Lab 01:Sampling Distribution and Standard Error

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library(help="datasets")

##CHOOSING AN IN-BUILT DATASET

#This dataset includes the data from Violent Crime Rates by US State  
p=USArrests  
p

## Murder Assault UrbanPop Rape  
## Alabama 13.2 236 58 21.2  
## Alaska 10.0 263 48 44.5  
## Arizona 8.1 294 80 31.0  
## Arkansas 8.8 190 50 19.5  
## California 9.0 276 91 40.6  
## Colorado 7.9 204 78 38.7  
## Connecticut 3.3 110 77 11.1  
## Delaware 5.9 238 72 15.8  
## Florida 15.4 335 80 31.9  
## Georgia 17.4 211 60 25.8  
## Hawaii 5.3 46 83 20.2  
## Idaho 2.6 120 54 14.2  
## Illinois 10.4 249 83 24.0  
## Indiana 7.2 113 65 21.0  
## Iowa 2.2 56 57 11.3  
## Kansas 6.0 115 66 18.0  
## Kentucky 9.7 109 52 16.3  
## Louisiana 15.4 249 66 22.2  
## Maine 2.1 83 51 7.8  
## Maryland 11.3 300 67 27.8  
## Massachusetts 4.4 149 85 16.3  
## Michigan 12.1 255 74 35.1  
## Minnesota 2.7 72 66 14.9  
## Mississippi 16.1 259 44 17.1  
## Missouri 9.0 178 70 28.2  
## Montana 6.0 109 53 16.4  
## Nebraska 4.3 102 62 16.5  
## Nevada 12.2 252 81 46.0  
## New Hampshire 2.1 57 56 9.5  
## New Jersey 7.4 159 89 18.8  
## New Mexico 11.4 285 70 32.1  
## New York 11.1 254 86 26.1  
## North Carolina 13.0 337 45 16.1  
## North Dakota 0.8 45 44 7.3  
## Ohio 7.3 120 75 21.4  
## Oklahoma 6.6 151 68 20.0  
## Oregon 4.9 159 67 29.3  
## Pennsylvania 6.3 106 72 14.9  
## Rhode Island 3.4 174 87 8.3  
## South Carolina 14.4 279 48 22.5  
## South Dakota 3.8 86 45 12.8  
## Tennessee 13.2 188 59 26.9  
## Texas 12.7 201 80 25.5  
## Utah 3.2 120 80 22.9  
## Vermont 2.2 48 32 11.2  
## Virginia 8.5 156 63 20.7  
## Washington 4.0 145 73 26.2  
## West Virginia 5.7 81 39 9.3  
## Wisconsin 2.6 53 66 10.8  
## Wyoming 6.8 161 60 15.6

## SHAPE OF THE DATASET

dim(p)

## [1] 50 4

## THE FIRST 6 ROWS OF THE DATASET WILL BE DISPLAYED

head(p)

## Murder Assault UrbanPop Rape  
## Alabama 13.2 236 58 21.2  
## Alaska 10.0 263 48 44.5  
## Arizona 8.1 294 80 31.0  
## Arkansas 8.8 190 50 19.5  
## California 9.0 276 91 40.6  
## Colorado 7.9 204 78 38.7

##THE LAST 6 ROWS OF THE DATASET WILL BE DISPLAYED

tail(p)

## Murder Assault UrbanPop Rape  
## Vermont 2.2 48 32 11.2  
## Virginia 8.5 156 63 20.7  
## Washington 4.0 145 73 26.2  
## West Virginia 5.7 81 39 9.3  
## Wisconsin 2.6 53 66 10.8  
## Wyoming 6.8 161 60 15.6

##QUESTION 1:

## DESCRIPTIVE ANALYSIS OF EACH FACTOR OF THE DATASET

summary(p)

## Murder Assault UrbanPop Rape   
## Min. : 0.800 Min. : 45.0 Min. :32.00 Min. : 7.30   
## 1st Qu.: 4.075 1st Qu.:109.0 1st Qu.:54.50 1st Qu.:15.07   
## Median : 7.250 Median :159.0 Median :66.00 Median :20.10   
## Mean : 7.788 Mean :170.8 Mean :65.54 Mean :21.23   
## 3rd Qu.:11.250 3rd Qu.:249.0 3rd Qu.:77.75 3rd Qu.:26.18   
## Max. :17.400 Max. :337.0 Max. :91.00 Max. :46.00

##STANDARD DEVIATION OF THE ASSAULT FACTOR

sd(USArrests$Assault)

## [1] 83.33766

## WE WILL WORK WITH A PARTICULAR FACTOR - “ASSAULT” -> THIS WILL BE THE TARGET VARIABLE

population=USArrests$Assault  
population

## [1] 236 263 294 190 276 204 110 238 335 211 46 120 249 113 56 115 109 249 83  
## [20] 300 149 255 72 259 178 109 102 252 57 159 285 254 337 45 120 151 159 106  
## [39] 174 279 86 188 201 120 48 156 145 81 53 161

QUESTION 2:

WE SHALL ESTIMATE THE AVERAGE , STANDARD DEVIATION OF THE SAMPLES

samplesize1=15  
samplesize2=10

## A sample of 15 observations has been taken

s1=sample(population,samplesize1,replace=FALSE)  
s1

## [1] 56 86 285 335 190 120 211 252 115 109 276 109 300 159 110

## A sample of 10 observations has been taken

s2=sample(population,samplesize2,replace=FALSE)  
s2

## [1] 259 159 156 335 120 249 236 81 56 252

## AVERAGE OF SAMPLE 1 HAS BEEN TAKEN

mean(s1)

## [1] 180.8667

## AVERAGE OF SAMPLE 2 HAS BEEN TAKEN

mean(s2)

## [1] 190.3

## STANDARD ERROR OF SAMPLE 1 IS TAKEN

sd(s1)/sqrt(samplesize1)

