Final Project (Group 2)

Group 2

2024-05-20

«««< 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

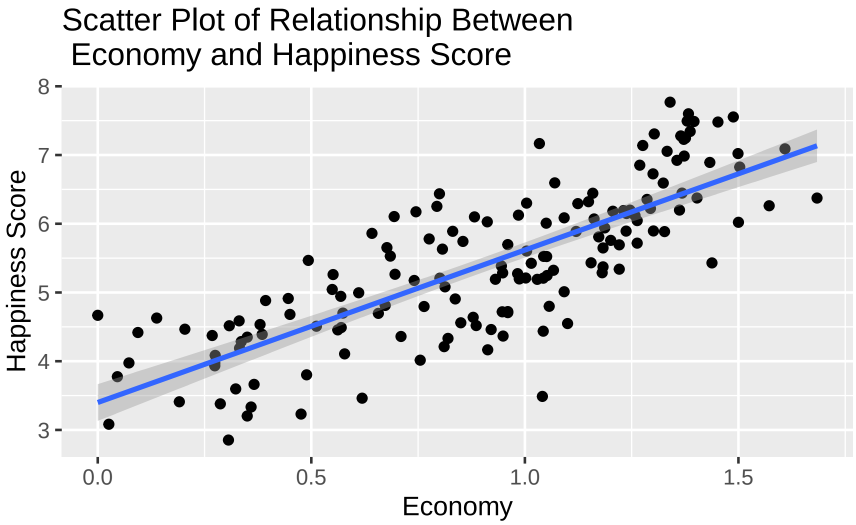
[Module 2: Junhyung Kim, Jiho Lee]

*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.
```

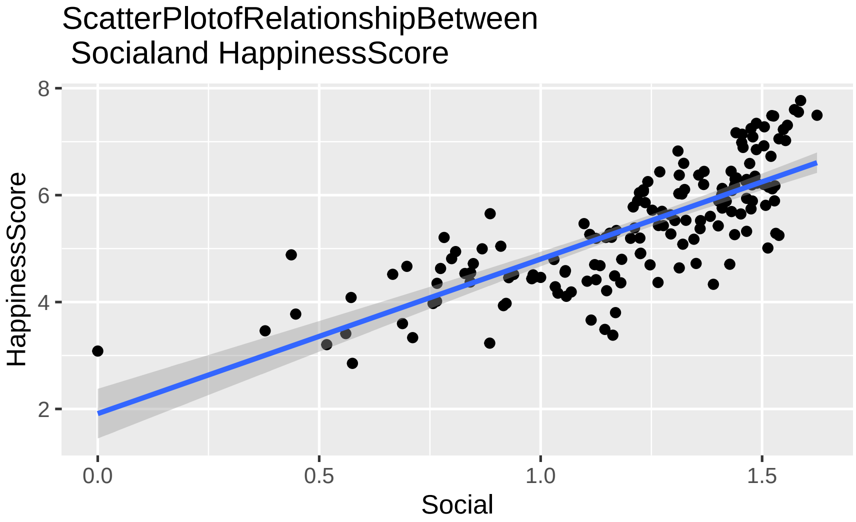
```
## Warning in geom_point(method = "lm"): Ignoring unknown parameters: ‘method‘
## ‘geom_smooth()‘ using formula = ’y ~ x’
```



```
qplot(x= Social,y=Happiness_Score,data=data,
geom=c("point","smooth"),method="lm")+
labs(title =
"ScatterPlotofRelationshipBetween
Socialand HappinessScore",
x="Social",y="HappinessScore")
```

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

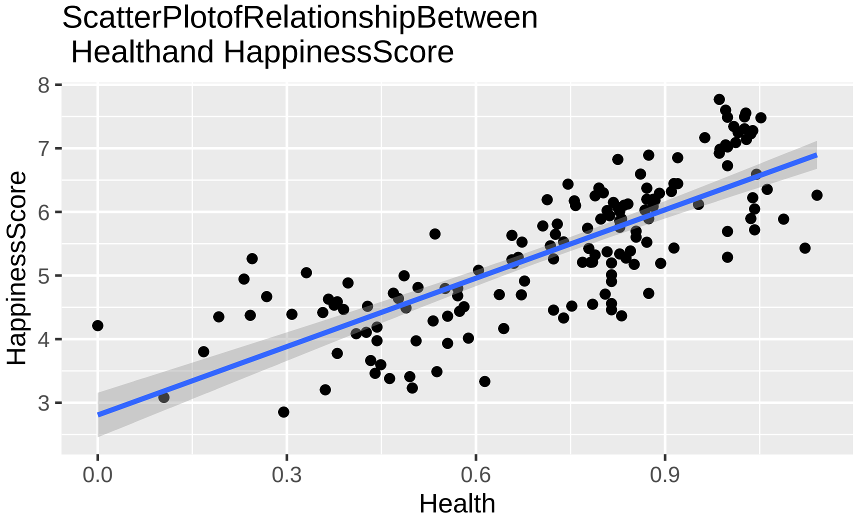
```
## ‘geom_smooth()‘ using formula = ’y ~ x’
```



