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1 Itinerario Global (Global Schedule)

2 Itinerario Detallado (Detailed Schedule)

Horario	Lugar	Actividad
Viernes		
4:00-6:00	VCD ¹	Registro
4:00-9:00	CBA ²	Mesas de Exhibición
5:00-5:25		Conferencias Concurrentes
	ECT 231	<i>Sobre una conjetura de Waldhausen,</i> <u>Pedro E. Arraiza González</u> e Iván Cardona.
5:30-5:55		Conferencias Concurrentes
	ECT 231	<i>A Note on Dirichlet Algebras,</i> Gabriela Bulancea.
	ELC 105	<i>El Descenso más Empinado,</i> Javier Perez Arocho, y Alvaro Lecompte Montes.
	ELC 104	<i>Intrinsic Spectral Geometry of the Kerr-Newman Event Horizon,</i> Martin Engman.
	ECT 238	<i>Mathematics at the National Security Agency,</i> Lucia Jesús-Santana.
6:00-6:25		Conferencias Concurrentes
	ECT 231	<i>Sobre algunos tipos de curvatura en espacios homog- neos reductivos,</i> Marlio Paredes.
	ELC 105	<i>Positivity Methods in Multivariable Operator Theory,</i> Raúl E. Curto.
	ELC 104	<i>SQS-Graph Invariants of Extended Perfect Codes,</i> <u>Carlos Araujo</u> and Italo J. Dejter.
	ECT 238	<i>Desempeño Estudiantil en Matematica Fundamental y en Algebra,</i> <u>Marilu Lebrón Vázquez,</u> Idalyn Rios Diaz y Bárbara L. Santiago Figueroa.
6:30-7:30	CBA	Sesión de Afiches
		<i>Line Graphs of Zero Divisor Graphs,</i> <u>Camil I. Aponte,</u> Patrice S. Johnson, and Nathan A. Mims.
		<i>A model for the dynamics of a kite with an arbitrary lift coefficient,</i> Carlos Avenancio.
		<i>The Structure of Zero-Divisor Graphs,</i> <u>Natalia I. Cordova,</u> Clyde Gholston, Helen A. Hauser.

¹VCD=Vestíbulo de la Escuela de Ciencias y Tecnología y Centro de Estudios Doctorales

²CBA=Corredor entre Biblioteca y Anfiteatro Morales Nieva

Horario	Lugar	Actividad
		<i>Monomial permutations that decompose in cycles of Length 2,</i> Louis Cruz Ubiles.
		<i>Interleavers for Error Correcting Codes,</i> Joyce M Fernández.
		<i>Sistemas Dinámicos Probabilísticos,</i> Mariely Angeli Hernández Morales.
		<i>An Optimization Problem for a $Na^+ - K^+ - 2Cl^-$ Co-transporter Model,</i> Aniel Nieves-Gonzalez.
		<i>Comparación de Rendimiento entre Técnicas de Recuperación de la Información,</i> Oliver Perez Hernández.
		<i>Modelos Basados en Agentes del Mecanismo de Producción y Control de las Células Sanguíneas en el Cuerpo Humano,</i> José Pimentel.
		<i>A Computational Model of Mars Craters-Size Frequency Distribution,</i> Axel Rivera.
		<i>Utilización de la estadística bayesiana para probar la existencia de reversion a la media en el índice de valores de Puerto Rico,</i> Zulyn M. Rodriguez.
		<i>A splitting technique for the advection-diffusion equation,</i> Lourdes Vazquez.
7:30-8:30	Anfiteatro Argentina Hill	Conferencia Plenaria <i>The Mathematics Behind Google's PageRank Algorithm,</i> Michelle D. Wagner.
8:30-10:00	Casa Rectoría (Balcones)	Actividad de Confraternización
Sábado		
7:00-8:30	VCD ³ y CBA ⁴	Registro y desayuno
8:00-5:00	CBA	Mesas de Exhibición
8:30-8:55		Conferencias Concurrentes
	ECT 231	<i>Sistemas de descomposición de Variedades de Genero de Heegaard dos,</i> Luz Dary Camacho Olarte e Iván Cardona Torres.

³VCD=Vestíbulo de la Escuela de Ciencias y Tecnología y Centro de Estudios Doctorales

⁴CBA=Corredor entre Biblioteca y Anfiteatro Morales Nieva

Horario	Lugar	Actividad
	ECT 230	<i>Global bifurcation analysis of a higher gradient model for deformations of a rectangular slab,</i> Errol L. Montes–Pizarro and Pablo V. Negrón–Marrero.
	ELC 105	<i>A univariable approach to fix point nonlinear discrete dynamical systems,</i> <u>Omar Colón–Reyes</u> , Dorothy Bollman, and Edusmildo Orozco.
	ELC 104	<i>Versions of the probability centrifuge algorithm,</i> Dennis G. Collins.
	ECT 239	<i>Efficient Finite Field Arithmetic for Field Programmable Gate Arrays (FPGAs),</i> Edgar Ferrer and Dorothy Bollman.
	ECT 238	<i>A method of detection of pollution for dissipative systems of incomplete data,</i> A. Omrane.
9:00-9:30	Anfiteatro Morales Nieva	Apertura Oficial
9:30-10:30	Anfiteatro Morales Nieva	Conferencia Plenaria <i>Topology and mechanics of DNA,</i> David Swigon.
10:30-11:00	CBA ⁵	Afiches y Merienda
11:00-11:25		Conferencias Concurrentes
	ECT 231	<i>Graph Measures,</i> Ilwoo Cho.
	ECT 230	<i>A Connection between Algebraic Structures and Propositional Logic,</i> <u>Wanda Ortiz Hernández</u> and Luis F. Cáceres.
	ELC 105	<i>Multivariable Polynomial Interpolation and Reverse Engineering Genetic Networks,</i> Dorothy Bollman and <u>Edusmildo Orozco</u> .
	ELC 104	<i>Vanishing Capillarity as a Selection for Young–Measure Equilibrium Solutions in a Model Two–Phase Problem of Nonlinear Elasticity,</i> Timothy J. Healey.
	ECT 239	<i>Bayesian Mapping of Multiple Quantitative Trait Loci,</i> Damaris Santana Morant.
	ECT 238	<i>Repensando el orden de la enseñanza: Investigación en la acción,</i> Ana Helvia Quintero.
11:30-11:55		Conferencias Concurrentes
	ECT 231	<i>The condition for zero Gaussian curvature,</i> Krzysztof Rozga.

