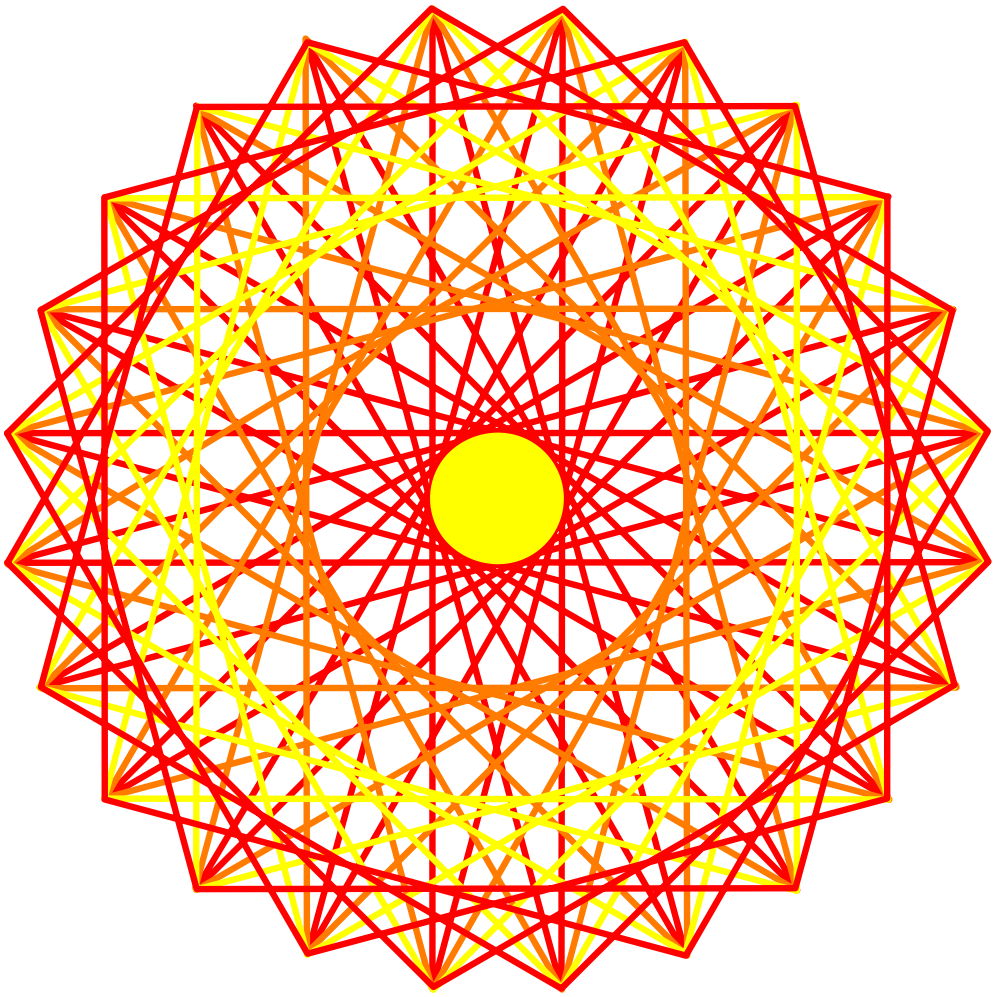
10 th Conference for African−American Researchers in the Mathematical Sciences
Mathematical Sciences Research Institute & Lawrence Berkeley National Laboratory



CAARMS10
Graduate Student
Poster Abstracts

POSTER PRESENTER INDEX

BAGGING BAYESIAN NETWORKS: DETERMINANTS OF DISASTER RISK

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A common quantification of risk, of a disaster, under spatial independence, is as a probabilistic product over exposed elements and their vulnerability to the disaster. A non-trivial joint quantification of Risk, from multiple disasters, involves the determination of dependencies between the elements and vulnerabilites. A Bayesian Network (BN) - a Directed Acyclic Graph (DAG) where the joint [probability] distribution is the product of marginal, conditionally independent distributions - can be applied to the problem of,divining dependency structure. We investigate BN learning on a composite,global disaster dataset of large dimension (n =24600; k = 8) using the DEAL algorithm - which reduces the NP-complete problem by using a heuristic search with random restarts. The DEAL algorithm is highly sensitive to perturbations in the learning set - to improve accuracy, we apply Bayesian Aggregation (Bagging) to many learned networks

