bm-project

YISU

2024-12-19

```r
# Load necessary libraries
library(tidyverse)
library(broom)
library(GGally)
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```r
library(gridExtra)
```

```
##
## Attaching package: 'gridExtra'

## The following object is masked from 'package:dplyr':
##
##     combine
```

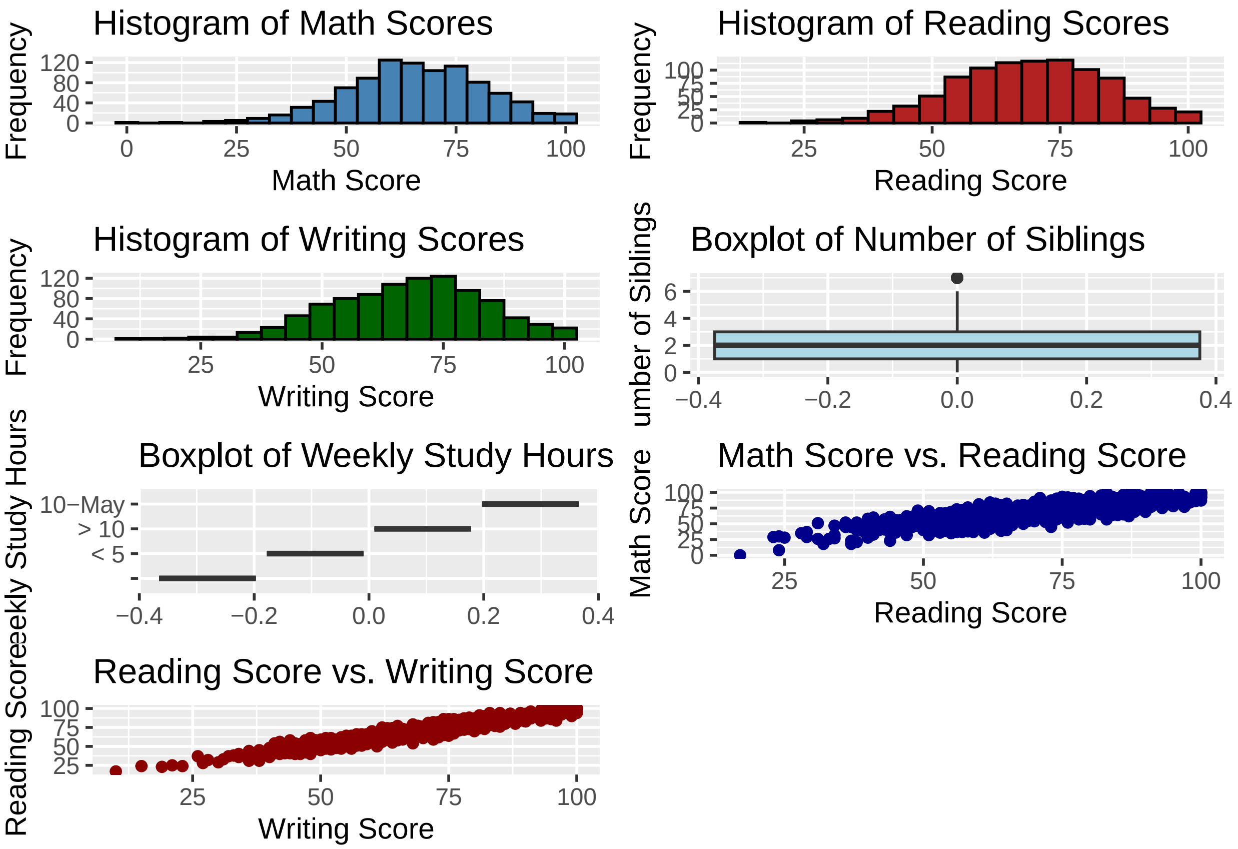
```r
# Read the dataset
data <- read.csv("Project_1_data.csv")

# Inspect the structure of the data
glimpse(data)
```

```
## Rows: 948
## Columns: 14
## $ Gender              <chr> "female", "female", "female", "male", "male", "fem~
## $ EthnicGroup         <chr> "", "group C", "group B", "group A", "group C", "g~
## $ ParentEduc          <chr> "bachelor's degree", "some college", "master's deg~
## $ LunchType           <chr> "standard", "standard", "standard", "free/reduced"~
## $ TestPrep            <chr> "none", "", "none", "none", "none", "none", "compl~
## $ ParentMaritalStatus <chr> "married", "married", "single", "married", "marrie~
## $ PracticeSport       <chr> "regularly", "sometimes", "sometimes", "never", "s~
## $ IsFirstChild        <chr> "yes", "yes", "yes", "no", "yes", "yes", "no", "ye~
## $ NrSiblings          <int> 3, 0, 4, 1, 0, 1, 1, 1, 3, NA, 1, 1, 1, 1, 2, 0, 0~
## $ TransportMeans      <chr> "school_bus", "", "school_bus", "", "school_bus", ~
## $ WklyStudyHours      <chr> "< 5", "10-May", "< 5", "10-May", "10-May", "10-Ma~
## $ MathScore           <int> 71, 69, 87, 45, 76, 73, 85, 41, 65, 37, 58, 40, 66~
## $ ReadingScore        <int> 71, 90, 93, 56, 78, 84, 93, 43, 64, 59, 54, 52, 82~
## $ WritingScore        <int> 74, 88, 91, 42, 75, 79, 89, 39, 68, 50, 52, 43, 74~
```

```r
hist_math <- ggplot(data, aes(x = MathScore)) +
  geom_histogram(binwidth = 5, fill = "steelblue", color = "black") +
  labs(title = "Histogram of Math Scores", x = "Math Score", y = "Frequency")
```

```r
hist_reading <- ggplot(data, aes(x = ReadingScore)) +
  geom_histogram(binwidth = 5, fill = "firebrick", color = "black") +
  labs(title = "Histogram of Reading Scores", x = "Reading Score", y = "Frequency")

hist_writing <- ggplot(data, aes(x = WritingScore)) +
  geom_histogram(binwidth = 5, fill = "darkgreen", color = "black") +
  labs(title = "Histogram of Writing Scores", x = "Writing Score", y = "Frequency")
