Overview:

Linear Regression

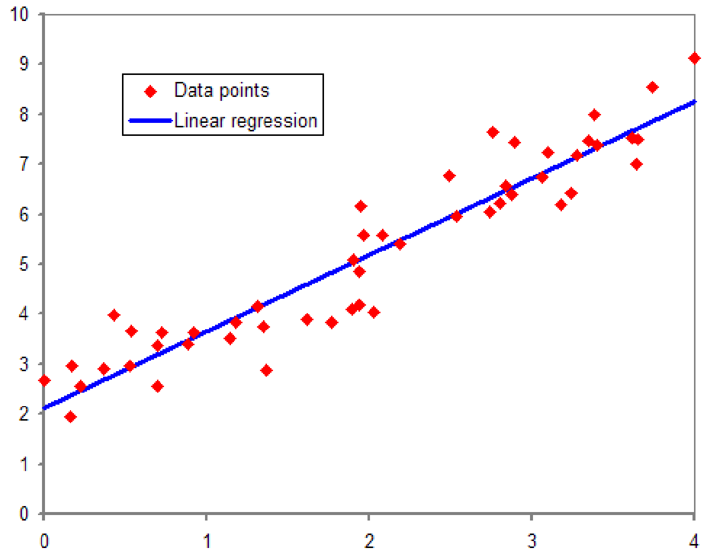
Types of Linear Regression

How Linear Regression Works

Evaluation Metrics

Linear Regression

- Linear regression allows us to make predictions about the dependent variable based on the values of the independent variables
- Predict continuous numerical value
- The linear regression equation is typically represented y=mx+b
- y is the predicted value (dependent variable) m is the slope of the line
- x is the input features(independent variable) b is the y-intercept



Type of Linear Regression:

YearsExperience	Salary
1.1	35342
1.3	46200
1.5	38731
2	44526
2.2	39895
2.9	55645
3	60180
3.2	54445
3.2	64446
3.7	57175
3.9	63218
4	55794
4	57967
4.1	58080

Simple Linear Regression:

- Simple Linear Regression helps to find the linear relationship between One independent and one dependent feature.

y=mx+b

Multi Linear Regression:

- In multi linear regression we have two or more than two input variable

y=m1x1+m2x2+m3x3+⋯+mnxn+b

y	X_1	X_2
140	60	22
155	62	25
159	67	24
179	70	20
192	71	15
200	72	14
212	75	14
215	78	11

How Linear Regression Works:

- Linear regression is a supervised machine learning method.
- That is used to finds a linear equation that best describes the correlation of the independent variables with the dependent variable.
- This is achieved by fitting a line to the data using least squares.
- The line tries to minimize the sum of the squares of the residuals.
- The residual is the distance between the line and the actual value of the independent variable.
- Finding the line of best fit is an iterative process
- we use mostly Mean Squared Error which is the average of the squared difference between actual value and predicted value

$$MSE = \frac{1}{N}\sum_{i=1}^{n}(y_i - (mx_i + b))^2$$

Gradient Descent:

- Gradient Descent is an optimization algorithm used to minimize the cost function (like MSE) by updating model parameters iteratively.

Gradient descent

One feature

repeat {

$$\underbrace{w} = w - \alpha \underbrace{\frac{1}{m}\sum_{i=1}^{m}\left(f_{w,b}(x^{(i)}) - y^{(i)}\right)\underbrace{x^{(i)}}}_{\frac{\partial}{\partial w}J(w,b)}$$

$$b = b - \alpha\frac{1}{m}\sum_{i=1}^{m}\left(f_{w,b}(x^{(i)}) - y^{(i)}\right)$$

simultaneously update w, b

}

n features ($n \geq 2$)

repeat {

$j=1$

$$\underbrace{w_1} = w_1 - \alpha \underbrace{\frac{1}{m}\sum_{i=1}^{m}\left(f_{\vec{w},b}(\vec{x}^{(i)}) - y^{(i)}\right)\underbrace{x_1^{(i)}}}_{\frac{\partial}{\partial w_1}J(\vec{w},b)}$$

