# Classification

## HW2

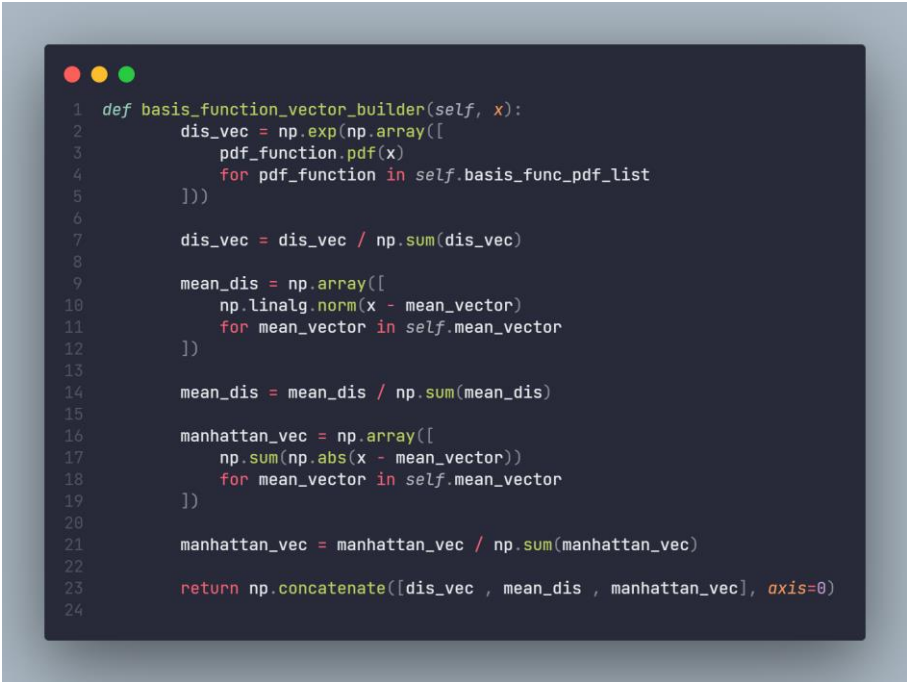109511276 練鈞揚 |Machine Learning | 4/17/2023

# Discuss About the Classification

In this HW Classification, I learned a lot about building generative and discriminative models.

First, let's talk about building a generative model. The basic idea is to create a multivariate normal distribution for each class, and then generate data based on the model. We can then use this data to create a joint Gaussian and predict the data of a particular class.

Second, let's talk about building a discriminative model. We need to define a basis function for splitting the data in high dimensions. We can also take the data eigenvalue. We then choose an error function, such as cross-entropy, and try to find its minimum value. We can take the gradient and use the Newton-Raphson method to approximate the function. Since this is a convex function, finding the value will give us the minimum value of this function. We use the softmax function as a normalization function for the prediction, and the training data of true data is mapped to the 1-to-K format for training.

In the discriminative model look like this

```python
def basis_function_vector_builder(self, x):
    dis_vec = np.exp(np.array([
        pdf_function.pdf(x)
        for pdf_function in self.basis_func_pdf_list
    ]))

    dis_vec = dis_vec / np.sum(dis_vec)

    mean_dis = np.array([
        np.linalg.norm(x - mean_vector)
        for mean_vector in self.mean_vector
    ])

    mean_dis = mean_dis / np.sum(mean_dis)

    manhattan_vec = np.array([
        np.sum(np.abs(x - mean_vector))
        for mean_vector in self.mean_vector
    ])

    manhattan_vec = manhattan_vec / np.sum(manhattan_vec)

    return np.concatenate([dis_vec , mean_dis , manhattan_vec], axis=0)
```

I design this basis function it is because I use two different to find the distance , and use the pdf to guess the data in which group. The loss is more better.

These two models are based on different approaches to implementation. In terms of prediction, the discriminative model is better than the generative model, and the prediction speed is faster.

