Practical, Feb 26, 2006

For beginners

1. Write a MATLAB program, `guess`, that produces a set of n randomly distributed integers.
2. Using MATLAB, verify that this set is indeed randomly distributed.
3. Write a MATLAB program, `planef`, that, given a domain x and y, and three coefficients a, b and c, calculates the coordinates z of a plane according to the equation $z = ax + by + c$.
4. Using MATLAB, plot this plane in three dimensions.
5. Write a MATLAB program, `geninv`, that, given a data vector $\mathbf{d}$ and a sensitivity matrix $\mathbf{G}$, calculates the best-fitting model vector $\mathbf{m}$ that satisfies the equation $\mathbf{d} = \mathbf{G} \cdot \mathbf{m}$. Use the undamped generalized inverse.
6. Write a MATLAB program, `planefit`, that, given a $M \times N$ matrix of height data $z(1 \rightarrow M, 1 \rightarrow N)$, calculates the best-fitting coefficients a, b and c that produce a least-squares fit to the equation $z = ax + by + c$.
7. Using MATLAB, test this program on synthetic data giving the coordinates of a random plane contaminated by noise, i.e. generate the data using known but random coefficients, add random noise to it, and invert for the coefficients as if they were unkown. Study the results in function of the magnitude of the noise added.

For advanced users

Consider a tomographic problem in which a two-dimensional square consists of 10×10 smaller square cells. Along the sides of the square are distributed a number S explosive sources and R receivers. The raypaths from source to receiver are straight lines.

1. Write a MATLAB program that, given a source-receiver location pair, calculates the length of the ray paths in each of the cells that are crossed.
2. Write a MATLAB program that calculates the sensitivity matrix consisting of all the path segment lengths in the entire experiment of S sources and R receivers. All sources connect to each of the receivers.
3. Write a MATLAB program that, given a fixed number of 10 sources and 10 receivers, finds their optimal geometric configuration using as a criterion, for all of a great number of random locations, the rank of the resulting sensitivity matrices.
4. Write a MATLAB program that performs an inversion for slowness inside the cells, with this optimal configuration, on data that you generate synthetically from a known slowness distribution with noise added. Compare the results of this inversion with the results of a random non-optimal source-receiver configuration.