BACS HW3

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Question 1

Here is the helper functions for Q1

```
standardize <- function(data) {
  standardized <- (data - mean(data)) / sd(data)
  return(standardized)
}

create_density <- function(data, title) {
  mean <- mean(data)

  sd_values = c(
    mean(data) - 2 * sd(data),
    mean(data) - sd(data),
    mean(data) + sd(data),
    mean(data) + 2 * sd(data)
  )

  ggplot(mapping = aes(data)) +
    geom_density(
      fill="#69b3a2",
      color="#e9ecef",
    ) +
    geom_vline(xintercept = mean, col="black") +
    geom_vline(xintercept = sd_values, col="red") +
    ggtitle(title)
}

create_histogram <- function(data, title) {
  n = length(data)

  # Freidman-Darconis' BiUnwidth Rule
  binwidth <- (2 * IQR(data)) / n^(1/3)
  bins <- ceiling(max(data) - min(data)) + binwidth

  ggplot(mapping = aes(data)) +
    geom_histogram(
      fill="#69b3a2",
      color="#e9ecef",
      bins = bins,
```

```
      binwidth = binwidth
    ) +
    ggtitle(title)
}
```

A. create a normal distribution (`mean = 940, sd = 190`) and standardize it

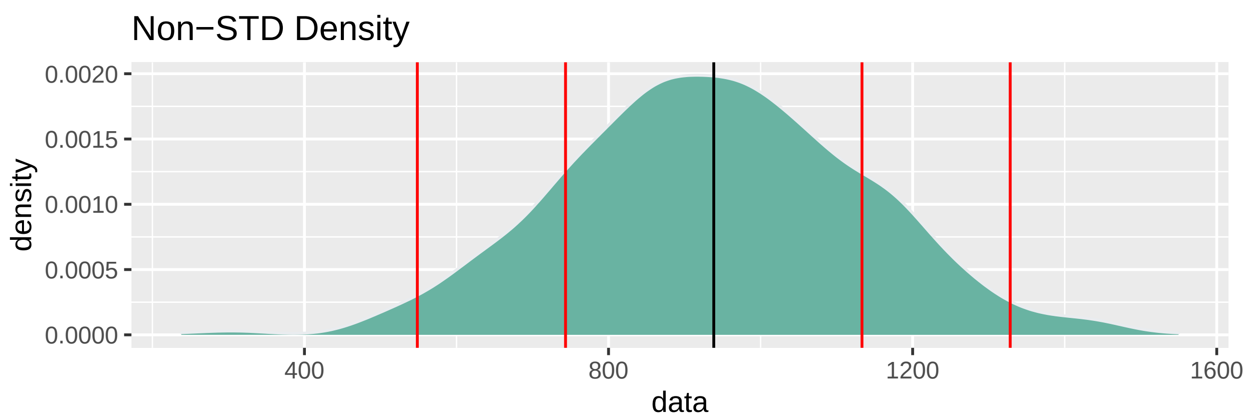
```
rnorm_q1 <- rnorm(1000, mean = 940, sd = 190)
rnorm_std <- standardize(rnorm_q1)
```

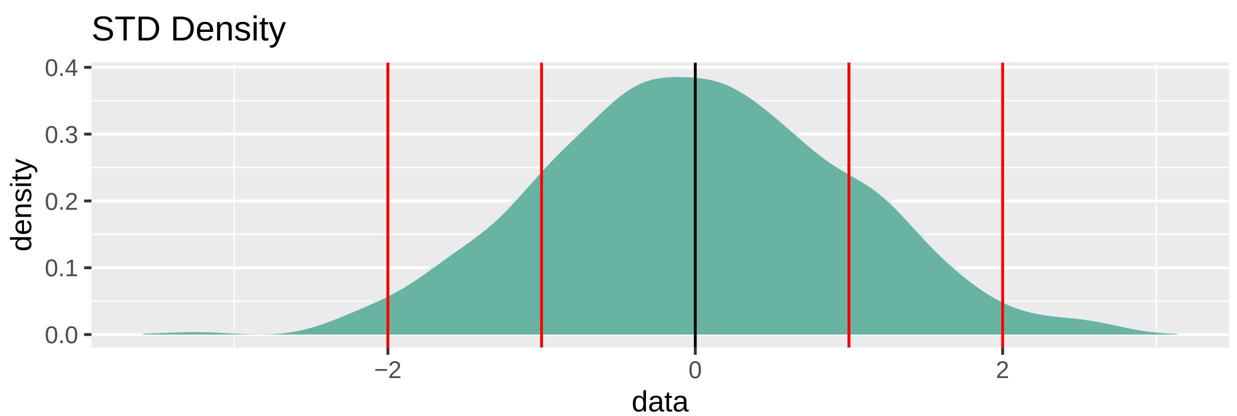
i) What should we expect the mean and standard deviation of rnorm_std to be, and why?

```
## The mean of rnorm is 938.407518961576,
## and its standard deviation is 194.965849416951.
```

```
## The mean of rnorm_std is -9.25748193381093e-17,
## and its standard deviation is 1.
```

```
grid.arrange(
  rnorm_density,
  rnorm_std_density,
  ncol=1,
  nrow=2
)
```

