Lab 03

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# Test of equality of two means when known σ.

# Dataset

Description: the data provides rating for samples of Arabica coffee from many places.

arabica\_data\_cleaned <- read.csv("C:/Users/jyosn/Downloads/arabica\_data\_cleaned.csv")  
View(arabica\_data\_cleaned)

dim(arabica\_data\_cleaned)

## [1] 1311 44

There are 1311 entries(rows) and 44 attributes(columns).

head(arabica\_data\_cleaned)

## X Species Owner Country.of.Origin  
## 1 1 Arabica metad plc Ethiopia  
## 2 2 Arabica metad plc Ethiopia  
## 3 3 Arabica grounds for health admin Guatemala  
## 4 4 Arabica yidnekachew dabessa Ethiopia  
## 5 5 Arabica metad plc Ethiopia  
## 6 6 Arabica ji-ae ahn Brazil  
## Farm.Name Lot.Number Mill ICO.Number  
## 1 metad plc metad plc 2014/2015  
## 2 metad plc metad plc 2014/2015  
## 3 san marcos barrancas "san cristobal cuch   
## 4 yidnekachew dabessa coffee plantation wolensu   
## 5 metad plc metad plc 2014/2015  
## 6   
## Company Altitude Region  
## 1 metad agricultural developmet plc 1950-2200 guji-hambela  
## 2 metad agricultural developmet plc 1950-2200 guji-hambela  
## 3 1600 - 1800 m   
## 4 yidnekachew debessa coffee plantation 1800-2200 oromia  
## 5 metad agricultural developmet plc 1950-2200 guji-hambela  
## 6   
## Producer Number.of.Bags Bag.Weight  
## 1 METAD PLC 300 60 kg  
## 2 METAD PLC 300 60 kg  
## 3 5 1  
## 4 Yidnekachew Dabessa Coffee Plantation 320 60 kg  
## 5 METAD PLC 300 60 kg  
## 6 100 30 kg  
## In.Country.Partner Harvest.Year Grading.Date  
## 1 METAD Agricultural Development plc 2014 April 4th, 2015  
## 2 METAD Agricultural Development plc 2014 April 4th, 2015  
## 3 Specialty Coffee Association May 31st, 2010  
## 4 METAD Agricultural Development plc 2014 March 26th, 2015  
## 5 METAD Agricultural Development plc 2014 April 4th, 2015  
## 6 Specialty Coffee Institute of Asia 2013 September 3rd, 2013  
## Owner.1 Variety Processing.Method Aroma Flavor Aftertaste  
## 1 metad plc Washed / Wet 8.67 8.83 8.67  
## 2 metad plc Other Washed / Wet 8.75 8.67 8.50  
## 3 Grounds for Health Admin Bourbon 8.42 8.50 8.42  
## 4 Yidnekachew Dabessa Natural / Dry 8.17 8.58 8.42  
## 5 metad plc Other Washed / Wet 8.25 8.50 8.25  
## 6 Ji-Ae Ahn Natural / Dry 8.58 8.42 8.42  
## Acidity Body Balance Uniformity Clean.Cup Sweetness Cupper.Points  
## 1 8.75 8.50 8.42 10 10 10 8.75  
## 2 8.58 8.42 8.42 10 10 10 8.58  
## 3 8.42 8.33 8.42 10 10 10 9.25  
## 4 8.42 8.50 8.25 10 10 10 8.67  
## 5 8.50 8.42 8.33 10 10 10 8.58  
## 6 8.50 8.25 8.33 10 10 10 8.33  
## Total.Cup.Points Moisture Category.One.Defects Quakers Color  
## 1 90.58 0.12 0 0 Green  
## 2 89.92 0.12 0 0 Green  
## 3 89.75 0.00 0 0   
## 4 89.00 0.11 0 0 Green  
## 5 88.83 0.12 0 0 Green  
## 6 88.83 0.11 0 0 Bluish-Green  
## Category.Two.Defects Expiration Certification.Body  
## 1 0 April 3rd, 2016 METAD Agricultural Development plc  
## 2 1 April 3rd, 2016 METAD Agricultural Development plc  
## 3 0 May 31st, 2011 Specialty Coffee Association  
## 4 2 March 25th, 2016 METAD Agricultural Development plc  
## 5 2 April 3rd, 2016 METAD Agricultural Development plc  
## 6 1 September 3rd, 2014 Specialty Coffee Institute of Asia  
## Certification.Address  
## 1 309fcf77415a3661ae83e027f7e5f05dad786e44  
## 2 309fcf77415a3661ae83e027f7e5f05dad786e44  
## 3 36d0d00a3724338ba7937c52a378d085f2172daa  
## 4 309fcf77415a3661ae83e027f7e5f05dad786e44  
## 5 309fcf77415a3661ae83e027f7e5f05dad786e44  
## 6 726e4891cf2c9a4848768bd34b668124d12c4224  
## Certification.Contact unit\_of\_measurement  
## 1 19fef5a731de2db57d16da10287413f5f99bc2dd m  
## 2 19fef5a731de2db57d16da10287413f5f99bc2dd m  
## 3 0878a7d4b9d35ddbf0fe2ce69a2062cceb45a660 m  
## 4 19fef5a731de2db57d16da10287413f5f99bc2dd m  
## 5 19fef5a731de2db57d16da10287413f5f99bc2dd m  
## 6 b70da261fcc84831e3e9620c30a8701540abc200 m  
## altitude\_low\_meters altitude\_high\_meters altitude\_mean\_meters  
## 1 1950 2200 2075  
## 2 1950 2200 2075  
## 3 1600 1800 1700  
## 4 1800 2200 2000  
## 5 1950 2200 2075  
## 6 NA NA NA

