simulation

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Introduction

The purpose of this data analysis is to investigate the exponential distribution and compare it to the Central Limit Theorem. For this analysis, the lambda will be set to 0.2 for all of the simulations. This investigation will compare the distribution of averages of 40 exponentials over 1000 simulations.

Load library

```
library(tinytex)
```

```
## Warning: package 'tinytex' was built under R version 4.0.3
```

```
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 4.0.3
```

Simulations

Set the simulation variables lambda, exponentials, and seed.

```
library(ggplot2)

set.seed(28) ##to ensure reproducibility, I am setting seed arbitrary on 28.

lambda <- 0.2
```

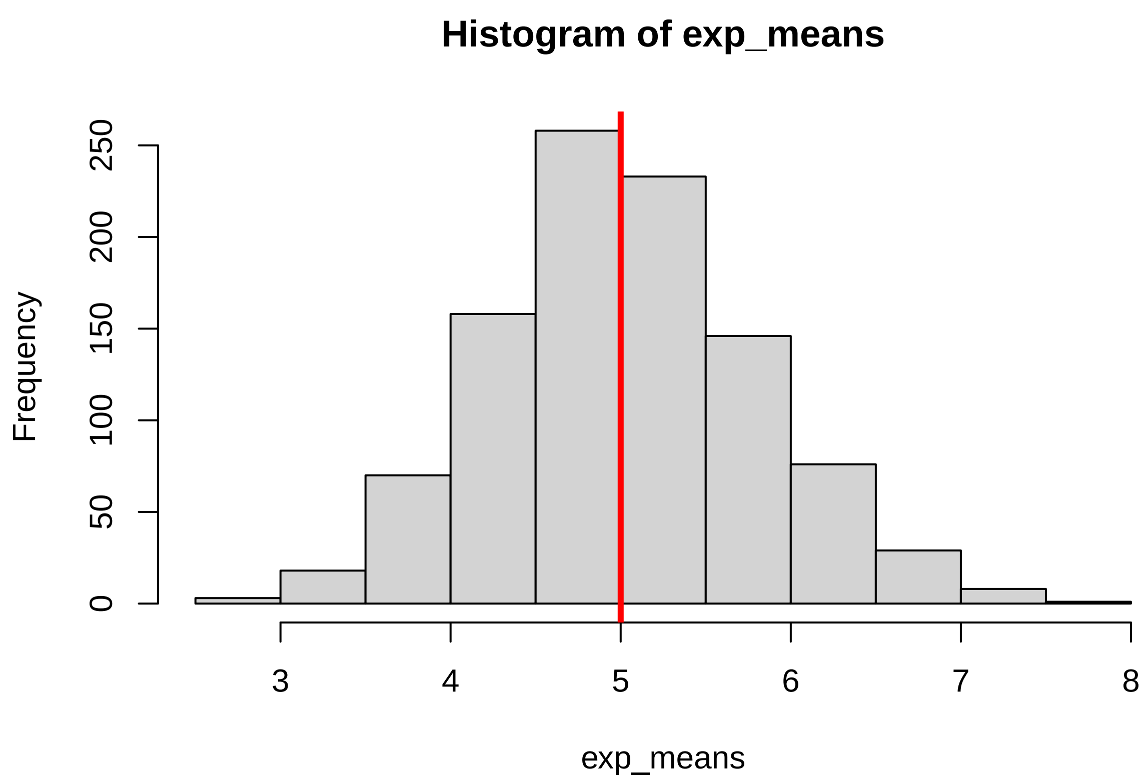
Run Simulations with variables

```
exp_means =NULL
for (i in 1 : 1000)
  exp_means = c(exp_means , mean(rexp(40, 0.2)))
```

Drowing histogram to show simple mean

Sample Mean Calculating the mean from the simulations with give the sample mean.