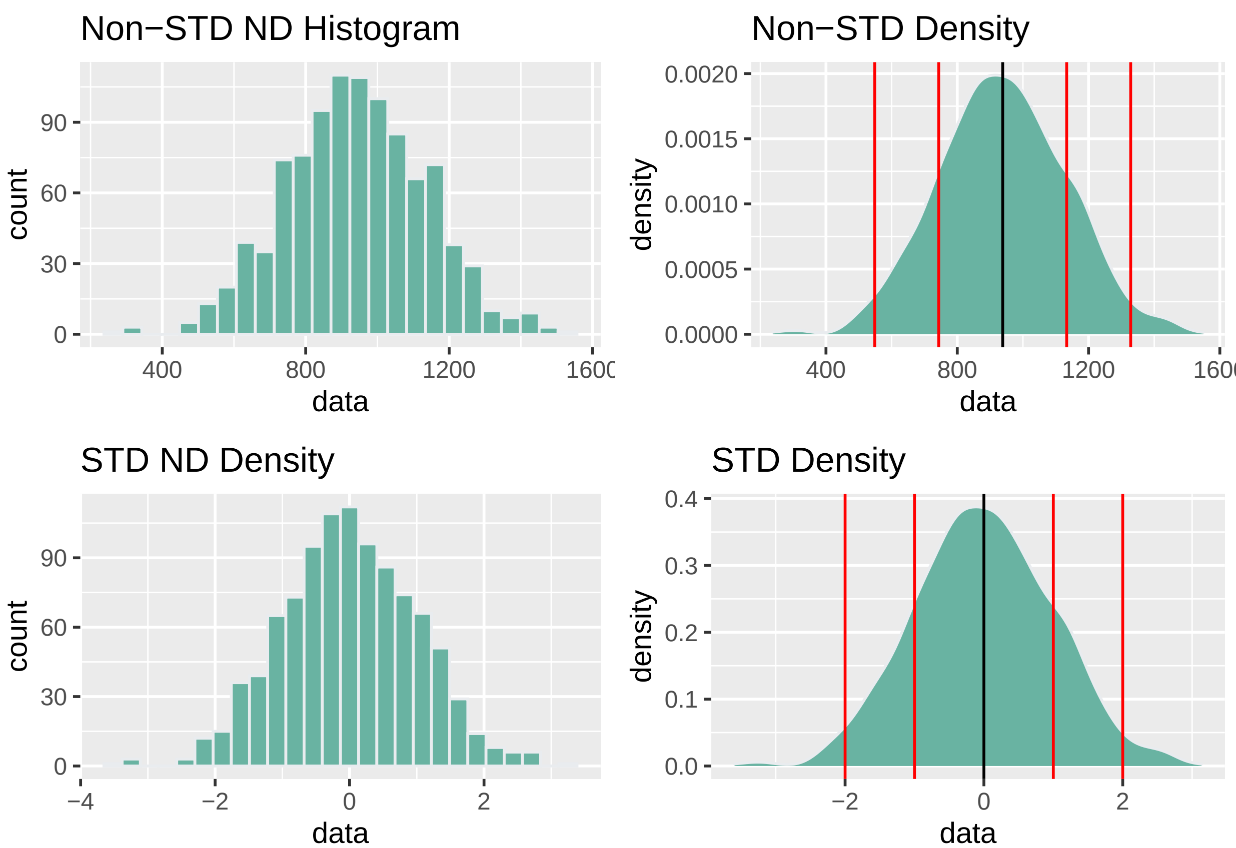




In this case, the `mean` value is `0`. After standardization, `x_value` has a range of `-3` to `3`. That range represents how far each instance from the mean in STD unit. This happens because standardization scales down everything to STD unit scale.

ii) What should the distribution (shape) of rnorm_std look like, and why?

```
grid.arrange(
  rnorm_hist,
  rnorm_density,
  rnorm_std_hist,
  rnorm_std_density,
  ncol=2,
  nrow=2
)
```



Basically, `rnorm_std` and `rnorm` plots should look entirely the same, but they are not. Let's take the graph above as a reference.