box_nr_siblings <- ggplot(data, aes(y = NrSiblings)) +
  geom_boxplot(fill = "lightblue") +
  labs(title = "Boxplot of Number of Siblings", y = "Number of Siblings")

box_wkly_study_hours <- ggplot(data, aes(y = WklyStudyHours)) +
  geom_boxplot(fill = "lightgreen") +
  labs(title = "Boxplot of Weekly Study Hours", y = "Weekly Study Hours")
scatter_math_reading <- ggplot(data, aes(x = ReadingScore, y = MathScore)) +
  geom_point(color = "darkblue") +
  labs(title = "Math Score vs. Reading Score", x = "Reading Score", y = "Math Score")

scatter_reading_writing <- ggplot(data, aes(x = WritingScore, y = ReadingScore)) +
  geom_point(color = "darkred") +
  labs(title = "Reading Score vs. Writing Score", x = "Writing Score", y = "Reading Score")
# Convert categorical variables to factors if needed
data <- data %>%
  mutate(across(c(Gender, EthnicGroup, ParentEduc, LunchType, TestPrep,
                ParentMaritalStatus, PracticeSport, IsFirstChild,
                TransportMeans, WklyStudyHours), as.factor))

pairwise_plots <- ggpairs(data,
  columns = c("MathScore", "ReadingScore", "WritingScore", "NrSiblings", "WklyStudyHours"),
  aes(color = Gender),
  lower = list(continuous = "smooth"),
  upper = list(continuous = "cor"),
  diag = list(continuous = "densityDiag"))
grid.arrange(
  hist_math, hist_reading, hist_writing,
  box_nr_siblings, box_wkly_study_hours,
  scatter_math_reading, scatter_reading_writing,
  ncol = 2
)
```

```
## Warning: Removed 46 rows containing non-finite outside the scale range
## (`stat_boxplot()`).
```



```r
data$Gender <- as.factor(data$Gender)
data$EthnicGroup <- as.factor(data$EthnicGroup)
data$ParentEduc <- as.factor(data$ParentEduc)
data$LunchType <- as.factor(data$LunchType)
data$TestPrep <- as.factor(data$TestPrep)
data$ParentMaritalStatus <- as.factor(data$ParentMaritalStatus)
data$PracticeSport <- as.factor(data$PracticeSport)
data$IsFirstChild <- as.factor(data$IsFirstChild)
data$TransportMeans <- as.factor(data$TransportMeans)
data$WklyStudyHours <- as.factor(data$WklyStudyHours)

# Handle missing values by removing rows with NA
data <- na.omit(data)

# Define the full model for MathScore
math_full_model <- lm(MathScore ~ Gender + EthnicGroup + ParentEduc + LunchType + TestPrep +