⁵CBA=Corredor entre Biblioteca y Anfiteatro Morales Nieva

Horario	Lugar	Actividad
	ECT 230	<i>Endomorphisms of Monadic Boolean Algebras</i> , M.E. Adams and W. Dziobiak.
	ELC 105	<i>Técnicas de Recuperación de Información</i> , <u>Luis Gabriel Jaimes</u> y Fernando Vega Riveros.
	ELC 104	<i>Mathematical Modeling of Elastic Deformations with Defect Nucleation</i> , Lev Steinberg.
	ECT 239	<i>Regresión Logística PLS para la Reducción de la Dimensionalidad en Datos de Microarreglos</i> , José Carlos Vega Vilca.
	ECT 238	<i>Análisis Multidimensional del Aprovechamiento Académico de los Estudiantes de Nuevo Ingreso en los cursos de Precálculo en UPR-Bayamón</i> , Edward A. Caro López.
11:30-1:30	Salón de Actos	Almuerzo
1:30-2:30	Anfiteatro Morales Nieva	Conferencia Plenaria <i>Acerca del principio de transferencia de Lefchetz</i> , Xavier Caicedo.
2:30-2:55		Conferencias Concurrentes
	ECT 231	<i>Homología de Khovanov y Torsion de Reidemeister</i> , <u>Juan Ariel Ortíz-Navarro</u> y Charles Frohman.
	ECT 230	<i>Elementary Proofs of Some Eigenvalue Bounds of Reingold, Vadhan and Wigderson on the Zig-Zag Product of Graphs</i> , <u>Qi Guo</u> and Heeralal Janwa.
	ELC 105	<i>High Dimensional Star Coordinates in 3D</i> , <u>Elio Lozano</u> and Edgar Acuña.
	ELC 104	<i>On the exact multiplicity of solutions for boundary-value problems via computing the direction of bifurcations</i> , <u>Joaquin Rivera</u> and Yi Li.
	ECT 239	<i>Escalabilidad de los algoritmos de selección de instancias usando el Muestreo Progresivo</i> , <u>Luis Alberto Daza Portocarrero</u> y Edgar Acuña.
	ECT 238	<i>Summer Undergraduate Mathematical Sciences Research Institute (SUMSRI)</i> , Vasant Waikar.
3:00-3:15	CBA ⁶	Receso (Café)
3:15-3:40		Conferencias Concurrentes
	ECT 231	<i>W*-Correspondences and Finite Directed Graphs</i> , Victor M. Vega.

⁶CBA=Corredor entre Biblioteca y Anfiteatro Morales Nieva

Horario	Lugar	Actividad
	ECT 230	<i>On the Inverse of the Gold's and the Welch's Power Function,</i> <u>Alfonso Heras</u> , Francis N. Castro, Oscar Moreno.
	ELC 105	<i>Using Rough Sets theory in KDD methods,</i> <u>Frida R. Coaquira Nina</u> and Edgar Acuña.
	ELC 104	<i>Estimation of Parameters in Chemical Kinetic Models,</i> Mariano Marcano.
	ECT 239	<i>Semi-parametric Bayesian Modelling of Censored Data using Correlated Beta Processes,</i> <u>Saba Infante</u> and <u>María-Eglée Pérez</u> .
	ECT 238	<i>Mathematical Teaching And Learning Support Center,</i> <u>Evelyn Torres Gallardo</u> and <u>Maytee Cruz Aponte</u> .
3:45-4:10		Conferencias Concurrentes
	ECT 231	<i>Unbounded hypercyclic operators,</i> Héctor Salas.
	ECT 230	<i>Sistemas dinámicos discretos no lineales y afines</i> Omar Colón y <u>Leonid Sepúlveda</u>
	ELC 105	<i>Mejorando la Usabilidad de un Código para la Solución Numérica de Ecuaciones Diferenciales con Retardo,</i> Elio Ramos.
	ELC 104	<i>Dirichlet and Neumann boundary conditions: What is in between?,</i> Mahamadi Warma.
	ECT 239	<i>Applications of Newcomb-Benford's Law to Electoral Processes, Bioinformatics and the Stock Market,</i> <u>David Torres</u> and <u>L. R. Pericchi</u> .
	ECT 238	<i>Algunos problemas de Olimpiadas Matemáticas,</i> <u>Luis F. Cáceres</u> y <u>Arturo Portnoy</u> .
4:15-4:45	Anfiteatro Morales Nieva	Sesión Administrativa

3 Resúmenes de Conferencias Plenarias (*Abstracts of Invited Presentations*)

Acerca del principio de transferencia de Lefschetz

Xavier Caicedo, Universidad de los Andes, Universidad Nacional de Colombia Bogotá.

El llamado principio de transferencia de Lefschetz afirma que una propiedad válida para variedades algebraicas sobre el cuerpo de los números complejos debe valer igualmente para variedades sobre cualquier otro cuerpo algebraicamente cerrado de característica 0. La teoría de modelos permite explicar este principio heurístico de la geometría algebraica como simple consecuencia de la completud lógica de la teoría de dichos cuerpos. Este es uno de los ejemplos más sencillos de interacción no trivial entre la teoría de modelos y otras áreas de las matemáticas. Discutiremos principios de transferencia más generales y otras aplicaciones de la teoría de modelos que ilustran su creciente papel como poderoso instrumento matemático en álgebra, análisis y teoría de números.

About Lefschetz transfer principle

Lefschetz transfer principle states that any property valid for algebraic varieties over the complex numbers must hold for varieties over any algebraically closed field of zero characteristic. Model theory permits to explain this heuristic principle of algebraic geometry as immediate consequence of the logical completeness of the theory of algebraic closed fields of a given characteristic. This is one of the simplest examples of non trivial interaction between model theory and other areas of mathematics. We will discuss more general transfer principles and other applications of model theory which illustrate its growing role as a powerful mathematical instrument in algebra, analysis, and number theory.

Topology and mechanics of DNA

David Swigon⁷, Department of Mathematics, University of Pittsburgh.

