Program for the 2006 Front Range Applied Mathematics Student Conference

Breakfast and Registration: 8:30 - 9:00

Morning Session - Room 1521
9:00 - 10:30

9:00 - 9:20	**Geo Sanders** *n e y o Coo do Bo de*	**Adaptive Non-Symmetric Smooth Aggregation Multigrid**
9:25 - 9:45	**Brad Klingenberg** *n e y o Coo do Bo de*	**Exploiting the Geometry of Non-negative Matrix Factorization**
9:50 - 10:05	**McKenna Roberts** *n e y o Coo do Coo do p n*	**Modeling the External Counterpulsation Eects on the Human Arterial System**
10:10 - 10:25	**John Hyatt** *Coo do c oo o M ne*	**Domain Decomposition with Non-Matching Grids for Orthogonal Spline Collocation Problems**

M e M O

MCMCMC Session - Room 1525
9:00 - 10:20

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9:00 - 9:15 San6]TJ /R1310.9091Tf 242504.33268(i)2.77954(x)-341.239.33(C)06353(o)-2977991(o)5(l)2.7773(l)3.222

Plenary Address, David Donoho: 10:45 - 11:45

Exotic New Data Need Exotic New Wavelets

Lunch: 12:00 - 1:00

Afternoon Session I - Room 1521
1:00 - 3:15

1:00 - 1:20	**Darren Homrighausen** *n e y o Co o do Den e*	**An Investigation into Statistical Tests for Stochastic Dominance with Applications to Economic Decision Theory**
1:25 - 1:40	**Michael Giannetto** *Co o do e n e y e o*	**Symplectic Integrators: We Know Good Approximation**
1:45 - 2:05	**Pascal Getreuer** *n e y o Co o do Bo de*	**Nonlinear Multiresolution: New Discretizations for ENO Schemes**
2:10 - 2:25	**Brian Camley** *n e y o Co o do Bo de*	**Modeling Polymerization In A Smectic Liquid Crystal Host With Random Trapping**
2:30 - 2:50	**Brendan Sheehan** *n e y o Co o do Bo de*	**Spatial Multigrid for Transport**
2:55 - 3:10	**Jingling Guan** *n e y o yo n*	**Computational Simulation and Modification of Supersonic Delta Wings**

Afternoon Session II - Room 1525
1:00 - 3:15

1:00 - 1:20	**Mikal Grant** *n e y o yo n*	**Numerical Simulations of Stochastic Differential Equations**

Plenary Speaker (10:45 - 11:45)

EXOTIC NEW DATA NEED EXOTIC NEW WAVELETS

David Donoho, Stanford University

MORNING SESSION

ADAPTIVE NON-SYMMETRIC SMOOTH AGGREGATION MULTIGRID

Geoff Sanders
(Geoffrey.Sanders@colorado.edu)
University of Colorado Boulder
Marian Brezina, Tom Manteuffel (Advisor), Steve McCormick, and John Ruge

Algebraic Multigrid has been of interest for solving large linear systems that come from discretizing PDEs on unstructured meshes or complicated geometries. Adaptive algorithms have been devloped that use little or no a priori knowledge about the geometry of the problem. These methods tend to fail on systems that are very non-symmetric. This is a presentation of a developing algorithm that intends to expand the class of problems that Adaptive Smooth Aggregation Multigrid can handle by including many non-symmetric problems within it.

EXPLOITING THE GEOMETRY OF NON-NEGATIVE MATRIX FACTORIZATION

Brad Klingenberg
(Bradley.Klingenberg@colorado.edu)
University of Colorado Boulder
Advisors: James Curry and Anne Dougherty

With numerous applications to feature extraction, component analysis, and numerical linear algebra, non-negative matrix factorization (NMF) can provide insight into a variety of problems. Unfortunately, while several iterative algorithms for performing the factorization exist, convergence is slow. An investigation into the relevant geometry provides insights into the underlying problem. An algorithm pendently on each subdomain. Numerical results indicate that the error convergence is suboptimal. We reformulate the problem using mortar conditions on the interface. Mortar conditions are generally used in conjunction with finite element methods. These conditions consist of integral constraints on the subdomain solutions. Our approach is a discrete mortar method in the sense that we use a discrete inner product instead of integrals. Additionally, we include constraints on the normal derivatives of the subdomain solutions. We reduce the discrete mortar OSC problem to an interface problem. We solve this interface problem, and then solve OSC problems independently on each subdomain. Numerical results indicate that this method gives optimal error convergence.

