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Olgamary Rivera Marrero, Talleres en Blanco y Negro, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico, Recinto de Mayaguez

Rima Brusi, Megasección de Precálculo I, Universidad de Puerto Rico, Recinto de Mayaguez

Sandra Dika, Megasección de Precálculo I, Universidad de Puerto Rico, Recinto de Mayaguez

Arturo Portnoy, Megasección de Precálculo I, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico, Recinto de Mayaguez

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Ivonne M. Deliz, ARBIMON, Universidad de Puerto Rico - Rio Piedras

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Rafael Alvarez, Ciencia de Cómputos, Universidad de Puerto Rico - Rio Piedras

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| | C-204 | <i>Groupoids</i> <u>Alberto Marrero Carrasquillo</u> |
| | C-206 | <i>Mathematical Model for Detecting Diabetes</i> <u>Yesenia Cruz</u> and Pablo Negrón |
| | C-209 | <i>The Web expands into the forest: real-time biodiversity data acquisition, processing, and presentation</i> <u>Héctor Rodríguez</u> , Carlos J. Corrada Bravo, T. Mitchell Aide, Ivonne M. Deliz, Carlos Milán, Rafael Alvarez, Pedro J. Pastrana, and Alberto Estrada |
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| | C-209 | <p><i>Statistics at the Large Hadron Collider</i> <u>Wolfgang Rolke</u></p> |

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| | C-206 | <i>Epidemic Spread in Populations at Demographic Equilibrium</i> <u>Karen Rios-Soto</u> |
| | C-209 | <i>Classification of leaf epidermis microphotographs using texture features</i> <u>Elio Ramos</u> |
| | C-211 | <i>Detection of some malignant 2D tumors by 1D continuous symmetry</i> <u>Dennis Collins</u> |
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| Hora | Lugar | Actividad |
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| | C-202 | <p><i>Fast multiplication in finite fields with Odd characteristic</i></p> <p><u>Edusmildo Orozco</u> and <u>Dorothy Bollman</u></p> |
| | C-204 | <p><i>Arithmetic conditions on surfaces with self-maps</i></p> <p><u>Jorge Pineiro</u></p> |

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| | C-206 | <i>The complementing condition - some examples</i> <u>Pablo Negrón-Marrero</u> and Errol Montes-Pizarro |
| | C-209 | <i>Scaled Inverse Document Frequency: A Model for the Evaluation of the Conditional Specificity of Query Terms in Search Engine Collections</i> <u>Edel Garcia</u> |
| | C-211 | <i>Likelihood- and quasi-likelihood-based model selection criteria for generalized linear models</i> <u>Laura Ación</u> and Joseph Cavanaugh |
| 11:30-11:55 | | Conferencias concurrentes |
| | C-202 | <i>Some properties and questions about magic squares</i> <u>Tina Straley</u> |
| | C-204 | <i>Singular Solutions of the Vlasov-Poisson System</i> <u>Yi Li</u> |
| | C-206 | <i>Mathematical Modeling of Planar Defects in Elastic Materials</i> <u>Lev Steinberg</u> |
| | C-209 | <i>Del sonar al nanosensor: la influencia de Oscar Moreno sobre nuestra práctica de la investigación subgraduada</i> <u>José O. Sotero Esteva</u> |
| | C-211 | <i>Intrinsic priors for testing Hardy-Weinberg equilibrium</i> Brenda Betancourt and <u>María-Eglée Pérez</u> |
| 12:00-1:30 | Vestíbulo | Almuerzo |
| 1:30-2:20 | Anfiteatro | Conferencia plenaria <i>Integer Valued Sequences with 2-Level Autocorrelation from Iterative Decimation Hadamard Transform</i> Guang Gong |
| 2:30-2:45 | Vestíbulo | Receso (café) |

| Hora | Lugar | Actividad |
|-----------|-------|--|
| 2:45–3:10 | | Conferencias concurrentes |
| | C-202 | <i>Solvability of systems of polynomial equations over finite fields</i> <u>Ivelisse Rubio Canabal</u> and Francis N. Castro |
| | C-204 | <i>On Generalized Factorizations</i> <u>Reyes M. Ortiz-Albino</u> |
| | C-206 | <i>A TAL cell model, estimation of acid-base and sodium transport parameters using inverse methods</i> <u>Aniel Nieves-González</u> , Mariano Marcano, Chris Clausen, Harold E. Layton, and Leon C. Moore |
| | C-209 | <i>Evaluating a Dependable Sharable Atomic Data Service on a Planetary-scale Network</i> <u>Peter Musial</u> , Chryssis Georgiou, and Nicolas Hadjiprocopiou |
| | C-211 | <i>¿Robust priors in clinical trials: an R package for practitioners</i> <u>Jairo A. Fuquene Patino</u> and Luis R. Pericchi |
| 3:15–3:40 | | Conferencias concurrentes |
| | C-202 | <i>Divisibility of Exponential Sums with Prescribed Leaders Monomials</i> <u>Francis N. Castro</u> , Raul Figueroa, and Ivelisse Rubio |
| | C-204 | <i>Teoría de Frames Métodos Multiescala</i> <u>Juan R. Romero Oliveras</u> |
| | C-206 | <i>A survey in Dimensionality Reduction and Manifold Learning</i> <u>Maidier Marin Quintero</u> and Miguel Vélez Reyez |
| | C-209 | <i>High Performance Reconfigurable Computing</i> <u>Rafael Arce-Nazario</u> |

| Hora | Lugar | Actividad |
|-----------|-------|--|
| | C-211 | <i>The case for a fully robust hierarchical Bayesian statistica</i> <u>Luis R. Pericchi</u> , María-Eglée Pérez, and John Cook |
| 3:45–4:10 | | Conferencias concurrentes |
| | C-202 | <i>New computational Solutions for Latin Square $n = 6$ Orthogonality</i> <u>Javier Córdova Iturregui</u> , Rafael Arce-Nazario, Ivelisse Rubio, and Francis Castro |
| | C-204 | <i>A categorical approach to absolute closure</i> <u>Gabriele Castellini</u> and David Holgate |
| | C-206 | <i>Physical Manipulatives for Visualizing Multivariable Concepts and How They Can Enhance Mathematics Courses such as Basic Algebra, Precalculus and Calculus</i> <u>Daniel McGee</u> and Maider Marin Quintero |
| | C-209 | <i>Aplicación de la ecuación de Euler-Poisson-Darboux para el mejoramiento de imágenes digitales</i> <u>José Luis Calderón Cárdenas</u> |
| | C-211 | <i>Objective Bayes Factors for Informed Hypotheses: “Completing”</i> <u>David Torres Núñez</u> , <u>Luis Pericchi</u> , and Liu Guimei |
| 4:15–4:45 | A-211 | Sesión administrativa |

3. Charlas Plenarias / Plenary Talks

Combinatorial Game Theory

Elwyn Berlekamp, University of California at Berkeley

There are many interesting two-person games of no chance, such as checkers, chess, Go, Dots and Boxes, Amazons, Konane, and Domineering. Except for checkers and chess, all of the games just mentioned have the property that, as the game progresses, it tends to decompose into separate battles in different parts of the board. Using the “divide and conquer” methodology, a body of mathematics called “combinatorial game theory” has led to a deeper understanding of many such endgames, and it has begun to shed light on questions of decomposition and modularity in other contexts.

This talk will introduce the subject via a simple game called Hackenbush, and will then present an overview of where the field stands today.

The Search for Costas Arrays

Solomon W. Golomb, University of Southern California

A *Costas array of order n* can be defined as an $n \times n$ permutation matrix in which, among the $\binom{n}{2}$ vectors connecting the 1's of the matrix, no two agree in both magnitude and slope. These arrays, when interpreted as frequency-hopping patterns for radar or sonar, have ideal “thumb-tack” ambiguity functions. Several systematic constructions, all based on primitive roots in finite fields, provide examples for infinitely many values of n . Computer searches have found all the examples of Costas arrays for all orders $n \leq 26$. No examples are known for $n = 32$ and $n = 33$, and for infinitely many larger values of n . It is possible that for most large values of n only the examples obtained from the known systematic constructions may exist. Important theoretical results as well as exhaustive computer searches for many values of the order n are due to Professor Oscar Moreno.

