hw5

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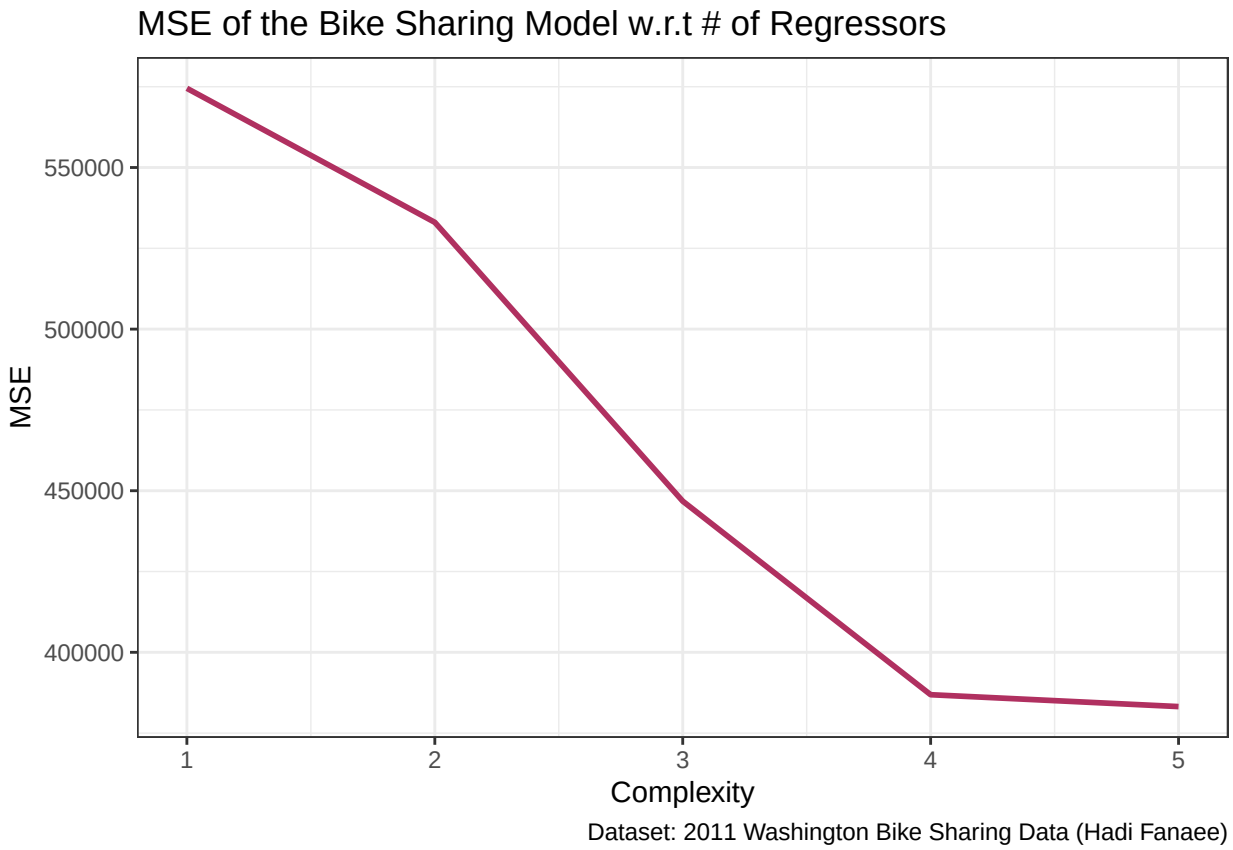
```
set.seed(10000)
# Data Processing
day <- read.csv("day.csv")
hour <- read.csv("hour.csv")
data_day <- subset(day, yr == 0)
data_day <- data_day %>%
  mutate(clearday = ifelse(weathersit == 1, 1, 0))
data_day <- data_day %>%
  mutate(temp = (temp-min(temp))/(max(temp)-min(temp)))
```

```
# Fitting Models
model_1 <- lm(registered ~ temp, data = data_day)
model_2 <- lm(registered ~ temp + I(temp^2), data = data_day)
model_3 <- lm(registered ~ temp + I(temp^2) + workingday, data = data_day)
model_4 <- lm(registered ~ temp + I(temp^2) + workingday + clearday, data = data_day)
model_5 <- lm(registered ~ temp + I(temp^2) + workingday + clearday + temp*workingday, data = data_day)
# stargazer(model_1, model_2, model_3, model_4, model_5, type = 'latex')
```

