Q1 - Brief Questions

1. Linear Regression is one of supervised machine learning algorithms. It is used to find the linear relationship between dependent variable(s) and independent variable. The primary objective of linear regression is to find the best linear equation (best fit line) that outputs the smallest difference between predicted values and true values.
2. Logistic Regression is needed for discrete values to transform into binary values. However, Linear Regression uses "best fit line" which works well only when dependent variable is continuous, therefore, it is not suitable for classification.
3. Fig.1 shows plotted true data and fit lines. Through Fig.1, we can see which fit line is the best line to follow a trend of true data. Fig.2 shows cost at z-axis along with the parameters at x-axis and y-axis. Even though we use gradient descent to find the minimum cost, the result might not be the minimum and there could be many points that have the same cost but with different parameters. Fig.3 shows that the cost function with parameters approaches 0 as it iterates more times, which is ideal shape.

Q2 - Calculation Questions

Below link has codes for question 2.

https://github.com/jinhoishere/MachineLearning/blob/main/Homework2.ipynb

1. The first iteration has weight(0.1) and bias(0.1). The estimated exam scores ($\hat{y}$) for each hour studied(x) with the given weight and bias is 0.3, 0.4, and 0.5 respectively. The second iteration goes with weight(4.663) and bias(1.59). Weight is updated through the gradient descent, such that

$$w_{updated} = w_{current} - \alpha * \frac{\partial f}{\partial w}$$

where α is learning rate and f is loss function. Bias is updated as well, which is

$$b_{updated} = b_{current} - \alpha * \frac{\partial f}{\partial b}$$

Therefore, the estimated exam scores ($\hat{y}$) with these updated weight and bias will be 10.917, 15.58, and 20.243 respectively for each studied hour.
In the third iteration, weight and bias are updated again with the same equations above, such that weight(8.042) and bias(2.685). The estimated exam scores ($\hat{y}$) are 18.769, 26.811, and 34.853 respectively.

2. Given the weight and bias are the same as the previous iteration, which are 8.042 and 2.685 respectively, the estimated exam score($\hat{y}$) will be 56.209 if the studied hours(x) is 5.

Q3 - Coding Questions

1. # of features: 4
2. # of samples: 20
3. https://github.com/jinhoishere/MachineLearning/blob/main/Question3.ipynb
4. The chosen learning rate is suitable because as I increase the number of iterations, the shape of the graph is curved just like Fig.3.