Integer Valued Sequences with 2-Level Autocorrelation from Iterative Decimation Hadamard Transform

Guang Gong, University of Waterloo

A *Costas array of order n* can be defined as an $n \times n$ permutation matrix in which, among the $\binom{n}{2}$ vectors connecting the 1's of the matrix, no two agree in both magnitude and slope. These arrays, when interpreted as frequency-hopping patterns for radar or sonar, have ideal "thumb-tack" ambiguity functions. Several systematic constructions, all based on primitive roots in finite fields, provide examples for infinitely many values of n . Computer searches have found all the examples of Costas arrays for all orders $n \leq 26$. No examples are known for $n = 32$ and $n = 33$, and for infinitely many larger values of n . It is possible that for most large values of n only the examples obtained from the known systematic constructions may exist. Important theoretical results as well as exhaustive computer searches for many values of the order n are due to Professor Oscar Moreno.

4. Charlas Concurrentes / Concurrent Talks

Likelihood- and quasi-likelihood-based model selection criteria for generalized linear models

Laura Ación, Department of Biostatistics, University of Iowa
Joseph Cavanaugh, Department of Biostatistics, University of Iowa

The Akaike information criterion (AIC) is an extensively known and used tool for statistical model selection. AIC serves as an asymptotically unbiased estimator of Kullback's directed divergence between the true model and a fitted approximating model. The directed divergence is an asymmetric measure of separation between two statistical models, meaning that an alternate directed divergence may be obtained by reversing the roles of the two models in the definition of the measure. The sum of the two directed divergences is Kullback's symmetric divergence. We propose a model selection criterion (TKIC) that serves as an asymptotically unbiased estimator of the symmetric divergence. The unbiasedness of TKIC holds under more general conditions than the unbiasedness of AIC, including settings where the distribution of the response is misspecified. We also propose a modification of TKIC where the likelihood is replaced by the quasi-likelihood. This criterion can be used as a model selection tool when generalized estimating equations, a non-likelihood based method, are used for model fitting. We examine the performance of both criteria relative to other well-known criteria in simulation studies.

Keywords: Akaike information criterion, Generalized linear models, Generalized estimating equations

High performance reconfigurable computing

Rafael Arce-Nazario, Department of Computer Science, University of Puerto Rico, Rio Piedras Campus

High performance computing (HPC) instrumentation has traditionally meant a computing platform equipped with multiple state of the art general purpose processors (GPP) operating in parallel and with access to large and high throughput memory, storage and network subsystems. Albeit the successful implementation of many scientific computation applications

to traditional HPC platforms, there exist a significant number of problems whose effective parallelization requires finer-grained processing elements. The implementation of the later is more amenable to a computing platform that offers fine-grained parallelism, while maintaining an application development flow that is adequate for the common (software trained) programmer. Reconfigurable computers offer such properties. They combine the familiarity and versatility of GPPs with the high-performance/low-power/fine-grained-parallelism of field programmable gate arrays (FPGAs).

For an increasing number of applications, reconfigurable computers represent a higher performance (10x-100x) and lower energy (up to 90% reduction) option to traditional high-performance computing. In this presentation we will discuss the operation, features, and applications of these novel computing platforms. Additionally, we will give an overview of some UPR-RP research projects that are using this technology.

Keywords: FPGA, reconfigurable computing, high performance

Modeling body weight fluctuations as a simple discrete dynamical system

Francisco Arencibia-Albite, Departamento de Ciencias Naturales, Universidad del Sagrado Corazón

Obesity is a chronic disease that results in substantial loss of the quality of life since it may lead to diabetes, hypertension, cancer, cardiovascular disease and social stigmatisation. Energy restriction or overfeeding alters lean mass and fat mass compartments causing weight loss or weight gain, respectively. These changes lead to alterations in the metabolic rate that tend to prevent the body weight from moving away from its current value. However, under a persistent perturbation in energy intake these counteracting mechanisms are unable to prevent the evolution to a new steady body weight. Body weight stabilization results when energy input and energy dissipation are in balance. Altogether raises the question: how can the evolution of the body weight to a new steady weight be predicted as a function of the energy input and the change in metabolic rate evoked by the former? This work shows that body weight fluctuations can be modeled by a simple discrete dynamical system (a convergent monotonic sequence) that only uses three input variables: current body weight, average daily energy intake and percent of change in metabolic rate. This is accomplished in two steps. First, the model is derived in a step wise manner and some examples of its applications are presented. Finally, a theoretical discussion is developed that suggests that

under appropriate conditions it is possible to guarantee that a given percentage of caloric restriction will evoke, at least, the exact same percentage of weight loss. Clearly, this is of great clinical value.

Keywords: metabolism, calorie, body mass index

Intrinsic priors for testing Hardy-Weinberg equilibrium

Brenda Betancourt, Department of Mathematics, University of Puerto Rico, Rio Piedras Campus

María-Eglée Pérez, Department of Mathematics, University of Puerto Rico, Rio Piedras Campus

Testing Hardy-Weinberg equilibrium is a relevant concern, for example, in studies relating genetical configurations with health conditions. The selection of prior distributions for testing Hardy-Weinberg equilibrium is a challenging issue as we are dealing with a low dimensional null hypothesis for a discrete model. In this work, intrinsic priors for testing Hardy-Weinberg equilibrium are calculated using hypothetical training samples from uniform and Haldane priors. Properties of both priors are discussed, and their performances are compared on hypothetical data sets, and on real data from a case-control study of risk factors for gastric cancer in Western Venezuela. Analysis of sensitivity to different training samples sizes is shown, and possible criteria for the selection of the training sample size are discussed.

Keywords: Bayesian statistics, intrinsic priors, population genetics.

Pensando en gran escala: proyectos noveles de enseñanza y apoyo a estudiantes de precálculo en el RUM. (Panel)

Luis Caceres, Talleres en Blanco y Negro, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico, Recinto de Mayaguez

Angel L. Cruz Delgado, Talleres en Blanco y Negro, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico, Recinto de Mayaguez

Olgamary Rivera Marrero, Talleres en Blanco y Negro, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico, Recinto de Mayaguez

Rima Brusi, Megasección de Precálculo I, Universidad de Puerto Rico, Recinto de Mayaguez

Sandra Dika, Megasección de Precálculo I, Universidad de Puerto Rico, Recinto de Mayaguez

Arturo Portnoy, Megasección de Precálculo I, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico, Recinto de Mayaguez

Nilsa Toro, Megasección de Precálculo I, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico, Recinto de Mayaguez

Dos proyectos dirigidos a mejorar el rendimiento de los estudiantes del curso Precálculo I (MATE 3171) fueron implantados durante el semestre de agosto de 2008 en el RUM. Ambas iniciativas pretenden crear un ambiente de aprendizaje donde los estudiantes asumen un compromiso personal de trabajo académico sistemático y desarrollan hábitos de estudio efectivos. Los proyectos están dirigidos a servir al mayor número de estudiantes posible.

La meta del primer proyecto, Talleres en Blanco y Negro, es promover el éxito de los estudiantes en el primer examen departamental del curso. Esta intervención se programa como actividad cocurricular, dirigida a todos los estudiantes del curso y ofrecida en la hora libre universal.

El segundo proyecto consiste en ofrecer una sección del curso a 150 estudiantes de nuevo ingreso, escogidos en forma estratificada y aleatoria. En esta sección la asistencia de una hora adicional de práctica por semana es compulsoria. Los retos asociados a dictar conferencias a grupos numerosos, se atendieron de manera novel mediante el uso de la tecnología,

En este panel, facultad involucrada en cada proyecto identifica los retos confrontados, describe las estrategias utilizadas para enfrentarlos, discute los resultados obtenidos, comparte sus percepciones y experiencias y señala áreas de oportunidad para planes futuros.