$\vdots$

$j=n$

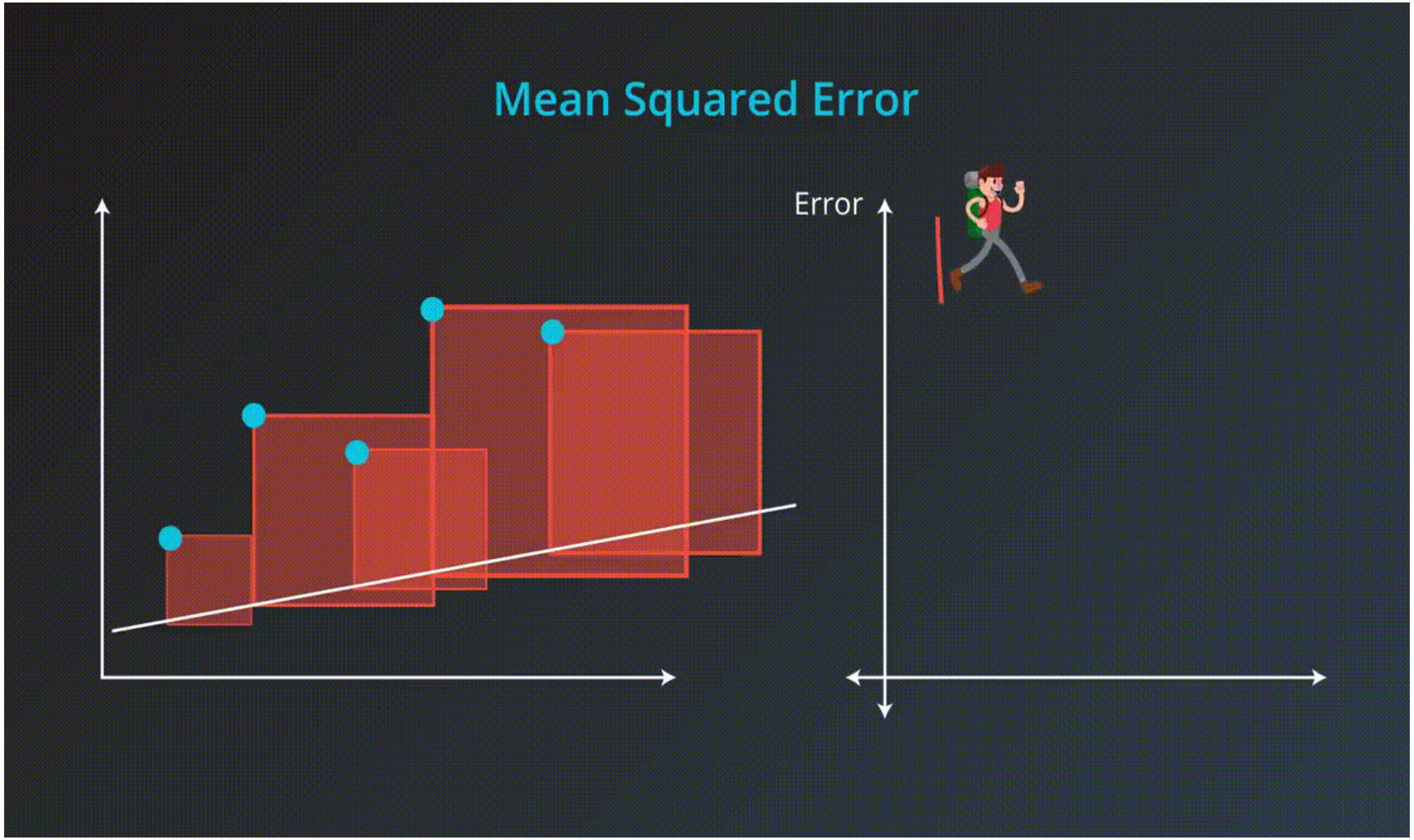
$$w_n = w_n - \alpha\frac{1}{m}\sum_{i=1}^{m}\left(f_{\vec{w},b}(\vec{x}^{(i)}) - y^{(i)}\right)x_n^{(i)}$$

