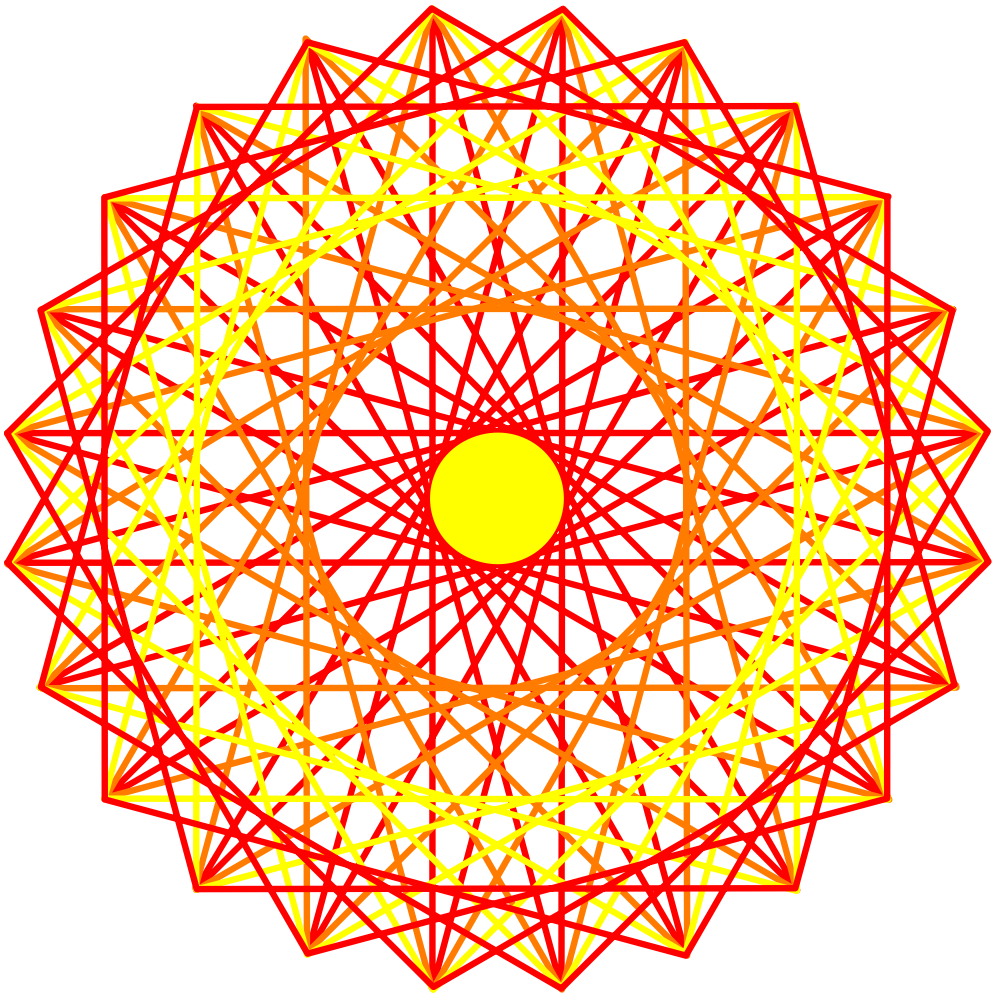

CAARMS10
Speaker Abstracts

SPEAKER INDEX


10 th Conference for African−American Researchers in the Mathematical Sciences
Mathematical Sciences Research Institute & Lawrence Berkeley National Laboratory

THE ORIGIN OF MATTER IN THE UNIVERSE: GRAVITY WAVES, QUANTUM SQUEEZING AND BESSEL FUNCTIONS

Stephon Alexander
Stanford Linear Accelerator Center
stephon@slac.stanford.edu

Cosmic inflation succeeds in explaining the problems associated with the *standard big bang scenario*, such as the horizon, flatness and monopole problems. Inflation also provides us with a causal mechanism for generating large scale structure, such as galaxies and clusters. We show that quantized gravitational waves which are consistently produced during inflation can produce the observed matter-antimatter asymmetry observed on galactic and cosmic scales today. The mechanism has some curious connections to squeezed oscillators and special bessel functions.

TRIVARIATE SPLINE APPROXIMATIONS OF 3D NAVIER-STOKES EQUATIONS

Gerard Awanou
Institute for Mathematics and its Applications
awanou@ima.umn.edu

We present numerical approximations of the 3D steady state Navier-Stokes equations in velocity-pressure formulation. We use trivariate splines of arbitrary degree d and arbitrary smoothness $r < d$. Using functional arguments, we derive the discrete Navier-Stokes equations in terms of B-coefficients of trivariate splines over a tetrahedral partition of any given polygonal domain. Smoothness conditions, boundary conditions and the divergence-free conditions are enforced through Lagrange multipliers. The discrete equations are solved by a variant of the augmented Lagrangian algorithm for which we prove a linear algebraic convergence rate. We have implemented this approach in MATLAB and present numerical evidence of the convergence rate as well as experiments on the lid driven cavity flow problem.