## [1] 23.13107

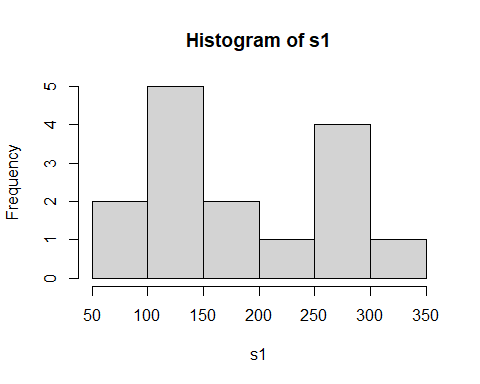
## STANDARD ERROR OF SAMPLE 2 IS TAKEN

sd(s2)/sqrt(samplesize2)

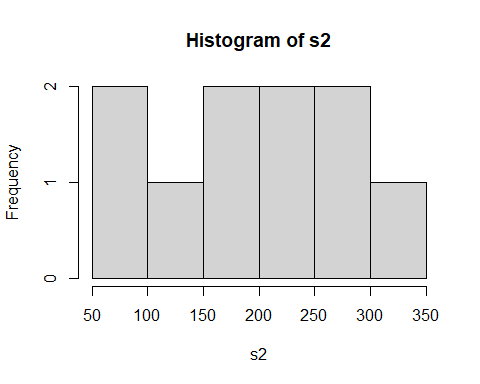
## [1] 28.3

## REPRESENTATION OF SAMPLE 1

hist(s1)

 ##REPRESENTATION OF SAMPLE 2 THROUGH HISTOGRAM

hist(s2)