We proceed to develop an efficient method for solving the discrete mortar OSC problem. This efficient method consists of three steps. The first and the third steps require solving OSC problems independently on each subdomain. Efficient methods for these steps appear in the OSC literature and the cost is $O(N^2 \log N)$, where N is the number of subintervals in the coarse grid. The second step consists of solving the interface problem. In the reduction

Caryn Knutsen, Kirsten Pyhtila, and Daniel Newman
University of Colorado Colorado Springs

A Symplectic integrator is a numerical method that approximates the solution of a Hamiltonian system of differential equations. Symplectic integrators better approximate solutions of orbital systems over the long term. Good approximation depends upon choosing an efficient step sizea trade off between speed and accuracy. Symplectic integrators are designed to preserve certain differential invariants like phase space volume. Since angular momentum and energy are not preserved, it is the goal of our research to compare symplectic integrators with general purpose integrators using these physical properties. These provide a measure of the physical accuracy of computed solutions.

NONLINEAR MULTIRESOLUTION: NEW DISCRETIZATIONS FOR ENO SCHEMES

Pascal Getreuer (getreuer@colorado.edu)
University of Colorado Boulder

Essentially Non-Oscillatory (ENO) schemes are nonlinear multiresolution decompositions designed to efficiently represent piecewise smooth data. ENO schemes are usually applied with either point-value or cell-average discretization. This presentation will show how to construct ENO and Harten schemes consistent with Harten's framework for a variety of discretizations. The construction here begins with

grids are generated and transformed, and then a numerical method is set up to solve the governing PDE. The solutions of the PDE shows how exactly the air-

Typically the subject is exposed to a stimulus such as a picture, word, or sound. The EEG records the brain waves before and after the stimulus. In any one EEG recording from a subject there is noise, masking the underlying brain activity associated with the stimulus. To reduce this noise multiple trials are conducted by displaying the same stimulus to the subject. The raw data from the trials associated with the stimulus of interest are then averaged together creating an Event Related Potential (ERP).

The EEG data before the stimulus is assumed to be uncorrelated with the stimulus and therefore merely ongoing brain activity. When the EEG trials are averaged, these data are assumed to cancel each other out. The post-stimulus ERP usually displays a waveform that is associated with the stimulus. Though ERPs are often used in current psychological research, it is unknown whether the resulting waveform after the stimulus is due to an increase in amplitude of ongoing brain activity at particular frequencies, a form of phase reset inside the brain, or a combination of both.

To identify if the ERP waveform is produced by phase resetting a new method is being developed. First a Morlet wavelet is applied to the raw EEG data for each of the trials. This shows the frequency bands that are primary contributers to the signal at a given time. For each trial, frequency, and time step the phase is then computed. Using directional statistics, the variance of the phases is computed. According to the literature the phases before the stimulus are expected to be uncorrelated. In this case being uncorrelated translates to the pre-stimulus data having a higher variance than the post variance data. Using the pre-stimulus variances as a control group, it can determined if the post stimulus phase variances are significantly different from the pre-stimulus variances. This talk will present the results of research work done to date and will discuss future work in this area.

AUTOMATED AUTHORSHIP ATTRIBUTION USING ARTIFICIAL NEURAL NETWORKS

Kye Taylor (Kye.Taylor@colorado.edu)
University of Colorado Boulder
Advisor: M.O. Tearle

Neuro-computing provides a novel opportunity to investigate the disputed or unknown origins of literary works that until recently could receive only subjective review in deciding authorship. Results are obtained using a "Committee of Machines" where each committee member is a multi-layer perceptron (MLP) trained to differentiate between works of different authors based on stylometric parameters that are assumed to be indicative of an author's style. Different variables that quantitatively measure word collocations, proportionate pairs, words per sentence, letter spacing, $e\ c$, are used as inputs to each network. The networks are then trained on known works of contempories such as William Shakespeare and Thomas Marlowe before making a decision on an unknown or disputed work by one of these authors.

In designing each network in the committee, m different discriminators on the literature were measured. Assuming all m are helpful in classifying any given sample, each neural network would consist of m input neurons, a hidden layer of n neurons and finally an output layer of a single neuron corresponding to either a match or not between the work being investigated and a given author. The neurons in each ited data.

IDENTITY VERIFICATION IN ELECTRONIC VOTING

Brenda Christensen
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Advisor: Bryan Shader

Electro