Homework 4

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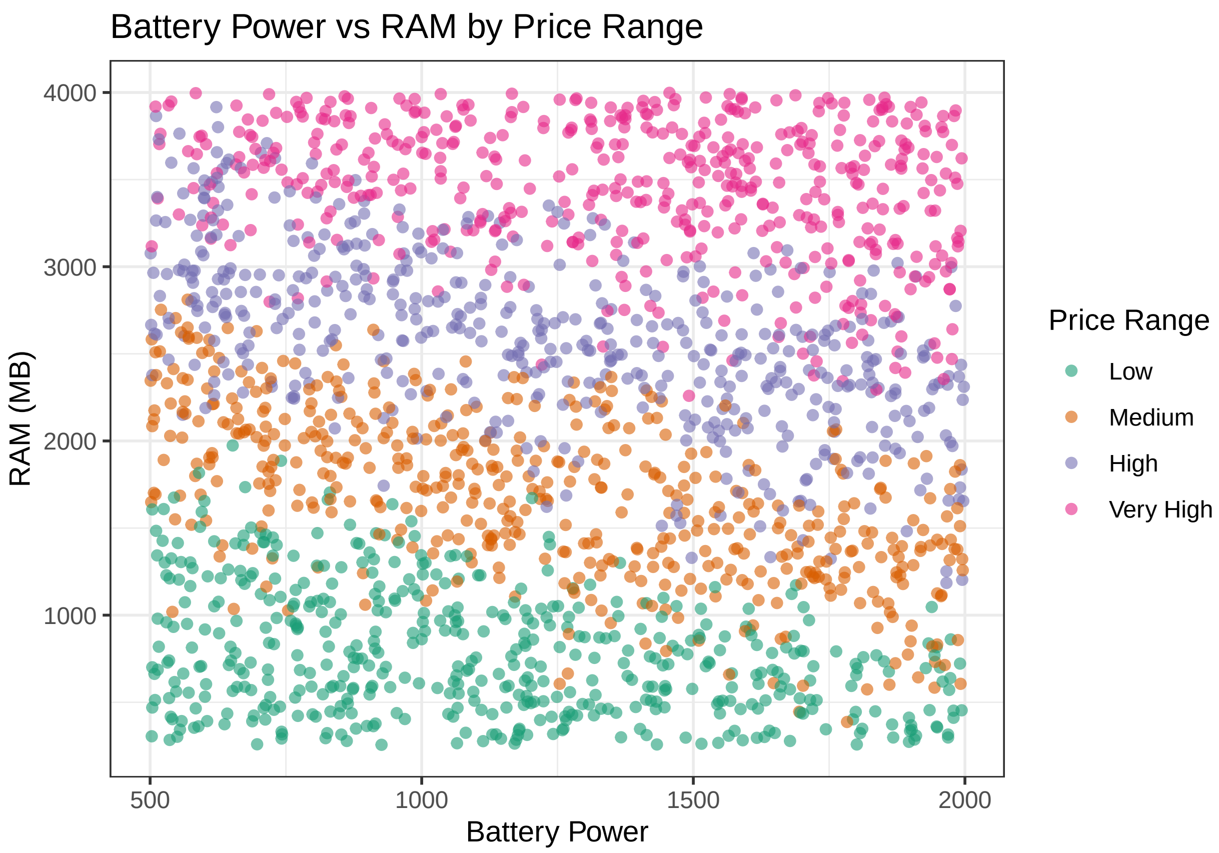
Problem 1

```r
# Load ggplot2
library(ggplot2)

# Read the data
mobile_data <- read.csv("train.csv")

# Convert price_range to factor with labels
mobile_data$price_range <- factor(mobile_data$price_range,
                                  levels = c(0, 1, 2, 3),
                                  labels = c("Low", "Medium", "High", "Very High"))
```

(a) Scatter plot: Battery Power vs RAM with colors by Price Range

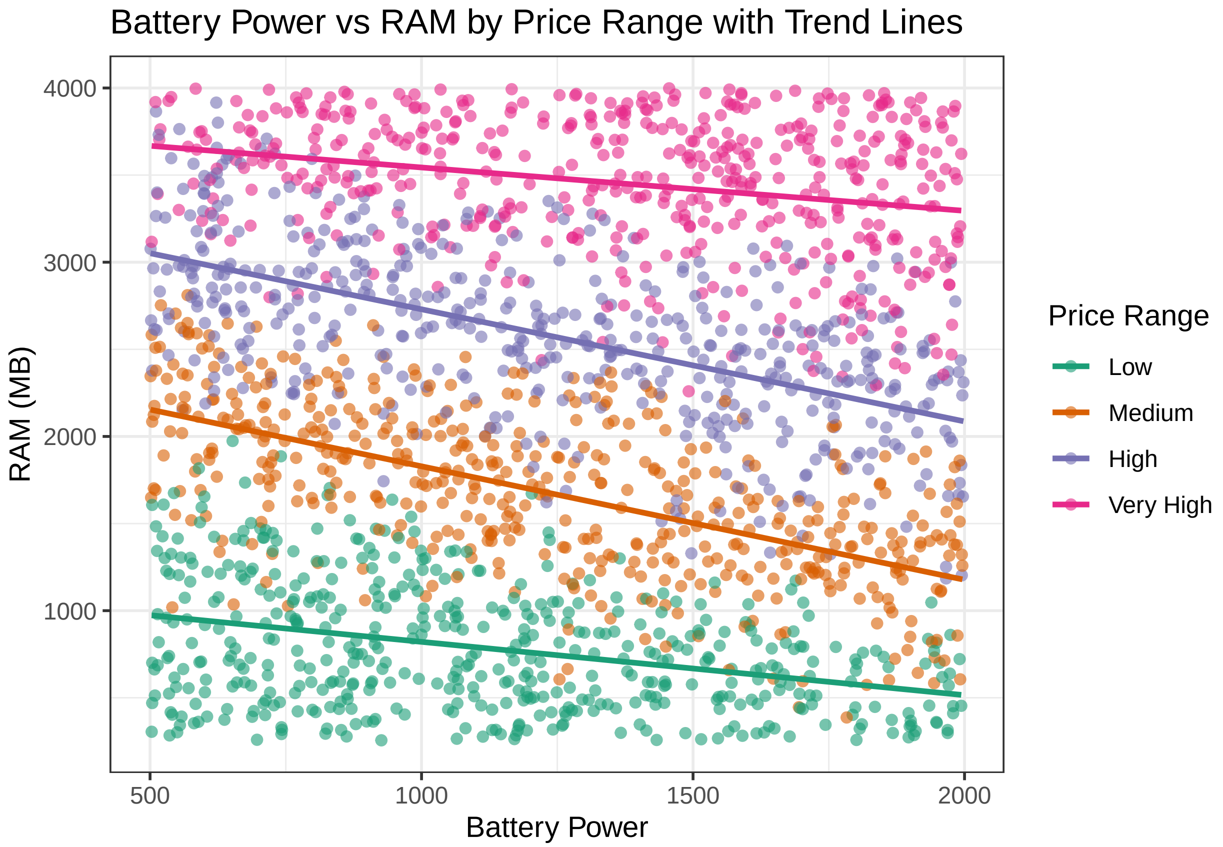
```r
ggplot(mobile_data, aes(x = battery_power, y = ram, color = price_range)) +
  geom_point(alpha = 0.6) +
  labs(title = "Battery Power vs RAM by Price Range",
       x = "Battery Power",
       y = "RAM (MB)",
       color = "Price Range") +
  theme_bw() +
  scale_color_brewer(palette = "Dark2")
```