 ## QUESTION 3:

ESTIMATION OF THE SAMPLING DISTRIBUTION

## FOR SAMPLE 1  
samp\_dist\_1=replicate(1000,mean(sample(USArrests$Assault,samplesize1,replace=TRUE)))  
samp\_dist\_1

## [1] 133.4000 147.8000 156.1333 166.6667 177.4000 160.6000 157.4667 156.4667  
## [9] 119.3333 174.4000 176.8667 170.2000 183.6000 170.4667 180.2000 192.2000  
## [17] 190.7333 125.6667 157.2667 148.4667 176.0000 163.3333 195.8667 147.6000  
## [25] 194.5333 163.1333 161.5333 141.1333 160.2667 159.3333 181.7333 204.4667  
## [33] 169.3333 173.2667 177.2000 198.0000 177.8000 200.2000 159.4667 200.5333  
## [41] 192.4667 179.3333 198.0000 143.1333 173.8667 124.6667 187.3333 161.6000  
## [49] 188.0000 193.0667 162.3333 166.8667 170.2000 205.5333 219.6000 181.0667  
## [57] 187.0667 151.6667 193.4000 148.0000 184.0000 119.4667 181.8000 179.6000  
## [65] 171.6667 187.0667 162.1333 152.9333 141.9333 156.7333 181.6000 174.0000  
## [73] 189.6000 170.3333 156.6000 127.8000 162.4000 147.3333 136.4667 165.4000  
## [81] 182.0000 192.6000 185.1333 169.2000 203.2667 205.5333 173.0667 140.0667  
## [89] 176.4667 173.2000 150.8000 177.2000 149.6000 185.6000 157.9333 161.5333  
## [97] 192.6000 160.1333 171.2000 150.7333 183.7333 166.9333 186.0000 152.0667  
## [105] 191.8000 160.8667 153.0667 154.8667 187.4667 194.2000 150.0000 196.8000  
## [113] 185.0667 155.2667 127.7333 168.8000 177.4667 162.2667 198.6000 161.6667  
## [121] 153.3333 178.0667 150.4667 151.7333 136.0667 198.0000 189.6000 180.9333  
## [129] 156.9333 178.5333 175.1333 190.0000 168.0667 156.6667 161.1333 163.8000  
## [137] 194.8667 151.4000 194.7333 195.2000 160.4000 162.1333 202.7333 183.0000  
## [145] 176.0000 152.2000 181.3333 163.6000 190.5333 153.4667 215.2000 183.1333  
## [153] 167.2667 184.1333 162.8667 173.1333 170.2000 184.8667 159.2000 177.7333  
## [161] 148.2000 164.1333 187.6000 184.4667 203.9333 177.2667 172.4000 139.1333  
## [169] 191.6000 149.8000 179.1333 208.5333 155.1333 183.9333 127.5333 199.8000  
## [177] 167.1333 121.8667 160.0667 186.3333 189.1333 166.1333 194.5333 200.0000  
## [185] 160.1333 190.3333 161.3333 171.2667 134.7333 164.6000 173.3333 136.6000  
## [193] 170.9333 153.8000 152.8667 160.2000 172.4000 178.7333 166.2667 157.4667  
## [201] 135.6667 169.4667 176.8000 147.3333 193.4667 167.6000 176.4667 161.9333  
## [209] 186.6667 166.5333 212.8000 160.8667 194.8667 179.8000 122.2667 181.7333  
## [217] 180.0667 226.5333 163.8667 199.6000 182.3333 194.0667 190.3333 185.0000  
## [225] 165.9333 140.3333 149.1333 205.6000 154.6667 145.0000 228.8000 186.6667  
## [233] 156.5333 193.2667 182.0667 163.6000 183.0667 115.6000 192.4000 171.4667  
## [241] 220.8000 211.3333 167.5333 172.2667 170.0667 174.1333 172.4000 186.0000  
## [249] 154.2000 178.8667 178.7333 124.0000 177.3333 160.6667 191.0667 172.8000  
## [257] 163.4667 206.9333 196.0667 167.2667 161.3333 158.4667 170.9333 216.6667  
## [265] 178.4000 154.0000 163.0000 147.1333 212.0667 211.6000 162.8667 204.9333  
## [273] 177.0667 137.1333 165.2667 208.2000 151.6667 195.2667 202.2000 177.2667  
## [281] 143.7333 127.5333 176.7333 180.6000 193.6000 193.8000 190.1333 183.7333  
## [289] 181.0000 174.8000 186.9333 154.6000 154.1333 172.2000 166.1333 164.6000  
## [297] 158.0000 189.2667 190.5333 187.2667 194.7333 188.0000 165.2000 177.6667  
## [305] 147.6667 178.6000 181.2667 166.4667 183.7333 214.2000 132.4667 161.4000  
## [313] 179.6667 206.0000 157.4000 186.3333 179.4667 149.8000 175.7333 201.5333  
## [321] 175.2667 168.4667 209.8667 194.6000 171.5333 203.2667 152.8000 131.9333  
## [329] 209.8667 181.5333 164.8000 178.9333 192.6667 132.8000 190.6667 197.4667  
## [337] 156.0667 179.7333 167.2667 200.6667 149.6000 171.2667 209.4000 178.0000  
## [345] 188.3333 136.4000 185.0000 190.2667 154.9333 158.6000 186.1333 132.4000  
## [353] 160.4667 186.2000 211.6000 172.5333 205.3333 137.6000 112.3333 169.2000  
## [361] 157.9333 153.5333 162.3333 140.1333 163.1333 149.4000 148.6000 125.2667  
## [369] 181.7333 167.0667 170.2000 189.5333 170.2667 146.2000 154.3333 184.0667  
## [377] 168.8000 176.5333 174.8000 162.4000 140.9333 141.1333 154.4000 207.4667  
## [385] 192.8667 161.8000 157.0667 167.6667 164.0000 151.7333 183.8000 159.1333  
## [393] 169.1333 166.7333 150.7333 163.4000 184.9333 182.6667 143.2000 193.0667  
## [401] 163.8667 175.3333 165.8000 158.9333 169.9333 186.1333 187.7333 198.8667  
## [409] 183.7333 198.4667 196.8667 133.6667 153.3333 161.0000 172.1333 191.3333  
## [417] 162.8000 164.5333 165.6667 137.3333 163.2000 174.6667 141.4000 167.6667  
## [425] 212.2667 168.0000 214.0667 144.6000 168.8667 172.3333 144.5333 165.1333  
## [433] 147.5333 147.0000 174.6000 232.6667 158.5333 168.3333 212.3333 175.8000  
## [441] 195.4667 153.0000 131.8000 178.7333 142.8667 163.0667 169.4667 154.7333  
## [449] 171.4000 167.3333 139.9333 201.8000 163.2000 151.2667 185.9333 125.8000  
## [457] 197.3333 182.0667 164.6000 139.4667 177.2667 153.8000 181.0000 143.2667  
## [465] 200.4000 178.4667 139.3333 223.4667 150.2667 178.5333 178.7333 144.7333  
## [473] 178.4667 168.6667 148.2667 176.0000 175.4667 128.6000 176.2000 163.2000  
## [481] 164.4000 187.6667 176.8000 182.9333 184.8667 180.9333 162.0667 181.4667  
## [489] 125.5333 164.0667 176.2000 179.3333 