# Final Project (Group 2)

Group 2

2024-05-28

«««< HEAD - Research Question/Hypothesis: What variable in the world happiness report (family, health, trust, generosity, and economics) has the greatest effect on a nation's happiness score? =======

- Research Question/Hypothesis: What variable in the world happiness report (family, health, trust, generosity, and economics) has the greatest effect on a nation's happiness score? »»»> 81e6af9ac23978bbafb85c9fa12c41d73c572ee5
- Hypothesis: Economics plays the largest role in a nation's happiness score.

```
library(readxl)
library(dplyr)
library(ggplot2)
library(tidyr)

data <- read_excel("2019.xls")

colnames(data)
```

```
## [1] "Overall rank"                "Country or region"
## [3] "Score"                       "GDP per capita"
## [5] "Social support"              "Healthy life expectancy"
## [7] "Freedom to make life choices" "Generosity"
## [9] "Perceptions of corruption"
```

```
library(readxl)

data <- read_excel("2019.xls")

print(colnames(data))
```

```
## [1] "Overall rank"                "Country or region"
## [3] "Score"                       "GDP per capita"
## [5] "Social support"              "Healthy life expectancy"
## [7] "Freedom to make life choices" "Generosity"
## [9] "Perceptions of corruption"
```

```r
data <- data %>%
  rename(
    Economy = `GDP per capita`,
    Social = 'Social support',
    Health = `Healthy life expectancy`,
    Freedom = `Freedom to make life choices`,
    Corruption = 'Perceptions of corruption',
    Happiness_Score = `Score`
  )
print(colnames(data))
```

```
## [1] "Overall rank"      "Country or region" "Happiness_Score"
## [4] "Economy"           "Social"            "Health"
## [7] "Freedom"           "Generosity"        "Corruption"
```

```r
  head(
    select(data, Economy, Social, Health, Freedom, Corruption, Happiness_Score)
  )
```

| Economy | Social | Health | Freedom | Corruption | Happiness_Score |
|---|---|---|---|---|---|
| 1.340 | 1.587 | 0.986 | 0.596 | 0.393 | 7.769 |
| 1.383 | 1.573 | 0.996 | 0.592 | 0.410 | 7.600 |
| 1.488 | 1.582 | 1.028 | 0.603 | 0.341 | 7.554 |
| 1.380 | 1.624 | 1.026 | 0.591 | 0.118 | 7.494 |
| 1.396 | 1.522 | 0.999 | 0.557 | 0.298 | 7.488 |
| 1.452 | 1.526 | 1.052 | 0.572 | 0.343 | 7.480 |

[Module 2: Junhyung Kim, Jiho Lee]

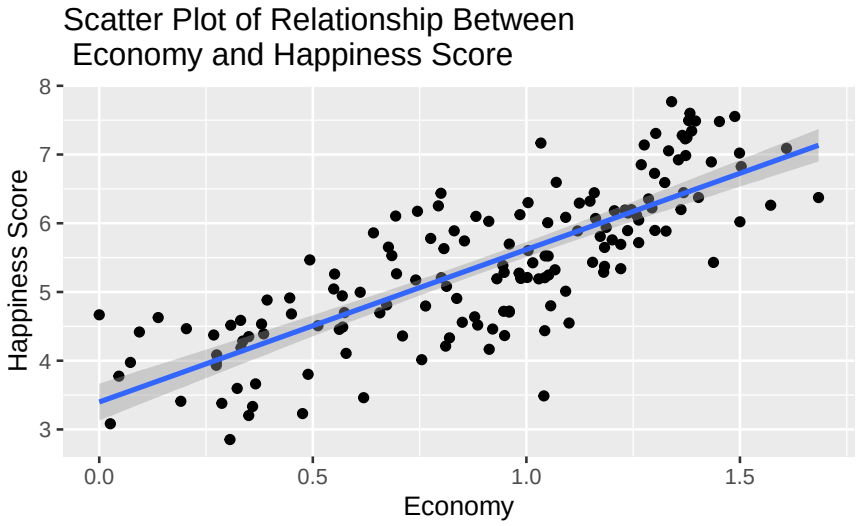
*Scatter Plot

```r
qplot(x = Economy, y= Happiness_Score, data = data,
 geom = c("point", "smooth"), method = "lm") +
 labs(title =
 "Scatter Plot of Relationship Between
 Economy and Happiness Score",
 x = "Economy", y = "Happiness Score")
```

```
## Warning: `qplot()` was deprecated in ggplot2 3.4.0.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

```
## Warning in geom_point(method = "lm"): Ignoring unknown parameters: `method`
```

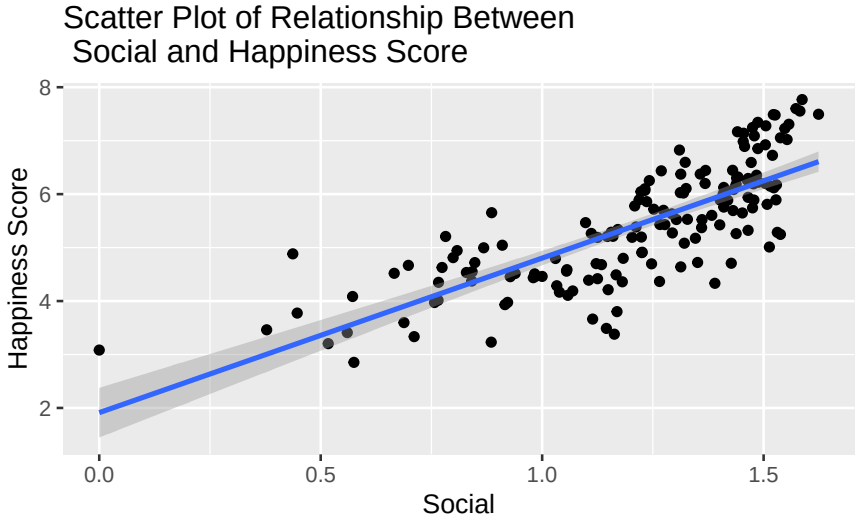
```
## `geom_smooth()` using formula = 'y ~ x'
```




```
qplot(x= Social,y=Happiness_Score,data=data,
geom=c("point","smooth"),method="lm")+
labs(title =
"Scatter Plot of Relationship Between
Social and Happiness Score",
x="Social",y="Happiness Score")
```