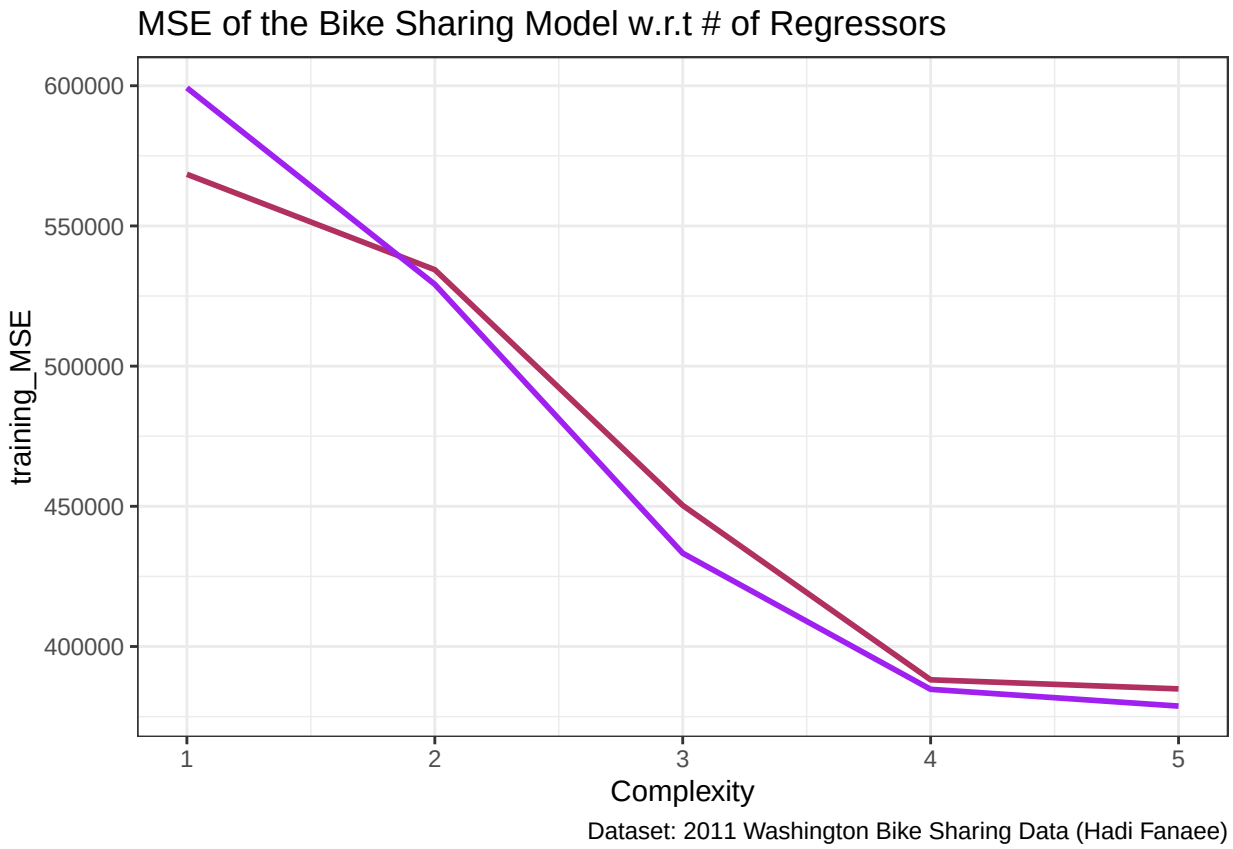
```
# Basic Model Comparison
MSE <- rep(0,5)
MSE[1] = mean(model_1$residuals^2)
MSE[2] = mean(model_2$residuals^2)
MSE[3] = mean(model_3$residuals^2)
MSE[4] = mean(model_4$residuals^2)
MSE[5] = mean(model_5$residuals^2)
MSE %>% data.frame("Complexity" = 1:5, MSE = MSE) %>%
  ggplot() + theme_bw() +
  geom_line(aes(x = Complexity, y = MSE), color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model w.r.t # of Regressors",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```




```r
# Hold-out Method
subs <- sample(365, 292)
# Subtracting Training and Test Set
trainingSet <- data_day[subs, ]
testSet <- data_day[-subs, ]
# Train the Model
model_1 <- lm(registered ~ temp, data = trainingSet)
model_2 <- lm(registered ~ temp + I(temp^2), data = trainingSet)
model_3 <- lm(registered ~ temp + I(temp^2) + workingday, data = trainingSet)
model_4 <- lm(registered ~ temp + I(temp^2) + workingday + clearday, data = trainingSet)
model_5 <- lm(registered ~ temp + I(temp^2) + workingday + clearday + temp*workingday, data = trainingS
# Compute the training MSE
MSE <- rep(0,5)
MSE[1] = mean(model_1$residuals^2)
MSE[2] = mean(model_2$residuals^2)
MSE[3] = mean(model_3$residuals^2)
MSE[4] = mean(model_4$residuals^2)
MSE[5] = mean(model_5$residuals^2)
# Compute the test MSE
test_MSE = rep(0,5)
testX = cbind(1, testSet$temp)
test_MSE[1] = mean((testSet[, "registered"] - testX %*% model_1$coefficients)^2)
testX = cbind(1, testSet$temp, testSet$temp^2)
test_MSE[2] = mean((testSet[, "registered"] - testX %*% model_2$coefficients)^2)
testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday)
test_MSE[3] = mean((testSet[, "registered"] - testX %*% model_3$coefficients)^2)
```

```
testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday, testSet$clearday)
test_MSE[4] = mean((testSet[, "registered"] - testX %*% model_4$coefficients)^2)
testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday, testSet$clearday, testSet$temp * tes
test_MSE[5] = mean((testSet[, "registered"] - testX %*% model_5$coefficients)^2)
```

```
data.frame("Complexity" = 1:5, training_MSE = MSE, test_MSE = test_MSE) %>%
  ggplot() + theme_bw() +
  geom_line(aes(x = Complexity, y = training_MSE), color = 'maroon', size = 1) +
  geom_line(aes(x = Complexity, y = test_MSE), color = 'purple', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model w.r.t # of Regressors",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```



Problem 5 Bike Sharing: Cross-validation

```
# Create 10 folds
fold <- list()
tempdata <- data_day
i = 1
data_day <- data_day %>%
  mutate(fold = 0)
while (nrow(tempdata)>5){
```

```
  fold[[i]] <-   sample_n(tempdata, 36)
  tempdata <- tempdata %>%
    filter(!(instant %in% fold[[i]]$instant))
  i = i+1
}
for (i in 1:nrow(data_day)){
  for (j in 1:10){
    if (data_day$instant[i] %in% fold[[j]]$instant){
      data_day$fold[i] = j
    }
  }
}
```

