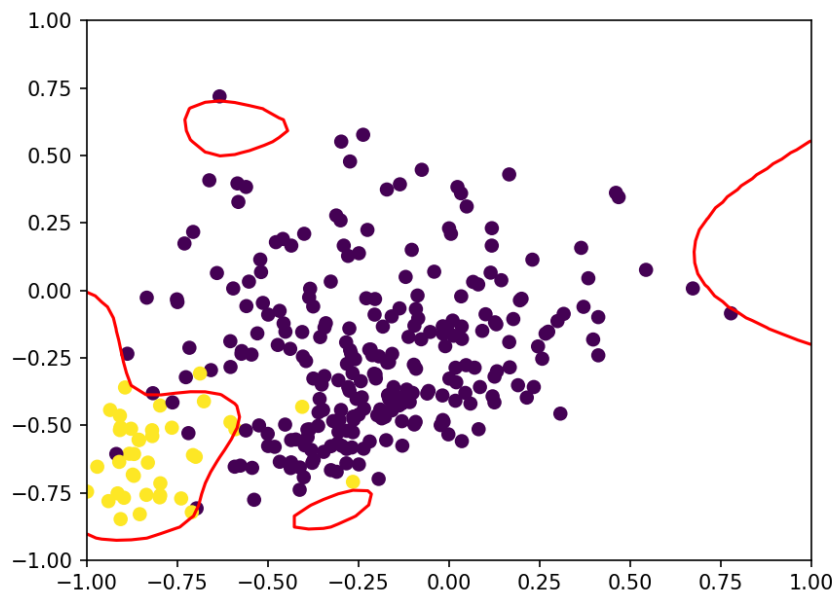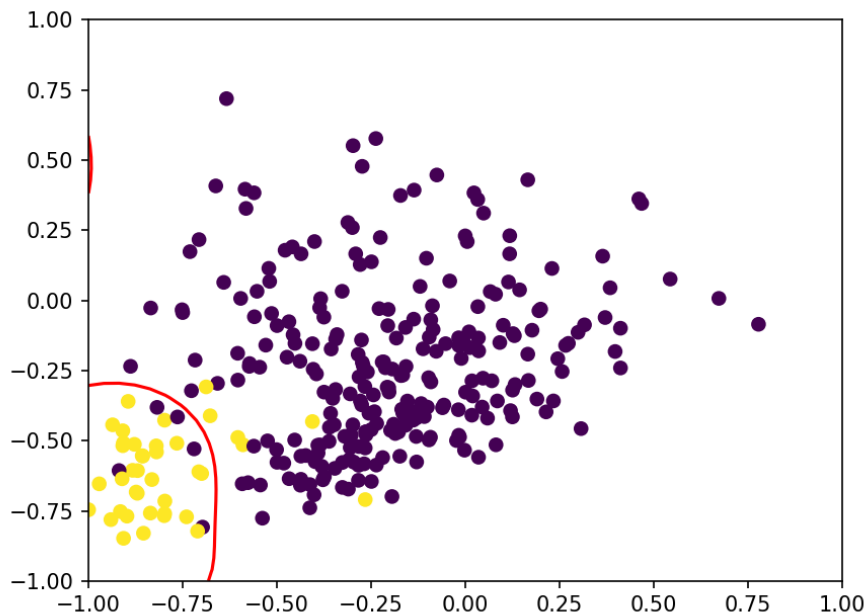Q1:

From running my code, there will be 45 features after doing 8th order transform. Since we know there are 300 samples. The dimension of Z is 300 by 45.
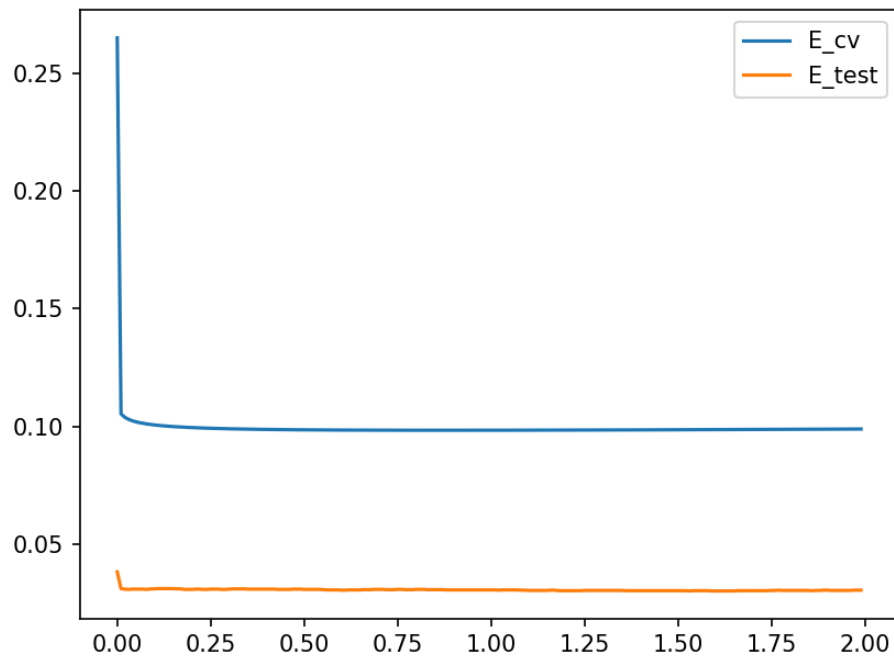
Q2:

I think there is a overfitting
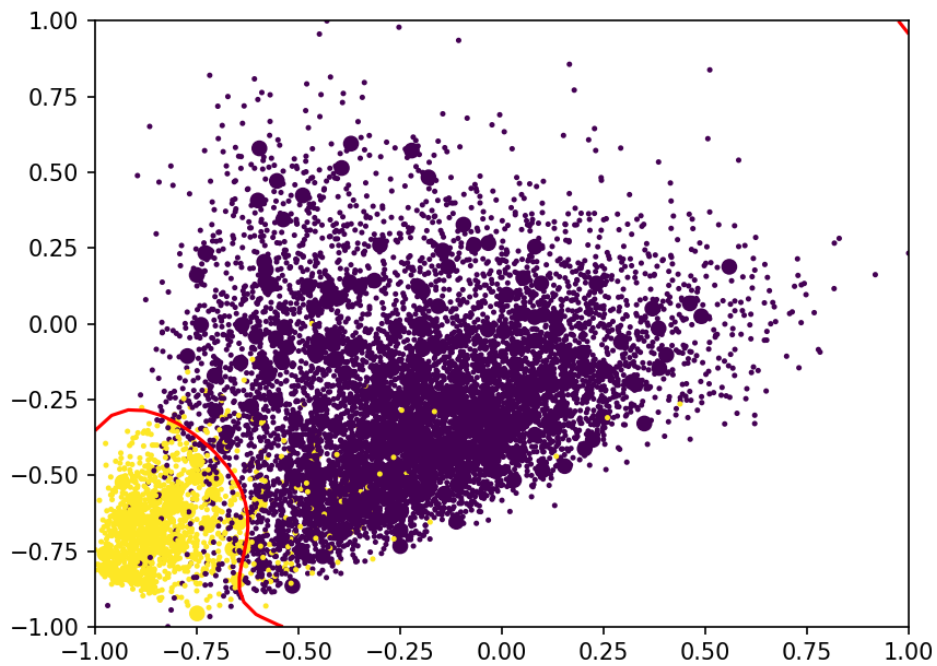
Q3:

I think there is an underfitting.

Q4:

From the graph, it seems like E_cv and E_test have similar trends. Also E_test is always smaller than E_cv.

Q5:

$\lambda^* = 1.99$

Q6:

At 0.0316737052678373

Etest = 0.0316737052678373

Eout < Etest $+ \sqrt{\frac{1}{2N} ln \frac{2M}{\delta}}$

N =8998 , M = 1, δ = 0.01

Eout < 0.0316737052678373 $+ \sqrt{\frac{1}{2*8998} ln \frac{2}{0.01}}$

Eout = 0.05593958

Q7: It is unbiased, because the data in the validation didn't involve training, and λ^{*} is chosen based on Ecv.

Q8: No, Etest is not an unbiased estimate of Eout. Because get Etest using λ^{*}, which is obtained from a training dataset. In this question, the training dataset is not independent with the test dataset, because we normalize the whole dataset together, and then split it into training dataset and test dataset, which means the training dataset affect the test dataset, as it can affect the scale of the test dataset. So data snooping occurs. To avoid data snooping, we should first split the dataset into training dataset and test dataset, and then normalize them separately.