Homework 1:

1. ML approach:

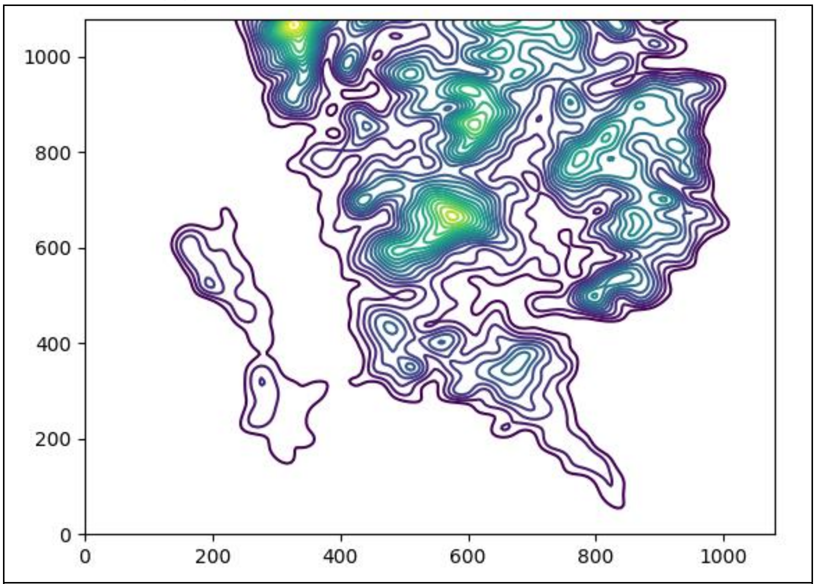

Figure1. Contour for ML approach

I set 41*41+1 dimension Gaussian distributions with the same separation over this map as my model.

Why do I choose that dimension? It is because the higher dimension tends to have smaller error. However, we also have to avoid over fitting occurs. We can just use the close form to get our parameter, vector w. After considering the computer performance and the above reason, I choose the dimension as my model, and get a MSE around 110. Due to the fact that we already know height is bigger or equal to 0, I set all negative value to 0.

2. MAP approach:

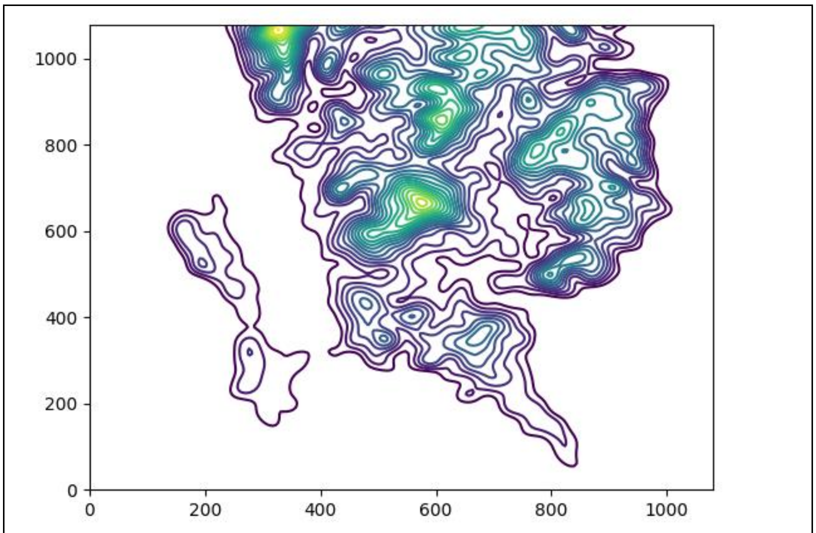

Figure2. Contour of MAP approach

This model is as same as the above one. Only difference is that we add prior term to the curve, which shows as a little noise on our Gaussian that gives it much flexibility to match the data. However, the higher is the variance of our prior, the higher the error is. Thus, we choose our variance a very small one.

3. Bayesian approach :

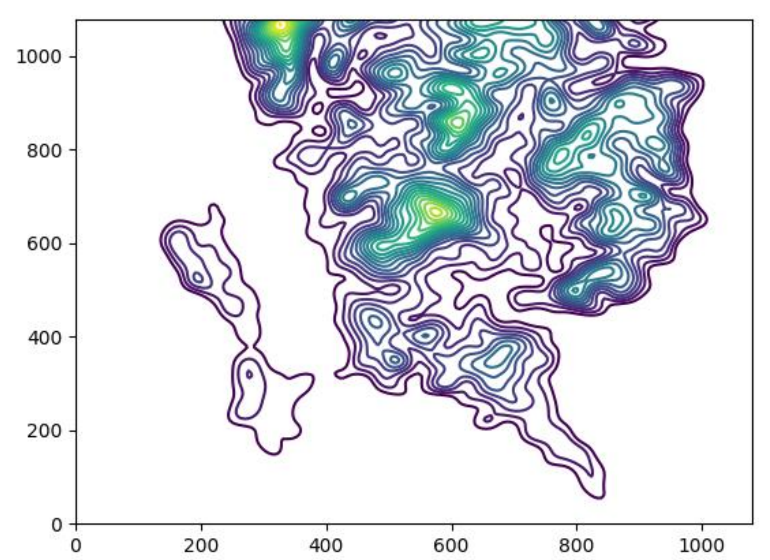

Figure3. Contour of Bayesian approach

We take 100 inputs as a set. In every process, we change the current prior's mean and variance. Due to the fact that we are using Gaussian distribution as our model, the expectation of our mean, is coincidentally just at our mean value, so mean is equal to out vector w.