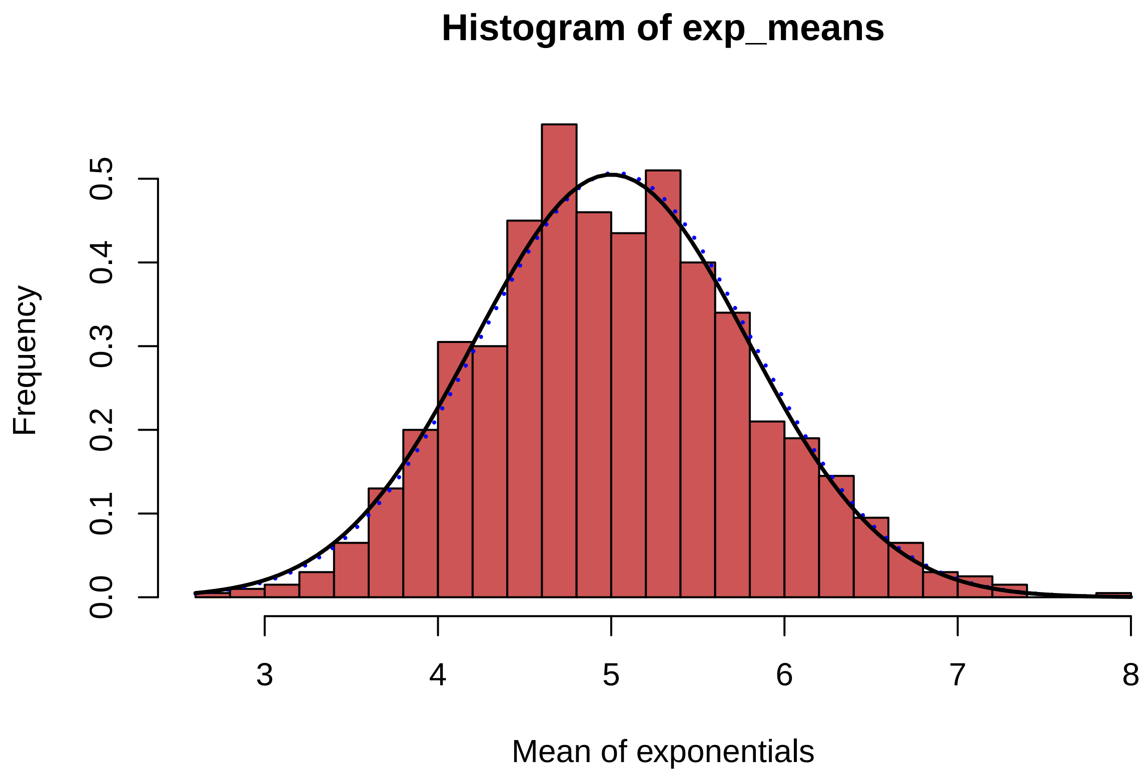
```r
hist(exp_means)

simMeanMean <- mean(exp_means)
# theoretical exponential mean
theMean <- 1/lambda

abline(v=theMean, col="red", lwd=3)
```



Gaussian distribution

Gaussian distribution compare with a normal distribution.

```r
hist(exp_means, breaks=20, prob=TRUE, xlab="Mean of exponentials", ylab="Frequency",
     col="IndianRed3")
curve(dnorm(x, mean=mean(exp_means), sd=sd(exp_means)), col="blue", lwd=2,
      lty = "dotted", add=TRUE, yaxt="n")
curve(dnorm(x, mean=5, sd=0.79), col="black", lwd=2, add=TRUE, yaxt="n")
```



Part 2 Basic Inferential Data Analysis Instructionsless

Now in the second portion of the project, we're going to analyze the ToothGrowth data in the R datasets package.

1. Load the ToothGrowth data and perform some basic exploratory data analyses. The dataset contains data from a study on the Effect of Vitamin C on Tooth Growth in Guinea Pigs.

```
sampleCI <- round (mean(exp_means) + c(-1,1)*1.96*sd(exp_means)/sqrt(1000),3)
cat ("95% confidence interval of my sample : ",sampleCI)
```

```
## 95% confidence interval of my sample :  4.978 5.075
```