Ever since the discovery of the double-helical DNA structure by Watson and Crick it became apparent that the survival and reproduction of a cell requires the solution of a number of problems ranging from efficient packaging of DNA to the untangling of DNA strands during replication and transcription. Theoretical understanding of these problems required the use of concepts from topology and differential geometry, and prompted the development of new approaches to solving open problems in the mechanics of slender elastic bodies. Presented will be an introduction to the main concepts in the theory of DNA topology and elasticity and an overview of the results

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obtained in recent years on (i) equilibrium configurations of DNA segments with the effects of impenetrability and self-contact forces taken into account and (ii) the effects of inhomogeneity and intrinsic curvature on configurations of DNA minicircles that are subject to binding of untwisting ligands.

The Mathematics Behind Google's PageRank Algorithm

Michelle D. Wagner, National Security Agency.

I use Google on a daily basis to retrieve information from the internet. What's going on behind the scenes is a proprietary algorithm called PageRank that was developed by two Stanford University computer scientists, Larry Page and Sergey Brin. In this talk I will describe Google's PageRank algorithm and show how it connects to several areas in mathematics and computer science.

4 Resúmenes de Conferencias Concurrentes (*Abstracts of Concurrent Presentations*)

Los resúmenes aparecen en orden alfabético de acuerdo al apellido del primer autor nombrado en el trabajo. (*The abstracts appear in alphabetical order according to the last name of the first listed author.*)

Endomorphisms of Monadic Boolean Algebras

*M.E. Adams, The State University of New York, and
W. Dziobiak, University of Puerto Rico at Mayagüez.*

A classical result about Boolean algebras independently proved by Magill, Maxson, and Schein says that non-trivial Boolean algebras are isomorphic whenever their endomorphism monoids are isomorphic. The main point of this talk is to show that the finite part of this classical result is true within monadic Boolean algebras. By contrast, there exists a proper class of non-isomorphic (necessarily) infinite monadic Boolean algebras the endomorphism monoid of each of which has only one element (namely, the identity map).

Sobre una conjetura de Waldhausen

Pedro E. Arraiza González e Iván Cardona Torres⁸, Departamento de Matemáticas, Universidad de Puerto Rico en Río Piedras.

En este trabajo intento encontrar al menos un ejemplo de una 3-Variedad no Haken obtenida por cirugías de Dehn que resulte ser virtualmente Haken, utilizando como punto de partida una conjetura de Waldhausen que dice que toda 3-Variedad orientable, cerrada e irreducible con grupo fundamental infinito tiene una Variedad Haken como espacio recubridor de un número finito de hojas. En 1972 Evans y Jaco presentaron un ejemplo de una 3-Variedad casi suficientemente grande que no era suficientemente grande. Esta Variedad fue obtenida por cirugías de Dehn en un "3-punctured Sphere Bundle". En 1989 Baker presenta una 3-Variedad cuyo grupo fundamental era virtualmente \mathbb{Z} -representable pero no \mathbb{Z} -representable. Esta Variedad fue obtenida por cirugías en un "once-punctured Torus Bundle". Por sus definiciones, los términos Haken, virtualmente Haken, suficientemente grande, casi suficientemente grande, \mathbb{Z} -representable y virtualmente \mathbb{Z} -representable están relacionados, como presentara Kirby en 1995 en el problema 3.2 de su lista de Problemas de Topología. Mi trabajo intenta generalizar el trabajo de Baker, obteniendo mediante cirugías en un "2-punctured Torus Bundle", una 3-Variedad con grupo fundamental infinito y primer grupo de Homología finito, para entonces demostrar que tiene un espacio recubridor Haken.

SQS-Graph Invariants of Extended Perfect Codes

Carlos Araujo⁹ and Italo J. Dejter, University of Puerto Rico at Río Piedras, Department of Mathematics, San Juan, PR 00936.

A perfect 1-error-correcting code C is 'foldable' over its kernel via the Steiner triple systems associated to its codewords. The resulting 'folding' produces a graph invariant for C via Pasch configurations. It is known that such invariant is complete for Vasilév codes of length 15. We are extending those results to the the extended perfect codes of length 16 via the Steiner quadruple systems associated to their codewords, concretely to those codes obtained via a construction method due to Phelps and Solovéva.

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Multivariable Polynomial Interpolation and Reverse Engineering Genetic Networks

Dorothy Bollman, Department of Mathematics, University of Puerto Rico at Mayagüez, and

Edusmildo Orozco, Department of Computer Science, University of Puerto Rico at Rio Piedras.

The reverse engineering problem for genetic networks is the problem of discovering the functional relation between genes, given a time series of gene expression data. In this work we present an algorithm in a multivariable finite field model which, given a time series of gene expression data and a gene g , determines a multivariable polynomial that interpolates the given data and that contains only those variables that correspond to genes that affect g . More generally, this algorithm can be used to find a multivariable polynomial with no “nonessential” variables that interpolates a set of points in (F^n, F) , where F is any finite field.

A Note on Dirichlet Algebras

Gabriela Bulancea¹⁰, Departamento de Matemática – Física, Universidad de Puerto Rico en Cayey.

The main issue in the theory of perturbations of Banach algebras is to determine what properties of a given Banach algebra A are preserved when we slightly deform A by means of defining a new multiplication between the elements of A , multiplication which is “close” to the original one. A uniform algebra A with Shilov boundary Γ is a Dirichlet algebra if the space of the real parts of functions in A , ReA , is dense in $C_R(\Gamma)$, the space of continuous real-valued functions on Γ . Richard Rochberg proved that being Dirichlet is a stable property for uniform algebras. Using results of best approximation in normed linear spaces by elements of a linear subspace, we give a new proof of this result.

Algunos problemas de Olimpiadas Matematicas

Luis F. Cáceres y Arturo Portnoy, Departamento de Matemáticas, Universidad de Puerto Rico en Mayagüez.

Presentaremos algunos problemas interesantes que han aparecido en distintas olimpiadas matemáticas, y sus soluciones, con el objeto de ilustrar el nivel de dificultad, el reto y el espíritu de estas competencias.

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Sistemas de descomposición de Variedades de Género de Heegaard dos

Luz Dary Camacho Olarte¹¹ e Iván Cardona Torres¹², Departamento de Matemáticas, Universidad de Puerto Rico en Río Piedras.