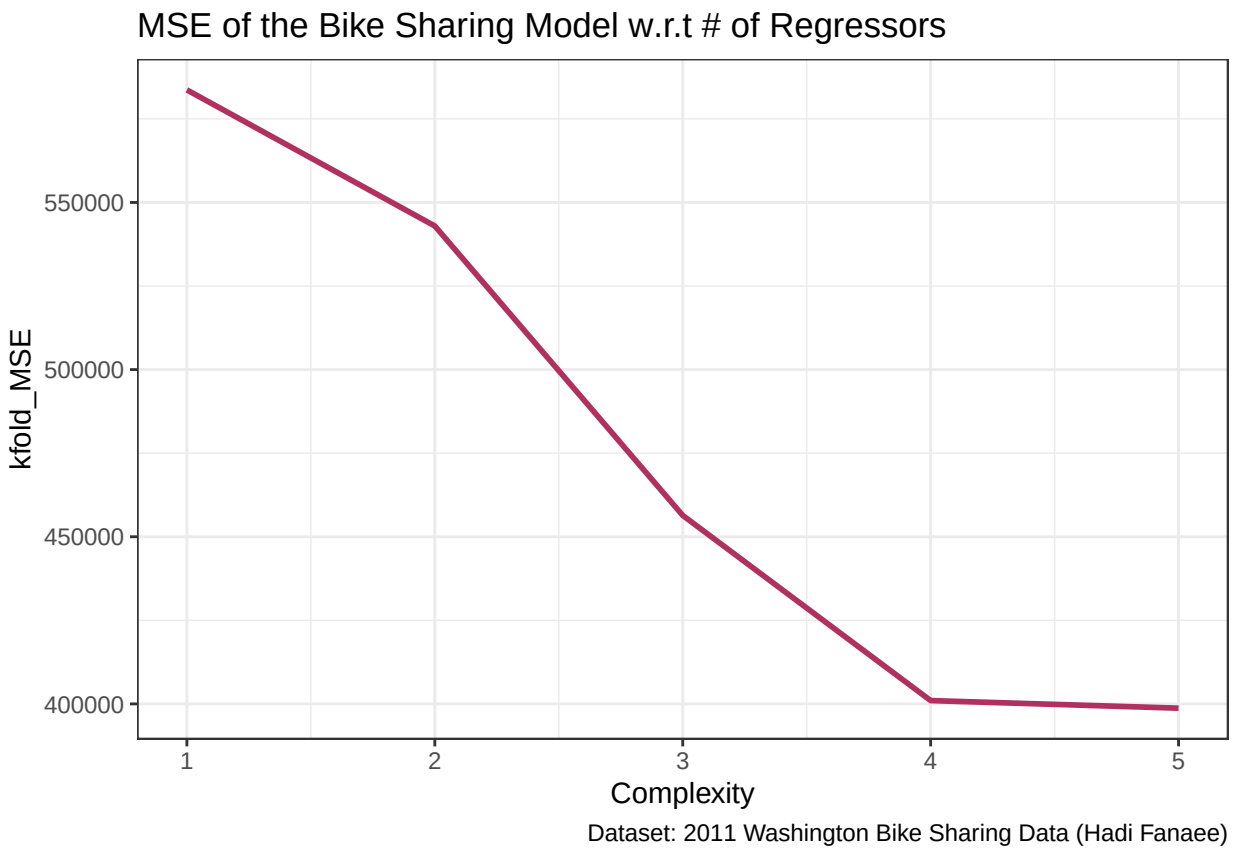
```
MSE <- matrix(0, nrow = 5, ncol = 10)
for (i in 1:10){
  trainingSet = data_day %>% filter(fold != i)
  testSet = data_day %>% filter(fold == i)
  model_1 <- lm(registered ~ temp, data = trainingSet)
  model_2 <- lm(registered ~ temp + I(temp^2), data = trainingSet)
  model_3 <- lm(registered ~ temp + I(temp^2) + workingday, data = trainingSet)
  model_4 <- lm(registered ~ temp + I(temp^2) + workingday + clearday, data = trainingSet)
  model_5 <- lm(registered ~ temp + I(temp^2) + workingday + clearday + temp*workingday, data = trainin
  testX = cbind(1, testSet$temp)
  MSE[1, i] = mean((testSet[, "registered"] - testX %*% model_1$coefficients)^2)
  testX = cbind(1, testSet$temp, testSet$temp^2)
  MSE[2, i] = mean((testSet[, "registered"] - testX %*% model_2$coefficients)^2)
  testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday)
  MSE[3, i] = mean((testSet[, "registered"] - testX %*% model_3$coefficients)^2)
  testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday, testSet$clearday)
  MSE[4, i] = mean((testSet[, "registered"] - testX %*% model_4$coefficients)^2)
  testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday, testSet$clearday, testSet$temp * te
  MSE[5, i] = mean((testSet[, "registered"] - testX %*% model_5$coefficients)^2)
}
MSE
```

```
##          [,1]     [,2]     [,3]     [,4]     [,5]     [,6]     [,7]
## [1,] 758856.4 466304.8 509418.4 707323.6 677892.4 485899.7 521152.0
## [2,] 717297.5 469081.1 470483.5 638717.2 589642.4 438569.0 453312.3
## [3,] 648848.3 412820.9 305583.0 551156.8 436616.1 534552.3 349198.8
## [4,] 577146.7 359617.3 344021.8 391933.1 419637.6 460725.7 330256.5
## [5,] 555948.2 377214.5 344582.6 375084.5 409372.8 444682.4 349162.2
##          [,8]     [,9]    [,10]
## [1,] 443595.7 507893.4 758339.8
## [2,] 434179.4 461025.4 757344.9
## [3,] 314773.5 361993.6 648256.4
## [4,] 276733.8 342148.6 507739.0
## [5,] 277027.0 342049.1 512121.6
```

```
MSE_bar <- c()
for (i in 1:5){
  print(mean(MSE[i, ]))
  MSE_bar <- c(MSE_bar, mean(MSE[i, ]))
}
```

```
## [1] 583667.6
## [1] 542965.3
## [1] 456380
## [1] 400996
## [1] 398724.5
```

```
data.frame("Complexity" = 1:5, "kfold_MSE" = MSE_bar) %>%
  ggplot() + theme_bw() +
  geom_line(aes(x = Complexity, y = kfold_MSE), color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model w.r.t # of Regressors",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```



Problem 6 BootStrap MSE

