Final Project (Group 2)

Group 2

2024-05-17

- 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?

- 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"
```

```
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"
```

```
  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

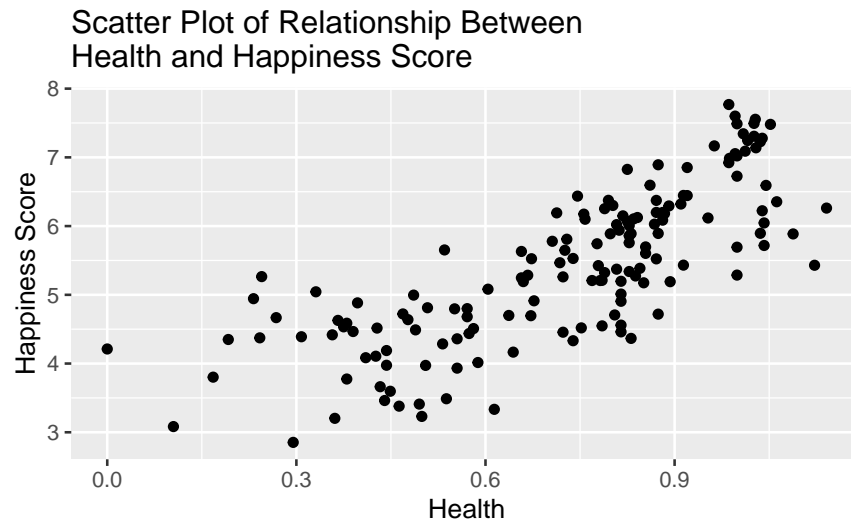[Module 2: Junhyung Kim, Jiho Lee]

*Scatter Plot

```
data %>%
ggplot() +
geom_point(mapping = aes (x = Economy, y= Happiness_Score)) +
labs(title =
       "Scatter Plot of Relationship Between
Economy and Happiness Score",
x = "Economy", y = "Happiness Score")
```

Scatter Plot of Relationship Between Economy and Happiness Score


```r
data %>%
ggplot() +
geom_point(mapping = aes (x = Social, y= Happiness_Score)) +
labs(title =
        "Scatter Plot of Relationship Between
Social and Happiness Score",
x = "Social", y = "Happiness Score")
```
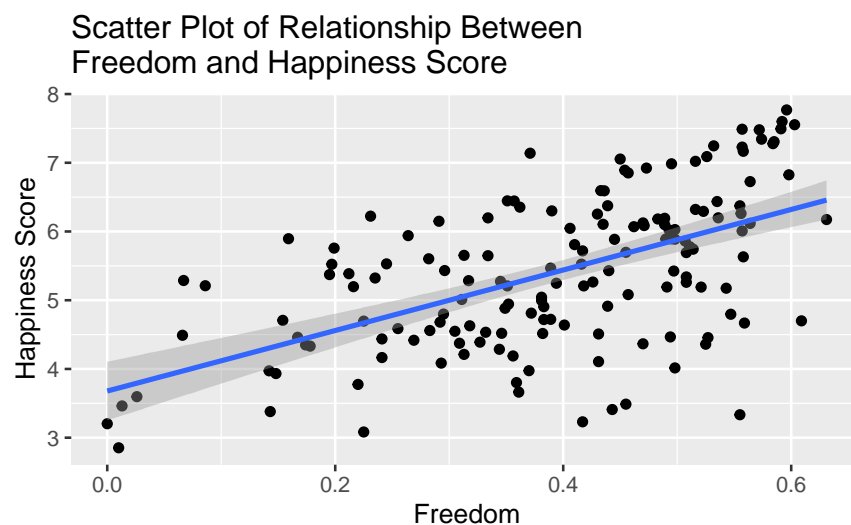
Scatter Plot of Relationship Between Social and Happiness Score


```r
data %>%
ggplot() +
geom_point(mapping = aes (x = Health, y= Happiness_Score)) +
labs(title =
        "Scatter Plot of Relationship Between
Health and Happiness Score",
x = "Health", y = "Happiness Score")
```
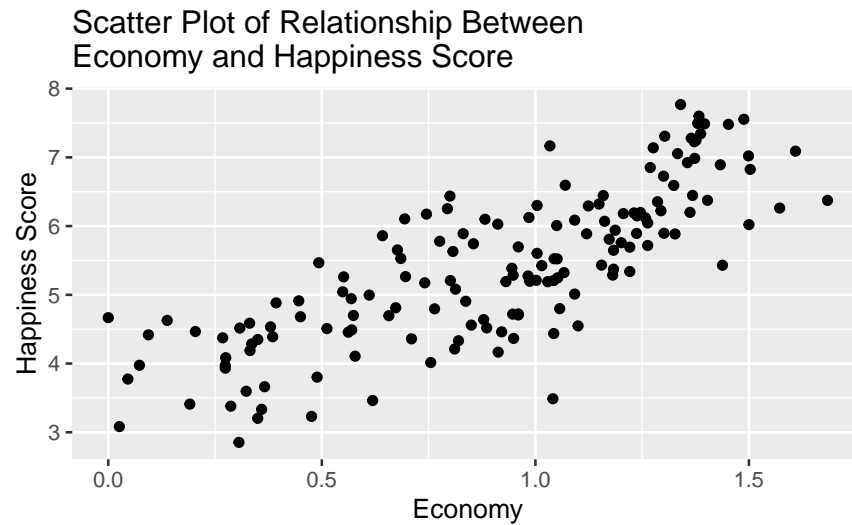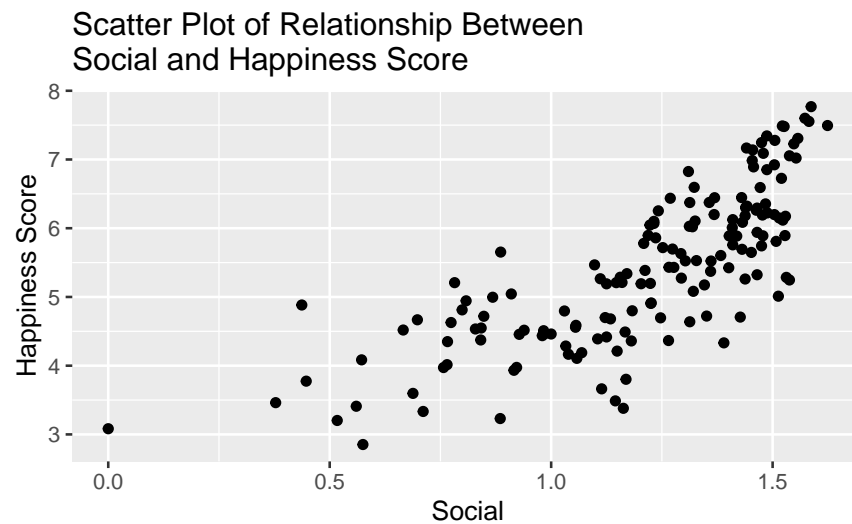
Scatter Plot of Relationship Between Health and Happiness Score

```
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'

Scatter Plot of Relationship Between Freedom and Happiness Score