```
## Warning in geom_point(method = "lm"): Ignoring unknown parameters: `method`
```

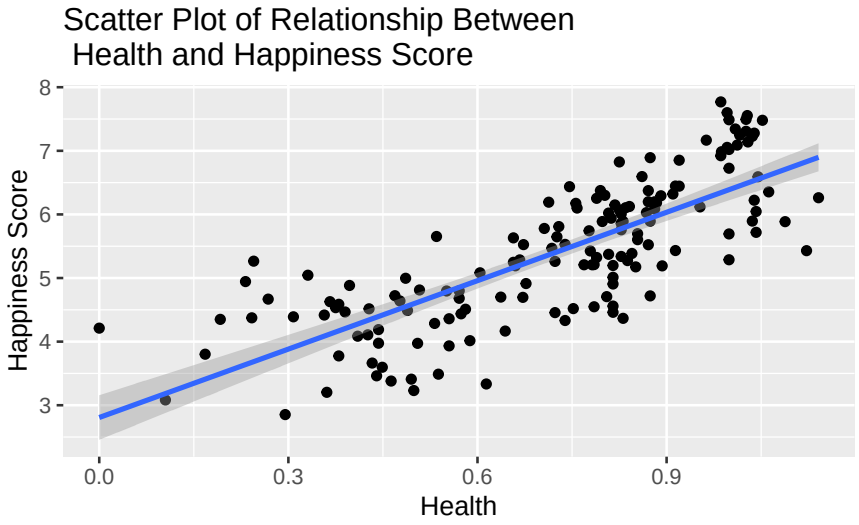
```
## `geom_smooth()` using formula = 'y ~ x'
```



```
qplot(x= Health,y=Happiness_Score,data=data,
 geom=c("point","smooth"),method="lm")+
 labs(title =
 "Scatter Plot of Relationship Between
 Health and Happiness Score",
 x="Health",y="Happiness Score")
```

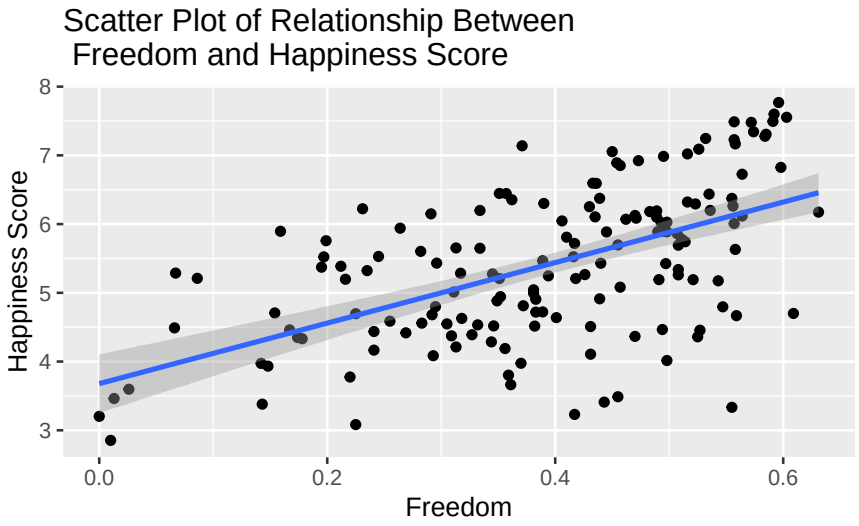
```
## Warning in geom_point(method = "lm"): Ignoring unknown parameters: ‘method‘
```

```
## ‘geom_smooth()‘ using formula = ’y ~ x’
```



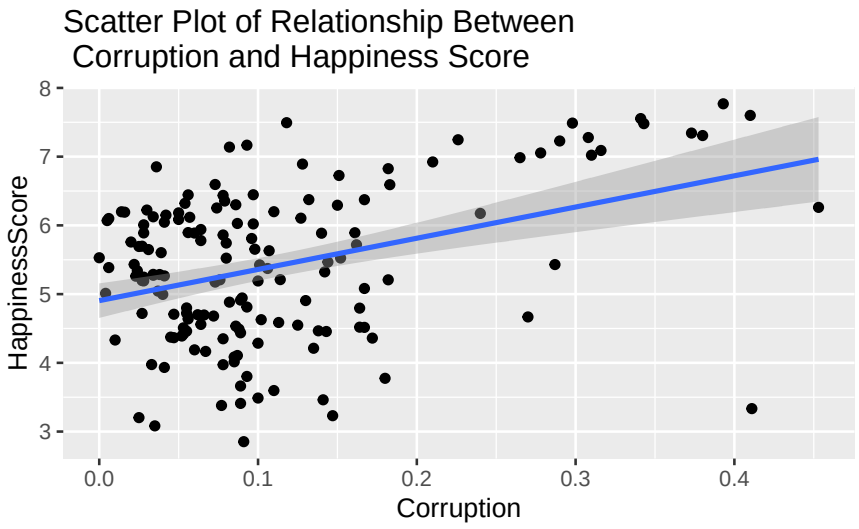

```
qplot(x= Freedom,y=Happiness_Score,data=data,
 geom=c("point","smooth"),method="lm")+
 labs(title =
 "Scatter Plot of Relationship Between
 Freedom and Happiness Score",
 x="Freedom",y="Happiness Score")
```

```
## ‘geom_smooth()‘ using formula = ’y ~ x’
```



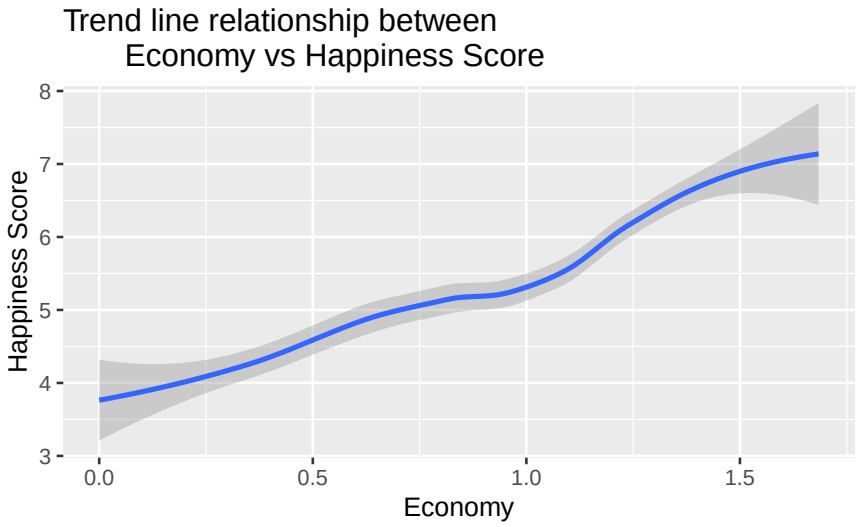

```
qplot(x= Corruption,y=Happiness_Score,data=data,
geom=c("point","smooth"),method="lm")+
labs(title ="Scatter Plot of Relationship Between
Corruption and Happiness Score",
x="Corruption",y="HappinessScore")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



