Assignment 3: Serial and Parallel Building Blocks
Lars Karlsson
Bo Kågström
Mikael Rännar
Björn Adlerborn (assistant)

Lab session: 2011-05-13 (8.15-12.00)
Due date: 2011-05-13 (12.00)
Assignment

Your task is to fill out the missing details in a skeleton subroutine in C that solves a mathematical problem. You will first do this using LAPACK and BLAS routines. After you will go Parallel using ScaLAPACK, PBLAS and BLACS.

These are the major steps:

- For the serial implementation only: read input parameters (n,k,nb), generate matrices.
- For the Parallel implementation only: Initialize BLACS, read and broadcast input parameters (n, k,nb, pr, pc), generate matrices. pr = number of processor rows, pc = number of processor columns.
- Copy A, so you can verify your solution later using the routine \((p)dlacpy\).
- Compute \(B = A \times X\) using the routine \((p)dgemm\).
- Copy \(B\) to \(X\) using the routine \((p)dlacpy\).
- Now Solve the linear system \(A \times X = B\) for \(X\)
  - Compute a LU factorization of \(A\) using the routine \((p)dgetrf\). This will overwrite \(A\).
  - Apply the permutation represented by the vector piv to the rows of the matrix \(X\) using the routine \((p)dlaswp\).
  - Solve \(L \times Y = X\) for \(Y\) overwriting \(X\) using the routine \((p)dtrsm\).
  - Solve \(U \times Z = X\) for \(Z\) overwriting \(X\) using the routine \((p)dtrsm\).
- Compute the residual: \(B = ACopy \times X \times B\) using the routine \((p)dgemm\).
- Compute and output the Frobenius norm of the residual now stored in matrix \(B\) using the routine \((p)dlange\). This value should be \(\sim 10^{-10}\) if you have done it correctly.

In the skeletons files lab3_serial.c and lab3_parallel.c an there are places marked with todo which precedes a couple of deleted lines that your task is to reconstruct. There are in all cases just a handful up to a dozen of lines to add in each place and the context should be helpful.

Besides the skeleton files you will also be handed wrappers for calling the Fortran based libraries and also some helper routines.

You will do this assignment in a lab session (4 hours max). The skeleton codes etc. will be published at 8 am the same day.

Some useful links:
Information about ScaLAPACK : [http://www.netlib.org/scalapack/](http://www.netlib.org/scalapack/)
Information about LAPACK : [http://www.netlib.org/lapack](http://www.netlib.org/lapack)
Information about BLAS: [http://www.netlib.org/blas](http://www.netlib.org/blas)
Information about PBLAS: [http://www.netlib.org/scalapack/pblas_qref.html](http://www.netlib.org/scalapack/pblas_qref.html)
Information about BLACS: [http://www.netlib.org/blacs](http://www.netlib.org/blacs)

You can already now start to read up on the different libraries.