# Linear Regression

## Linear Regression related terms

**Note:** Linear regression is a foundational algorithm in machine learning, providing a solid understanding of the core concepts. It's essential to grasp these terms to delve deeper into more complex models and techniques.

### Linear Regression

- **Definition:** A statistical method used to model the relationship between a dependent variable (target) and one or more independent variables (predictors) by fitting a linear equation to the observed data.
- **Goal:** To find the best-fitting line that minimizes the difference between the predicted values and the actual values.

### Gradient Descent

- **Definition:** An optimization algorithm used to find the minimum of a function. In machine learning, it's used to find the optimal parameters (weights and biases) of a model.
- **Process:** It iteratively adjusts the parameters in the direction of steepest descent (negative gradient) of the error function until a minimum is reached.

### Gradient Descent Optimizer

- **Definition:** An algorithm that implements the gradient descent process.
- **Role:** It determines how the parameters are updated at each iteration.
- **Examples:** Stochastic Gradient Descent (SGD), Adam, RMSprop.

### Best Fit Line: y = mx + c

- **Definition:** The straight line that best represents the relationship between two variables on a scatter plot.
- **Equation:** y = mx + c, where:
  - y is the dependent variable
  - x is the independent variable
  - m is the slope of the line
  - c is the y-intercept (the value of y when x is 0)

### Slope (m)

- **Definition:** The rate of change of the dependent variable with respect to the independent variable. It represents the steepness of the line.

- **Interpretation:** A positive slope indicates a positive relationship between the variables, while a negative slope indicates a negative relationship.

## Intercept (c)

- **Definition:** The value of the dependent variable when the independent variable is zero. It's the point where the line crosses the y-axis.

## Error (Residual)

- **Definition:** The difference between the actual value of the dependent variable and the predicted value from the regression line.
- **Role:** The goal of linear regression is to minimize the sum of squared errors.

## Global Minima

- **Definition:** The lowest point of a function over its entire domain.
- **Goal:** In gradient descent, the aim is to find the global minimum of the error function to achieve the best model performance.

## Mathematical Intuition of Linear Regression

- **Objective:** To find the values of m and c that minimize the sum of squared errors between the observed data points and the predicted values on the line.
- **Method:**
  1. Initialize random values for m and c.
  2. Calculate the error for each data point.
  3. Calculate the gradient of the error function with respect to m and c.
  4. Update m and c using gradient descent.
  5. Repeat steps 2-4 until the error converges to a minimum.
- **Underlying principle:** The line that minimizes the sum of squared errors is the best fit line.

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