Una 3-variedad M tiene una infinidad de SISTEMAS DE DESCOMPOSICIÓN COMPLETOS DE DISCOS que determinan un HEEGAARD SPLITTINGS dado, lo cual dificulta conseguir información estructural de dicha 3-variedad. Sin embargo durante los últimos años se han logrado grandes avances en este campo, introduciendo condiciones adicionales que permiten el acceso a esta información, como por ejemplo, LA CONDICIÓN DE RECTÁNGULO, dada por A. Casson y C. Gordon, en “Reducing Heegaard Splittings”, *Topology and its Applications*, volumen 27, Issue 3, diciembre, 1987, pp 275-283, la cual recientemente fue ligeramente reforzada con LA CONDICIÓN DOBLE DE RECTÁNGULO, dada por Martin Lustig and Yoav Moriah, en “A finiteness result for Heegaard Splittings”, *Topology*, volumen 43, 2004, pp 1165-1182; condición que nos garantiza la existencia de un número finito de tales sistemas de descomposición completos que satisfagan la condición doble de rectángulo. Tomando una 3-variedad particular M y un Heegaard Splittings dado, $M = H_1 \cup_{\partial H_1 = \partial H_2} H_2$, nos proponemos mostrar los distintos Sistemas de Descomposición completos que satisfacen la Condición doble rectángulo, los cuales son finitos.

Análisis Multidimensional del Aprovechamiento Académico de los Estudiantes de Nuevo Ingreso en los cursos de Precálculo en UPR–Bayamón

Edward A. Caro López, Departamento de Matemáticas, Universidad de Puerto Rico en Bayamón.

Este es un segundo estudio que sirve de extensión del titulado: “Variables Predictoras en el Aprovechamiento Académico en los Cursos de Precálculo de la Universidad de Puerto Rico en Bayamón”. La nueva base de datos incluye los años 1995-2004 y otras variables no consideradas en el estudio previo, como: escolaridad de los padres, ingreso familiar, tipo de escuela de procedencia, carga académica, profesor que dictó el curso, entre otras. Nuevamente analizaremos por separado las tres versiones de Precálculo que el Departamento de Matemáticas ofrece: Mate 1001, Mate 3011 y Mate 3171.

Establecemos una ecuación de regresión no lineal para tener un estimado la probabilidad de aprobar uno de los tres cursos en discusión, a base de las variables independientes. Se determina la significancia estadística y el peso de cada variable

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independiente en la estimación de las probabilidades de aprobación. Utilizamos el modelo estadístico no lineal “probit” para el análisis de una base datos de 7,046 expedientes de estudiantes de nuevo ingreso y se hace un estimado de la probabilidad de aprobar (obtener A,B ó C) de los estudiantes de nuevo ingreso que toman estos cursos en los primeros semestres académicos.

Graph Measures

Ilwoo Cho, Saint Ambrose University, Davenport, Iowa.

In this talk, we will define a measure on a finite directed graph G , with its vertex set $V(G)$ and its edge set $E(G)$. A directed graph G is finite if it has finite entries of vertices and edges. Recently, statistical group theorists study about the (bounded) positive measures on presented groups. By using the similar techniques, we define graph measures on finite directed graphs. Let $FP_n(G)$ be the set of all finite paths with their length n and $FP(G)$, the set $\cup_{n=1}^{\infty} FP_n(G)$. If the graph G does not have loop finite paths, then $FP(G)$ is the finite union of $FP_k(G)$'s. However, if there exists at least one loop finite path, then there are infinitely many finite paths. In this case, it is hard to give a finite (discrete) measure on $FP(G)$. To avoid such case, we define the diagram measure Δ on $FP(G)$. Also, give the degree measure d on $V(G)$. Then, on G , we can define the bounded measure $\mu = d \cup \Delta$. We will observe the measure theory on the measurable space (G, μ) . Similarly, we will also consider the shadowed graph measure space $(\hat{G}, \mu_{\hat{G}})$, where $\hat{G} = G \cup G^{-1}$ is the shadowed graph of G . We observe the graph integrals of graph measurable functions with respect to the shadowed graph measure $\mu_{\hat{G}}$. Such graph measuring is an invariant on finite directed graphs. Finally, we briefly introduce the graph von Neumann algebra M_G .

Using Rough Sets theory in KDD methods

*Frida R. Coaquira Nina*¹³ and *Edgar Acuña*, *University of Puerto Rico at Mayagüez*.

Rough Sets Theory was introduced by Z. Pawlak (1982) as a mathematical tool for data analysis. Rough sets have many applications in the field of Knowledge Discovery, some of them to feature selection, discover decision rules, making data reduction, and to the discretization of continuous features.

The theory can be used when the dataset has irrelevant (dispensable) features that can be eliminated, reducing in this way the dimension of the problem and finding subsets of relevant (indispensable) features. By combining Rough Set Theory with the usual feature selection methods, we obtain an algorithm like a wrapper method for feature selection. The principal idea is to recognize the dispensable and indispensable

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features, using the discernibility relation across the dataset.

Versions of the probability centrifuge algorithm

Dennis G. Collins, Department of Mathematics, University of Puerto Rico at Mayagüez.

Different versions of the author's probability centrifuge algorithm are presented with examples. These algorithms are based on the possibility of moving probability amplitude around without affecting entropy. A radial algorithm is based on one-dimensionalized entropy, and dependence on boundary conditions is discussed.

A univariable approach to fix point nonlinear discrete dynamical systems

*Omar Colón-Reyes and Dorothy Bollman, Department of Mathematics, University of Puerto Rico at Mayagüez, and
Edusmildo Orozco, Department of Computer Science, University of Puerto Rico at Rio Piedras.*

Discrete dynamical systems, and in particular those defined over finite fields, have a number of important applications, including biological and biochemical networks. It is of interest to determine when such networks enter a steady state, i.e., the conditions under which the corresponding dynamical system is a fixed point system. In this work we give a method for converting a multidimensional dynamical system to an equivalent one-dimensional system and we give simple criteria for the resulting one-dimensional system to be a fixed point system.

Sistemas dinámicos discretos no lineales y afines

Omar Colón-Reyes y Leonid Sepúlveda, Universidad de Puerto Rico en Mayagüez.

Un problema importante en la teoría de los sistemas dinámicos discretos es el de relacionar la estructura de un sistema con su dinámica. Este trabajo presenta dicha relación para una familia de sistemas no lineales afines boléanos. Para sistemas que pueden ser descritos por monomios, uno puede obtener información sobre la estructura de los ciclos basándose en la estructura de los monomios. En este trabajo presentaremos criterios para clasificar dichos sistemas como uno de punto fijo.

