Excercise2

April 21, 2025

[8]:
```
library(tidyverse)
library(cluster)
```

[9]:
```
set.seed(1)
```

[10]:
```
happiness <- read_csv("/home/asus/content/Notes/Semester 4/FDN Lab/Experiments/
↪Experiment 6/archive(11)/2019.csv")
```

```
Rows: 156 Columns: 9
  Column specification


Delimiter: ","
chr (1): Country
dbl (8): Overall rank, Score, GDP per capita, Social support, Healthy
life e…

 Use `spec()` to retrieve the full column specification for this
data.
 Specify the column types or set `show_col_types = FALSE` to quiet
this message.
```

[11]:
```
head(happiness)
summary(happiness)
```

A tibble: 6 × 9

Overall rank <dbl>	Country <chr>	Score <dbl>	GDP per capita <dbl>	Social support <dbl>	Healthy life expectancy <dbl>
1	Finland	7.769	1.340	1.587	0.986
2	Denmark	7.600	1.383	1.573	0.996
3	Norway	7.554	1.488	1.582	1.028
4	Iceland	7.494	1.380	1.624	1.026
5	Netherlands	7.488	1.396	1.522	0.999
6	Switzerland	7.480	1.452	1.526	1.052

```
  Overall rank      Country               Score       GDP per capita
 Min.   :  1.00   Length:156         Min.   :2.853   Min.   :0.0000
 1st Qu.: 39.75   Class :character   1st Qu.:4.545   1st Qu.:0.6028
 Median : 78.50   Mode  :character   Median :5.380   Median :0.9600
```

```
Mean   : 78.50                     Mean   :5.407   Mean   :0.9051
3rd Qu.:117.25                     3rd Qu.:6.184   3rd Qu.:1.2325
Max.   :156.00                     Max.   :7.769   Max.   :1.6840
Social support  Healthy life expectancy Freedom to make life choices
Min.   :0.000   Min.   :0.0000          Min.   :0.0000
1st Qu.:1.056   1st Qu.:0.5477          1st Qu.:0.3080
Median :1.272   Median :0.7890          Median :0.4170
Mean   :1.209   Mean   :0.7252          Mean   :0.3926
3rd Qu.:1.452   3rd Qu.:0.8818          3rd Qu.:0.5072
Max.   :1.624   Max.   :1.1410          Max.   :0.6310
  Generosity     Perceptions of corruption
Min.   :0.0000   Min.   :0.0000
1st Qu.:0.1087   1st Qu.:0.0470
Median :0.1775   Median :0.0855
Mean   :0.1848   Mean   :0.1106
3rd Qu.:0.2482   3rd Qu.:0.1412
Max.   :0.5660   Max.   :0.4530
```

[12]:
```r
# Filtering out the text cols
features <- c("Overall rank", "Score", "GDP per capita", "Social support",␣
 ↪"Healthy life expectancy", "Freedom to make life choices", "Generosity",␣
 ↪"Perceptions of corruption")

happiness <- happiness %>%
  select(all_of(features)) %>%
  na.omit()
```

[13]:
```r
features <- c("Overall rank", "Score", "GDP per capita", "Social support",␣
 ↪"Healthy life expectancy", "Freedom to make life choices", "Generosity",␣
 ↪"Perceptions of corruption")

happiness_country <- happiness %>%
  select(all_of(features))
```