```
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 = "Happiness Score")
```

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

Scatter Plot of Relationship Between
Corruption and Happiness Score
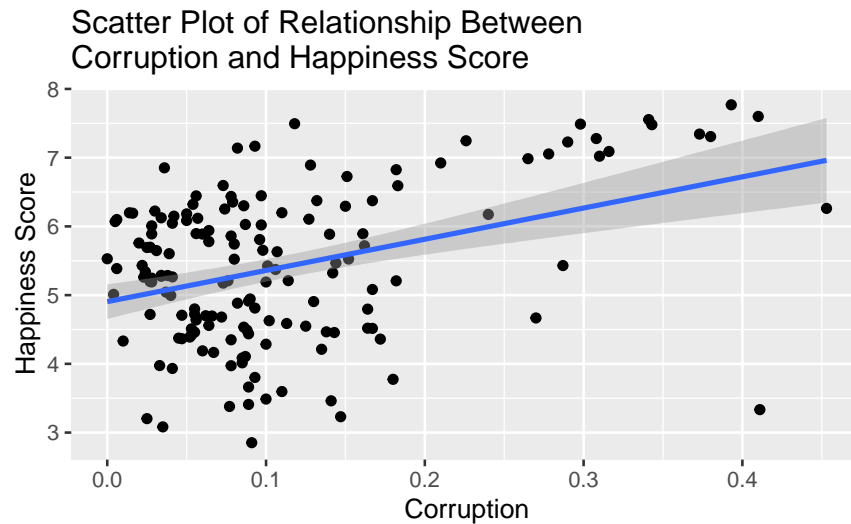

```r
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Economy, y = Happiness_Score)) +
  labs(x = "Economy", y = "Happiness Score",
       title="Trend line relationship between
       Economy vs Happiness Score")
```
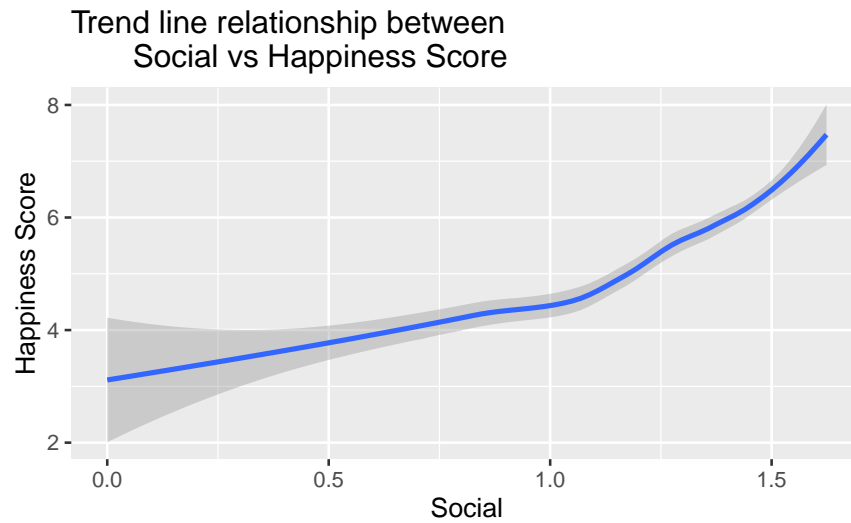
```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```