However, there is a worth mentioning here:

1. Non-standardized and standardized histograms look almost the same, but there is a slight difference if you take a close look.
2. The `x_values` range becomes smaller in standardized density plot because standardization scales down everything to STD unit scale.

iii) What do we generally call distributions that are normal and standardized?

It's called **bell-shaped curved** distribution.

B. Create a standardized version of `minday` from the earlier question (let's call it `minday_std`)

```
minday_std <- standardize(minday)
```

i) What should we expect the mean and standard deviation of `minday_std` to be, and why?

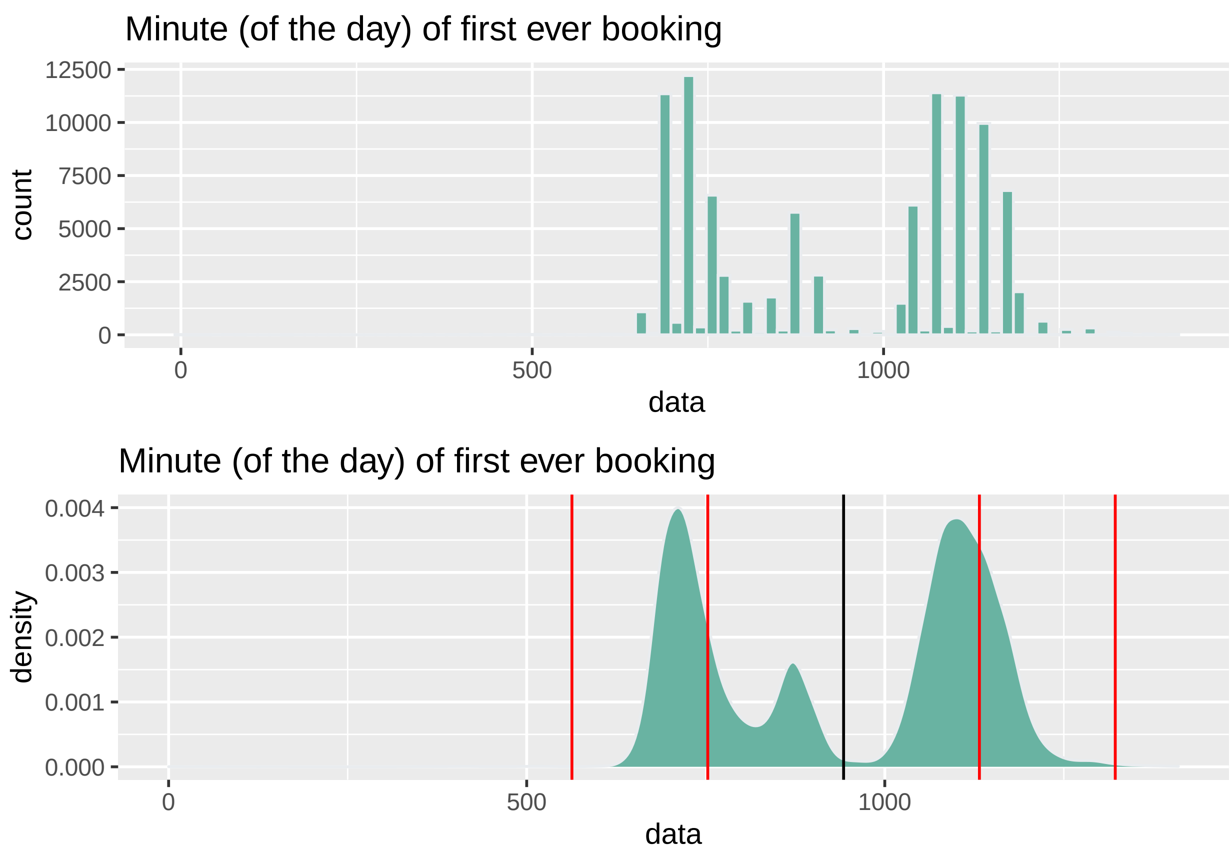
```
## The mean of minday_std -4.25589034500073e-17, while its SD is 1.
```

We expect the mean and the STD values to be really small which are within `-2.5` to `2.5` range after standardization because standardization scales down everything to STD unit scale. In this case, `mean` becomes zero.

ii) What should the distribution of `minday_std` look like compared to `minday`, and why?

