Lab01

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## AIM: To calculate the sampling distribution and the standard error

## Dataset:

cars

## speed dist  
## 1 4 2  
## 2 4 10  
## 3 7 4  
## 4 7 22  
## 5 8 16  
## 6 9 10  
## 7 10 18  
## 8 10 26  
## 9 10 34  
## 10 11 17  
## 11 11 28  
## 12 12 14  
## 13 12 20  
## 14 12 24  
## 15 12 28  
## 16 13 26  
## 17 13 34  
## 18 13 34  
## 19 13 46  
## 20 14 26  
## 21 14 36  
## 22 14 60  
## 23 14 80  
## 24 15 20  
## 25 15 26  
## 26 15 54  
## 27 16 32  
## 28 16 40  
## 29 17 32  
## 30 17 40  
## 31 17 50  
## 32 18 42  
## 33 18 56  
## 34 18 76  
## 35 18 84  
## 36 19 36  
## 37 19 46  
## 38 19 68  
## 39 20 32  
## 40 20 48  
## 41 20 52  
## 42 20 56  
## 43 20 64  
## 44 22 66  
## 45 23 54  
## 46 24 70  
## 47 24 92  
## 48 24 93  
## 49 24 120  
## 50 25 85

tail(cars)

## speed dist  
## 45 23 54  
## 46 24 70  
## 47 24 92  
## 48 24 93  
## 49 24 120  
## 50 25 85

head(cars)

## speed dist  
## 1 4 2  
## 2 4 10  
## 3 7 4  
## 4 7 22  
## 5 8 16  
## 6 9 10

c = cars

print(c)

## speed dist  
## 1 4 2  
## 2 4 10  
## 3 7 4  
## 4 7 22  
## 5 8 16  
## 6 9 10  
## 7 10 18  
## 8 10 26  
## 9 10 34  
## 10 11 17  
## 11 11 28  
## 12 12 14  
## 13 12 20  
## 14 12 24  
## 15 12 28  
## 16 13 26  
## 17 13 34  
## 18 13 34  
## 19 13 46  
## 20 14 26  
## 21 14 36  
## 22 14 60  
## 23 14 80  
## 24 15 20  
## 25 15 26  
## 26 15 54  
## 27 16 32  
## 28 16 40  
## 29 17 32  
## 30 17 40  
## 31 17 50  
## 32 18 42  
## 33 18 56  
## 34 18 76  
## 35 18 84  
## 36 19 36  
## 37 19 46  
## 38 19 68  
## 39 20 32  
## 40 20 48  
## 41 20 52  
## 42 20 56  
## 43 20 64  
## 44 22 66  
## 45 23 54  
## 46 24 70  
## 47 24 92  
## 48 24 93  
## 49 24 120  
## 50 25 85

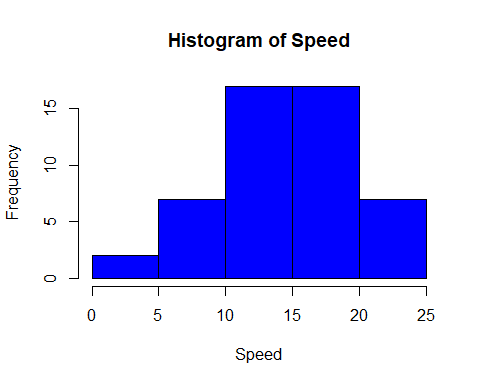
dim(cars)

## [1] 50 2

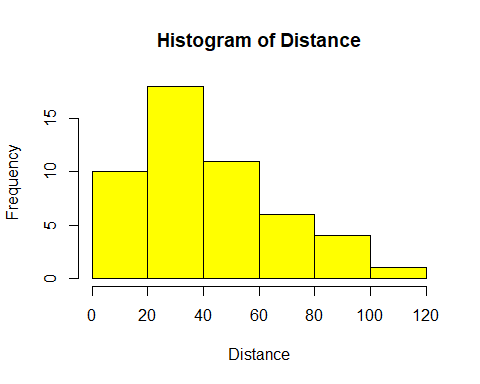
summary(cars)

## speed dist   
## Min. : 4.0 Min. : 2.00   
## 1st Qu.:12.0 1st Qu.: 26.00   
## Median :15.0 Median : 36.00   
## Mean :15.4 Mean : 42.98   
## 3rd Qu.:19.0 3rd Qu.: 56.00   
## Max. :25.0 Max. :120.00

hist(cars$speed, xlab="Speed", main="Histogram of Speed", col="blue")



hist(cars$dist, xlab="Distance", main="Histogram of Distance", col="yellow")



sd(cars$speed)

## [1] 5.287644

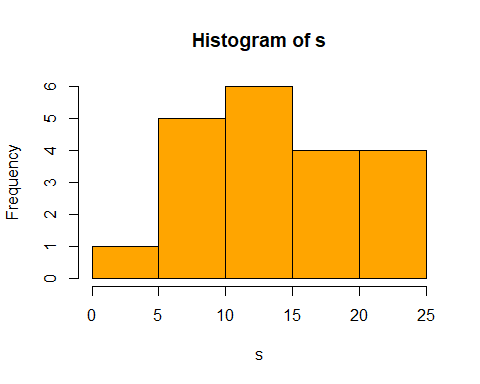
population=cars$speed  
samplesize=20  
s=sample(population,samplesize,replace = FALSE)  
mean(s)

## [1] 15

var(s)