Keywords: matemática educativa

Aplicación de la ecuación de Euler-Poisson-Darboux para el mejoramiento de imágenes digitales

José Luis Calderón Cardenas, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico en Mayaguez

La ecuación de Euler-Poisson-Darboux es una ecuación diferencial parcial singular, reversible, la cual posee un parámetro libre k . Existen muchos trabajos que brindan soluciones para esta ecuación para determinados valores de k y determinadas condiciones iniciales. Siguiendo un reporte preliminar de Kichenasemy usamos como data inicial una imagen (con ruido) y obtenemos un problema de valor inicial. Nuestro interés es mostrar experimentos numéricos para el problema mencionado y discutir los resultados obtenidos. Se observa que la imagen resultante presenta menos ruido que la imagen inicial. Las soluciones conocidas para la ecuación de Euler-Poisson-Darboux están dadas en todo el espacio. Analizamos en que casos hay solución única y comparamos los resultados con un análisis de Fourier. Se observa que los resultados también son validos para un dominio rectangular.

Acknowledgements: A mi asesor Robert Acar

Keywords: Euler-Poisson-Darboux, imágenes, suavizamiento, mejoramiento.

A categorical approach to absolute closure

Gabriele Castellini, Department of Math. Sc., UPRM

David Holgate, Dept. of Math., University of Stellenbosch, South Africa

A notion of absolutely closed object with respect to a closure operator C on an arbitrary category \mathcal{X} and with respect to a subcategory \mathcal{Y} is introduced. This approach is a further extension of the notion of absolutely closed object with respect to a subcategory \mathcal{A} of topological spaces introduced in [DG], in which the regular closure operator induced by \mathcal{A} was implicitly used. There are several interesting aspects of our approach. First, the behaviour of absolutely closed objects is similar to other closure operator related notions such as separation, connectedness, disconnectedness for instance, in that there is a Galois connection between closure operators on a given category \mathcal{X} and subclasses of a given subcategory \mathcal{Y} of \mathcal{X} in which the absolutely closed objects are sought. A classical consequence of this situation is that given a subclass \mathcal{A} of \mathcal{Y} , there is always a largest closure operator with respect to

which the objects of \mathcal{A} are absolutely closed. We do characterize the left fixed points of this Galois connection and we see that the related construction is basically a generalization of the pullback closure operator introduced by Holgate in [H₁]. We also identify some right fixed points even though we do not have a full characterization of them. In the second part of the paper we show a relationship of these notions with some compactness notions. In particular, the interesting aspect that justifies our two parameter approach is the relationship with the notion of Asymmetric Compactness introduced in [H₂]. Some examples are provided.

[DG] D. Dikranjan, E. Giuli, “Urysohn-closed spaces - old and new,” preprint.

[H₁] D. Holgate, *The Pullback Closure, Perfect Morphisms and Completions*, Ph.D. Thesis, University of Cape Town, 1995.

[H₂] D. Holgate, “A generalization of the functional approach to compactness,” *Topology and its Appl.*, to appear.

Keywords: Closure operator, Galois connection, Compactness

Divisibility of Exponential Sums with Prescribed Leaders Monomials

Francis N. Castro, Matemáticas, UPR, Rio Piedras

Raul Figueroa, Matemáticas, UPR, Rio Piedras

Ivelisse Rubio Canabal, Ciencia de Computos, UPR, Rio Piedras

In this presentation we consider the following problem over finite fields: To compute the exact divisibility of exponential sums of the type

$$S = \sum_{x_1, \dots, x_n \in \mathbb{F}_p} \psi(x_1 \cdots x_d + x_1^d + \cdots + x_d^d + G(x_1, \dots, x_d)),$$

where ψ is an additive character and the degree of G is less than d . Also we compute the exact divisibility of the number of solutions of the polynomial equation

$$X_1 \cdots X_d + X_1^d + \cdots + X_d^d + G(X_1, \dots, X_d) = 0,$$

over \mathbb{F}_p , where the degree of G is less than d .

Keywords: Finite fields, Exponential sums

Detection of some malignant 2D tumors by 1D continuous symmetry

Dennis G. Collins, Departamento de Ciencias Matematicas, Universidad de Puerto Rico, Recinto de Mayaguez

Malignant tumors show a 'tortuous' boundary compared with benign tumors. Based on the Circle Theorem of the author's previous 2008 SIDIM paper, *Examples of measuring continuous symmetry*, the diameter (distance across) of a two-dimensional plane figure of (perimeter) length one puts a lower boundary on its continuous symmetry. If the continuous symmetry of the given tumor figure, normalized to length one, is more than the continuous symmetry of a circle of the same length (perimeter) one, it is shown to be some indication of malignancy.

Keywords: Circle Theorem, continuous symmetry, malignant tumors

A mathematical model for detecting diabetes

Yesenia Cruz, Department of Mathematics, University of Puerto Rico at Humacao
Pablo Negrón-Marrero, Department of Mathematics, University of Puerto Rico at Humacao

Diabetes is a syndrome of disordered metabolism, usually due to a combination of hereditary and environmental causes, resulting in abnormally high blood sugar levels. Blood glucose levels are controlled by various hormones in our body such as insulin, growth hormone, glucagon, epinephrine best known as adrenaline, glucocorticoids and thyroxine. The two most common forms of diabetes are due to either a diminished production of insulin (Type 1 diabetes), or diminished response by the body to insulin (Type 2 and gestational diabetes). Both lead to hyperglycemia, which largely causes the acute signs of diabetes: excessive urine production, resulting compensatory thirst and increased fluid intake, blurred vision, unexplained weight loss, lethargy, and changes in energy metabolism. We will explain how each hormone is activated and how it affects glucose levels in blood. We present a mathematical

model that determines diabetes in patients based on the results of the glucose tolerance test (GTT), usually of 5 hours. Our model extends the one proposed by E. Ackerman, et al. (1969) to include three instead of two hormones concentrations. In particular we include concentrations for glucose, glucagon and a global variable that includes other hormones such as insulin. The model is based on a system of three non-homogenous ordinary differential equations. A nonlinear least square method is used to determine the coefficient parameters of the system based on actual data from GTT. The simulations also provide an indicator similar to the one proposed by E. Ackerman, et al. (1969), to diagnose a diabetic condition. Additionally, we develop a graphical user interface to facilitate the entering of the patient's data and the visualization of the results.

Acknowledgements: This work has been supported in part by the National Security Agency, Grant Number H98230-04-C-0486; and the National Institute of Health MARC Program at the UPRH.

Keywords: differential equations, diabetes, simulations, graphical user interface

New computational solutions for latin square $n=6$ orthogonality

Javier Córdova Iturregui, Computer Science, UPR - Rio Piedras

Rafael Arce-Nazario, Computer Science, UPR - Rio Piedras

Ivelisse Rubio, Computer Science, UPR - Rio Piedras

Francis Castro, Mathematics, UPR - Rio Piedras

A latin square of order n is an $n \times n$ array in which each cell contains a single element from an n -set S , such that each element occurs exactly once in each row and exactly once in each column. There is no known formula to determine the number of latin squares of order n , aside from the factorially growing computation of a representative subset. The rate of growth is so dramatic that to this date, $n = 11$ is the highest value which the number of latin squares is known exactly ($7,77 \times 10^{47}$). Given a pair L_1, L_2 of latin squares of order n , let $\omega_2^n = D_2(L_1, L_2)$ denote the number of distinct ordered pairs which occur when L_1 and L_2 are superimposed. When $D_2(L_1, L_2) = r$, L_1 and L_2 are said to be r -orthogonal. More generally, let $\omega_m^n = D_n(L_1, L_2, \dots, L_m) = \sum_{i,j=1\dots m, i < j} D_2(L_i, L_j)$. There is no known algorithm of polynomial time complexity to compute the spectrum or the maximum value for r for latin squares of order n . In fact, aside from prime numbers, whose $\max |\omega_2^n|$ is known to be n^2 , the maximum non-power-of-prime number for which $\max |\omega_2^n|$ is known is $n = 6$. Sets of latin squares with high orthogonality are of practical use in applications such as error

correcting codes.

Our research group is interested in the LS orthogonality problem from the computational discrete mathematics perspective. Acknowledging that new computer-generated results help support and eventually prove conjectures in this area, we conduct research to improve algorithms in the search for new results. Our group has made significant advances by designing and implementing algorithms to compute previously unknown values for $\max |\omega_3^6|$ through $\max |\omega_5^6|$. In this presentation, we will discuss our methodology for obtaining the new results, and some future strategies, such as implementations to a reconfigurable computer, that may provide additional speedup.