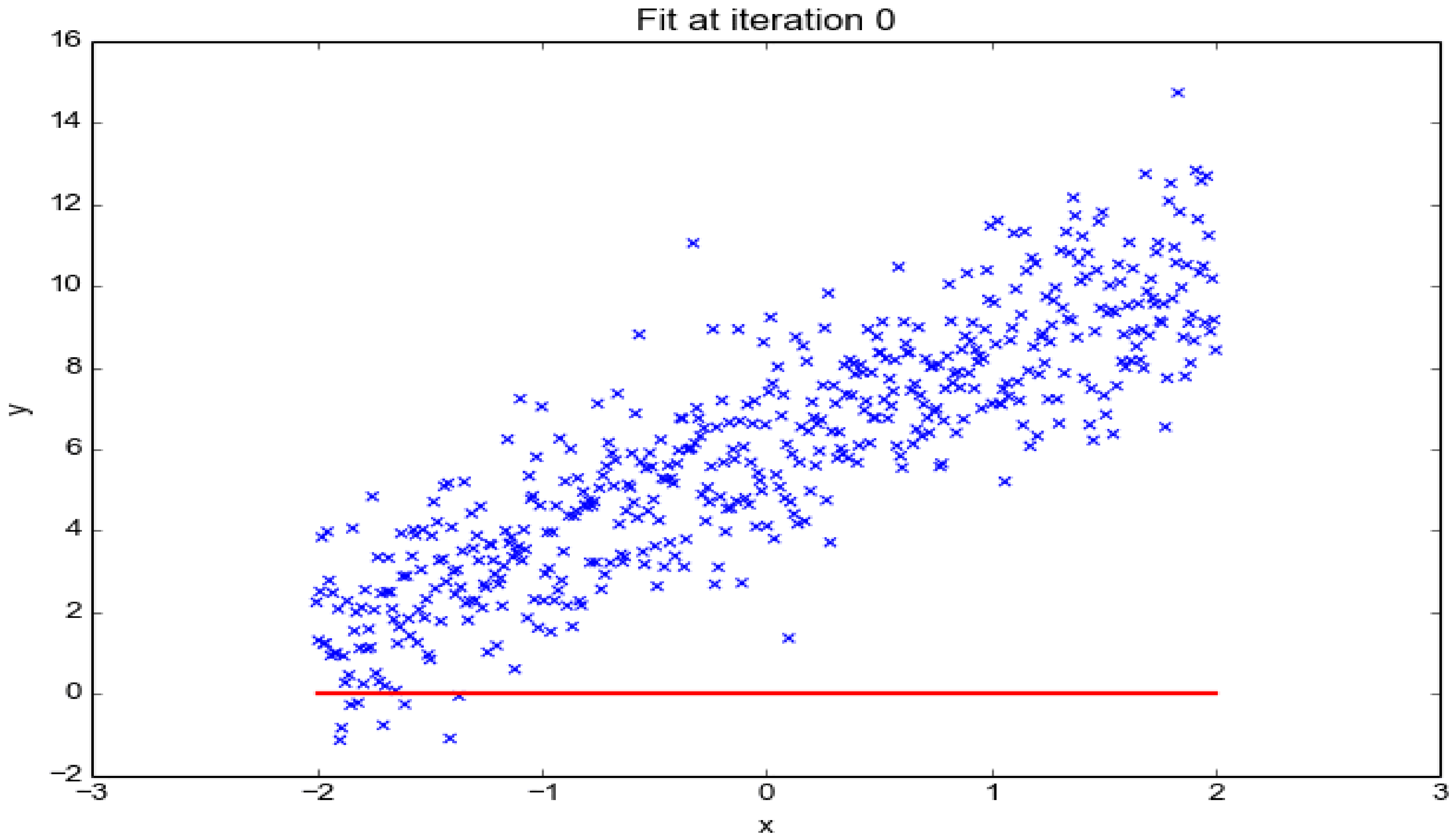
$$b = b - \alpha\frac{1}{m}\sum_{i=1}^{m}\left(f_{\vec{w},b}(\vec{x}^{(i)}) - y^{(i)}\right)$$

simultaneously update

w_j (for $j = 1, \cdots, n$) and b

}


Mean Squared Error
Error


Fit at iteration 0
16
14
12
10
8
6
4
2
0
−2
y
−3
−2
−1
0
1
2
3
x

Evaluation Metrics:

- **MAE:** measures the average absolute differences between predicted and actual values.
- **MSE:** measures the average of the squares of the errors, which gives more weight to larger errors.
- **RMSE:** is the square root of MSE, providing error in the same units as the target variable.