## [1] 38.73684

hist(s, col="orange")



samp\_dist = replicate(1000, mean(sample(cars$speed, 20, replace = FALSE)))  
samp\_dist

## [1] 14.85 15.55 15.85 15.70 16.35 16.00 16.40 13.85 14.60 15.30 15.55 15.65  
## [13] 14.05 15.85 15.80 14.95 13.80 18.85 14.55 15.25 15.20 14.25 15.50 15.70  
## [25] 15.60 14.30 14.15 15.25 15.55 14.80 17.10 15.00 14.35 15.45 14.35 16.15  
## [37] 16.30 15.95 14.00 15.95 15.40 15.30 15.80 14.85 15.65 15.45 14.85 15.25  
## [49] 16.00 14.40 14.25 14.95 14.15 16.15 15.50 14.30 15.20 14.40 15.55 16.40  
## [61] 16.65 15.05 16.60 15.20 15.70 15.30 15.85 14.20 15.75 14.10 14.95 16.10  
## [73] 15.45 17.05 15.70 14.85 15.40 14.60 14.70 15.80 16.30 15.05 15.55 13.75  
## [85] 17.00 16.05 14.05 15.85 16.00 13.80 15.20 14.10 15.20 15.00 15.90 14.85  
## [97] 15.55 16.05 15.30 16.40 16.80 15.95 16.85 14.15 14.80 14.55 14.95 16.40  
## [109] 16.65 14.55 14.95 15.00 15.45 15.70 15.45 14.85 16.15 15.90 15.10 16.90  
## [121] 15.20 14.80 15.55 15.30 15.65 14.30 15.50 16.00 15.05 16.35 14.75 14.65  
## [133] 15.70 16.35 15.95 14.95 14.50 16.80 15.05 14.55 15.85 17.40 15.45 15.20  
## [145] 13.50 15.60 14.25 15.10 15.35 15.30 15.55 16.60 14.35 14.10 16.65 15.90  
## [157] 15.85 15.55 15.35 17.20 15.15 16.85 15.75 15.75 14.80 15.05 15.00 15.60  
## [169] 15.35 15.10 15.70 14.20 15.25 17.00 14.95 15.80 14.65 15.40 16.55 17.50  
## [181] 13.90 16.75 13.65 15.85 14.10 14.20 16.65 16.10 15.35 15.00 15.45 16.00  
## [193] 16.25 15.75 13.90 15.60 15.70 16.90 16.35 16.20 16.25 17.35 16.00 15.15  
## [205] 18.05 13.50 14.65 15.60 17.15 14.70 14.50 15.75 14.40 15.00 15.75 15.65  
## [217] 15.95 14.95 14.10 13.55 14.40 17.75 15.45 15.70 15.95 16.05 15.60 13.70  
## [229] 14.45 15.45 15.50 15.15 15.70 15.30 15.25 14.15 16.40 14.20 15.60 16.25  
## [241] 17.35 15.10 15.30 16.90 14.75 14.10 16.30 15.60 13.65 15.55 16.40 15.25  
## [253] 15.35 15.90 17.00 16.15 14.95 13.70 16.65 14.20 14.95 16.90 14.20 14.75  
## [265] 15.80 14.55 14.90 14.40 16.10 15.55 15.30 14.50 13.25 14.85 16.00 14.35  
## [277] 15.30 16.00 15.20 14.00 15.30 16.50 16.65 15.15 15.60 15.10 14.75 14.40  
## [289] 16.40 14.70 16.70 15.65 15.90 17.35 14.05 15.25 15.45 15.00 13.70 15.10  
## [301] 15.25 16.00 15.10 13.80 16.95 15.90 16.95 16.05 16.50 15.80 15.70 14.90  
## [313] 14.25 14.65 15.45 15.15 15.55 13.25 15.35 16.15 15.25 15.45 15.15 16.35  
## [325] 14.15 16.40 15.35 13.50 16.05 16.70 14.25 15.00 12.75 14.10 16.10 15.40  
## [337] 15.35 17.95 15.55 16.50 15.20 16.45 16.90 17.10 16.30 15.75 14.80 13.75  
## [349] 13.60 15.30 15.15 16.95 16.15 15.95 16.10 15.45 15.20 15.80 13.80 17.50  
## [361] 14.50 14.80 15.60 16.30 16.00 15.25 13.70 16.50 15.35 16.70 15.85 16.05  
## [373] 16.65 17.00 15.65 16.05 14.10 16.00 15.20 13.85 15.80 15.05 15.85 14.85  
## [385] 15.85 16.20 14.65 14.85 15.70 16.15 14.85 15.35 15.35 15.75 15.15 14.85  
## [397] 15.35 13.60 16.15 14.10 16.20 16.70 15.40 15.40 16.35 14.80 14.60 14.75  
## [409] 15.70 15.85 13.95 14.30 16.40 15.20 14.75 16.10 15.35 14.75 14.05 15.80  
## [421] 14.35 16.25 14.95 14.00 14.00 17.60 15.40 15.30 14.60 16.60 16.20 16.10  
## [433] 14.10 15.40 14.80 15.30 15.00 15.55 14.55 17.20 14.55 14.35 14.45 16.40  
## [445] 15.40 15.95 15.65 16.45 15.40 15.55 15.45 15.70 15.40 15.35 15.85 16.00  
## [457] 16.15 15.00 13.40 14.10 16.25 15.90 14.75 15.65 15.85 15.85 16.80 15.15  
## [469] 15.80 16.10 16.20 15.70 16.00 14.95 15.75 15.30 15.25 13.75 13.25 16.05  
## [481] 16.55 15.60 16.95 15.35 15.85 13.80 14.90 16.75 16.20 15.05 15.05 16.75  