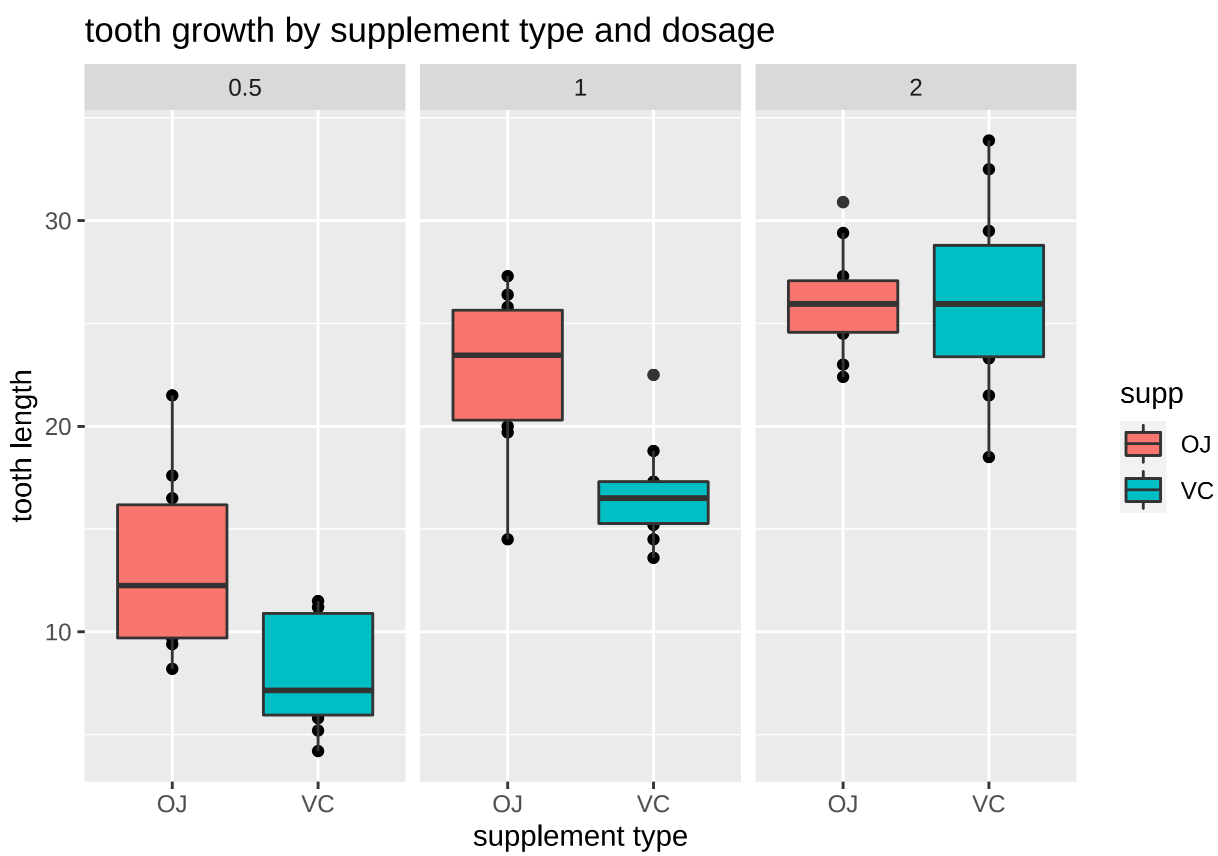
```
theoryCI <- round (5 + c(-1,1)*1.96*0.79/sqrt(1000),3)
cat ("     ; 95% confidence interval in theory : ",theoryCI)
```

```
##      ; 95% confidence interval in theory :  4.951 5.049
```

```
data(ToothGrowth)
ToothGrowth$dose<-as.factor(ToothGrowth$dose)
summary(ToothGrowth)
```

```
##        len          supp     dose
##  Min.   : 4.20   OJ:30   0.5:20
##  1st Qu.:13.07   VC:30   1  :20
##  Median :19.25           2  :20
##  Mean   :18.81
##  3rd Qu.:25.27
##  Max.   :33.90
```

```r
qplot(x=supp,y=len,data=ToothGrowth, facets=~dose,
      main="tooth growth by supplement type and dosage",xlab="supplement type", ylab="tooth length") +
      geom_boxplot(aes(fill = supp))
```



2- Provide a basic summary of the data. The summary revelas the dataset consists of 3 variables and 60 observations:

2 numeric variables: lenght (?) and dosage (mg/day)

1 factor variable supp (OJ = Orange Juice or VC = Vitamin C).

3- Use confidence intervals and/or hypothesis tests to compare tooth growth by supp and dose. Before we can do some 2 sample t-testing on the dataset we need to split the data into groups with a level of 2 by supplement OJ and VC:

```r
OJ<-subset(ToothGrowth, ToothGrowth$supp == "OJ")
VC<-subset(ToothGrowth, ToothGrowth$supp == "VC")
dose5<-subset(ToothGrowth, ToothGrowth$dose == 0.5)
dose1<-subset(ToothGrowth, ToothGrowth$dose == 1)
dose2<-subset(ToothGrowth, ToothGrowth$dose == 2)


cat("variance for OJ supp. :",var(OJ$len))
```

```
## variance for OJ supp. : 43.63344
```

```r
cat(";    variance for VC supp. :",var(VC$len))
```

```
## ;    variance for VC supp. : 68.32723
```

```r
cat(";    variance for dose 0.5 :",var(dose5$len))
```

```
## ;    variance for dose 0.5 : 20.24787
```

```r
cat(";   variance for dose 1 :",var(dose1$len))
```

```
## ;   variance for dose 1 : 19.49608
```

```r
cat(";    variance for dose 2 :",var(dose2$len))
```

```
## ;    variance for dose 2 : 14.24421
```

Then we can test whether OJ or VC per similar dosis of x mg/mL have statistical significant differences in mean length (tooth growth):