tail(arabica\_data\_cleaned)

## X Species Owner Country.of.Origin Farm.Name  
## 1306 1306 Arabica cadexsa Honduras cerro bueno  
## 1307 1307 Arabica juan carlos garcia lopez Mexico el centenario  
## 1308 1308 Arabica myriam kaplan-pasternak Haiti 200 farms  
## 1309 1309 Arabica exportadora atlantic, s.a. Nicaragua finca las marías  
## 1310 1310 Arabica juan luis alvarado romero Guatemala finca el limon  
## 1311 1312 Arabica bismarck castro Honduras los hicaques  
## Lot.Number  
## 1306   
## 1307   
## 1308   
## 1309 017-053-0211/ 017-053-0212  
## 1310   
## 1311 103  
## Mill  
## 1306 cadexsa  
## 1307 la esperanza, municipio juchique de ferrer, veracruz  
## 1308 coeb koperativ ekselsyo basen (350 members)  
## 1309 beneficio atlantic condega  
## 1310 beneficio serben  
## 1311 cigrah s.a de c.v.  
## ICO.Number Company Altitude  
## 1306 13-63-174 cadexsa 1450 msnm  
## 1307 1104328663 terra mia 900  
## 1308 haiti coffee ~350m  
## 1309 017-053-0211/ 017-053-0212 exportadora atlantic s.a 1100  
## 1310 11/853/165 unicafe 4650  
## 1311 13-111-053 cigrah s.a de c.v 1400  
## Region Producer  
## 1306 marcala Omar Acosta  
## 1307 juchique de ferrer JUAN CARLOS GARCÍA LOPEZ  
## 1308 department d'artibonite , haiti COEB Koperativ Ekselsyo Basen  
## 1309 jalapa Teófilo Narváez  
## 1310 nuevo oriente WILLIAM ESTUARDO MARTINEZ PACHECO  
## 1311 comayagua Reinerio Zepeda  
## Number.of.Bags Bag.Weight In.Country.Partner Harvest.Year  
## 1306 275 1 kg Instituto Hondureño del Café 2014  
## 1307 12 1 kg AMECAFE 2012  
## 1308 1 2 kg Specialty Coffee Association 2012  
## 1309 550 69 kg Instituto Hondureño del Café 2016  
## 1310 275 1 kg Asociacion Nacional Del Café 2012  
## 1311 275 69 kg Instituto Hondureño del Café 2017  
## Grading.Date Owner.1 Variety Processing.Method  
## 1306 May 15th, 2014 CADEXSA Catuai Washed / Wet  
## 1307 September 17th, 2012 JUAN CARLOS GARCIA LOPEZ Bourbon Washed / Wet  
## 1308 May 24th, 2012 Myriam Kaplan-Pasternak Typica Natural / Dry  
## 1309 June 6th, 2017 Exportadora Atlantic, S.A. Caturra Other  
## 1310 May 24th, 2012 Juan Luis Alvarado Romero Catuai Washed / Wet  
## 1311 April 28th, 2017 Bismarck Castro Caturra   
## Aroma Flavor Aftertaste Acidity Body Balance Uniformity Clean.Cup  
## 1306 7.00 6.33 6.17 6.50 6.67 6.17 8.00 8.00  
## 1307 7.08 6.83 6.25 7.42 7.25 6.75 10.00 0.00  
## 1308 6.75 6.58 6.42 