Positivity Methods in Multivariable Operator Theory

Raúl E. Curto, The University of Iowa.

Using a generalized version of Choleski's Algorithm to detect positivity for numerical matrices, we study quadratures and curvatures in one or more real or complex variables. This leads in a natural way to the study of truncated moment problems, which in turn are associated with recursively generated weighted shifts when the underlying measure is supported in the positive real axis. Of particular interest are Gaussian quadratures and the connections with the theory of orthogonal polynomials, including the study of singular quartic moment problems, whose supporting measures lie in planar conics. For these problems, we obtain a complete solution in case the associated moment matrix $M(2)$ is singular. We show that rank $M(2)$ -atomic minimal representing measures exist in case the moment problem is subordinate to an ellipse, parabola, or non-degenerate hyperbola. If QMP is subordinate to a pair of intersecting lines, minimal representing measures sometimes require more than rank $M(2)$ atoms, and those problems subordinate to a general intersection of two conics may not have any representing measure at all.

Escalabilidad de los algoritmos de selección de instancias usando el Muestreo Progresivo

Luis Alberto Daza Portocarrero y Edgar Acuña, Departamento de Matemáticas, Universidad de Puerto Rico en Mayagüez.

El crecimiento exponencial en la disponibilidad de datos que se generan en las distintas áreas de las ciencias e ingeniería ha creado la necesidad de metodologías que tengan la capacidad para analizar y procesar la información contenida en dichos datos. La selección de instancias emerge como una alternativa para reducir el tamaño del conjunto de datos con la finalidad de hacer posible que los algoritmos de la minería de datos puedan trabajar de manera eficiente y se logre extraer el conocimiento relevante de la inmensa cantidad de datos en la que se encuentra escondida. Sin embargo, el principal problema que enfrentan los algoritmos de selección de instancias es que aun tienen un costo computacional demasiado alto. El muestreo progresivo permite mejorar el rendimiento de los algoritmos de selección de instancias cuando el tamaño del conjunto de datos es grande, reduciendo la complejidad computacional en espacio y tiempo, ya que no se requiere procesar la totalidad de los instancias en la muestra de entrenamiento para seleccionar las instancias más relevantes. En este trabajo se presentan algunos resultados experimentales y estudios comparativos de conjuntos de datos disponibles para evaluar la efectividad y eficiencia de la estrategia propuesta.

Intrinsic Spectral Geometry of the Kerr-Newman Event Horizon

Martin Engman¹⁴, Departamento de Ciencias y Tecnología, Universidad Metropolitana, San Juan, PR 00928.

The well known theorems of Robinson and Carter imply that the most general stationary, axisymmetric, asymptotically flat solutions of the vacuum Einstein-Maxwell equations which have a regular event-horizon are given by the Kerr-Newman family of solutions. The instantaneous black hole event horizon of such a solution inherits an intrinsic metric which is that of a surface of revolution. We study the spectrum of the Laplacian for this surface metric using trace formulae of its associated Greens operator. With these trace formulae we uniquely and explicitly reconstruct the instantaneous intrinsic metric of the Kerr-Newman Event Horizon. In the process we find that the angular momentum parameter, the area, and (in the uncharged case) the mass can be written in terms of these eigenvalues. In the uncharged case this immediately leads to the unique and explicit determination of the Kerr metric in terms of the spectrum of the event horizon. In this sense, thinking of the event horizon as a vibrating membrane, one can “hear” the shape of non-charged stationary axially symmetric black hole space-times

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Efficient Finite Field Arithmetic for Field Programmable Gate Arrays (FPGAs)

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Finite field arithmetic has a wide range of applications in various fields, including cryptography and error-correcting codes. This project is motivated by a novel method modelling genetic networks by means of finite fields. In order to deal with very large genetic networks, it is essential to develop capacity for performing very fast and efficient arithmetic over finite fields. For this purpose we are developing efficient algorithms that will be hardwired into FPGAs. One very efficient method for arithmetic on $\text{GF}(2^m)$ involves the use of Zech logarithm tables. This method is very efficient for small m . For large composite m , say $m = rs$, $\text{GF}(2^m)$ is an extension of $\text{GF}(2^r)$ and we can make use of the fact that $\text{GF}(2^m)$ is isomorphic to $\text{GF}((2^r)^s)$. In this project we make use of the Zech log table method for arithmetic over the ground field $\text{GF}(2^r)$ and FPGAs for arithmetic over the extension field.

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Elementary Proofs of Some Eigenvalue Bounds of Reingold, Vadhan and Wigderson on the Zig-Zag Product of Graphs

Qi Guo¹⁶ and Heeralal Janwa¹⁷, Department of Mathematics, University of Puerto Rico at Rio Piedras.

One of the major recent breakthroughs in complexity theory was the introduction of the concept of Zig-Zag graph product of graphs by O. Reingold, S.Vadhan and A.Wigderson (RVW), "Entropy Waves, The Zig-Zag Graph Product, and New Constant-Degree Expanders and Extractors" *Annals of Math.* Vol.155, no. 1, pp. 157-187. This construction yielded asymptotic families of expander graphs that give optimal expansion.

Such expansions are not possible even by the famous Ramanujan graph families of Lubotzky, Phillips and Sarnak. In proving their results, RVW give upper bounds on the normalized absolute values of the zig-zag product of graphs in terms of the constituent graphs.

The main results of our presentation will be elementary proofs of the eigenvalue bounds of the theorems of RVW. More specifically, when the vertices of a (small) graph B label the edges around each vertex of a (big) graph A, a larger graph A zig-zag B can be constructed, whose vertices are pairs $\{(g, h) : g \in V(G), h \in V(H)\}$, and adjacency is defined using the above labeling in a nontrivial way., The resulting graph inherits (roughly) its size from the large one, its degree from the small one, and its expansion properties from both. By setting up Lagrange multipliers, we obtain better eigenvalue bound on modified Zig-Zag graph product A and B. Furthermore, we give an explicit example of Zig-Zag graph construction and a program Zig-Zag(A,B,C) which generate the adjacency matrix of the Zig-Zag product given the adjacency matrix of graph A and graph B and the permutation matrix C.

Research is supported by FIPI.

Vanishing Capillarity as a Selection for Young-Measure Equilibrium Solutions in a Model Two-Phase Problem of Nonlinear Elasticity

Timothy J. Healey¹⁸, Theoretical and Applied Mechanics, Cornell University.