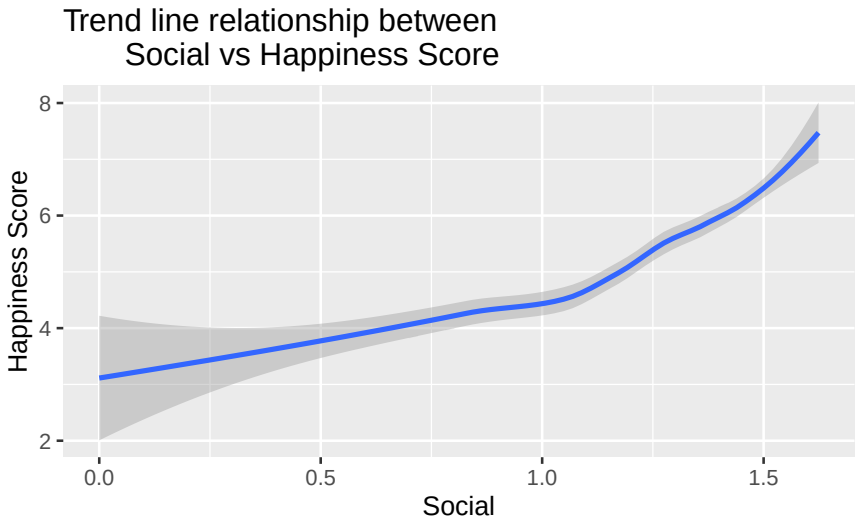

```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Economy, y = Happiness_Score)) +
  labs(x = "Economy", y = "Happiness Score",
       title="Trend line relationship between
       Economy vs Happiness Score")
```

```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```




```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Social, y = Happiness_Score)) +
  labs(x = "Social", y = "Happiness Score",
       title="Trend line relationship between
       Social vs Happiness Score")
```

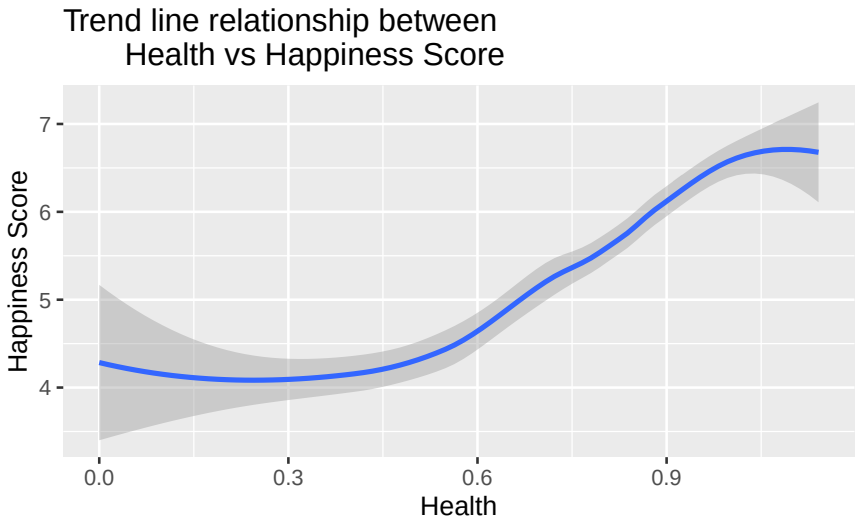
```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```




```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Health, y = Happiness_Score)) +
```

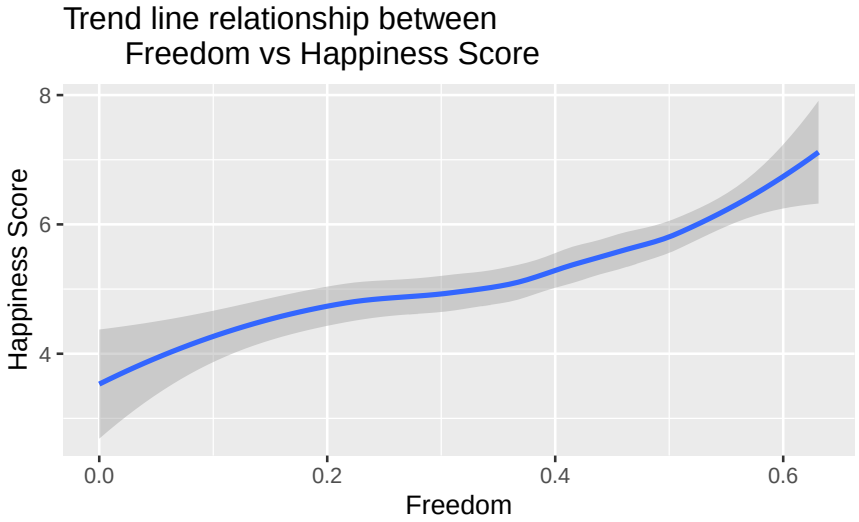
```
  labs(x = "Health", y = "Happiness Score",
       title="Trend line relationship between
       Health vs Happiness Score")
```

```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```



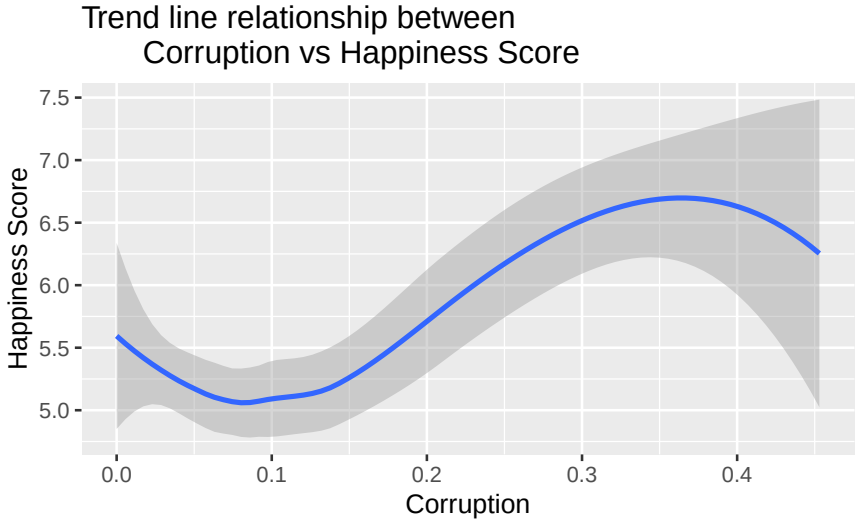

```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Freedom, y = Happiness_Score)) +
  labs(x = "Freedom", y = "Happiness Score",
       title="Trend line relationship between
       Freedom vs Happiness Score")
```

```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```



```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Corruption, y = Happiness_Score)) +
  labs(x = "Corruption", y = "Happiness Score",
       title="Trend line relationship between
       Corruption vs Happiness Score")
```