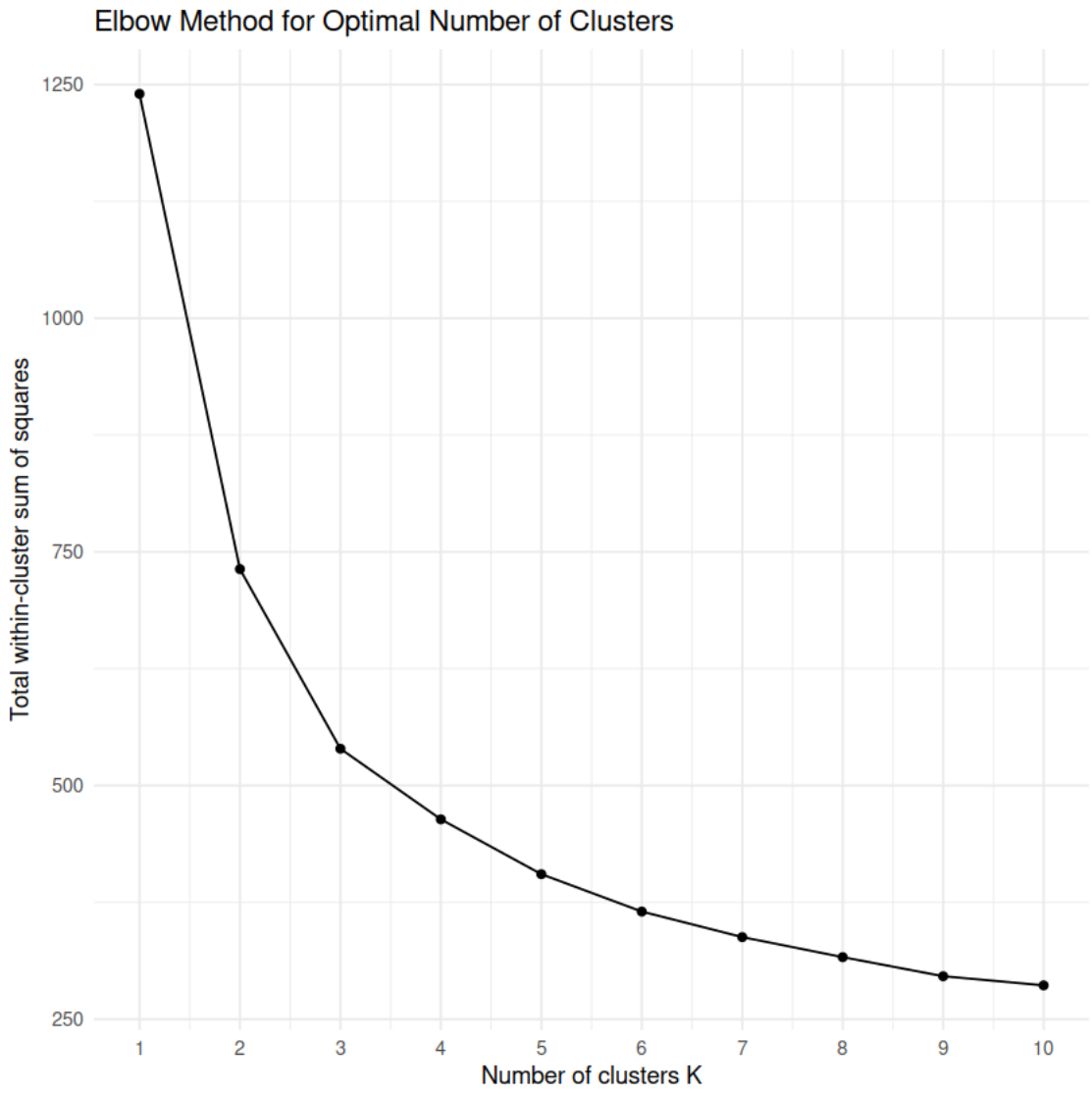
[14]:
```r
#SCAAAAAAAAAAAAAAAALIng
happiness_scaled <- scale(happiness)
```

[15]:
```r
# total within-cluster sum of squares
wss <- function(k) {
  kmeans(happiness_scaled, k, nstart = 10)$tot.withinss
}
```

[16]:
```r
k_values <- 1:10
wss_values <- map_dbl(k_values, wss)
```

[17]:
```r
ggplot(data.frame(k = k_values, wss = wss_values), aes(k, wss)) +
  geom_line() + geom_point() +
```