167.8667 197.6667 146.8000 142.3333  
## [497] 186.9333 152.4667 180.0000 156.4000 181.5333 175.3333 185.4000 182.8000  
## [505] 162.4000 140.7333 183.7333 149.5333 172.5333 159.3333 164.7333 124.8667  
## [513] 202.2667 166.7333 165.8667 199.2000 155.9333 182.3333 134.4667 170.7333  
## [521] 198.2667 165.9333 176.1333 143.0000 189.7333 168.1333 182.2000 195.1333  
## [529] 163.3333 161.9333 164.4667 161.7333 163.1333 143.6000 182.6000 140.4667  
## [537] 156.3333 149.7333 169.8667 161.0000 206.0000 163.7333 170.0667 157.8000  
## [545] 153.9333 143.4667 155.8667 200.2667 170.2000 155.7333 187.8000 190.4667  
## [553] 161.2667 168.3333 194.2667 171.2667 173.5333 155.6667 156.6000 198.4000  
## [561] 189.6667 145.5333 173.2667 159.0667 200.4667 193.0000 137.0667 174.0000  
## [569] 166.1333 173.4000 176.9333 188.0667 206.9333 177.2000 163.0667 166.5333  
## [577] 191.6000 134.4000 197.3333 170.1333 155.4667 173.4000 227.0667 154.0667  
## [585] 172.9333 170.1333 162.4667 150.7333 162.8000 168.6667 174.1333 178.7333  
## [593] 166.6667 153.0667 164.4667 163.0000 144.2000 174.7333 180.1333 170.3333  
## [601] 150.4000 170.0667 148.0667 191.1333 146.4000 192.1333 162.4000 165.9333  
## [609] 142.6667 180.1333 182.2667 174.2667 177.1333 194.9333 159.4667 139.0667  
## [617] 185.4667 169.3333 205.9333 194.8667 163.1333 150.7333 175.1333 168.0667  
## [625] 180.1333 170.0667 203.9333 163.4000 198.6000 186.2000 177.6000 197.4667  
## [633] 203.7333 170.7333 160.8000 183.8667 200.4667 179.8667 196.5333 172.0000  
## [641] 222.1333 170.7333 154.2667 176.1333 148.2667 153.2667 166.0000 180.2000  
## [649] 200.6000 191.9333 142.8667 196.6000 135.5333 147.4667 178.6000 185.0667  
## [657] 156.2667 118.9333 191.5333 187.6000 215.1333 164.0667 114.5333 182.3333  
## [665] 185.0000 208.6000 174.8000 197.3333 166.6000 162.0667 211.2667 147.7333  
## [673] 153.2000 137.8000 188.0000 159.3333 181.0000 173.3333 213.5333 198.0667  
## [681] 153.4667 192.0667 185.9333 144.0000 166.7333 171.9333 135.6000 146.8000  
## [689] 147.6667 138.2667 190.0667 206.4000 166.7333 188.5333 166.7333 160.7333  
## [697] 175.4000 200.2667 203.8000 175.2000 168.6000 134.6667 195.2667 193.4667  
## [705] 151.0667 212.4000 226.5333 169.0000 162.4667 183.7333 153.4000 146.9333  
## [713] 203.2000 197.6000 165.7333 172.5333 166.6000 170.8667 159.0667 126.6000  
## [721] 172.5333 187.6667 176.7333 206.2667 169.0667 158.6000 197.3333 215.0667  
## [729] 152.4667 191.0000 198.2000 176.6667 196.1333 166.4000 156.1333 219.4000  
## [737] 126.6000 181.3333 177.3333 176.0667 171.7333 189.6000 178.8667 201.6667  
## [745] 159.4000 194.6000 180.6667 178.7333 104.7333 168.2667 171.6667 133.9333  
## [753] 175.2000 182.7333 148.2000 172.3333 177.1333 148.0000 166.4000 166.6667  
## [761] 172.0000 127.1333 162.5333 181.6667 164.8667 151.8667 184.0000 176.0000  
## [769] 157.0000 173.4000 217.8667 161.0667 172.0000 224.2000 163.5333 177.2000  
## [777] 171.5333 151.4667 211.2000 177.4000 206.8667 183.9333 172.2000 168.9333  
## [785] 175.2000 185.9333 154.5333 162.8000 160.6000 181.6000 164.8000 158.2000  
## [793] 143.9333 176.6667 156.9333 189.4667 186.0667 192.5333 201.4000 208.9333  
## [801] 172.2000 177.8000 152.7333 163.5333 153.4667 181.4000 188.4000 180.1333  
## [809] 166.2000 133.1333 152.8000 185.5333 172.2667 192.2000 168.1333 115.8667  
## [817] 179.0000 162.6000 165.6667 146.9333 166.2000 163.4667 146.3333 165.3333  
## [825] 163.1333 169.8667 166.0667 147.0000 166.4000 151.2000 163.9333 150.9333  
## [833] 188.6667 145.9333 149.2000 184.4000 149.0000 184.3333 135.8667 113.7333  
## [841] 160.6000 184.6667 172.9333 163.0667 149.0000 169.6667 161.0000 169.7333  
## [849] 135.0000 197.6000 132.6000 165.3333 214.6667 182.6000 188.2667 175.6000  
## [857] 179.2000 187.0667 169.3333 147.6000 210.9333 169.7333 173.9333 193.9333  
## [865] 171.2000 190.7333 188.7333 175.8000 157.6667 148.4000 184.8667 172.0000  
## [873] 158.7333 173.0667 131.7333 145.5333 171.6667 173.3333 171.1333 175.7333  
## [881] 152.9333 176.2000 162.4667 198.6000 146.6667 210.0000 177.7333 207.0667  
## [889] 164.4667 172.0000 141.4000 186.0000 176.0667 178.7333 144.6667 154.2667  
## [897] 149.2667 171.2000 183.7333 129.6000 172.4667 126.5333 199.7333 177.4667  
## [905] 167.6000 173.5333 165.3333 176.4000 179.3333 182.7333 179.6667 193.8667  
## [913] 207.2667 162.0000 186.9333 175.8000 182.4000 150.8667 183.1333 169.2000  
## [921] 196.0667 198.0000 171.0000 186.2000 174.2667 183.8000 160.0667 199.8000  
## [929] 174.6000 158.5333 146.8000 145.6000 157.1333 145.4667 152.5333 180.4000  
## [937] 164.2000 114.5333 204.0000 149.8000 201.3333 157.6000 176.0667 187.0000  
## [945] 147.4000 200.0000 126.6667 165.6000 133.6667 172.4667 130.5333 168.6667  
## [953] 182.3333 174.5333 163.1333 201.0000 166.4667 172.1333 119.2000 138.0000  
## [961] 190.9333 163.8667 169.0667 190.6667 168.8667 177.7333 156.6000 187.3333  
## [969] 159.9333 170.3333 164.0667 180.9333 179.6667 183.4667 202.4667 175.2000  
## [977] 164.8000 157.7333 174.6000 168.8667 164.5333 135.2000 197.6667 216.7333  
## [985] 186.7333 196.6000 184.2000 181.9333 146.6000 164.7333 161.3333 176.2000  
## [993] 200.4667 168.4000 172.4000 185.3333 203.6667 158.0667 166.2667 155.3333