## [493] 16.25 13.55 14.80 14.60 12.95 15.25 16.00 16.20 15.20 14.20 15.85 14.95  
## [505] 14.75 17.15 15.25 16.00 15.70 14.80 15.25 16.20 16.60 16.35 13.70 16.10  
## [517] 15.55 15.70 13.90 15.00 14.55 17.30 17.05 15.60 14.75 14.70 15.70 15.70  
## [529] 16.55 15.25 14.40 15.10 15.65 15.80 14.70 14.10 16.00 15.60 16.15 16.20  
## [541] 15.45 16.10 14.65 13.75 16.70 14.90 15.45 14.90 16.00 15.90 15.75 15.90  
## [553] 16.30 16.95 16.30 14.90 15.30 14.50 15.35 15.15 16.40 15.40 14.45 15.75  
## [565] 15.05 14.00 13.85 15.05 15.05 15.20 14.10 16.20 15.35 14.75 15.55 17.00  
## [577] 14.50 15.15 16.40 15.50 16.75 14.55 13.75 16.20 14.35 14.85 15.50 15.90  
## [589] 14.15 16.05 14.45 16.90 14.60 15.70 15.30 16.70 14.95 15.65 16.15 16.05  
## [601] 14.75 17.15 14.65 14.00 14.10 14.25 15.50 15.20 15.05 14.70 16.65 14.30  
## [613] 14.10 15.65 17.45 14.85 14.55 16.40 14.25 15.10 16.05 16.30 16.05 15.75  
## [625] 15.75 14.95 14.05 15.30 13.50 13.90 14.15 15.35 15.30 15.65 14.25 14.65  
## [637] 15.80 14.95 15.05 14.15 13.25 16.00 14.10 16.85 16.35 14.50 17.05 14.30  
## [649] 14.50 15.55 15.05 15.25 16.10 15.55 16.20 14.25 15.45 15.65 16.20 14.00  
## [661] 15.80 15.40 16.30 15.20 15.60 15.40 14.80 14.50 14.90 14.50 16.40 15.80  
## [673] 15.95 16.45 14.60 14.35 14.15 16.20 15.20 15.40 13.90 14.45 14.85 15.35  
## [685] 15.10 15.45 15.90 15.15 15.20 15.60 15.70 15.55 15.85 15.05 15.60 15.30  
## [697] 14.85 14.35 15.85 16.00 15.30 14.90 14.35 16.45 15.20 13.75 14.75 14.50  
## [709] 16.40 15.15 14.20 16.50 14.55 17.00 15.25 14.65 17.40 15.40 15.15 17.30  
## [721] 16.50 16.05 14.35 16.50 14.40 15.35 15.65 15.85 15.80 15.50 13.65 14.50  
## [733] 14.05 15.20 16.60 16.65 15.80 14.60 15.50 15.20 16.35 15.20 16.00 16.50  
## [745] 15.65 15.65 15.60 15.80 15.45 14.40 15.50 15.60 17.00 15.70 16.25 15.25  
## [757] 15.50 14.65 14.80 17.40 14.20 16.05 14.45 15.65 17.05 13.65 15.00 14.75  
## [769] 15.30 13.55 16.10 16.15 14.20 16.50 15.25 16.75 16.55 13.85 15.20 15.70  
## [781] 15.75 16.95 14.25 14.10 15.65 15.45 13.60 16.50 16.40 13.90 14.20 16.90  
## [793] 16.05 16.05 15.40 15.05 15.60 15.80 14.60 14.75 13.40 16.00 15.00 15.70  
## [805] 15.80 13.65 14.30 14.80 14.70 14.65 15.35 16.30 17.90 16.70 16.50 16.20  
## [817] 13.65 16.65 14.95 16.10 15.75 15.25 15.10 16.45 13.90 16.00 15.85 15.35  
## [829] 15.50 16.10 15.40 15.95 16.05 13.85 16.10 16.10 16.10 14.95 16.35 17.00  
## [841] 13.40 13.95 15.95 14.95 16.30 15.80 16.10 14.40 15.00 15.75 15.05 14.60  
## [853] 16.30 15.30 12.65 15.80 16.45 16.60 16.90 16.35 16.70 16.60 15.80 15.60  
## [865] 15.40 14.10 14.55 15.70 13.95 16.20 15.05 14.85 13.30 15.15 14.75 14.95  
## [877] 15.50 15.40 16.90 15.00 15.20 15.85 18.20 14.25 15.75 15.00 16.10 16.05  
## [889] 15.60 16.35 14.75 14.60 14.75 16.00 14.85 13.35 15.95 13.90 14.00 16.60  
## [901] 18.05 15.55 14.95 15.60 15.40 14.65 14.50 13.70 16.15 16.35 14.75 14.35  
## [913] 14.75 14.20 13.65 16.45 15.75 17.40 16.15 13.25 14.35 16.45 13.60 16.50  
## [925] 15.25 16.00 16.25 17.05 14.50 17.35 16.05 14.80 16.30 15.50 14.75 15.45  
## [937] 14.15 15.45 15.40 15.95 15.30 15.40 16.35 14.60 16.90 15.50 15.05 14.95  
## [949] 15.90 15.85 14.55 14.30 15.65 16.30 15.50 14.45 14.75 16.05 15.05 14.50  
## [961] 15.45 14.80 14.00 16.95 16.55 14.00 14.80 15.95 14.45 15.60 14.35 13.95  
## [973] 15.30 16.55 15.90 16.00 15.35 15.20 15.95 16.00 16.10 17.05 14.65 15.65  
## [985] 16.70 15.90 15.60 14.70 14.80 15.05 14.40 15.95 15.10 15.20 15.75 15.90  
## [997] 14.05 16.85 15.50 15.10