                        ParentMaritalStatus + PracticeSport + IsFirstChild + NrSiblings +
                        TransportMeans + WklyStudyHours, data = data)

# Perform stepwise model selection
math_selected_model <- stepAIC(math_full_model, direction = "both", trace = FALSE)
math_selected_model
```

```
##
## Call:
## lm(formula = MathScore ~ Gender + EthnicGroup + ParentEduc +
##     LunchType + TestPrep + ParentMaritalStatus + IsFirstChild +
##     WklyStudyHours, data = data)
## 
## Coefficients:
##                  (Intercept)                    Gendermale  
##                      51.2910                        5.0885  
##           EthnicGroupgroup A            EthnicGroupgroup B  
##                      -1.2758                        0.1118  
##           EthnicGroupgroup C            EthnicGroupgroup D  
##                      -0.2774                        3.5351  
##           EthnicGroupgroup E  ParentEducassociate's degree  
##                       8.5754                        4.7280  
##  ParentEducbachelor's degree         ParentEduchigh school  
##                       6.0476                       -0.8361  
##    ParentEducmaster's degree        ParentEducsome college  
##                       6.4044                        3.7222  
##   ParentEducsome high school             LunchTypestandard  
##                      -0.5013                       11.0841  
##            TestPrepcompleted                  TestPrepnone  
##                       4.4017                       -0.9571  
##  ParentMaritalStatusdivorced    ParentMaritalStatusmarried  
##                      -0.5039                        3.2310  
##    ParentMaritalStatussingle    ParentMaritalStatuswidowed  
##                       0.1923                        4.2876  
##               IsFirstChildno               IsFirstChildyes  
##                      -1.1316                        0.8604  
##            WklyStudyHours< 5            WklyStudyHours> 10  
##                      -4.7980                       -1.0807  
##         WklyStudyHours10-May  
##                      -1.4518
```

```
# Display the summary of the selected model
cat("\nSelected Model for MathScore:\n")
```

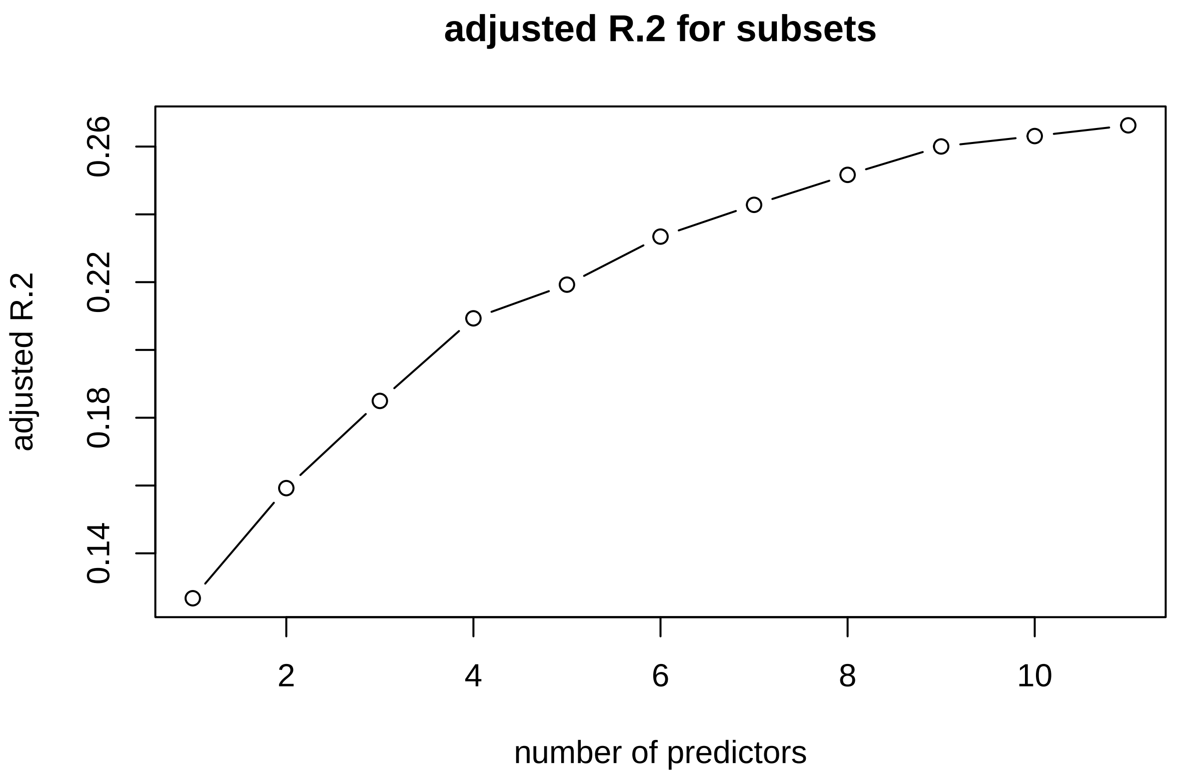
```
## 
## Selected Model for MathScore:
```

```
summary(math_selected_model)
```