My experience with this HW was challenging. It took me about two weeks to complete it because, at first, I didn't understand the meaning of the mathematical equations. However, after seeking guidance from my teacher and asking questions, I was able to better understand how the models work.

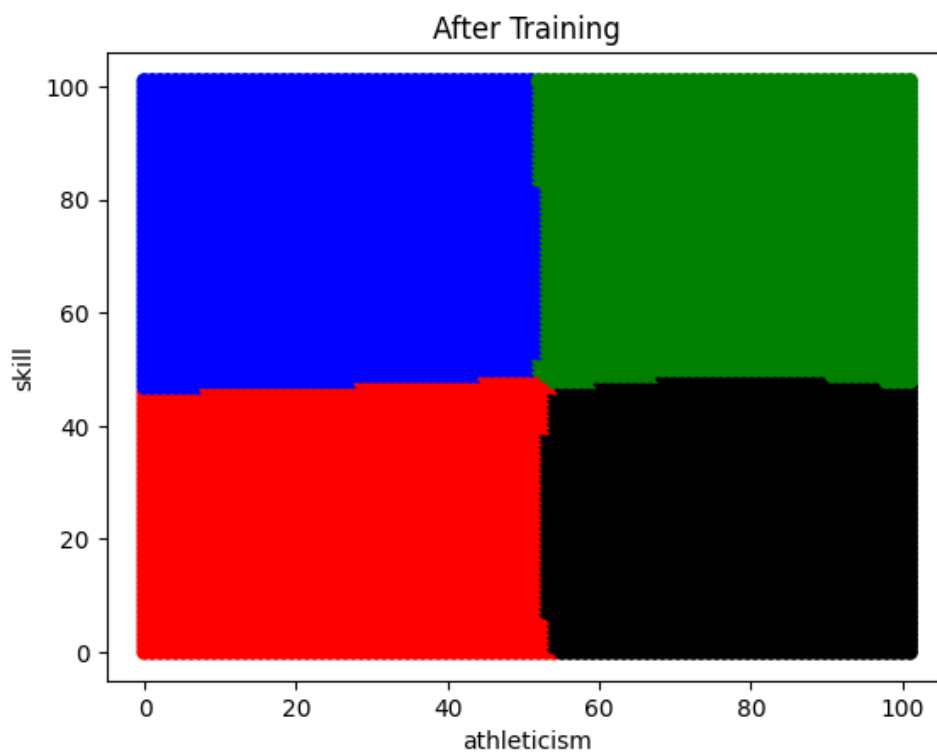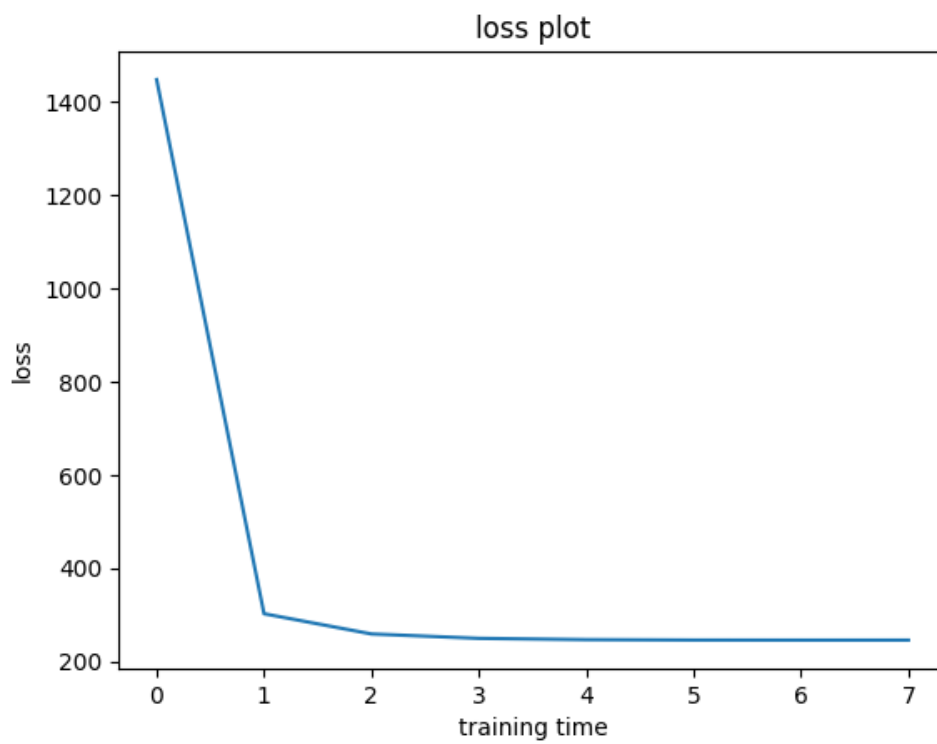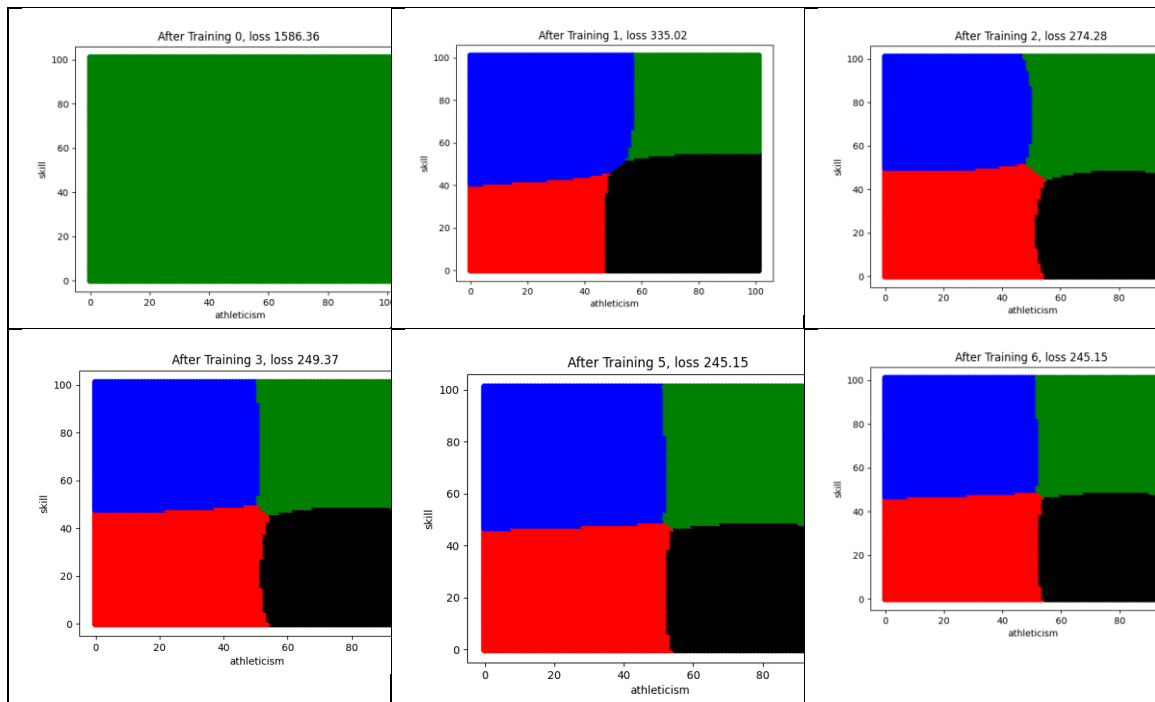## Part 1