# best se  
sd(samp\_dist)

## [1] 0.9261237

# se  
print(sd(cars$speed)/sqrt(samplesize))

## [1] 1.182353

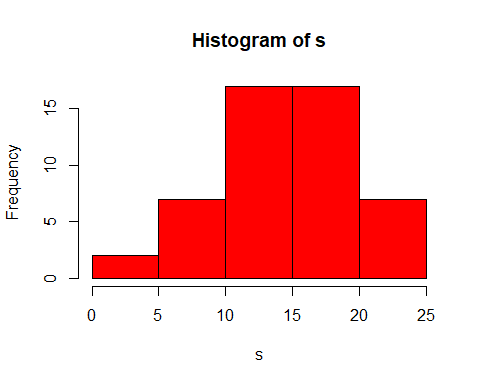
population=cars$speed  
samplesize=50  
s=sample(population,samplesize,replace = FALSE)  
mean(s)

## [1] 15.4

var(s)

## [1] 27.95918

hist(s, col="red")



samp\_dist = replicate(1000, mean(sample(cars$speed, 50, replace = FALSE)))  
samp\_dist

## [1] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [15] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [29] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [43] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [57] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [71] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [85] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [99] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [113] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [127] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [141] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [155] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [169] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [183] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [197] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [211] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [225] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [239] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [253] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [267] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [281] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [295] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [309] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [323] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [337] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [351] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [365] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [379] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [393] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [407] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [421] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [435] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [449] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [463] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [477] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [491] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [505] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [519] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [533] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [547] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [561] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [575] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [589] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [603] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [617] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [631] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [645] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [659] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [673] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [687] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [701] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [715] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [729] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [743] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [757] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [771] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [785] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [799] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [813] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [827] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [841] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [855] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [869] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [883] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [897] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [911] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [925] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [939] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [953] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [967] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [981] 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4 15.4  
## [995] 15.4 15.4 15.4 15.4 15.4 15.4

# best se  
sd(samp\_dist)

## [1] 0

# se  
print(sd(cars$speed)/sqrt(samplesize))

## [1] 0.7477858

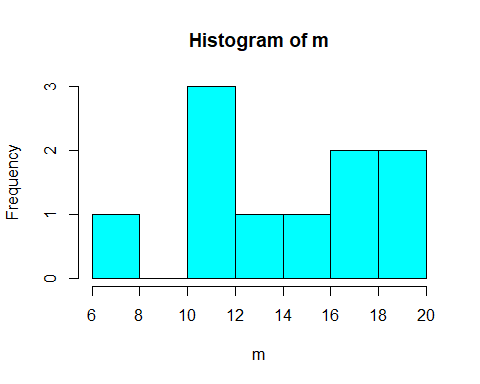
population=cars$speed  
samplesize = 10  
m=sample(population,samplesize,replace = TRUE)  
mean(m)

## [1] 14.6

var(m)

## [1] 16.93333

hist(m, col="cyan")



samp\_dist = replicate(1000, mean(sample(cars$speed, 10, replace = TRUE)))  
samp\_dist