```
## 
## Call:
## lm(formula = MathScore ~ Gender + EthnicGroup + ParentEduc + 
##     LunchType + TestPrep + ParentMaritalStatus + IsFirstChild + 
##     WklyStudyHours, data = data)
## 
## Residuals:
##     Min      1Q  Median      3Q     Max 
## -49.527  -8.997   0.498   9.626  30.285 
## 
## Coefficients:
##                              Estimate Std. Error t value Pr(>|t|)    
## (Intercept)                   51.2910     5.1078  10.042  < 2e-16 ***
## Gendermale                     5.0885     0.8992   5.659 2.06e-08 ***
## EthnicGroupgroup A            -1.2758     2.4139  -0.529 0.597264    
## EthnicGroupgroup B             0.1118     2.0927   0.053 0.957422    
## EthnicGroupgroup C            -0.2774     1.9986  -0.139 0.889628    
## EthnicGroupgroup D             3.5351     2.0268   1.744 0.081489 .  
## EthnicGroupgroup E             8.5754     2.2003   3.897 0.000105 ***
## ParentEducassociate's degree   4.7280     2.1442   2.205 0.027708 *
## ParentEducbachelor's degree    6.0476     2.3515   2.572 0.010280 *
## ParentEduchigh school         -0.8361     2.1666  -0.386 0.699661
## ParentEducmaster's degree      6.4044     2.6695   2.399 0.016643 *
## ParentEducsome college         3.7222     2.1417   1.738 0.082561 .
## ParentEducsome high school    -0.5013     2.1831  -0.230 0.818444
## LunchTypestandard             11.0841     0.9381  11.815  < 2e-16 ***
## TestPrepcompleted              4.4017     2.0171   2.182 0.029357 *
## TestPrepnone                  -0.9571     1.9433  -0.493 0.622484
## ParentMaritalStatusdivorced   -0.5039     2.3146  -0.218 0.827721
## ParentMaritalStatusmarried     3.2310     2.0944   1.543 0.123277
## ParentMaritalStatussingle      0.1923     2.2226   0.087 0.931062
## ParentMaritalStatuswidowed     4.2876     3.4046   1.259 0.208240
## IsFirstChildno                -1.1316     2.6597  -0.425 0.670602
## IsFirstChildyes                0.8604     2.6059   0.330 0.741341
## WklyStudyHours< 5             -4.7980     2.3751  -2.020 0.043676 *
## WklyStudyHours> 10            -1.0807     2.4903  -0.434 0.664422
## WklyStudyHours10-May          -1.4518     2.3020  -0.631 0.528423
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 13.36 on 877 degrees of freedom
## Multiple R-squared:  0.2819, Adjusted R-squared:  0.2623
## F-statistic: 14.35 on 24 and 877 DF,  p-value: < 2.2e-16
```

```r
# Make predictions using the selected model
math_predictions <- predict(math_selected_model, newdata = data)

# Combine actual and predicted values for MathScore
math_results <- data.frame(
  Actual_MathScore = data$MathScore,
  Predicted_MathScore = math_predictions
)

# Save results to a CSV file
write.csv(math_results, "math_score_predictions.csv", row.names = FALSE)
```

```r
best_subset_math = regsubsets(MathScore ~ Gender + EthnicGroup + ParentEduc + LunchType + TestPrep + Pa
best_summary = summary(best_subset_math)
plot(best_summary$adjr2, type = "b",
xlab = "number of predictors",
ylab = "adjusted R^2",
main = "adjusted R^2 for subsets")
```



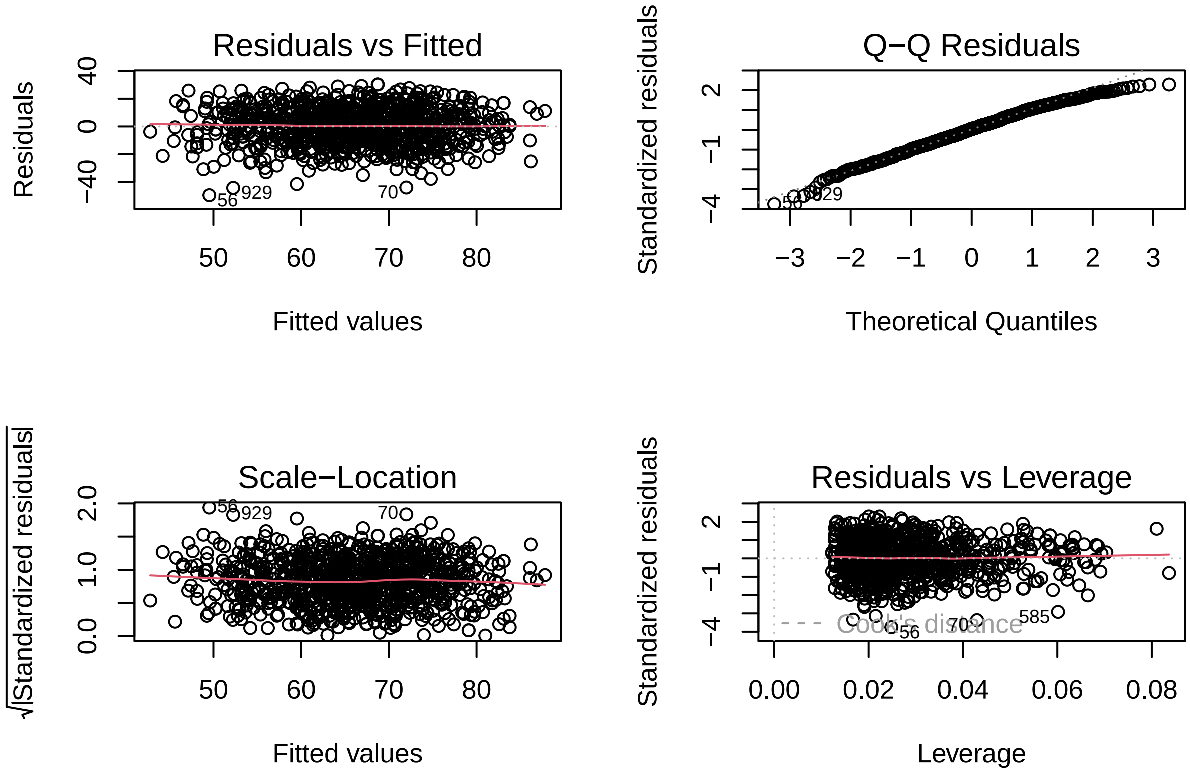
