Statistics & Bootstrapping
Part 2

Sampling With Replacement: When you sample with replacement, the object you selected is put back into the pool before another object is sampled.

Example:

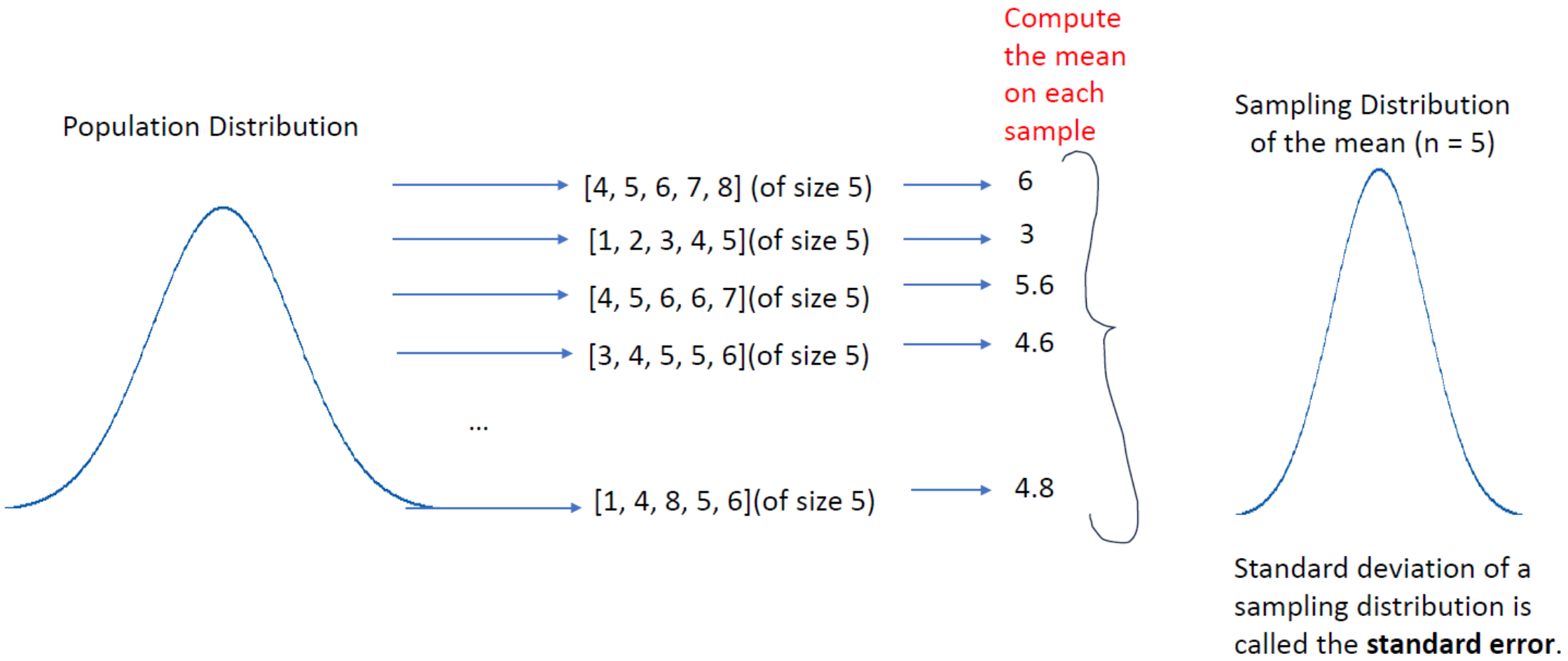
```
vector <- 1:6
sample(vector,  3,  replace = TRUE)
```

Sampling with replacement

Output: 1 6 1

Note: every time you run the codes you will get a different result.

Sampling Distribution of the Mean (n=5)



Standard deviation of a sampling distribution is called the **standard error**.

Standard Error: it's the standard deviation of a sampling distribution.

Review from the last class

Review: Computing the Standard Error of a Sampling Distribution of the Mean with n = 100

Population

```
normal_pop <- rnorm(1000000, mean = 100, sd = 15)
```

Function

```
get_one_sample_mean  <- function(i, population_vector, n)
{
  one_sample <- sample(population_vector, n)
  one_sample_mean <- mean(one_sample)
  return(one_sample_mean)
}
```

Sampling Distribution of the Mean with n = 100

```
sampling_distribution <- map_dbl(1:10000,
get_one_sample_mean, population_vector= normal_pop, n = 100)
```