We consider the equilibrium of a 1-dimensional, 2-phase elastic solid in the presence of live body loads and small "interfacial" or higher-gradient elasticity, the latter characterized by capillarity coefficient $\varepsilon > 0$. The existence of equilibria is fairly routine,

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and we examine their behavior in the limit $\varepsilon \rightarrow 0$. With physically reasonable growth conditions, we establish uniform (in ε) a-priori L^∞ -bounds on the strain fields. In the limit we obtain a continuous displacement field and a stress and "strain" field, the latter two of which belong to $L^\infty(0,1)$, with each characterized by the family of Young measures associated with the weak* limit of the strains. In general, the limiting "strain" is incompatible with the limiting displacement. We show that the Young-measure characterization of the stress field has a C^1 representation (within its equivalence class) that satisfies the balance-of-forces equilibrium equation classically.

On the Inverse of the Gold's and the Welch's Power Function

Alfonso Heras, Francis N. Castro, Department of Mathematics, University of Puerto Rico at Río Piedras, and Oscar Moreno¹⁹, Department of Computer Science, University of Puerto Rico at Río Piedras.

In this presentation we explicitly compute the inverse function of the Welch's power function, which is maximally nonlinear. We also present an algorithm to compute the inverse function of the Gold's power function, which is maximally nonlinear. Furthermore, the exponential sums corresponding to the previous power functions provide a family that improves results of Ax-Katz, Adolphson-Sperber and Moreno-Moreno.

Semi-parametric Bayesian Modelling of Censored Data using Correlated Beta Processes

Saba Infante, Universidad de Carabobo, Valencia, Venezuela, María-Eglée Pérez²⁰, University of Puerto Rico at Río Piedras.

Beta processes with independent increments (Hjort, 1990) and with correlated increments (Nieto-Barajas and Walker, 2002) are used for modelling base risk in Cox proportional risk model (Cox, 1972) for the study of discrete survival times. The regression parameter is modeled using a multivariate normal prior. This approach allows to obtain smooth estimates for survival curves and for the risk function, and has the convenient conjugate properties of the Beta prior for implementing MCMC estimation. An example is analyzed using this technique, and the results obtained are compatible with those obtained using other existent approaches.

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Técnicas de Recuperación de Información

*Luis Gabriel Jaimes, Departamento de Matemáticas, Universidad de Puerto Rico en Humacao, y
Fernando Vega Riveros, Departamento de Matemáticas, Universidad de Puerto Rico en Mayagüez.*

La Recuperación de Información (RI) es una rama de la computación que se ocupa de la recuperación de información (no datos) en documentos no estructurados (cartas, periódicos, artículos, etc.) de los cuales, a diferencia de los datos con estructura (almacenados en bases de datos) no es fácil extraer información útil automáticamente.

Estas técnicas (RI) son parte de una rama más amplia de la computación conocida como minería de textos (text mining) que puede ser vista como un caso particular de minería de datos (Data Mining o Data Discovery). Actualmente estas técnicas son ampliamente usadas en buscadores de Internet como GOOGLE, YAHOO, etc. En este trabajo se presentarán tres de los modelos clásicos de RI: booleano, vectorial y probabilístico, además de la posibilidad de utilizar ontologías como medio de recuperación de información, haciendo uso de técnicas de lenguaje natural. Finalizaremos mostrando las aplicaciones y proyectos futuros alrededor de estos conceptos.

Mathematics at the National Security Agency

Lucia Jesús-Santana, National Security Agency.

The National Security Agency (NSA) is the largest employer of mathematicians in the United States. In this talk, we will describe how mathematicians contribute to NSA's cryptologic mission as well as to other facets of the Agency's mission. We will also discuss programs such as summer internships, employment opportunities, and sabbatical opportunities for faculty.

Desempeño Estudiantil en Matemática Fundamental y en Álgebra

Marilú Lebrón Vázquez, Idalyn Ríos Díaz y Bárbara L. Santiago Figueroa, Departamento de Matemáticas, Universidad de Puerto Rico en Humacao.

Los estudiantes de los departamentos de Ciencias Sociales, Sistemas de Oficina, Comunicaciones y Terapia tomaban originalmente el curso de Álgebra Elemental. Debido al alto porcentaje de bajas y fracasos se creó el curso de Matemática Fundamental en el Departamento de Matemáticas de la UPRH. Con miras a determinar la efectividad de dicho curso se realizó un estudio cuyo objetivo fue investigar cuánto progreso se

logra en la retención, ejecución y el nivel de satisfacción del estudiantado. En esta presentación mostramos los resultados obtenidos hasta mayo del 2005.

High Dimensional Star Coordinates in 3D

Elio Lozano and Edgar Acuña, University of Puerto Rico at Mayagüez.

High dimensional data visualization techniques are very useful in supervised classification and clustering. It is helpful in data preprocessing tasks such as outlier detection, feature selection, and to measure the degree of correlation among the features of the dataset. There are plenty of data visualization techniques and, one of the most useful is the 2D Star Coordinates plot, but it has some drawbacks and limitations. In this research the 2D star coordinates plot will be enhanced by introducing new parameters that allow the visualization of the data in three dimensions. The transformed data points, along with their parameters, will be visualized as 3D polyhedrons. One challenge in scientific visualization is the visualization of large datasets, thus to solve in some way this problem, data parallelism in conjunction with the visualization system VTK will be used to deal with these datasets.

Estimation of Parameters in Chemical Kinetic Models

Mariano Marcano²¹, Department of Mathematics, University of Puerto Rico at Río Piedras.

Mathematical models for the transport mechanism of certain chemical substances across cell membranes are described. The models consist of sets of ordinary differential equations. To compute sets of parameters that lead to solutions in agreement with experimental measurements for the translocation fluxes of the substances, an optimization problem is formulated. The model equations and the optimization method are solved numerically. The optimization problem exhibits multiple optima and thus the criteria and the technique used to choose the best optimum are discussed. Parameter sets are computed for two different transporters: the transport of glucose in pancreas cells; the transport of sodium in cells of the wall of a particular segment of a renal tubule.