```
best_num_predictors <- which.max(best_summary$adjr2)
selected_predictors <- names(coef(best_subset_math, best_num_predictors))
cat("Selected predictors for the best model:\n")
```

```
## Selected predictors for the best model:
```

```
print(selected_predictors)
```

```
##  [1] "(Intercept)"                    "Gendermale"
##  [3] "EthnicGroupgroup D"             "EthnicGroupgroup E"
##  [5] "ParentEducassociate's degree" "ParentEducbachelor's degree"
##  [7] "ParentEducmaster's degree"    "ParentEducsome college"
##  [9] "LunchTypestandard"              "TestPrepcompleted"
## [11] "ParentMaritalStatusmarried"   "WklyStudyHours< 5"
```

```
par(mfrow = c(2, 2))
plot(math_selected_model)
```



```r
par(mfrow = c(1, 1))
```

```r
reading_full_model <- lm(ReadingScore ~ Gender + EthnicGroup + ParentEduc + LunchType + TestPrep +
                        ParentMaritalStatus + PracticeSport + IsFirstChild + NrSiblings +
                        TransportMeans + WklyStudyHours, data = data)

# Perform stepwise model selection
reading_selected_model <- stepAIC(reading_full_model, direction = "both", trace = FALSE)
reading_selected_model
```

```
##
## Call:
## lm(formula = ReadingScore ~ Gender + EthnicGroup + ParentEduc +
##     LunchType + TestPrep + ParentMaritalStatus + IsFirstChild,
##     data = data)
##
## Coefficients:
##                 (Intercept)                   Gendermale
##                    58.63929                     -7.15237
##          EthnicGroupgroup A           EthnicGroupgroup B
##                     2.11437                      1.61464
##          EthnicGroupgroup C           EthnicGroupgroup D
##                     2.10744                      4.82071
##          EthnicGroupgroup E  ParentEducassociate's degree
##                     6.46862                      5.14291
##   ParentEducbachelor's degree         ParentEduchigh school
##                     6.13542                     -0.87311
##     ParentEducmaster's degree        ParentEducsome college
##                     9.02888                      3.27435
##    ParentEducsome high school             LunchTypestandard
##                      0.05839                        7.56883
##            TestPrepcompleted                   TestPrepnone
##                      6.15804                       -0.75034
##  ParentMaritalStatusdivorced    ParentMaritalStatusmarried
##                     -1.08867                        2.67064
##    ParentMaritalStatussingle    ParentMaritalStatuswidowed
##                     -0.53098                        3.47406
##               IsFirstChildno               IsFirstChildyes
##                     -1.44383                        0.71327
```

```
# Display the summary of the selected model
cat("\nSelected Model for Reading:\n")
```

```
##
## Selected Model for Reading:
```

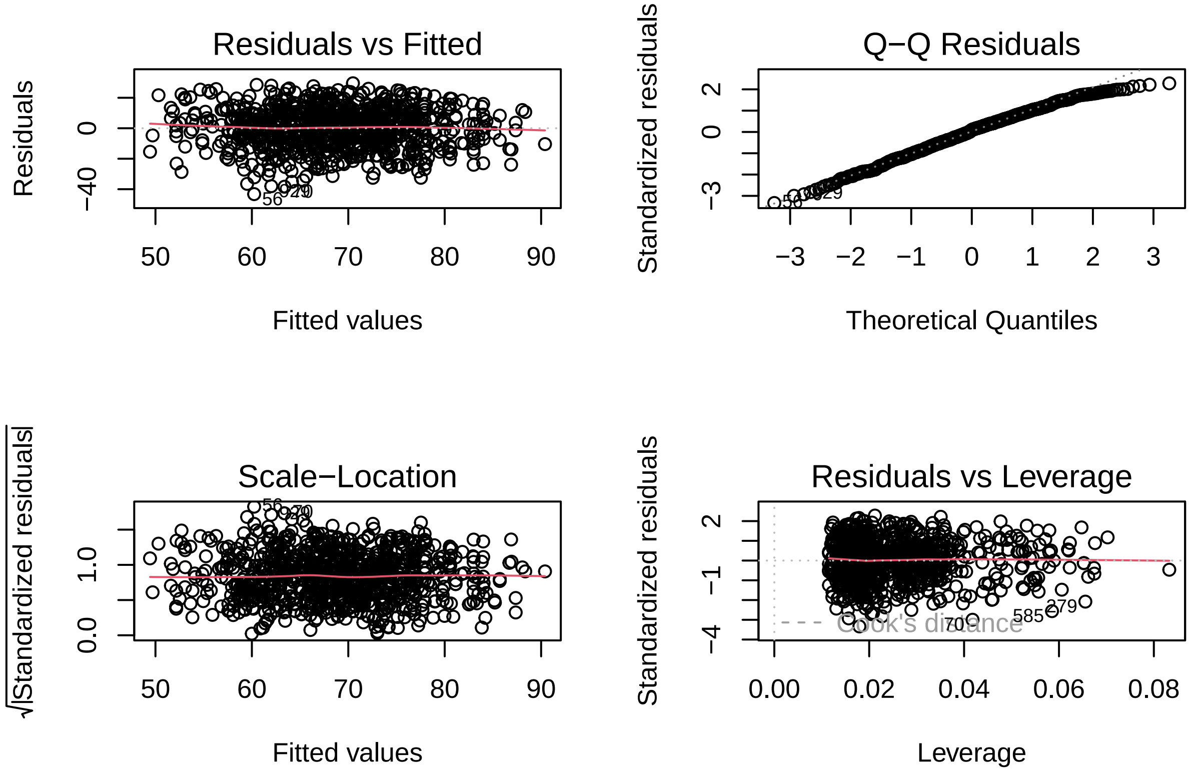
```
summary(reading_selected_model)
```

```