```
MSE <- matrix(0, nrow = 5, ncol = 200)
for (i in 1:200){
  trainingSet <- data_day[sample(365, 200, replace = TRUE), ]
  testSet <- data_day %>%
    filter(! instant %in% trainingSet$instant)
  model_1 <- lm(registered ~ temp, data = trainingSet)
  model_2 <- lm(registered ~ temp + I(temp^2), data = trainingSet)
  model_3 <- lm(registered ~ temp + I(temp^2) + workingday, data = trainingSet)
```

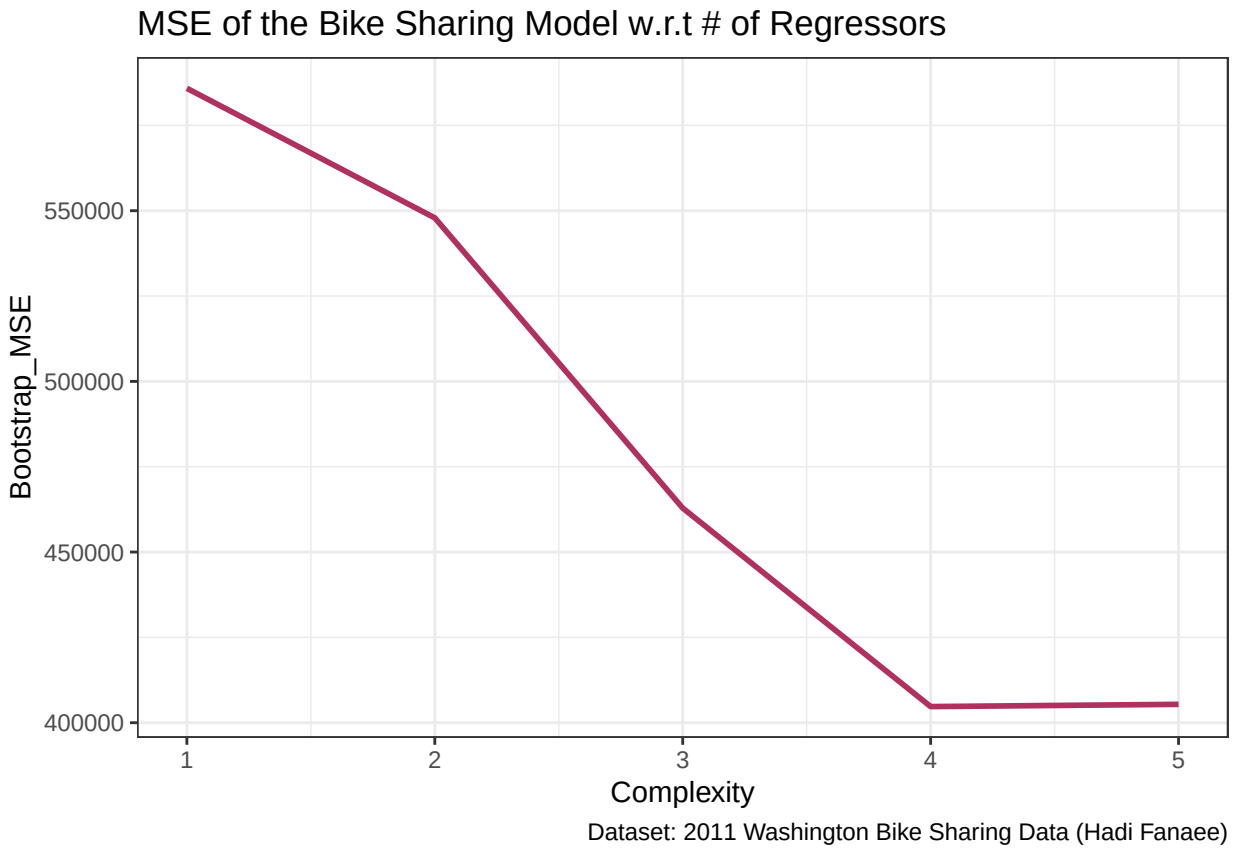
```
  model_4 <- lm(registered ~ temp + I(temp^2) + workingday + clearday, data = trainingSet)
  model_5 <- lm(registered ~ temp + I(temp^2) + workingday + clearday + temp*workingday, data = trainin
  testX = cbind(1, testSet$temp)
  MSE[1, i] = mean((testSet[, "registered"] - testX %*% model_1$coefficients)^2)
  testX = cbind(1, testSet$temp, testSet$temp^2)
  MSE[2, i] = mean((testSet[, "registered"] - testX %*% model_2$coefficients)^2)
  testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday)
  MSE[3, i] = mean((testSet[, "registered"] - testX %*% model_3$coefficients)^2)
  testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday, testSet$clearday)
  MSE[4, i] = mean((testSet[, "registered"] - testX %*% model_4$coefficients)^2)
  testX = cbind(1, testSet$temp, testSet$temp^2, testSet$workingday, testSet$clearday, testSet$temp * te
  MSE[5, i] = mean((testSet[, "registered"] - testX %*% model_5$coefficients)^2)
}
MSE_bar <- c()
for (i in 1:5){
  print(mean(MSE[i, ]))
  MSE_bar <- c(MSE_bar, mean(MSE[i, ]))
}
```

