GEOPH421 **Homework 3**
Due Nov 7, Thursday (in class)

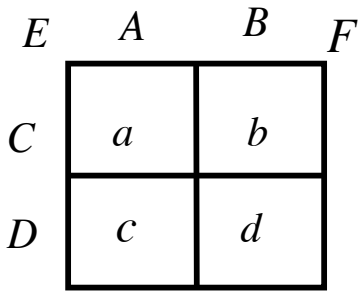
Problem 1 (30 pt): This problem aims to solve the following four simultaneous equations

$$\frac{x^3 y\sqrt{z}}{w} = 2 \qquad \frac{y^3 z^4 \sqrt{w}}{x} = 4$$

$$\frac{z^3 w^3 \sqrt{x}}{y} = 8 \qquad xyzw = 16$$

Find and report values for the four quantities x, y, z and w matrix inverse while using the Least Squares approach. (Note: if you don't think this is a linear problem, think again. You have to come up with a clever way to turn these equations into a set of a linear problem first before solving. Meaning, turn the multiplications of x, y, and zs into some sort of additions through an operation that you learned from high-school math.) You must write the revamped **AX=D** on paper (~80% work on paper), where **X *contains*** variables x, y, z, and w (but not necessarily just x, y, z, w). As the last step, implement this linear problem using Matlab to get the final answer for **X** (using the inv() function, check matlab help, ~20% work, need to attach code).

Problem 2 (40 pt): Consider 4 blocks labeled *a* through *d* as shown. The capital letters *A* through *F* denote the summation of two block values vertically, horizontally and diagonally, e.g.,, *A=a+c*, *C=a+b, E=a+d* and so on. Need to attach code for some parts.



(1) (10 pt) Given values of *A, B, C* and *E (assume they are **observations**)*, define data vector, model vector, and sensitivity matrix for a linear

inverse problem based on the configuration above (how do you set that up?).

(2) (5 pt) If *A=4, B=-3, C=-1,* and *E=0*, find the least squares solution (can use Matlab)

(3) (10 pt) If *A=7, B=-2, C=-1, D=7, E=2, and F=2*, define data vector, sensitivity matrix, and model vector. Find the least-squares solution. Why is the total misfit non-zero? Calculate the misfit (data-prediction) for each datum.

(4) Consider a set of data *A=3, B=2, C=1*, and *D=4*.

4.1 (5 pt) Try and see if you can find least-squares solution and comment on whether and why it is achievable (or not).

4.2 (10 pt) Find damped least-squares solution using norm damping. Plot the norm (L2) misfit and model parameters as a function of the damping parameter. Comment on your result and explain what is happening physically as you vary the damping parameter.

Problem 3 (25 pt): Synthetic Seismogram Calculation

(1) Make a new directory, Copy content of ~jgu/geop624/lab6/ to this directory

cp ~ygu/geop624/sources/* .

(2) You should see a file called **runexp.e**. This is an executable file that contain a bunch of commands that include computation of Green's function (myreflectivity), synthetic seismogram output by convolving the source (mysynd_new), and filtering (applyfilter) for a given station seismic record.

(3) Run program runexp.e by

runexp.e

(4) The selected output files for mysynd_new program are exp_st1.V exp_st1.R exp_st1.T (Vertical, Radial and Transverse, respectively). The output files after filtering (this filtering programs applies a buttersworth filter just like SAC2000) are exp_st1.V.filt, exp_st2.V.filt, and exp_st2.V.filt, respectively.

(5) Look at the seismogram exp_st1.V by

xmgrace exp_st1.V

(6) Identify P, S and surface waves on exp_st1.V or exp_st1.T.

a. Predicted P time = Observed P time =
b. Average Rayleigh wave time = Phase velocity =
c. Predicted S time = Observed S time =
d. Average Love wave time = Phase velocity =
e. Look at your model, roughly how deep roughly do you think the surface wave at this frequency range goes? Give reasoning.