Generative model
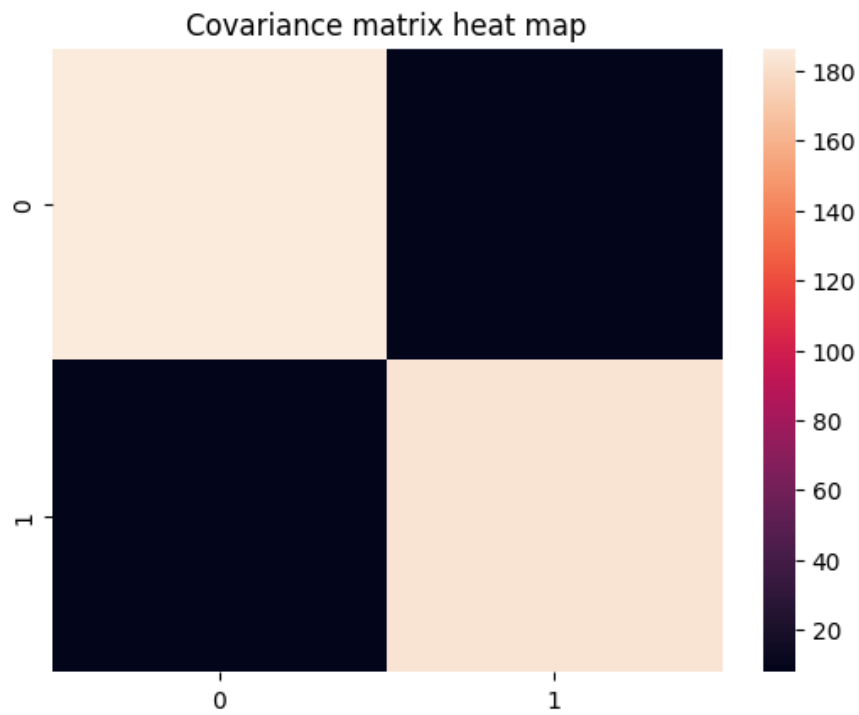
Heat map



Prediction :
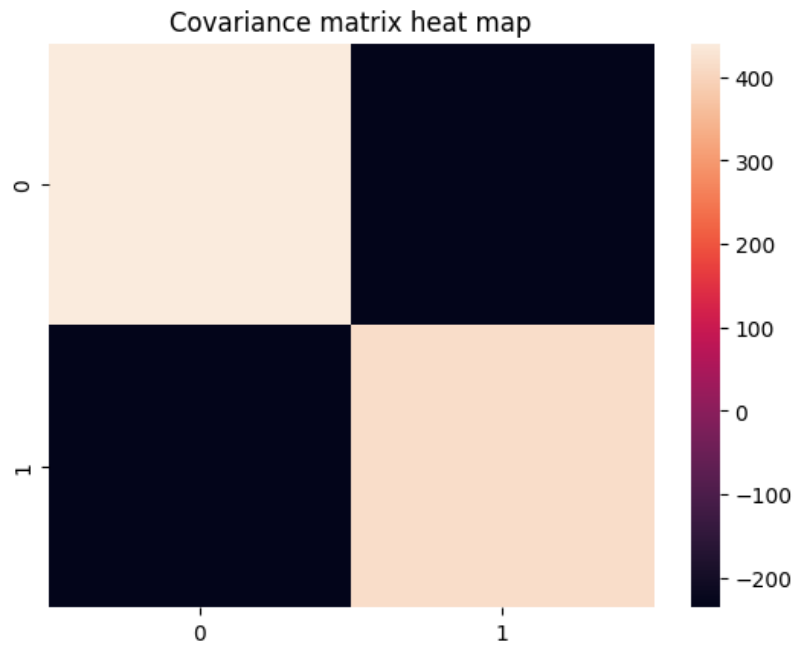
