CS/ECE/ME532 Assignment 9

1. **Face Emotion Classification with Kernel Classifier.** In this problem you will apply a kernel classifier to the face emotion dataset. You may find it very helpful to use code from an activity.

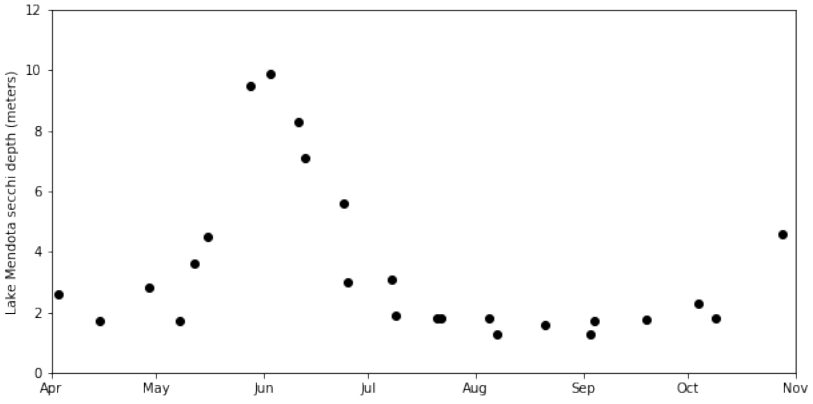
   a) Build a kernel classifier using
   - the squared error loss function
   - an ℓ_2 regularizer with $\lambda = 0.5$.
   - the Guassian Kernel $K(\boldsymbol{u}, \boldsymbol{v}) = \exp(-||\boldsymbol{u} - \boldsymbol{v}||^2/(2\sigma^2)$.

   b) Train your classifier choosing for different values of σ and create a plot with σ on the horizontal axis and accuracy on the vertical axis and comment on the plot. Does your classifier achieve 0% training error?

   c) Find a more realistic estimate of the accuracy of your classifier by using 8-fold cross validation. Can you achieve perfect test accuracy?

2. **Kernel Regression, Lake Mendota Clarity**. The *Secchi depth* is a measure of water clarity obtained by lowering a black and white disk off the shady side of a boat and recording the depth at which the disk is no longer visible.

   A dataset obtained from the University of Wisconsin's Limnology department contains Secchi disk readings (in meters) on Lake Mendota from 2019 and 2020. A Secchi depth of less than 2 meters is consider poor clarity, while a Secchi depth greater than 6 meters is consider very clear. Lake Mendota can have very clear water in late spring when native zooplankton *daphnia pulicaria* consume large amounts of algae and phytoplankton (for more details, see https://blog.limnology.wisc.edu/2019/06/12/whats-behind-this-extended-phase-of-crazy-clear-water-in-lake-mendota/).



   a) Use kernel ridge regression with a Gaussian kernel to fit the measurements. You may find it useful to use code from an activity. Use regularization parameter

$\lambda = 0.01$ and scale parameter $\sigma = 10$. Plot the resulting fit, and comment on the results. Do these parameters overfit or underfit the data? Adjust the regularization parameter to find a visually better fit.

b) Describe how you could use k-fold cross validation to systematically find a good value of σ and λ.