Keywords: Latin Squares, Reconfigurable Computing, Computational Discrete Math

Robust priors in clinical trials: an R package for practitioners

Jairo Alberto Fuquene Patino, Institute of Statistics, Business School, University of Puerto Rico, Rio Piedras

Luis Raul Pericchi Guerra, Department of Mathematics, University of Puerto Rico, Rio Piedras

There is a very much unexplored avenue of Bayesian analysis in clinical trials which are based on robust heavy tailed priors. The behavior of robust Bayesian methods is qualitative different than conjugate and short tailed Bayesian methods and arguably much more reasonable and acceptable to the practitioner and regulatory agencies. Alternatively, we assume heavy tailed Cauchy and also Berger's priors, with the same location and scale than the previous analysis. The conjugate and robust posterior densities are quite different: The robust posterior is much more sensible since it is closer to the Likelihood (current data) because the robust Bayes analysis "discounts" the prior when there is conflict with a previous study. Moreover, the conjugate Bayes is too much precise leading to unduly too short posterior intervals. The robust Bayes analysis is more cautious less dogmatic and most important it detects when previous and current data are similar or not. We show in this work a new R package for practitioners of clinical trials. This package it is useful to compute the distributions (prior, likelihood and posterior) and moments of the robust models: Cauchy/Binomial and Berger/Normal. Both, Bernoulli and Normal likelihoods can be handled by the software. Furthermore, the assessment of the hyper-parameters and the posterior analysis can be processed.

Keywords: Clinical Trials, R Package, Robust models.

Scaled Inverse Document Frequency: A Model for the Evaluation of the Conditional Specificity of Query Terms in Search Engine Collections

Edel Garcia, Internet Business Development Center, Interamerican University of Puerto Rico, Metropolitan Campus

Inverse document frequency (IDF) is a measure of the specificity of query terms over a collection of D number of documents that has been successfully incorporated into numerous vector space information retrieval models. Since these models assume term independence, the specificity of a given term, present in different queries, is assumed to be unique and independent from other query terms. To the best of our knowledge, there are no known models that condition the specificity of terms to the presence of other terms in a query.

This paper proposes a new measure called scaled inverse document frequency (SIDF) which evaluates the conditional specificity of query terms over a subset S of D and without making any assumption about term independence. S can be estimated from search results, OR searches, or computed from inverted index data. We have evaluated SIDF values from commercial search engines by submitting queries relevant to the financial investment domain. Results compare favorably across search engines and queries. Our approach has practical applications for real-world scenarios like in Web Mining, Homeland Security, and keyword-driven marketing research scenarios. SIDF can be incorporated into a variety of information retrieval models as a global weight scoring system.

Keywords: inverse document frequency, conditional term specificity, web mining, search engines

Bimodal epidemic size distributions for near critical SIR with vaccination

Luis Gordillo, Department of Mathematics, University of Puerto Rico at Mayaguez

Anders Martin-Lof, Department of Mathematics, Stockholm University

Steven Marion, Health Care, University of British Columbia

Priscilla Greenwood, Department of Mathematics, Arizona State University

In this talk we will introduce a recursive algorithm which enables the computation of the distribution of epidemic size in a stochastic SIR model for very large population sizes. In the important parameter region where the model is just slightly supercritical the distribution of epidemic size is decidedly bimodal. We find close agreement between the distribution for large populations and the limiting case where the distribution is that of the time a Brownian motion hits a quadratic curve. The model includes the possibility of vaccination during the epidemic. The effects of the parameters, including vaccination level, on the form of the epidemic size distribution are explored.

Singular Solutions of the Vlasov-Poisson System

Yi Li, Mathematics and AMCS, University of Iowa

In this talk we study the positive solutions of the generalized Matukuma elliptic partial differential equation (which T. Matukuma proposed in 1935 for the description of certain stellar globular clusters in a steady state), and the corresponding system for “Flat” Galaxy. They correspond to time-independent solutions of the Vlasov-Poisson system in the case of spherical symmetry. This is a joint work with Jurgen Batt, University of Munich, Germany.

Keywords: Singular Solutions, Matukuma Equation, “Flat” Galaxy, Asymptotic Behavior

A survey in dimensionality reduction and manifold learning

Maidor Marin Quintero, Electrical Engineering Department, University of Puerto Rico at Mayaguez

Miguel Velez Reyez, Electrical Engineering Department, University of Puerto Rico at Mayaguez

Part of our research involves finding ways to extend several existing algorithms to hyperspectral image processing. In this presentation, we discuss several algorithms of Dimensionality Reduction used in High Dimensional Image Processing, from classical lineal reduction methods such as Principal Component Analysis (PCA) and Multidimensional Scaling (MDS) to Graph Based algorithms such as Semidefinite Embedding, SDE, [WS] passing from Isomap [TSL], Linear Local Embedding, LLE, [RS] and Laplacian Eigenmaps, LE, [BN]. We provide a review of how these algorithms work, their mathematical justification and limitations and finally an overview on how they might be extended to hyperspectral image processing.

Keywords: Manifold Learning, Dimensional Reduction Algorithms

Groupoids

Alberto Marrero Carrasquillo, Mathematics-Physics, University of Puerto Rico at Cayey

An elegant way to specify a groupoid is to define it as a small category with inverses. The main intuition here, however, is that a groupoid is a set with a partially defined multiplication for which the usual properties of a group hold whenever they make sense. We would like to present the notion of groupoids in more details as well as to present examples to motivate the importance of these objects in operator algebras.

Keywords: groupoid

Student manipulatives for visualizing multivariable concepts of pre-calculus and calculus

Daniel McGee, Mathematics, University of Puerto Rico - Mayaguez

Maidor Marin Quintero, Mathematics, University of Puerto Rico - Mayaguez

Computers are invaluable for visualizing concepts in 3D. However, there are many concepts where the 2D nature of a computer screen can limit their effectiveness. E.g., directional derivatives require the projection of a normal to a surface in a specified direction. In 3D, a surface can be placed over the xy plane, the direction on the xy plane can be indicated and the concept can be visualized quite easily. However, working with a precise direction and its associated tangent line on a 2D computer screen requires that students visualize and reason about a 3D situation in a virtual 2D environment. A more effective pedagogical approach is the use of physical 3D manipulatives. 3D manipulatives also allow us to present multivariable concepts much earlier. Visually presenting precalculus concepts, such as the definition of a function, in both 2D and 3D improves student comprehension.

In this presentation, a consortium of universities (NSF-DUE-0442365) will provide an overview of the physical manipulatives being created, some of the basic algebra, precalculus and multivariable calculus materials that accompany them, some preliminary results on their effectiveness and a summary of how these tools provide a new direction for the reform movement in math education..

Acknowledgements: National Science Foundation: NSF-DUE-0442365

Keywords: Visualization Calculus PreCalculus 3D

Evaluating a dependable sharable atomic data service on a planetary-scale network

Peter Musial, Department of Computer Science, University of Puerto Rico at Rio Piedras

Chryssis Georgiou, Department of Computer Science, University of Cyprus

Nicolas Hadjiprociou, Department of Computer Science, University of Cyprus

Abstraction of atomicity for read and modify objects is an important building block that allows implementation of higher level applications that rely on linearizable data access while

being oblivious to its implementation. This is especially important when survivability of the atomic memory is provided by a distributed platform consisting of networked nodes, where both nodes and connections are subject to failure. In this work, we assess through experimental evaluation the practicality of one atomic memory service implementation, called RAMBO, that uses replication to ensure data survivability. Novelty of this service attributed to the fact that it is the first to support multiple reader, multiple writer access to the atomic data with an integrated reconfiguration protocol to replace the underlying set of replicas without any interruption of the ongoing operations. Theoretical guarantees of this service are well understood. However, only rudimentary analytical performance along with limited LAN testing were performed on the implementation of RAMBO, where neither of these reflects realistic deployment settings. In order to assess true practicality of the RAMBO service, we devised a series of experiments tested on PlanetLab, a planetary-scale research WAN network. Our experiments show that RAMBO's performance is reasonable (under the tested scenarios) and under the somewhat extreme conditions of PlanetLab. This demonstrates the feasibility of developing dependable reconfigurable sharable data services with provable consistency guarantees on unreliable distributed systems.