##
## Call:
## lm(formula = ReadingScore ~ Gender + EthnicGroup + ParentEduc +
##     LunchType + TestPrep + ParentMaritalStatus + IsFirstChild,
##     data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -43.237  -8.650   1.161   9.385  29.517
##
## Coefficients:
##                              Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  58.63929    4.50285  13.023  < 2e-16 ***
## Gendermale                   -7.15237    0.88045  -8.124 1.53e-15 ***
## EthnicGroupgroup A            2.11437    2.35196   0.899 0.368908
## EthnicGroupgroup B            1.61464    2.04598   0.789 0.430219
## EthnicGroupgroup C            2.10744    1.94808   1.082 0.279636
## EthnicGroupgroup D            4.82071    1.97981   2.435 0.015092 *
## EthnicGroupgroup E            6.46862    2.15021   3.008 0.002701 **
## ParentEducassociate's degree  5.14291    2.09638   2.453 0.014351 *
## ParentEducbachelor's degree   6.13542    2.29642   2.672 0.007685 **
## ParentEduchigh school        -0.87311    2.11963  -0.412 0.680499
## ParentEducmaster's degree     9.02888    2.60907   3.461 0.000565 ***
## ParentEducsome college        3.27435    2.09170   1.565 0.117848
## ParentEducsome high school    0.05839    2.13514   0.027 0.978191
## LunchTypestandard             7.56883    0.91763   8.248 5.83e-16 ***
## TestPrepcompleted             6.15804    1.96245   3.138 0.001758 **
## TestPrepnone                 -0.75034    1.89705  -0.396 0.692548
## ParentMaritalStatusdivorced  -1.08867    2.26625  -0.480 0.631072
## ParentMaritalStatusmarried    2.67064    2.05082   1.302 0.193177
## ParentMaritalStatussingle    -0.53098    2.17544  -0.244 0.807227
## ParentMaritalStatuswidowed    3.47406    3.33026   1.043 0.297151
## IsFirstChildno               -1.44383    2.60496  -0.554 0.579541
## IsFirstChildyes               0.71327    2.55239   0.279 0.779964
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
```

```
## Residual standard error: 13.09 on 880 degrees of freedom
## Multiple R-squared:  0.2389, Adjusted R-squared:  0.2207
## F-statistic: 13.15 on 21 and 880 DF,  p-value: < 2.2e-16
```

```
# Make predictions using the selected model
reading_predictions <- predict(reading_selected_model, newdata = data)

# Combine actual and predicted values for MathScore
reading_results <- data.frame(
  Actual_ReadingScore = data$ReadingScore,
  Predicted_ReadingScore = reading_predictions
)

# Save results to a CSV file
write.csv(reading_results, "reading_score_predictions.csv", row.names = FALSE)
```

```
par(mfrow = c(2, 2))
plot(reading_selected_model)
```



```
par(mfrow = c(1, 1))
```

```
writing_full_model <- lm(WritingScore ~ Gender + EthnicGroup + ParentEduc + LunchType + TestPrep +
                           ParentMaritalStatus + PracticeSport + IsFirstChild + NrSiblings +
                           TransportMeans + WklyStudyHours, data = data)

# Perform stepwise model selection
writing_selected_model <- stepAIC(writing_full_model, direction = "both", trace = FALSE)
writing_selected_model
```

```
##
## Call:
```

```
