MATH 568
Linear Inverse Methods, Homework
Due February 22 (before class)

Complete Exercise 4. in Chapter 3 of your textbook, which is an extended case study of a rank deficient tomography problem. Each group will perform different inversions based the four travel time scans available on the textbook GitHub site:

Yemi and Evi	diagonal scan c and diagonal scan d
Ibrahim and Sandra	row a, column b, and diagonal scan c
Patricia and Yao	row a, column b, and diagonal scan d
Habeeb and Brian	row a, diagonal scan c, and diagonal scan d
Hang and Michael	column b, diagonal scan c, and diagonal scan d

Please number your answers to the questions in the following manner:

4 (a) Note the rank of your $\mathbf{G}$ matrix that relates the data and model.

(b) State and discuss

i. significance of the elements and dimensions of the data and model null spaces. Plot and interpret at least one element of each space,

ii. contour or otherwise display a nonzero model that fits the trivial data set exactly

iii. show the model resolution by contouring or otherwise displaying the 256 diagonal elements of the model resolution matrix, reshaped into an appropriate 16 by 16 grid. Note if there are any model parameters that have perfect resolution.

(c) Produce a 16 by 16 element contour or other plot of your slowness perturbation model, displaying the maximum and minimum slowness perturbations in the title of the plot. Interpret any internal structures geometrically and in terms of seismic velocity (in m/s). In addition, produce a plot of the data fit and discuss it.

(d) Describe how one could use solutions to $\mathbf{Gm} = \mathbf{d} = \mathbf{0}$ to demonstrate that very rough models exist that will fit any data set just as well as a generalized inverse model. Show one such wild model.

In addition:

(e) Plot and interpret the correlation matrix.

(f) Quantify and discuss stability of slowness perturbation estimates.