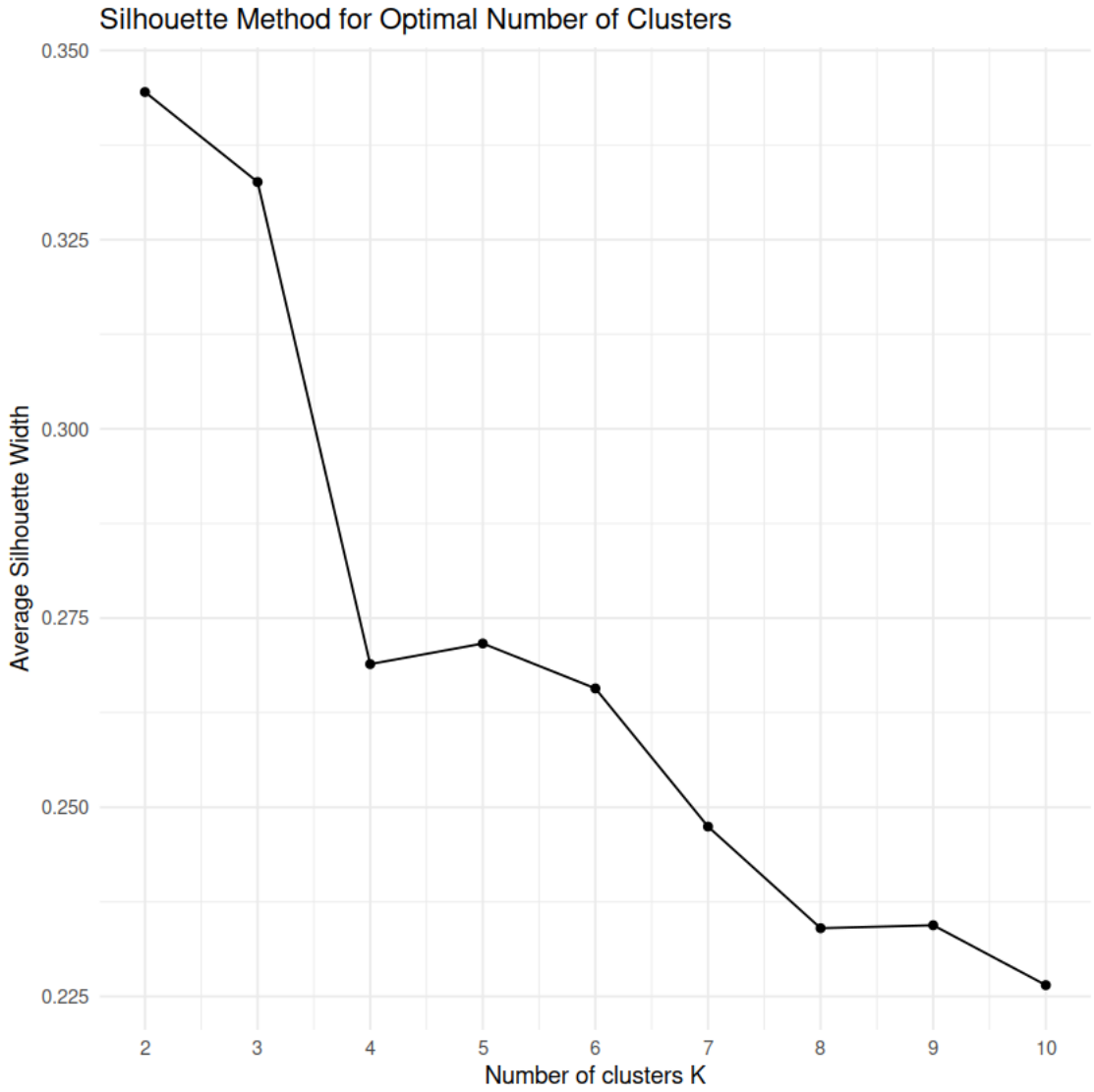
```
  scale_x_continuous(breaks = k_values) +
  labs(title = "Elbow Method for Optimal Number of Clusters",
       x = "Number of clusters K",
       y = "Total within-cluster sum of squares") +
  theme_minimal()
```



[18]:
```
avg_sil <- function(k) {
  km.res <- kmeans(happiness_scaled, centers = k, nstart = 25)
  ss <- silhouette(km.res$cluster, dist(happiness_scaled))
  mean(ss[, 3])
}
```