```
qplot(x= Health,y=Happiness_Score,data=data,
 geom=c("point","smooth"),method="lm")+
 labs(title =
 "ScatterPlotofRelationshipBetween
 Healthand HappinessScore",
 x="Health",y="HappinessScore")
```

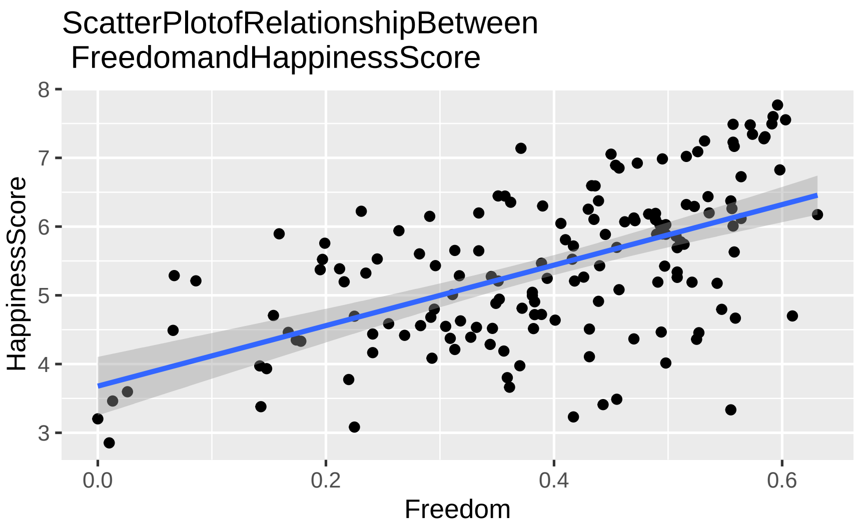
```
## Warning in geom_point(method = "lm"): Ignoring unknown parameters: ‘method‘
```

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



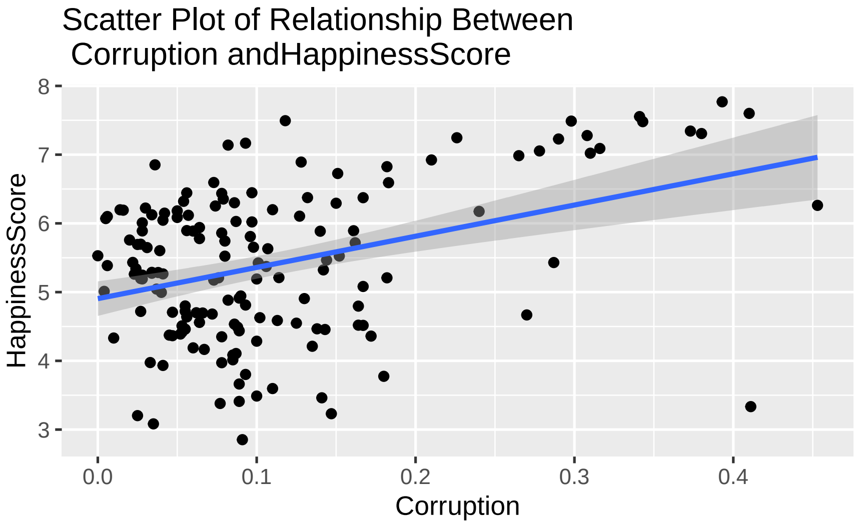
```
qplot(x= Freedom,y=Happiness_Score,data=data,
 geom=c("point","smooth"),method="lm")+
 labs(title =
 "ScatterPlotofRelationshipBetween
 FreedomandHappinessScore",
 x="Freedom",y="HappinessScore")
```

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



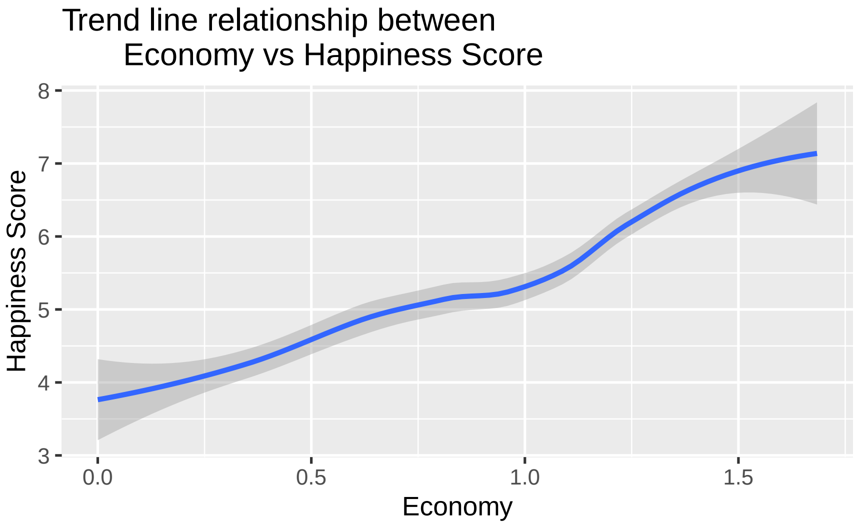
```
qplot(x= Corruption,y=Happiness_Score,data=data,
geom=c("point","smooth"),method="lm")+
labs(title ="Scatter Plot of Relationship Between
Corruption andHappinessScore",
x="Corruption",y="HappinessScore")
```

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



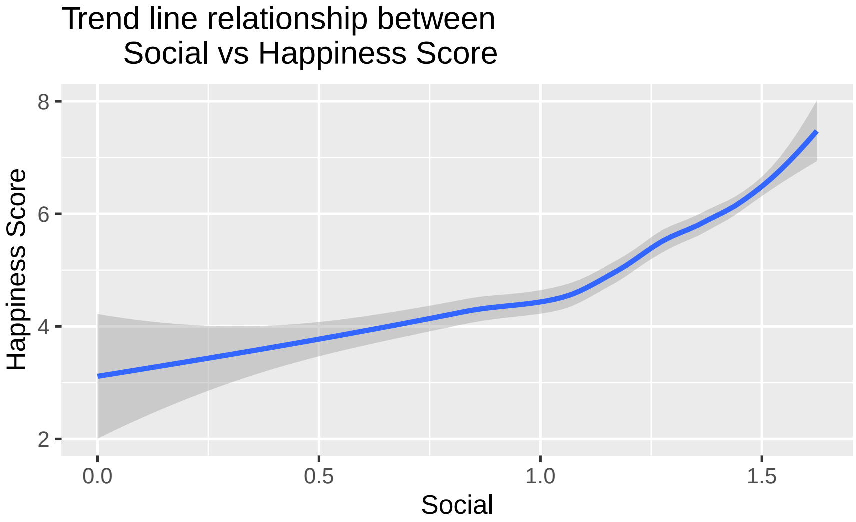
```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Economy, y = Happiness_Score)) +
  labs(x = "Economy", y = "Happiness Score",
       title="Trend line relationship between
       Economy vs Happiness Score")
```

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



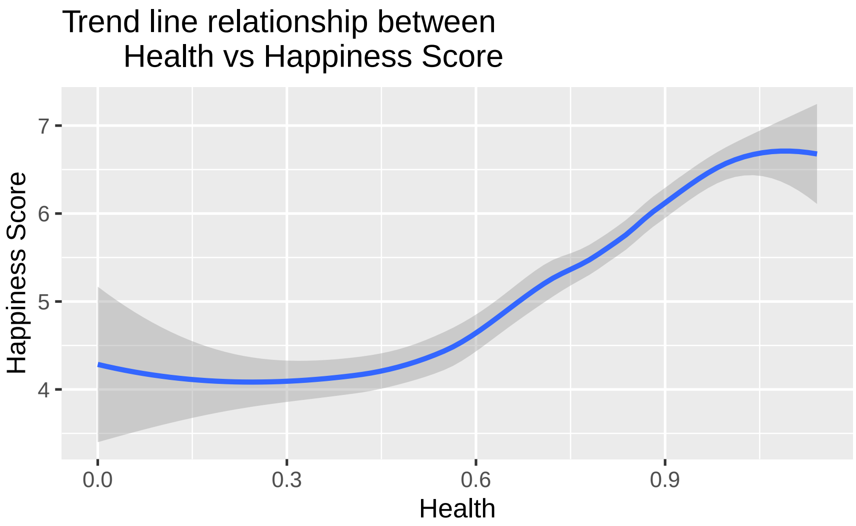
```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Social, y = Happiness_Score)) +
  labs(x = "Social", y = "Happiness Score",
       title="Trend line relationship between
       Social vs Happiness Score")
```

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



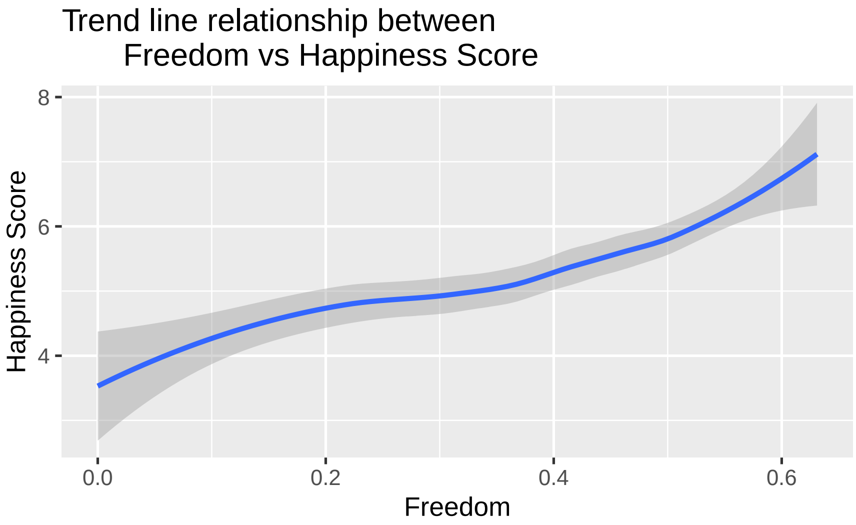
```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Health, y = Happiness_Score)) +
  labs(x = "Health", y = "Happiness Score",
       title="Trend line relationship between
       Health vs Happiness Score")
```

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



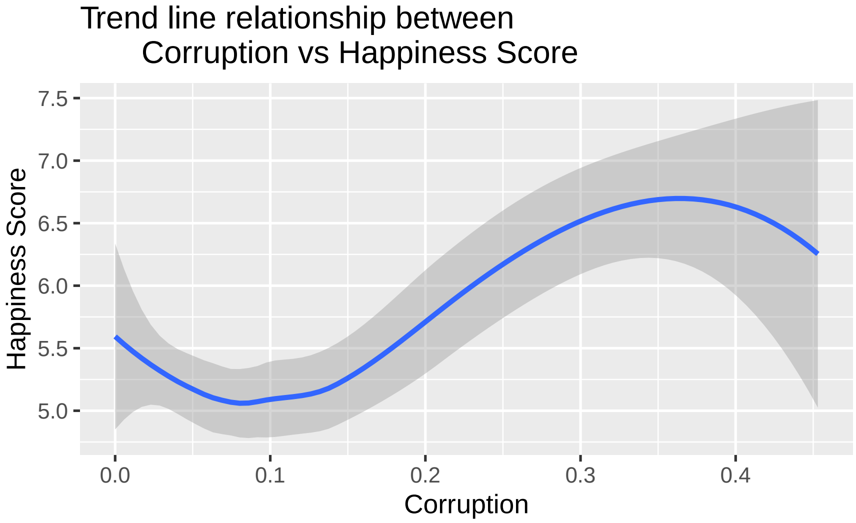
```
data %>%
  ggplot() +
  geom_smooth(mapping = aes(x = Freedom, y = Happiness_Score)) +
  labs(x = "Freedom", y = "Happiness Score",
       title="Trend line relationship between
       Freedom vs Happiness Score")
```

