

Linear Regression

Linear Regression:

1. Definition:

- Linear regression is a statistical method used to model the relationship between a dependent variable and one or more independent variables by fitting a linear equation to observed data.

2. Assumptions:

- The relationship between the variables is linear.
- The residuals (errors) are normally distributed.
- The variance of the residuals is constant (homoscedasticity).
- The predictors are independent of each other.

3. Simple Linear Regression:

- In simple linear regression, there is only one independent variable predicting the dependent variable.
- The equation of a simple linear regression model is: $y = \beta_0 + \beta_1 x + \epsilon$, where y is the dependent variable, x is the independent variable, β_0 is the intercept, β_1 is the slope, and ϵ is the error term.

4. Multiple Linear Regression:

- In multiple linear regression, there are multiple independent variables predicting the dependent variable.
- The equation of a multiple linear regression model is: $y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_n x_n + \epsilon$, where y is the dependent variable, $x_1, x_2, \dots, x_n$ are the independent variables, β_0 is the intercept, $\beta_1, \beta_2, \dots, \beta_n$ are the coefficients, and ϵ is the error term.

5. Evaluation of the Model:

- Common metrics used to evaluate the performance of a linear regression model include R-squared, adjusted R-squared, Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and p-values of coefficients.

6. Applications:

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- Linear regression is commonly used in various fields such as economics, finance, marketing, and social sciences to analyze trends, make forecasts, and understand relationships between variables.

7. Limitations:

- Linear regression assumes a linear relationship between variables, which may not always hold true.
- It is sensitive to outliers and multicollinearity.
- Non-linear relationships cannot be captured using linear regression.

8. Extensions:

- To address non-linear relationships, techniques like polynomial regression, ridge regression, lasso regression, and elastic net regression can be used as extensions to linear regression.