Trend line relationship between
Economy vs Happiness Score
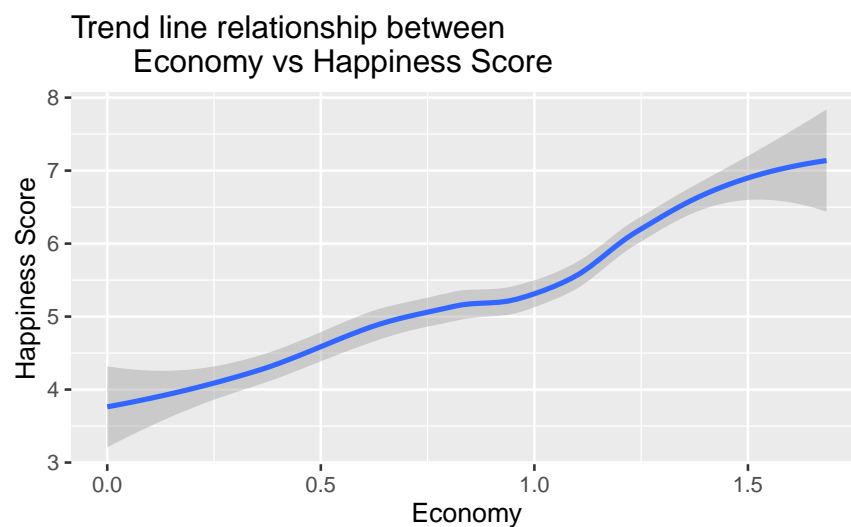

```r
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Social, y = Happiness_Score)) +
```
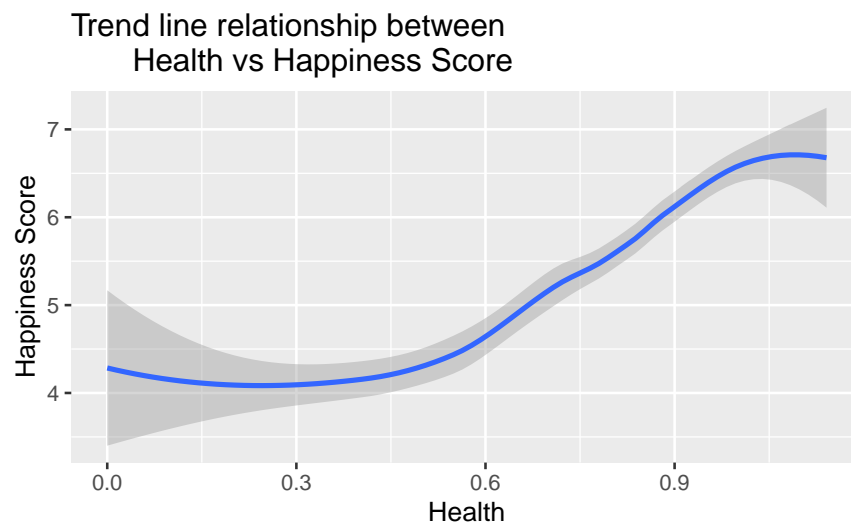
```
    labs(x = "Social", y = "Happiness Score",
         title="Trend line relationship between
         Social vs Happiness Score")
```

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

Trend line relationship between
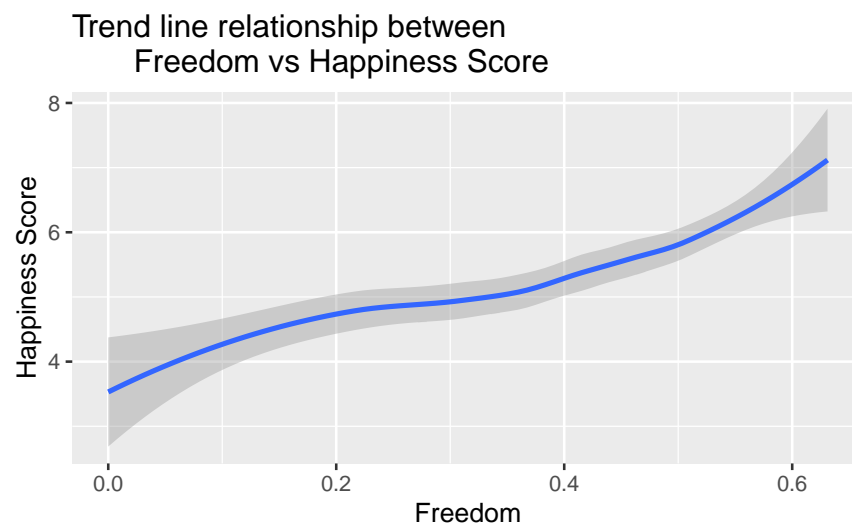Social vs Happiness Score

```
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'

Trend line relationship between
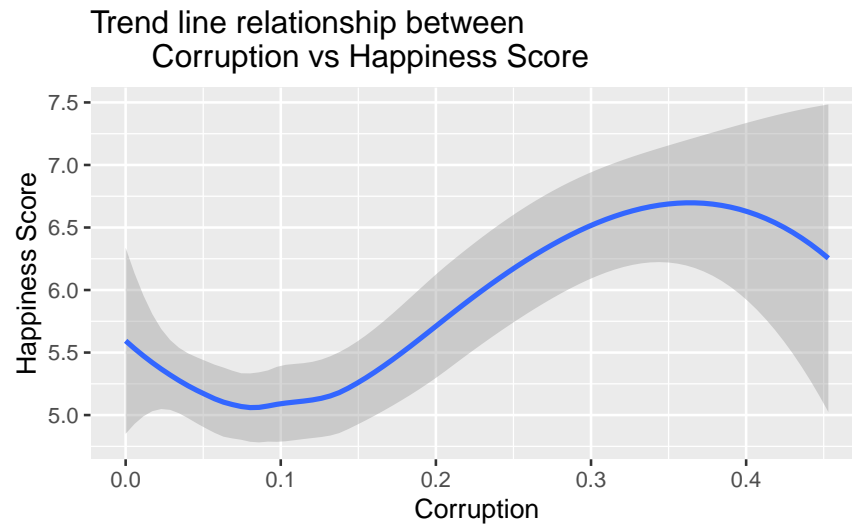Health vs Happiness Score

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```
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'

Trend line relationship between
Freedom vs Happiness Score

