```r
# Setting the directory
setwd("D:\\SLIIT\\Y2S1\\Probabilty & Statistics\\Labs\\Lab 8")

# Importing the data set
data = read.csv("Exercise - LaptopsWeights.csv", header=TRUE)
fix(data)
attach(data)

# Extract the weight column
laptop_bag_weights <- data$Weight
```

```r
# --------------------------------
# Question 1: Population Mean and Standard Deviation
popmn <- mean(Weight.kg.)
popmn
popsd <- sd(Weight.kg.)
popsd
```

```
> # Question 1: Population Mean and Standard Deviation
> popmn <- mean(Weight.kg.)
> popmn
[1] 2.468
> popsd <- sd(Weight.kg.)
> popsd
[1] 0.2561069
```

```r
## Question 02
# Generate 25 random samples of size 6 (with replacement)

samples <- c()
n <- c()

for (i in 1:25) {
  s <- sample(laptop_bag_weights, 6, replace = TRUE)  # one sample
  samples <- cbind(samples, s)                        # add column
  n <- c(n, paste('s', i))                            # sample names
}

colnames(samples) <- n  # assign column names
```

```r
# Calculate sample means and variances column-wise
s.means <- apply(samples, 2, mean)
s.vars  <- apply(samples, 2, var)
s.sds   <- apply(samples, 2, sd)

results <- data.frame(
  Sample = colnames(samples),
  Sample_Mean = round(s.means,3),
  Sample_SD   = round(s.sds,3)
)

print("=== Sample Results (25 samples) ===")
print(results)
```

```
> print(results)
      Sample Sample_Mean Sample_SD
s 1      s 1       2.522     0.187
s 2      s 2       2.300     0.241
s 3      s 3       2.425     0.419
s 4      s 4       2.400     0.287
s 5      s 5       2.288     0.459
s 6      s 6       2.660     0.137
s 7      s 7       2.513     0.119
s 8      s 8       2.343     0.234
s 9      s 9       2.447     0.327
s 10    s 10       2.462     0.229
s 11    s 11       2.400     0.324
s 12    s 12       2.537     0.295
s 13    s 13       2.477     0.221
s 14    s 14       2.553     0.207
s 15    s 15       2.358     0.179
s 16    s 16       2.507     0.281
s 17    s 17       2.538     0.111
s 18    s 18       2.192     0.202
s 19    s 19       2.500     0.054
s 20    s 20       2.480     0.211
s 21    s 21       2.565     0.167
s 22    s 22       2.138     0.349
s 23    s 23       2.460     0.224
s 24    s 24       2.325     0.299
s 25    s 25       2.338     0.358
>
```

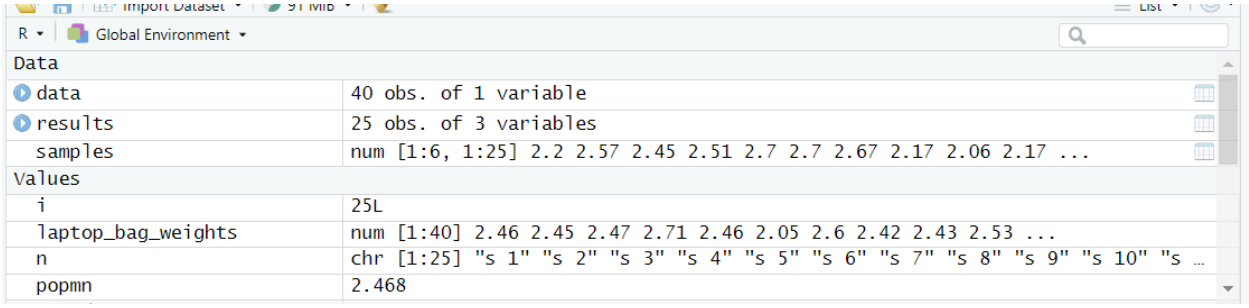
```r
## Question 03: Mean and SD of the 25 sample means

# Calculate mean of the sample means
samplemean <- mean(s.means)

# Calculate variance of the sample means
samplevars <- var(s.means)

# Standard deviation of sample means
samplesd <- sd(s.means)

# Display results
print("=== Mean and SD of Sample Means ===")
samplemean
samplesd
```

```r
## Relationship with population values
print("=== Relationship with Population ===")
popmn            # population mean
popsd <- sqrt(popvar)  # population standard deviation
popsd
```

```
> print("=== Mean and SD of Sample Means ===")
[1] "=== Mean and SD of Sample Means ==="
> samplemean
[1] 2.429133
> samplesd
[1] 0.1216478
> ## Relationship with population values
> print("=== Relationship with Population ===")
[1] "=== Relationship with Population ==="
> popmn            # population mean
[1] 2.468
> popsd <- sqrt(popvar)  # population standard deviation
> popsd
[1] 0.2561069
```

```r
print("Relationship:")
print("1. The mean of the sample means is approximately equal to
      the population mean (Law of Large Numbers).")
print("2. The standard deviation of the sample means is smaller than the population SD
      and approximately equals population SD divided by sqrt(sample size) (Central Limit Theorem).")
print(paste("Theoretical SD of sample means =", round(popsd/sqrt(6),3)))
```

```
> print("1. The mean of the sample means is approximately equal to
+       the population mean (Law of Large Numbers).")
[1] "1. The mean of the sample means is approximately equal to\n      the population mean (Law of Large Number
s)."
> print("2. The standard deviation of the sample means is smaller than the population SD
+       and approximately equals population SD divided by sqrt(sample size) (Central Limit Theorem).")
[1] "2. The standard deviation of the sample means is smaller than the population SD\n      and approximately e
quals population SD divided by sqrt(sample size) (Central Limit Theorem)."
> print(paste("Theoretical SD of sample means =", round(popsd/sqrt(6),3)))
[1] "Theoretical SD of sample means = 0.105"
```



popsd	0.256106948813907
popvar	0.0655907692307692
s	num [1:6] 1.71 2.67 2.42 2.65 2.17 2.41
s.means	Named num [1:25] 2.52 2.3 2.42 2.4 2.29 ...
s.sds	Named num [1:25] 0.187 0.241 0.419 0.287 0.459 ...
s.vars	Named num [1:25] 0.0349 0.0582 0.1754 0.0822 0.2106 ...
sample_data	num [1:6] 2.57 2.42 2.66 2.45 2.7 2.05
sample_means	num [1:25] 2.53 2.57 2.47 2.59 2.46 ...
sample_sds	num [1:25] 0.151 0.119 0.172 0.135 0.275 ...
samplemean	2.42913333333333
samplesd	0.121647753476692
samplevars	0.0147981759259259