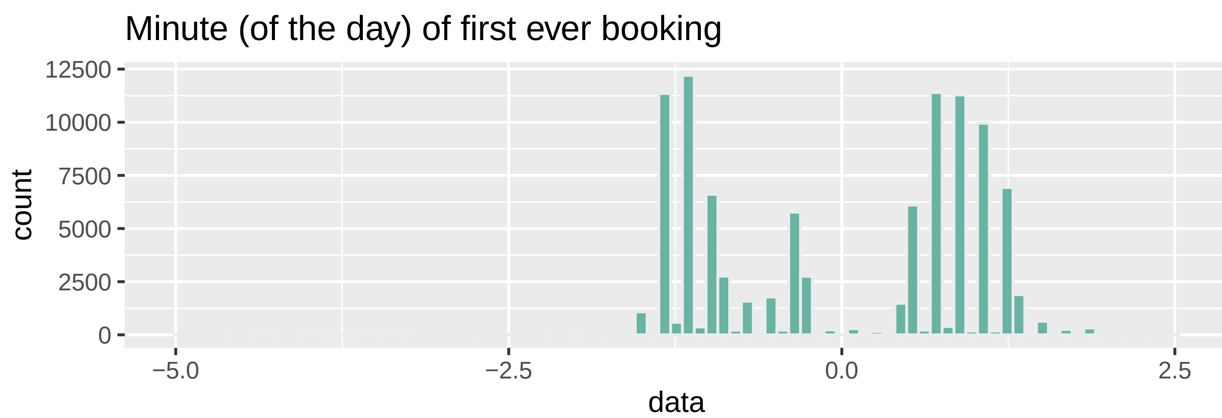
Before standardization,

```
grid.arrange(
  minday_hist,
  minday_density,
  ncol=1,
  nrow=2
)
```



After standardization,

```
grid.arrange(
  minday_std_hist,
  minday_std_density,
  ncol=1,
  nrow=2
)
```



The situation is the similar to the section a, part ii. In the non-standardized data set, the STD lines are far away when we expect them to be. Besides, we have a huge range of `x_value` which is from `0` to `1500`.

However, in the standardized data set, the mean line is exactly in between the STD lines. In addition, we have a smaller range of `x_value` which is from `-4` to `4`.

Question 2

a) Simulate 100 samples (each of size 100), from a normally distributed population of 10,000:

i) How many samples do we expect to NOT include the population mean in its 95% CI?

