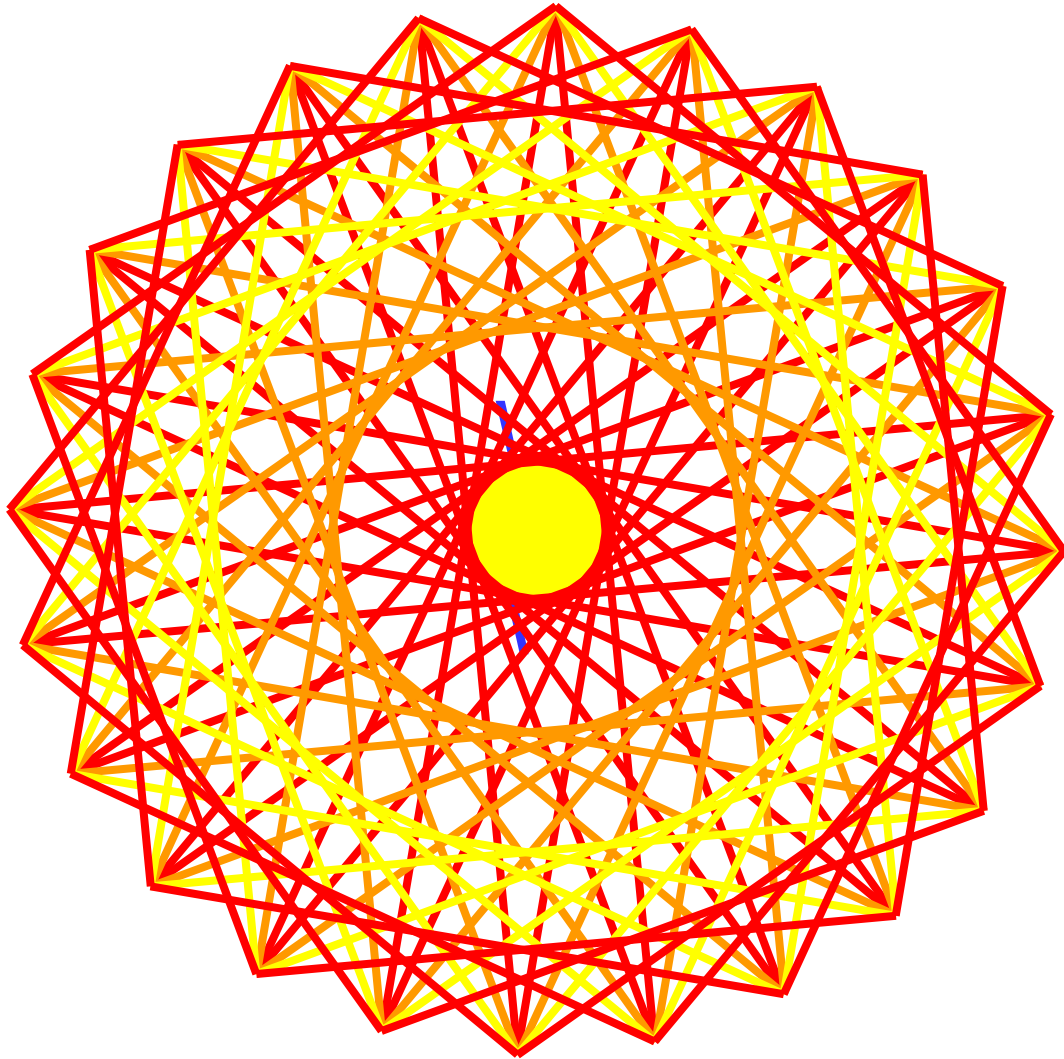


CAARMS15 STUDENT POSTER ABSTRACTS



**Conference for African American
Researchers in the Mathematical Sciences
at Rice University on July 23-26 of 2009**

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Benjamin Appiah

Rice University

“Inversion Method for Analyses of Tissue Fluorescence: A Solution to an Overdetermined System”

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An inversion model is used to analyze the fluorescence spectra of normal and cancerous tissues of the cervix. This model produces a 2-norm (least squares) fit to an overdetermined system. The problem involves an approximation of the diffusion equation which is used to describe fluorescence intensity in biological tissues. A Levenberg-Marquardt approach in which analytical solutions of the Jacobians are computed is used. A comparison is made between 4 extracted parameters from this inversion method. The parameters involve metrics describing the cellular, collagen, absorption and scattering contributions to bulk fluorescence spectra. The parameters are grouped into that belonging to either a cancerous or normal category and then analyzed. The comparison shows a marked difference between these 2 categories. This suggests that an algorithm could be developed to clinically diagnose cancerous tumors.