MATHEMATICAL METHODS FOR MODELING OPTICAL SOLITONS

Sean Brooks
Department of Mathematics
Howard University
shakofi@hotmail.com

Variational methods are presented as tools to discuss the existence of solitons for the *coupled nonlinear Schrodinger equation* (CNLS) with elliptically polarizing terms. In addition, a parameter for losses is introduced and a mechanism governing the losses is presented. Finally, the approximate soliton form for the system is constructed and numerically simulated using the split step Fourier algorithm as an initial value problem.

APPLICATIONS QUEST: USING CLUSTERING ALGORITHMS TO ADDRESS AFFIRMATIVE ACTION

Juan E. Gilbert
Computer Science and Software Engineering
Auburn University
gilbert@eng.auburn.edu

Two land mark cases challenged the University of Michigan admissions policies, one focused on Law School admission and the other on undergraduate admissions. In Grutter v. Bollinger, the case focused on the Law School, the U. S. Supreme Court ruled 5–4 in favor of the Law School. However, in the Gratz v. Bollinger, by a vote of 6–3, the Court reversed, in part, the Universitys undergraduate admissions policy to provide points for race/ethnicity. Therefore, the Court decided that race could be considered in admissions decision, but could not be the deciding factor. Although this decision appears to support affirmative action efforts, it limits how race can be used to achieve diversity goals. In sum, the Supreme Court ruled that diversity could be used in university-based admissions, but did not specify how diversity should be used. As a result, the University of Michigan and several other academic institutions have spent large sums of money to holistically evaluate admissions applications. When university-based admission offices holistically evaluate applications, how does this translate into practice? What techniques could be employed to compare large volumes of applications? In an effort to address these questions, Applications Quest was developed. Applications Quest is software that clusters admissions applications. This software uses well known clustering algorithms from computer science and information retrieval to automatically compare thousands of applications to each other and place them into clusters or groups, based upon a holistic view of their similarity (i.e., similar applications appear within the same cluster). The clusters represent diverse application pools with respect to a holistic view of each application. Applications Quest uses attribute-values on an application to determine similarity. For example, the more attribute-values two applications have in common, the more likely they will be clustered together. University-based admission offices can use this software to define diversity within an application pool based upon the holistic view of all the applications where race/ethnicity is one of many attributes used to compare applications. This approach adheres to the Supreme Courts ruling because it does not assign points to race/ethnicity. The software simply uses race/ethnicity in conjunction with all the other attributes to compare applications.

TUTORIAL ON TECHNICAL COMMUNICATION

Robert C. Hampshire
Department of Operations Research and Financial Engineering
Princeton University
rhampshi@princeton.edu

We will give an introduction to the various types of software tools that help to facilitate technical communication. On the first day, we will discuss graphs and plotting through the use of software packages such as *MATLAB* and *Excel*. On the second day, we will discuss slide presentations by the use of commercial software packages such as *Powerpoint* and *MathType 5.0* as well as freeware software tools such as *Adobe Reader 6.0* and *PdfCreator*. Finally, we will discuss how to create Latex mathematical documents on personal computers by using the interactive environment of *WinEdt* and *Miktex*.

DETECTING DISEASE CLUSTERS AND DISEASE SURVEILLANCE

Monica C. Jackson
Department of Biostatistics
Emory University
mcjack2@sph.emory.edu

One purpose of spatial analysis in public health is to detect local clusters or anomalies in patterns of disease. Historically, the spatial analysis literature tends to fall into one of two groups regarding spatial clustering. The statistical literature often assumes independent regional counts and seeks to identify local areas inconsistent with global patterns of disease risk. In contrast, the geography and spatial econometric literature often builds inference based on global and local indices of spatial autocorrelation. Tango (1995) developed a statistic to detect spatial clustering. Rogerson (1999) noticed that Tango's statistic could be broken into two components, the first measuring goodness-of-fit and the second measuring spatial autocorrelation. We explore the use of Rogerson's (1999) expression of Tango's (1995) index of spatial clustering as a hybrid between these two types of approaches, and provide examples of patterns driving the goodness-of-fit and spatial autocorrelation components of the statistic. As well as give on overall view of how important disease surveillance has become since 9/11.

A MATHEMATICAL MODEL TO OPTIMIZE THE OPERATIONS OF A PARCEL CONSOLIDATION TERMINAL

Douglas McWilliams
Department of Industrial and Systems Engineering
North Carolina A& T University / Purdue University
dm003160@ncat.edu

In this presentation a mathematical model is described to solve the *hub scheduling problem* (HSP). The HSP is a special batch-scheduling problem common to consolidation terminals in the parcel delivery industry. The HSP is defined as follows. A consolidation terminal has a set of inbound trailers. Each inbound trailer contains a number of parcels with varying destinations. At the consolidation terminal, the inbound trailers are to be unloaded by unload personnel and the parcels sorted and routed to the load docks. An outbound trailer is assigned to each load dock. The parcels are loaded onto the outbound trailers which deliver the parcels to other points in the delivery network. The HSP involves assigning the inbound trailers to a fixed number of unload docks with the objective of minimizing the time span of the transferring operation.