(b) Scatter plot with trend lines for each price range

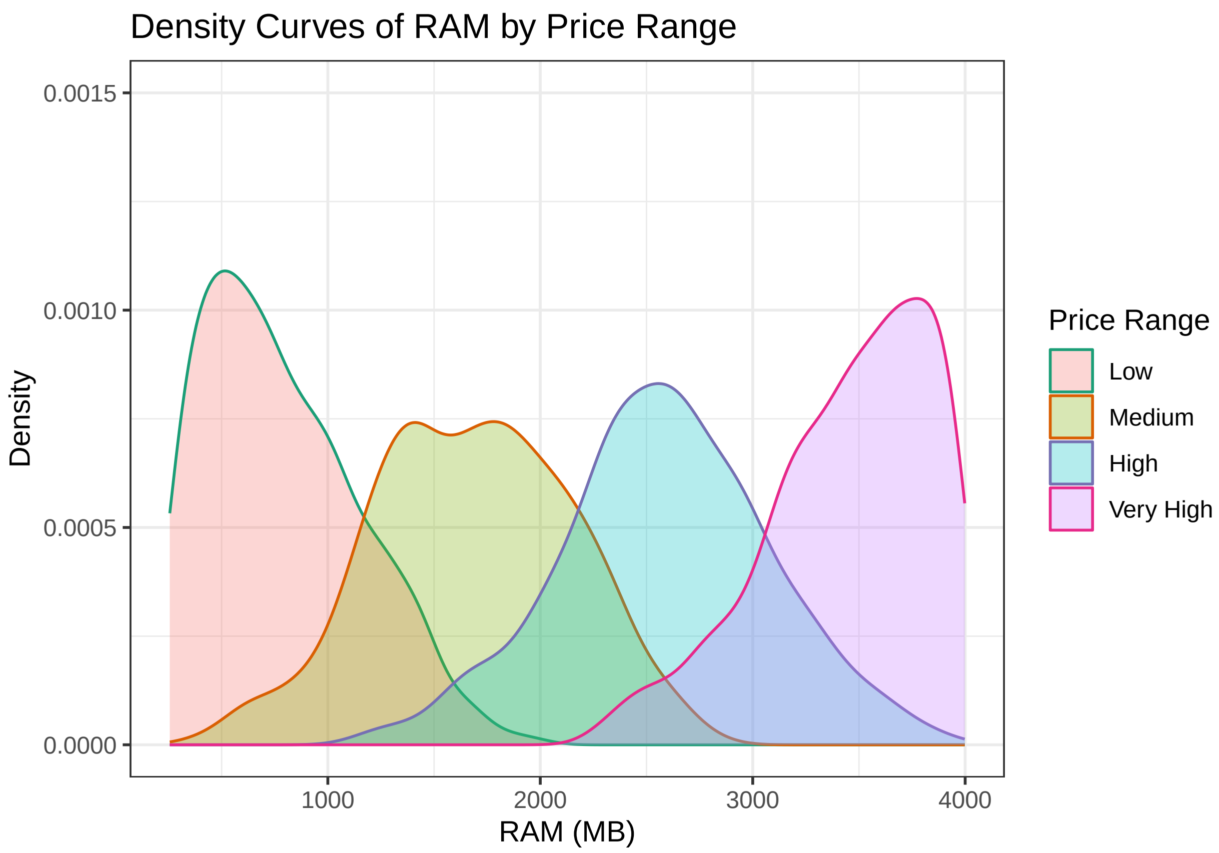
```r
ggplot(mobile_data, aes(x = battery_power, y = ram, color = price_range)) +
  geom_point(alpha = 0.6) +
  geom_smooth(method = "lm", se = FALSE) +
  labs(title = "Battery Power vs RAM by Price Range with Trend Lines",
       x = "Battery Power",
       y = "RAM (MB)",
       color = "Price Range") +
  theme_bw() +
  scale_color_brewer(palette = "Dark2")
```

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



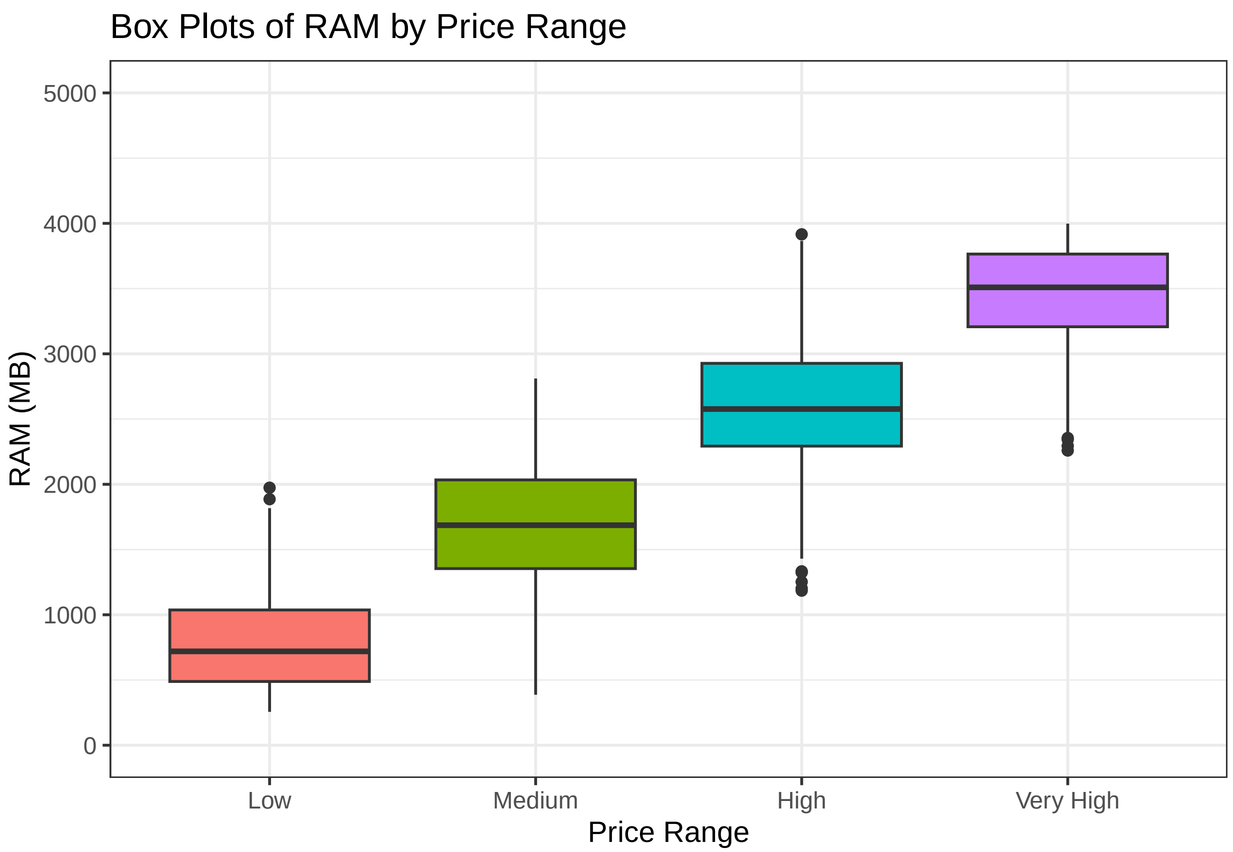
(c) Density curves of RAM for 4 price ranges

```
ggplot(mobile_data, aes(x = ram, fill = price_range, color = price_range)) +
  geom_density(alpha = 0.3) +
  labs(title = "Density Curves of RAM by Price Range",
       x = "RAM (MB)",
       y = "Density",
       fill = "Price Range",
       color = "Price Range") +
  theme_bw() +
  ylim(0, 0.0015) +
  scale_color_brewer(palette = "Dark2")
```



