516
```

Conclusion

OJ ensures more tooth growth than VC for dosages 0.5 & 1.0. OJ and VC gives the same amount of tooth growth for dose amount 2.0 mg/day. For the entire trail we cannot conclude OJ is more effective that VC for all scenarios.