Keywords: Atomic Memory Service, Distributed Architecture, Performance Evaluation, Planetary Scale Experiments, Provable Guarantees

The complementing condition - some examples

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The complementing condition (CC) is an algebraic compatibility requirement between the principal part of a linear elliptic differential operator and the principal part of the corresponding boundary operators. It has recently been observed that failure of the CC implies the existence of nontrivial branches of solutions accumulating at the point where the CC fails, a phenomena we call *bifurcation cascades*. In nonlinear elasticity these accumulations are associated with material *wrinkling*. In this paper we study the CC in several problems, both elementary and from three dimensional nonlinear elasticity. We examine as well in a more rigorous setting the relation between violation of the CC and the existence of bifurcation cascades.

Acknowledgements: The research of Negrón-Marrero was sponsored in part by the Nation-

al Security Agency (NSA) under grant number H98230-07-1-0114. That of Montes-Pizarro was sponsored in part by the National Institute of Health (NIH) under grant number P20MD001112.

Keywords: nonlinear elasticity, complementing condition, global bifurcation, bifurcation cascades

A TAL cell model, estimation of acid-base and sodium transport parameters using inverse methods

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Chris Clausen, Physiology and Biophysics, Stony Brook University
Harold E. Layton, Mathematics, Duke University
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A mathematical model of a cortical thick ascending limb cell (cTAL) was used to study cytosolic pH (pH_i) responses to luminal NH_4^+ perturbations and the effects of cell volume regulation (CVR) on Na^+ transport. TAL cells load NH_4^+ via apical NH_4^+ -permeable channels and the NKCC2 cotransporter, resulting in a rapid fall in pH_i . Similarly TAL cells load Na^+ via the NKCC2 on the apical side and extrudes it via the Na^+, K^+ -ATPase on the basolateral side. Our goals were to use our model and published NH_4^+ perturbation and Na^+ transport data to estimate parameters associated with pH_i regulation and CVR respectively using inverse methods. The TAL cell model is derived from conservation laws, and includes the proper expressions for trans- and paracellular electrodiffusion as well as kinetic models for its characteristic cotransporters, exchangers, and Na^+ pump (KCC1, NKCC2, NHE, BCE, Na^+, K^+ -ATPase). Also, an empirical function that represents the CVR properties of the cell was included. Firstly, steady-state short-circuit current data was used to estimate parameters important in Na^+ transport; this yielded reasonable cytosolic concentrations, membrane potential differences and resistances. The model was then fit to time records of NH_4^+ perturbations, with and without inhibition of NKCC2 or K^+ channels, to estimate parameters associated with NH_4^+ transport. The results show that our TAL cell model, when used with parameter sets obtained from optimization methods, exhibits behaviors consistent with a wide variety of experimental results, including NH_4^+ perturbations, in isolated perfused TAL segments. This provides validation of the TAL model, which we intend to use in a multi-cell model of the TAL segment.

Acknowledgements: NIH grant DK42091

Keywords: model, kidney, TAL

Reverse engineering and Discrete Dynamical Systems

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Given a set of data over a finite field F_q , we are interested in finding a function that interpolates such data. This function can be obtained using reverse engineering. Such function is of the form: $f = (f_1, f_2, \dots, f_n) : F_n^q \rightarrow F_n^q$, where F_n^q is the n -fold Cartesian product of a finite field with q elements, and $f_i \in F_q[x_1, \dots, x_n]$. Due to the applications of these methods, a feasible question is: Can we write f_i in terms of x_j for every i ?

Using a version of Tsasao's Algorithm developed by D. Bollman and E. Orozco we can produce a minimal basis \mathcal{X} with no redundant variables. Using \mathcal{X} and The Chinese Remainder Algorithm we can find a particular solution f_0 that interpolates the data in terms of x_j and the variables of \mathcal{X} . Later we will compute the ideal I of all solutions that vanishes on the data and using elimination theory we will obtain the reduction f of f_0 with respect to $I \cap F_q[\mathcal{X}, x_j]$.

Keywords: Reverse engineering, gene regulatory networks

Fast multiplication in finite fields with Odd characteristic

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Dorothy Bollman, Mathematical Sciences, University of Puerto Rico at Mayaguez

The usual algorithms for multiplication in a finite field $GF(p^m)$ require $O(m^2)$ operations. In this work we give an $O(m \log m)$ algorithm for the case $2m-1 \leq 2k$, where $p = t2^k + 1$, odd t , and where $GF(p^m)$ can be defined by an irreducible trinomial $x^m - x^n - 1$ over $GF(p)$. The question that arises is how abundant are the cases in which this algorithm can be applied? That is, given a prime $p = t2^k + 1$, for what values of $m \leq (2^k + 1)/2$ does there exist an

irreducible trinomial of the form $x^m - x^n - 1$? We discuss some computational results related to this question and state some related conjectures.

Keywords: finite field, multiplication irreducible trinomial

On generalized factorizations

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The notion of factorizations goes back to Greek arithmetic and yet it plays an important role in commutative ring theory today. Most of the algebraists studied factorizations into irreducible elements, but recently several mathematicians have worked on generalized factorizations, i.e., D. D. Anderson, A. M. Frazier, S. Hamon and others.

Let D be an integral domain and τ a relation on $D^\#$, the nonzero nonunits of D . For $x \in D^\#$, a τ -factorization of x is a factorization $x = \lambda x_1 \cdots x_n$ where λ is a unit, $x_i \in D^\#$, and $x_i \tau x_j$ for $i \neq j$. This definition give a new direction to study factorizations, which can be understood as a new multiplication. Now, instead looking for a structure with nice properties, we can verify some type of multiplications on a certain structures with nice properties. In this talk, we may assumed that the structure is an integral domain, but the idea can be extended to a commutative ring.

Keywords: Factorizations

The case for a fully robust hierarchical Bayesian statistical analysis of clinical trials

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John Cook, MD Anderson Cancer Center, University of Texas

In Fúquene, Cook and Pericchi (2008) for two clinical trials (past and present), conjugate priors are compared with (Robust) Cauchy- Student-t and what we call Berger's prior. The behavior of the latter robust Bayesian methods is qualitatively different from conjugate

Bayesian methods and arguably much more reasonable and acceptable to the practitioner and regulatory agencies like the FDA (Food and Drug Administration). Here we extend the previous work to several clinical trials or hospitals, in a hierarchical fashion, using not only (robust) priors with heavy tails, but also a particular class of heavy tailed likelihoods to model “sufficient” statistics. The usual Exponential Family Hierarchical Modeling with conjugate priors is myopic with respect to large deviations of a single group from the bulk of the groups. This leads to potential excessive (and spurious) shrinkage to the general mean. On the other hand, Robust Hierarchical Modeling leads to “local shrinkage”; that is, only groups which are consistent affect each other, but groups which are outliers have a smaller influence on the not outlying groups. In that sense, outlying groups are discounted under the Robust Hierarchical Bayesian Model. The methods are illustrated with both simulated and real data.

Arithmetic conditions on surfaces with self-maps

Jorge Pineiro, Department of Mathematics and Computer Science, Bronx Community College

Let X be an algebraic variety defined over a number field K . One common way to study diophantine problems is their definition of height functions. A height function is a function $h : X(K) \rightarrow \mathbb{R}$ that computes the complexity of the different points in $X(K)$. A dynamics $f : X \rightarrow X$ on X and a polarization L that satisfy the functional equation $f^*L \cong L^\alpha$ for some $\alpha > 1$, are sufficient condition for the construction of a special height function h_f . The functional equation $f^*L \cong L^\alpha$ has many other consequences on the geometry of the variety, for example, the Kodaira dimension $\kappa(X) \leq 0$. This functional equation however is a rather strong condition on the variety. We would like to consider the case of an algebraic surface X with a self-map $f : X \rightarrow X$, and substitute the polarization property by taking the height function as our starting point. We will try to get similar geometric conditions for X based on an axiomatic for the height functions.