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Global bifurcation analysis of a higher gradient model for deformations of a rectangular slab

*Errol L. Montes–Pizarro*²², *Department of Mathematics and Physics, University of Puerto Rico at Cayey, and*
*Pablo V. Negrón–Marrero*²³, *Department of Mathematics, University of Puerto Rico at Humacao .*

In this paper we present some preliminary results for a global bifurcation analysis for a higher–gradient model for the deformations of a rectangular slab. After reviewing some previous results from the authors on the local existence of nontrivial branches of solutions bifurcating from the trivial branch, we discuss the additional steps required to extend these branches globally.

Acknowledgement: The research by Negrón–Marrero has been sponsored in part by the National Security Agency (NSA) under grant number H98230-04-C-0486.

A method of detection of pollution for dissipative systems of incomplete data

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Many environmental problems contain incomplete data. We propose a sentinel method for the detection of pollution present in the state equation of a dissipative system of incomplete initial condition. In the present case, the control and the observation have their supports in different open sets. The problem of determining a sentinel is equivalent to a controllability problem, for which we use Carleman inequalities. We then prove the existence of a non null sentinel.

A Connection between Algebraic Structures and Propositional Logic

*Wanda Ortiz Hernández*²⁵, *and Luis F. Cáceres*²⁶, *Department of Mathematics, University of Puerto Rico at Mayagüez.*

The relationship between propositional logic using theories and models, and algebraic structures such as groups, rings, lattices, R-modules and algebras, including Boolean

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Algebras, have been studied.

One of the results that will be discussed is the following: if we define the sentential theory $T(G)$ associated with a group G , it can be shown that there exists a one to one correspondence between the subgroups of G and the models of the sentential theory, $T(G)$. Also, if we define $M(C)$ to be a model associated with a non-empty set C , then given two subsets A and B of C , the model associated with the union of A and B is equal to the union of $M(A)$ and $M(B)$. Similarly, the model associated with the intersection of A and B is equal to the intersection of $M(A)$ and $M(B)$. Also, the model associated with the complement of A is equal to the complement of the model associated to A . A complete proof of these properties will be discussed, and examples will be provided. A similar approach will be applied to other algebraic structures, in order to establish their properties, and concrete examples will be given.

Homología de Khovanov & Torsión de Reidemeister

*Juan Ariel Ortiz-Navarro*²⁷ y *Charles Frohman*, *Universidad de Iowa, Departamento de Matemáticas.*

En 2001 M. Khovanov presentó una teoría que asigna grupos homológicos a un diagrama de un nudo. Su teoría impulsó nuevas preguntas en teoría de nudos como también propuso nuevas formas de atacar viejos problemas en topología. En este proyecto se estudia la torsión de Reidemeister en el complejo de Khovanov. Los resultados proponen que una nueva invariante de nudos puede definirse con esto. En esta presentación mostraremos computaciones que respaldan lo antes afirmado y algunos resultados parciales.

Sobre algunos tipos de curvatura en espacios homogneos reductivos

*Marlio Paredes*²⁸, *Escuela de Matemáticas, Universidad Industrial de Santander.*

En este trabajo consideramos la variedad bandera general \mathbb{F}_Θ como un espacio homogneo reductivo dotado con una métrica U -invariante Λ^Θ y una estructura cuasi-compleja invariante J^Θ . Nuestra referencia central para los cálculos, que presentamos aquí, es el libro de Kobayashi y Nomizu, *Foundations of differential geometry, Vol. 2, Interscience Publishers, 1969*. El objetivo principal de este trabajo es explorar la forma para la conexión riemanniana asociada con la métrica Λ^Θ con el fin de calcular algunas clases de curvaturas tales como, curvatura seccional, curvatura biseccional holomorfa y curvatura seccional kalhriana. Los resultados presentados aquí se encuen-

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tran consignados en el artículo titulado *Curvature on reductive homogeneous spaces*, el cual pronto será sometido para publicación.

El Descenso más Empinado

*Javier Pérez Arocho*²⁹, *Escuela Superior Eugenio María de Hostos en Mayagüez, Puerto Rico, y*
*Álvaro Lecompte Montes*³⁰, *Universidad Interamericana de Puerto Rico, Recinto de San Germán.*

El Método del Descenso se utiliza para la minimización numérica de funciones en una y varias variables. El mismo ha sido empleado en trabajos recientes para encontrar las soluciones periódicas de osciladores mecánicos no lineales, como puentes y otras estructuras, minimizando una función de error y con ventaja sobre el método de iterar el operador de traslación. Aparte de sus múltiples aplicaciones, el método es muy sencillo de visualizar y contribuye a un mayor entendimiento de los conceptos de gradiente, laplaciano y flujo potencial, por lo que puede enriquecer el contenido del curso de Cálculo Vectorial. En el trabajo se revisa el método así como su contexto como solución a un flujo potencial y se presenta una implementación del mismo en el programa Mathematica, que permite ver las iteraciones intermedias y analizar la convergencia.

Repensando el orden de la enseñanza: Investigación en la acción

Ana Helvia Quintero, *Departamento de Matemáticas, Universidad de Puerto Rico en Río Piedras.*

La matemática que recibimos es el fruto de milenios de años de desarrollo. El orden en que se presentan los conceptos matemáticos, no es el orden en que los mismos fueron descubiertos o creados, sino como la matemática actualmente los organiza. Ahora bien, la lógica del aprendizaje corresponde más a la historia del desarrollo de los conceptos que a la lógica de la disciplina. Al presentar en la enseñanza los conceptos de acuerdo al orden lógico de las disciplina chocamos con la forma que los conceptos se aprenden. Es pues necesario investigar que cambios se requieren en el orden en que se enseñan los conceptos para que apoye el aprendizaje.

En la presentación se dará un ejemplo del desfase del orden de la enseñanza con el aprendizaje y se discutirá una investigación en la acción que se está realizando como parte del Proyecto Alacima para estudiar como adecuar el orden de la enseñanza al

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del aprendizaje.

Mejorando la Usabilidad de un Código para la Solución Numérica de Ecuaciones Diferenciales con Retardo

Elio Ramos, Departamento de Matemáticas, Universidad de Puerto Rico en Humacao.