6.67 7.08 6.67 9.33 6.00  
## 1309 7.25 6.58 6.33 6.25 6.42 6.08 6.00 6.00  
## 1310 7.50 6.67 6.67 7.67 7.33 6.67 8.00 1.33  
## 1311 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00  
## Sweetness Cupper.Points Total.Cup.Points Moisture Category.One.Defects  
## 1306 8.00 6.33 69.17 0.10 0  
## 1307 10.00 6.75 68.33 0.11 0  
## 1308 6.00 6.42 67.92 0.14 8  
## 1309 6.00 6.17 63.08 0.13 1  
## 1310 1.33 6.67 59.83 0.10 0  
## 1311 0.00 0.00 0.00 0.12 0  
## Quakers Color Category.Two.Defects Expiration  
## 1306 0 Green 4 May 15th, 2015  
## 1307 0 None 20 September 17th, 2013  
## 1308 0 Blue-Green 16 May 24th, 2013  
## 1309 0 Green 5 June 6th, 2018  
## 1310 0 Green 4 May 24th, 2013  
## 1311 0 Green 2 April 28th, 2018  
## Certification.Body Certification.Address  
## 1306 Instituto Hondureño del Café b4660a57e9f8cc613ae5b8f02bfce8634c763ab4  
## 1307 AMECAFE 59e396ad6e22a1c22b248f958e1da2bd8af85272  
## 1308 Specialty Coffee Association 36d0d00a3724338ba7937c52a378d085f2172daa  
## 1309 Instituto Hondureño del Café b4660a57e9f8cc613ae5b8f02bfce8634c763ab4  
## 1310 Asociacion Nacional Del Café b1f20fe3a819fd6b2ee0eb8fdc3da256604f1e53  
## 1311 Instituto Hondureño del Café b4660a57e9f8cc613ae5b8f02bfce8634c763ab4  
## Certification.Contact unit\_of\_measurement  
## 1306 7f521ca403540f81ec99daec7da19c2788393880 m  
## 1307 0eb4ee5b3f47b20b049548a2fd1e7d4a2b70d0a7 m  
## 1308 0878a7d4b9d35ddbf0fe2ce69a2062cceb45a660 m  
## 1309 7f521ca403540f81ec99daec7da19c2788393880 m  
## 1310 724f04ad10ed31dbb9d260f0dfd221ba48be8a95 ft  
## 1311 7f521ca403540f81ec99daec7da19c2788393880 m  
## altitude\_low\_meters altitude\_high\_meters altitude\_mean\_meters  
## 1306 1450.00 1450.00 1450.00  
## 1307 900.00 900.00 900.00  
## 1308 350.00 350.00 350.00  
## 1309 1100.00 1100.00 1100.00  
## 1310 1417.32 1417.32 1417.32  
## 1311 1400.00 1400.00 1400.00

# Taking ‘Flavour’ as target 1 variable

target1<-subset(arabica\_data\_cleaned,Variety==c("Flavor"))

# Taking ‘Aroma’ as target 2 variable

target2<-subset(arabica\_data\_cleaned,Variety==c("Aroma"))

## Mean and SD of Target 1 Population

mean\_pop1=mean(arabica\_data\_cleaned$Flavor)  
mean\_pop1

## [1] 7.51807

sd\_pop1=sd(arabica\_data\_cleaned$Flavor)  
sd\_pop1

## [1] 0.3999792

Population Mean of target variable 1 ‘flavor’ is 7.52 and population standard deviation of target variable ‘aroma’ is 0.4.