```
## ‘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")
```

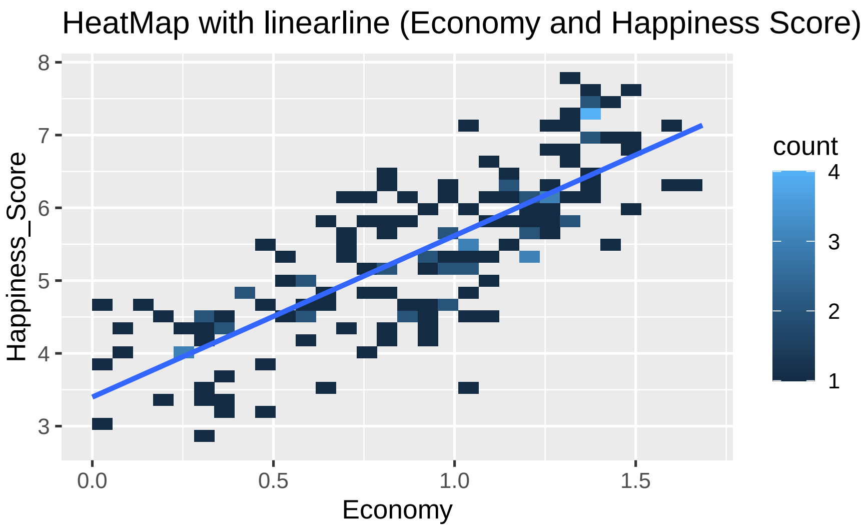
```
## `geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```



