September 13, 2017

Matlab Assignments – Lecture 9, Fall 2016

In these assignments we will investigate regularisation effect of iterative methods.

Download the file `nolet.tar` from the course webpage. This archive contains the files `nolet.m`, `soluti.m`, `plotsol.m`, `matrix.dat` and `solution.dat`. The script `soluti.m` computes the (regularised) solution using the SVD. The script `plotsol.m` plots the solution.

Assignment 9.1.

(a) Run the script `nolet.m`. It will show you the model solution to the problem and the singular values of the system matrix $\mathbf{A}$. Next it will ask you how big the noise in the right-hand side should be (relative error in the right-hand side). Take $\mathbf{0}$. The script will ask you how many singular values (vectors) should be included in the computation of the solution. Predict this number on basis of the distribution of the singular values, and validate this experimentally. The script will give you the solution and the error (difference between computed solution and model solution) after every calculation.

(b) Repeat the assignment with a relative error in the right-hand side of 0.01.

(c) Repeat the assignment with a relative error in the right-hand side of 0.1.

Assignment 9.2.

(a) Implement the CGLS algorithm (as efficient as possible). Start with $\mathbf{x}_0 = \mathbf{0}$. Your algorithm should be called as follows:

```
[x_it res err] = cgls( A, b, m_iter, eps, x_mod );
```

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The input parameters are:

- `A`: the system matrix,
- `b`: the right-hand side,
- `m_iter`: maximum number of iterations,
- `eps`: error tolerance.
- `x_mod`: the model solution.

The output parameters are:

- `x_it`: Iterative solution,
- `res`: residual norm $\|\mathbf{A}^{\mathrm{T}}\mathbf{b} - \mathbf{A}^{\mathrm{T}}\mathbf{A}\mathbf{x}_k\|_2$ in every iteration.
- `err`: norm of difference vector between iterative solution and model solution $\|\mathbf{x}_{\mathrm{it}} - \mathbf{x}_{\mathrm{mod}}\|_2$ in every iteration.

(b) Use your algorithm to solve the Nolet problem. Plot after every iteration the approximate solution by including the call `plotsol(x_it)` after you update your solution. Also plot the norm of the residual and the error as function of the iteration number. First compute the solution without adding noise to the right-hand side. How many

iterations do you need to minimise the difference between iterative solution and model solution?

(c) Repeat the assignment with a relative error in the right-hand side of 0.01.

(d) Repeat the assignment with a relative error in the right-hand side of 0.1.