[19]:
```
k_values <- 2:10
avg_sil_values <- map_dbl(k_values, avg_sil)
```

[20]:
```
ggplot(data.frame(k = k_values, silhouette = avg_sil_values), aes(k,␣
↪silhouette)) +
 geom_line() + geom_point() +
 scale_x_continuous(breaks = k_values) +
 labs(title = "Silhouette Method for Optimal Number of Clusters",
      x = "Number of clusters K",
      y = "Average Silhouette Width") +
 theme_minimal()
```



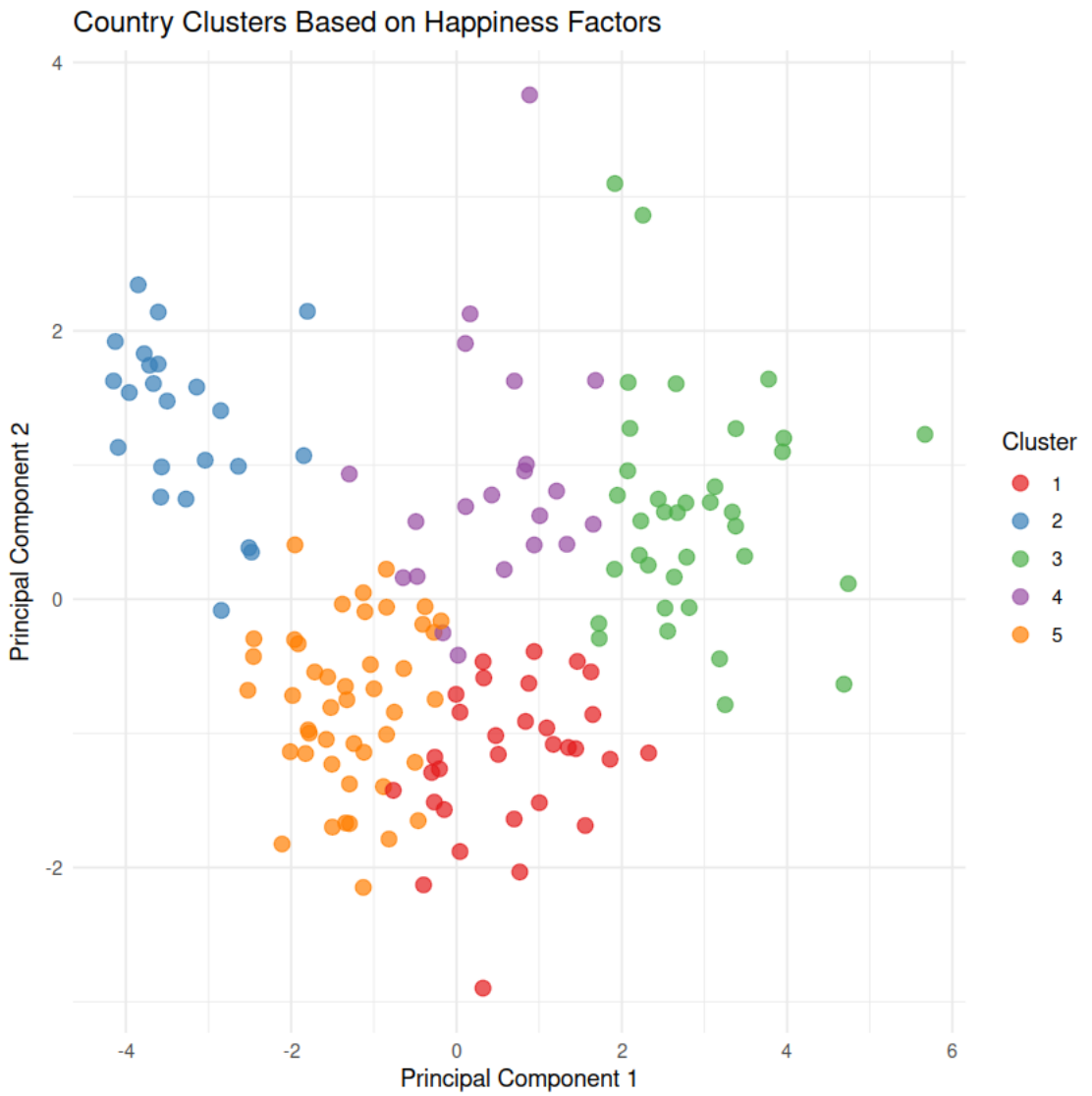
[21]:
```
optimal_k <- 5
```

[22]:
```r
kmeans_result <- kmeans(happiness_scaled, centers = optimal_k, nstart = 25)
```