```
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'

## Trend line relationship between Corruption vs Happiness Score

*HeatMap

```
data %>%
ggplot() +
geom_bin2d(mapping = aes(x = Economy, y = Happiness_Score)) +
labs(title = "HeatMap (Economy and Happiness Score)",x= "Economy",
     y= "Happiness_Score")
```

HeatMap (Economy and Happiness Score)


```
data %>%
ggplot() +
geom_bin2d(mapping = aes(x = Social, y = Happiness_Score)) +
labs(title = "HeatMap (Social and Happiness Score)",x= "Social",
     y= "Happiness_Score")
```

HeatMap (Social and Happiness Score)
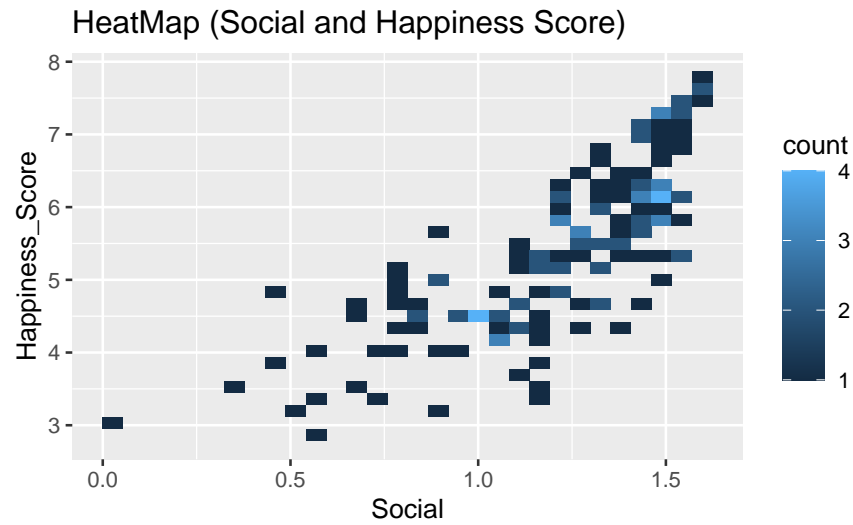
```
data %>%
ggplot() +
geom_bin2d(mapping = aes(x = Health, y = Happiness_Score)) +
labs(title = "HeatMap (Health and Happiness Score)",x= "Health",
     y= "Happiness_Score")
```