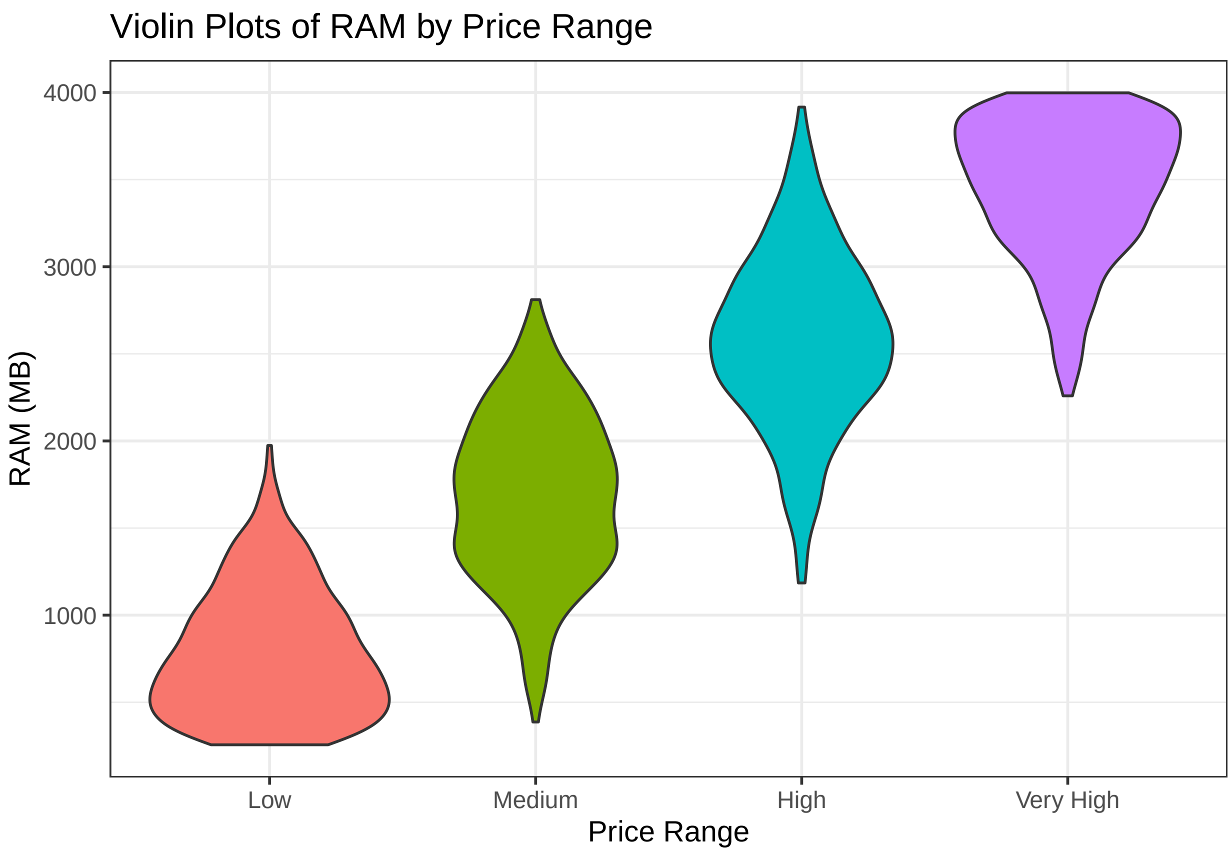
(d) Box plots of RAM for 4 price ranges

```
ggplot(mobile_data, aes(x = price_range, y = ram, fill = price_range)) +
  geom_boxplot() +
  labs(title = "Box Plots of RAM by Price Range",
       x = "Price Range",
       y = "RAM (MB)") +
  theme_bw() +
  theme(legend.position = "none") +
  ylim(0, 5000) +
  scale_color_brewer(palette = "Dark2")
```