[23]:
```r
# Add cluster assignments to original data
happiness$Cluster <- as.factor(kmeans_result$cluster)
```

[24]:
```r
# Perform PCA for visualization
pca_result <- prcomp(happiness_scaled, scale. = TRUE)
pca_df <- as.data.frame(pca_result$x[, 1:2])
pca_df$Cluster <- happiness$Cluster
```

[25]:
```r
# Plot clusters in PCA space
ggplot(pca_df, aes(x = PC1, y = PC2, color = Cluster)) +
  geom_point(size = 3, alpha = 0.7) +
  scale_color_brewer(palette = "Set1") +
  labs(title = "Country Clusters Based on Happiness Factors",
       x = "Principal Component 1",
       y = "Principal Component 2") +
  theme_minimal()
```



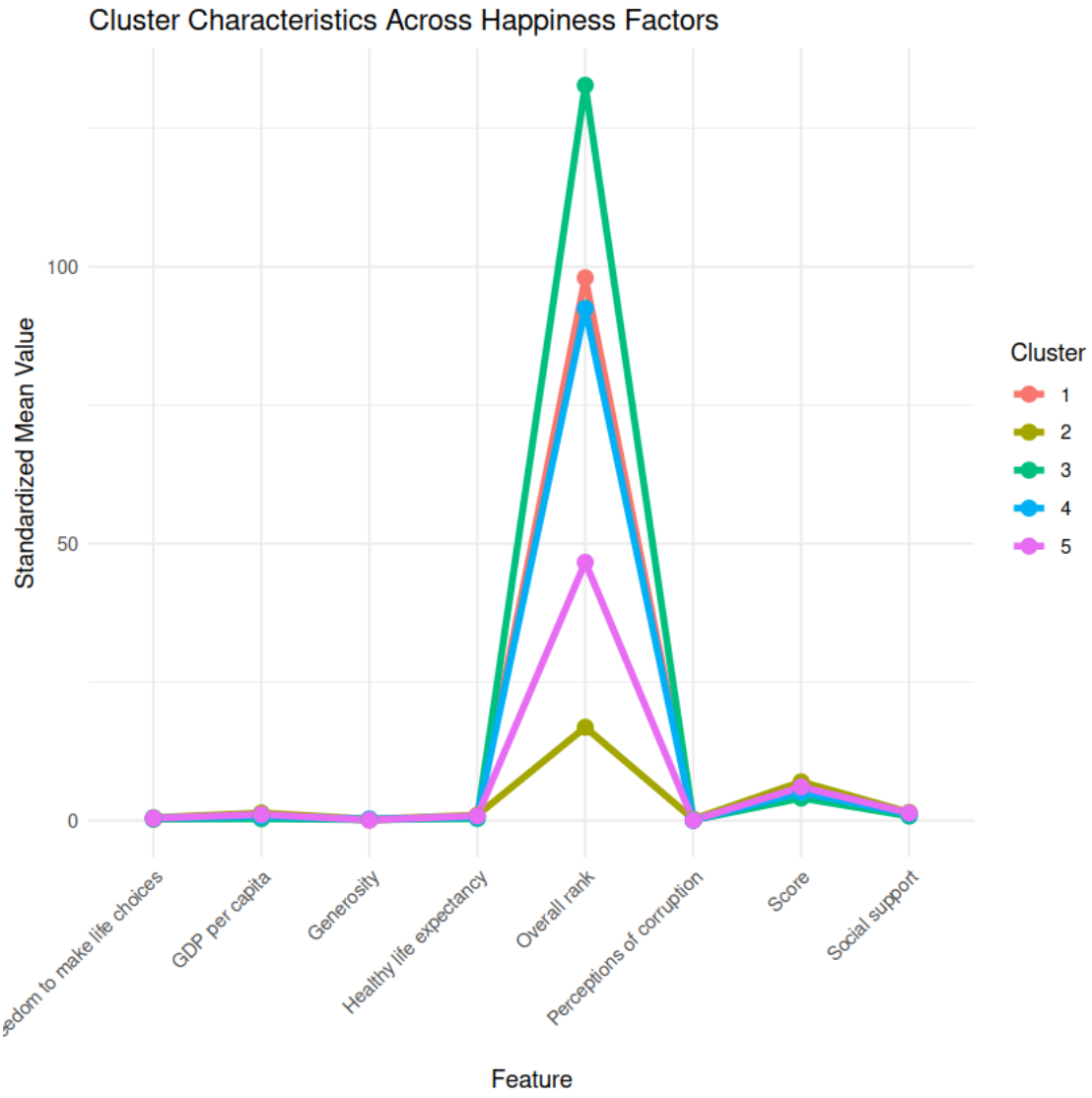
[26]:
```
# Prepare data for parallel coordinates plot
cluster_means <- happiness %>%
  group_by(Cluster) %>%
  summarise(across(where(is.numeric), mean))
```