HeatMap (Health and Happiness Score)

```
data %>%
ggplot() +
geom_bin2d(mapping = aes(x = Freedom, y = Happiness_Score)) +
labs(title = "HeatMap (Freedom and Happiness Score)",x= "Freedom",
     y= "Happiness_Score")
```
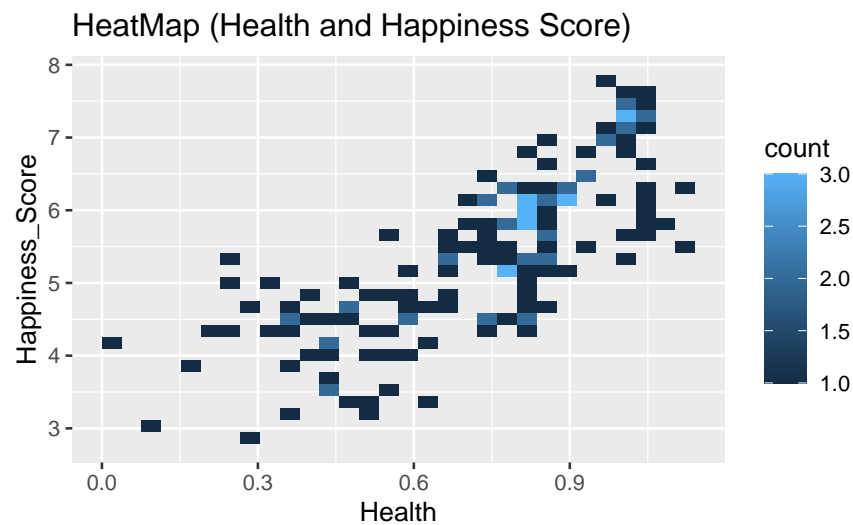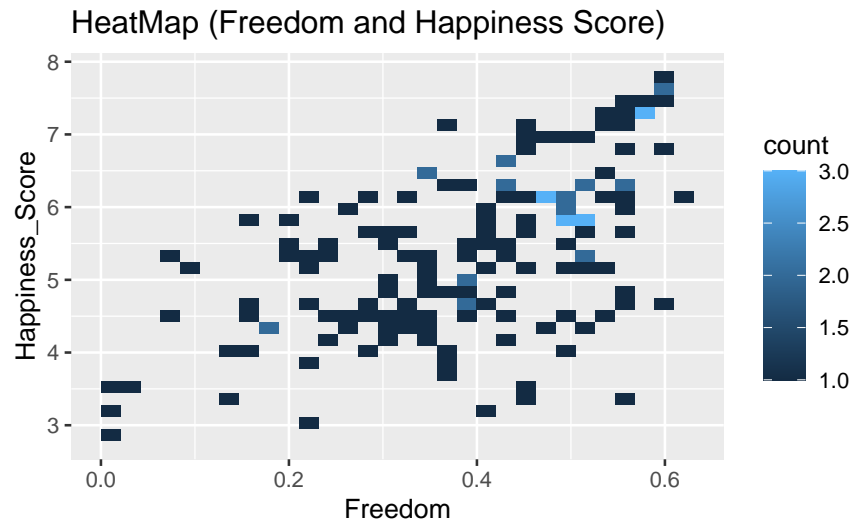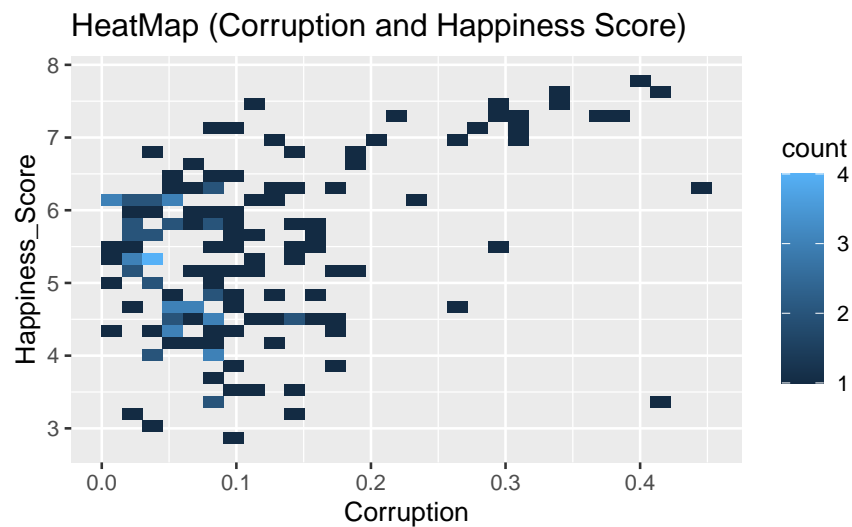
HeatMap (Freedom and Happiness Score)

```
data %>%
ggplot() +
geom_bin2d(mapping = aes(x = Corruption, y = Happiness_Score)) +
labs(title = "HeatMap (Corruption and Happiness Score)",x= "Corruption",
     y= "Happiness_Score")
```


HeatMap (Corruption and Happiness Score)

```
data %>%
pivot_longer(cols = Economy:Corruption, names_to = "Variable",
             values_to = "value") %>%
ggplot() +
geom_bin2d(mapping = aes(x = value, y = Happiness_Score)) +
labs(title = "HeatMap between Variables and Happiness Score",
     x= "Variables") +
facet_wrap(~ Variable, scales = "free_x")
```

HeatMap between Variables and Happiness Score
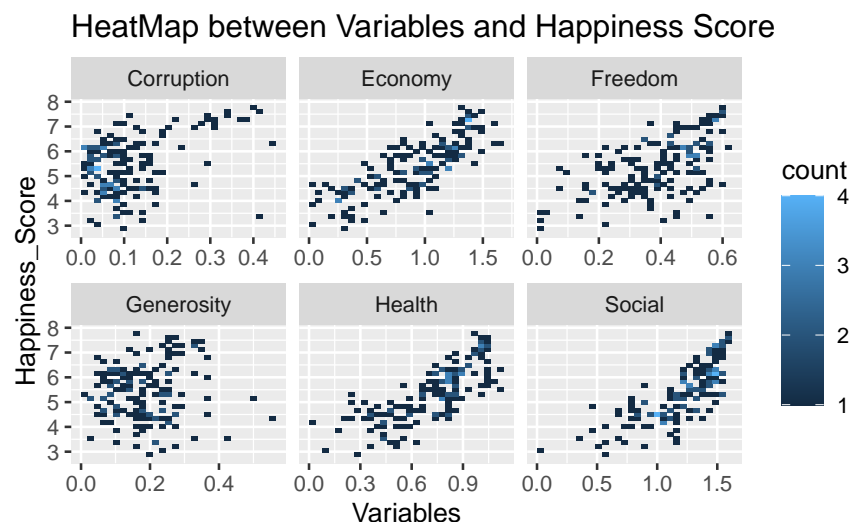
======= [Module 4: Eugene Kim, Harold Lee - Explanatory Data Analysis]

```r
str(data)
```

```
## tibble [156 x 9] (S3: tbl_df/tbl/data.frame)
##  $ Overall rank     : num [1:156] 1 2 3 4 5 6 7 8 9 10 ...
##  $ Country or region: chr [1:156] "Finland" "Denmark" "Norway" "Iceland" ...
##  $ Happiness_Score  : num [1:156] 7.77 7.6 7.55 7.49 7.49 ...
##  $ Economy          : num [1:156] 1.34 1.38 1.49 1.38 1.4 ...
##  $ Social           : num [1:156] 1.59 1.57 1.58 1.62 1.52 ...
##  $ Health           : num [1:156] 0.986 0.996 1.028 1.026 0.999 ...
##  $ Freedom          : num [1:156] 0.596 0.592 0.603 0.591 0.557 0.572 0.574 0.585 0.584 0.53
##  $ Generosity       : num [1:156] 0.153 0.252 0.271 0.354 0.322 0.263 0.267 0.33 0.285 0.244
##  $ Corruption       : num [1:156] 0.393 0.41 0.341 0.118 0.298 0.343 0.373 0.38 0.308 0.226
```

```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