Discriminative model

Loss graph

## loss plot



## After Training
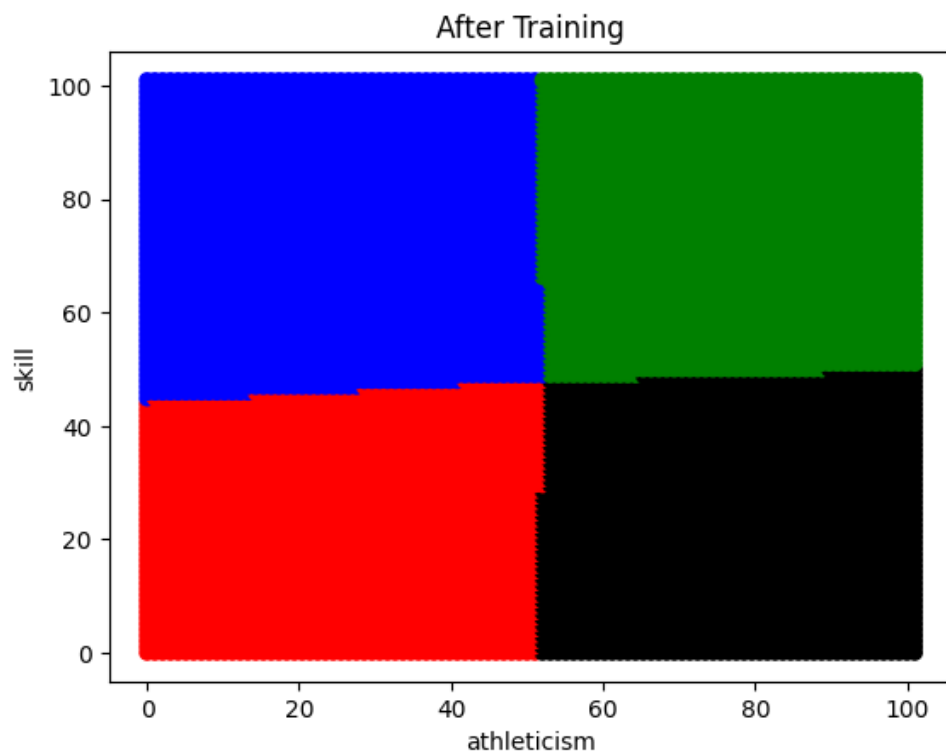
I also make the gif