Dosis of 0.5 mg/mL have a p-value lower than 0.05 which means there is a difference in means. The zero hypothesis can be rejected (when p is low H0 must go…) and there is a significant difference in supplement type with the chosen dosis

```r
t.test(OJ$len,VC$len, var.equal = F, paired = F)
```

```
##
##  Welch Two Sample t-test
##
## data:  OJ$len and VC$len
## t = 1.9153, df = 55.309, p-value = 0.06063
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1710156  7.5710156
## sample estimates:
## mean of x mean of y
##  20.66333  16.96333
```

```r
t.test(dose5$len,dose1$len, var.equal = T, paired = F)
```

```
##
##  Two Sample t-test
##
## data:  dose5$len and dose1$len
## t = -6.4766, df = 38, p-value = 1.266e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -11.983748  -6.276252
## sample estimates:
## mean of x mean of y
##    10.605    19.735
```

```r
t.test(dose5$len,dose2$len, var.equal = F, paired = F)
```

```
##
##  Welch Two Sample t-test
##
## data:  dose5$len and dose2$len
## t = -11.799, df = 36.883, p-value = 4.398e-14
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -18.15617 -12.83383
## sample estimates:
## mean of x mean of y
##    10.605    26.100
```

```r
t.test(dose1$len,dose2$len, var.equal = F, paired = F)
```

```
##
##  Welch Two Sample t-test
##
## data:  dose1$len and dose2$len
## t = -4.9005, df = 37.101, p-value = 1.906e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -8.996481 -3.733519
## sample estimates:
## mean of x mean of y
##    19.735    26.100
```

```r
OJ5<-subset(ToothGrowth, ToothGrowth$supp == "OJ" & ToothGrowth$dose == 0.5)
VC5<-subset(ToothGrowth, ToothGrowth$supp == "VC" & ToothGrowth$dose == 0.5)
```

Dosis of 1.0 mg/mL have a p-value lower than 0.05 which means there is a difference in means. The zero hypothesis can be rejected (when p is low H0 must go…) and there is a significant difference in supplement type with the chosen dosis:

```r
cat("variance for OJ supp. :",var(OJ5$len))
```

```
## variance for OJ supp. : 19.889
```

```r
cat(";    variance for VC supp. :",var(VC5$len))
```

```
## ;    variance for VC supp. : 7.544
```

```r
t.test(VC5$len, OJ5$len, paired=F, var.equal = F)
```

```
##
##  Welch Two Sample t-test
##
## data:  VC5$len and OJ5$len
## t = -3.1697, df = 14.969, p-value = 0.006359
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -8.780943 -1.719057
## sample estimates:
## mean of x mean of y
##      7.98     13.23
```

```r
OJ1<-subset(ToothGrowth, ToothGrowth$supp == "OJ" & ToothGrowth$dose == 1)
VC1<-subset(ToothGrowth, ToothGrowth$supp == "VC" & ToothGrowth$dose == 1)
```

Dosis of 2.0 mg/mL have a p-value greater than 0.05 which means there is NOT a difference in means. The zero hypothesis can NOT be rejected and there is NOT a significant difference in supplement type with the chosen dosis:

```r
cat("variance for OJ supp. :",var(OJ1$len))
```

```
## variance for OJ supp. : 15.29556
```

```r
cat(";    variance for VC supp. :",var(VC1$len))
```

```
## ;    variance for VC supp. : 6.326778
```

```r
t.test(VC1$len, OJ1$len, paired=F, var.equal = F)
```

```
##
##  Welch Two Sample t-test
##
## data:  VC1$len and OJ1$len
## t = -4.0328, df = 15.358, p-value = 0.001038
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -9.057852 -2.802148
## sample estimates:
## mean of x mean of y
##     16.77     22.70
```

```r
OJ2<-subset(ToothGrowth, ToothGrowth$supp == "OJ" & ToothGrowth$dose == 2)
VC2<-subset(ToothGrowth, ToothGrowth$supp == "VC" & ToothGrowth$dose == 2)
```

All types of dosis (0.5 - 2.0 mg/mL) have a p-value lower than 0.05 which means there is a difference in means. The zero hypothesis can be rejected (when p is low H0 must go...) and there is a significant difference in supplement type:

```r
cat("variance for OJ supp. :",var(OJ2$len))
```

```
## variance for OJ supp. : 7.049333
```

```r
cat(";    variance for VC supp. :",var(VC2$len))
```

```
## ;    variance for VC supp. : 23.01822
```

```r
t.test(VC2$len, OJ2$len, paired=F, var.equal = F)
```

```
##
##  Welch Two Sample t-test
##
## data:  VC2$len and OJ2$len
## t = 0.046136, df = 14.04, p-value = 0.9639
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -3.63807  3.79807
## sample estimates:
## mean of x mean of y
##     26.14     26.06
```

4- State your conclusions and the assumptions needed for your conclusions. The t-test assumes random and independent sampling (paired = FALSE), normality of data distribution, adequacy of sample size, and equality of variance (var.equal = TRUE). From the tests it seems that supplement type have a significant difference in mean tooth length (growth) except when dosis is high (2.0 mg/mL).

A brief conclusion on part2

I have observed that dose and treatments had an effect. However, in the context of this course, I only used really basic tests. A much more correct approach would have been to test properly normality of groups compared and to use a correction as I used multiple comparisons.