Assignment 2
Learning Dynamics from Video

DUE: Tuesday, February 28, 2023 at 11:59 pm PST
Late assignments will **NOT** be accepted

Professor: Jason J. Bramburger

Included with this assignment are movie files (turned into MATLAB files) created from three different cameras. The experiments are an attempt to illustrate various aspects of the PCA, its practical usefulness, and the effects of noise on the PCA algorithms. In all four cases we will consider video of a spring-mass system, as is described in the lecture notes included with this assignment. The cases are as follows:

1. **Test 1: Ideal Case.** Consider a small displacement of the mass in the z direction and the ensuing oscillations. In this case, the entire motion is in the z direction with simple harmonic motion being observed. MATLAB files: camN_1.mat where $N = 1, 2, 3$.

2. **Test 2: Noisy Case.** Repeat the ideal case experiment, but this time introduce camera shakes into the video recording. This should make it more difficult to extract the simple harmonic motion. But, if the shake isn't too bad, the dynamics will still be extracted with the PCA algorithms. MATLAB files: camN_2.mat where $N = 1, 2, 3$.

In order to use PCA, you will have to extract the mass positions from the video frames. You should begin by converting the MATLAB data to a data file that your programming language of choice can work with and then using a video player to watch the video. You may also find it useful to view the video by creating a loop and displaying each frame.

Goal: After applying PCA to your mass positions, extract the time evolution from only the first two dominant principal components. Apply the SINDy method to try and learn equations of motion that govern the dynamics of the system. Comment on the library used, how you applied the SINDy method, what you should expect the equation to look like, and the effect of the sparsity parameter.

Question to answer: Why did I tell you to use the first two principal components and not just the first one? What does the second represent physically/mathematically? Hint: Think Isaac Newton.