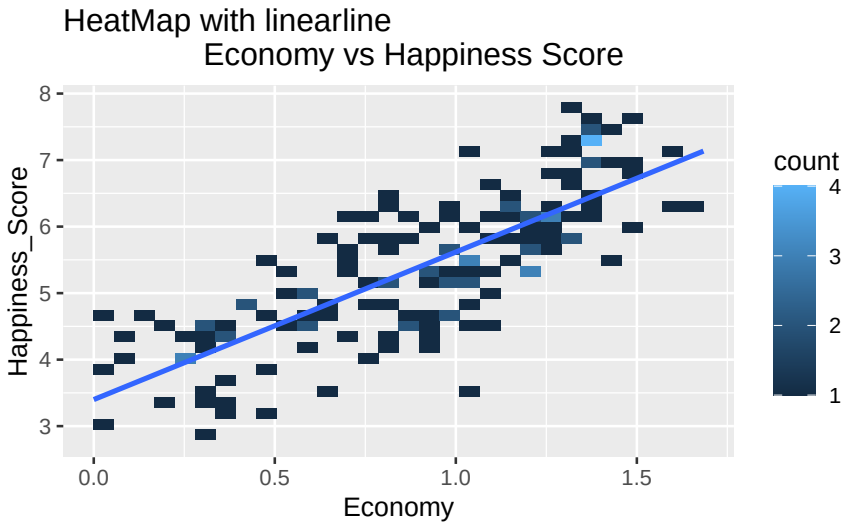
```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```




*HeatMap

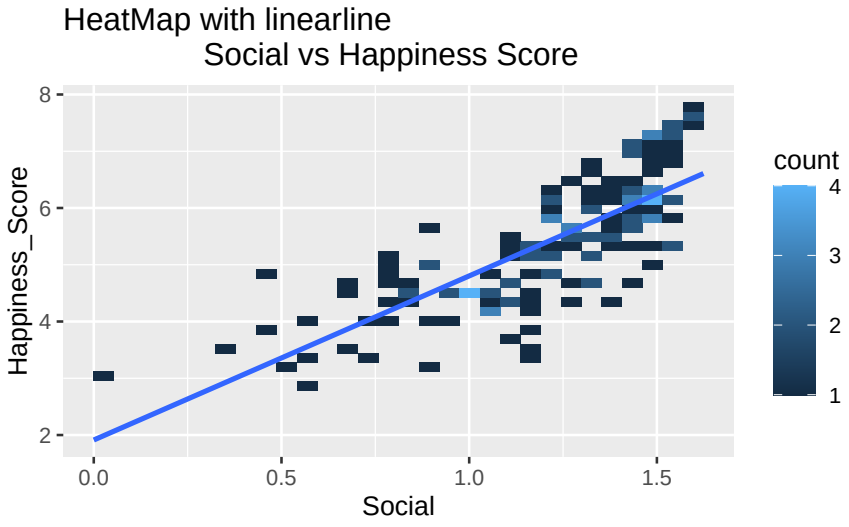
```
data %>%
ggplot(aes(x = Economy, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "HeatMap with linearline
                Economy vs Happiness Score",
           x = "Economy", y = "Happiness_Score")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```




```
data %>%
ggplot(aes(x = Social, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "HeatMap with linearline
                Social vs Happiness Score",
          x = "Social", y = "Happiness_Score")
```

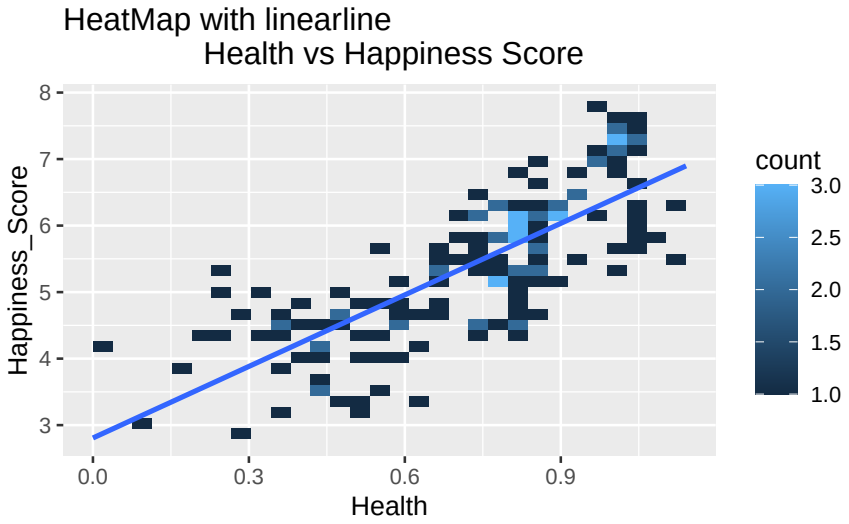
```
## `geom_smooth()` using formula = 'y ~ x'
```




```
data %>%
ggplot(aes(x = Health, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
```

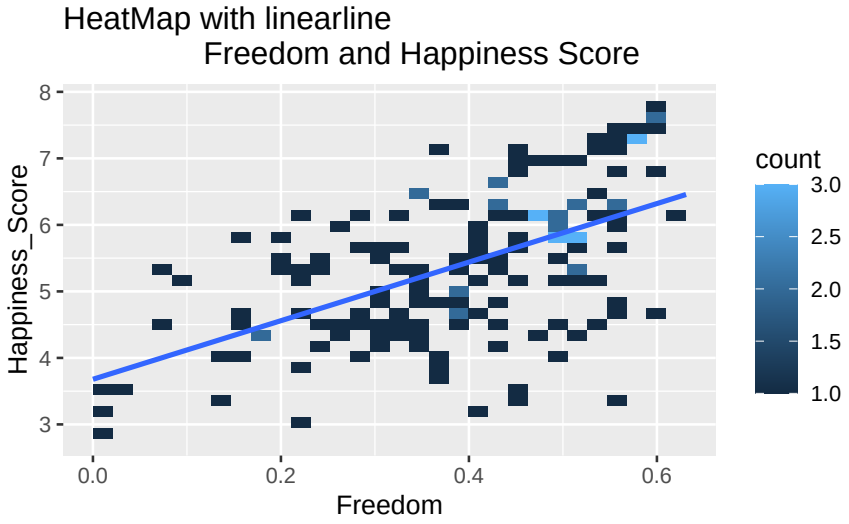
```
  labs(title = "HeatMap with linearline
                Health vs Happiness Score",
           x = "Health", y = "Happiness_Score")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



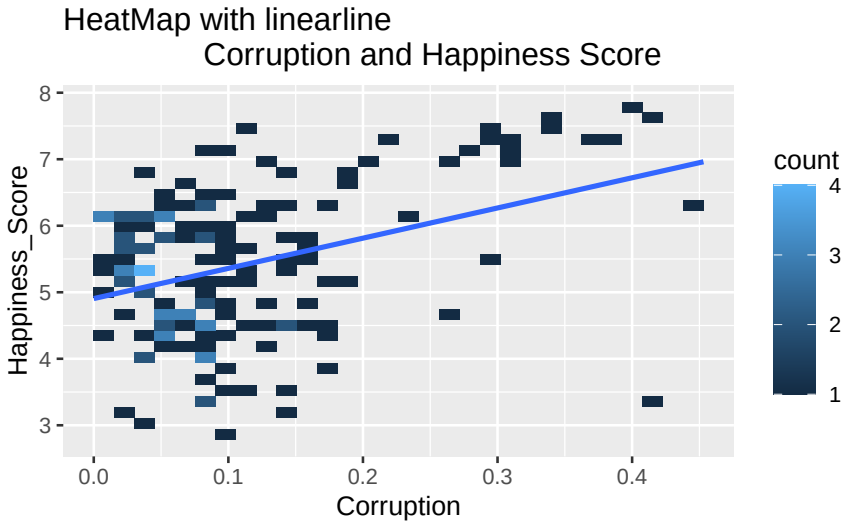