Keywords: Algebraic surfaces, Height functions, Algebraic dynamics

Classification of leaf epidermis microphotographs using texture features

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We present the results of a Gray Level Co-occurrence Matrix (GLCM) analysis for two sets of leaf epidermis images for the adaxial(20X_H) and abaxial sides (20X_E). The leaves were collected from a dry forest in Mona Island which is located between the Dominican Republic and Puerto Rico. For each set of images the GLCM texture features were calculated namely the energy, correlation, contrast, absolute value, inverse difference, homogeneity, and entropy. From the calculated statistics a features matrix was obtained for each image and randomly divided into training set and test set using the hold-out method. In this method 70 % of the images were considered as a training set and 30 % as the test set. For each training and test set a linear discrimination analysis (LDA) was performed resulting in a average classification percent of 90 % for the abaxial side in comparison with 80 % for the adaxial side.

Keywords: image processing; pattern recognition; image classification; computer vision

Epidemic spread in populations at demographic equilibrium

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An integro-difference equation model is introduced to study the spatial spread of epidemics through populations with overlapping and non-overlapping epidemiological generations. Monotone and non-monotone epidemic growth functions are considered. The focus is on the application of a recent theory of existence of traveling wave solutions for integro-difference equations. Numerical studies with emphasis on the minimum asymptotic speed of propagation (c) are conducted. The results presented are contrasted with similar works carried out in the context of ecological invasions. The theoretical results are illustrated numerically in the context of SI (susceptible-infected) and SIS (susceptible-infected-susceptible) epidemic models.

Keywords: Biomathematics, discrete-time models, integrodifference equations, dispersal, epidemiology, travelling waves

The Web expands into the forest: real-time biodiversity data acquisition, processing, and presentation

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In this work we describe the ARBIMON web application. This application will change the way researchers confront the challenge of providing information to help protect the biodiversity and to manage natural resources in the context of a world that is changing rapidly. Instead of sending many experts, to many sites for a long time, recording devices with cameras and weather stations can be deployed. We are developing a web application that can receive, process, analyze and present this information.

Presently, we have developed a web-based visualizer/analysis tool that provides a user-friendly GUI that allows researchers to access recordings and associated data, play and annotate recordings as areas of interest and specify a code or species name. In addition, the application automatically generates areas of interest in each recording. These computer-generated boxes contain part of a single event (i.e. note or call) and are used to extract spectral features for automatic species identification.

Keywords: eco-acoustic, web application, web-based audio visualizer, audio analysis, ARBIMON, species identification, species vocalizations, computer-generated areas of interest in spectrogram

Statistics at the Large Hadron Collider

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The LHC at CERN in Geneva, Switzerland, is the largest particle accelerator in the world. It will open new frontiers in High Energy Physics and answer many open questions.

The statistical analysis of the data generated by the LHC also presents many challenges. I will give a short introduction to high energy physics and the LHC, and then discuss some of the statistical issues.

Teoría de Frames Métodos Multiescala

Juan R. Romero Oliveras, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico Recinto de Mayaguez

La noción de frame o marco, como algunos lo traducen nace del trabajo *A Class of Nonharmonic Fourier Series*, publicado en el 1952, y cuyos autores son R. J. Duffin y A. C. Schaeffer. En este trabajo se estudian expansiones del tipo

$$\sum_n c_n e^{i\lambda_n x}. \quad (1)$$

Aquí, los términos de la sucesión $\{\lambda_n\} \subset \mathbf{R}$ no están distribuidos uniformemente, y para algunos casos especiales de $\{\lambda_n\}$ con $\{c_n\} \in l^2$, la expansion (1) converge a una función $g \in L^2(-\pi, \pi)$.

La primera ondícula (wavelet) la encontramos en la tesis de Alfred Haar en el 1903. No es sino hasta los 80s que ingenieros, matemáticos, físicos, y científicos de la computación se dan cuenta de que hablaban un mismo idioma. La teoría de multiresolución es ese lenguaje, y su importancia es de gran impacto en nuestra sociedad. El espectro de aplicaciones incluye la compresión de datos (FBI's Integrated Automated Fingerprint System, JPEG 2000), ingeniería nuclear, codificación en sub-bandas, acústica, procesamiento de imágenes, neurofisiología, música, imágenes biomédicas (CTs and MRIs), clasificación de texturas, discriminación de voz, óptica, fractales, astronomía, turbulencia, mecánica cuántica, predicción de terremotos y ataques epilépticos, exploración petrolera, radares, visión humana, y hasta en matemáticas puras (descomposición atómica y molecular, ecuaciones diferenciales parciales, etc). En esta corta presentación veremos algunas de las propiedades de algunos tipos especiales de frames y su conexión con la teoría de ondículas.

Keywords: ondícula (wavelet)

Solvability of systems of polynomial equations over finite fields

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In this work we determine the solvability of families of systems of polynomial equations over finite fields by computing the exact divisibility of the exponential sums associated to the systems. This generalizes a theorem of Carlitz to systems of equations. In some cases, our result gives an upper bound for the Waring number of systems of diagonal equations. Also, as a by-product, we also obtain information about the p -divisibility of the number of solutions of the systems for cases for which the well known results of Chevalley-Waring and Katz do not give any information.

Keywords: Equations, exponential sums, Waring Number, p -divisibility

Estimación de la proporción de una población oculta a través de muestreo “Bola de nieve” estratificado

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Julio C. Quintana Díaz, Matemáticas, UPRM

En poblaciones ocultas y de difícil acceso el proceso de inferencia es ineficiente cuando se emplean técnicas de muestreo convencionales. El muestro por referencia o “Rastreo por vínculos” (“Bola de Nieve”) permite obtener mas información, usando las relaciones existentes entre sus miembros a partir de una muestra inicial. En este contexto la población se representa como un grafo, donde cada individuo es un nodo que describe su característica y cada arco la relación existente entre ellos. Teniendo en cuenta que el ser humano tiende a formar estratos bajo algún criterio de asociación, la estimación de un parámetro en particular puede influir en el tipo de muestreo aplicado. Desde este enfoque, aplicar la técnica de rastreo por vínculos escogiendo la muestra inicial de la población completa, en lugar de seleccionar una muestra inicial considerando los estratos, no sería apropiado si la característica bajo estudio define una división natural en la población, con una homogeneidad interna establecida. El objetivo es estimar la proporción y el tamaño de una subpoblación oculta, a partir de una muestra inicial S_0 y de los contactos S_1 , identificando la característica de cada individuo y considerando las relaciones existentes, en cada estrato.

Keywords: Población Oculta, Muestreo “Bola de Nieve”, Muestreo en Grafos, Muestreo Adaptativo.

Del sonar al nanosensor: la influencia de Oscar Moreno sobre nuestra práctica de la investigación subgraduada

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En esta presentación se reflexiona sobre la influencia que Oscar Moreno, a quien se le dedica este congreso, sobre la mentoría de estudiantes de investigación subgraduada desde una perspectiva personal. Hace 25 años involucrar a estudiantes en proyectos de investigación subgraduada no era considerado posible en grandes sectores de la academia en Puerto Rico, particularmente en departamentos de matemática. En esa época el autor, quien era estudiante subgraduado, comenzó a interesarse en este tipo de proyectos y recibió las primeras guías de parte de Moreno. Durante el resto de los estudios universitarios observamos sus estrategias para formular problemas apropiados para cada estudiante, guiarle en su estudio, asistir en la preparación de presentaciones y procurar financiamiento para sus actividades.

En esta charla presentaremos la evolución durante quince años ejerciendo la cátedra de nuestros temas de investigación, criterios para definir proyectos de investigación subgraduada y otros aspectos de la práctica. Evaluaremos los resultados de tal práctica a la luz de los cerca de cuarenta estudiantes que han trabajado en nuestros proyectos. De seguro nuestros criterios han evolucionado de maneras distintas a las de Oscar Moreno. Pero siguen sosteniéndose en la creencia de la importancia del trabajo creativo en la educación universitaria y el inculcar la responsabilidad social de contribuir al desarrollo de la técnica y el conocimiento.

Keywords: Oscar Moreno, investigación subgraduada

Mathematical modeling of planar defects in elastic materials

Lev Steinberg, Department Mathematical Sciences, University of Puerto Rico, Mayaguez Campus

The purpose of this talk is to present a new approach for mathematical modeling of planar defects in elastic materials. This approach is based on the local theory of surfaces in the 3 dimensional space. Formal definitions of the planar defect and its geometrical characteristics will be proposed. Also, we shall discuss nature of configurational force acting on the planar defect and the relation of this defect with dislocations.