# FOR SAMPLE 2  
samp\_dist2=replicate(1000,mean(sample(USArrests$Assault,samplesize2,replace=TRUE)))  
samp\_dist2

## [1] 155.9 170.7 206.4 161.6 175.3 146.9 208.9 215.0 188.4 191.0 207.3 147.2  
## [13] 179.6 168.8 166.7 184.9 157.8 195.7 125.6 184.6 167.9 146.7 164.5 179.1  
## [25] 164.5 189.2 134.2 173.4 142.2 189.7 140.0 160.8 181.1 208.2 108.2 186.6  
## [37] 175.0 180.5 165.2 161.8 168.2 175.1 182.1 187.8 127.9 168.4 145.0 164.4  
## [49] 208.9 172.5 141.3 217.5 168.6 160.0 238.4 167.2 157.7 127.6 170.6 134.7  
## [61] 190.8 219.0 182.8 202.1 203.9 167.6 170.6 135.8 160.1 210.3 153.3 158.7  
## [73] 183.3 142.0 176.7 168.4 174.5 147.1 196.0 174.1 105.4 189.2 175.7 118.1  
## [85] 186.0 151.2 162.9 161.4 199.8 125.3 176.6 151.8 157.2 103.7 148.0 164.3  
## [97] 197.3 179.8 193.8 156.3 151.7 123.5 207.8 145.0 186.1 152.6 137.3 139.2  
## [109] 167.6 169.4 161.2 198.7 194.7 175.8 162.9 155.1 136.6 178.8 164.5 175.0  
## [121] 214.5 204.4 153.5 190.0 205.1 159.0 173.3 189.4 156.8 166.5 150.1 111.6  
## [133] 189.3 146.7 180.8 191.8 158.4 190.8 149.2 117.3 204.8 119.2 168.4 176.3  
## [145] 176.7 170.9 184.5 184.4 193.6 127.6 190.8 136.3 231.8 162.2 207.8 167.3  
## [157] 146.2 196.8 150.7 160.7 174.7 161.8 146.4 116.5 185.4 185.8 169.6 181.6  
## [169] 171.8 140.6 165.5 147.9 168.1 162.1 129.4 184.8 175.7 213.0 174.6 183.5  
## [181] 208.5 181.2 192.8 152.4 177.6 233.8 217.6 204.8 194.7 147.7 157.0 171.3  
## [193] 226.9 219.3 147.2 175.4 132.3 184.9 192.4 191.6 113.1 156.1 189.0 170.2  
## [205] 137.2 174.6 152.4 230.5 115.6 147.8 190.8 197.2 133.0 143.9 189.6 146.5  
## [217] 230.4 139.5 143.7 176.8 175.1 167.9 137.2 158.7 188.6 150.1 154.2 153.2  
## [229] 201.7 173.5 130.3 193.9 158.2 207.7 208.7 143.2 131.8 175.3 189.1 137.4  
## [241] 151.5 229.6 182.1 169.9 139.1 207.3 159.6 121.4 177.5 196.5 195.7 187.4  
## [253] 183.0 155.6 223.6 186.7 151.0 184.4 181.2 167.0 157.1 160.9 158.3 173.5  
## [265] 180.0 149.4 131.1 223.8 122.9 225.1 143.4 137.0 165.4 164.1 182.6 173.0  
## [277] 183.8 177.2 197.0 123.7 167.6 168.3 167.1 205.6 207.9 161.5 198.3 193.1  
## [289] 144.3 140.0 132.9 161.1 172.2 147.9 107.1 171.9 175.8 183.6 150.1 192.2  
## [301] 176.1 194.0 162.4 115.9 141.4 188.5 169.3 163.0 147.4 152.6 242.2 144.0  
## [313] 134.1 234.7 135.6 136.9 207.0 184.2 217.2 105.5 204.1 176.4 162.1 185.2  
## [325] 180.6 164.0 189.8 185.0 130.2 186.7 181.0 163.3 150.5 155.4 241.5 190.5  
## [337] 142.2 166.8 189.7 136.8 150.9 183.5 152.8 170.3 184.9 187.2 155.4 202.9  
## [349] 155.3 145.2 152.3 194.9 191.7 199.1 126.3 126.1 150.5 150.6 168.4 147.4  
## [361] 178.2 193.0 164.1 155.6 161.1 193.7 214.1 124.7 190.2 204.1 166.1 147.4  
## [373] 197.9 148.8 202.0 161.8 156.9 145.4 162.6 159.0 161.8 186.7 132.4 182.3  
## [385] 200.9 191.0 181.0 150.8 141.1 191.0 152.7 145.5 163.8 184.0 165.0 123.5  
## [397] 189.1 176.2 171.4 198.8 178.9 202.4 189.6 154.1 181.4 210.3 152.6 190.2  
## [409] 124.6 234.9 209.8 102.6 203.6 236.2 182.2 174.9 149.5 179.9 162.7 179.8  
## [421] 164.4 216.8 200.3 185.7 177.5 168.2 124.0 182.5 173.9 162.4 139.9 228.4  
## [433] 164.2 188.2 202.1 174.9 135.0 215.8 137.2 218.7 158.5 184.3 163.8 188.4  
## [445] 166.7 176.3 149.8 186.0 183.0 119.7 180.1 178.5 171.0 173.6 144.9 183.1  
## [457] 165.9 152.6 174.9 141.9 120.6 186.2 188.3 165.9 182.3 178.4 174.2 138.3  
## [469] 184.1 112.9 203.0 204.8 161.8 153.1 140.0 162.9 215.0 150.6 144.0 154.7  
## [481] 168.6 176.4 165.9 220.9 180.1 161.9 186.1 185.1 167.4 170.0 164.3 114.3  
## [493] 163.9 151.0 142.1 189.7 149.6 172.2 156.6 220.0 167.5 160.1 216.5 189.5  
## [505] 189.4 143.5 192.8 199.1 169.0 199.6 147.7 145.7 178.1 177.7 175.7 181.6  
## [517] 175.9 133.4 171.3 167.9 143.3 197.0 157.2 159.7 138.0 203.5 171.1 165.5  
## [529] 172.2 200.1 145.5 142.6 186.9 162.5 201.8 187.2 154.0 198.2 144.9 178.1  
## [541] 155.3 144.3 193.9 190.3 183.6 151.2 172.9 187.5 202.9 168.8 129.9 188.6  
## [553] 143.9 184.0 183.7 152.8 156.7 203.8 160.2 133.9 169.2 170.6 189.4 179.8  
## [565] 188.4 174.5 163.3 181.1 157.6 144.2 158.5 148.7 182.6 131.5 154.1 167.7  
## [577] 168.7 203.0 183.3 179.8 159.2 191.5 154.3 181.7 131.8 176.9 162.1 162.8  
## [589] 159.2 184.0 190.5 221.3 174.0 175.1 199.4 189.1 203.5 140.0 133.1 185.8  
## [601] 204.3 174.6 180.0 167.9 106.6 109.4 205.8 181.1 206.7 179.6 140.3 199.8  
## [613] 143.7 232.9 161.1 190.6 173.6 179.8 145.1 167.6 154.6 165.2 170.3 166.5  
## [625] 192.0 186.6 162.1 184.5 150.9 180.0 167.5 169.7 168.5 169.4 109.5 180.0  
## [637] 200.9 172.1 183.1 152.4 133.9 190.4 157.6 156.8 164.8 151.4 166.4 213.6  
## [649] 123.4 190.0 147.2 196.2 201.2 117.4 169.8 171.1 141.4 148.2 157.0 166.0  
## [661] 150.9 197.4 151.0 198.1 164.8 187.4 214.7 150.5 185.2 206.4 197.8 169.0  
## [673] 139.4 167.6 181.4 141.9 191.1 194.9 172.3 192.3 145.1 133.1 161.7 146.5  
## [685] 195.9 157.9 161.9 202.4 160.1 192.7 175.0 176.9 134.6 147.3 189.2 197.8  
## [697] 168.9 120.8 156.3 163.3 151.8 192.2 180.0 147.6 166.3 132.4 186.0 177.6  
## [709] 155.2 129.3 158.7 180.6 136.2 185.3 190.4 217.8 171.6 186.2 205.8 230.2  
## [721] 205.4 152.0 176.6 147.1 160.5 158.2 126.3 183.8 190.0 211.2 172.9 187.9  
## [733] 145.7 181.8 185.7 178.7 137.9 156.3 114.7 121.5 179.3 179.8 199.3 192.7  
## [745] 204.0 168.6 149.5 172.5 207.9 159.0 161.1 143.8 169.4 142.4 185.1 212.9  
## [757] 154.7 189.0 148.4 149.7 145.5 199.4 142.9 195.7 180.5 150.8 133.6 147.4  
## [769] 207.9 159.1 182.9 160.1 187.9 167.3 141.6 159.3 168.0 153.8 173.3 187.4  
## [781] 128.6 190.8 163.9 169.2 220.4 120.6 245.9 193.8 168.9 194.9 169.2 181.5  
## [793] 157.4 132.8 142.4 151.8 169.3 200.3 207.4 148.2 189.2 158.9 154.1 120.4  
## [805] 219.9 206.9 180.3 175.4 153.0 187.2 126.8 187.6 165.6 165.9 179.5 167.7  
## [817] 145.7 144.2 177.9 167.0 138.7 206.6 133.4 170.6 185.9 150.6 200.1 161.2  
## [829] 152.8 155.9 126.8 216.8 133.3 159.2 177.9 170.3 158.5 177.2 159.0 162.2  
## [841] 148.5 185.9 175.0 188.4 136.6 185.9 138.8 167.5 170.7 180.7 162.0 185.4  
## [853] 231.0 163.1 153.5 135.0 202.6 213.9 162.9 148.0 153.5 168.0 196.3 124.6  
## [865] 162.2 156.1 143.9 185.6 196.1 141.4 184.3 149.3 182.1 198.7 181.5 185.0  
## [877] 182.3 150.3 219.1 197.4 183.4 163.8 174.3 148.0 188.7 178.2 204.8 203.6  
## [889] 196.7 201.0 106.3 139.6 152.0 186.4 168.0 155.3 170.1 171.2 164.3 181.0  
## [901] 177.0 196.5 127.4 192.1 127.6 153.1 137.8 155.3 136.4 211.1 191.8 146.1  
## [913] 148.4 163.4 202.4 158.9 202.4 189.4 159.0 140.7 137.5 146.2 188.7 121.3  
## [925] 222.6 167.4 178.6 158.8 199.1 153.8 171.3 197.5 140.8 183.4 123.7 194.6  
## [937] 184.1 156.1 165.4 167.8 144.2 157.8 187.6 208.0 177.6 151.1 212.0 145.8  
## [949] 173.2 202.0 156.3 140.1 184.5 169.1 143.4 178.1 170.0 153.3 131.4 194.5  
## [961] 175.9 151.1 212.1 150.1 184.2 137.1 182.7 184.0 188.8 97.5 186.8 152.7  
## [973] 181.6 215.8 177.1 131.8 164.4 183.1 173.3 174.3 148.1 190.0 136.8 143.9  
## [985] 190.1 191.1 224.9 183.3 176.1 217.6 167.2 200.9 142.1 175.1 163.6 122.9  
## [997] 160.4 156.0 193.2 203.3