## lm(formula = WritingScore ~ Gender + EthnicGroup + ParentEduc +
##     LunchType + TestPrep + ParentMaritalStatus + WklyStudyHours,
##     data = data)
##
## Coefficients:
##                  (Intercept)                    Gendermale
##                     59.36546                      -9.23816
##           EthnicGroupgroup A            EthnicGroupgroup B
##                      0.63448                       0.66800
##           EthnicGroupgroup C            EthnicGroupgroup D
##                      1.27259                       5.76199
##           EthnicGroupgroup E  ParentEducassociate's degree
##                      5.03801                       4.48934
##  ParentEducbachelor's degree         ParentEduchigh school
##                      6.69286                      -2.30978
##    ParentEducmaster's degree       ParentEducsome college
##                      9.76964                       3.19346
##   ParentEducsome high school             LunchTypestandard
##                     -1.80483                       8.31180
##            TestPrepcompleted                  TestPrepnone
##                      7.72567                      -1.82437
##  ParentMaritalStatusdivorced    ParentMaritalStatusmarried
##                     -0.34162                       3.20838
##    ParentMaritalStatussingle    ParentMaritalStatuswidowed
##                     -0.05569                       3.15168
##            WklyStudyHours< 5            WklyStudyHours> 10
##                     -2.17429                      -0.16869
##         WklyStudyHours10-May
##                      0.34306
```

```r
# Display the summary of the selected model
cat("\nSelected Model for WritingScore:\n")
```

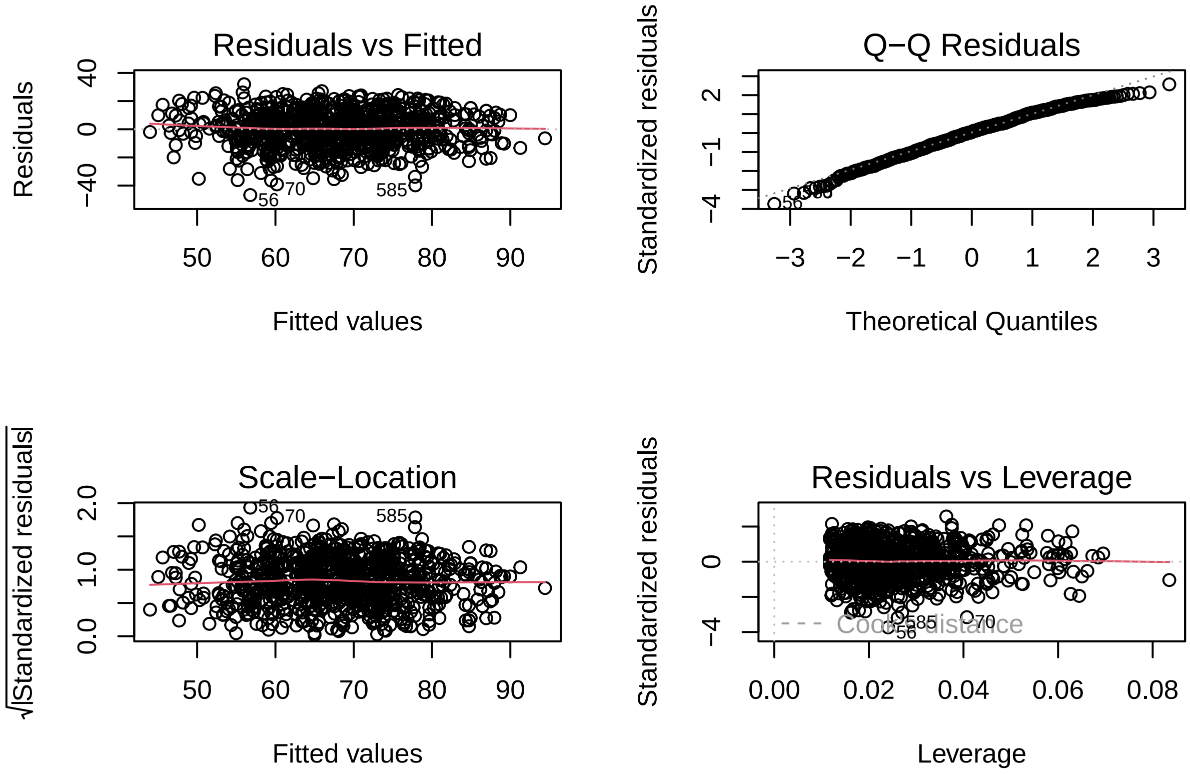
```
##
## Selected Model for WritingScore:
```

```r
summary(writing_selected_model)
```

```
##
## Call:
## lm(formula = WritingScore ~ Gender + EthnicGroup + ParentEduc +
##     LunchType + TestPrep + ParentMaritalStatus + WklyStudyHours,
##     data = data)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -46.784  -7.859   0.772   8.712  32.001
##
## Coefficients:
##                              Estimate Std. Error t value Pr(>|t|)
## (Intercept)                  59.36546    4.20505  14.118  < 2e-16 ***
## Gendermale                   -9.23816    0.85274 -10.834  < 2e-16 ***
## EthnicGroupgroup A            0.63448    2.28724   0.277 0.781539
## EthnicGroupgroup B            0.66800    1.98226   0.337 0.736205
## EthnicGroupgroup C            1.27259    1.89387   0.672 0.501790
## EthnicGroupgroup D            5.76199    1.92143   2.999 0.002787 **
## EthnicGroupgroup E            5.03801    2.08690   2.414 0.015977 *
## ParentEducassociate's degree  4.48934    2.03180   2.210 0.027394 *
## ParentEducbachelor's degree   6.69286    2.22839   3.003 0.002745 **
## ParentEduchigh school        -2.30978    2.05029  -1.127 0.260235
## ParentEducmaster's degree     9.76964    2.52630   3.867 0.000118 ***
## ParentEducsome college        3.19346    2.02703   1.575 0.115516
## ParentEducsome high school   -1.80483    2.06990  -0.872 0.383478
## LunchTypestandard             8.31180    