Course: AM5630
Topic: Data-driven methods
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Assignment

1. **Linear algebra**: understanding basis. (Work it out on paper.)
   a. Find null space of: $A = \begin{bmatrix} 1 & 2 & 3 & 4 \\ 2 & 4 & 6 & 8 \end{bmatrix}$
   b. Work out the eigen values and vectors of $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$
   c. Work out the eigen values and vectors of $A = \begin{bmatrix} 1 & 1 & 0 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$
   d. Consider the matrix: $A = \begin{bmatrix} 3 & 1 \\ 1 & 4 \\ 2 & 3 \\ 1 & 2 \end{bmatrix}$. Decompose it into a sum of two matrices of decreasing importance.

2. **POD**: A fun problem.
   a. Take a picture of your face similar to the dataset in file **allfaces.mat**. (see the data and the codes for this already posted in the shared google folder.)
   b. Try to construct your face by using the "basis faces" you get from the POD of the dataset. Comment on how many of these basis faces you needed to get a sense for your face.

3. **DMD**: Load the spiralwaves.mat (same data we used in class).
   a. Solve the DMD problem: find A and also $\widehat{\mathrm{A}}$.
   b. Compare the eigen values for both these matrices. Make comments.
   c. Compare the eigen vectors $\widehat{\Phi} = \mathrm{U}\omega$ and Φ. Make comments.

4. **SINDY**: Load dataforsindy.mat[1]
   a. Write a code for STLSQ method from scratch. (I do not want you to run existing packages for this method).
   b. Find the ODE model that best explains the data as a function of the threshold.

Submission:
- Submit a PDF with your results.
- Codes for each problem should be in one file. It should access data from the same folder.

[1] I will upload the dataset after Tuesday's class.