*HeatMap

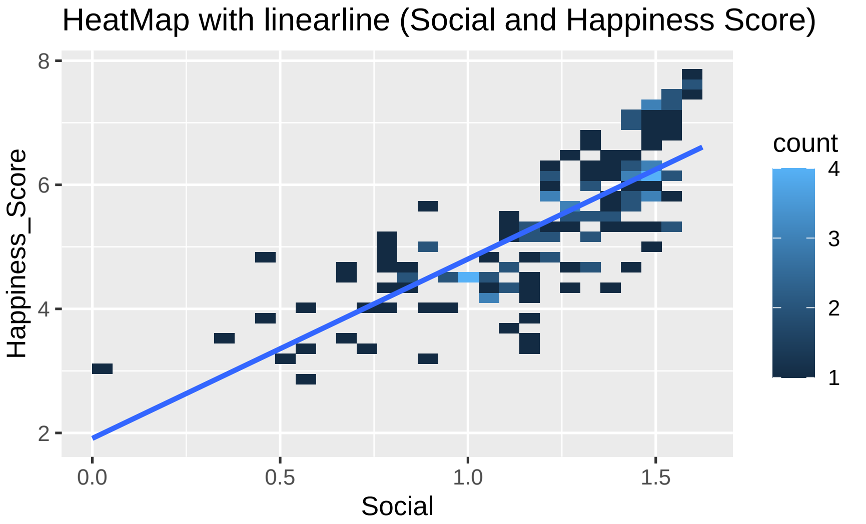
```
data %>%
ggplot(aes(x = Economy, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "HeatMap with linearline (Economy and Happiness Score)",
          x = "Economy", y = "Happiness_Score")
```

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



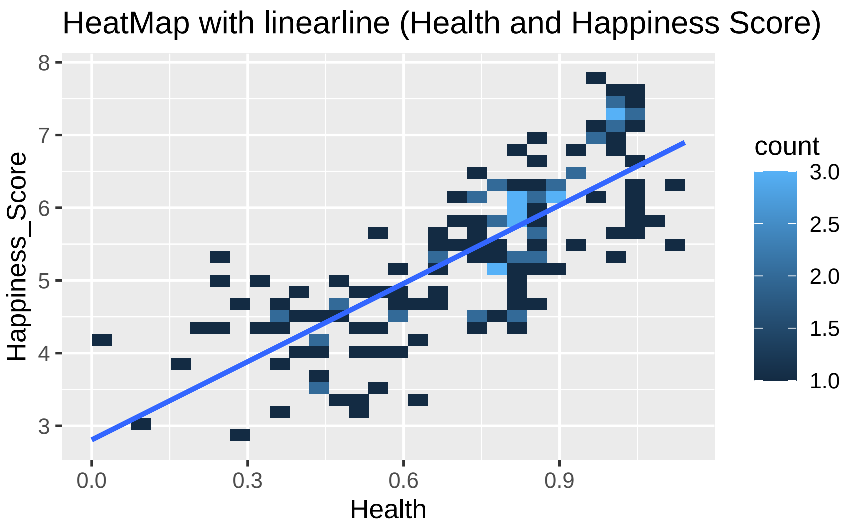
```
data %>%
ggplot(aes(x = Social, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "HeatMap with linearline (Social and Happiness Score)",
           x = "Social", y = "Happiness_Score")
```

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



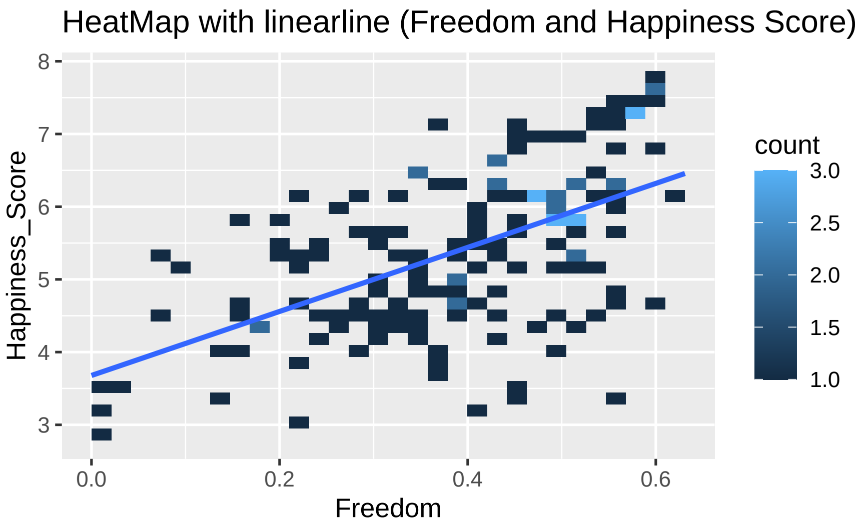
```
data %>%
ggplot(aes(x = Health, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "HeatMap with linearline (Health and Happiness Score)",
           x = "Health", y = "Happiness_Score")
```