in readme , you can go to check it
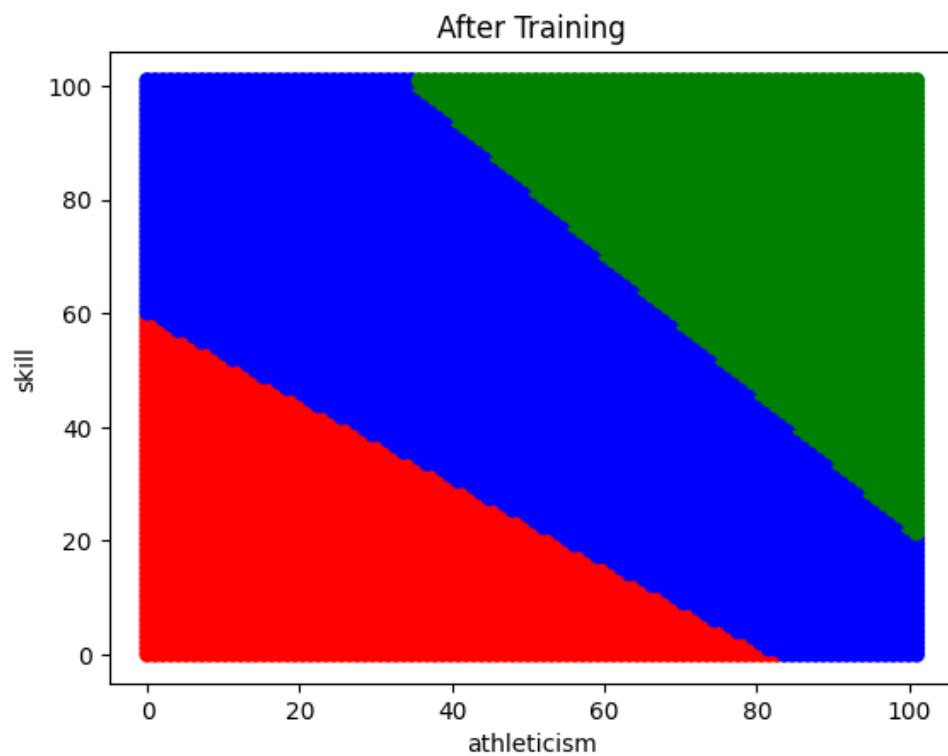
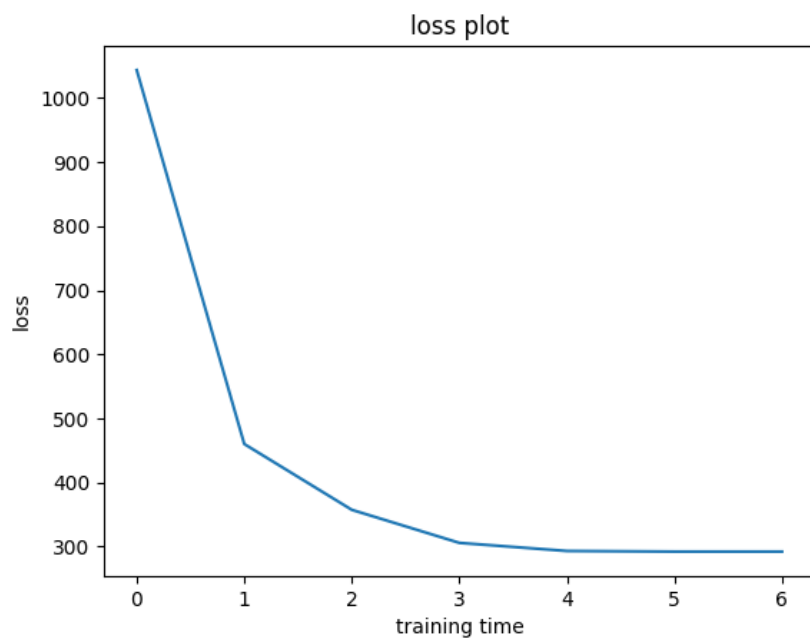# Part 2