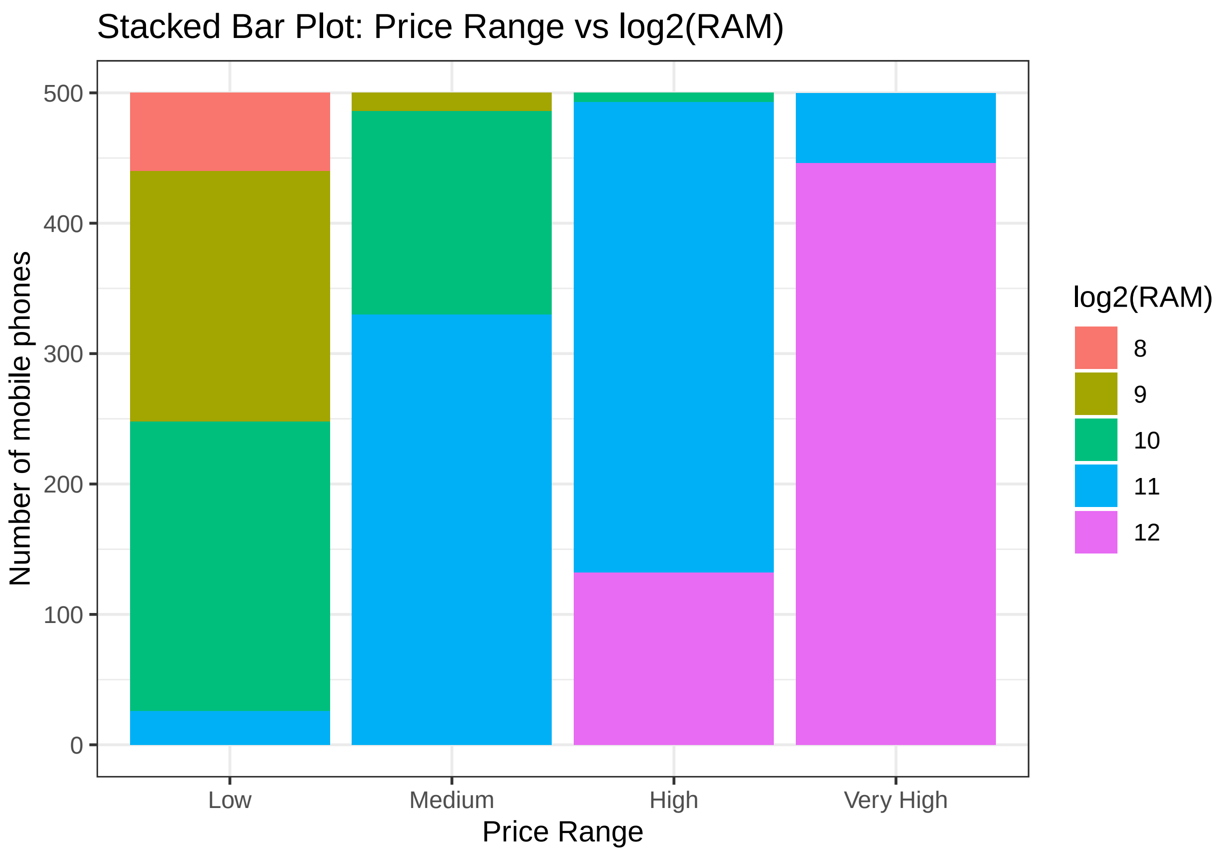
(e) Violin plot of RAM for 4 price ranges

```
ggplot(mobile_data, aes(x = price_range, y = ram, fill = price_range)) +
  geom_violin() +
  labs(title = "Violin Plots of RAM by Price Range",
       x = "Price Range",
       y = "RAM (MB)") +
  theme_bw() +
  theme(legend.position = "none") +
  scale_color_brewer(palette = "Dark2")
```



(f) Stacked bar plot: Price Range vs log2(RAM)

```
# Create log2(ram) variable
mobile_data$log2_ram <- factor(round(log2(mobile_data$ram)))

ggplot(mobile_data, aes(x = price_range, fill = log2_ram)) +
  geom_bar(position = "stack") +
  labs(title = "Stacked Bar Plot: Price Range vs log2(RAM)",
       x = "Price Range",
       y = "Number of mobile phones",
       fill = "log2(RAM)") +
  theme_bw()
```


Stacked Bar Plot: Price Range vs log2(RAM)
Number of mobile phones
0
100
200
300
400
500
Low
Medium
High
Very High
Price Range
log2(RAM)
8
9
10
11
12

Problem 2

```
# Load necessary packages
library(ggplot2)
library(UsingR)
```

```
## Loading required package: MASS

## Loading required package: HistData

## Loading required package: Hmisc

##
## Attaching package: 'Hmisc'

## The following objects are masked from 'package:base':
##
##     format.pval, units
```

```
# Load the UScereal dataset
data("UScereal")
```

(a) Replace manufacturer abbreviations with full names

```
levels(UScereal$mfr) <- c("General Mills", "Kelloggs", "Nabisco",
                           "Post", "Quaker Oats", "Ralston Purina")
```

(b) Convert shelf to factor with proper labels

```
UScereal$shelf <- factor(UScereal$shelf,
                         levels = c(1, 2, 3),
                         labels = c("Lower", "Middle", "Upper"))
```

(c) Create Product variable from row names

```
UScereal$product <- rownames(UScereal)
```

Check the structure:

```
str(UScereal)
```

```
## 'data.frame':    65 obs. of  12 variables:
##  $ mfr      : Factor w/ 6 levels "General Mills",..: 3 2 2 1 2 1 6 4 5 1 ...
##  $ calories : num  212 212 100 147 110 ...
##  $ protein  : num  12.12 12.12 8 2.67 2 ...
##  $ fat      : num  3.03 3.03 0 2.67 0 ...
##  $ sodium   : num  394 788 280 240 125 ...
##  $ fibre    : num  30.3 27.3 28 2 1 ...
##  $ carbo    : num  15.2 21.2 16 14 11 ...
##  $ sugars   : num  18.2 15.2 0 13.3 14 ...
##  $ shelf    : Factor w/ 3 levels "Lower","Middle",..: 3 3 3 1 2 3 1 3 2 1 ...
##  $ potassium: num  848.5 969.7 660 93.3 30 ...
##  $ vitamins : Factor w/ 3 levels "100%","enriched",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ product  : chr  "100% Bran" "All-Bran" "All-Bran with Extra Fiber" "Apple Cinnamon Cheerios" ...
```

