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.

As λ increases, the **training RSS will steadily increase** because the model is progressively restricted from fitting the data closely.

Answer

The correct answer is: **iii. Steadily increase.**

For part (b), we are analyzing how the **test residual sum of squares (RSS)** behaves as we increase λ in Ridge regression.

As λ increases from 0, the **test RSS will initially decrease**, as regularization helps reduce overfitting. However, after a certain point, as λ becomes too large and the model underfits, the **test RSS will start to increase**, resulting in a **U-shaped curve**.

Answer

The correct answer is: **ii. Decrease initially, and then eventually start increasing in a U shape.**

For part (c), we are examining how the **variance of the model's predictions** changes as we increase λ in Ridge regression.

As λ increases, the **variance of the model's predictions will steadily decrease** due to the increasing regularization, which limits model flexibility.

Answer

The correct answer is: **iv. Steadily decrease.**

For part (d), we need to analyze how the **squared bias of the model's predictions** changes as we increase λ in Ridge regression.

As λ increases, the **squared bias of the model's predictions will steadily increase** due to the model's reduced flexibility and tendency to underfit the data.

Answer

The correct answer is: **iii. Steadily increase.**

For part (e), we are examining how the **irreducible error** behaves as we increase λ in Ridge regression.

The **irreducible error remains constant** regardless of the value of λ.

Answer

The correct answer is: **v. Remain constant.**