## [1] 15.2 19.2 15.0 15.6 17.1 17.7 17.0 17.6 14.3 16.5 16.2 16.4 15.0 16.1  
## [15] 14.9 15.7 19.1 14.7 13.7 15.6 13.1 15.7 16.8 12.8 16.5 12.6 15.9 17.2  
## [29] 16.0 18.6 14.6 13.6 17.2 17.2 14.9 20.0 18.0 14.3 13.4 11.9 13.7 12.5  
## [43] 17.1 13.8 16.5 17.5 13.4 14.2 15.6 15.5 15.4 14.6 16.8 16.8 17.0 15.2  
## [57] 15.4 16.4 13.7 17.4 14.8 18.8 16.1 16.9 15.5 16.4 14.7 15.4 13.5 16.4  
## [71] 17.1 12.7 13.4 15.1 16.2 15.1 18.1 14.4 14.9 16.5 16.9 15.3 15.8 13.2  
## [85] 16.2 15.4 15.5 15.0 13.1 12.9 16.3 15.3 14.6 15.6 17.6 14.5 14.4 15.9  
## [99] 16.1 16.9 16.1 12.5 19.0 16.5 15.1 15.1 18.3 12.9 15.2 16.0 14.3 15.2  
## [113] 13.0 17.9 13.8 13.3 16.3 12.0 15.7 15.6 15.7 19.4 15.8 15.4 15.5 16.3  
## [127] 17.9 15.2 15.8 17.0 12.1 15.0 16.5 16.7 15.7 15.7 17.0 17.6 17.8 12.3  
## [141] 13.0 14.3 17.4 14.4 14.2 16.4 16.0 13.9 15.8 15.1 16.9 16.7 16.2 14.1  
## [155] 14.4 15.8 16.0 11.6 13.6 15.8 16.0 14.7 15.5 16.9 17.2 15.1 14.6 15.3  
## [169] 17.2 13.7 14.3 17.3 16.2 15.4 16.5 14.8 15.5 15.4 16.6 13.5 15.4 17.2  
## [183] 15.6 15.0 15.3 15.7 15.2 12.4 16.0 11.6 12.3 12.9 13.4 18.7 14.4 12.9  
## [197] 13.1 14.3 14.2 14.0 14.7 16.4 13.4 16.9 14.7 15.5 18.4 16.0 15.8 16.7  
## [211] 14.2 16.1 15.8 17.1 15.2 16.7 15.8 15.0 16.0 14.5 16.3 14.9 14.9 13.6  
## [225] 11.2 13.6 16.0 14.5 14.0 15.2 13.0 15.1 15.5 16.9 13.6 9.0 15.8 17.8  
## [239] 14.9 17.7 14.0 14.0 18.7 16.8 17.6 16.0 14.8 15.8 17.4 15.3 14.5 16.5  
## [253] 14.5 13.8 16.2 14.8 14.2 13.2 16.8 14.9 14.9 15.0 17.9 15.3 16.5 14.9  
## [267] 15.9 17.2 17.4 12.9 16.2 15.7 19.4 13.1 14.1 18.6 20.3 16.3 15.9 17.3  
## [281] 15.0 15.1 16.9 16.1 16.7 18.0 14.9 15.0 13.3 13.3 16.8 13.9 14.0 15.1  
## [295] 15.7 15.3 17.8 15.6 16.8 16.2 12.9 15.1 14.8 13.7 16.0 16.1 16.5 16.0  
## [309] 16.0 18.7 14.8 16.0 15.1 14.0 16.3 17.0 19.5 11.7 12.4 15.8 15.6 15.7  
## [323] 14.6 15.0 13.3 15.6 14.4 14.6 16.1 20.4 14.9 18.0 13.5 16.9 15.2 15.5  
## [337] 14.7 14.1 15.4 15.5 18.8 13.9 16.4 15.4 16.3 14.2 14.1 15.2 13.3 11.6  
## [351] 15.1 14.8 14.5 16.2 18.1 16.7 15.9 12.4 14.7 17.2 14.9 17.3 14.4 13.5  
## [365] 16.7 13.2 14.9 18.6 14.4 10.9 13.6 16.0 17.6 14.3 16.5 17.9 14.4 14.1  
## [379] 14.4 13.3 16.2 15.5 13.4 16.2 17.8 18.0 15.4 14.9 14.3 17.1 19.5 14.5  
## [393] 17.1 14.9 16.6 16.8 13.4 15.1 14.8 13.1 15.0 14.8 15.4 12.3 15.1 15.8  
## [407] 16.6 16.4 14.1 16.8 12.0 15.5 15.7 16.4 16.7 14.0 13.6 16.4 11.6 15.3  
## [421] 14.3 17.2 12.9 13.6 14.7 15.7 14.8 16.2 12.0 17.0 14.5 15.5 14.6 17.9  
## [435] 14.5 17.1 16.6 16.3 17.8 15.9 16.9 17.4 16.1 14.9 15.7 16.4 15.1 15.5  
## [449] 16.6 14.2 16.9 16.1 17.6 15.4 15.3 15.5 13.9 17.7 20.1 15.7 13.4 19.4  
## [463] 10.8 13.5 15.8 14.5 13.0 17.0 14.5 16.6 13.2 13.6 13.2 17.3 16.7 17.4  
## [477] 12.9 18.3 16.2 13.6 17.9 15.6 14.4 14.9 16.7 14.5 14.0 15.3 15.0 13.4  
## [491] 18.2 14.7 12.4 18.7 16.1 13.5 14.5 15.7 14.7 15.0 14.4 