## MEAN OF THE SAMPLE STATISTIC

mean(samp\_dist\_1) #the mean of the sample statistic is almost equal to the population mean which is 170.8.So the sample of 15 observations is a good way to determine the population mean

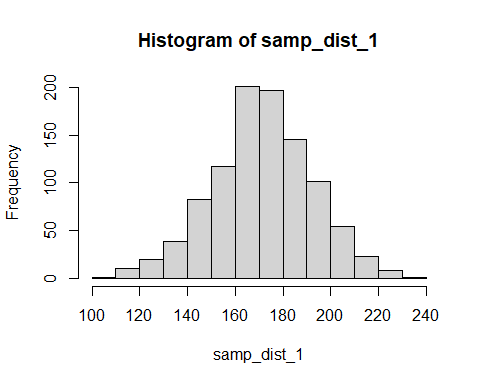
## [1] 171.3257

mean(samp\_dist2)

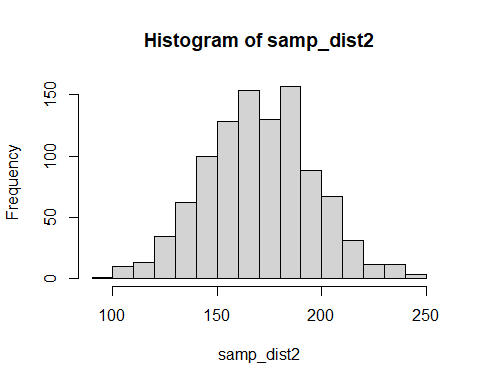
## [1] 170.2515

## REPRESENTATION OF THE SAMPLING DISTRIBUTION

hist(samp\_dist\_1)



hist(samp\_dist2)

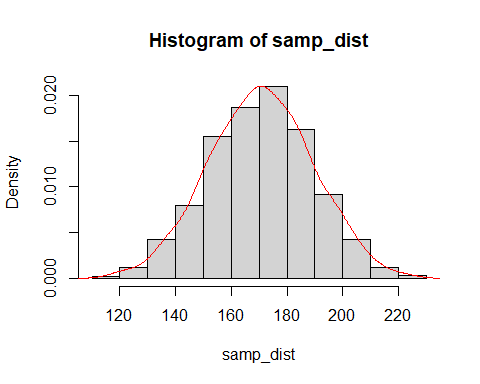
 ## QUESTION 3:

Let us take a sample of 20 observations to check its precision.

samp\_dist=replicate(1000,mean(sample(USArrests$Assault,20,replace=TRUE)))  
samp\_dist