Taniecea A. Arceneaux

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“Network Connectivity: Uncovering Implicit Segregation within a Group of Southern Women”

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In the interdisciplinary study of networks, scholars from many fields strive to describe the properties of relationships that link individuals and objects within a given grouping. Because of the subjective nature of the formation of interpersonal connections, it is especially important to consider the implications of a particular model to the social network involved. A classic social network dataset collected by Davis, Gardner, and Gardner denotes the attendance of a group of 18 Southern women at 14 social events. We apply a Markov chain model to the irreducible and aperiodic Southern women data, in which the stationary distribution provides a measure of connectivity for each woman in the group. However, the connectedness of the group defies the inclination that distinct subgroups seem to emerge through attendance at these social events. Through inventive reasoning, we reconstruct the data in order to isolate the social events that appear to encourage segregation within the group. Again applying a Markov chain model to the reconstructed data, we find two irreducible and aperiodic subgroups. We give a measure of connectivity for the women within each subgroup through inspection of its stationary distribution.



Reginald J. Askew
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**“Multivariate Thresholding for
Environmental Hazards”**
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Multivariate thresholding is partitioning a mixed multivariate distribution into regular and extreme valued; thresholding multivariate data is identifying extreme valued vector observations.

We investigate multivariate thresholding procedures on latitude-longitude gridded data of environmental hazards and vulnerabilities. Distinguishing locations where rare environmental hazards are frequent can assist and effect preventative measures.



Byron E. Bell
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**“The 1905 Einstein Equation in $f(w) = w$, Framework
Towards a General Mathematical Analysis Model”**

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The 1905 wave equation of Albert Einstein is a model that can be used in many areas. Like Physics, Applied Mathematics, Statistics, Quantum Chaos and Financial Mathematics, etc. I will give a proof from the equation of A. Einstein in the paper “On the Electrodynamics of Moving Bodies.” By removing the variable time (t) and the constant “ c ” the speed of light from the above equation and looking at the factors that effect the model, in a real analysis framework.



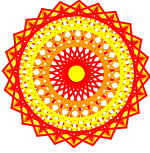
Terrence Richard Blackman

Mount Holyoke College

“Arithmetic and Geometry of Quaternion Algebras”

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The goal of my project is to extend current work on the spectral correspondence between co-compact Fuchsian groups derived from quaternion algebras and non-co-compact Fuchsian groups coming from congruence subgroups. It involves understanding orders in quaternion algebras of Eichler invariant -1 and understanding how the spectral theory of the co-compact Fuchsian groups coming from those orders resembles that of the newforms of the Hecke congruence subgroups $\Gamma_0(d)$, where d is discriminant of the order.



**Crystal Boston^{†‡}, Raquel Hill[†],
Loretta Moore[‡]**

†Indiana University, ‡Jackson State University

**“The Feasibility of Designing a Secure System to
Prevent Surgical Errors Using Radio Frequency
Identification Technology”**

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The health care system in the United States is essential to the well-being of the country and its population; yet, researchers estimate that 1300 to 2700 wrongful surgeries are reported annually. It is startling to know that once a patient is admitted into a hospital for a surgical procedure, he or she is at risk of having surgery performed on the wrong-side, in the wrong place (wrong-site), or receiving a surgical procedure that was intended for another patient. Although the precise cause for the occurrence of these errors are uncertain, researchers proclaim that these events are often the result of communication barriers between medical personnel, lack of collaborative work ethics, failure to adhere to safety regulations, and the consistent error of determining right from left. The National Practitioner Data Bank (NPDB) recorded 5,940 (over a 13 year period) wrong-side/wrong-site, wrong-procedure, and wrong-patient adverse events (WSPEs). Reducing the number of WSPEs is an ongoing focus.