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



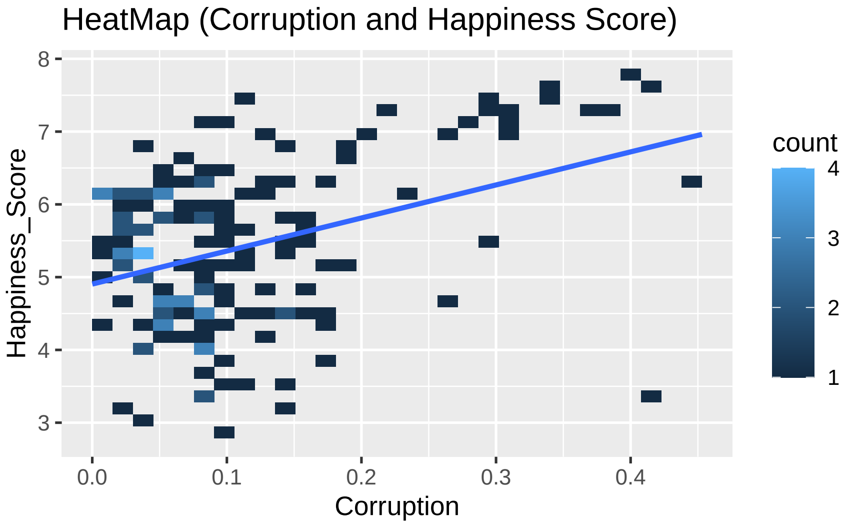
```
data %>%
ggplot(aes(x = Freedom, y = Happiness_Score)) +
  geom_bin2d(bins = 30) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "HeatMap with linearline (Freedom and Happiness Score)",
           x = "Freedom", y = "Happiness_Score")
```

```
## `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 (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

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

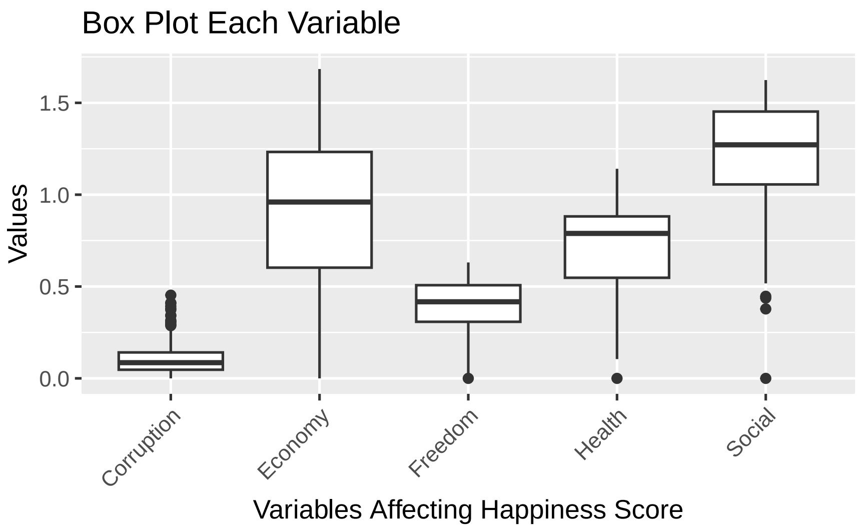
Economy	Social	Health	Freedom	Corruption	Happiness_Score
0.287	1.163	0.463	0.143	0.077	3.380
0.359	0.711	0.614	0.555	0.411	3.334
0.476	0.885	0.499	0.417	0.147	3.231
0.350	0.517	0.361	0.000	0.025	3.203
0.026	0.000	0.105	0.225	0.035	3.083
0.306	0.575	0.295	0.010	0.091	2.853

*Summary statistics

*Box Plot

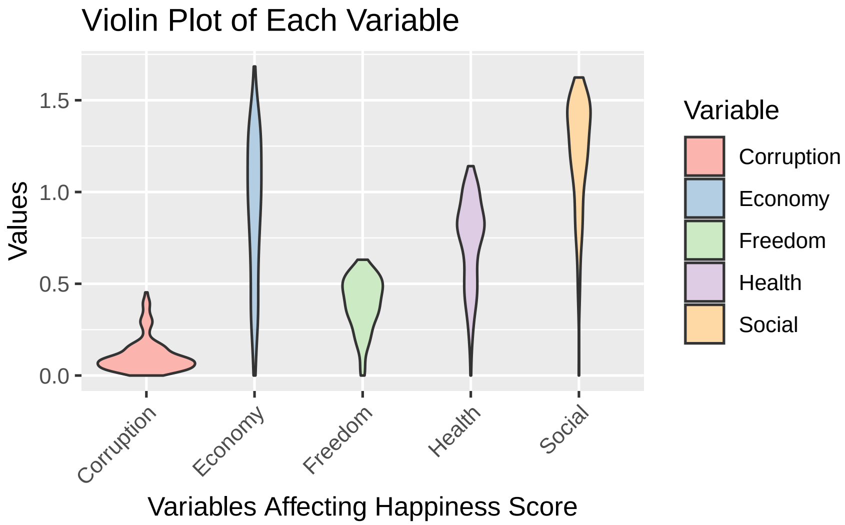
```r
data_long <- data %>%
  gather(key = "Variable", value = "Score", Economy, Social, Health,
         Freedom, Corruption)