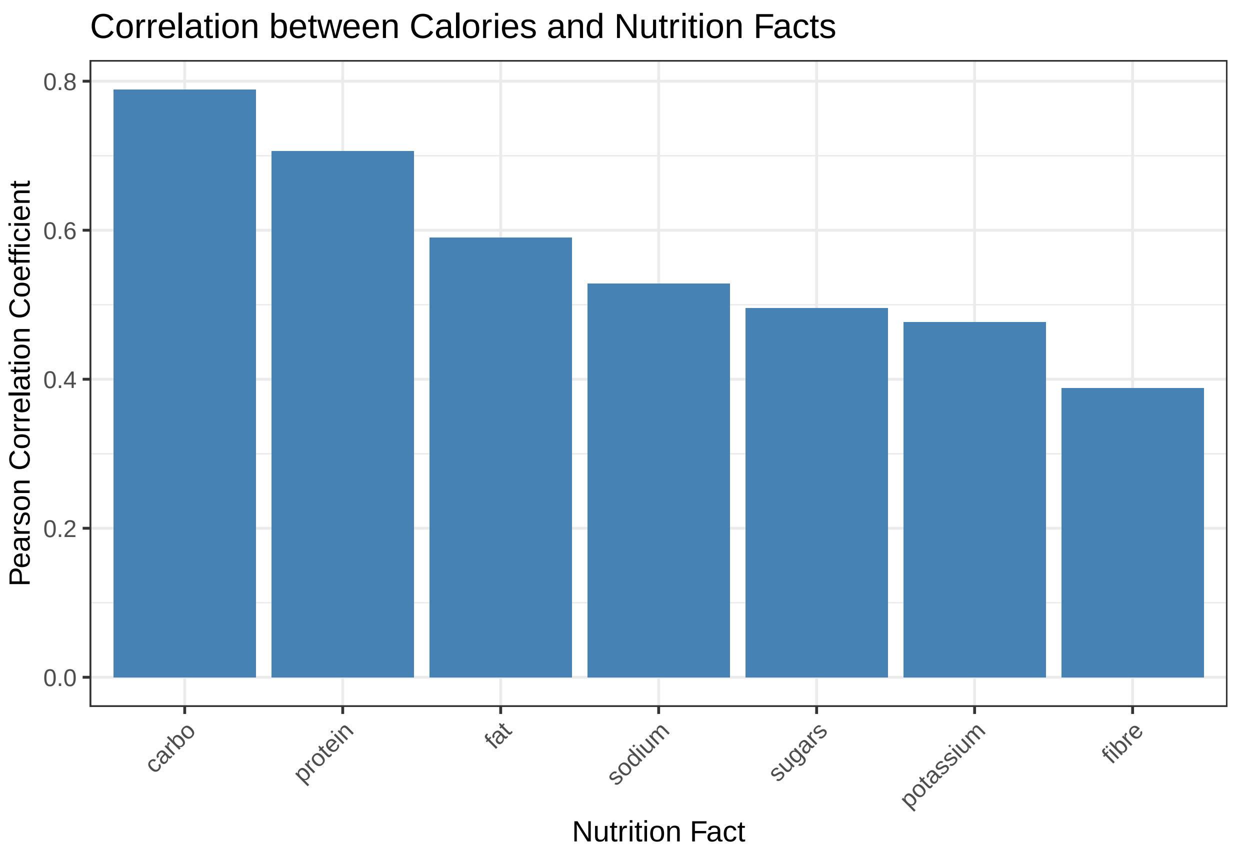
(d) Pearson correlation between calories and nutrition facts

```r
# Calculate correlations
nutrition_vars <- c("protein", "fat", "sodium", "fibre", "carbo",
                    "sugars", "potassium")
correlations <- sapply(nutrition_vars, function(var) {
  cor(UScereal$calories, UScereal[[var]])
})

# Display correlations
print(round(correlations, 4))
```

```
##   protein       fat    sodium     fibre     carbo    sugars potassium
##    0.7060    0.5902    0.5287    0.3882    0.7887    0.4953    0.4766
```

(e) Bar plot of correlations in decreasing order

```r
# Create data frame for plotting
cor_df <- data.frame(
  nutrition = names(correlations),
  correlation = correlations
)
cor_df <- cor_df[order(-cor_df$correlation), ]
cor_df$nutrition <- factor(cor_df$nutrition, levels = cor_df$nutrition)

ggplot(cor_df, aes(x = nutrition, y = correlation)) +
  geom_bar(stat = "identity", fill = "steelblue") +
  labs(title = "Correlation between Calories and Nutrition Facts",
       x = "Nutrition Fact",
       y = "Pearson Correlation Coefficient") +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```

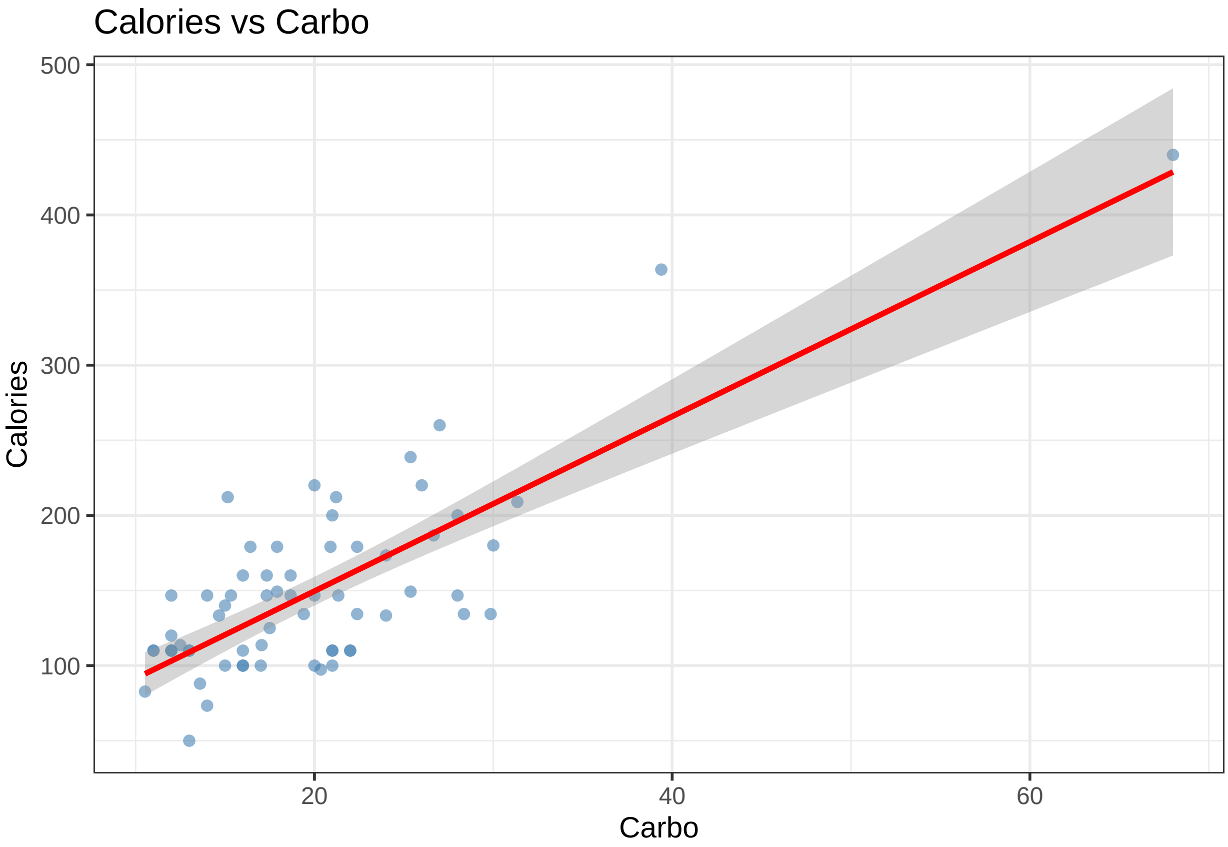


The nutrition fact with the highest correlation to calories is **carbo** with a correlation of 0.7887.

(f) Scatter plot with trend line for highest correlation