```
data %>%
ggplot(aes(x = Freedom, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "HeatMap with linearline
                Freedom and Happiness Score",
           x = "Freedom", y = "Happiness_Score")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```



```
data %>%
ggplot(aes(x = Corruption, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "HeatMap with linearline
                Corruption and Happiness Score",
           x = "Corruption", y = "Happiness_Score")
```

```
## `geom_smooth()` using formula = 'y ~ x'
```




======= [ Module 4: Eugene Kim, Harold Lee - Explanatory Data Analysis ]

```
str(data, vec.len = 2)
```

```
## tibble [156 x 9] (S3: tbl_df/tbl/data.frame)
##  $ Overall rank     : num [1:156] 1 2 3 4 5 ...
##  $ Country or region: chr [1:156] "Finland" "Denmark" ...
##  $ Happiness_Score  : num [1:156] 7.77 7.6 ...
##  $ Economy          : num [1:156] 1.34 1.38 ...
##  $ Social           : num [1:156] 1.59 1.57 ...
##  $ Health           : num [1:156] 0.986 0.996 ...
##  $ Freedom          : num [1:156] 0.596 0.592 0.603 0.591 0.557 ...
##  $ Generosity       : num [1:156] 0.153 0.252 0.271 0.354 0.322 ...
##  $ Corruption       : num [1:156] 0.393 0.41 0.341 0.118 0.298 ...
```

```
head(
    select(data, Economy, Social, Health, Freedom, Corruption,
           Happiness_Score)
  )
```

| Economy | Social | Health | Freedom | Corruption | Happiness_Score |
|---|---|---|---|---|---|
| 1.340 | 1.587 | 0.986 | 0.596 | 0.393 | 7.769 |
| 1.383 | 1.573 | 0.996 | 0.592 | 0.410 | 7.600 |
| 1.488 | 1.582 | 1.028 | 0.603 | 0.341 | 7.554 |
| 1.380 | 1.624 | 1.026 | 0.591 | 0.118 | 7.494 |
| 1.396 | 1.522 | 0.999 | 0.557 | 0.298 | 7.488 |
| 1.452 | 1.526 | 1.052 | 0.572 | 0.343 | 7.480 |

```
tail(select(data, Economy, Social, Health, Freedom, Corruption,
            Happiness_Score)
  )
```

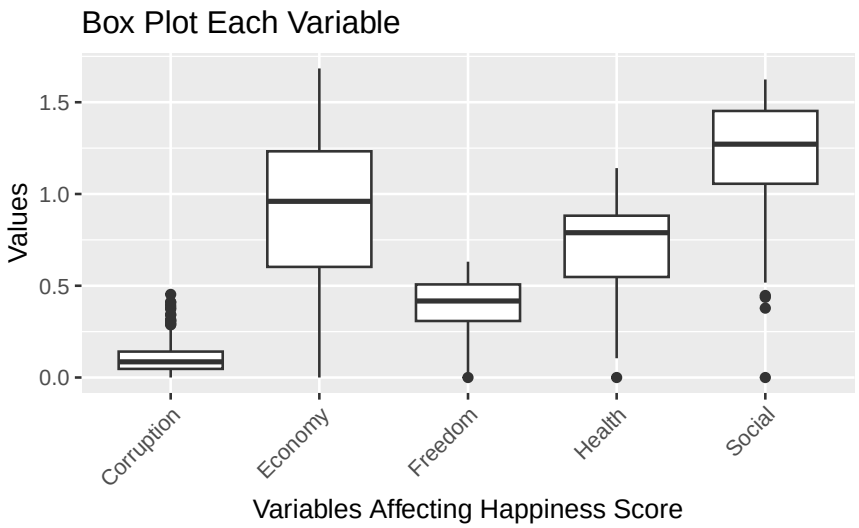
| Economy | Social | Health | Freedom | Corruption | Happiness_Score |
|---|---|---|---|---|---|
| 0.287 | 1.163 | 0.463 | 0.143 | 0.077 | 3.380 |
| 0.359 | 0.711 | 0.614 | 0.555 | 0.411 | 3.334 |
| 0.476 | 0.885 | 0.499 | 0.417 | 0.147 | 3.231 |
| 0.350 | 0.517 | 0.361 | 0.000 | 0.025 | 3.203 |
| 0.026 | 0.000 | 0.105 | 0.225 | 0.035 | 3.083 |
| 0.306 | 0.575 | 0.295 | 0.010 | 0.091 | 2.853 |

*Summary statistics

*Box Plot

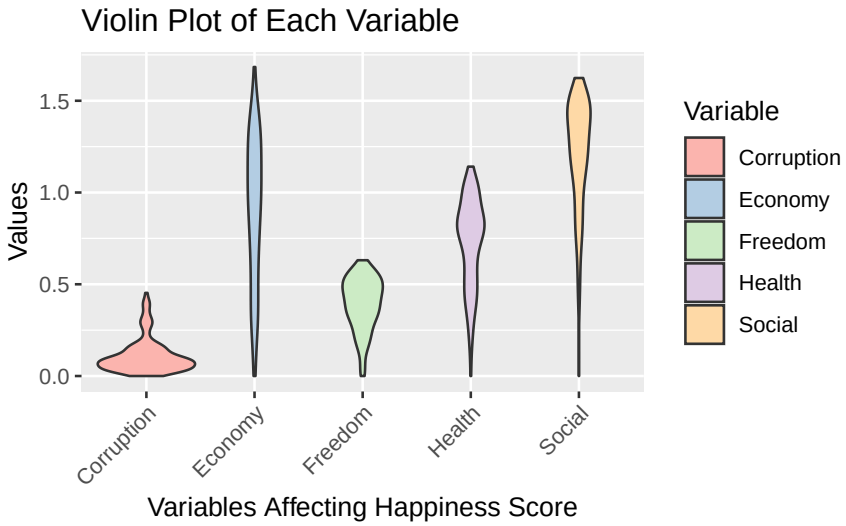
```
data_long <- data %>%
  gather(key = "Variable", value = "Score", Economy, Social, Health,
         Freedom, Corruption)

ggplot(data_long, aes(x = Variable, y = Score)) +
  geom_boxplot(width = 0.7) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  labs(title = "Box Plot Each Variable",
       x = "Variables Affecting Happiness Score", y = "Values")
```




*Violin Plot

```
ggplot(data_long, aes(x = Variable, y = Score, fill = Variable)) +
  geom_violin(trim = TRUE) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1)) +
  labs(title = "Violin Plot of Each Variable",
       x = "Variables Affecting Happiness Score", y = "Values") +
  scale_fill_brewer(palette = "Pastel1")
```




