ECE 569 HW 3

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Due 5 December 2025

All code has been submitted on canvas.

1. Consider the classification problem in HW 2. Implement the following using CVX.
   (a) Apply the C-Hull formulation to train a classifier:

$$\begin{aligned} \underset{u,v}{\text{minimize}} \; & ||Au - Bv||_2^2 \\ \text{subject to } & 1^T u = 1, u \succeq 0 \\ & 1^T v = 1, v \succeq 0. \end{aligned}$$

   Visualize the training data together with a classifier. Also visualize the testing data and the classifier in another figure, and report the classification error on the testing data using the true labels provided in `test_separable.mat`.

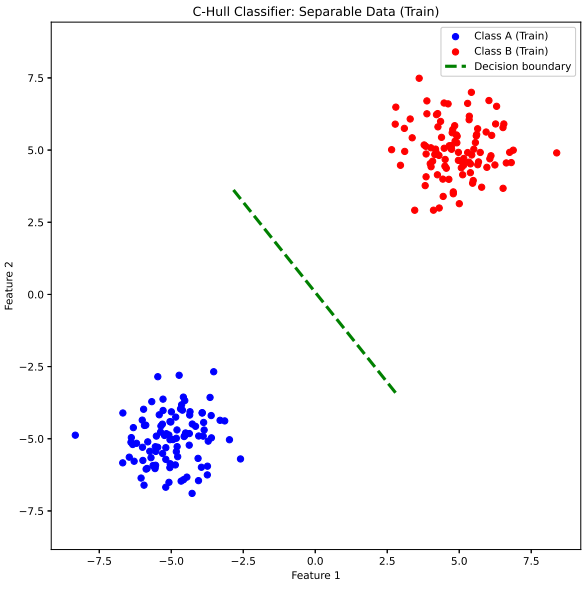

Figure 1: C-Hull Classifier, Separable Training Data

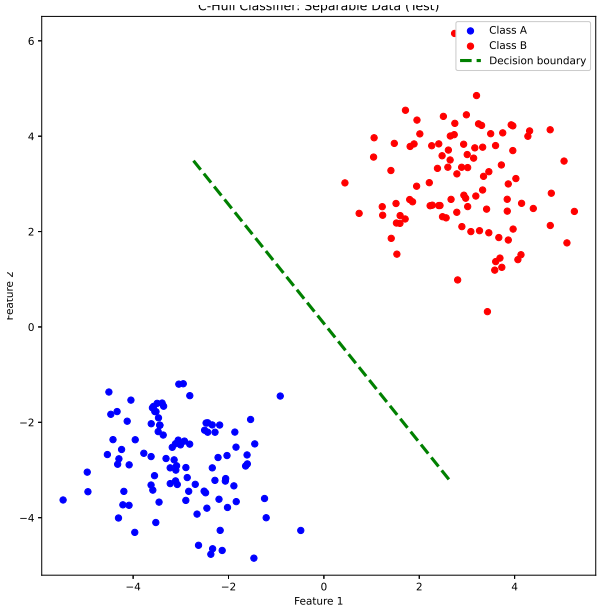

Figure 2: C-Hull Classifier, Separable Testing Data

After solving for a C-Hull classifier, the given test data is classified with 100% accuracy.

(b) repeat the above for `train_overlap.mat` and `test_overlap.mat` using the reduced C-Hull:

$$\begin{aligned} \underset{u,v}{\text{minimize}} \; & ||Au - Bv||_2^2 \\ \text{subject to } & 1^T u = 1, d1 \succeq u \succeq 0 \\ & 1^T v = 1, d1 \succeq v \succeq 0. \end{aligned}$$

Report the classification error on the testing data using an appropriate d.

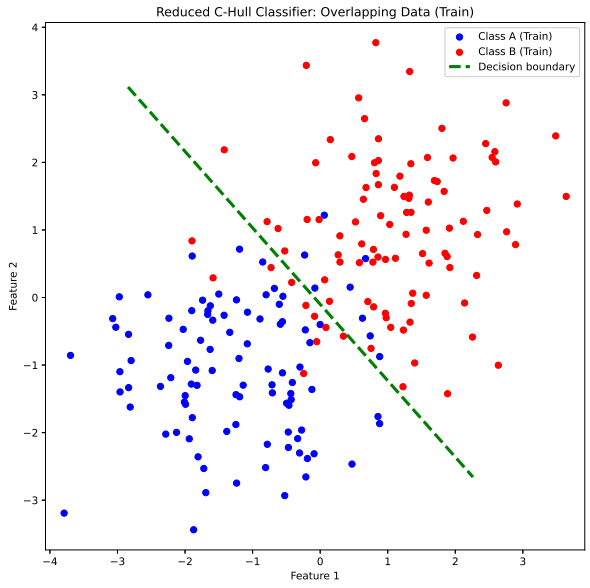

Figure 3: Reduced C-Hull Classifier, Overlapping Training Data

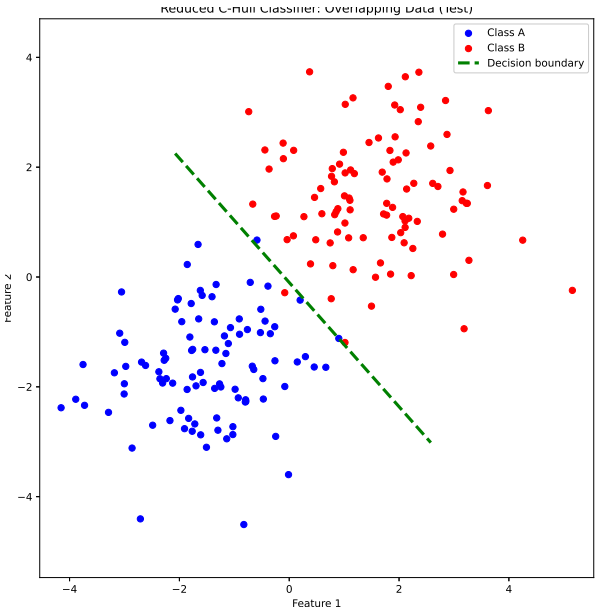

Figure 4: Reduced C-Hull Classifier, Overlapping Testing Data

After solving for a Reduced C-Hull classifier with $d = 0.75$ (admittedly arbitrary), an accuracy of 98.5% is achieved on the test data.