FLUX RATIO ANOMALIES DUE TO A CHANG-REFSDAL LENS

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In gravitational lensing, the local magnification theorem predicts that pairs of very close images have equal flux. However, close pairs of images have been observed where one image has much less flux than the other — a phenomenon referred to as a "ratio flux anomaly." These anomalies are caused by small scale structures in the gravitational lens. This project considers the case where the small scale structure is due to a Chang-Refsdal lens, which is an important analytical model in the theory of Gravitational Lensing. The lens represents a star sitting in a constant density smooth matter distribution along with a constant external shear due to surrounding matter. My research project is to classify mathematically the possible flux ratio anomalies due to a Chang-Refsdal lens.

SIMULATION OF STRIPES IN DROSOPHILA MUTANT EMBRYOS

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Driever and Nusslein-Volhard showed that the bicoid protein determines position in the Drosophila embryo in a concentration- dependent manner. In their lab work, increases or decreases in bcd protein levels in a given region of the embryo cause a corresponding posterior or anterior shift in the embryo.

We reproduce that result in a computational manner with the gene circuit method which is based on three main ideas:

1. The choice of protein concentration as state variables for the description of gene regulation.
2. A summary of chemical reaction kinetics by an ODE.
3. The use of least-squares fits to gene expression data to measure changes occurring in the gene circuit.

We later apply simulated annealing as a mean to understand robustness in the genetic behavior of Drosphila mutant embryos.

ALGORITHM FOR QUANTIFYING STRAIN RATES

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The strain record at a place is a value of all strain as a function of time for a specified period of time (e.g., an hour, a day, a lifetime). Certain aspects of the strain record have been proposed to be important contributors to bone adaptation. The strain rate might be one of those contributors, and so a protocol was developed to quantify the strain rate. The strain rate was quantified by taking the average strain rate of half cycle of a cyclic strain event. A FIR (Finite Impulse Response) or moving average digital filter was used to remove background noise from the strain signal before the strain rate could be quantified. The protocol was tested using actual data and the algorithm performed well within its design requirements. This is joint work with Susannah P. Fritton.

MULTIMODAL E-VOTING SYSTEM

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After the debacle of the 2000 Presidential election it became painfully obvious that Americas voting system was outdated and in need of an upgrade. In response, the federal government has made funding available for the purchase of new voting equipment. Direct Recording Electronic (DRE) voting machines such as Electronic Voting (E-Voting) machines are one type of modern voting machine currently being considered and in some cases being used in a few states and counties, but not without controversy.

It has been noted in various news articles that these machines pose an unacceptable risk. E-Voting machines have been proven vulnerable to hackers, malignant workers, faulty code, lack of recount ability and/or human error to name a few. As such many counties have halted the purchase and use of these systems. In addition the current E-Voting machines do not solve the issues of accessibility to American voters with visual disabilities.

An electronic voting system that will solve many of the above issues has been developed. This system is multimodal allowing for either speech, touch or both interactions. It has a unique printing feature, network and non network options, increased security and the ability to do recounts. My research involves the design, development and evaluation of this system.

SIMULATION STUDIES OF THE STATISTICAL RELIABILITY OF SPACE SYSTEMS

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Drawing decisive conclusions about the constitutive elements of environmental and space system models are integral to the mission of NASA. The nature of activities at the Lyndon B. Johnson Space Center gives rise to a number of research opportunities in the areas of reliability and safety of space vehicles. These areas are of critical importance as we seek to improve space flight systems and prevent future system failures. Using knowledge of system architecture and failure data, probability and statistical models will be developed to determine system reliability. Furthermore, simulation and modelling tools will provide insight into predicting the time-to-failure of system components.