12.9 17.8 15.5  
## [505] 14.0 13.5 15.6 14.1 15.3 13.7 12.8 14.9 16.5 12.0 17.5 15.4 14.2 18.5  
## [519] 13.4 16.7 15.6 13.3 18.1 17.3 12.4 15.7 16.3 15.7 16.1 16.1 17.7 15.6  
## [533] 14.6 16.3 16.1 14.0 13.3 16.5 15.0 17.4 14.7 16.4 13.6 16.5 14.8 18.3  
## [547] 13.1 16.3 13.7 17.9 16.2 13.8 14.4 15.7 13.3 15.1 16.1 14.4 13.0 16.0  
## [561] 13.2 16.6 12.2 15.1 19.7 18.5 14.4 13.9 13.7 14.2 15.9 14.1 16.0 15.0  
## [575] 13.9 16.3 16.5 14.2 15.0 14.9 13.5 15.2 15.1 17.5 15.1 16.4 14.0 17.1  
## [589] 18.7 12.0 14.1 14.9 14.4 15.6 17.0 15.1 15.8 14.4 16.2 14.7 16.6 14.7  
## [603] 15.3 14.6 14.2 14.5 15.5 15.3 13.7 16.1 16.2 16.5 16.7 11.3 15.6 16.1  
## [617] 15.8 17.4 15.1 12.5 18.5 15.2 12.5 18.5 15.4 14.8 14.3 16.1 17.0 16.8  
## [631] 16.6 15.1 16.7 18.0 16.4 14.1 14.6 19.5 15.6 19.4 14.2 16.4 17.6 18.1  
## [645] 17.3 15.2 14.2 17.3 16.3 12.4 16.7 15.5 16.6 17.4 18.7 17.6 15.5 12.8  
## [659] 13.6 15.0 14.8 14.9 16.2 14.7 15.1 15.5 15.8 15.9 15.9 14.3 14.4 15.0  
## [673] 13.2 13.4 16.6 14.5 16.4 19.1 15.7 14.7 17.1 16.1 13.6 16.4 16.3 15.9  
## [687] 17.5 12.9 16.5 17.5 15.0 15.9 15.7 18.3 16.8 15.0 16.6 14.9 14.6 17.4  
## [701] 17.6 17.3 16.1 17.3 16.3 17.1 18.0 12.1 18.2 15.2 17.6 14.6 14.3 19.0  
## [715] 14.1 17.3 14.9 15.7 15.5 13.9 15.1 13.6 15.2 11.7 15.0 17.8 15.4 18.0  
## [729] 15.3 13.6 14.9 15.2 16.3 16.1 13.6 13.1 13.5 17.3 14.8 14.5 14.3 16.2  
## [743] 12.9 17.2 14.2 14.7 12.9 15.3 13.1 16.4 15.8 14.2 14.4 14.0 18.5 14.2  
## [757] 17.7 15.9 14.6 15.3 12.0 10.9 14.8 15.2 15.2 16.5 16.1 15.8 15.5 13.7  
## [771] 14.7 14.9 12.5 14.6 16.6 12.5 16.4 15.4 17.9 13.6 15.4 15.0 16.2 15.4  
## [785] 15.0 14.5 16.5 17.6 14.5 13.7 16.3 16.1 14.6 14.9 13.8 17.5 14.4 16.9  
## [799] 15.2 17.1 16.6 14.8 16.6 16.2 16.6 17.5 17.7 15.1 17.1 14.3 16.2 13.0  
## [813] 13.8 16.4 15.5 16.4 16.9 14.7 14.9 15.7 14.6 16.4 14.6 14.4 15.0 14.6  
## [827] 18.8 17.8 14.3 15.6 14.9 14.2 14.2 16.0 17.3 16.7 16.0 13.0 16.5 17.7  
## [841] 13.9 14.5 13.0 16.4 17.5 15.9 13.5 16.3 14.1 17.7 15.2 17.0 14.8 17.3  
## [855] 15.1 13.9 16.9 13.9 16.7 15.7 17.5 16.5 18.2 13.8 17.1 13.2 15.1 15.0  
## [869] 15.1 17.3 17.2 17.6 16.3 13.9 14.4 15.7 16.2 17.1 13.9 15.3 14.2 14.1  
## [883] 15.2 14.4 13.8 16.8 14.7 13.5 15.2 14.0 15.7 16.6 16.7 17.2 13.3 13.8  
## [897] 15.6 17.4 11.5 14.8 14.6 15.8 16.6 13.0 15.4 14.9 16.7 13.7 16.1 14.8  
## [911] 16.9 14.9 17.8 16.7 16.5 15.7 17.1 18.5 15.8 14.8 15.5 14.3 16.2 16.5  
## [925] 16.4 14.5 12.7 13.5 14.2 14.5 14.0 18.3 17.9 18.2 15.3 16.6 17.7 16.0  
## [939] 14.8 14.2 14.1 15.7 15.8 12.3 16.5 16.8 16.1 16.9 15.1 14.0 12.6 16.0  
## [953] 13.2 12.0 13.2 13.9 15.3 14.5 15.4 15.1 15.4 16.7 14.6 14.9 15.7 15.2  
## [967] 14.5 14.8 15.7 13.0 13.7 17.1 13.3 14.3 15.5 14.0 16.8 13.6 15.1 12.2  
## [981] 12.2 13.1 15.6 14.4 14.6 16.1 16.5 12.5 13.1 16.5 14.3 18.0 15.1 15.1  
## [995] 18.9 12.4 16.5 14.7 14.5 16.2