With these dismaying facts in mind, this research will facilitate communication within surgical environments. To this end, we propose to enable mobile information access through the utilization of radio frequency identification (RFID) tags. This research assesses the limitations and feasibility of implementing this technology and derives functional and security requirements from medical personnel. We consider the following feasibility concerns: usability, privacy, the availability of accurate and adequate patient information at the time of care, storage capabilities, data transmission, and security issues related to legal and ethical complications (inappropriate disclosure of medical information). After analyzing several resources including interviews with medical personnel, journals, articles and other literature regarding medical reviews, a preliminary design has been devised to eradicate WSPEs with the use of RFID technology.



Saikou Camara, Raquel Hill, Loretta Moore

Indiana University, Jackson State University

“Understanding How RFID Technology Impacts Patient Privacy”

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Patient privacy is the right or desire to control and protect identifiable information about patients or their medical circumstances. The HIPAA Privacy Rule, a Federal law, gives you rights over your health information and sets rules and limits on who can access and receive your health information. To satisfy these rules, institutions must use confidentiality mechanisms to ensure patient privacy. The protection of patient privacy and the reduction of medical errors will be the dominant concerns for the next decade of healthcare reform and will stimulate many of the structural changes to current HIPAA regulations. As we develop our responses to these issues, researchers are trying to solve some of the causes of medical errors with the help of radio frequency identification (RFID) technology. A RFID tag provides a unique identification number (an electronic code or an individual serial number) that can be read by contact-less readers, which enables automatic real-time tracking of devices as they pass through RF scanners. One of the major RFID security concerns is the threat of illegal tracking. RFID tags could be read from a distance without the owner's knowledge, leading to the disclosure of location or other sensitive information contained in the RFID tag's memory. Another security concern is the cloning of RFID tags. Cloning can lead to impersonation, and unauthorized changes to an individual's medical record. This research explores the security vulnerabilities of RFID technology and its impact on patient privacy. We look specifically at issues of patient tracking and post-treatment surveillance.



Dennis A. Dean II

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“Using Mathematical Models of Circadian Phase to Take the Lag out of Jet Lag”

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Traveling across multiple time zones causes the desynchronization of environmental time cues and sleep-wake schedules from their normal phase relationships with the circadian system. Circadian misalignment can also cause poor neurobehavioral performance, decreased sleep efficiency, and inappropriately timed physiological signals, including gastro-intestinal activity and hormone release. Frequent and repeated transmeridian travel is associated with long-term cognitive deficits. One approach to reduce these problems is to use a limit cycle model of the circadian pacemaker in conjunction with differential equations that describe human neurobehavioral performance to design countermeasures that rapidly shift the circadian pacemaker to align with the new schedule.

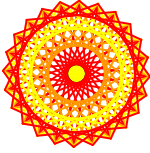
An approach to designing countermeasures that combines an algorithm for countermeasure placement with a novel mode of schedule representation is presented. The algorithm is shown to be optimal and results in theoretical predictions about the effect of shifting schedules on human performance.

Using these methods results in rapid circadian re-synchrony, and the resulting improvement in neurobehavioral performance can be quickly achieved even after moderate to large shifts in the sleep-wake schedule. The key schedule design inputs are endogenous circadian period length, desired sleep-wake schedule, length of intervention, background light level, and countermeasure strength. The new schedule representation facilitates schedule design, simulation studies, and experiment design; it also significantly decreases the amount of time to design an appropriate intervention. The method presented in this paper has direct implications for designing jet lag, shift-work, and non-24-hour schedules, including scheduling for extreme environments, such as in space, undersea, or the polar regions.



Amina C. Dozier
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**“Mathematical Modeling of Viruses:
A Study of the H1N1 Influenza Virus”**
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Mathematical models have many uses and value in society's everyday problem solving. We will focus on the importance of mathematical modeling in the study of viruses, particularly the H1N1 virus. These models are used to study viruses that can lead to a human epidemic such as the H1N1 Influenza virus also known as *swine flu*. Currently this swine flu virus has been reported in over 70 countries with over 130 deaths. Our main goals for this research are to determine what the relationships between the different strains of Influenza are and to distinguish the connection between these Influenza viruses and human epidemics. We will determine and construct the best mathematical model needed to study the various strains of the Influenza viruses. The results obtained from the models we develop may be used for tracking the spread of the swine flu virus and other strains of the Influenza viruses. This data may also be beneficial for the development of better treatment options and could aid in preventing the development of other strains of Influenza viruses.