[27]:
```
cluster_means_long <- cluster_means %>%
  pivot_longer(cols = -Cluster, names_to = "Feature", values_to = "Mean_Value")
```

[28]:
```
ggplot(cluster_means_long, aes(x = Feature, y = Mean_Value, group = Cluster,␣
↪color = Cluster)) +
  geom_line(size = 1.5) +
  geom_point(size = 3) +
  labs(title = "Cluster Characteristics Across Happiness Factors",
```

```
      y = "Standardized Mean Value") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

```
Warning message:
"Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
 Please use `linewidth` instead."
```



[29]:
```
# Calculate and display cluster characteristics
cluster_profiles <- happiness %>%
  group_by(Cluster) %>%
  summarise(
    Count = n(),
```

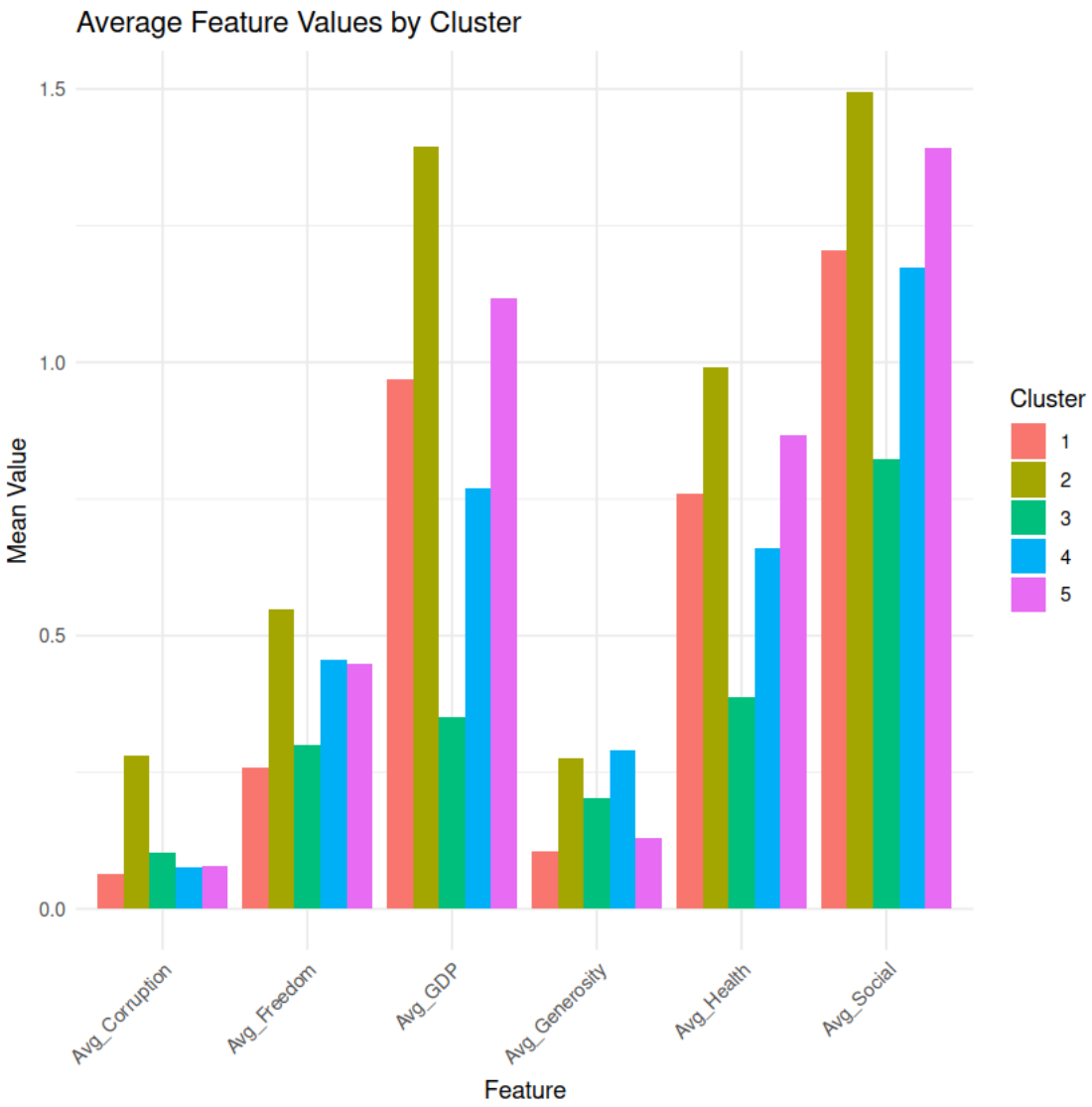
```
    Avg_GDP = mean(`GDP per capita`, na.rm = TRUE),
    Avg_Social = mean(`Social support`, na.rm = TRUE),
    Avg_Health = mean(`Healthy life expectancy`, na.rm = TRUE),
    Avg_Freedom = mean(`Freedom to make life choices`, na.rm = TRUE),
    Avg_Generosity = mean(Generosity, na.rm = TRUE),
    Avg_Corruption = mean(`Perceptions of corruption`, na.rm = TRUE)
  )
```

[30]:
```
# Print cluster profiles
print(cluster_profiles)