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),
```

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

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

```r
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

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

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

```r
data_H <- data %>%
 summarize(
  mean= mean(Health),
  median = median(Health),
  max = max(Health),
  iqr = IQR(Health)
)
```

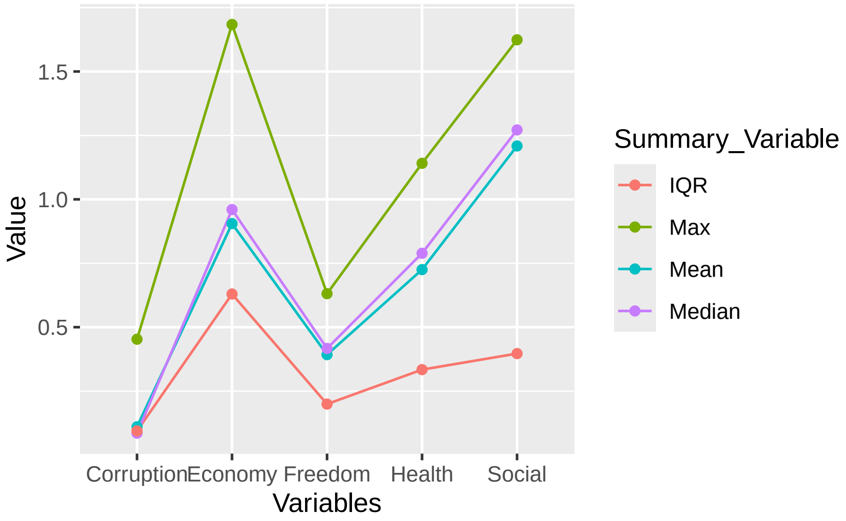
```r
data_F <- data %>%
  summarize(
    mean= mean(Freedom),
    median = median(Freedom),
    max = max(Freedom),
    iqr = IQR(Freedom)
 )
```

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

```r
combined_data <- rbind(data_E, data_S, data_H, data_F, data_C)
combined_data$c <- c('Economy', 'Social', 'Health', 'Freedom', 'Corruption')
colnames(combined_data) <- c("Mean", "Median", "Max", "IQR", "Variables")
```

```r
group_data2 <- combined_data %>%
 pivot_longer(cols = Mean:IQR, names_to = "Summary_Variable" , values_to = "Value")
```

```r
ggplot(data=group_data2, aes(x=Variables, y=Value, group=Summary_Variable)) +
  geom_line(aes(color=Summary_Variable)) +
  geom_point(aes(color=Summary_Variable))
```



[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
```

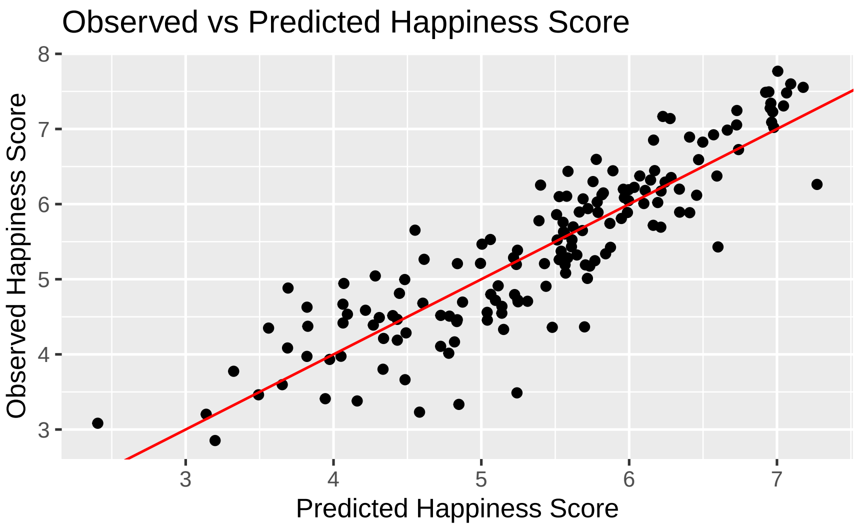
glance to get the model's performance metrics

```
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>
```

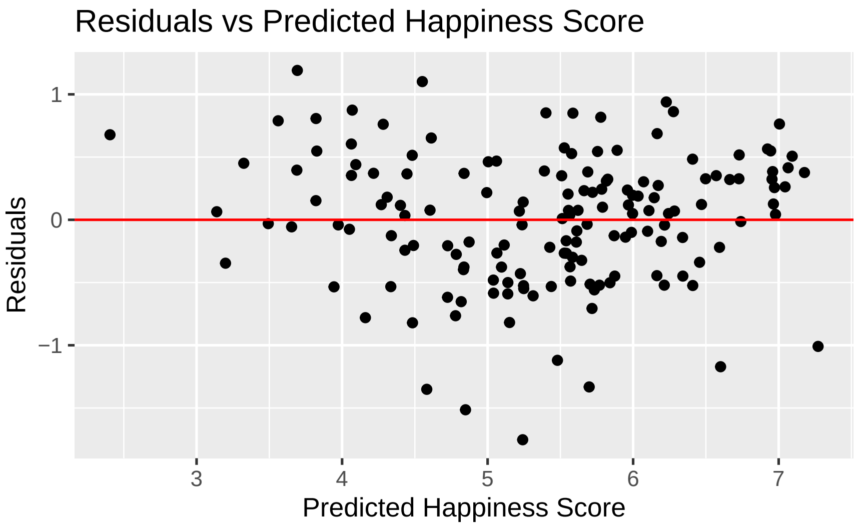
Observed vs Predicted plot