SPECIAL VALUES OF DIRICHLET L-FUNCTIONS

Milton Nash
Department of Mathematics
University of Georgia
mnash@math.uga.edu

Let χ be a Dirichlet character with conductor Q. Though the general case presents no additional difficulties, for ease of exposition, I will assume that $\chi(-1) = 1$. Let $L(s, \chi)$ be the Dirichlet L-function associated to χ. What can we say about the $\mathbb{Q}$-dimension $\delta_\chi(a)$ of the space generated by the set $\{\chi(1), ..., \chi(Q-1), L(3, \chi), ..., L(a, \chi)\}$ where a runs through odd values? This question is the focus of my current research. In fact, I prove the following:
Theorem. *For each $\epsilon > 0$ there is an $A(\epsilon)$ such that for $a > A(\epsilon)$*

$$\delta_\chi(a) \geq \frac{1-\epsilon}{Q + \log(2)} \log\left(\frac{a}{Q}\right).$$

In my talk I will show how one can arrive at such results using a criterion for linear independence and a suitably chosen auxiliary function.

TUTORIAL ON ALGEBRAIC STATISTICS

Kimberly Sellers
Department of Statistics
Carnegie Mellon University
ksellers@stat.cmu.edu

"Algebraic Statistics" is an emerging field that considers and applies tools from computational algebra and algebraic geometry, to statistics. Statisticians are finding useful results in computational commutative algebra because many applications of statistical interest reduce to solving systems of polynomial equations. The primary emphasis is on problems that arise in the study of multidimensional contingency tables, as well as other areas of statistics (e.g. maximum likelihood estimation, experimental design). Meanwhile, algebraists are keenly interested in further developing computational algebraic results stemming from these applications, and the relevance of Gröbner bases to statistics. The series of tutorial sessions will provide background linking computational algebra to statistics, and illustrate its use to address statistical problems.

CONSTRUCTING SIMPLY-CONNECTED ISOSPECTRAL MANIFOLDS VIA SUNADA'S METHOD

Craig Sutton
Department of Mathematics
University of Pennsylvania
cjsutton@math.upenn.edu

Spectral geometry explores the relationship between the geometry of a Riemannian manifold (M, g) and the spectrum of its associated Laplace-Beltrami operator $\Delta : C^\infty(M) \to C^\infty(M)$. In this talk we will extend Sunada's method to produce pairs of isospectral simply-connected, locally non-isometric manifolds. In addition, we will see that our manifolds admit isospectral group actions which are not measurably conjugate, thus demonstrating that von Neumann's result concerning the spectral rigidity of abelian group actions does not hold in general.

A REDUCED BASIS METHOD FOR MOLECULAR DYNAMICS SIMULATIONS

Rachel E. Vincent
Department of Computational and Applied Mathematics
Rice University
rvincen@caam.rice.edu

Molecular dynamics (MD) simulations are computationally expensive and generally require a large amount of data storage. We propose a method to reduce computational costs and storage requirements using singular value decomposition (SVD) analysis. In particular, we compute the truncated SVD of the MD trajectory in order to obtain a reduced representation of the trajectory. We update the basis defined by the left singular vectors as new information becomes available.

SVD analysis of the computed trajectories will be developed to augment abilities to locate active sites, to identify preferred molecular configurations, and to study periodic behavior. Visualization and manipulation for display purposes can also be vastly improved through the data compression made possible by the truncated SVD - reduced basis approach.

In any trajectory, whether generated by traditional dynamics methods, time-averaged refinements, or a reduced-basis set method, classical principal component analysis may be used to classify and represent the dominant characteristics of the MD trajectory. Here we augment the classical principal component analysis with an SVD updating scheme. We present preliminary results obtained with respect to a harmonic oscillator model and butane.

ON THE FORMULATION OF A CONSTRAINED OPTIMIZATION FRAMEWORK FOR PRICING AMERICAN-STYLE OPTIONS

Donald C. Williams
Department of Computational & Applied Mathematics
Rice University
donald@caam.rice.edu

Fundamental to many complex derivative financial products is the valuation and optimal exercise of options with American-style exercise features. In this talk, we review some fundamental notions regarding option contract specifications. We then examine the PDE approach to modeling American-style option contracts. We discuss the variational inequality formulation of the problem, the resulting linear complementarity problem (LCP), and a typical technique for approximating numerical solutions. A more general constrained optimization framework will be posited and discussed from the perspective of incorporating additional economic constraints into the pricing model.