Rosalyn Johnson^{†‡}, Raquel Hill[†], Loretta Moore[‡]

[†]Indiana University, [‡]Jackson State University

**“Security Issues with Radio Frequency
Identification Technology Used in the
Environment of the Healthcare System”**

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Radio Frequency Identification (RFID) technology is becoming widely used in various application domains. Applications like Exxon Mobil Speedpass and remote keyless entry enable remote access to resources by storing an individual's identification credentials in a transponder and communicating those credentials via radio waves. Earlier versions of these RFID applications exhibited vulnerabilities that resulted in unfavorable actions such as cloning, which leads to impersonation; weak encryption, which leads to simple decryption; and lack of encryption, which leads to easy access to confidential information.

Even with its known vulnerabilities, RFID technology has really been an attention grabber in the Healthcare system. It has been used in applications for patient and medicine identification and tracking. Research shows that by using this technology, some hospitals have been able to boost its efficiency and accuracy while also reducing costly and dangerous errors. Some security issues that arise with the implementation of the RFID technology in the Healthcare System are: security of the communication channel, patient safety concerns and data security with respect to the wireless transmission. Given the known security issues some of the same attacks and threats that occur in other RFID applications may also occur in the medical environment. This research explores the security vulnerabilities of RFID technology and its use within medical environments and the limitations of its use when trying to protect against unauthorized access to patient records.



Wainwright Joseph
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“Probability and Finite Groups”
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A Markov Chain is a discrete time stochastic process X_1, \dots, X_n with the property that $P(X_n | X_{n-1}, \dots, X_1) = P(X_n | X_{n-1})$. This is described as the probability of getting to the X_n stage conditioned on all the previous stages is equal to the probability of getting to the X_n stage conditioned only on X_{n-1} stage. A random walk can be viewed as a Markov Chain. In particular a random walk on a group G , where $|G| = n$ are described as a permutations of the symmetric group. In this expository project we investigated the phenomena of random walks on finite groups. Specifically we reviewed a classical paper by Persi Diaconis that used the representation theory of the symmetric group to give the first complete analysis of a complex ergodic random walk.



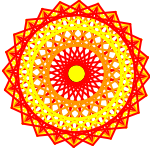
Dakota Killpack

Rutgers University

“The Symmetry of the Wallpaper Groups”

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Throughout history, artists from all cultures have created beautiful patterns in the plane by repeating motifs according to the symmetry of the wallpaper groups -- the groups of symmetry in the plane. As it turns out, there are only 17 distinct groups of this nature. We provide examples and descriptions of the 17 groups and show the repeating patterns commonly seen in wallpaper and other decorative art are generated by the action of the group on a simple motif. We analyze the art of M.C. Escher and show methods to easily imitate his style.



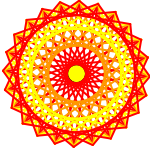
Geoffrey Lovely

California Institute of Technology

“Genome Mechanics: The Governing Dynamics of the Immunoglobulin and T-Cell Receptor Repertoire”

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Since its discovery, DNA has been critically assessed by biology, chemistry and physics. As a result of this concerted effort we now know that the synchronized beauty of the processes governing DNA e.g. replication, recombination, and repair, are the result of macromolecular assemblies acting physically upon DNA. This same orchestrated dance of DNA recombination is utilized during the generation of the immune systems immunoglobulin (Ig) and T-Cell Receptors (TCR) in a process called V(D)J Recombination, which stands for the gene regions that are rearranged (Variable, Diversity and Joining). The protein machine mediating the process aptly named the V(D)J Recombinase is composed of two proteins, the Recombination Activating Gene-1 and 2 (RAG1 and RAG2). RAG1 and RAG2 rearrange the heavy (H) and light (L) chains in immunoglobulins and alpha (A) and beta(B) chains of T-cell receptors. The recombination reaction begins with RAG1/2 binding to two conserved Recombination Signal Sequences (RSS) and ends with recombination and subsequent cleavage of the DNA in between the two RSSs. In order for recombination between two RSSs to occur the DNA must be looped. To date, this reaction has been characterized with gel electrophoretic approaches that only yield a classical mechanics output i.e. initial and final states. We have decided to employ a technique from single molecule biophysics called Tethered Particle Motion (TPM), to observe the looping dynamics in realtime. We have discovered that the V(D)J recombinase can loop DNA independently of a Human Mobility Group B1 Protein (HMGB1). For the past decade HMGB1 has been thought to be required for DNA looping but RAG1/2 can do it alone, we have also discovered that HMGB1 does however stabilize looped states, which has immense implications in vivo. We plan on modeling this polymer physics problem by employing Boltzmann's distribution, which derives naturally from the second law of thermal dynamics as the distribution that maximizes the entropy of a system.



