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# *Research Topics in Computer Science*

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# Over-All Themes

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- Scientific Computing; floating point, numerical linear algebra, matrices, cluster computing
- Enterprise and Distributed Software: lots of computers cooperating, highly reliable, mission critical, high load
- Programming: open source, C or C++, often adding to or working with existing codes containing up to millions of lines.
- Lots of Opportunities for Publications in Refereed Journals
- Possibilities of high visibility and wide adoption.
- I'd be glad to tutor you during the learning curve.

# Highest Priority

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- Get the MedGrid cluster running and documented and monitored. NWChem, bioinformatics software. (Nicky Carrascoso) (others collaborators welcome!)
- Write monitoring software for the AGILA cluster.
- Implement, test, and improve some fast approximate algorithms for multiplying and inverting matrices.  $O(N)$  vs.  $O(N^3)$ . Several people could work on this. At least one paper.
- Implement a certain heuristic algorithm for solving certain systems of equations, as well as one or two exact algorithms, and compare the results in detail. At least one peer reviewed paper.

# Other Scientific Computing I

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- Problem of choosing an optimal path for traversing a data set. (Reduce cache latency on computers; possibly multiply computational speed by two.) Implement a library containing many of the known algorithms, so that they can be compared for a given data set. Possibly develop improved algorithms.
- Computing the permanent of a matrix is an NP-complete problem related to Nobel-Prize-winning physics. Implement a library of existing approximate algorithms for this problem. Possibly develop improved algorithms.
- Challenge of dealing with moving, twisting surfaces. As a warm-up, work towards a simulation of a lava lamp. Cluster.

# Other Scientific Computing II

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- Create an experiment for introductory physics classes where students use their cell phones or video cameras to measure the motion of a ribbon blowing in the wind, and then analyze the resulting data to see chaos in the system. Movies in mpeg format; get video editing software like Adobe Premier running on Linux, then write programs in C or C++ accessing the mpeg api to turn the mpeg frames into pixels and finding the outline of the ribbon. Possible peer-reviewed article.
- Write software which gets the most out of our computerized data measurement system. For a lab on measuring turbulence. Possible journal article.

# Other Scientific Computing III

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- ECCE: Get an analog to digital converter chip working, with software. Useful and possibly publishable or saleable.
- Create and test a program which solves certain nonlinear equations related to the Coherent Potential Approximation for alloys. Useful to others.
- Most or all functions or APIs for creating array of random numbers make no guarantee that you won't generate the same array tomorrow as you did today. Take an existing random number API and adapt it so that it can provide that guarantee, but still allows you to tell it explicitly to repeat an array it already generated. Useful.

# Enterprise and Distributed I

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- Design and write test suites for the MySQL database or for mono. Analyze the code coverage of the existing test suites. Could involve clusters. Several could work on this. Very useful, good visibility, would help your resume.
- Write a test suite capable of figuring out whether programs fully conform to the Extensible Messaging and Presence Protocol (XMPP) used by Jabber. Language of your choice, sort of. Good visibility in the IM programming community.

# Enterprise and Distributed II

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- Write an extension of Source Navigator, the open source tool for analyzing and viewing large software projects, so that it will do C#. Undergraduate thesis. C or C++. Good visibility, and would help your resume. If you wrote a similar extension for IL, the byte code of the .NET runtime, then even better visibility.
- I could possibly supervise other work on developing or especially testing open-source software.

# Enterprise and Distributed III - Needs Investigation

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- Port the Java Open Transaction Manager to C# running on the Mono implementation of .NET. Accompany it with a test suite. Good visibility.
- Help add XA transactions to the MySQL database - both implementation and testing. Good visibility.
- Write a test suite for the XA two-phase-commit transactioning capabilities of InnoDB, the new back end of MySQL. C or C++. Some visibility.

# Miscellaneous

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- Turn lecture notes into textbooks or parts of textbooks.
- Help me set up an open source web site for courses. Source code control database and web front end. User management software.
- The GNU Privacy Guard is an open source encryption program which allows you to send and receive encrypted messages in a very secure way. On Linux there are GUIs that make it very convenient to use, for instance to encrypt the mail that you send. Windows GUIs are expensive or unreliable. Develop a GUI which is full-featured, works well and reliably, and gives seamless integration with Outlook.

# Thank You!

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