Standard Error

```
st_error <- sd(sampling_distribution)
st_error
```

Output : 1.501716

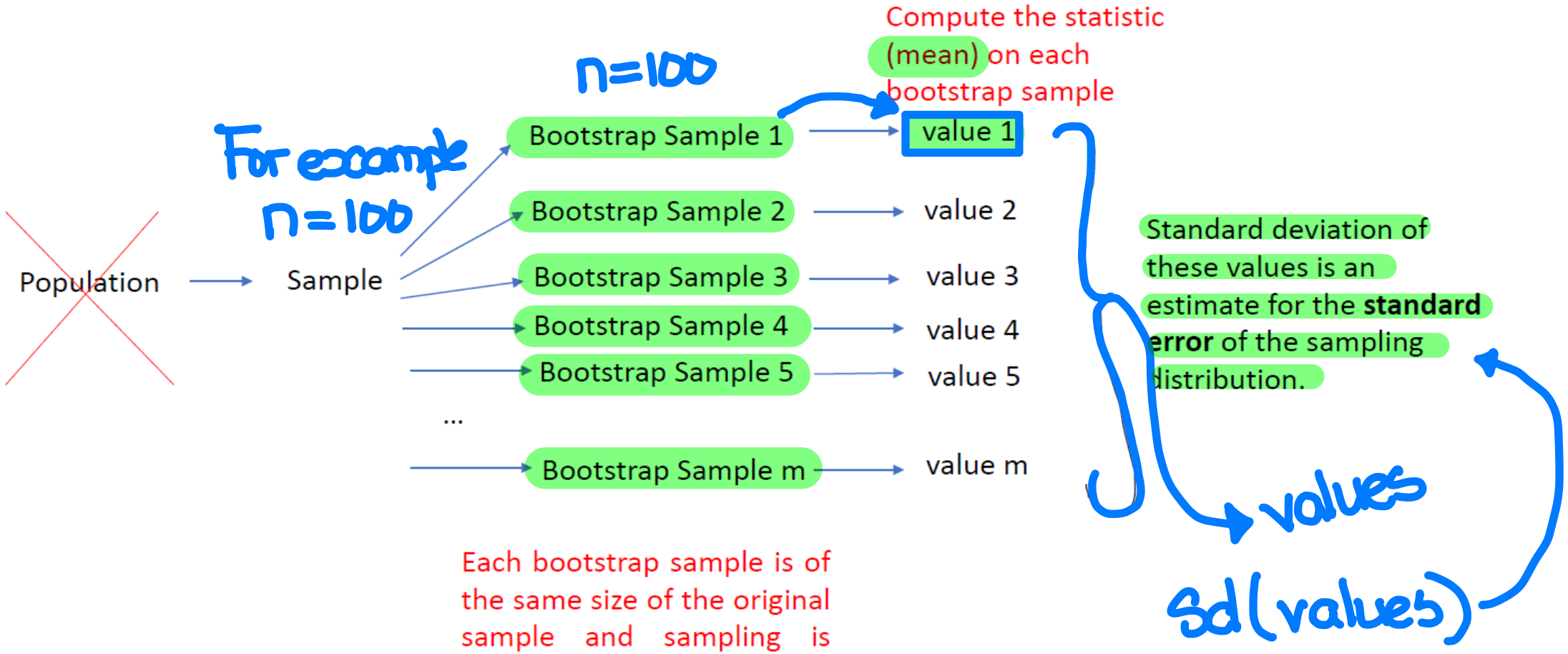
Bootstrapping

The bootstrap is a resampling technique used to estimate standard errors and confidence intervals for sample statistics. It's particularly useful when you don't know the underlying data distribution.

A bootstrap sample is a sample of the same size of the original sample and sampling is done with replacement.

Bootstrapping

Main goal estimate the standard error



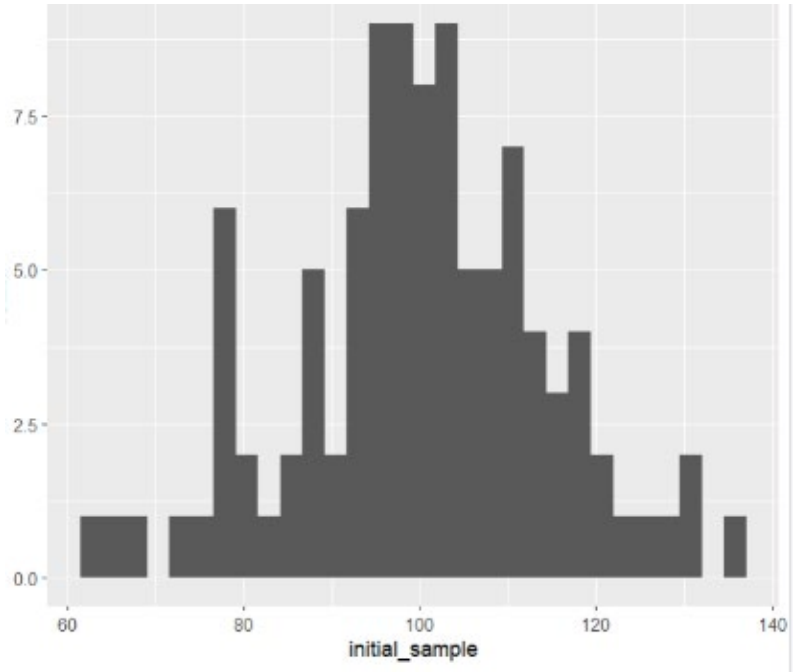
Each bootstrap sample is of the same size of the original sample and sampling is done with replacement.

Step 1: Start with a sample.

```
initial_sample <- sample(normal_pop, 100)
```

Plot of the Initial Sample

```
sample_plot <- data.frame(initial_sample) %>%
  ggplot(aes(x=initial_sample)) +
  geom_histogram()
sample_plot
```



Step 2: Create a function that draws one bootstrap sample from a given sample and computes a statistic on the bootstrap sample. In this example the statistic is the mean.

```
boot_mean <- function(i, y){
  boot_sample <- sample(y, length(y), replace = TRUE)
  value <- mean(boot_sample)
  return(value)
}
```

Step 3: Using the function from Step 2, draw 10000 bootstrap samples and compute the mean on each.

function I created

```
all_values <- map_dbl(1:10000, boot_mean, y = initial_sample)
```

Step 4: Compute the standard deviation of the 10000 bootstrap sample means from Step 3. That is the estimated standard error.

```
sd(all_values)
```

Output: 1.435214

Estimated standard error

From mathematical formulas we know that the standard error should be 1.5.