Build a predictive model based on Galton Family Data

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Data description: The Galton Families Data Set

The Galton family height data is accessed by R package `HistData`, where the mid-parent heights are calculated by (father+1.08*mother)/2. You may use `?GaltonFamilies` to check more details of the data set.

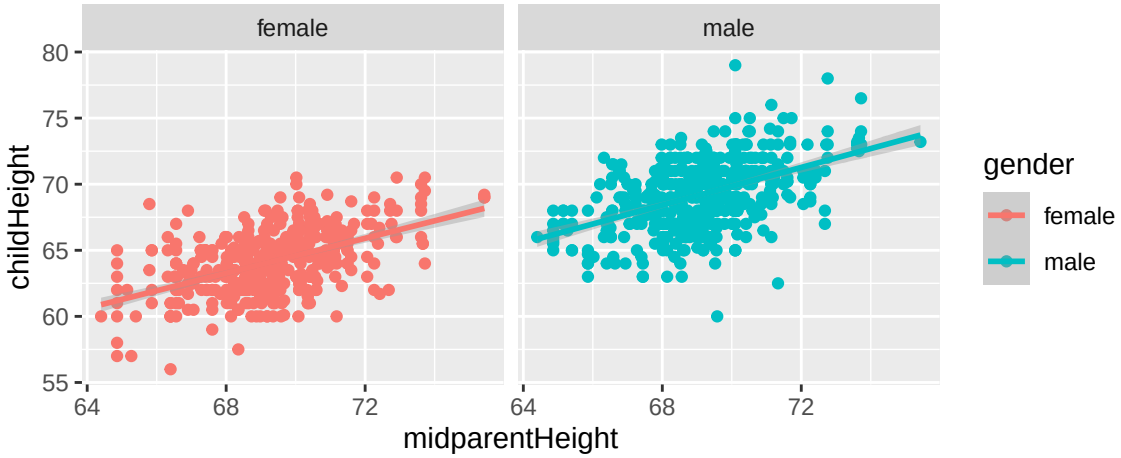
```
library(HistData)
data(GaltonFamilies)
head(GaltonFamilies)
```

```
##   family father mother midparentHeight children childNum gender childHeight
## 1    001   78.5   67.0           75.43        4        1   male        73.2
## 2    001   78.5   67.0           75.43        4        2 female        69.2
## 3    001   78.5   67.0           75.43        4        3 female        69.0
## 4    001   78.5   67.0           75.43        4        4 female        69.0
## 5    002   75.5   66.5           73.66        4        1   male        73.5
## 6    002   75.5   66.5           73.66        4        2   male        72.5
```

The relationship between the mid-parent heights and children's heights can be visualized as

```
ggplot(data=GaltonFamilies,aes(x=midparentHeight,y=childHeight,color=gender)) +
  facet_wrap(~gender) +
  geom_point()  +
  geom_smooth(method="lm")
```

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



An example of the predictive model

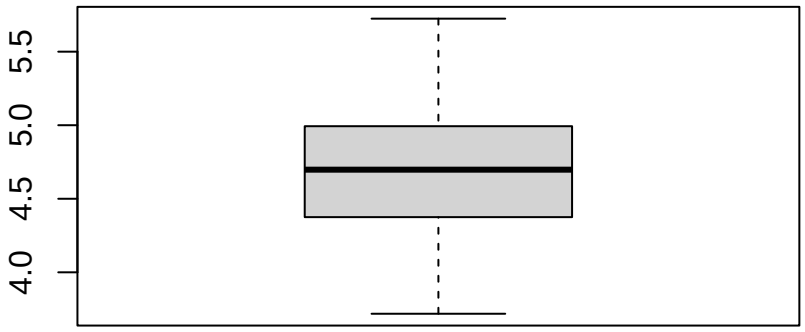
In this assignment, you are asked to fit a model to predict childHeight based on the GaltonFamilies data set. Specifically, you need to partition the whole data set into training set and testing set (Suppose you randomly select 200 children as the test set and the remaining samples are used for training). Let's take a

standard linear regression model as an example. The linear model is fitted using the training set, and its performance is evaluated on the testing set. Due to the randomness of partition, you should summarize your comparison based on 100 replications. (Hint: the prediction performance can be evaluated by mean-square error $MSE = \frac{1}{200}\sum_{i=1}^{200}(y_i - \hat{y}_i)^2$, where y_i is a childheight in the test set and y_i is the predicted value from your model). The code is given as follows:

```
set.seed(1) # set random seed for the reproduciable purpose
nrep <- 100
n <- dim(GaltonFamilies)[1]
ntest <- 200
MSE <- data.frame(matrix(0,nrep,1))
names(MSE) <- c("lm")
for (i in 1:nrep){
# partion training data and testing data
train <- sample(1:n, n-ntest, replace = FALSE)
traindata <- GaltonFamilies[train,]
testdata <- GaltonFamilies[-train,]
# Fit a baseline model
fit_baseline <- lm(childHeight~gender + midparentHeight, traindata)
# make prediction based on the fitted model
height_baseline_pred <- predict(fit_baseline,testdata)
# Evaluate model performance
MSE[i,1] <- mean((testdata$childHeight - height_baseline_pred)^2)
# Warning: You should not use childNum as a predictor in your model
# because children within a family are listed in decreasing order of height
# for boys followed by girls
}
sum(MSE)/nrep #the mean squared errors of the baseline model
```

```
## [1] 4.694932
```

```
boxplot(MSE)
```




```
head(MSE)
```

```
##         lm
## 1 4.626201
## 2 4.635080
## 3 3.718198
## 4 4.826436
## 5 4.361618
## 6 4.282380
```

Your task

Try your best to build your own model such that it can be better than the standard linear regression model in terms of the prediction accuracy (measured by the mean squared error and evaluated in the same way as the above code). Note that you should NOT use the variable childNum in your prediction model because children within a family are listed in decreasing order of height for boys followed by girls.

Requirement

You must **work independently** on this assignment. Borrowing ideas from others will lead to a **substantial reduction** of your grading. Your grading will be **zero** if your solution is quite similar with someone else, including your classmates and students who enrolled in the past few years. The similarity only depends on the judgement of the instructor.

You need to submit a report, in which you should clearly describe your method and explain your idea. The code should also be included. It takes up **10%** in the grading of this course.

You can use R, Python or Matlab for coding. You are also **allowed to call packages in R or Python** to do this project. Please make sure that you understand the method you are calling.

Your report should be in the **pdf** format, which is automatically generated by either R markdown or Jupyter notebook.

The report is due to September, 16, 2025 (11:59 pm).