Lab 2

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Task 1

- The code I typed in the console:

```
install.packages("ISLR2")
```

- Code chunks:

```
library(ISLR2)
head(Boston)
```

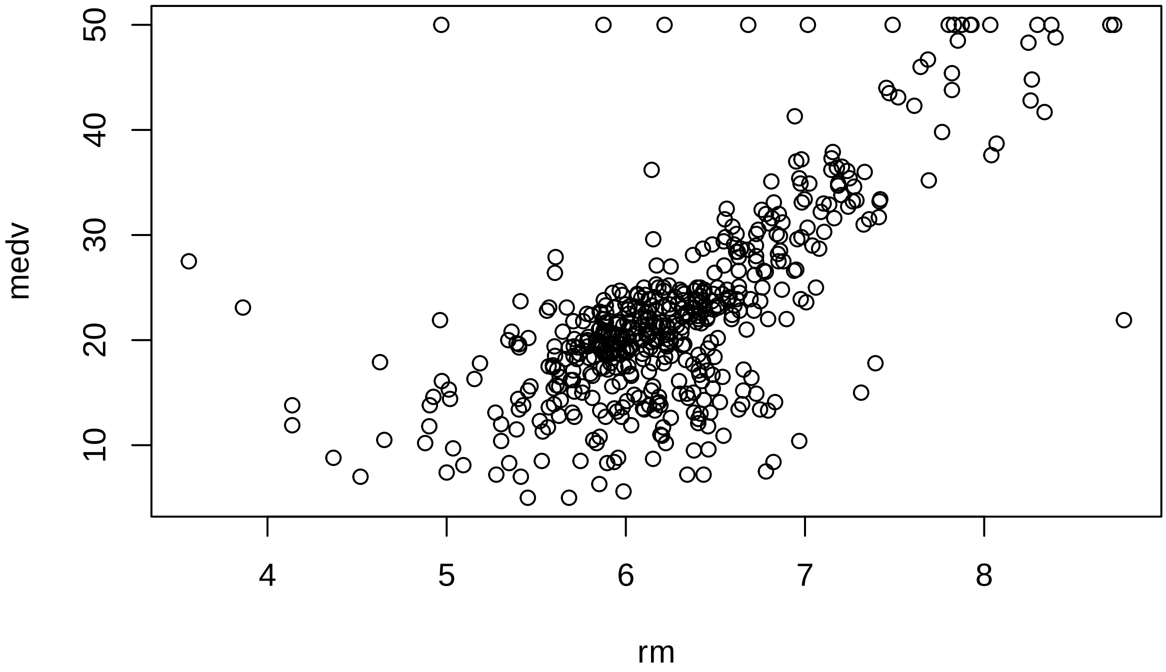
```
##      crim zn indus chas   nox    rm  age    dis rad tax ptratio lstat medv
## 1 0.00632 18  2.31    0 0.538 6.575 65.2 4.0900   1 296    15.3  4.98 24.0
## 2 0.02731  0  7.07    0 0.469 6.421 78.9 4.9671   2 242    17.8  9.14 21.6
## 3 0.02729  0  7.07    0 0.469 7.185 61.1 4.9671   2 242    17.8  4.03 34.7
## 4 0.03237  0  2.18    0 0.458 6.998 45.8 6.0622   3 222    18.7  2.94 33.4
## 5 0.06905  0  2.18    0 0.458 7.147 54.2 6.0622   3 222    18.7  5.33 36.2
## 6 0.02985  0  2.18    0 0.458 6.430 58.7 6.0622   3 222    18.7  5.21 28.7
```

- We are wanting to find a linear model with '*medv*' (median house value per $1000) as the response (output) and '*rm*' (average number of rooms per dwelling) as the predictor (input).
- **Question 1**: For the 6th suburb of Boston what is the median house value and the average number of rooms per dwelling?
  - **Answer**: For the 6th suburb of Boston the median house value '*medv*' is **28.7** and the average number of rooms per dwelling '*rm*' is **6.430**