```
# Find the nutrition fact with highest correlation
highest_cor_var <- names(which.max(correlations))

ggplot(UScereal, aes(.data[[highest_cor_var]], calories)) +
  geom_point(color = "steelblue", alpha = 0.6) +
  geom_smooth(method = "lm", se = TRUE, color = "red") +
  labs(title = paste("Calories vs", tools::toTitleCase(highest_cor_var)),
       x = tools::toTitleCase(highest_cor_var),
       y = "Calories") +
  theme_bw()
```

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



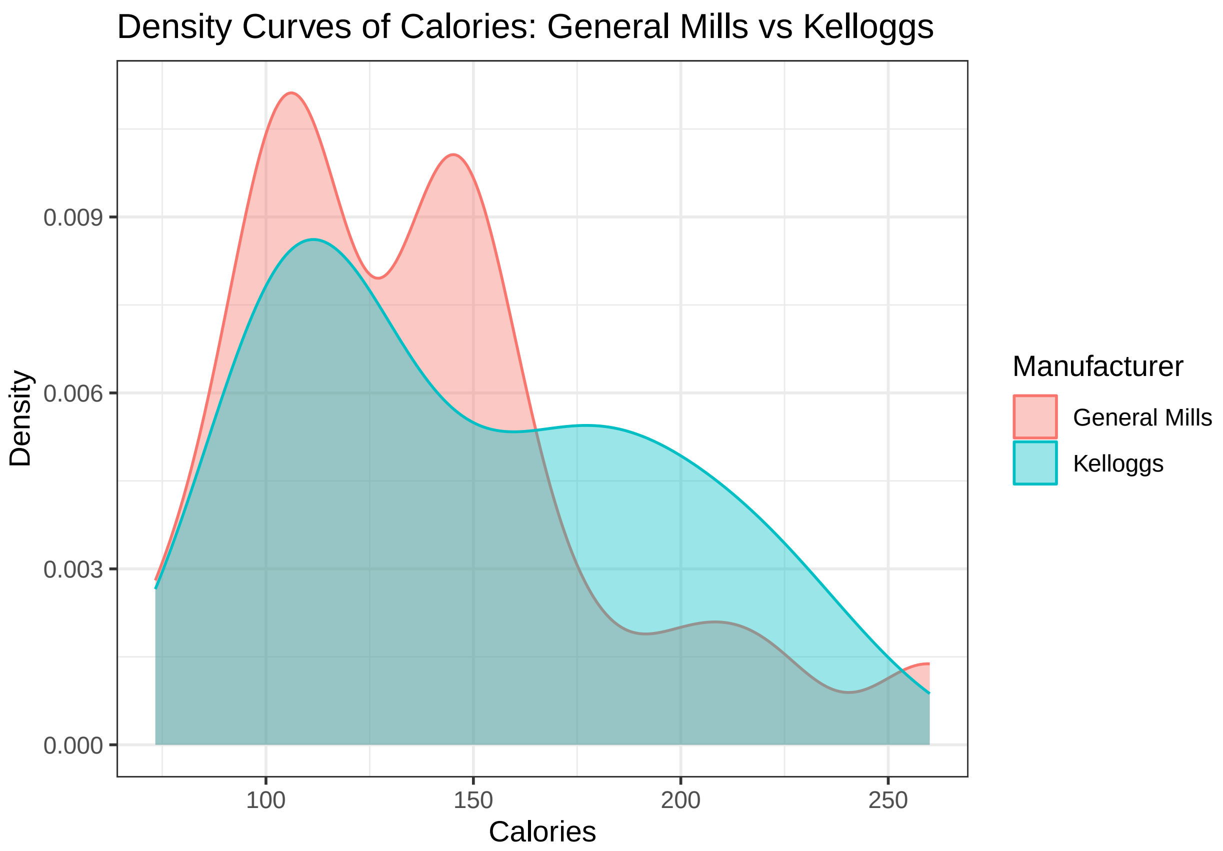
```
# Get the linear model for interpretation
lm_model <- lm(calories ~ fat, data = UScereal)
intercept <- round(coef(lm_model)[1], 2)
slope <- round(coef(lm_model)[2], 2)
```

Interpretation:

- **Intercept** (117.6): When carbo content is 0 grams, the predicted calorie content is approximately 117.6 calories.
- **Slope** (22.36): For each additional gram of carbo, the calorie content increases by approximately 22.36 calories on average.

(g) Density curves comparing General Mills and Kelloggs

```
# Subset data for General Mills and Kelloggs
gm_kelloggs <- subset(UScereal, mfr %in% c("General Mills", "Kelloggs"))

