

Compulsory exercise 1: Group 5

TMA4268 Statistical Learning V2022

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Problem 1

a)

$$\begin{aligned} E[y_0 - \hat{f}(x_0)]^2 &= E[(f(x_0) + \varepsilon - \hat{f}(x_0))^2] \\ &= E[(f(x_0))^2] + E[\varepsilon^2] + E[\hat{f}(x_0)^2] - 2E[f(x_0)\hat{f}(x_0)] + 2E[f(x_0)\varepsilon] + 2E[\hat{f}(x_0)\varepsilon] \\ &= f(x_0)^2 + \text{Var}(\varepsilon) + \text{Var}(\hat{f}(x_0)) + E[\hat{f}(x_0)]^2 - 2E[f(x_0)\hat{f}(x_0)] \\ &= (f(x_0) - E[\hat{f}(x_0)])^2 + \text{Var}(\hat{f}(x_0)) + \text{Var}(\varepsilon) \end{aligned}$$

The three terms in the last line are the squared bias, variance, and irreducible error respectively.

b)

The three terms can be interpreted as the following. The bias term is the error that comes from modeling a complicated real-life problem with a simple model. The more flexible the model is, the smaller the bias will be. The variance term is how much the estimate \hat{f} would change if we were using different training data. The more flexible the model is, the larger the variance will be. Lastly, the irreducible error term is simply the error that comes from the error in the data itself.

c)

- (i) True
- (ii) False
- (iii) True
- (iv) False

d)

e)

Problem 2

Here is a code chunk:

```
library(palmerpenguins) # Contains the data set "penguins".
data(penguins)
head(penguins)

## # A tibble: 6 x 8
##   species island bill_length_mm bill_depth_mm flipper_length~ body_mass_g sex
##   <fct>   <fct>         <dbl>         <dbl>         <int>         <int> <fct>
```

```
## 1 Adelie Torge~      39.1      18.7      181      3750 male
## 2 Adelie Torge~      39.5      17.4      186      3800 fema~
## 3 Adelie Torge~      40.3      18      195      3250 fema~
## 4 Adelie Torge~      NA      NA      NA      NA NA
## 5 Adelie Torge~      36.7      19.3      193      3450 fema~
## 6 Adelie Torge~      39.3      20.6      190      3650 male
## # ... with 1 more variable: year <int>
```

a)

b)

c)

Problem 3

Problem 4