2. Under the same setting of Question 1, do the following:

   (a) Implement C-Hull and Reduced C-Hull using the projected gradient. Do the same visualization as in Question 1.

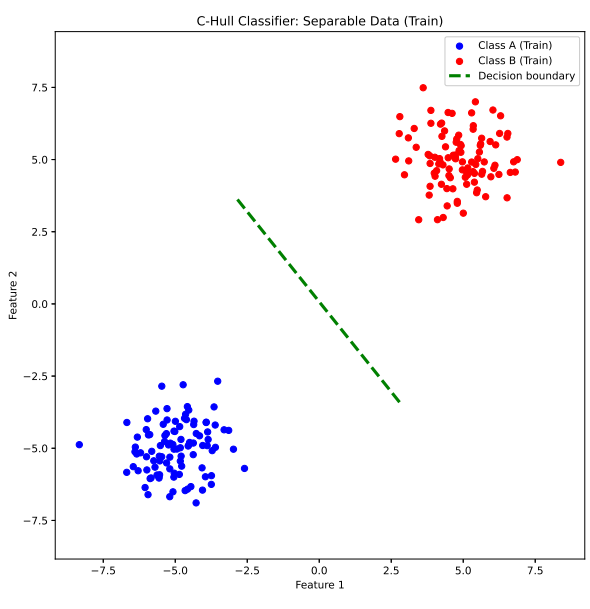

Figure 5: Projected Gradient (C-Hull), Separable Training Data

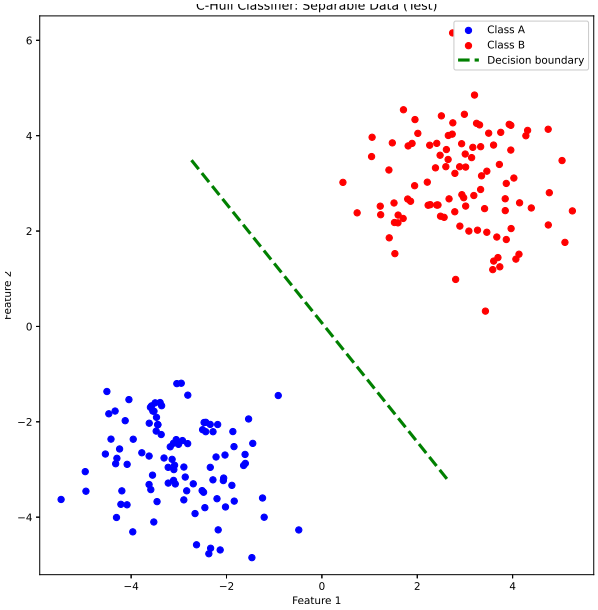

Figure 6: Projected Gradient (C-Hull), Separable Testing Data

After implementing Projected Gradient Descent for the C-Hull classifier, an accuracy of 100% was achieved on the test data. The pseudo-code for the implementation is provided in `q2_pgd_chull.py`.

   (b) Repeat the above using Nesterov acceleration.

3. Under the same setting of Question 1, implement C-Hull and Reduced C-Hull using ADMM. Do the same visualization as in Question 1.

4. Plot an Iteration vs Objective Value figure for the training process. Compare all the alogrithms that you implemented in this figure. In addition, plot a Time vs Objective Value figure using all the algorithms.

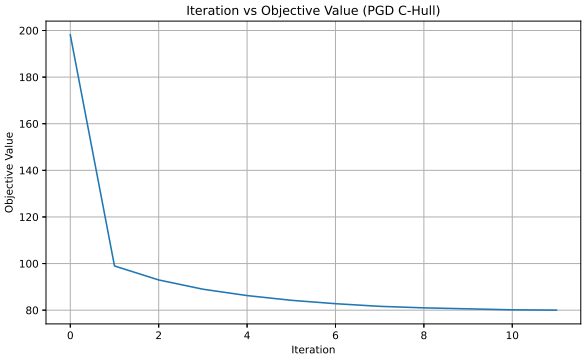

Figure X: Iteration vs Objective Value (PGD C-Hull)

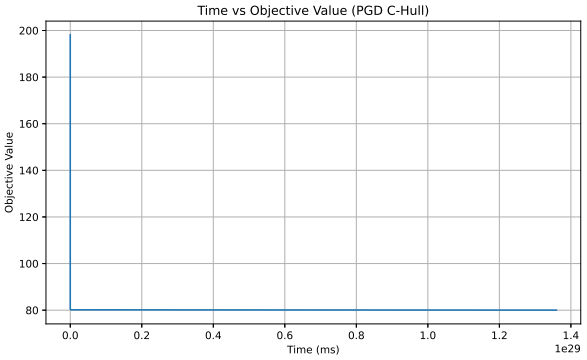

Figure X: Time (ms) vs Objective Value (PGD C-Hull)