# best se  
sd(samp\_dist)

## [1] 1.634747

# se  
print(sd(cars$speed)/sqrt(samplesize))

## [1] 1.6721

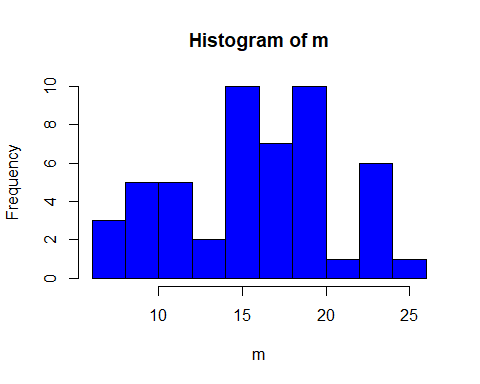
population=cars$speed  
samplesize = 50  
m=sample(population,samplesize,replace = TRUE)  
mean(m)

## [1] 16.4

var(m)

## [1] 23.42857

hist(m, col="blue")



samp\_dist = replicate(1000, mean(sample(cars$speed, 50, replace = TRUE)))  
samp\_dist

## [1] 15.44 14.62 14.84 15.92 16.56 15.34 15.28 16.10 15.58 14.14 15.68 16.34  
## [13] 16.74 14.62 15.82 15.40 15.76 17.02 16.26 14.64 15.28 16.46 13.60 15.04  
## [25] 14.12 15.46 14.96 16.46 14.86 15.60 15.96 15.12 14.20 14.74 14.88 15.36  
## [37] 14.72 15.54 15.86 15.10 15.56 15.68 14.48 16.10 15.30 15.66 14.68 16.20  
## [49] 14.68 15.32 14.12 16.04 13.80 15.22 17.58 14.98 16.08 16.80 14.18 14.58  
## [61] 14.70 14.44 15.66 14.24 15.52 15.52 15.72 15.42 14.44 13.68 15.46 15.00  
## [73] 14.54 14.50 15.50 15.58 13.84 16.06 15.58 16.60 15.36 14.42 15.38 14.80  
## [85] 13.88 16.48 15.18 14.84 15.38 15.60 17.10 14.44 14.84 15.58 14.20 15.04  
## [97] 14.62 14.50 15.30 16.74 14.52 16.68 16.36 15.82 15.50 15.02 15.18 15.74  
## [109] 15.08 14.40 15.46 14.68 15.22 15.20 15.22 13.80 15.36 15.14 15.68 15.40  
## [121] 13.82 14.86 15.28 13.50 14.60 14.34 16.94 14.54 14.28 14.80 14.36 14.90  
## [133] 16.16 15.00 14.88 15.34 16.62 14.34 15.00 15.24 15.28 14.98 14.88 16.12  
## [145] 14.14 17.42 16.20 15.14 15.18 16.20 16.36 14.56 15.24 16.22 16.10 14.68  
## [157] 15.98 14.88 15.50 15.88 16.40 16.24 14.44 15.34 14.78 14.48 15.70 15.16  
## [169] 15.34 15.94 14.76 15.22 16.00 16.56 16.44 15.06 15.74 15.14 14.04 15.32  
## [181] 14.32 15.18 14.00 15.80 16.18 15.70 14.54 15.48 16.52 14.74 16.50 16.12  
## [193] 15.84 15.80 14.62 15.80 15.24 15.62 15.08 14.04 15.12 14.98 15.44 15.02  
## [205] 14.70 16.08 16.64 14.88 16.34 15.20 15.20 13.92 13.60 15.26 14.40 14.46  
## [217] 15.90 15.14 15.82 16.90 14.64 15.70 15.38 15.50 14.76 16.44 16.08 14.34  
## [229] 15.28 15.18 14.44 17.00 15.00 15.60 15.16 15.24 14.44 16.24 15.06 14.56  
## [241] 16.46 15.38 14.62 14.76 16.12 15.06 15.46 15.06 16.18 15.10 16.08 15.00  
## [253] 16.56 16.10 14.42 15.38 14.38 15.18 15.12 16.16 15.22 15.04 15.44 15.46  
## [265] 15.90 15.64 15.34 14.38 15.20 14.50 15.22 15.06 15.28 15.84 13.84 15.88  
## [277] 15.56 15.76 15.16 15.18 15.72 14.94 15.06 16.66 14.82 15.80 15.92 14.56  
## [289] 15.16 14.26 14.74 14.56 15.42 15.86 15.62 15.26 15.02 15.20 15.52 15.16  
## [301] 13.88 16.62 14.48 14.38 15.22 15.70 16.26 14.90 15.76 16.04 15.52 15.84  
## [313] 14.70 15.26 14.82 14.10 14.30 15.38 15.46 14.68 16.60 15.04 16.06 16.22  
## [325] 14.84 14.52 17.06 16.62 16.04 15.64 16.32 15.28 15.88 14.62 14.80 15.56  
## [337] 15.76 16.82 15.18 14.74 14.88 16.34 14.94 16.72 15.20 14.44 15.92 15.80  
## [349] 15.82 15.44 15.98 14.76 15.68 15.52 15.22 15.82 14.70 15.68 16.44 14.94  
## [361] 15.12 15.56 14.34 15.28 15.36 15.20 16.08 16.54 14.66 15.42 15.46 15.94  
## [373] 15.82 14.98 16.02 17.14 14.44 14.72 15.18 15.06 16.22 14.58 14.84 15.68  
## [385] 15.82 14.92 15.78 15.12 15.72 15.92 15.20 14.70 14.94 13.80 14.32 15.82  
## [397] 16.62 16.16 14.96 16.68 15.92 15.66 15.76 15.10 15.16 15.04 14.00 14.76  
## [409] 16.82 14.24 14.38 15.32 14.82 15.80 16.40 15.64 15.70 15.70 13.44 15.94  
## [421] 15.12 15.72 15.68 14.16 14.88 15.60 16.00 14.52 15.78 16.02 16.22 15.76  
## [433] 15.50 14.70 15.12 14.96 16.56 15.94 15.10 14.78 16.36 12.76 16.00 14.10  
## [445] 14.36 16.58 15.08 14.28 15.66 14.78 15.76 15.86 15.86 16.50 14.78 15.16  
## [457] 15.20 15.08 14.60 14.08 15.32 15.16 15.96 15.56 15.44 15.16 14.62 14.92  
## [469] 15.74 15.72 14.80 15.80 14.90 14.92 15.58 14.94 13.84 15.34 14.68 14.04  
