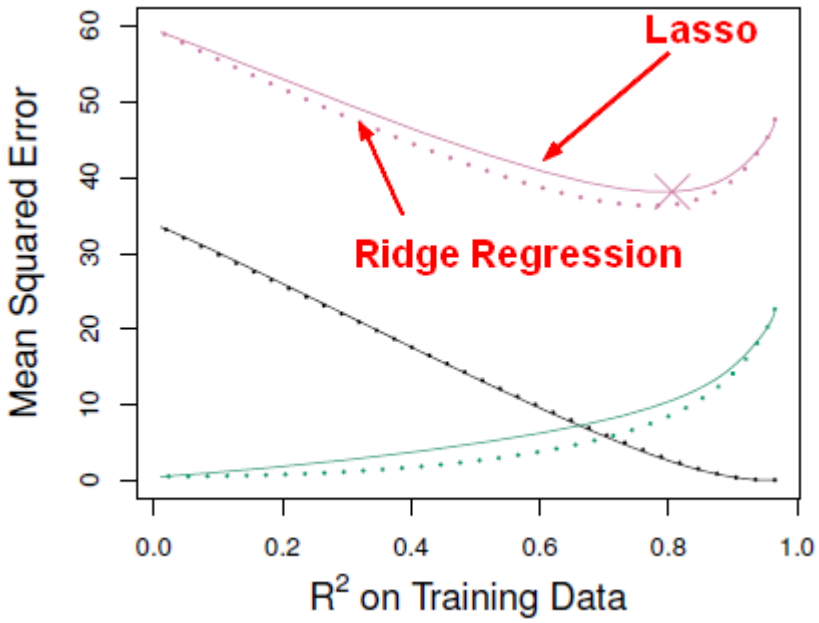
Shrinkage Methods:

Shrinkage methods, also known as regularization methods, are a set of techniques in data analytics and machine learning used to prevent overfitting and improve the generalization performance of predictive models. These methods introduce constraints or penalties on the model parameters during training, encouraging the model to be simpler or less complex. Two common shrinkage methods are ridge regression and lasso regression:

1. **Ridge Regression:**



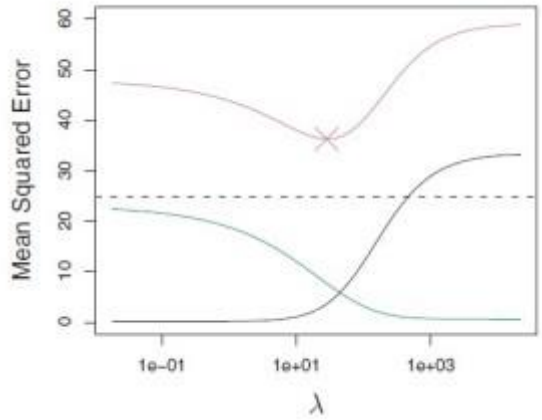
- **Objective:** Ridge regression adds a penalty term to the linear regression objective function, aiming to minimize the sum of squared errors while also minimizing the sum of the squared values of the model's coefficients (L2 regularization).
- **Purpose:** Ridge regression is particularly useful when multicollinearity (high correlation between predictors) is present in the data. It helps prevent coefficients from becoming too large, effectively reducing the impact of less important predictors.
- **Effect:** Ridge regression shrinks the coefficients toward zero but does not set them exactly to zero. This means that all predictors remain in the model, but their impact is reduced, making it less prone to overfitting.

- **Formula:** The ridge regression objective function is defined as follows:

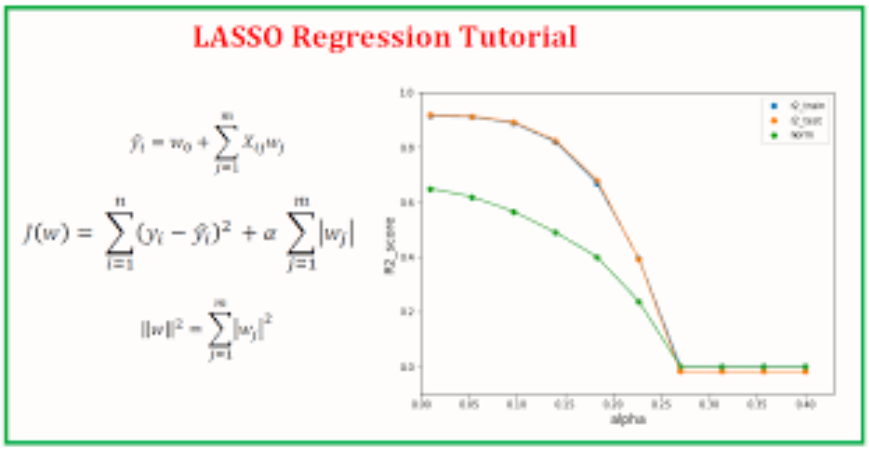
makefileCopy code

Minimize: Σ(y - ŷ)^2 + λ * Σ(β^2)

- λ (lambda) is the regularization strength parameter, controlling the amount of regularization applied.