Keywords: defects, elastic materials, configurational force

Some properties and questions about magic squares

Tina Straley, Executive Director, Mathematical Association of America

This talk is based upon a 1998 article by Martin Gardner appearing in Math Horizons, the student magazine of the Mathematical Association of America. Magic Squares have been studied since 2800 BC in China and appeared again in Greek mathematics as early as 1300 BC. They continue to interest mathematicians, puzzle advocates, and magicians because they are easy to understand, fun to construct, and yet lead to interesting mathematical questions. Magic squares have been used in the study of mysticism and are the subject of a detailed scholarly book written in France in the 18th century. Gardner's paper looks at squares that have properties relating the sums and the squares of the sums for the rows, the columns, and the diagonals. These properties lead to interesting and challenging mathematical questions. Like other combinatorial subjects, magic squares are appealing to a wide audience because the questions are easy to state and to understand but solutions are often very challenging.

Keywords: magic squares

Objective Bayes Factors for Informed Hypotheses: “Completing” The Informed Hypothesis and “Splitting” the Bayes Factors.

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Luis Pericchi Guerra, Department of Mathematics, University of Puerto Rico at Rio Piedras Campus and Universidad Simón Bolívar

Guimei Liu, Department of Mathematics, University of Puerto Rico at Rio Piedras Campus

Informed Hypotheses is the name than in Social Sciences is given for very specific and difficult to analyze hypotheses which involve several constraints in the parameter space. Objective Bayes Factors have been originally developed for “Point Null Hypotheses”, starting with the now “classical” Bayesian work of Sir Harold Jeffreys. Some of these methods (Conventional Approach) assume a prior from the start. Other more recent and more “objective” methods perform some sort of “bootstrap” of the data (or summary of it) in order to calibrate Bayes Factors with improper priors. A major theoretical advance has been the discovery of the implicit or *intrinsic* prior that can be “dug out” from empirical procedures. It is argued here that Conventional and Intrinsic priors, and in general Objective Factors are sensible tests of Informed Hypothesis, as can be seen from the priors implicit or explicit in the procedures. The novel methodology introduced here is that of “*completing*” the informed hypothesis and “*splitting*” the Bayes Factors in two factors: one is a ratio of Probabilities (estimated by MCMC methods) and the other a Bayes Factor of Encompassing Hypotheses (calculated by Objective Bayes Factors methods). This discovery massively simplifies the computations and avoids the need to assess extra parameters. The results of our methodology has been published in: “Bayesian Evaluation of Informative Hypotheses” Chapter 7, p. 131-154 Springer, Hoijtink H. et al editors, 2008.

Keywords: Bayes factor, Informed hypotheses, Competing and splitting methods

Conformal Geometry

Alfredo Villanueva, Department of Mathematics, University of Puerto Rico, Mayaguez

Conformal geometry study transformation which preserve angles in Riemannian geometry, for instant the mobius transformation. Now days conformal geometry play a important

role in Invariant theory, Theoretical Physics, image processing; 3D Shape Matching, Recognition, etc. We will first give an introduction to conformal geometry and second we will focus in Conformally invariant operators, including some material we have been working on.

Keywords: Conformal geometry, Riemannian geometry., conformally invariant operators

Statistical analysis of microbial diversity of anaerobic granules in starch wastewater treatment plant

Wei Wei, Mathematical Sciences, University of Puerto Rico-Mayaguez

Bo Hu, Chemical Engineering, University of Puerto Rico-Mayaguez

Different groups of microorganisms are working together as a food chain to degrade the organic compounds to produce methane and carbon dioxide which can be used as bioenergy. In this study, we apply statistical methods to analyze the microbial communities of a wastewater sample before and after a chloroform treatment, furthermore, to study the effects of the chloroform treatment on microbial diversity.

We use 16s rRNA T-FLP method, PCR amplification and DNA sequence analysis to obtain the sequences of archaea and bacteria species in the wastewater sample. Phylogenetic analyses such as classification, richness, and abundance analyses are conducted to study the community differences before and after the chloroform treatment.

We found that there are significant differences between the microbial communities before and after the chloroform treatment.

Keywords: Phylogenetic analysis, richness, abundance, 16srRNA, methane

5. Carteles / Posters

Digital literacy in Puerto Rico: challenges and opportunities

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Edgar Ferrer Moreno, Negocios y Empresarismo, Universidad del Turabo

In this work we present a study and some preliminary results regarding our experience within an ICT-for-development project in several municipalities of Puerto Rico. In particular, we focus on issues involved in digital literacy from a local perspective. The study consider an important problem which is of special concern to digital literacy, this is the digital divide. Some recommended solutions are framed in the scheme of digital cities for Puerto Rico which is proposed in this work.

Keywords: digital literacy, digital divide, digital city

Parameter estimation for mathematical models of potassium-chloride cotransporters

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Mariano Marcano, Computer Science, University of Puerto Rico, Rio Piedras Campus

Potassium-chloride cotransporters (KCCs) perform electroneutral transport of K and Cl ions simultaneously when activated by cell swelling in order to control intracellular K concentrations. Four types of KCCs with similar characteristics (isoforms) are known to date. For each isoform a mathematical model was formulated using a system of ordinary differential equations to model the cotransporter states, from which unidirectional fluxes of the ions are computed. Nonlinear optimization was performed to obtain transition rates for each state by minimizing the distance between published experimental data and the unidirectional flux of the model. For the optimal parameters the half-maximal effective concentrations were very similar to those of the published data. Solutions are not unique since various sets of parameter values resulted in solutions with similar accuracy. Slow rates for movement of ions

into the cell with fast rates out of the cell were obtained and are in accordance with the cotransporter function of potassium excretion from the cell.

Acknowledgements: This work was supported in part by NIH grant number SC1GM084744

Keywords: Parameter estimation, KCC, potassium-chloride cotransporter, mathematical model

Study of r -Orthogonality for Latin Squares

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A **Latin square** (LS) of order n , is an $n \times n$ array of n different elements, where in each row and each column the elements are never repeated. Latin squares have various applications in Coding Theory and Cryptography. Examples of latin squares are the famous Sudoku squares. Two latin squares of order n are said to be **r -orthogonal** if when the squares are superimposed we get r distinct ordered pairs of symbols. We study generalizations of the r -orthogonality to sets of LS. In this work we present preliminary results on some properties of these generalizations.

Keywords: Latin Squares

Analysis of the Dynamics of the Landen Transformations Through $\cot(4\theta)$

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Ivan Ojeda, Mathematics, University of Puerto Rico Rio Piedras, PR
Bobby Wilson, Mathematics, Morehouse College Atlanta, GA

The Landen transformations for the coefficients of $\frac{cx^4+dx^2+e}{x^6+ax^4+bx^2+1}$ has been studied through the change of variable $y = \frac{x^2-1}{2x}$. We analyze the transformations and study the dynamics of the recurrences of a and b through the alternative change of variable $y = \frac{x^4-6x^2+1}{4x^3-4x}$.

Bayesian analysis of movement after release for headstarted Mona Island iguana (*Cyclura cornuta stejnegeri*)

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The endemic Mona Island iguana (*Cyclura cornuta stejnegeri*), is an endangered species that exhibits low density, low relative abundance of young iguanas and an skewed age distribution. Since 1999, a headstarting program has been implemented to increase the effective population size of this species. As part of the evaluation of this program, Bayesian models are used for analyzing trajectories of released individuals. These models incorporate releasing sites sex and body mass at release time as explanatory variables. We expect that the outcome of this analysis will help to determine if future modifications in release strategies are needed in order to improve success rates of current conservation programs.