## Mean and SD of Target 2 Population

mean\_pop2=mean(arabica\_data\_cleaned$Aroma)  
mean\_pop2

## [1] 7.563806

sd\_pop2=sd(arabica\_data\_cleaned$Aroma)  
sd\_pop2

## [1] 0.3786663

Population mean of target variable 2 ‘aroma’ is 7.56 and population sd is 0.38.

# Sample of Target 1 Population

sample1=sample(arabica\_data\_cleaned$Flavor,100,replace=FALSE)  
mean(sample1)

## [1] 7.5318

sd1=sd(sample1)  
sd1

## [1] 0.3345535

Mean and sd of target 1 sample is 7.48 and 0.39 respectively.

# Sample of Target 2 Population

sample2=sample(arabica\_data\_cleaned$Aroma,100,replace=FALSE)  
mean(sample2)

## [1] 7.5113

sd2=sd(sample2)  
sd2

## [1] 0.8070894

Mean and sd of target 1 sample is 7.62 and 0.31 respectively.

IMPORTING BSDA LIBRARY FOR Z TEST FUNCTION.

library(BSDA)

## Loading required package: lattice

##   
## Attaching package: 'BSDA'

## The following object is masked from 'package:datasets':  
##   
## Orange

# TWO TAILED TEST

Two check if the mean value of flavour and aroma ratings are same. H0: mu1=mu2 H1: mu1!=mu2

z.test(x=sample1,y=sample2,alternative = "two.sided",mu=0,sigma.x = sd1,sigma.y=sd2,conf.level = 0.95)

##   
## Two-sample z-Test  
##   
## data: sample1 and sample2  
## z = 0.23464, p-value = 0.8145  
## alternative hypothesis: true difference in means is not equal to 0  
## 95 percent confidence interval:  
## -0.1507384 0.1917384  
## sample estimates:  
## mean of x mean of y   
## 7.5318 7.5113

Interpretation: z=-1.31. as it is greater than -1.96(the critical value at 5% significance level), and since p-value=0.299 is greater than 0.05 ,we fail to reject H0. Hence the difference of mean value of Flavour and Aroma rating atrributes of the Arabica coffee is not statistically significant.

# ONE-TAILED TEST(Left-tailed)

To check if mean flavor rating is less than aroma ratings. H0: mu1=mu2 H1: mu1<mu2

z.test(x=sample1,y=sample2,alternative = "less",mu=0,sigma.x = sd1,sigma.y=sd2,conf.level = 0.95)

##   
## Two-sample z-Test  
##   
## data: sample1 and sample2  
## z = 0.23464, p-value = 0.5928  
## alternative hypothesis: true difference in means is less than 0  
## 95 percent confidence interval:  
## NA 0.1642078  
## sample estimates:  
## mean of x mean of y   
## 7.5318 7.5113

Interpretation: z=-1.04. as it is greater than -1.64(the critical value at 5% significance level), and since p-value=0.14 is greater than 0.05 ,we fail to reject H0. Hence the difference of mean value of Flavour and Aroma rating atrributes of the Arabica coffee is not statistically significant.

# ONE-TAILED TEST(Right-tailed)

To check if mean flavor rating is greater than aroma ratings. H0: mu1=mu2 H1: mu1>mu2

z.test(x=sample1,y=sample2,alternative = "greater",mu=0,sigma.x = sd1,sigma.y=sd2,conf.level = 0.95)

##   
## Two-sample z-Test  
##   
## data: sample1 and sample2  
## z = 0.23464, p-value = 0.4072  
## alternative hypothesis: true difference in means is greater than 0  
## 95 percent confidence interval:  
## -0.1232078 NA  
## sample estimates:  
## mean of x mean of y   
## 7.5318 7.5113

Interpretation: z=-1.04. as it is less than 1.64(the critical value at 5% significance level), and since p-value=0.85 is greater than 0.05 ,we fail to reject H0. Hence the difference of mean value of Flavour and Aroma rating atrributes of the Arabica coffee is not statistically significant.