Statistical Learning

Masoud Faridi

2024-09-28

What Is Statistical Learning?

Suppose that we observe a quantitative response Y and p different predictors, $X_1, X_2, \cdots, X_p$. We assume that there is some relationship between Y and $X = (X_1, X_2, \cdots, X_p)$, which can be written in the very general form $Y = f(X) + \epsilon$.

Here f is some fixed but unknown function of $X_1, ..., X_p$, and ϵ is a random error term, which is independent of X and has mean zero. In this formulation, f represents the systematic information that X provides about Y.

Consider a given estimate $\hat{f}$ and a set of predictors X, which yields the prediction $\hat{Y} = \hat{f}(X)$. Assume for a moment that both $\hat{f}$ and X are fixed, so that the only variability comes from ϵ. Then, it is easy to show that

$$E(Y - \hat{Y})^2 = E\left(f(X) + \epsilon - \hat{f}(X)\right)^2 = \left(f(X) - \hat{f}(X)\right)^2 + \text{Var}(\epsilon)$$

$$= \underbrace{[f(X) - \hat{f}(X)]^2}_{\text{Reducible}} + \underbrace{\text{Var}(\epsilon)}_{\text{Irreducible}}$$

Slide with Bullets

- Bullet 1
- Bullet 2
- Bullet 3

Slide with R Output

```
summary(cars)
```

```
##      speed           dist       
##  Min.   : 4.0   Min.   :  2.00  
##  1st Qu.:12.0   1st Qu.: 26.00  
##  Median :15.0   Median : 36.00  
##  Mean   :15.4   Mean   : 42.98  
##  3rd Qu.:19.0   3rd Qu.: 56.00  
##  Max.   :25.0   Max.   :120.00
```

Slide with Plot