*Summary

```
data %>%
  summarize(
    mean= mean(Economy),
```

```
    median = median(Economy),
    sd = sd(Economy),
    iqr = IQR(Economy),
    min = min(Economy),
    max = max(Economy)
 )
```

| mean | median | sd | iqr | min | max |
|---|---|---|---|---|---|
| 0.9051474 | 0.96 | 0.3983895 | 0.62975 | 0 | 1.684 |

```
data %>%
  summarize(
    mean= mean(Social),
    median = median(Social),
    sd = sd(Social),
    iqr = IQR(Social),
    min = min(Social),
    max = max(Social)
 )
```

| mean | median | sd | iqr | min | max |
|---|---|---|---|---|---|
| 1.208814 | 1.2715 | 0.2991914 | 0.39675 | 0 | 1.624 |

```
data %>%
  summarize(
    mean= mean(Health),
    median = median(Health),
    sd = sd(Health),
    iqr = IQR(Health),
    min = min(Health),
    max = max(Health)
 )
```

| mean | median | sd | iqr | min | max |
|---|---|---|---|---|---|
| 0.7252436 | 0.789 | 0.242124 | 0.334 | 0 | 1.141 |

```
data %>%
  summarize(
    mean= mean(Freedom),
    median = median(Freedom),
    sd = sd(Freedom),
    iqr = IQR(Freedom),
```

```
    min = min(Freedom),
    max = max(Freedom)
 )
```

| mean | median | sd | iqr | min | max |
|---|---|---|---|---|---|
| 0.3925705 | 0.417 | 0.1432895 | 0.19925 | 0 | 0.631 |

```
data %>%
  summarize(
    mean= mean(Corruption),
    median = median(Corruption),
    sd = sd(Corruption),
    iqr = IQR(Corruption),
    min = min(Corruption),
    max = max(Corruption)
 )
```

| mean | median | sd | iqr | min | max |
|---|---|---|---|---|---|
| 0.1106026 | 0.0855 | 0.0945378 | 0.09425 | 0 | 0.453 |

```
data_E <- data %>%
  summarize(
    mean= mean(Economy),
    median = median(Economy),
    sd = sd(Economy),
    iqr = IQR(Economy),
    min = min(Economy),
    max = max(Economy)
 )
```

```
data_S <- data %>%
  summarize(
    mean= mean(Social),
    median = median(Social),
    sd = sd(Social),
    iqr = IQR(Social),
    min = min(Social),
    max = max(Social)
 )
```

```
data_H <- data %>%
  summarize(
    mean= mean(Health),
```

```
    median = median(Health),
    sd = sd(Health),
    iqr = IQR(Health),
    min = min(Health),
    max = max(Health)
 )
```

```
data_F <- data %>%
  summarize(
    mean= mean(Freedom),
    median = median(Freedom),
    sd = sd(Freedom),
    iqr = IQR(Freedom),
    min = min(Freedom),
    max = max(Freedom)
 )
```

```
data_C <- data %>%
  summarize(
    mean= mean(Corruption),
    median = median(Corruption),
    sd = sd(Corruption),
    iqr = IQR(Corruption),
    min = min(Corruption),
    max = max(Corruption)
 )
```

```
combined_data <- rbind(data_E, data_S, data_H, data_F, data_C)
row.names(combined_data) <- c("Economy", "Social", "Health",
                              "Freedom", "Corruption")
```

```
## Warning: Setting row names on a tibble is deprecated.
```

```
print(combined_data)
```

```
## # A tibble: 5 x 6
##    mean median     sd    iqr   min   max
## * <dbl>  <dbl>  <dbl>  <dbl> <dbl> <dbl>
## 1 0.905 0.96   0.398  0.630      0 1.68
## 2 1.21  1.27   0.299  0.397      0 1.62
## 3 0.725 0.789  0.242  0.334      0 1.14
## 4 0.393 0.417  0.143  0.199      0 0.631
## 5 0.111 0.0855 0.0945 0.0942     0 0.453
```

## [Module 5: Chun Jin Park - Modeling].

## linear model using lm

```
model <- lm(Happiness_Score ~ Economy + Social + Health + Freedom + Generosity
            + Corruption, data = data)

summary(model)
```

```
##
## Call:
## lm(formula = Happiness_Score ~ Economy + Social + Health + Freedom +
##     Generosity + Corruption, data = data)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.75304 -0.35306  0.05703  0.36695  1.19059
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   1.7952     0.2111   8.505 1.77e-14 ***
## Economy       0.7754     0.2182   3.553 0.000510 ***
## Social        1.1242     0.2369   4.745 4.83e-06 ***
## Health        1.0781     0.3345   3.223 0.001560 **
## Freedom       1.4548     0.3753   3.876 0.000159 ***
## Generosity    0.4898     0.4977   0.984 0.326709
## Corruption    0.9723     0.5424   1.793 0.075053 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5335 on 149 degrees of freedom
## Multiple R-squared:  0.7792, Adjusted R-squared:  0.7703
## F-statistic: 87.62 on 6 and 149 DF,  p-value: < 2.2e-16
```

## tidy to get the model coefficients

```
coefficients <- tidy(model)
print(coefficients)
```

```
## # A tibble: 7 x 5
##   term        estimate std.error statistic  p.value
##   <chr>          <dbl>     <dbl>     <dbl>    <dbl>
## 1 (Intercept)    1.80      0.211     8.51  1.77e-14
```

```
## 2 Economy        0.775     0.218     3.55  5.10e- 4
## 3 Social         1.12      0.237     4.75  4.83e- 6
## 4 Health         1.08      0.335     3.22  1.56e- 3
## 5 Freedom        1.45      0.375     3.88  1.59e- 4
## 6 Generosity     0.490     0.498     0.984 3.27e- 1
## 7 Corruption     0.972     0.542     1.79  7.51e- 2
```

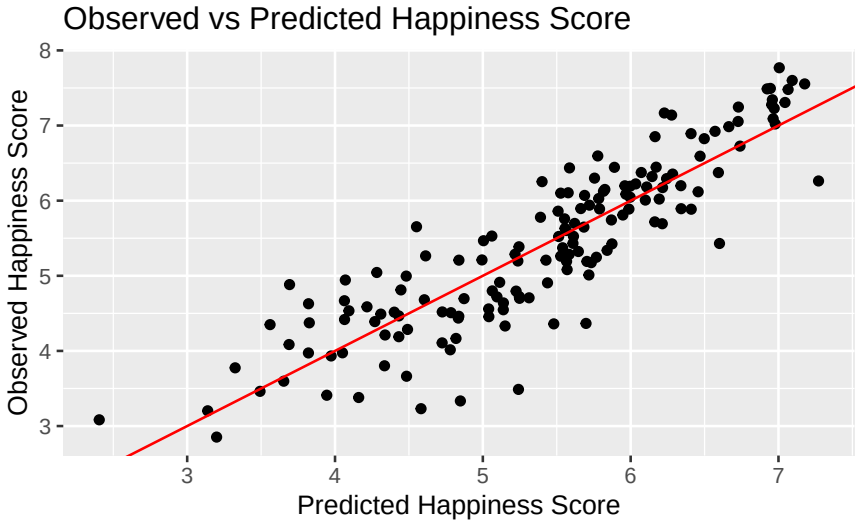
## glance to get the model's performance metrics

```
performance <- glance(model)
print(performance)
```

```
## # A tibble: 1 x 12
##   r.squared adj.r.squared sigma statistic  p.value    df logLik   AIC   BIC
##       <dbl>         <dbl> <dbl>     <dbl>    <dbl> <dbl>  <dbl> <dbl> <dbl>
## 1     0.779         0.770 0.534      87.6 2.40e-46     6  -120.  256.  280.
## # i 3 more variables: deviance <dbl>, df.residual <int>, nobs <int>
```

