

# CS 621: Assignment 4

Due: Friday, November 5, 2004 (In Lecture or 4130 Upson by 4pm)

Scoring for each problem is on a 0-to-3 scale ( 3 = complete success, 2 = overlooked a small detail, 1 = germ of the right idea, 0 = missed the point of the problem.) One point will be deducted for insufficiently commented code. Unless otherwise stated, you are expected to utilize fully MATLAB's vectorizing capability subject to the constraint of being flop-efficient. Test drivers and related material are posted on the course website <http://www.cs.cornell.edu/courses/cs621/2004fa/>. For each problem submit output and a listing of all scripts/functions that you had to write in order to produce the output. You are allowed to discuss *background* issues with other students, but the codes you submit must be your own.

## P1. (The p-TLS Problem)

Suppose  $A \in \mathbb{R}^{m \times n}$ ,  $b \in \mathbb{R}^m$ , and  $n < m$ . Consider the following problem where  $p$  satisfies  $0 \leq p \leq n$

$$\begin{aligned} \min \quad & \|E\|_F^2 + \|r\|_2^2 \\ & b + r \in \text{ran}(A + E) \\ & E(:, 1:p) = 0 \end{aligned}$$

Think of this as a total least squares problem where the first  $p$  columns of  $A$  are exact. (If  $p = 0$ , then we have the traditional TLS problem. If  $p = n$ , then we have the traditional LS problem.) If  $E_{pTLS}$  and  $r_{pTLS}$  are optimal, then there is a vector  $x_{pTLS} \in \mathbb{R}^n$  such that  $(A + E_{pTLS})x_{pTLS} = b + r_{pTLS}$ . We refer to  $\{x_{pTLS}, E_{pTLS}, r_{pTLS}\}$  as the pTLS solution.

```
function [x,E,r] = pTLS(A,b,p)
% A m-by-n, b m-by-1, 0 <=p <= n
% Assume that A has full rank and that the pTLS problem has a unique solution
% {x_pTLS, E_pTLS, r_pTLS.} Then x = x_pTLS, E = E_pTLS, and r = r_pTLS
```

Hint: Convert the problem into an equivalent easy-to-solve problem where  $A$  is upper triangular. Test your implementation with the script P1 that is available on the course website.

## P2. (Window LS)

Complete the following function so that it performs as specified

```
function rho = WindowLS(A,b,p)
% A is m-by-n, b is m-by-1, and p satisfies n < p <= m
% rank(A(i:i+p-1,:)) = n for i=1:m-p+1
% rho is a column (m-p+1)-vector where rho(i) is the minimum value of
% norm(A(i:i+p-1,:)*x - b(i:i+p-1),2)
```

Hint: Read §12.5 in GVL. Test your implementation with the script P2 that is available on the course website.