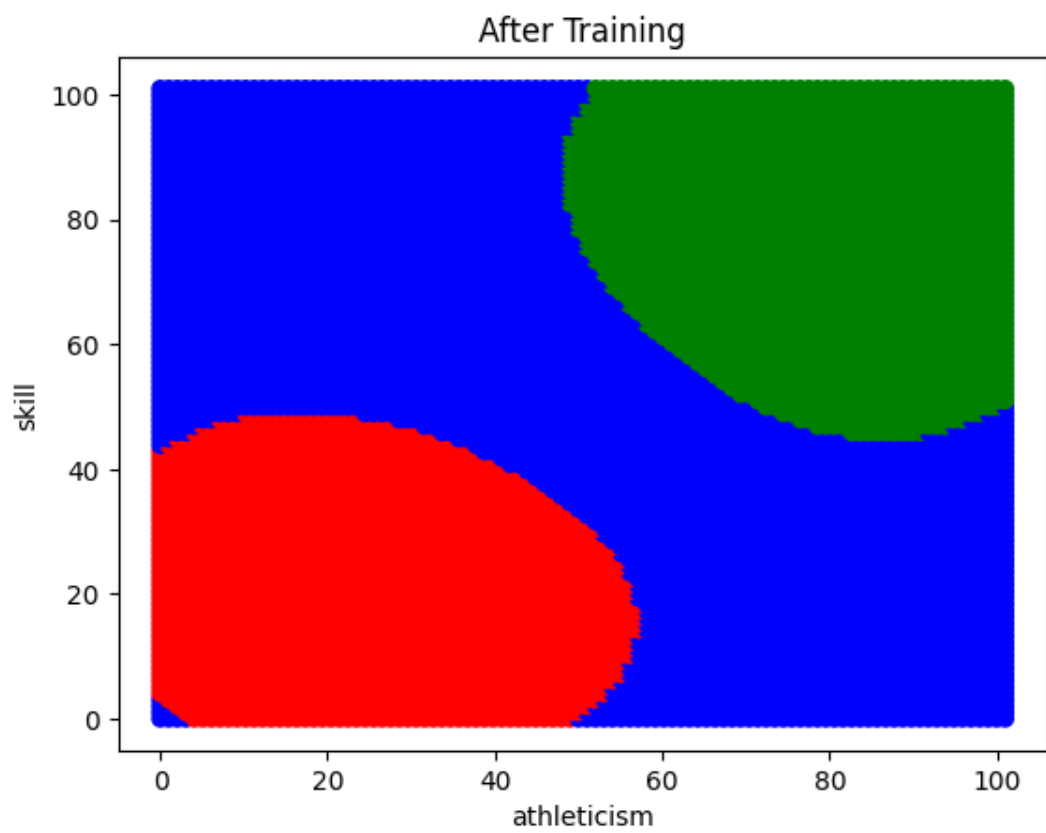Generative model
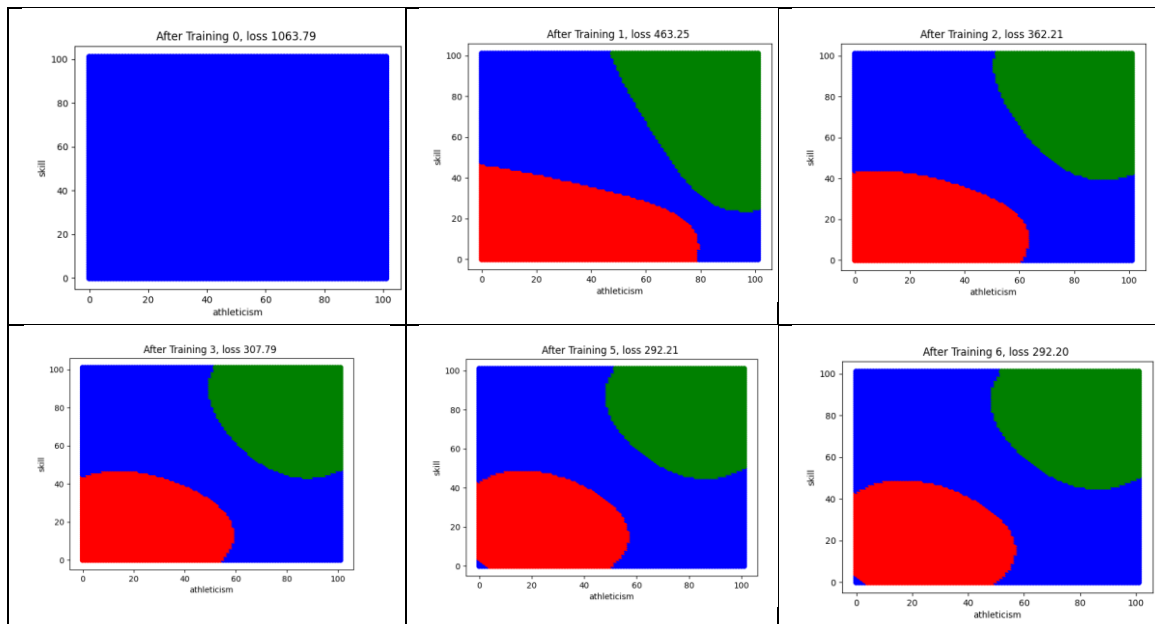
Heat map



Prediction :

Discriminative model

Loss graph



Prediction :

I also make the gif in readme , you can go to check it