ATTENTIVE USER INTERFACES AN INTERACTION STYLE PARADIGM SHIFT

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Attentive User Interfaces (AUIs) are moving to the forefront because the functionality of status quo computing interfaces presumes the users undivided attention; yet the propagation of ubiquitous computing devices has rendered this model obsolete. (AUIs) are interaction and visualization styles that infer knowledge about priorities and attempt to focus rather than distract the user. AUIs are implemented by augmenting computing devices with attention sensors. These sensors facilitate the computing devices ability to prioritize their demands for user attention. The practical functionality of AUIs involves users and devices entering a turn taking process similar to that employed during human group conversations. This presentation previews some early AUI implementations, provides an overview of the AUI systems infrastructure, and explores some of the future challenges/implications of AUI enabled technology.

EFFECTIVE PRODUCTION OF VARYING LENGTH TEMPORAL SEQUENCES FROM DISTAL TARGET TRAJECTORIES

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Existing methods for training a learning agent to produce sequences of actions in order to accomplish a task while situated in a complex environment have met with limited success. Various reinforcement learning techniques are often used to handle such learning tasks, but convergence to an optimal policy is not guaranteed for many of these methods. Traditional supervised learning methods tend to yield more goal-directed learning behavior than reinforcement learning methods. However, these methods are not well suited for such tasks as these since desired outputs in the learners local output space tend not to be readily available from the proverbial "teacher". Rather, distal target output sequences attainable through interaction in the environment are generally the only information the teacher can supply, leaving the learner to obtain the desired sequential behavior necessary to yield them.

Supervised learning techniques have since been devised such that the strengths of traditional supervised learning methods may now be used for training neural networks acting in external environments. Specifically, a neural network can now be trained not on examples in its own local, or proximal, output coordinate space, as is accustomed in traditional supervised learning methods, but from examples obtained distally through interaction with the environment. This can be done by training another neural network, termed a forward model, to model the environment and using this as an effective aid in training the learner.

However, these distal supervised learning methods have been developed primarily with training on single distal target outputs in mind. Training neural networks to produce sequences to correctly yield target distal sequences, or trajectories, given a single static input still has much room for improvement. In my work, the benefits of using recurrent neural nets in the distal supervised learning framework is investigated in enhancing the acquisition of time varying sequential behavior in an environment. Also, the ability of a recurrent learner to generate sequences of proximal actions even in the absence of current state information is observed.

BETTER THAN CHAOS: PERFORMANCE OPTIMIZATION ON CHAOTIC SYSTEMS

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Chaotic dynamical systems can exhibit a wide variety of motions, including periodic orbits of arbitrarily large period. I am considering the question of which motion is optimal, in the sense that it maximizes the average over time of some given scalar "performance function." Past work has shown that optimal motions tend to be periodic orbits with low period but does not describe, beyond a brute force approach, how to determine which orbit is optimal in a particular scenario. For one-dimensional expanding maps, I have developed a constructive method for calculating the optimal average and corresponding periodic orbit. This method, carried out on a computer, has been found to work quite well in practice. I am currently working on extending these results to higher-dimensional dynamical systems.

THE TRUTH ABOUT THE BIRDS AND THE MONKEYS A SURVIVAL OF THE FITTEST

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The purpose of this project was to perform a statistical comparison of three evolutionary strategy heuristics. The heuristics that were compared in this study were Genetic Algorithms, Hybrid Genetic Algorithms, and Particle Swarm Optimization. Each heuristic was evaluated and compared on the number of times their respective function was evaluated during each run as well as the objective value that was yielded. Three benchmark functions were used to evaluate the robustness of each algorithm. The following functions were used to assist in this evaluation: Rastrigin Function, Griewank Function, and the Schwefel Function. This is joint work with Vanessa Green.

