Stat 140: Pizza Slices Revisited

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December 6, 2017

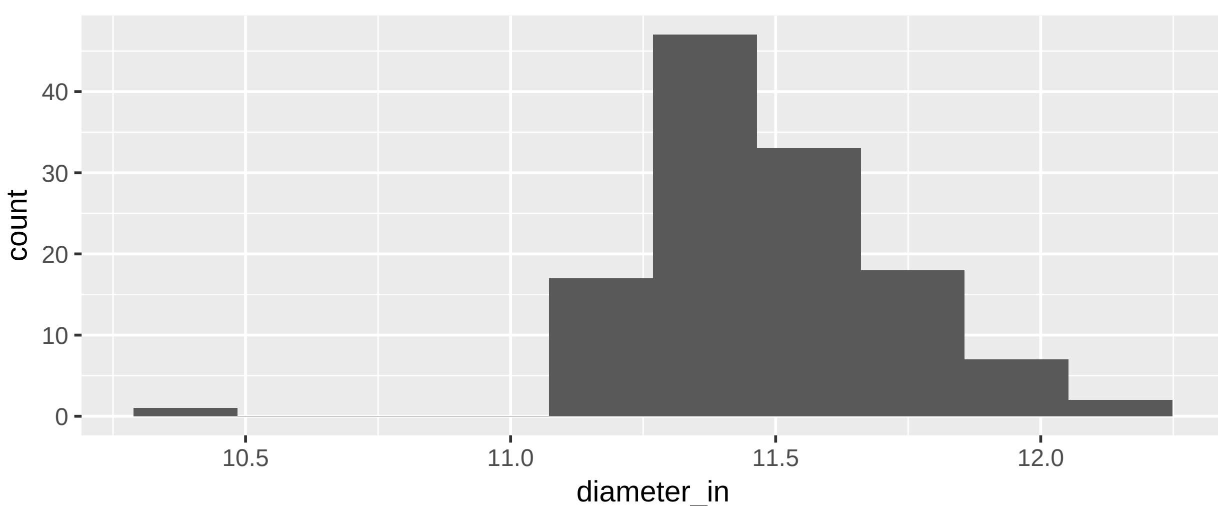
Pizza Slices

Reminder of context from HW7 problem: In 2012 a big Australian pizza chain, Eagle Boys, ran an advertising campaign saying their pizza was better than the competition's pizza because it was bigger. They made several specific claims, and one of them was that the average size of their pizzas was greater than 12 inches. (You can see a screenshot of their website making these claims here: https://mhc-stat140-2017.github.io/data/jse/pizza/pizza_website.png). Interestingly, the company also provided the data to "back up" their claims.

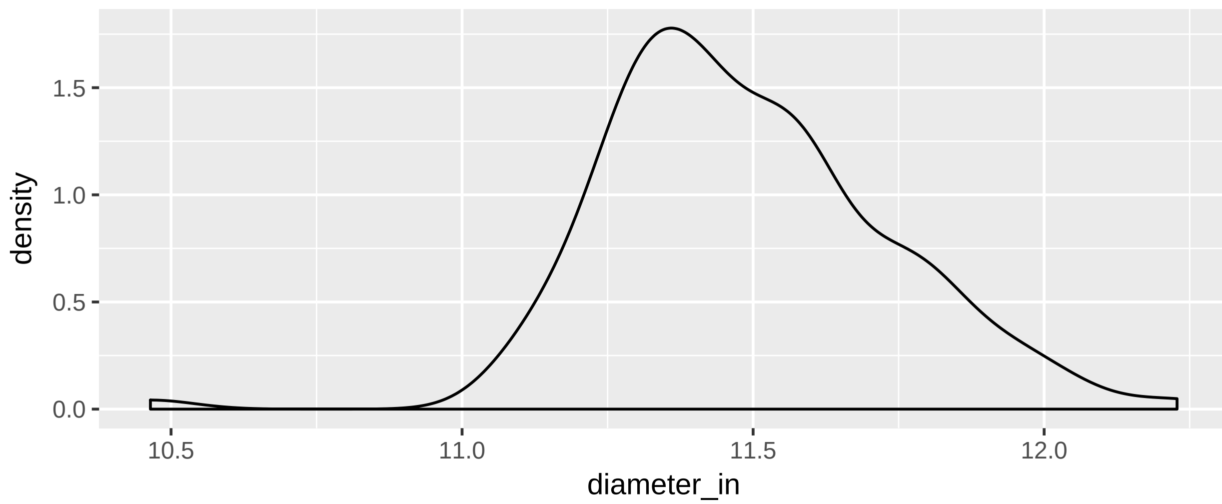
```
pizza <- read_csv("https://mhc-stat140-2017.github.io/data/jse/pizza/pizzasize.csv")
```

```
## Parsed with column specification:
## cols(
##   ID = col_integer(),
##   Store = col_character(),
##   CrustDescription = col_character(),
##   Topping = col_character(),
##   Diameter = col_double()
## )
```

```
pizza_eagle <- filter(pizza, Store == "EagleBoys") %>%
  mutate(diameter_in = Diameter * 0.39370079)
ggplot() +
  geom_histogram(mapping = aes(x = diameter_in), bins = 10, data = pizza_eagle)
```




```
ggplot() +
  geom_density(mapping = aes(x = diameter_in), data = pizza_eagle)
```