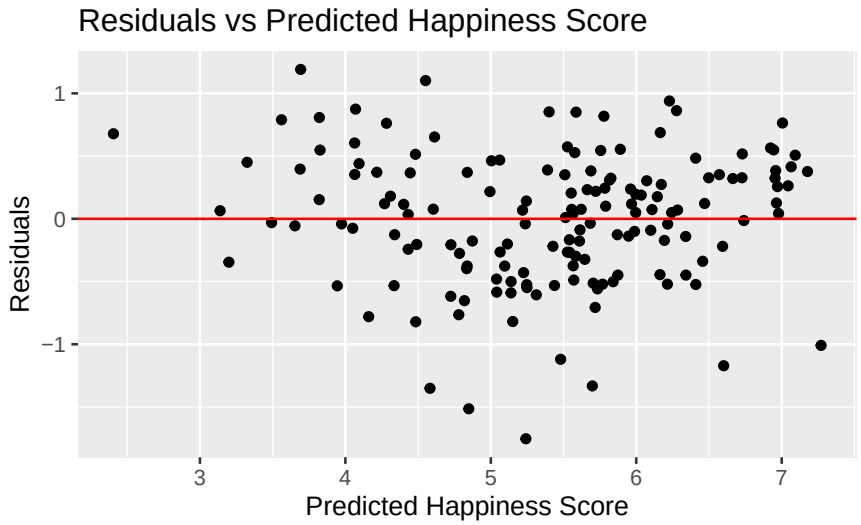
## Observed vs Predicted plot

```
ggplot(data, aes(x = predict(model), y = Happiness_Score)) +
  geom_point() +
  geom_abline(intercept = 0, slope = 1, col = "red") +
  labs(title =
         "Observed vs Predicted Happiness Score",
       x = "Predicted Happiness Score",
       y = "Observed Happiness Score")
```



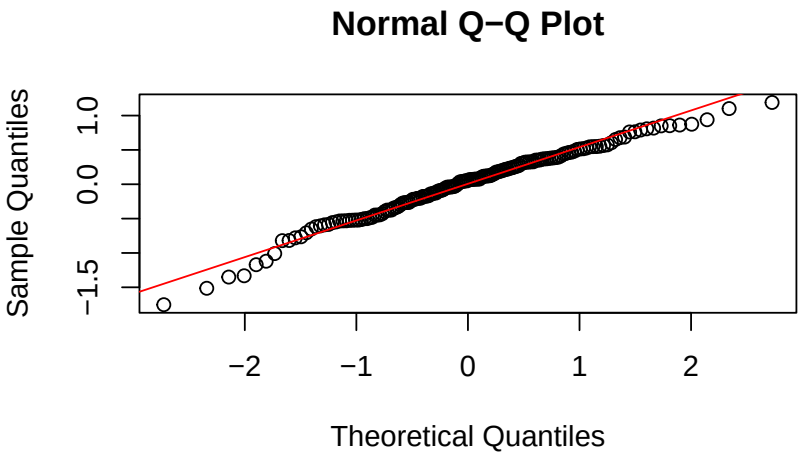
## Residuals vs Predicted plot

```
ggplot(data, aes(x = predict(model), y = residuals(model))) +
  geom_point() +
  geom_hline(yintercept = 0, col = "red") +
  labs(title = "Residuals vs Predicted Happiness Score",
       x = "Predicted Happiness Score",
       y = "Residuals")
```




## Q-Q plot

```
qqnorm(residuals(model))
qqline(residuals(model), col = "red")
```



## «««< HEAD

======= [ Module 6: SeNa Julsdorf, Hyeongseok Sim]

```
null_distribution_correlation <- data %>%
  specify(Happiness_Score ~ Social) %>%
  hypothesize(null = "independence") %>%
  generate(reps = 10000, type = "permute") %>%
  calculate(stat = "correlation")
```

```
happiness_obs_stat <- data %>%
  specify(Happiness_Score ~ Social) %>%
  calculate(stat = "correlation")
```

```
p_value <- null_distribution_correlation %>%
  get_p_value(obs_stat = happiness_obs_stat, direction = "both")
```

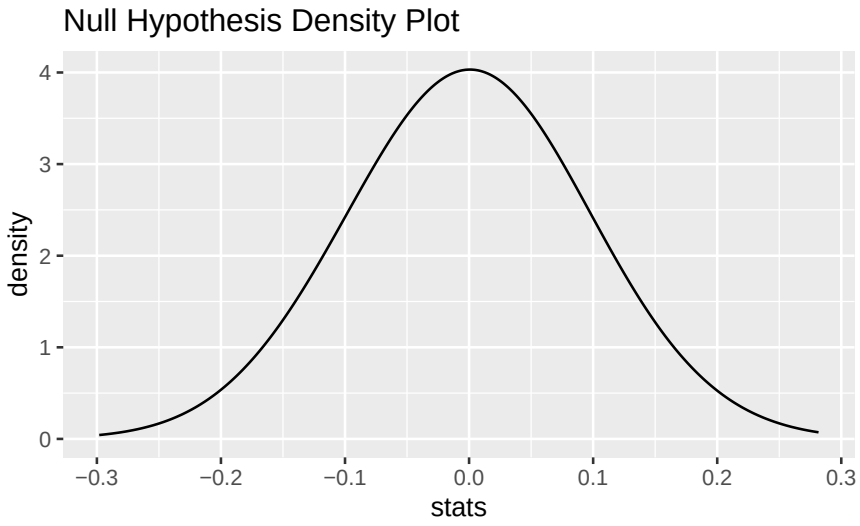
```
## Warning: Please be cautious in reporting a p-value of 0. This result is an approximation
## based on the number of `reps` chosen in the `generate()` step.
## i See `get_p_value()` (`?infer::get_p_value()`) for more information.
```

```
print(p_value)
```