```
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")
```
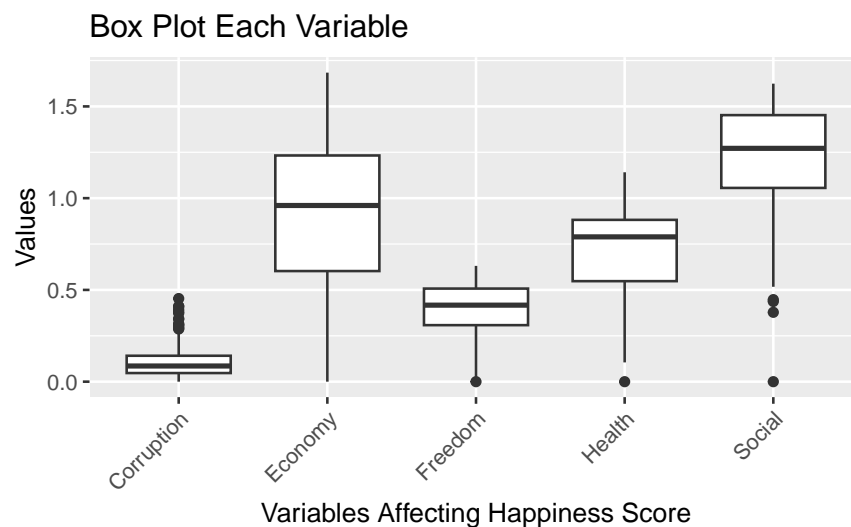

*Violin Plot

```
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")
```


Violin Plot of Each Variable
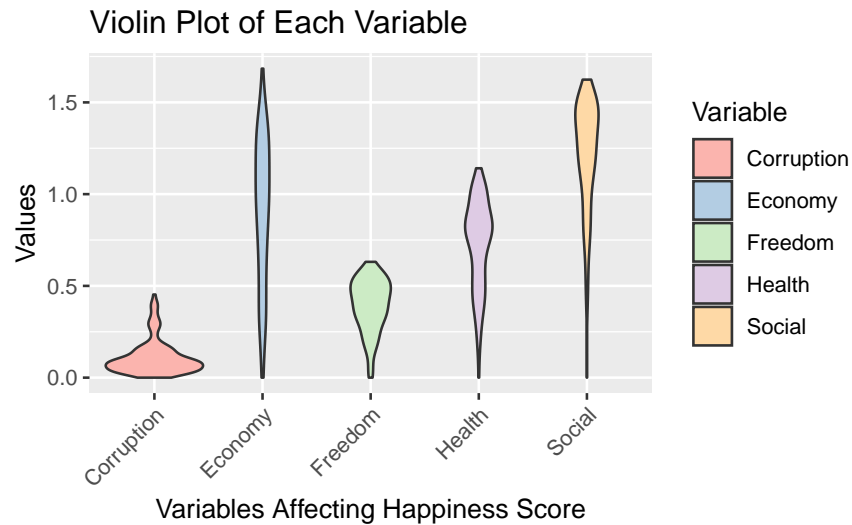
*Summary

```
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),
```

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```
    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

[Module 5: Chun Jin Park - Modeling].

linear model using lm

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

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")
```

Observed vs Predicted Happiness Score
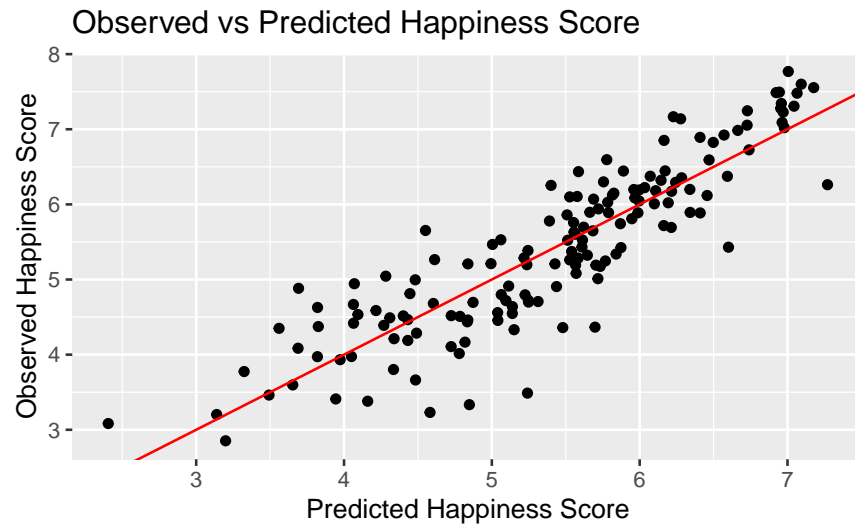
Residuals vs Predicted plot

```
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")
```