Check conditions for inference

1) Independence.

2) Data distribution nearly normal.

3) Sufficient sample size.

Being skeptical consumers, we don't believe the pizza chain's advertisements. Let's perform a hypothesis test of the claim that the population mean pizza diameter is less than 12 inches.

(a) State the null and alternative hypotheses

(b) What do you conclude?

SOLUTION:

```r
t.test(pizza_eagle$diameter_in, mu = 12, alternative = "less")
```

```
##
##  One Sample t-test
##
## data:  pizza_eagle$diameter_in
## t = -23, df = 120, p-value <2e-16
## alternative hypothesis: true mean is less than 12
## 95 percent confidence interval:
##   -Inf 11.52
## sample estimates:
## mean of x
##     11.49
```

(c) Conduct the hypothesis test again by comparing the test statistic to a critical value

```r
mean(pizza_eagle$diameter_in)
```

```
## [1] 11.49
```

```r
sd(pizza_eagle$diameter_in)
```

```
## [1] 0.2466
```

```r
nrow(pizza_eagle)
```

```
## [1] 125
```

```r
qt(0.05, df = 124)
```

```
## [1] -1.657
```

Type I Errors

Type I Error: We incorrectly reject the null hypothesis – the null hypothesis is actually true, but we say it's not.

(a) State what a Type I Error would be in this problem.

(b) Is it possible that we made a Type I Error in this case? If so, is there a way to tell for sure whether or not we made this error?

(c) If the null hypothesis was true, for what proportion of samples would we commit a Type I Error?

Type II Errors

Type II Error: We incorrectly fail to reject the null hypothesis – the null hypothesis is actually wrong, but we don't find conclusive evidence that it is wrong at the specified significance level α.

(a) State what a Type II Error would be in this problem.

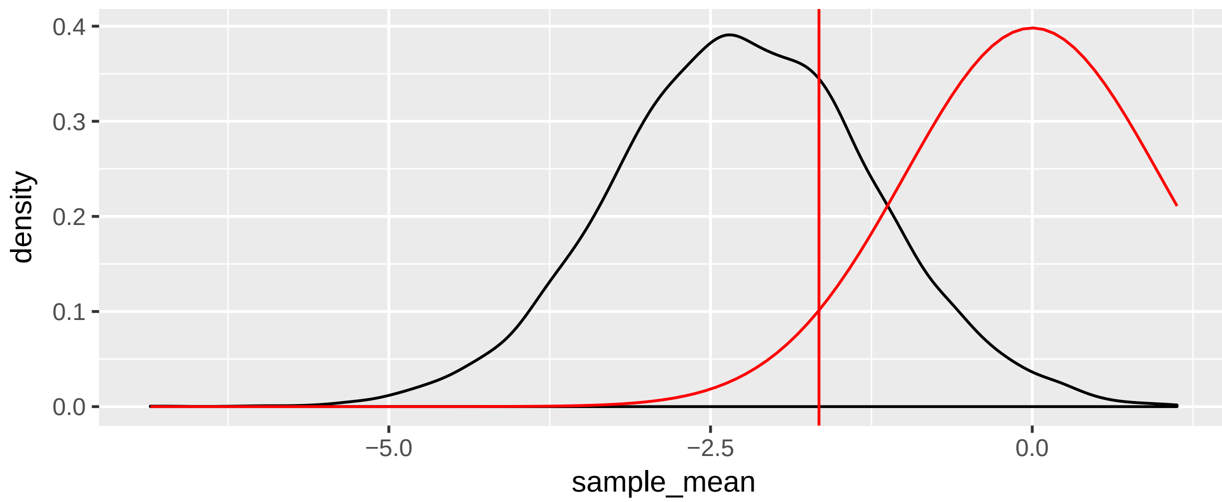
(b) Is it possible that we made a Type II Error in this case? If so, is there a way to tell for sure whether or not we made this error?