0.88936   9.346  < 2e-16 ***
## TestPrepcompleted             7.72567    1.91429   4.036 5.92e-05 ***
## TestPrepnone                 -1.82437    1.84365  -0.990 0.322669
## ParentMaritalStatusdivorced  -0.34162    2.19391  -0.156 0.876295
## ParentMaritalStatusmarried    3.20838    1.98472   1.617 0.106336
## ParentMaritalStatussingle    -0.05569    2.10631  -0.026 0.978913
## ParentMaritalStatuswidowed    3.15168    3.23112   0.975 0.329623
## WklyStudyHours< 5            -2.17429    2.25368  -0.965 0.334924
## WklyStudyHours> 10           -0.16869    2.36248  -0.071 0.943092
## WklyStudyHours10-May          0.34306    2.18355   0.157 0.875192
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 12.68 on 879 degrees of freedom
## Multiple R-squared:  0.3347, Adjusted R-squared:  0.3181
## F-statistic:  20.1 on 22 and 879 DF,  p-value: < 2.2e-16
```

```r
# Make predictions using the selected model
writing_predictions <- predict(writing_selected_model, newdata = data)

# Combine actual and predicted values for MathScore
writing_results <- data.frame(
  Actual_WritingScore = data$WritingScore,
  Predicted_WritingScore = writing_predictions
)

# Save results to a CSV file
write.csv(writing_results, "writing_score_predictions.csv", row.names = FALSE)
```

```r
par(mfrow = c(2, 2))
plot(writing_selected_model)
```



```r
par(mfrow = c(1, 1))
```

Summary of the the predit model

```r
# Fit the three linear models
model1 <- lm(formula = ReadingScore ~ Gender + EthnicGroup + ParentEduc +
               LunchType + TestPrep + ParentMaritalStatus + IsFirstChild, data = data)

model2 <- lm(formula = MathScore ~ Gender + EthnicGroup + ParentEduc +
               LunchType + TestPrep + ParentMaritalStatus + IsFirstChild + WklyStudyHours,
             data = data)

model3 <- lm(formula = WritingScore ~ Gender + EthnicGroup + ParentEduc +
               LunchType + TestPrep + ParentMaritalStatus + WklyStudyHours, data = data)
```

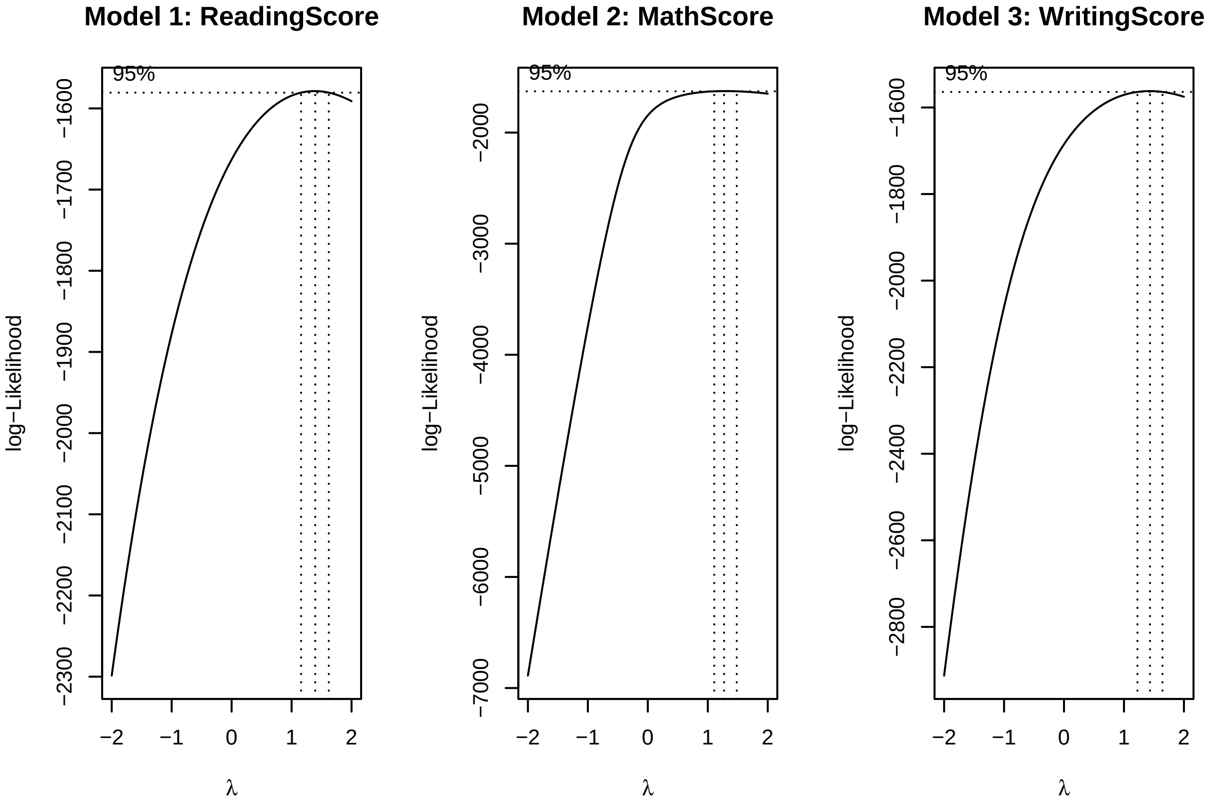
```r
summary(data$MathScore)  # Inspect the range of MathScore
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    0.00   56.00   66.00   66.03   76.00  100.00
```

```r
data$MathScore_shifted <- data$MathScore + 1
model2_shifted <- lm(MathScore_shifted ~ Gender + EthnicGroup + ParentEduc +
                       LunchType + TestPrep + ParentMaritalStatus + IsFirstChild +
                       WklyStudyHours, data = data)
```

~~~
``` r
# Set up a 1-row, 3-column layout
par(mfrow = c(1, 3))
~~~

```
# Box-Cox analysis for model1
boxcox(model1, lambda = seq(-2, 2, by = 0.1))  # Range of lambda values
title("Model 1: ReadingScore")

# Box-Cox analysis for model2
boxcox(model2_shifted, lambda = seq(-2, 2, by = 0.1))  # Range of lambda values
title("Model 2: MathScore")

# Box-Cox analysis for model3
boxcox(model3, lambda = seq(-2, 2, by = 0.1))  # Range of lambda values
title("Model 3: WritingScore")
```



Model 1: ReadingScore

Model 2: MathScore

Model 3: WritingScore

```
# Reset graphical parameters (optional)
par(mfrow = c(1, 1))
```