Residuals vs Predicted Happiness Score
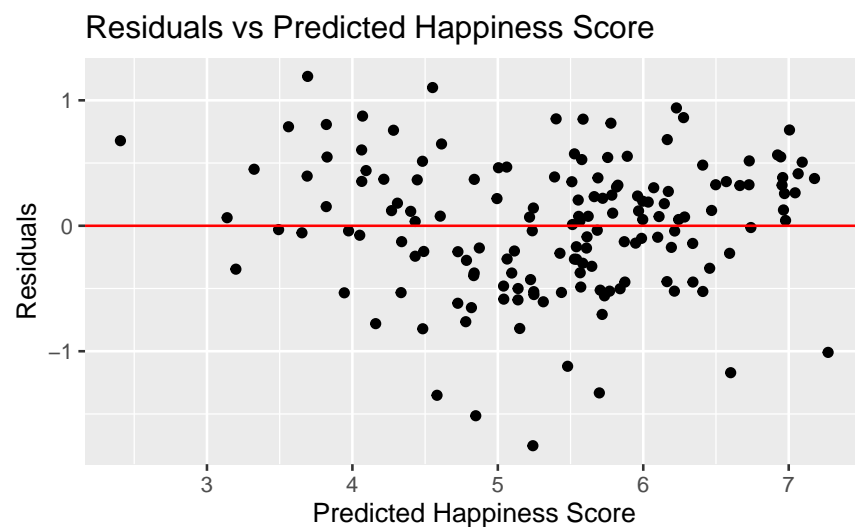
Q-Q plot

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

Normal Q–Q Plot
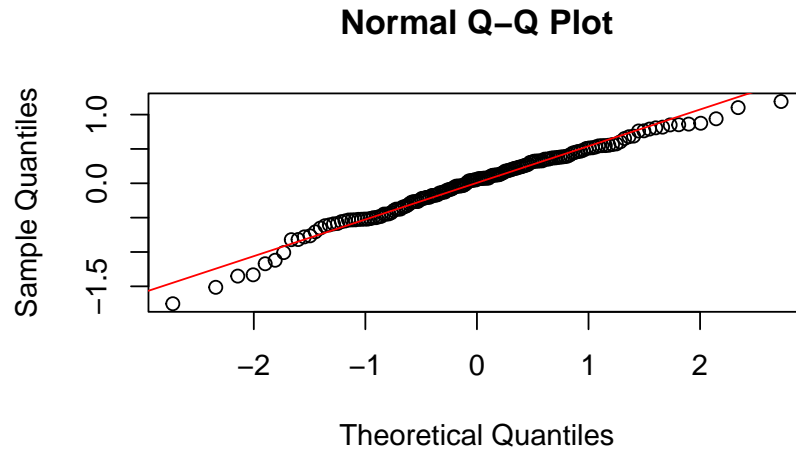
======= [Module 6: SeNa Julsdorf, Hyeongseok Sim]

```
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 of Happiness Score
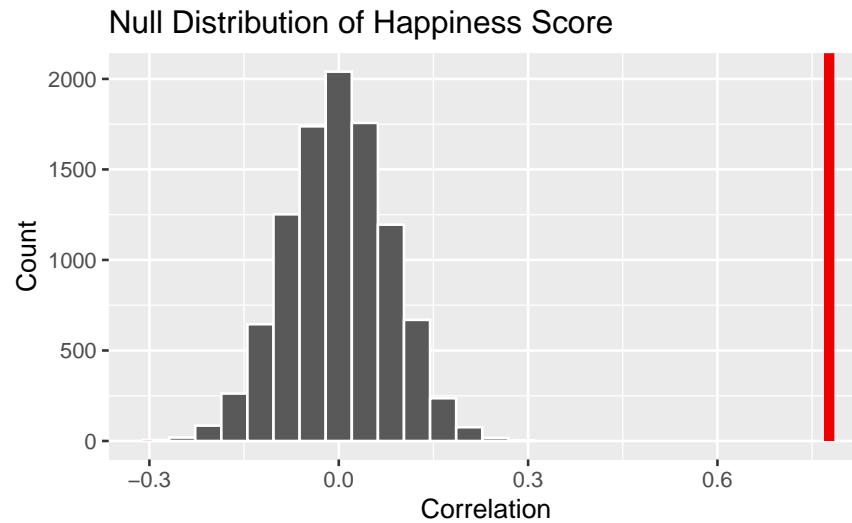