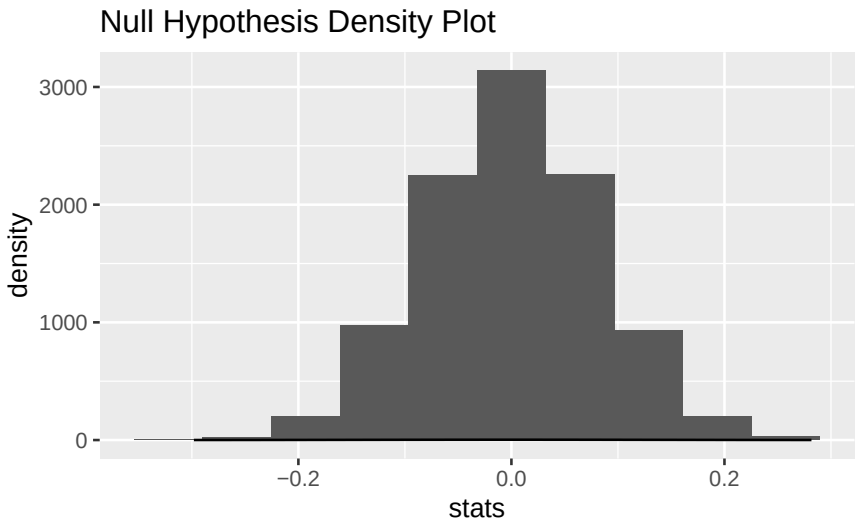
```
## # A tibble: 1 x 1
##   p_value
##     <dbl>
## 1       0
```

```
visualize(null_distribution_correlation) +
  shade_p_value(obs_stat = happiness_obs_stat, direction = "two_sided") +
    labs(title = "Null Distribution of Happiness Score", x = "Correlation",
         y = "Count")
```

```
null_distribution_correlation %>%
  ggplot +
  geom_density(mapping = aes(x = stat), adjust = 5) +
  labs(title = "Null Hypothesis Density Plot", x = "stats", y = "density")
```



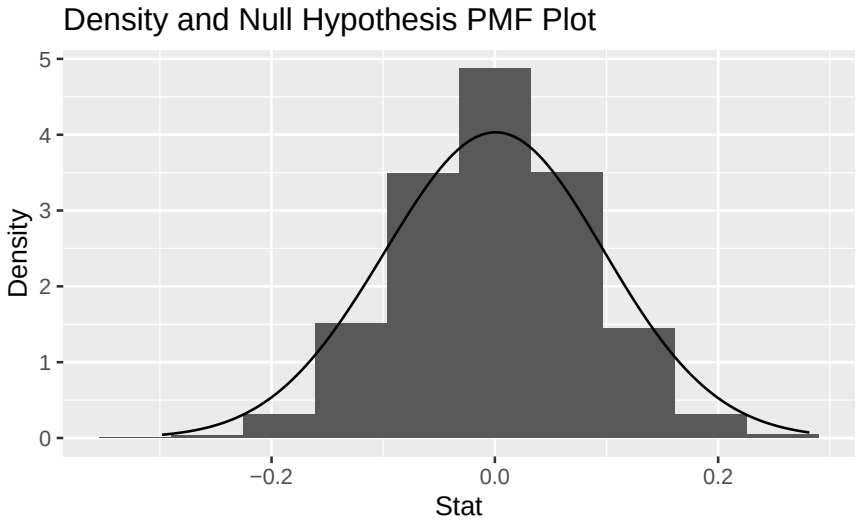

```
null_distribution_correlation %>%
  ggplot() +
  geom_histogram(mapping = aes(x = stat), bins = 10) +
  geom_density(mapping = aes(x = stat), adjust = 10) +
  labs(title = "Null Hypothesis Density Plot", x = "stats", y = "density")
```




```
null_distribution_correlation %>%
ggplot()+
geom_histogram(mapping = aes(x = stat, y = ..density..), bins = 10) +
```

```
geom_density(mapping = aes(x = stat), adjust = 5) +
labs(title = "Density and Null Hypothesis PMF Plot",
x = "Stat", y = "Density")
```

```
## Warning: The dot-dot notation (‘..density..‘) was deprecated in ggplot2 3.4.0.
## i Please use ‘after_stat(density)‘ instead.
## This warning is displayed once every 8 hours.
## Call ‘lifecycle::last_lifecycle_warnings()‘ to see where this warning was
## generated.
```




======= [ Module 7: Jeonghwa Cho]

```
bootstraps_distribution_correlation <- data %>%
specify(Happiness_Score ~ Social) %>%
generate( reps = 10000, type = "bootstrap") %>%
calculate(stat = "correlation")
```

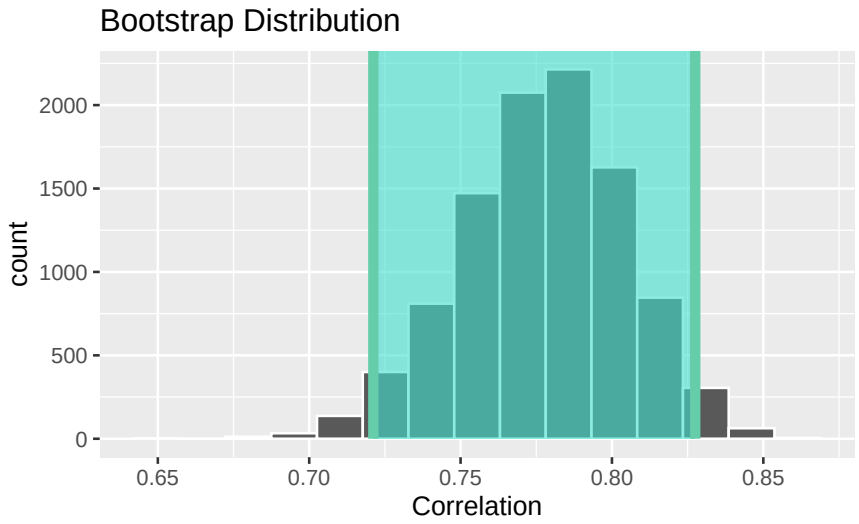
```
bootstrap_ci <- bootstraps_distribution_correlation %>%
get_confidence_interval()
```

```
## Using ‘level = 0.95‘ to compute confidence interval.
```

```
bootstrap_ci
```

| lower_ci | upper_ci |
|---|---|
| 0.7211866 | 0.8275057 |

```r
bootstraps_distribution_correlation %>%
visualize()+
shade_confidence_interval(bootstrap_ci)+
ggtitle("Bootstrap Distribution")+
xlab("Correlation")+
ylab("count")
```




```r
bootstrap_results <- cohens_d_bootstrap(
data = data_long,
model = Happiness_Score ~ Variable)
```

```r
bootstrap_report(bootstrap_results)
```

```
## BOOTSTRAP CONFIDENCE INTERVAL CALCULATIONS
## Based on 5000 bootstrap replicates
##
## CALL :
## boot::boot.ci(boot.out = cohens_d_bootstrap_sim, type = c("perc"))
##
## Intervals :
## Level     Percentile
## 95%   (-0.2207,  0.2228 )
## Calculations and Intervals on Original Scale
##
## Response variable
## Happiness_Score
##
## Explanatory variable
## Variable
##
```

```
## Explanatory category with larger mean
## Economy
##
## Explanatory category with smaller mean
## Social
##
## Cohen's d observed value
## 0
```

```
plot_ci(bootstrap_results)
```

```
## Warning: Using 'size' aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use 'linewidth' instead.
## This warning is displayed once every 8 hours.
## Call 'lifecycle::last_lifecycle_warnings()' to see where this warning was
## generated.
```