```
## [1] 585855.7
## [1] 547896.3
## [1] 462879.2
## [1] 404732
## [1] 405384.7
```

```
MSE_bar
```

```
## [1] 585855.7 547896.3 462879.2 404732.0 405384.7
```

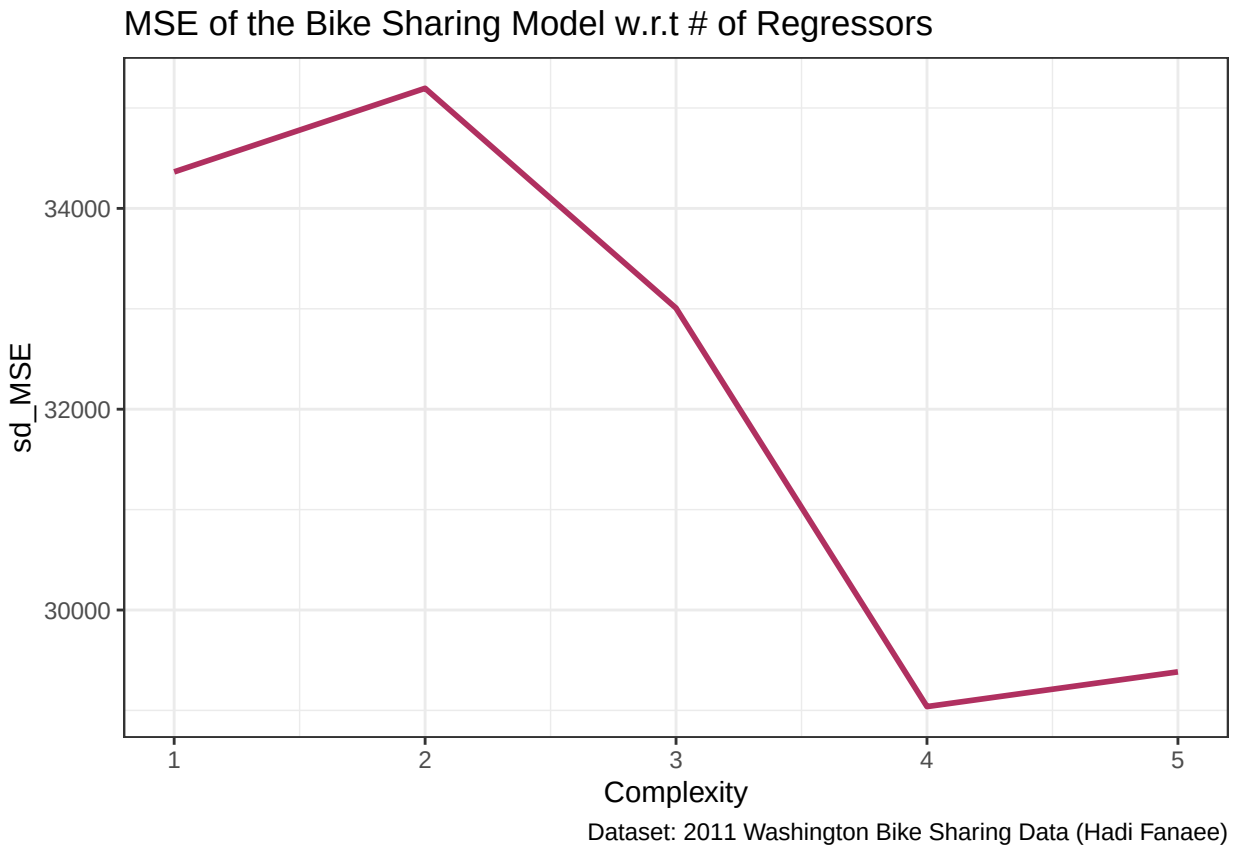
```
data.frame("Complexity" = 1:5, "Bootstrap_MSE" = MSE_bar) %>%
  ggplot() + theme_bw() +
  geom_line(aes(x = Complexity, y = Bootstrap_MSE), color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model w.r.t # of Regressors",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```




```
MSE_var <- c()
for (i in 1:5){
  print(sd(MSE[i, ]))
  MSE_var <- c(MSE_var, sd(MSE[i, ]))
}
```