Devroy McFarlane

Howard University

“Controlling HIV/AIDS in an ‘African’ Context”

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We analyze a mathematical model for the infectious disease, HIV/AIDS, that progress through distinct stages within infected individuals. We prove that the global dynamics are completely determined by the basic reproduction number R_0 : If $R_0 < 1$, then the disease-free equilibrium ε_0 is globally asymptotically stable and the disease always dies out. If $R_0 > 1$, then ε_0 is unstable, and the unique endemic equilibrium ε^* is globally asymptotically stable, and the disease persists at the endemic equilibrium.



Kenneth Milligan

Colorado State University

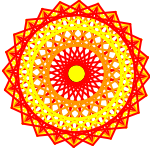
“Determining Energy Levels in Complex Fluorescence Trajectories through Change Point Analysis”

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Semiconductor nanocrystals, such as quantum dots (QD), exhibit fluorescence intermittency on the single molecule level. For small clusters of coupled QDs, a distinct change in this fluorescence intermittency (enhanced blinking) has been reported (Yu and Van Orden 2006), suggesting a coupling of the QDs. Determining the energy states in these small clusters has proven difficult utilizing the conventional analysis techniques. These techniques use thresholds to determine the various energy levels in a given fluorescence trajectory, however this method yields an incomplete analysis of enhanced blinking due to how quickly the change points occur. A new method for determining discrete energy levels utilizes a generalized maximum likelihood ratio test and Bayesian criterion to look for change points in the fluorescence trajectory (Watkins and Yang 2005). These change points will provide important information into the coupling of the QDs, which in turn will allow for rigorous testing of the various theories which currently exist to explain this enhanced blinking phenomenon in small QD clusters.

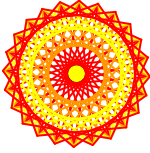
Watkins, L. P. and H. Yang (2005). "Detection of Intensity Change Points in Time-Resolved Single-Molecule Measurements." The Journal of Physical Chemistry B **109**(1): 617-628.

Yu, M. and A. Van Orden (2006). "Enhanced Fluorescence Intermittency of CdSe-ZnS Quantum-Dot Clusters." Physical Review Letters **97**(23): 237402-4.



Jamol Pender
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**“Differential Geometry and
Stochastic Volatility Models”**
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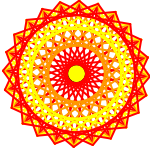
Stochastic volatility models are an important class of pricing models in finance. Stochastic volatility models represent one approach to remedy a flaw of the Black-Scholes model. The Black-Scholes model assumes that the underlying volatility or randomness of the stock price is constant over the life of the derivative security. Moreover, it assumes that the volatility is unaffected by the changes in the price level of the underlying among other factors. However, this simple Black-Scholes model fails to explain long-observed features of the implied volatility surface such as volatility smile and the volatility skew, which indicate that implied volatility does tend to vary with respect to the strike price and time to expiration. By assuming that the volatility of the underlying price is a stochastic process rather than a constant, it becomes possible to model and price derivatives more accurately. Once we add stochastic volatility these new models suffer from incompleteness of the market. Thus, we must look at new ways to analyze these models besides the well known PDE approach done by Black-Scholes or the change of measure approach done by Harrison and Pliska. Thus, one new way to analyze these models is to look at their short term behavior. This approach leads us to explore more about differential geometry and how looking at the short term behavior of the solution to these models corresponds to looking at geodesics of certain geometric spaces through the lens of large deviations.



Brian Walton
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**“Mid-IR Spectroscopy and UV/VIS
Fluorescence Imaging of Breast Tissues
Utilizing Intrinsic Contrast Agents”**
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Breast Cancer is the second leading cause of death for women and the leading overall cause of cancer death in women between the ages of 20 and 59. In the United States, breast cancer is expected to be newly diagnosed every three minutes, and a woman will die from breast cancer every 13 minutes. Inflammatory breast cancer (IBC) is an aggressive type of breast cancer that has a 25% to 50% *lower* five year survival rate than normal breast cancer. IBC occurs in the superficial skin, thus is an ideal target disease for optical technologies that do not provide significant depth penetration. There is an immediate need for healthcare professionals and scientists to develop early detection sources for breast cancer. The purpose of our research is to develop noninvasive imaging devices that can be used to categorize breast cancer as early as possible. We start by looking at the spectra of cancerous and non cancerous tissues.