ggplot(gm_kelloggs, aes(x = calories, fill = mfr, color = mfr)) +
  geom_density(alpha = 0.4) +
  labs(title = "Density Curves of Calories: General Mills vs Kelloggs",
       x = "Calories",
       y = "Density",
       fill = "Manufacturer",
       color = "Manufacturer") +
  theme_bw()
```

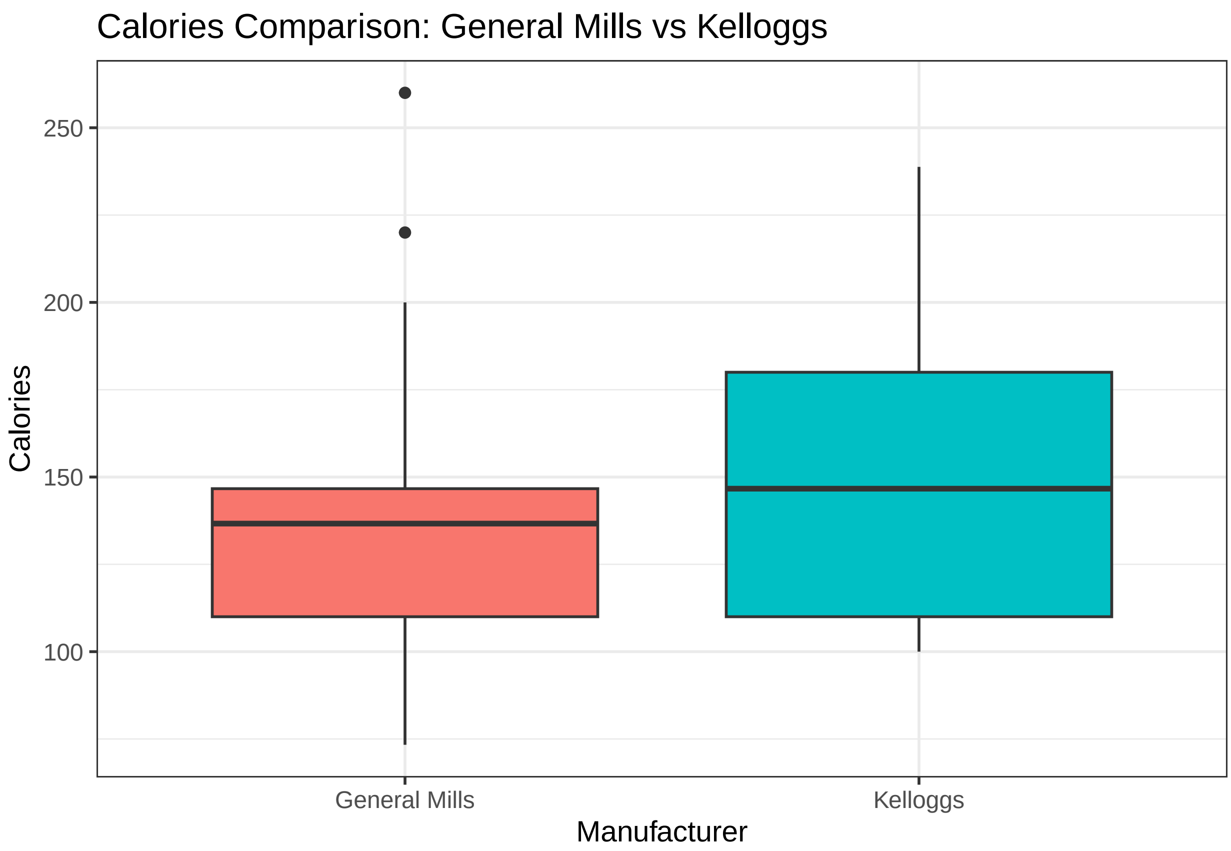


Shape descriptions:

- **General Mills:** The distribution appears bimodal with two distinct peaks - one around 100-110 calories and another around 140-150 calories. This suggests General Mills produces two distinct groups of cereals with different calorie contents.
- **Kelloggs:** The distribution is also bimodal or multimodal with peak at around 100-110 calories and another high around 180-200 calories. It shows a wider spread and more variability across the calorie range compared to General Mills, with products ranging from low to high calorie content.

(h) Box plot comparing calories between manufacturers

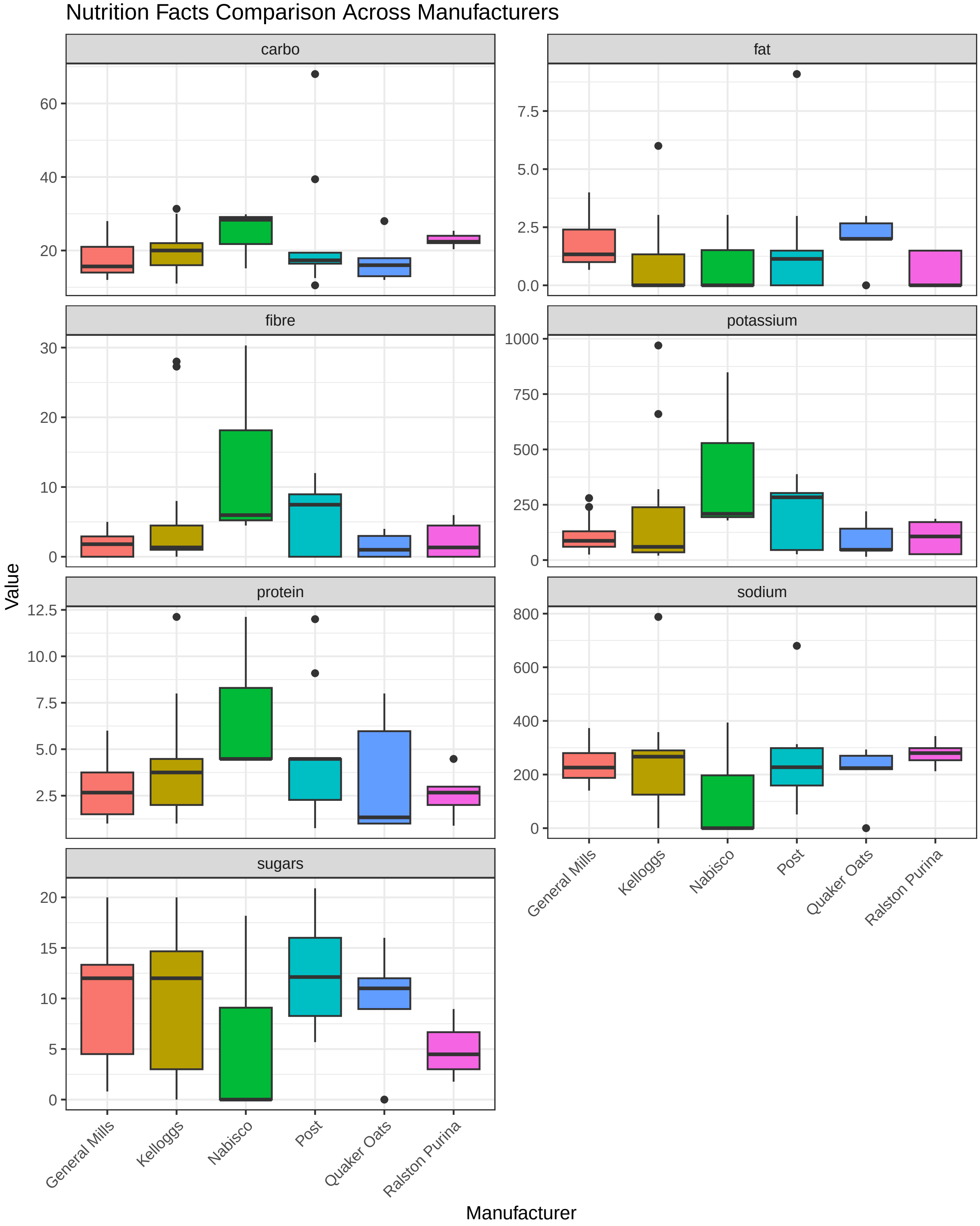
```
ggplot(gm_kelloggs, aes(x = mfr, y = calories, fill = mfr)) +
  geom_boxplot() +
  labs(title = "Calories Comparison: General Mills vs Kelloggs",
       x = "Manufacturer",
       y = "Calories") +
  theme_bw() +
  theme(legend.position = "none")
```



The box plots show that Kelloggs has a higher median calorie value (around 145-150 calories) compared to General Mills (around 135-140 calories). Kelloggs also shows greater variability with a wider interquartile range and a longer upper whisker extending to around 235 calories, plus one high outlier above 250 calories. General Mills has a more compact distribution with outliers around 220 and 260 calories. While there is some overlap in the interquartile ranges, Kelloggs cereals tend to have higher calorie content on average compared to General Mills.

(i) Side-by-side box plots for seven nutrition facts