```
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")
```



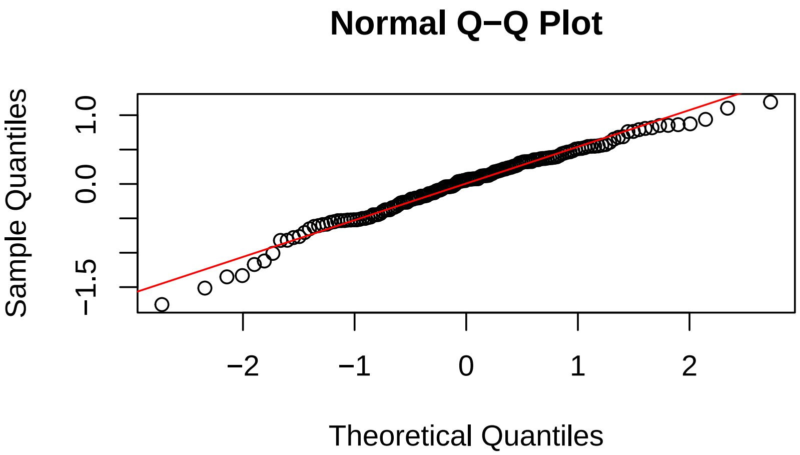
Residuals vs Predicted plot

```
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")
```



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======= [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")
```

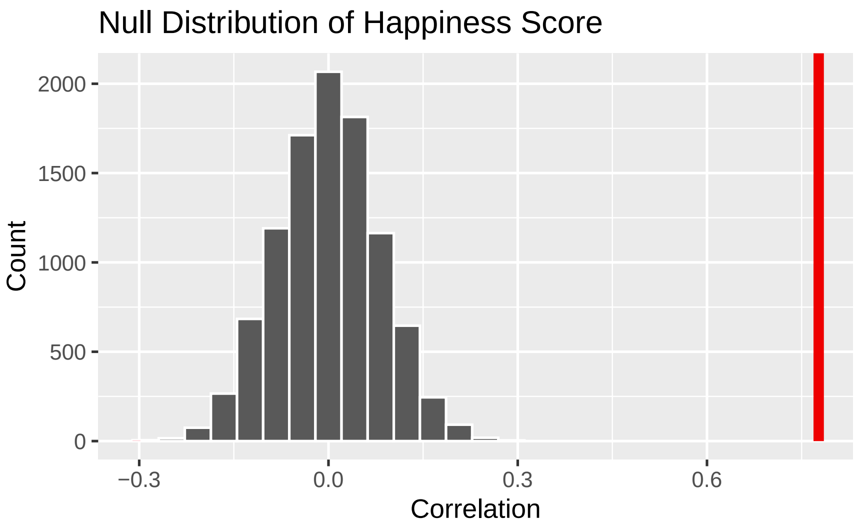
```
p_value <- null_distribution_correlation %>%
  get_p_value(obs_stat = happiness_obs_stat, direction = "both")
```

```
## 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.
```

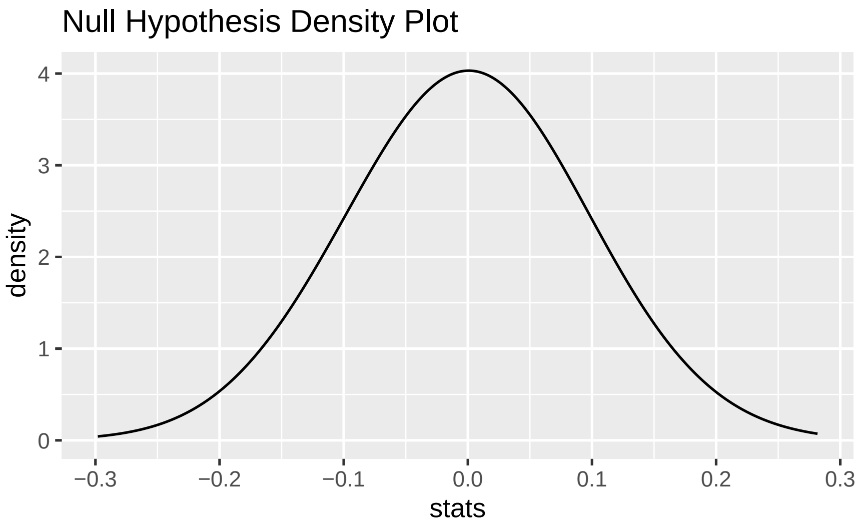
```
print(p_value)
```

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

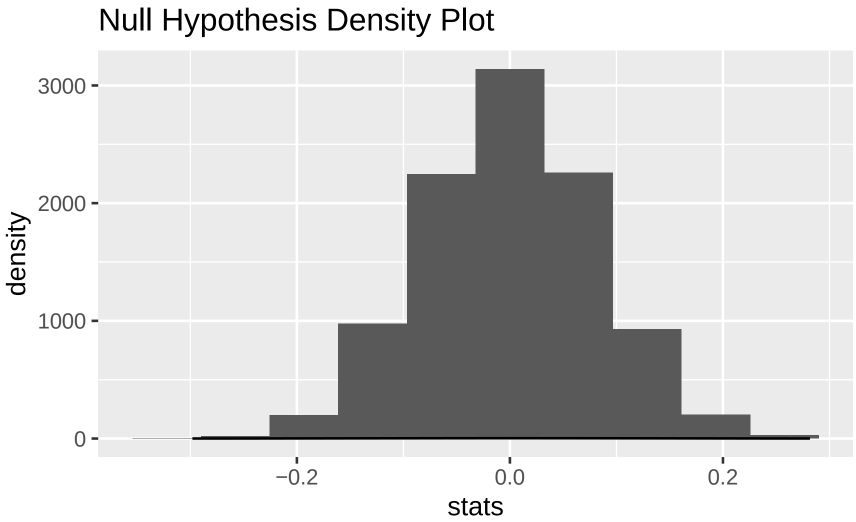
```
visualize(null_distribution_correlation) +
  shade_p_value(obs_stat = happiness_obs_stat, direction = "two_sided") +
    labs(title = "Null Distribution of Happiness Score", x = "Correlation", y = "Count")
```