We study intrinsic contrast agents for the differentiation of cancer and normal breast tissues; the methods used are Fourier Transform Infrared spectrometry (FTIR) and fluorescence imaging. FTIR, a standard transmission configuration was used to study the spectra of cancerous and normal tissue samples obtained in the mid-IR range of 815cm^{-1} - 1715cm^{-1} . We cut the tissues to $10\mu\text{m}$ in thickness using a cryostat and placed the slices on ZnSe before taking the spectra. We compared the spectra of both normal and cancerous tissues looking for variations in the intensity. This data will serve as an initial study for a Quantum Cascade Laser (QCL) imaging device for breast tissues. Fluorescence imaging is a technique that relies on the emission of light from a molecule after absorption of light with a shorter wavelength. The fluorescence images of the breast tissues were analyzed together with their corresponding FTIR spectra. The FTIR method provided us with contrast agents in the mid-IR, whilst the fluorescence method gave us intrinsic contrast agents in the visible wavelength range.



Andrea Watkins

Duke University

**“Truly Elliptic Stochastic
Partial Differential Equations”**

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We study ellipticity for a class of stochastic partial differential equations on an infinite dimensional Hilbert space. We determine non-degeneracy conditions for the diffusion coefficient that guarantee certain "elliptic" behaviors. In particular, we prove that under our specified conditions, the Markov transition densities of our process with different initial conditions are mutually absolutely continuous. In addition we show that these Markov transition densities are absolutely continuous with respect to some Gaussian measure on the infinite dimensional Hilbert space.



Sydeaka P. Watson

Baylor University

**“Semiparametric Approach to Modeling Confounders
in Observational Studies”**

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A confounder is a nuisance factor which may be a source of bias when assessing the effect of an exposure of interest. In observational studies, confounding may exist because health events typically have multiple causes, and the causes of these health events may differ across the levels of the exposure of interest. To remove confounding bias, the source of confounding should be identified, assessed, and controlled by a statistical method. This may include removing these confounding factors before collecting data or by designing the study so that the population is restricted to a particular subgroup. However, for a larger number of confounding factors, these approaches are often difficult to implement and are subject to a large amount of random variability. Adjusting for the confounders in a statistical model, using either parametric or semiparametric regression, is a preferred approach.

As an illustration of the semiparametric modeling approach presented in a paper by Dr. Remy Slama at Inserm U, logistic regression models featuring linear, quadratic, and cubic splines are used to determine a coding scheme for female age in the spontaneous abortion example presented above. This retrospective study involved women living in two French regions who were asked to describe all of their pregnancies which occurred between January, 1985 and April, 2000. In total, there were 2,333 pregnancies that ended either with a spontaneous abortion ($n=290$), a live birth or had a pregnancy still in progress for 20 weeks at the time of interview ($n=2,043$). We will assume that two covariates are considered simultaneously: continuous confounder X_1 (female age) and categorical variable X_2 (male age), which is the exposure of interest so that a smoothing approach is necessary only for X_1 . As presented in the paper, we will discuss linear, quadratic, and cubic splines using the knots suggested (age = 20, 25, 30, 35, and 40 years).



Deidre Watts

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“Intruder Detection Using Manhattan Metric”

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There are two methods of detecting intruders in a plane: directional triangulation, where the direction of the target is known, but not the distance; and distance triangulation, where the distance from the detection device is known, but the direction is not. The latter method is the focus of this presentation. Manhattan metric, also known as the L_1 norm, measures distance similar to the Manhattan district of New York- where as typically in Euclidean metric, one can move in any direction a set distance from center in a circle, in Manhattan metric one can only move one unit north or south, east or west, resulting in a diamond shape. In the regular Euclidean metric, three non-linear circles are sufficient to precisely detect any point in the plane. However, this is not the case for Manhattan metric; infinitely many detection devices cannot precisely identify a point in the entire plane. Conversely, three detection devices do suffice in a finite space.