```
null_distribution_correlation %>%
  ggplot +
  geom_density(mapping = aes(x = stat), adjust = 5) +
  labs(title = "Null Hypothesis Density Plot", x = "stats", y = "density")
```

Null Hypothesis Density Plot
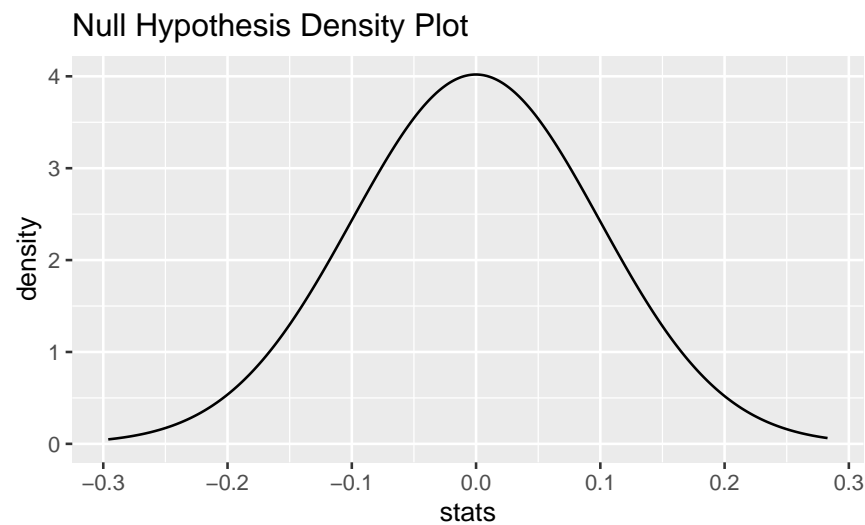

```
null_distribution_correlation %>%
  ggplot() +
  geom_histogram(mapping = aes(x = stat), bins = 10) +
  geom_density(mapping = aes(x = stat), adjust = 10) +
  labs(title = "Null Hypothesis Density Plot", x = "stats", y = "density")
```

Null Hypothesis Density Plot
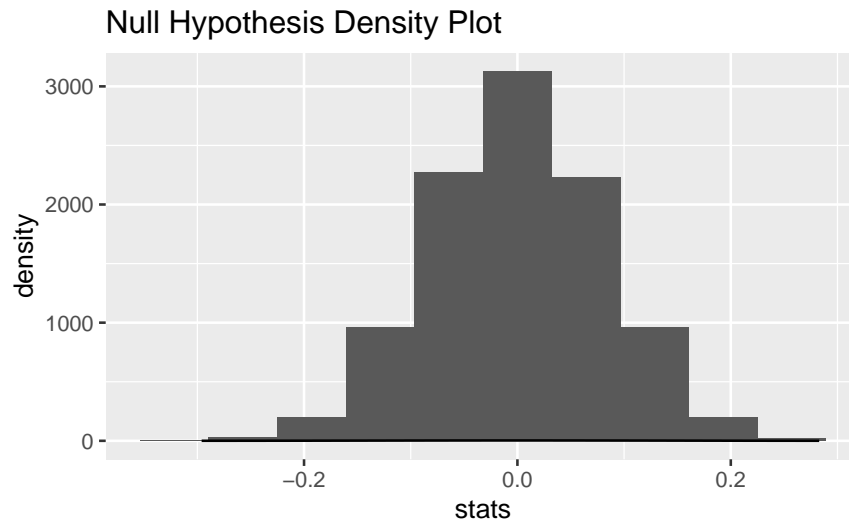

```
null_distribution_correlation %>%
ggplot()+
geom_histogram(mapping = aes(x = stat, y = ..density..), bins = 10) +
geom_density(mapping = aes(x = stat), adjust = 5) +
labs(title = "Density and Null Hypothesis PMF Plot",
x = "Stat", y = "Density")
```

```
## 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.
```

Density and Null Hypothesis PMF Plot
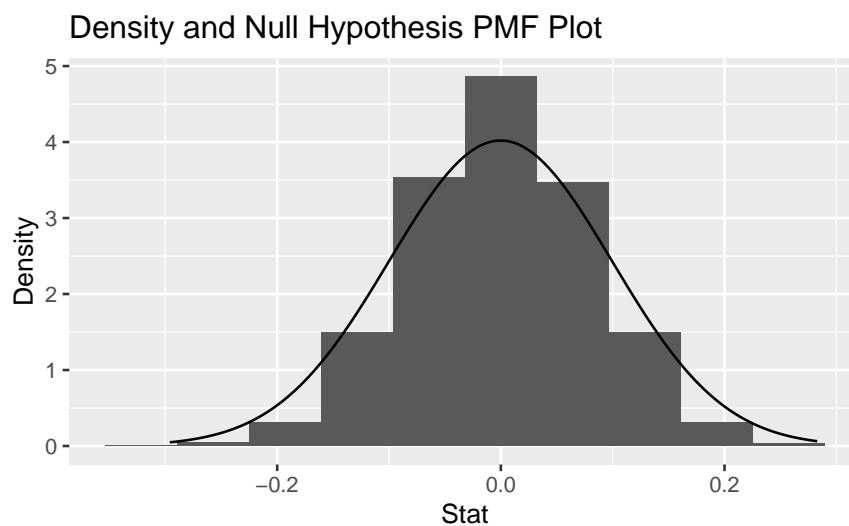
======= [Module 7: Jeonghwa Cho]

```
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
0.7209977	0.8262252

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