4. Overfitting:

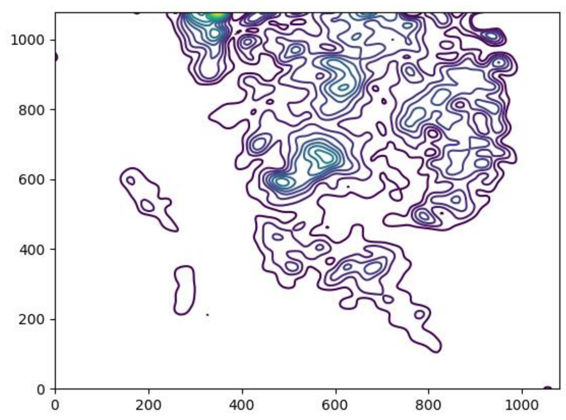

Figure4. Input 3000 data. Error 44.11

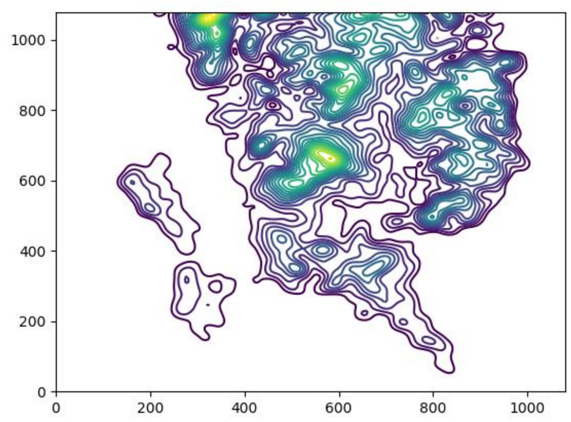

Figure5. Input 5000 data. Error 71.00258

In this model, we use 41*41+1 dimension Gaussian's distribution as our model. However we give very less inputs, make sure that they can be fit properly. As Figure4 shows, error is very small, while the map is really match to our real circumstances.

5. Underfitting：

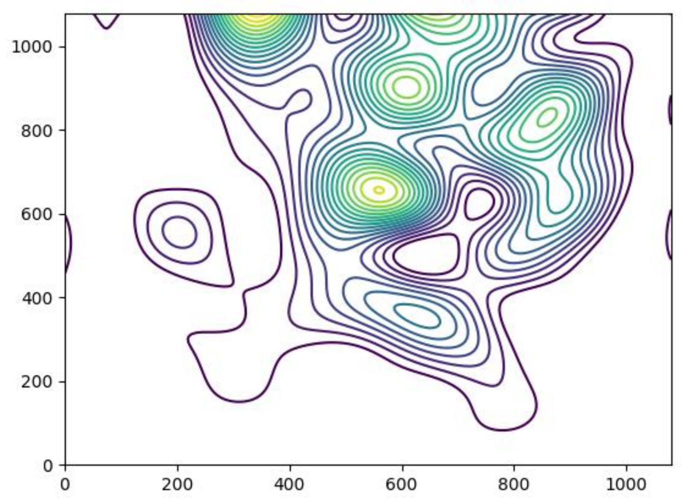

Figure6: Input 10000 data. M=122. E=973.81

I make the model dimension only 100 while there are 10000 inputs, so the curve unable to catch up all the data. All it can do is trying to build within data. That's why the curve is extremely smooth.

6. 2-fold cross validation:

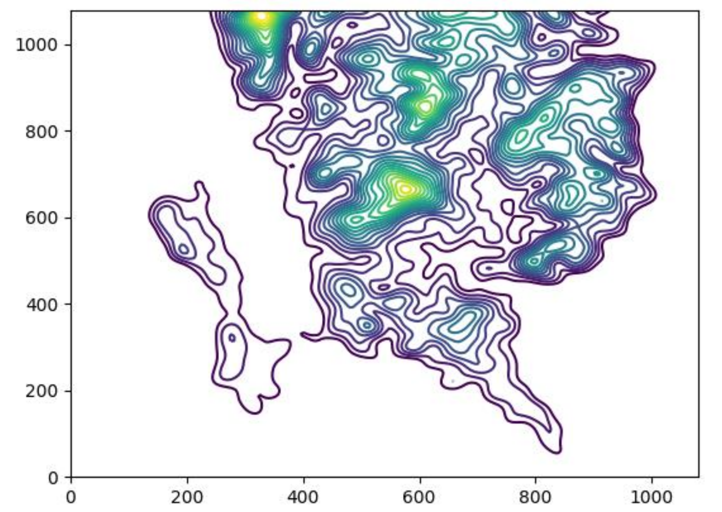

Figure7. 2-folds cross validation. Error: 14315.0649867

I separate data into two parts. And choose the one which comes up with smaller error. The result seems to be as great as normal ml approach.