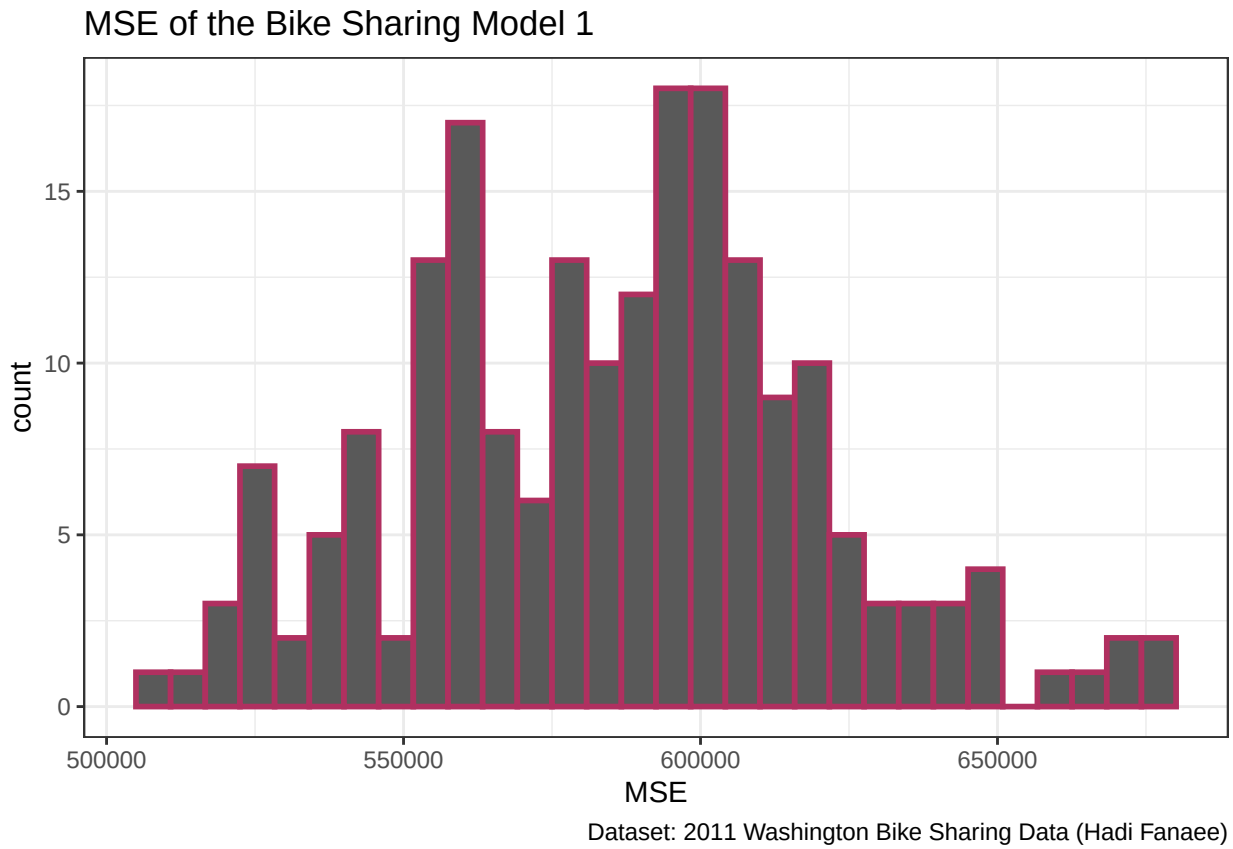
```
## [1] 34363.53
## [1] 35195.96
## [1] 33006.79
## [1] 29038.2
## [1] 29383.97
```

```
data.frame("Complexity" = 1:5, "sd_MSE" = MSE_var) %>%
  ggplot() + theme_bw() +
  geom_line(aes(x = Complexity, y = sd_MSE), color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model w.r.t # of Regressors",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```



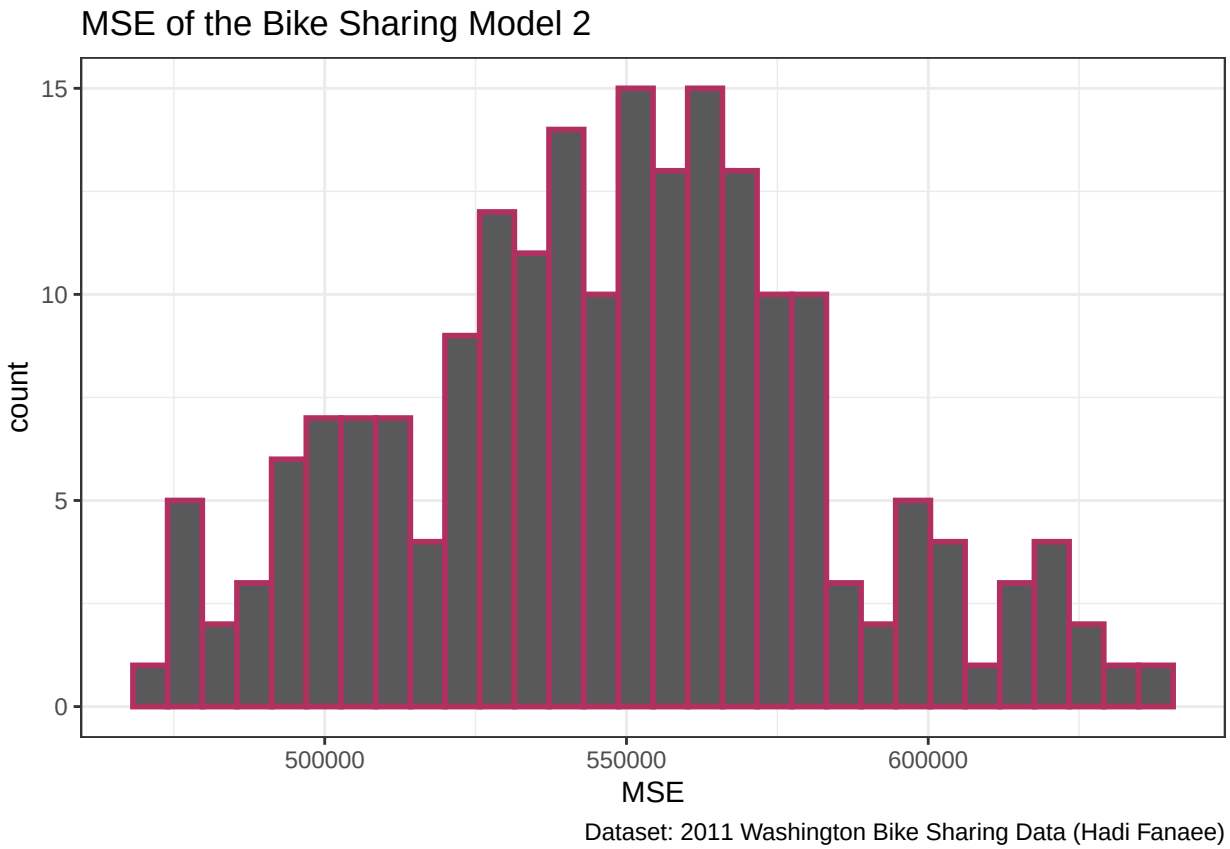