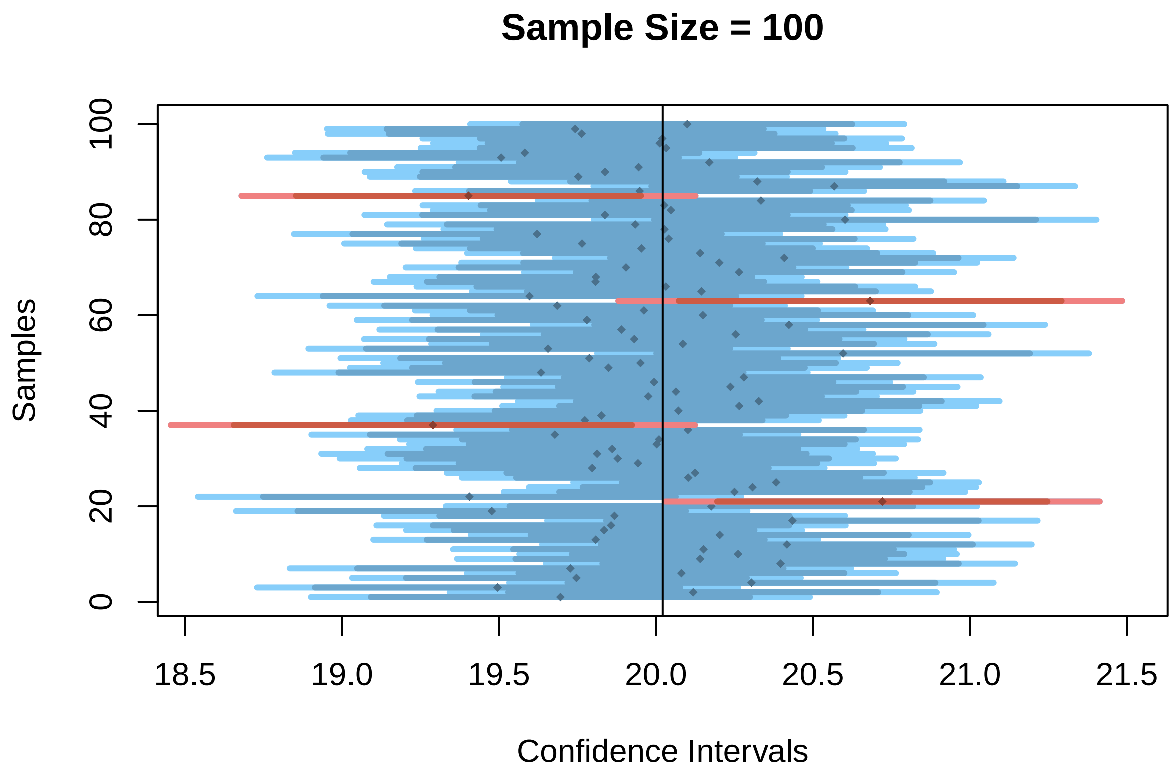
```
## 4.99
```

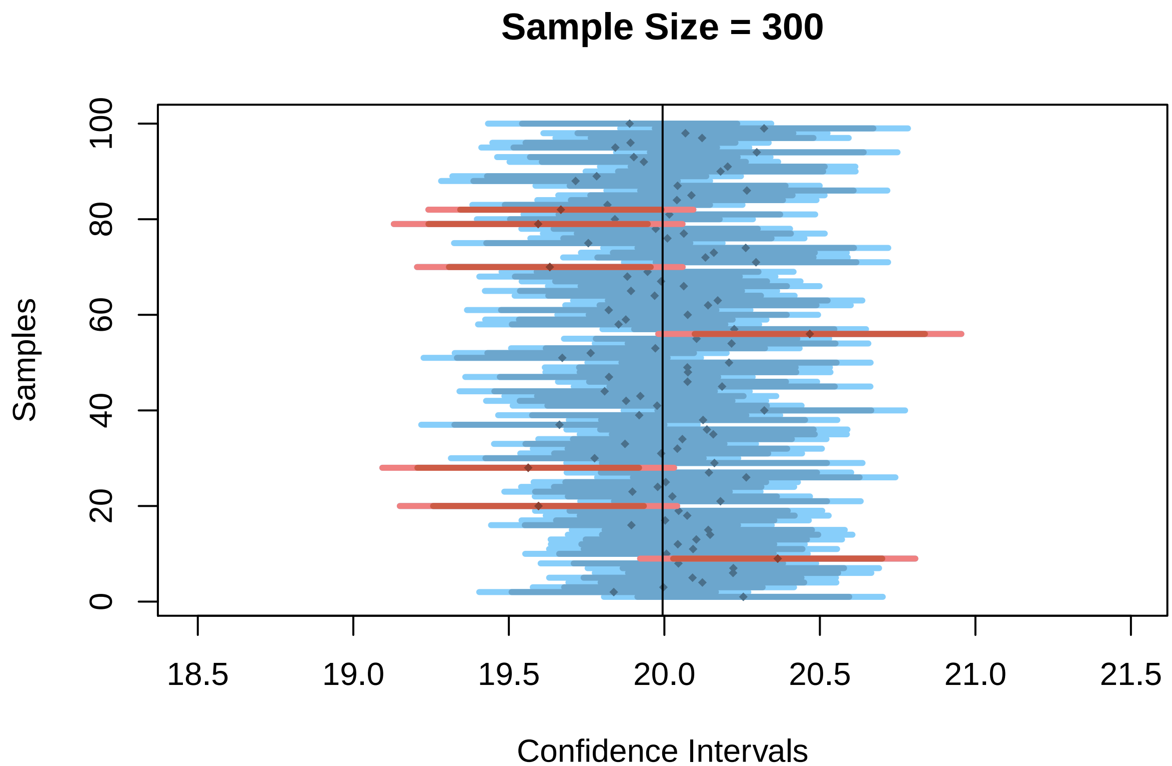
ii) How many samples do we expect to NOT include the population mean in their 99% CI?

```
## 1.17
```

b) Rerun the previous simulation with larger samples (sample_size=300):

i) Now that the size of each sample has increased, do we expect their 95% and 99% CI to become wider or narrower than before?





As we can see from the picture above, it becomes narrower

ii) This time, how many samples (out of the 100) would we expect to NOT include the population mean in its 95% CI?

```
## 5.15
```

c) If we ran the above two examples (a and b) using a uniformly distributed population (specify distr_func=runif for visualize_sample_ci), how do you expect your answers to (a) and (b) to change, and why?

Question 3