Task 2

- The code I typed for the graph:

```
plot(Boston$rm,Boston$medv,xlab = "rm",ylab = "medv")
```



- **Question 2**: According to the plot what is the relationship between median value of homes and average number of rooms per dwelling?
  - **Answer**: The relationship between '*medv*' and '*rm*' is *strong positive linear*.
  - We can also find the correlation to explain the correlation between median value of homes and average number of rooms per dwelling by:

```
cor(Boston$rm,Boston$medv)
```

```
## [1] 0.6953599
```

Task 3

- In the code chunk type:

```
lm.fit <- lm(medv ~ rm, data = Boston)
summary(lm.fit)
```

```
##
## Call:
## lm(formula = medv ~ rm, data = Boston)
##
## Residuals:
```

```
##     Min      1Q  Median      3Q     Max
## -23.346  -2.547   0.090   2.986  39.433
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -34.671      2.650  -13.08   <2e-16 ***
## rm             9.102      0.419   21.72   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 6.616 on 504 degrees of freedom
## Multiple R-squared:  0.4835, Adjusted R-squared:  0.4825
## F-statistic: 471.8 on 1 and 504 DF,  p-value: < 2.2e-16
```

- **Question 1**: Give the linear model equation.
  - **Answer**: $\hat{y} = 9.102x - 34.671$
- **Question 2**: What is the percent of variation of medv that can be explained by this model?
  - **Answer**: The percent of variation can be explain by R-square which is **0.4835**, therefore, **48.35%** of the data can be explained by the equation.
- **Question 3**: Is rm a good predictor for medv? Justify your answer.
  - **Answer**: Using $H_0 : \beta_1 = 0$ and p-value = 0
  - Since p-value $< \alpha = 0.05$, we fail to RHo and therefore there is a relationship between *medv* and *rm*.

Task 4

- In a code chunk type:

```
confint(lm.fit)
```

```
##                  2.5 %     97.5 %
## (Intercept) -39.876641 -29.464601
## rm            8.278855   9.925363
```

- **Question 6**: What is the 95% confidence interval for the slope β_1 of this model?
  - **Answer**: [$8,278.85, $9,925.36]

Task 5

- The *predict()* function can be used to produce predictions, confidence interval and prediction intervals for the prediction of *medv* for a given value of *rm*.
- The **confidence interval** is used to determine the average predicted value for the response variable.
- The **prediction interval** is used to determine the prediction for one observation of the response variable.
- Suppose we want to determine a predicted value of *medv* based on the average number of rooms per dwelling at 5, 6, and 7. We can type the following in a code chunk

```
predict(lm.fit, data.frame(rm = c(5, 6, 7)))
```

```
##        1        2        3
## 10.83992 19.94203 29.04414
```

```
predict(lm.fit, data.frame(rm = c(5, 6, 7)),
        interval = "confidence")
```

```
##        fit       lwr      upr
## 1 10.83992  9.634769 12.04508
## 2 19.94203 19.318469 20.56560
## 3 29.04414 28.219061 29.86922
```

```
predict(lm.fit, data.frame(rm = c(5, 6, 7)),
        interval = "prediction")
```