CLASSIFICATION OF ROTATIONAL FIGURES OF EQUILIBRIUM

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An immiscible liquid drop completely immersed in a homogeneous fluid and isolated from body forces assumes, at rest, the shape of a sphere. It is also possible, if the external fluid is perfectly inviscid, that an isolated drop may rigidly rotate and assume an axisymmetric shape. The shape and stability of such rotating drops have been investigated by many authors following the pioneering work of Joseph Plateau. We classify all possible meridian curves of rotationally symmetric rotating drops according to the standard variational formulation. After simple normalizations, these meridian curves form a two parameter family, and we examine the relationship between the two parameters and physical quantities associated with the drops.

SIGNAL ANALYSIS USING THE MULTIPLE SIGNAL CLASSIFICATION (MUSIC) ALGORITHM

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This project is centered on understanding the dynamics of a return signal and its source emitted from some device capable of sending an electromagnetic wave. It is assumed that this signal is partially absorbed by its target and partially reflected off of its target as a return signal. In our case, we consider the target to be the human chest area to determine if a medical patient potentially has collapsed lungs. Mathematically we could analyze the difference of the source or incident signal and the reflection or return signal of the target that we understand to be the autocorrelation of a signal. This is joint work with Hasan Bey. Our advisors were Drs. David Ellis and Stephen Lockhart, M.D.

ON A STATISTICAL APPROACH TO FINDING ELLIPTIC CURVES OF HIGH RANK

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Elliptic curves are an active area of research in mathematics. Although much is already known about elliptic curves, the size of the rank that is, the number of generators of the abelian group of rational points remains rather mysterious. No one knows how large it can be.

Currently number theorists all over the world are racing to find elliptic curves with large rank. Unfortunately, the computer packages which compute the rank for a given curve are slow at best, and may not even terminate at worst. In 2000, Nicholas Rogers introduced a statistical approach which sorts through curves associated to the congruent number problem having a dense number of rational points. This research, inspired by his algorithm yet tailored to a certain class of elliptic curves, has two goals: (1) to find elliptic curves of high rank via this statistical analysis of the density of rational points, and (2) to understand the theory of descents that inspires the computer packages which compute the rank.

ADVANCED DISTRIBUTED LEARNING IN AN ADAPTIVE INSTRUCTION ENVIRONMENT

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Each student has a personal learning style that originates from innate tendencies and environmental experiences. Because cultural groups often share common values, the experiences of children growing up with those values are reflected in their classroom learning behaviors (i.e. cultural learning style). Therefore, a culturally relevant pedagogy is central to the academic success of minority students.

The research described in this poster is influenced by the compelling impact of social and cultural issues on academic performance. Accordingly, the African American Distributed Multiple Learning Styles System (AADMLSS) was developed to provide Educators with an easy to use viable alternative, for supplementing their classroom instruction portfolio, with culture specific e-learning tools. AADMLSS embraces the differences in cultural learning styles by providing a culturally sensitive, multi-curriculum, e-learning pedagogical environment, in an effort to enhance a students overall learning experience and classroom performance. AADMLSS is an advanced distributed learning system that provides adaptive instruction to learners. There are multiple instructional methods stored in the system and learners are provided instruction such that their individual learning styles are accommodated.

A NOVEL COMBINATORIAL METHOD FOR QUANTIFYING MICROSATELLITE-DEPENDENT NON-RANDOMNESS IN GENOMIC DNA

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We have developed a method for computing the expected frequencies of microsatellites, using basic combinatorial techniques such as permutations, generating functions, and the principle of inclusion and exclusion. We have used a computer implementation of this method to study the non-randomness of microsatellites in five of the eight known human CAG disease genes (HD, SCA1, SCA2, SCA3, and SCA7). Our results show that all five CAG disease genes exhibit a very similar degree of CAG-dependent non-randomness. By contrast, none of the other microsatellites studied showed such similarity in their non-randomness across these genes. These results suggest a possible role of CAG-dependent non-randomness as a marker for putative CAG disease genes and lend support to the view that CAG diseases have a similar underlying mechanism.