## [1] 151.45 146.35 190.00 161.60 162.60 177.70 171.45 158.60 180.00 164.55  
## [11] 145.00 165.30 168.75 173.95 148.45 155.70 138.70 152.65 169.90 174.15  
## [21] 181.70 198.50 157.30 188.30 163.75 171.50 184.30 121.35 185.70 164.60  
## [31] 169.65 197.70 165.85 177.25 207.70 155.90 151.10 168.85 155.15 178.30  
## [41] 176.80 159.75 190.65 194.85 159.60 178.00 146.50 173.10 195.00 169.55  
## [51] 205.00 189.05 153.80 191.70 170.50 169.35 174.30 166.85 186.35 170.40  
## [61] 190.30 171.65 180.15 170.35 173.60 203.80 181.05 144.75 174.30 173.50  
## [71] 185.65 199.25 182.95 157.60 193.05 204.90 207.45 194.90 183.65 176.20  
## [81] 189.50 179.20 166.20 170.70 165.60 163.90 148.85 184.00 139.00 132.15  
## [91] 197.75 186.90 162.90 158.80 152.80 163.00 182.00 165.60 140.85 178.55  
## [101] 177.60 171.30 139.15 170.45 188.70 158.95 149.20 164.55 146.10 168.30  
## [111] 166.75 164.00 166.60 160.05 153.30 198.95 169.20 199.30 175.70 180.85  
## [121] 186.75 165.20 183.35 162.20 176.10 209.00 201.60 167.45 154.25 177.90  
## [131] 145.25 162.90 179.05 160.40 171.75 166.65 157.75 181.45 157.85 152.50  
## [141] 199.40 173.25 173.25 174.45 147.05 132.20 149.25 164.25 171.95 198.45  
## [151] 163.50 194.70 138.65 152.65 172.20 153.15 173.90 197.25 141.40 185.15  
## [161] 165.90 149.70 188.95 183.85 193.30 188.45 186.15 149.85 176.95 185.45  
## [171] 157.85 164.40 169.30 136.45 174.75 176.55 166.00 166.80 144.40 179.60  
## [181] 166.75 148.75 148.45 167.80 195.70 138.45 216.85 186.15 155.45 158.05  
## [191] 178.20 177.75 183.20 177.60 187.45 188.90 178.70 219.55 201.80 172.35  
## [201] 145.00 188.95 186.90 159.25 163.30 158.35 172.55 202.30 165.10 198.25  
## [211] 159.60 152.55 186.15 129.10 168.35 164.25 175.00 187.55 123.35 164.75  
## [221] 176.65 177.55 160.80 185.10 191.30 169.90 182.55 138.65 187.20 186.30  
## [231] 173.70 201.95 188.90 196.75 158.15 186.95 181.40 158.75 187.30 173.85  
## [241] 202.35 184.15 180.80 172.25 158.65 195.45 173.80 179.10 156.55 157.00  
## [251] 157.15 170.45 136.35 181.05 187.40 159.40 194.75 171.45 176.60 205.55  
## [261] 202.15 184.80 161.85 159.35 171.30 155.55 168.40 132.20 201.15 163.60  
## [271] 150.75 169.45 156.55 202.80 136.00 143.65 156.20 189.60 160.05 198.40  
## [281] 170.45 192.50 172.70 175.75 146.15 168.70 171.20 179.35 169.80 170.45  
## [291] 182.35 166.45 161.65 180.45 131.10 184.25 149.60 182.80 212.40 178.60  
## [301] 170.60 164.25 184.10 149.50 178.10 169.40 143.95 134.65 198.25 177.90  
## [311] 121.35 151.40 150.35 198.80 164.25 127.85 188.00 164.40 194.25 177.10  
## [321] 198.60 148.65 170.90 160.95 172.70 143.85 163.65 184.00 145.35 164.25  
## [331] 178.25 170.75 155.55 192.00 145.10 178.25 163.00 157.90 148.35 199.90  
## [341] 194.55 161.90 165.85 148.60 158.10 155.25 183.00 183.00 188.20 160.50  
## [351] 175.90 177.75 200.20 164.65 170.60 166.70 186.40 180.55 160.35 172.20  
## [361] 202.85 191.50 155.00 180.50 147.65 162.00 181.10 164.15 171.05 166.00  
## [371] 164.50 139.25 161.95 176.05 135.20 181.35 170.20 193.05 154.00 142.25  
## [381] 188.50 153.85 199.10 202.35 143.75 181.75 190.65 196.90 142.20 170.10  
## [391] 156.50 159.45 175.80 170.10 208.50 212.20 155.90 185.95 161.00 163.90  
## [401] 147.80 183.25 170.40 174.60 137.30 144.55 204.55 157.85 170.85 148.90  
## [411] 178.20 177.75 186.00 172.80 187.60 120.15 165.05 184.35 143.25 184.40  
## [421] 152.40 137.55 162.20 150.90 158.55 174.40 192.10 145.50 205.25 157.90  
## [431] 175.50 154.90 148.60 188.40 178.35 138.40 164.55 170.50 182.65 172.50  
## [441] 197.90 187.30 183.85 187.40 160.00 202.30 131.55 164.95 224.85 150.85  
## [451] 175.10 138.60 184.55 213.80 186.05 173.40 195.40 165.65 152.95 127.95  
## [461] 155.20 175.30 134.05 141.55 150.95 162.75 172.15 141.80 189.20 135.10  
## [471] 163.50 188.15 177.85 168.45 161.45 188.85 171.50 149.50 188.55 172.45  
## [481] 163.70 145.70 167.10 184.25 158.55 196.20 162.85 168.85 171.55 156.35  
## [491] 121.80 148.85 187.65 178.55 143.85 149.10 165.70 185.45 170.70 156.20  
## [501] 115.20 158.05 161.50 145.15 192.30 192.50 176.80 137.70 161.15 209.00  
## [511] 179.35 174.80 154.90 193.10 183.40 189.35 195.70 210.20 197.95 182.05  
## [521] 174.95 138.45 202.20 189.05 165.65 157.05 197.35 167.25 140.65 157.95  
## [531] 174.45 170.65 182.20 158.30 182.60 154.70 136.10 183.75 152.15 166.70  
## [541] 166.05 168.85 168.65 150.60 162.95 138.05 