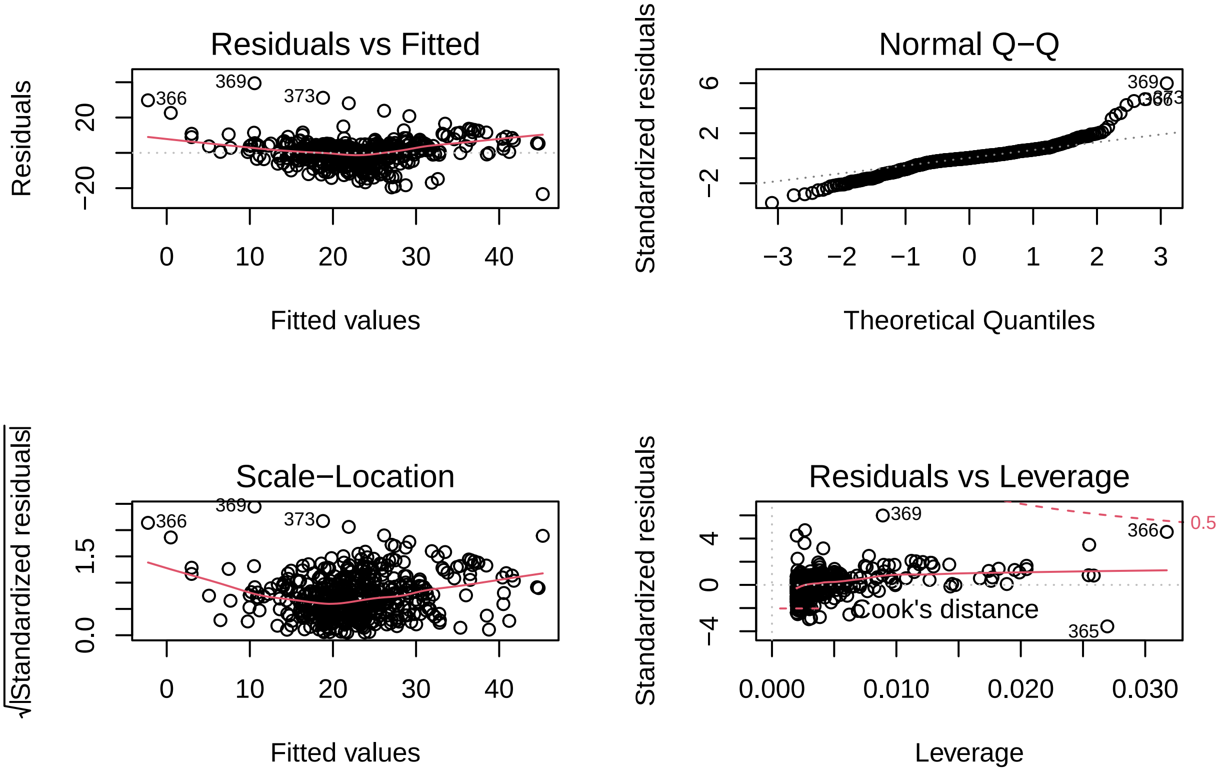
```
##        fit       lwr      upr
## 1 10.83992 -2.214474 23.89432
## 2 19.94203  6.928435 32.95563
## 3 29.04414 16.019333 42.06895
```

- **Question 7**: What is the predicted median value of homes where the average number of rooms per dwelling is 5?
  - **Answer**: $10,839.92
- Notice that the **confidence interval** for 5 is [9.634, 12.045]. The interpretation is: on average the median value of the homes in all of the suburbs with average of 5 rooms is between $9,634 and $12,45.
- Notice that the **prediction interval** for 5 is [-2.214, 23.894]. The interpretation is: if we look at one suburb, the predicted median home value for that suburb will be between -$2,214 and $23,894.

Task 6

- We can check assumptions through the plots of the model.
- Using the code chunk type:

```
par(mfrow = c(2,2))
plot(lm.fit)
```



- **Question 8**: Do there appear to be extreme values?
  - **Answer**: Yes at 366. Because we have extreme value, this might be the reason why our R-square value is low.
- We can use the leverage statistics to determine extreme values. The function to fnd the leverage statistics **hatvalues()**.
- Using the code chunk type:

```
which.max(hatvalues(lm.fit))
```

```
## 366
## 366
```

- The **which.max()** function identifies the index (row) of the largest element of a vector.
- **Question 9**: Which row has the largest leverage?
  - **Answer**: 366
- Using the code chunk type: **Boston[number of largest leverage,]**.

```
Boston[366,]
```

```
##        crim zn indus chas   nox    rm  age    dis rad tax ptratio lstat medv
## 366 4.55587  0  18.1    0 0.718 3.561 87.9 1.6132  24 666    20.2  7.12 27.5
```

- **Question 10**: How many average number of rooms per dwelling and what is the median value of the homes in this suburb?
  - **Answer**: The average number of rooms per dwelling '*rm*' is **3.561** and the median value of the homes '*medv*' is **27.5**.