## [481] 15.96 14.30 14.28 16.08 14.46 15.70 16.10 15.44 16.44 14.50 14.16 15.22  
## [493] 14.76 15.62 15.64 15.02 16.18 15.32 17.20 15.78 15.92 15.24 17.64 15.96  
## [505] 16.26 15.46 15.60 15.16 15.26 15.54 14.94 14.30 15.74 15.00 15.14 15.76  
## [517] 14.88 15.22 15.70 15.20 14.10 15.94 15.10 16.64 15.12 17.22 15.82 15.58  
## [529] 16.62 15.06 14.20 15.88 15.36 14.16 16.40 15.62 15.98 16.20 13.72 15.08  
## [541] 15.14 15.04 16.40 15.28 16.70 15.22 15.46 15.10 16.12 14.88 16.04 14.04  
## [553] 13.74 15.42 15.48 15.70 14.58 15.24 15.14 15.06 15.92 15.16 14.82 17.02  
## [565] 15.76 15.66 14.94 14.74 14.92 14.34 15.90 15.46 15.92 14.46 15.06 15.90  
## [577] 15.64 16.16 15.68 15.20 14.16 16.06 14.80 14.52 14.62 15.24 15.14 15.28  
## [589] 14.18 16.22 15.26 16.52 17.02 17.26 14.60 15.12 14.78 15.40 15.92 15.46  
## [601] 15.82 15.20 15.18 14.84 14.60 15.28 15.32 14.74 15.42 14.24 14.94 15.02  
## [613] 15.58 15.60 17.10 14.48 15.80 14.22 14.32 16.72 16.30 14.66 16.00 16.14  
## [625] 15.78 15.02 15.00 14.94 14.98 14.76 16.16 16.10 16.38 15.58 15.04 15.64  
## [637] 15.04 14.18 14.88 15.00 14.72 14.24 16.92 15.90 16.32 15.86 15.48 14.48  
## [649] 16.48 15.40 14.28 15.30 15.04 14.70 15.00 15.02 15.28 15.12 14.90 15.40  
## [661] 15.08 15.84 15.24 16.34 14.76 15.02 15.54 16.88 15.66 15.82 16.44 16.22  
## [673] 16.52 16.00 15.66 16.42 15.74 15.62 15.24 16.06 14.84 15.54 15.98 15.54  
## [685] 16.10 15.88 13.62 14.40 14.42 15.62 14.36 14.94 15.46 14.96 16.18 14.92  
## [697] 15.98 15.10 16.26 16.16 14.14 14.86 14.82 15.80 14.62 14.30 14.58 15.54  
## [709] 15.16 15.30 15.18 15.10 15.34 15.96 15.66 14.86 14.34 15.36 14.30 14.30  
## [721] 15.94 14.98 15.98 18.28 14.86 15.36 15.42 16.48 14.52 14.18 15.56 15.76  
## [733] 16.58 16.06 14.66 14.86 15.36 15.44 16.50 14.76 14.94 15.78 14.60 15.76  
## [745] 15.90 15.68 17.58 14.42 15.72 14.72 16.04 15.62 15.38 16.58 15.62 14.36  
## [757] 14.68 14.60 15.28 16.04 14.84 14.24 14.88 14.58 17.14 14.66 15.18 15.20  
## [769] 14.88 15.02 15.54 15.30 16.02 14.78 16.74 15.36 15.98 14.80 14.60 15.26  
## [781] 16.60 14.44 15.26 16.16 15.18 14.76 14.68 16.00 14.20 16.16 15.74 15.24  
## [793] 15.58 14.14 14.48 15.36 15.14 14.76 15.66 15.58 15.60 13.70 14.98 15.92  
## [805] 14.92 13.86 15.04 16.02 14.68 15.06 15.00 14.72 16.22 16.26 15.46 16.18  
## [817] 14.82 15.92 16.04 15.52 14.62 15.34 15.94 15.14 15.40 14.48 14.40 13.98  
## [829] 15.84 15.92 15.58 16.52 15.86 15.32 14.74 15.90 15.78 15.52 15.24 15.12  
## [841] 15.54 15.46 13.72 15.02 16.00 15.06 16.16 15.20 13.94 14.48 15.88 13.84  
## [853] 15.46 15.72 15.94 14.52 15.42 15.74 15.54 14.70 13.80 14.64 14.76 15.52  
## [865] 14.64 14.10 15.12 15.42 15.50 14.98 14.72 15.52 15.60 13.66 13.82 15.12  
## [877] 14.36 15.08 15.34 15.64 14.84 16.34 14.66 15.74 14.90 17.02 13.46 15.42  
## [889] 13.60 14.24 16.00 15.90 15.42 15.42 14.48 15.50 15.96 13.96 14.38 15.60  
## [901] 15.86 15.04 15.32 15.50 16.36 15.78 15.98 14.38 15.58 16.40 15.50 14.44  
## [913] 15.04 15.10 16.48 15.24 16.14 15.36 15.70 15.24 15.56 14.20 16.18 14.12  
## [925] 16.94 15.72 16.14 15.46 15.46 14.80 16.38 14.98 15.34 14.68 14.70 16.34  
## [937] 16.00 15.76 15.18 15.06 15.48 16.52 13.98 16.76 15.50 16.32 16.62 16.44  
## [949] 16.42 15.02 14.82 15.24 14.76 15.10 14.92 15.80 15.44 14.38 16.30 14.38  
## [961] 14.38 15.90 16.14 16.12 17.24 15.26 15.84 16.68 15.26 14.16 15.72 13.52  
## [973] 15.74 15.36 15.42 15.02 15.72 16.74 15.28 14.48 14.58 15.04 15.14 17.36  
## [985] 13.34 17.08 14.84 13.86 15.80 15.68 14.88 15.14 15.24 14.32 15.76 13.84  
## [997] 14.80 14.58 15.58 14.60

# best se  
sd(samp\_dist)

## [1] 0.7598812

# se  
print(sd(cars$speed)/sqrt(samplesize))

## [1] 0.7477858