```
data.frame("Complexity" = 1:5, "MSE" = MSE[1,]) %>%
  ggplot() + theme_bw() +
  geom_histogram(aes(x = MSE),color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model 1",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



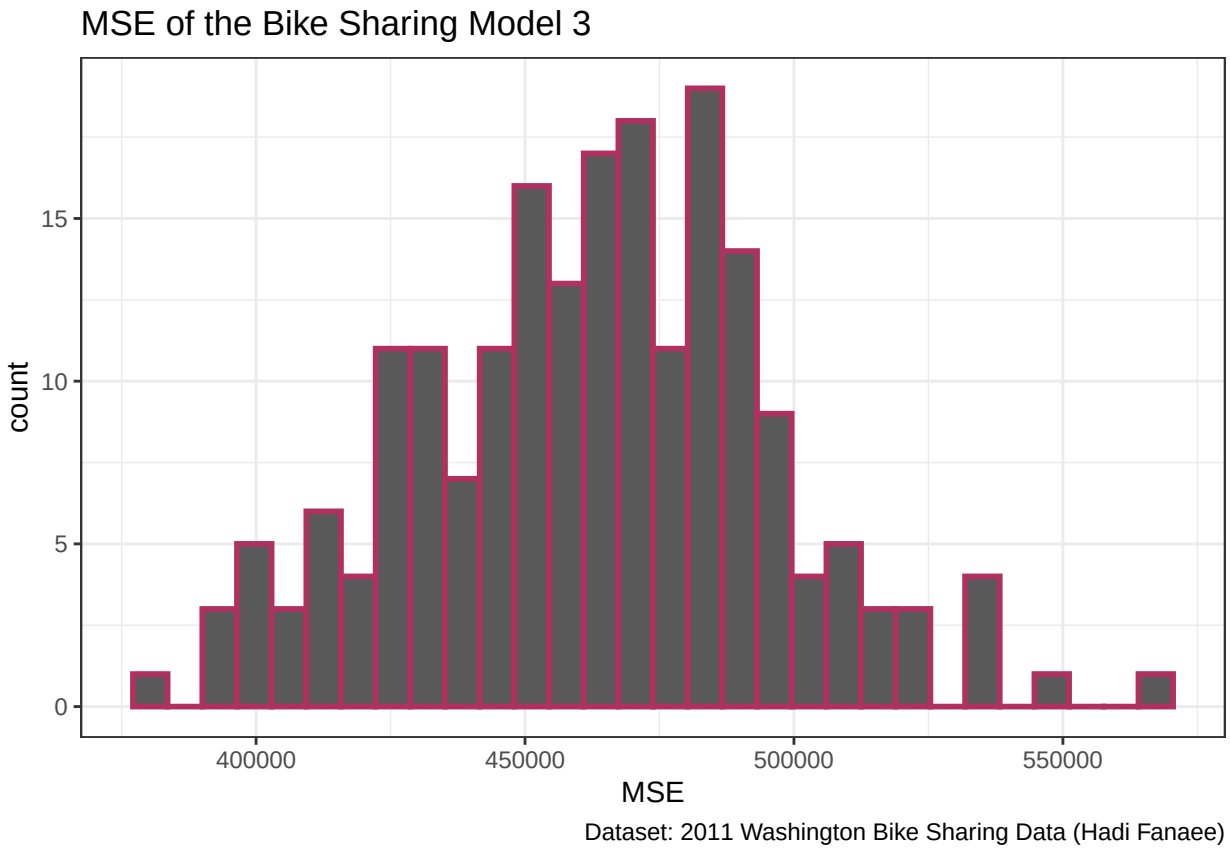

```
data.frame("Complexity" = 1:5, "MSE" = MSE[2,]) %>%
  ggplot() + theme_bw() +
  geom_histogram(aes(x = MSE),color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model 2",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



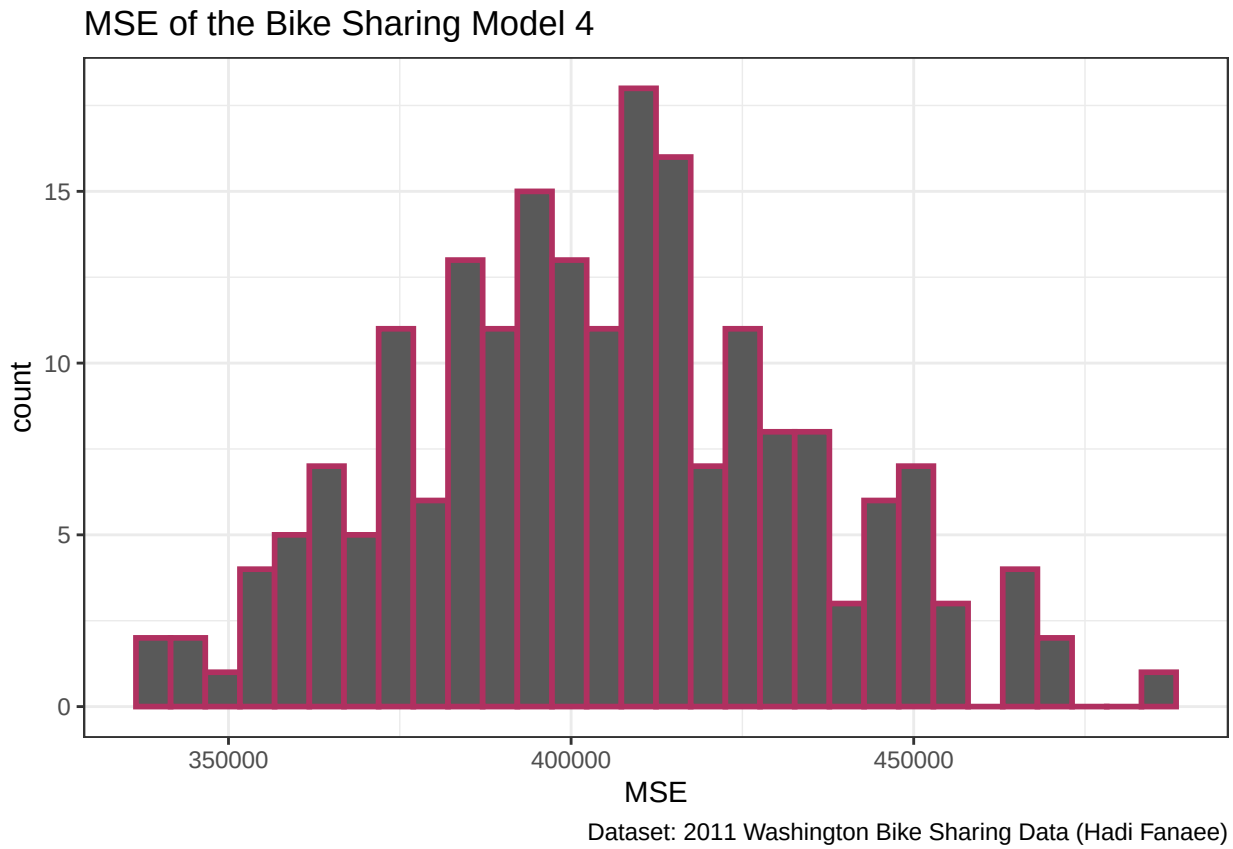

