SNS COLLEGE OF ENGINEERING

Kurumbapalayam(Po), Coimbatore – 641 107
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Department of AI &DS

Course Name – 23ADT201 ARTIFICIAL INTELLIGENCE

II Year / III Semester

UNIT 2

PROBLEM SOLVING

Topic: LOCAL SEARCH IN CONTINUOUS SPACE

LOCAL SEARCH IN CONTINUOUS SPACE

Case Study: An autonomous vehicle company improved navigation accuracy by 15% by applying continuous local search algorithms to optimize route planning in real-time."

Local Search in Continuous Space

- A local search is first conducted in the continuous space **until a local optimum is reached**. It then switches to a discrete space that represents a discretization of the continuous model to find an improved solution from there.
- The process continues switching between the two problem formulations until no further improvement can be found in either.
- To perform local search in continuous state space we need techniques from calculus.
- The main technique to find a minimum is called gradient descent.

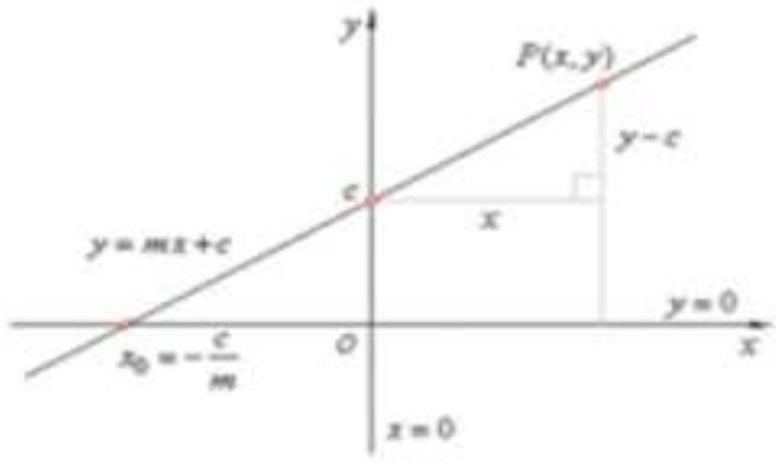
Gradient Descent

- A gradient measures how much the output of a function changes if you change the inputs a little bit.
- In machine learning, a gradient is a derivative of a function that has more than one input variable. Known as the slope of a function in mathematical terms, the gradient simply measures the change in all weights with regard to the change in error.
- Gradient descent is an iterative optimization algorithm to find the minimum of a function.
- Gradient Descent is an optimization algorithm for finding a local minimum of a differentiable function. Gradient descent is simply used in machine learning to find the values of a function's parameters (coefficients) that minimize a cost function as far as possible.

Linear Regression

- In statistics, linear regression is a linear approach to modelling the relationship between a dependent variable and one or more independent variables.

$$Y = m X + c$$



Gradient Descent

- Mean Squared Error Equation

$$E = \frac{1}{n}\sum_{i=0}^{n}(y_i - \bar{y}_i)^2$$

- Substituting the value of $\bar{y}_i$

$$E = \frac{1}{n}\sum_{i=0}^{n}(y_i - (mx_i + c))^2$$

Gradient Descent

- **Loss Function –**

The loss is the error in our predicted value of **m** and **c**. Our goal is to minimize this error to obtain the most accurate value of **m** and **c**.

Mean Squared Error function to calculate the loss:

Step 1 : Find the difference between the actual y and predicted y value(y = mx + c), for a given x.

Step 2 : Square this difference.

Step 3 : Find the mean of the squares for every value in X.

Gradient Descent Algorithm

- Applying gradient descent to **m** and **c** and approach it step by step:

Step 1 : Initially let m = 0 and c = 0. Let L be our learning rate. This controls how much the value of **m** changes with each step. L could be a small value like 0.0001 for good accuracy.

Step 2 : Calculate the partial derivative of the loss function with respect to m, and plug in the current values of x, y, m and c in it to obtain the derivative value **D**.

$$D_m = \frac{1}{n}\sum_{i=0}^{n} 2(y_i - (mx_i + c))(-x_i)$$

$$D_m = \frac{-2}{n}\sum_{i=0}^{n} x_i(y_i - \bar{y}_i)$$

Gradient Descent Algorithm

Step 3 : Now we update the current value of **m** and **c** using the following equation:

$$m = m - L \times D_m$$

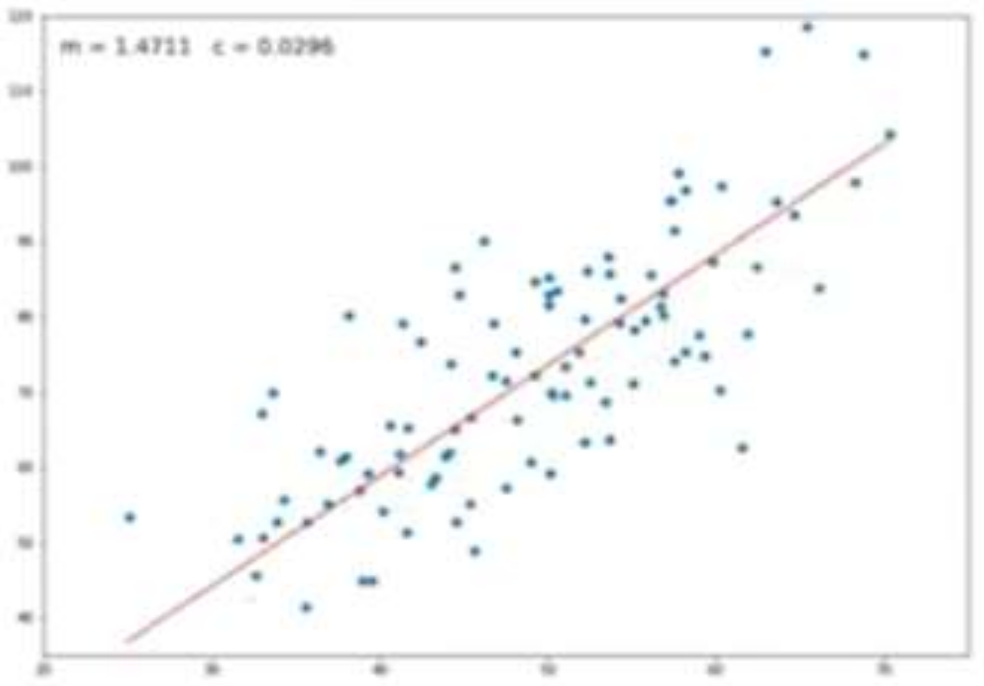
$$c = c - L \times D_c$$

Step 4 : We repeat this process until our loss function is a very small value or ideally 0 (which means 0 error or 100% accuracy). The value of **m** and **c** that we are left with now will be the optimum values.

LOCAL SEARCH IN CONTINUOUS SPACE

Gradient Descent

- The values of m and c are updated at each iteration to get the optimal solution



THANK YOU