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Keywords: *Cyclura cornuta stejnegeri*, animal movement, headstarting, Mona Island, analysis of radio tracking data, dispersal movement, Bayesian models, WinBUGS analysis

Un algoritmo recursivo para caminos de largo k en grafos dirigidos

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En esta investigación nos interesa trabajar los caminos de largo k en un grafo dirigido. Se presentará la implementación, con programación dirigida a objetos, de un algoritmo recursivo

para realizar la búsqueda de todos los posibles caminos. El algoritmo se basa en el uso de una lista de adyacencia creada a partir de la información del grafo entrada por el usuario. En adición, utilizamos la matriz de adyacencia para obtener la cantidad total de caminos para cada vértice, lo cual nos permite corroborar la cantidad de caminos encontrados por el algoritmo recursivo. Se diseño y desarrolló una interfaz gráfica para facilitar el manejo de la información.

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Keywords: Caminos de largo k, Grafos dirigidos, Digrafos, recursión, interfaces gráficas

A gray level run length texture analyzer applied to biological imaging

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The texture of an image can be determined by the relationship between gray levels in the pixels. In order to analyze this relationship there are some properties that can be defined to quantify the distribution of pixels for a specific region. Run length statistics quantifies regions with consecutive pixels of a certain length and the same gray level value for a specified direction. With this approach, we can define a run length matrix $RL(i,j)$ for the possible directions 0° , 45° , 90° , and 135° , where the rows correspond to the length of the run length and the columns correspond to the value of the grey level. From the RL matrix a set of features can be defined to measure different aspects of the textures observed in the images. A Java program, *RL_Features*, was developed to construct this matrix and consequently the calculation of run length features namely, the short run emphasis (SRE), long run emphasis (LRE), gray level nonuniformity (GLN), run length nonuniformity (RLN), run percentage (RP), low gray level run emphasis (LGRE), and high gray level run emphasis (HGRE). The program was applied to the characterization of a set of leaf epidermis micro-photographs.

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Keywords: texture analyzer, run length, biological imaging

Parameter estimation in mathematical models of renal Na-K-2Cl cotransporters

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Nonlinear optimization approaches were used to compute rate constants for mathematical models of renal sodium-potassium-chloride cotransporters. The optimization consisted of minimizing the distance between model unidirectional fluxes and experimental fluxes published for three different forms of this cotransporter. These forms of cotransporter, or isoforms, differ in their physical and chemical properties and in their location within the renal system. Taking into consideration some symmetry assumptions, a model with six unknown parameters was fitted to experimental data for each isoform. Because the used optimization method is locally convergent, an exploration of the parameter space was performed by generating a uniformly distributed set of initial iterates. Different parameter sets with almost similar residual values were found in this exploration, suggesting that the set that best fits the experimental data is not necessarily unique. For the optimal parameters, the model half-maximal effective concentrations for the three isoforms were found to be within the ranges of reported experimental values. These models can be significantly important for future research related to the function, regulation, and pathophysiology of Na-K-2Cl cotransporters within the renal system.

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Keywords: Nonlinear optimization; Na-K-2Cl cotransporter; Thick ascending limb of Henle; Mathematical models

The problem of the nonlinear cantilever

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The cantilever problem consists of studying the deformations of a bar or rod that is attached to a wall on one end and is subjected to a torque or applied force on the other end. In the classical cantilever problem, the constitutive functions (the functions characterizing the material that composes the bar) are linear, the material of the bar is homogeneous, inextensible, and unshearable; there is no applied torque, and the applied force is vertical. The classical problem was studied by Jas. Bernoulli (1694) and L. Euler (1727). The cantilever problem still has many applications in engineering, and more recently in nano technology (Sotres et al. (2007)). In this project we consider a nonlinear model of the cantilever in which the material of the bar is non-homogeneous, extensible and shearable (Antman 1995). After introducing the nonlinear model, we describe a finite difference numerical scheme for computing approximate solutions of the problem. The resulting nonlinear system of equations is solved with Newton's method, where we take advantage of the structure of the Jacobian matrix (almost tridiagonal) to solve the intermediate linear systems efficiently. Moreover we developed a graphic user interface which allowed us to experiment with the model and to control more effectively the different constitutive and force parameters. With these tools we study the dependence of the bar deformations on thickness variations and the different constitutive parameters and applied forces. Also we study the severity or magnitude of the shear strain as the parameters and forces are changed as well.

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Keywords: GUI, Nonlinear Cantilever

A mathematical model for the interaction between a sea fan colony, its immune system, and a potential pathogen

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We present a mathematical model to study the interaction between a sea fan colony and its immune system. We assume that there is an invading agent who can turn into pathogen. The model assumes that: (1) the polyps are the main unit of the coral; (2) the population of polyps is homogeneously distributed through the colony, and thus we consider a single compartment of the colony; (3) there is only one pathogen; and (4) the immune system is activated by a signal. When polyps detect a signal representing an insult or attack, stem cell precursors differentiate into humoral cells and amoebocyte cells, both of which are involved in defense against the pathogen. The interaction between the considered populations is described by a system of ordinary differential equations. The model presents a stable free-infection solution when the birth rate of polyps is greater than its rate of mortality and the amount of stem cells is greater than its rate of natural mortality.

Keywords: sea fan, immune system, invading agent, pathogen, mathematical model

Avaluación del aprovechamiento académico de los estudiantes en el curso de Métodos Cuantitativos I

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El curso de Métodos Cuantitativos I (MECU 3031) es un curso que toman estudiantes de la Facultad de Administración de Empresas de la Universidad de Puerto Rico en Humacao.

Típicamente el curso lo toman estudiantes de primer año que han obtenido una puntuación apropiada en la prueba del College Board. Durante el año académico 2006-2007, recopilamos información relacionada a los estudiantes que entran a tomar este curso en términos de perfil, destrezas aritméticas y algebraicas, y otros factores que entendíamos podían afectar el desempeño de los estudiantes en el curso. En dicho estudio el 45% de la población no aprobó el curso o se dio de baja. Durante el año académico 2007-2008, decidimos investigar cuáles son las áreas en las que los estudiantes muestran un aprovechamiento exitoso luego de tomar el curso de MECU 3031. Coordinamos todas las secciones de dicho curso, a fin de que al analizar cada semestre se impartiera el mismo examen final en todas las secciones. De esta manera, recopilamos y analizamos datos que nos ayudan a determinar cuál fue el aprovechamiento académico de nuestros estudiantes por áreas. La información nos ayuda a culminar el ciclo de evaluación del aprovechamiento académico puesto que brindamos recomendaciones a ser implementadas durante semestres subsiguientes.

Keywords: evaluación aprovechamiento

Acercamientos computacional y combinatorio al estudio de interacciones entre polímeros y fibras

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Las interacciones entre polímeros y fibras como los nanotubos de carbón tienen una gran importancia en la nanotecnología. Las propiedades mecánicas y eléctricas de estos híbridos les hacen útiles para la construcción de sensores y materiales con propiedades novedosas.

Las simulaciones por computadoras de esos sistemas constituyen una herramienta impor-

tante para su estudio. Aquellas herramientas computacionales que facilitan la visualización de propiedades a nivel atómico resultan particularmente útiles. Presentamos un módulo con un interfaz gráfico para el programa Visual Molecular Dynamics (VMD) con el que se puede visualizar potenciales electrostáticos en estos híbridos. Este consiste de una ventana de control y visualización de la distribución de cargas. El módulo también modifica la representación de las moléculas en la ventana principal de VMD para ilustrar el efecto de la interacción de las moléculas seleccionadas.

Por otro lado, el estudio desde un punto de vista combinatorio provee herramientas teóricas útiles para un acercamiento al problema desde la física estadística. El conteo de todos los posibles caminos o ciclos trazados sobre retículos rectangulares, arreglos de puntos en el plano puestos en n filas y m columnas, provee información relevante a este estudio. Aquí reportamos resultados nuevos sobre conteos hechos con la ayuda de la computadora. Además se demuestra que en el caso $n=3$ la cantidad de posibles ciclos en un retículo de largo m satisface la ecuación de recurrencia $C_m = 2C_{m-1} + C_{m-2}$, $C_2 = 3$, $C_3 = 7$ que tiene solución $C_m = 7 \frac{(1+\sqrt{2})^{m-2} - (1-\sqrt{2})^{m-2}}{2\sqrt{2}} + 3 \frac{(1+\sqrt{2})^{m-3} - (1-\sqrt{2})^{m-3}}{2\sqrt{2}}$.

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Keywords: polimeros, nanotubos de carbón, simulaciones por computadoras, física estadística, combinatoria

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