```

```
# A tibble: 5 × 8
  Cluster Count Avg_GDP Avg_Social Avg_Health Avg_Freedom Avg_Generosity
  <fct>   <int>   <dbl>
<dbl>      <dbl>
<dbl>          <dbl>
1 1          31   0.968      1.20       0.759       0.259
0.106
2 2          23   1.40       1.49       0.990       0.548
0.275
3 3          36   0.351      0.824      0.387       0.301
0.203
4 4          21   0.771      1.17       0.661       0.457
0.290
5 5          45   1.12       1.39       0.867       0.449
0.130
#   1 more variable: Avg_Corruption <dbl>
```

[31]:
```
cluster_profiles_long <- cluster_profiles %>%
  select(-Count) %>%
  pivot_longer(cols = -Cluster, names_to = "Feature", values_to = "Mean_Value")
```

[32]:
```
ggplot(cluster_profiles_long, aes(x = Feature, y = Mean_Value, fill = as.
 ↪factor(Cluster))) +
  geom_col(position = "dodge") +
  labs(title = "Average Feature Values by Cluster",
       y = "Mean Value",
       fill = "Cluster") +
  theme_minimal() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```


Average Feature Values by Cluster
1.5
1.0
0.5
0.0
Mean Value
Avg_Corruption
Avg_Freedom
Avg_GDP
Avg_Generosity
Avg_Health
Avg_Social
Feature
Cluster
1
2
3
4
5