COR501 Projects

This page gives a list of potential subjects for your projects. If none of these interest you, you may make a suggestion to me, and we can talk about whether the topic is appropriate; the topic cannot be directly part of your thesis/dissertation project, but may be related.

1. A Multigrid solver for the PDE (see http://www.mgnet.org/). Multigrid is a divide-and-conquer algorithm that solves elliptic equations by getting approximate solutions on fine grids, smoothing errors on coarse grids, and interpolating up and down a hierarchy of grids.

$$\nabla a(x, y) \nabla u = f \quad on\, the\, unit\, square, \; u = g \;\; on\, the\, boundary$$

Consider the discontinuous case, where, say,

$$a = 1 \;\; for\, 0 \le x, y, \le 1/4 \;\; and \;\; 3/4 \le x, y \le 1, \quad a = \alpha \;\; for\, 1/4 \le x, y, \le 3/4$$

Write a parallel multigrid solver to implement the scheme. Use Jacobi as the relaxation method.

http://www.llnl.gov/casc/people/henson/mgtut/welcome.html (the reference for multigrid)
http://www.cse.uiuc.edu/cs450/lectures.htm
http://www.library.cornell.edu/nr/bookcpdf/c19-6.pdf (Numerical Recipes)

2. Write a parallel version of the N-body problem – N point-particles interacting, either by Coulombic interaction or under short-range elastic interaction – in 2 dimensions (3 if you can get the neighbors right). Consider say 500 particles in the unit square (or cube). If you decide to do a Coulomb or gravitational problem (long range), you might consider particle-mesh methods. Or you might want to write a parallel multipole algorithm instead. If you decide to do short-range 'granular dynamics', you might consider "event driven" simulations, or a regular time-stepping algorithm solving Newton's equations.

http://www.amara.com/papers/nbody.html
http://widget.ecn.purdue.edu/~psl/
http://www.cs.berkeley.edu/~demmel/cs267/lecture26/lecture26.html

3. One can write a parallel Navier-Stokes solver for 3-D flow (finite volume or FEM), or a parallel high-order Godunov solver for Euler flows (finite volume or DG). We can talk about the specific flows to simulate.

4. Solve a D'Arcy model for flow in a 2-D porous medium http://www.civil.ualberta.ca/courses/Enve434/ContaminantHydrogeology.pdf, or the equations for overland flow in 2 dimensions http://www.sfwmd.gov/org/pld/hsm/modflow/wetland/wet_sim_mod.pdf

You might want to look at the Classroom Projects at CCR to see what students have done in the past http://www.ccr.buffalo.edu/video-lib.htm.