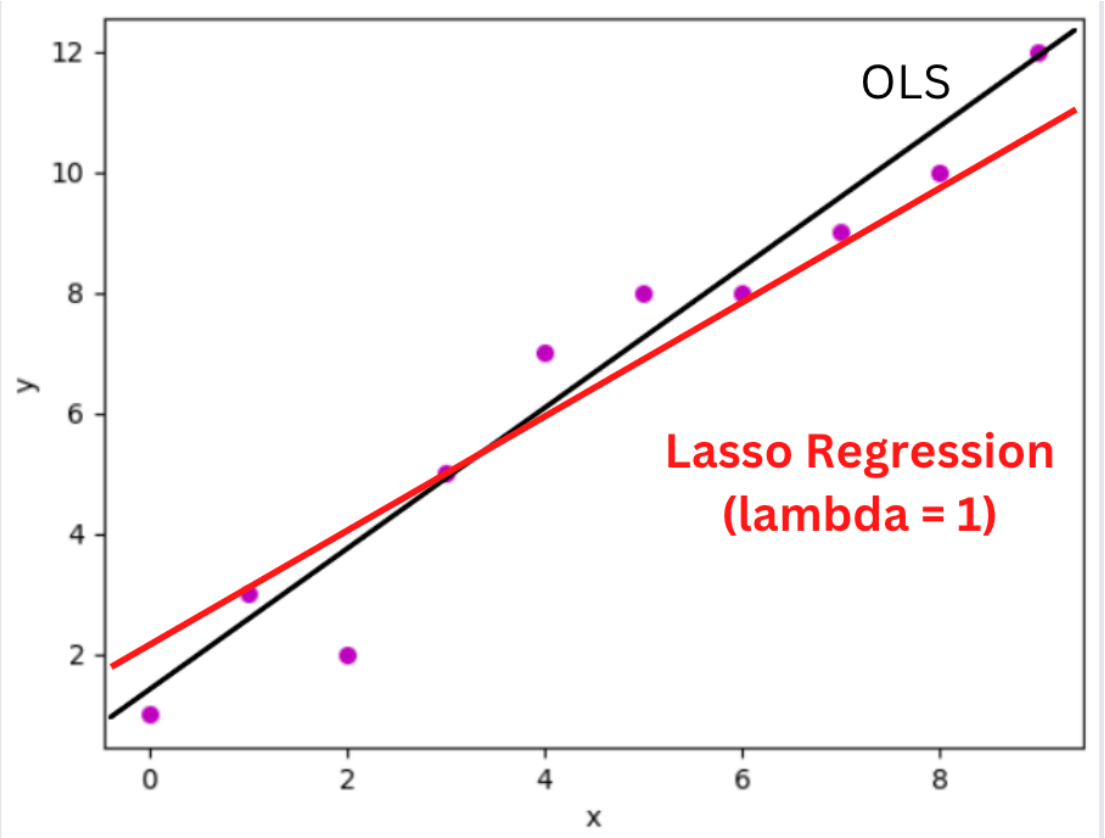
2. **Lasso Regression (Least Absolute Shrinkage and Selection Operator):**



- **Objective:** Lasso regression, like ridge regression, adds a penalty term to the linear regression objective function. However, it uses the L1 regularization, which minimizes the sum of squared errors while also minimizing the sum of the absolute values of the model's coefficients.
- **Purpose:** Lasso regression not only helps prevent overfitting but also performs feature selection by setting some coefficients exactly

to zero. This makes it especially useful when dealing with high-dimensional datasets with many irrelevant predictors.

- **Effect:** Lasso regression encourages sparsity in the model, resulting in a simpler model with only a subset of the predictors contributing to the predictions.
- **Formula:** The lasso regression objective function is defined as follows:



makefileCopy code

Minimize: Σ(y - ŷ)^2 + λ * Σ|β|

- λ (lambda) is the regularization strength parameter, controlling the amount of regularization applied.

Applications of Shrinkage Methods:

- Shrinkage methods like ridge and lasso regression are widely used in data analytics, particularly in predictive modeling and feature selection.
- They are applied in fields such as economics, finance, healthcare, and more to build robust models and select relevant features.

- These methods are also used in machine learning algorithms like support vector machines (SVM) and neural networks to improve model generalization.