INTEGRATING PROCESSOR NETWORKS INTO A DATA DRIVEN RESOURCE ARCHITECTURE

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Reconfigurable systems provide tens of millions of equivalent gates, allowing a highly parallel processing impossible to reach with general purpose processors. Nevertheless, designing a circuit is intrinsically more complicated than using a software approach because space and time concepts must be considered together. Current High-Level Description Languages (HDLs), which use a low level description, are only accessible to highly qualified hardware design engineers and require much more time than a pure software solution.

Our project demonstrates how the use of higher level HDL allows anyone with a software background to design complex architectures in a simple and efficient way. We are developing a tool based on an intermediate HDL, which integrates processor Networks into a Data Driven Resource Architecture based on Petri Networks principles. The applications for this project ranges from sort algorithms to Neural Networks.

Five sort algorithms have been designed and tested in a few days using our intermediate level HDL. Results show that the design time, circuit space and global performances are at least one order of magnitude better than a processor approach for a NoC, and in some cases, we are getting three orders of magnitude.

A PROCEDURE FOR QUANTIFYING MIXING

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Given two flow fields, we are interested in comparing their mixing characteristics. Thus far there has not been a very clear cut way for this to be accomplished quantitatively. Our study focuses on introducing a metric to measure mixing and implementing it numerically. The results should have both oceanic and atmospheric applications.

AGENT ASSISTED LESSON MANAGEMENT: AN INSTRUCTION CREATION TOOL

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AADMLSS, the African American Distributed Multiple Learning Styles System, is an agent-based e-learning tool designed to supplement classroom instruction. The basis of this tool is the use of "culturally relevant pedagogy" when providing information to students (Ladson-Billings 1995). AADMLSS is composed of two components, ADAM and EVE. ADAM is the portion of the system that presents instruction units to the student and provides adaptive instruction in order to maximize student success. EVE is a course content creation and management tool designed to help instructors add lessons to the AADMLSS instruction repository. EVE is in itself an agent-based interface which provides a step-by-step method to developing web-based instruction units. This work seeks to explain the implementation and usage of EVE and its relationship with the overall AADMLSS system. This is joint work with Juan Gilbert.

CLASSIFYING FINITE DIMENSIONAL DIVISION ALGEBRAS

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In science, much attention is given to organizing knowledge so that it is readily accessible to all those who wish to build upon its foundation. A primary goal for such organization is classifying the objects studied. Biologists study the distinguishable kinds of organisms inhabiting the earth; chemists study the distinct elements found in the universe; and mathematicians study various number systems. To make order out of this diversity in each area, a method of classification is necessary. My presentation will outline the problem of classifying a mathematical object called a *division algebra*. I will also give some results describing the cyclicity of $\mathbb{Q}_p((t))$ division algebras.

MODELLING THE RELATIONSHIP BETWEEN MANAGEMENT SYSTEMS AND HEALTH OUTCOMES: DOES LEAN PRODUCTION LEAD TO POOR ERGONOMICS?

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The purpose of this research is to investigate the relationship between lean production practices and work-related musculoskeletal disorder (WRMSD) risk exposure. Since the late 1980's, American manufacturing firms, particularly in the automotive sector, have begun to widely adopt the Japanese Management System (e.g. Toyota's Lean Production System) because of its superior quality and productivity measured against the traditional manufacturing systems of American and European firms. The proliferation of implementation of the lean production system within American firms gave rise to the debate over the extent to which this management system has adverse physical and psychological health effects on its labor force. A very basic model of the relationship between physical WRMSD risk exposure and lean production was developed and the results provide evidence to support the claims of the lean critics. This model is limited in that only value-added work content served as a proxy for lean production.