```r
# Reshape data manually without reshape2
nutrition_long <- data.frame(
  mfr = rep(UScereal$mfr, times = length(nutrition_vars)),
  Nutrition = rep(nutrition_vars, each = nrow(UScereal)),
  Value = c(UScereal$protein, UScereal$fat, UScereal$sodium,
            UScereal$fibre, UScereal$carbo, UScereal$sugars,
            UScereal$potassium)
)

ggplot(nutrition_long, aes(x = mfr, y = Value, fill = mfr)) +
  geom_boxplot() +
  facet_wrap(~ Nutrition, scales = "free_y", ncol = 2) +
  labs(title = "Nutrition Facts Comparison Across Manufacturers",
       x = "Manufacturer",
       y = "Value") +
  theme_bw() +
  theme(axis.text.x = element_text(angle = 45, hjust = 1),
        legend.position = "none")
```



Discussion:

Quaker Oats appears to aim for the healthiest diet overall. Their cereals show: - **High fiber content**: Significantly higher median fiber (~3-4g) compared to most other manufacturers
- **Low sodium**: Among the lowest sodium levels across all manufacturers
- **Moderate to low sugars**: Lower sugar content compared to General Mills and Kelloggs
- **Moderate fat**: Relatively low fat content
- **Good potassium**: Decent potassium levels

Nabisco also stands out as health-focused:
- **Highest fiber**: The highest median and range of fiber content (~7-18g), far exceeding other brands
- **Very low sodium**: Extremely low sodium levels (close to 0-200mg)
- **Low to zero sugars**: Very low sugar content
- **Low fat**: Among the lowest fat content

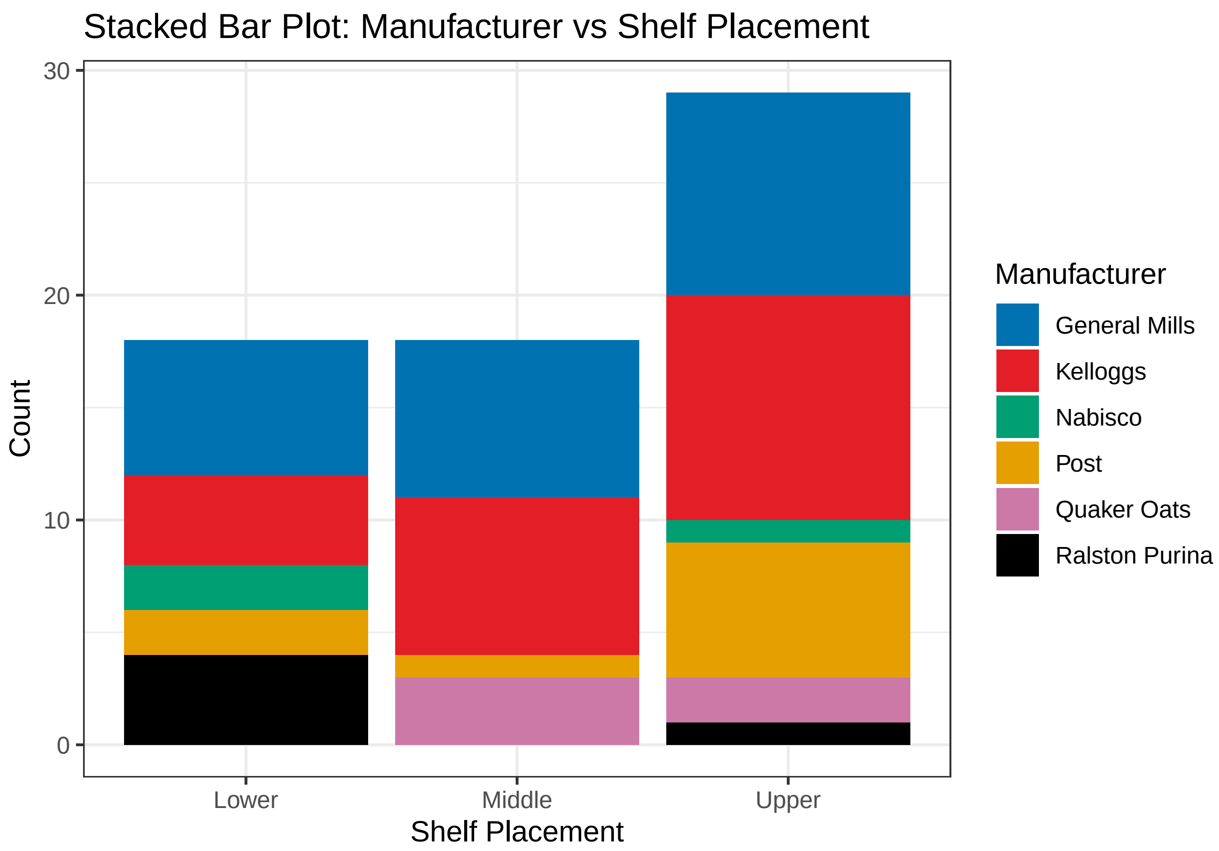
In contrast:

- **General Mills and Kelloggs** tend to have higher sugar content (10-15g median) and moderate to high sodium levels, making them less health-oriented
- **Post** shows high sodium levels and moderate sugars, suggesting less focus on health
- **Ralston Purina** has very low sugar (the lowest among all brands) but also very low fiber and moderate sodium

Conclusion: Nabisco and **Quaker Oats** are the manufacturers that most clearly aim for healthier diets, with Nabisco leading in fiber content and Quaker Oats providing a good balance of high fiber, low sodium, and moderate sugar levels.

(j) Stacked bar plot: Manufacturer vs Shelf placement

```r
# Create stacked bar plot with custom colors inspired by brand logos
brand_colors <- c(
  "General Mills"  = "#0072B2",
  "Kelloggs"       = "#E41E26",
  "Nabisco"        = "#009E73",
  "Post"           = "#E69F00",
  "Quaker Oats"    = "#CC79A7",
  "Ralston Purina" = "#000000"
)

ggplot(UScereal, aes(x = shelf, fill = mfr)) +
  geom_bar(position = "stack") +
  scale_fill_manual(values = brand_colors) +
  labs(title = "Stacked Bar Plot: Manufacturer vs Shelf Placement",
       x = "Shelf Placement",
       y = "Count",
       fill = "Manufacturer") +
  theme_bw()
```


Stacked Bar Plot: Manufacturer vs Shelf Placement
30
20
10
0
Count
Lower
Middle
Upper
Shelf Placement
Manufacturer
General Mills
Kelloggs
Nabisco
Post
Quaker Oats
Ralston Purina