

4. Suppose we estimate the regression coefficients in a linear regression model by minimizing

$$\sum_{i=1}^n \left(y_i - \beta_0 - \sum_{j=1}^p \beta_j x_{ij} \right)^2 + \lambda \sum_{j=1}^p \beta_j^2$$

for a particular value of λ . For parts (a) through (e), indicate which of i. through v. is correct. Justify your answer.

(a) As we increase λ from 0, the training RSS will:

- i. Increase initially, and then eventually start decreasing in an inverted U shape.
- ii. Decrease initially, and then eventually start increasing in a U shape.
- iii. Steadily increase.
- iv. Steadily decrease.
- v. Remain constant.

(b) Repeat (a) for test RSS.

(c) Repeat (a) for variance.

(d) Repeat (a) for (squared) bias.

(e) Repeat (a) for the irreducible error.

Ans :

(a) \bar{iii} (3)

(b) \bar{ii} (2)

(c) \bar{iv} (4)

(d) \bar{iii} (3)

(e) \bar{v} (5)

Reason :

(a) \bar{iii} : When λ increases, the regularization term penalizes the model heavily, causing the flexibility reduces, then RSS will steadily increases.

(b) \bar{ii} : As λ increases, test RSS initially decreases as overfitting is mitigated; however, if λ becomes too large, the model becomes too simple, then gets higher bias.

(c) \bar{iv} : When λ increases, the complexity reduces, then variance also decreases.

(d) \bar{iii} : As λ increases, it will cause model simple and bias increases.

(e) \bar{v} : Same as the question (e) in question 3, it depends on the random noise in data not the complexity, so it remains constant.