Applied Math 4380/5380 **Modeling; Project assignment 2** **Posted 10/07/09**
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We have in class discussed several methods for tomographic image reconstruction.

The assignment is as follows: You should form four teams (of typically four persons in each team; five only if all other teams already have at least four members). Each team then selects one of the following methods

- Least squares inversion - 1
  Implement least squares inversion, and solve the resulting overdetermined linear system with non-iterative solvers. Compare the options that Matlab offers in this regard; for ex.
  - Use of Matlab's "\" operator,
  - Use of normal equations plus Matlab's Cholesky method,
  - Use Matlab's QR factorization.

  Compare also costs and solution options when storing the matrix as a full matrix vs. as a sparse matrix.

- Least squares inversion - 2
  Compare the effectiveness of the numerous sparse matrix iterative solvers that Matlab provides. Can you find any useable solver which only requires information about A in the form of the result of the matrix×vector product $A\underline{x}$ for various x-vectors (and thereby makes it unnecessary to create the A-matrix explicitly)?

- Filtered back projection
  Explore various filter designs. Apart from reconstructing the CU logo data set, test also with a scan data set that corresponds to an object with just one pixel non-zero.

- Fast Fourier inversion

You should implement and run the methods in Matlab, and then describe the code and the results to the class. In all cases, try to make your codes as effective as you can, for ex. by using as much vector statements and as few loops as possible. Report in particular (in a way that is uniform between the four teams) on how your computer times vary with the size of your reconstructions.

The presentation in class should take around 20 minutes, with each team member presenting some part of the results. You can assume that the audience has a general familiarity with how your particular reconstruction method works, so a brief reminder is OK, but this should not take more than 5 minutes. The rest of the time should be focused on your code implementation and your results.

As input data for the inversions, your tests should use the codes logo.m and scan.m, which were described in class, and which can also be downloaded from the class web page. If you so want, you may additionally test also with other simulated sets of scan data.

Aim towards presenting about two weeks after the respective method has been described in class. For the first three methods, this means being ready by October 26.