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



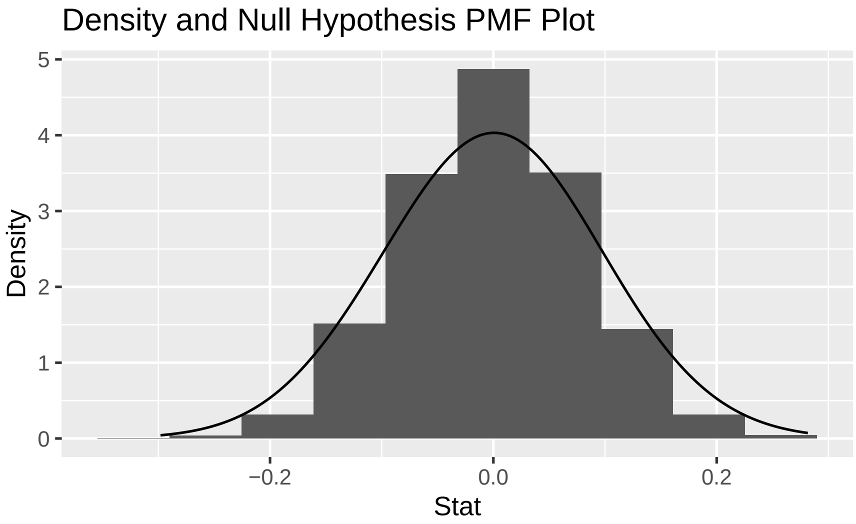
```
null_distribution_correlation %>%
  ggplot() +
  geom_histogram(mapping = aes(x = stat), bins = 10) +
  geom_density(mapping = aes(x = stat), adjust = 10) +
  labs(title = "Null Hypothesis Density Plot", x = "stats", y = "density")
```



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

```r
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]

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

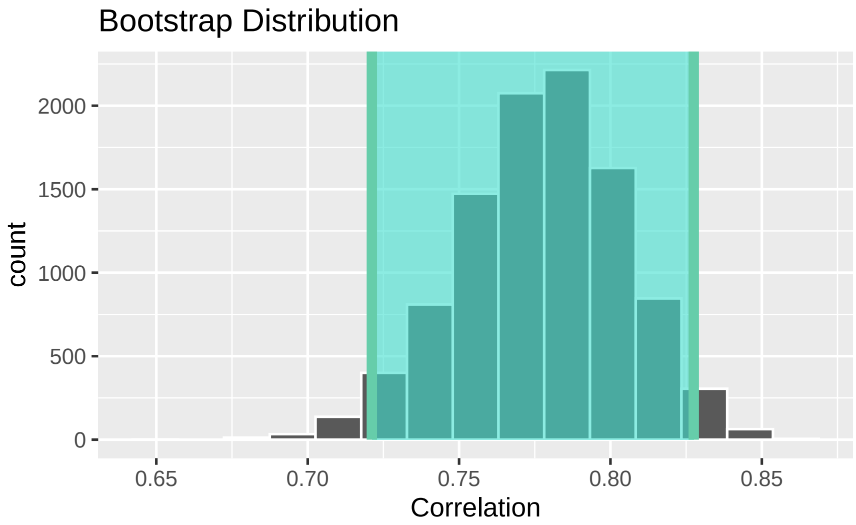
```r
bootstrap_ci <- bootstraps_distribution_correlation %>%
get_confidence_interval()
```

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

```r
bootstrap_ci
```

lower_ci	upper_ci
0.7211866	0.8275057

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



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

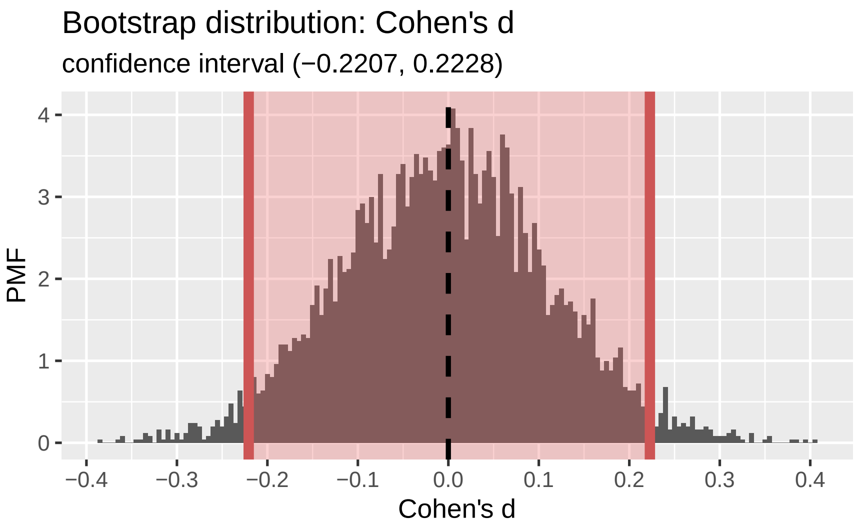
```
bootstrap_report(bootstrap_results)
```

```
## 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.
```


Bootstrap distribution: Cohen's d
confidence interval (−0.2207, 0.2228)
PMF
Cohen's d