```
data.frame("Complexity" = 1:5, "MSE" = MSE[3,]) %>%
  ggplot() + theme_bw() +
  geom_histogram(aes(x = MSE),color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model 3",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



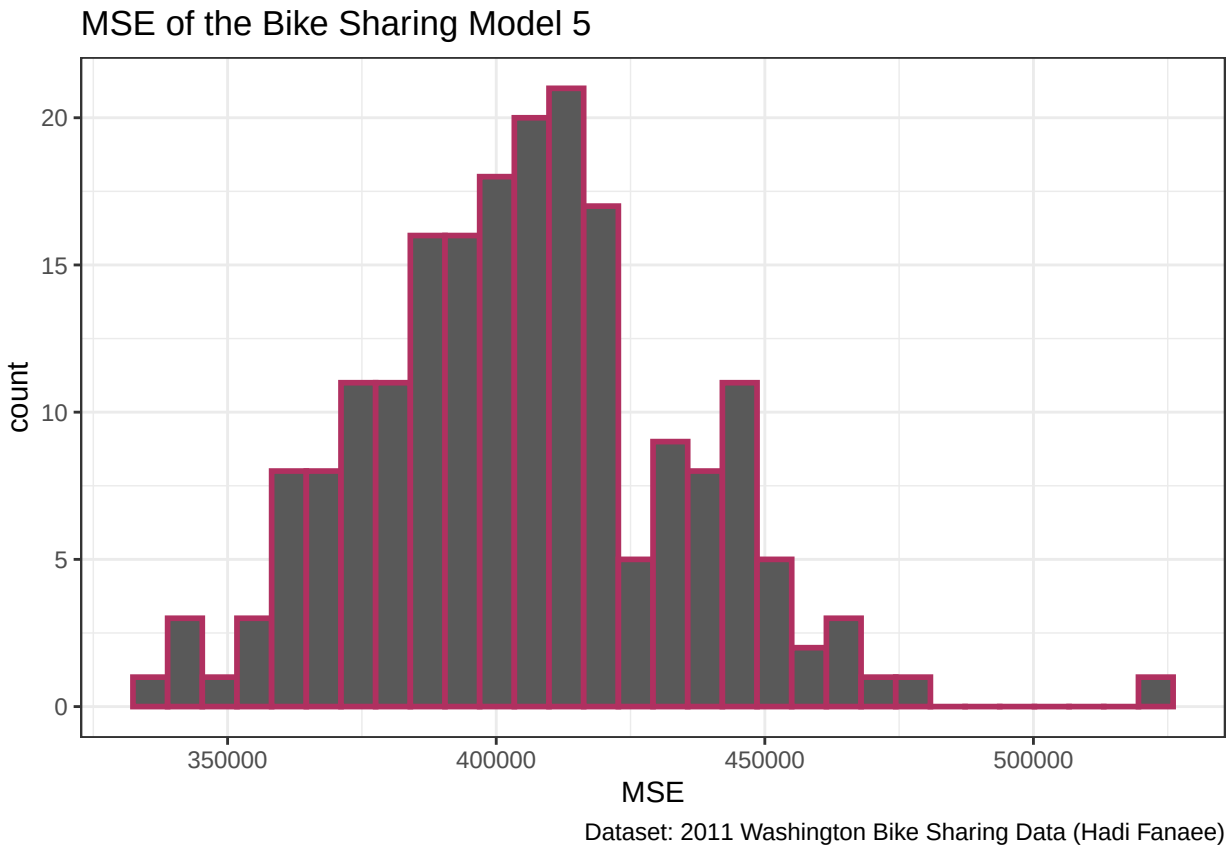

```
data.frame("Complexity" = 1:5, "MSE" = MSE[4,]) %>%
  ggplot() + theme_bw() +
  geom_histogram(aes(x = MSE),color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model 4",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
data.frame("Complexity" = 1:5, "MSE" = MSE[5,]) %>%
  ggplot() + theme_bw() +
  geom_histogram(aes(x = MSE),color = 'maroon', size = 1) +
  labs(
    title = "MSE of the Bike Sharing Model 5",
    caption = "Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)"
  )
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```


MSE of the Bike Sharing Model 5
count
20
15
10
5
0
350000
400000
450000
500000
MSE
Dataset: 2011 Washington Bike Sharing Data (Hadi Fanaee)