1. Experimenting with AdaBoost.
   - Use `generate_data_1.m` with \( n = 1000 \) to create a synthetic training and testing set.
   - Implement Discrete AdaBoost using a weak learner of your choice, and demonstrate it on the above synthetic data using 60 boosting iterations.
   - As a function of the number of iterations, plot the training error, the testing error, and the upper bound on the empirical error.

2. Suppose you and your homework partner obtain a dataset \( \mathbf{x}^i \in \mathbb{R}^d, i = 1, \ldots, n \), from which you assemble a data matrix \( \mathbf{X} = [\mathbf{x}^1, \ldots, \mathbf{x}^n] \in \mathbb{R}^{d \times n} \) and compute the inner product matrix \( \mathbf{Q} = \mathbf{X}^\top \mathbf{X} \in \mathbb{R}^{n \times n} \). After you compute \( \mathbf{Q} \), you realize you wanted to center the data before computing the inner products, i.e., to use \( \mathbf{x}^i - \mathbf{\mu} \) in place of \( \mathbf{x}^i \), where \( \mathbf{\mu} = \frac{1}{n} \sum_{i=1}^{n} \mathbf{x}^i \).
   Unfortunately, you deleted the dataset.

   Show your partner that hope is not lost, since \( \mathbf{Q}' \), the inner product matrix for the centered data, can be obtained from \( \mathbf{Q} \) via the expression \( \mathbf{Q}' = \mathbf{H} \mathbf{Q} \mathbf{H}^\top \) with \( \mathbf{H} = \mathbf{I} - \frac{1}{n} \mathbf{1}_n \mathbf{1}_n^\top \), where \( \mathbf{1}_n \) denotes a column vector of \( n \) ones.

3. Kernel PCA Experiment on Toy Data.
   (a) Implement Kernel PCA using a Gaussian kernel.
   (b) Reproduce the result in Fig. 4 of Schölkopf et al. (1999).