(c) If the null hypothesis was NOT true, for what proportion of samples would we commit a Type I Error?

Suppose pizza diameters follow a normal distribution with mean 11.9 inches and standard deviation 0.5 inches, and we take a sample of size $n = 125$. How often will we (incorrectly) fail to reject the null hypothesis?

```
sim_results <- do(10000) * {
  sample_x <- rnorm(125, mean = 11.9, sd = 0.5)
  sample_mean <- mean(sample_x)
  sample_sd <- sd(sample_x)
  test_stat <- (sample_mean - 12) / (sample_sd / sqrt(125))
}

plot_df <- data.frame(
  sample_mean = sim_results[[1]]
)
ggplot(mapping = aes(x = sample_mean), data = plot_df) +
  geom_density() +
  stat_function(fun = dt, color = "red", args = list(df = 124)) +
  geom_vline(xintercept = qt(0.05, df = 124), color = "red")
```



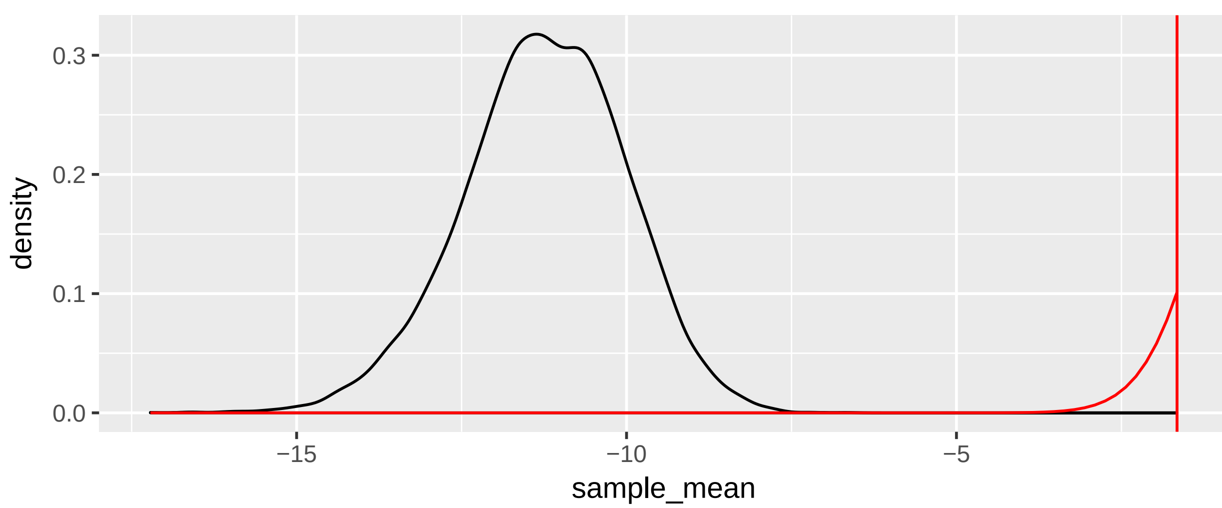

```
mean(sim_results >= qt(0.05, df = 124))
```

```
## [1] 0.2799
```

Suppose pizza diameters follow a normal distribution with mean 11.5 inches and standard deviation 0.5 inches, and we take a sample of size $n = 125$. How often will we (incorrectly) fail to reject the null hypothesis?

```
sim_results <- do(10000) * {
  sample_x <- rnorm(125, mean = 11.5, sd = 0.5)
  sample_mean <- mean(sample_x)
  sample_sd <- sd(sample_x)
  test_stat <- (sample_mean - 12) / (sample_sd / sqrt(125))
}

plot_df <- data.frame(
  sample_mean = sim_results[[1]]
)
ggplot(mapping = aes(x = sample_mean), data = plot_df) +
  geom_density() +
  stat_function(fun = dt, color = "red", args = list(df = 124)) +
  geom_vline(xintercept = qt(0.05, df = 124), color = "red")
```



```r
mean(sim_results >= qt(0.05, df = 124))
```

```
## [1] 0
```