197.20 153.85 159.25 160.45  
## [551] 166.85 156.30 173.05 199.00 198.90 158.80 160.10 174.35 161.50 156.20  
## [561] 180.80 209.70 172.90 158.85 174.45 161.95 174.20 178.25 148.05 191.95  
## [571] 180.00 177.30 158.40 173.80 168.20 160.05 184.30 133.10 179.55 135.75  
## [581] 150.05 190.55 151.25 206.40 167.35 161.55 159.50 157.05 168.05 192.45  
## [591] 178.75 155.70 180.05 178.25 192.25 161.15 170.40 131.45 169.35 179.10  
## [601] 194.90 158.65 152.90 197.15 193.00 170.90 196.75 176.20 177.60 197.05  
## [611] 172.45 188.95 178.35 224.55 166.65 189.00 190.20 174.50 183.65 184.30  
## [621] 182.35 155.30 189.35 180.70 161.95 163.15 197.30 170.30 182.85 147.90  
## [631] 165.50 179.05 191.10 176.15 153.10 189.30 161.70 186.50 157.30 180.25  
## [641] 151.10 181.40 164.00 136.25 198.75 172.60 186.70 163.55 173.40 159.30  
## [651] 205.35 182.45 127.20 171.00 164.65 187.65 183.45 158.05 145.45 164.35  
## [661] 167.40 167.70 148.05 152.80 190.50 205.90 155.40 166.45 201.00 153.30  
## [671] 143.65 203.80 186.00 154.35 175.85 170.10 169.85 185.75 187.50 182.85  
## [681] 191.90 168.70 173.25 166.65 186.45 154.20 207.40 178.20 194.40 167.25  
## [691] 173.45 145.80 161.20 162.65 171.35 151.30 151.10 170.60 138.50 154.10  
## [701] 185.40 196.75 152.35 188.90 168.65 154.10 163.20 148.45 166.95 183.00  
## [711] 175.55 176.00 178.10 169.00 140.70 217.10 185.65 186.80 132.65 159.65  
## [721] 196.10 207.60 153.25 172.90 203.30 155.50 152.05 158.65 169.20 189.00  
## [731] 160.25 170.75 195.05 181.05 197.45 179.25 154.40 181.90 154.00 176.45  
## [741] 162.75 156.05 171.80 131.55 193.85 200.95 179.55 156.90 172.85 174.50  
## [751] 150.15 152.30 183.50 164.05 153.75 181.70 170.55 162.55 177.40 143.00  
## [761] 175.20 181.10 162.15 141.75 191.30 166.85 160.70 174.50 167.35 168.60  
## [771] 171.00 184.60 173.10 167.25 158.90 189.10 150.20 149.60 202.15 166.40  
## [781] 173.00 172.90 195.00 185.60 142.00 125.80 176.85 182.05 146.10 154.70  
## [791] 164.75 143.90 166.60 167.60 179.05 170.40 149.00 169.25 122.00 136.35  
## [801] 171.25 181.00 215.65 147.60 192.95 174.65 145.50 194.20 162.35 154.45  
## [811] 166.50 174.45 159.80 159.60 183.10 178.80 172.95 182.85 184.85 151.05  
## [821] 191.85 199.55 183.25 166.30 152.10 146.65 212.65 168.10 140.35 174.05  
## [831] 182.40 183.35 136.95 150.80 164.75 173.20 170.95 153.15 149.30 155.55  
## [841] 167.75 178.00 180.95 158.65 176.90 174.20 158.30 182.75 161.20 169.60  
## [851] 178.90 180.10 175.25 158.20 190.65 153.40 193.75 147.40 168.00 197.30  
## [861] 182.05 183.30 198.45 166.80 182.90 139.10 171.65 180.75 164.75 204.40  
## [871] 153.90 171.60 186.60 176.15 166.00 162.25 174.35 133.45 150.85 166.25  
## [881] 162.85 180.30 171.35 158.85 151.70 193.75 181.85 210.55 208.20 171.80  
## [891] 196.40 148.15 171.50 165.40 150.50 163.55 142.35 192.20 174.35 169.90  
## [901] 183.95 171.80 174.95 187.40 176.40 204.85 161.95 151.80 217.65 213.90  
## [911] 178.10 158.65 194.80 157.75 194.20 181.80 183.40 182.95 143.55 179.45  
## [921] 167.25 155.80 203.75 181.15 159.55 163.60 172.65 165.95 178.60 174.20  
## [931] 168.45 153.10 158.80 157.70 182.85 180.45 137.45 222.10 138.45 147.60  
## [941] 178.50 154.80 152.80 190.80 200.10 162.45 168.15 179.20 182.70 209.65  
## [951] 166.10 190.70 186.00 177.45 167.15 118.45 170.20 135.50 152.40 150.25  
## [961] 167.45 168.10 173.10 146.05 158.70 206.00 156.55 150.95 172.10 177.45  
## [971] 156.90 175.30 148.95 164.85 154.70 144.90 176.50 159.40 163.15 127.70  
## [981] 187.25 149.80 140.00 177.05 172.10 179.70 149.65 193.55 162.70 180.40  
## [991] 190.95 174.10 169.30 184.85 168.80 198.70 142.40 176.55 164.40 181.30

hist(samp\_dist,prob=TRUE)  
lines(density(x=samp\_dist), col = "red")

 ##the above diagram almost resembles a normal distribution curve.Hence we can conclude that increasing the sample size will cause the sample statistic to follow standard normal distribution according to central limit theorem.

mean(samp\_dist)

## [1] 170.6553

sd(samp\_dist)

## [1] 18.67784

#we can see that increasing the sample size has decreased the standard error.This implies that sample size is inversely proportional to standard error.If sample size increases, standard error will decrease, hence increasing the precision.

QUESTION 4:

TO CALCULATE THE STANDARD ERROR OF THE SAMPLE STATISTIC

sd(samp\_dist\_1)

## [1] 20.91666

sd(samp\_dist2)

## [1] 25.6559