Las Ecuaciones Diferenciales con Retardo (EDRs) son modelos matemáticos de fenómenos dinámicos en donde hay un retardo temporal entre causa y efecto. Las mismas tienen muchas aplicaciones en sistemas biológicos tales como dinámica de poblaciones, epidemias, y mecanismos de control fisiológico. Uno de los problemas fundamentales en la solución numérica de las EDRs es la existencia de discontinuidades en las derivadas así como la propagación de estas en el tiempo. Es por esto que las técnicas numéricas más comúnmente utilizadas requieren monitorear y suavizar estas discontinuidades. Siendo este el caso, la mayoría de los códigos numéricos (robustos) para resolver EDRs requieren que el(la) usuario(a) no solo especifique la EDR sino que provea una gran cantidad de información relacionada a la presencia y la naturaleza de las discontinuidades en el problema que se quiere resolver. Esta situación limita la usabilidad de estos códigos al resultar, en muchos casos, extremadamente complejo formular una EDR, aun para problemas elementales. En esta charla presentamos una interfaz para resolver EDRs utilizando como base el código numérico Archi (Baker, Paul and Willé 1992). El mismo está basado en un método explícito de Runge-Kutta de quinto-orden y un interpolante hermitiano. La interfaz, denominada PyDDE, fue desarrollada utilizando el lenguaje interpretado Python el cual facilita la formulación y experimentación de diferentes problemas con EDRs. De esta manera el(la) usuario(a) puede formular y resolver una EDRs con un número reducido de líneas de código y sin la necesidad de compilación. Presentaremos algunos ejemplos de la utilización de PyDDE y las mejoras que representa en términos de usabilidad.

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On the exact multiplicity of solutions for boundary–value problems via computing the direction of bifurcations

Joaquín Rivera, University of Iowa, Iowa City, Iowa 52242, and Yi Li, Department of Mathematics, Hunan Normal University, Changsha 410081, Hunan, and University of Iowa, Iowa City, Iowa 52242.

We consider positive solutions of the Dirichlet problem:

$$u''(x) + f(u(x)) = 0 \text{ on } (-1, 1), \quad u(-1) = u(1) = 0,$$

depending on a positive parameter ζ . We use two formulas derived in [17] to compute all solutions u where a turn may occur and to compute the direction of the turn. As an application, we consider quintic polynomial $f(u)$ with positive and distinct roots. For such quintic polynomials we conjecture the exact multiplicity structure of positive solutions and present computer assisted proofs of such exact bifurcation diagrams for various distributions of the real roots.

The condition for zero Gaussian curvature

Krzysztof Rozga, Department of Mathematics, University of Puerto Rico at Mayagüez.

The following equation, $u_{xx}u_{yy} - u_{xy}^2 = 0$ is the condition of zero Gaussian curvature for the graph of $z = u(x, y)$, where u is a sufficiently smooth function. Such surface possesses the following property: for each of its points there exists a neighborhood which can be isometrically flattened.

We examine the condition of vanishing Gaussian curvature for the graphs of piecewise-linear functions. This is the simplest departure from the case of smooth surfaces. That however involves multiplication of distributions.

A brief exposition of that topic, in the framework of the Colombeau algebras, is presented as well.

Unbounded hypercyclic operators

Héctor Salas, Department of Mathematics, University of Puerto Rico at Mayagüez.

An operator (linear transformation) from a Banach space into itself is hypercyclic if there is a vector whose orbit under the operator is dense in the space. The structure of hypercyclic bounded operators has been intensely studied in the last twenty years. Among the highlights is Ansari's result that says that powers of these operators are also hypercyclic. We give an example which shows that this is not necessarily the case if the operator is unbounded. We also exhibit an unbounded Hilbert space operator for which every non-zero vector is hypercyclic.

Bayesian Mapping of Multiple Quantitative Trait Loci

Damaris Santana Morant, Department of Mathematics, University of Puerto Rico at Mayagüez.

Many agronomic traits in plants are classified as quantitative in nature, i.e., the observed phenotype is the joint result of the effects of a number of genetic and envi-

ronmental factors. The genetics of quantitative traits are studied through estimating the effects of the genes contributing to the traits as well as by determining their location in the genome. Once a molecular location is determined for the genes, they are called quantitative trait loci (QTL). Knowledge about these loci assists in the selection of superior genotypes in a population for trait improvement (e.g. yield and disease resistance in crops). A statistical method for the simultaneous estimation of the locations and effects of QTL in a backcross population will be presented. The posterior distribution of the QTL effects along the genome using a Gibbs sampler is obtained. This model was able to effectively determine QTL locations and effects in simulated data as well as in an experimental data set.

Mathematical Modelling of Elastic Deformations with Defect Nucleation

Lev Steinberg, University of Puerto Rico at Mayagüez.

In this talk we will present our current study of material deformations of poly-crystals, rocks and other elastic materials. Stress-strain relationships of these materials depend on the processing history and exhibit common behavior, including non-linearity, hysteresis, etc..

The presentation will focus on our study of elastic deformations with defect nucleation. In the beginning, we consider a singular source of singularities in the strain field and its influence on elastic deformation and then the continuum of the nuclei, which we describe in terms of volume density and flux. The reversible and irreversible defect nucleation mathematical modelling will be discussed.

Applications of Newcomb-Benford's Law to Electoral Processes, Bioinformatics and the Stock Market

David Torres³¹, Department of Mathematics, University of Puerto Rico at Rio Piedras, L. R. Pericchi³², Department of Mathematics, University of Puerto Rico at Rio Piedras, and Universidad Simón Bolívar, Caracas.

Since this rather amazing fact was discovered in 1881 by the American astronomer Simon Newcomb (Newcomb, S. Note on the Frequency of Use of the Different Digits in Natural Numbers. Amer. J. of Math., 4(1):3940, 1881) many scientist have been searching about members of the outlaws number family. Newcomb noticed that the pages of the logarithm books containing numbers starting with 1 were much more worn than the other pages. After analyzing several sets of naturally occurring data

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Newcomb went on to derive what later became Benford's law. As a tribute to the figure of Newcomb we call this phenomenon, the Newcomb - Benford's Law.

We start by establishing a connection between the Microarray and Stock Market data sets. That can be seen as an extension of the work done by Hoyle et al. (David C. Hoyle, R. J. A. B., Magnus Rattray. Making sense of microarray data distribution. *Bioinformatics*, 18(4):576584, 2002) and E. Ley (Ley, E. On the Peculiar Distribution of the U.S. Stock Indexes Digits. *The American Statistician*, 50(4):311313, 1996). Most of the analysis have been made using Classical and Bayesian statistics. Here is explained differences between the different scopes on the hypothesis testing between models (Berger and Pericchi L., J. Objective Bayesian methods for model selection: Introduction and comparison (with discussion), 135207. Beachwood OH: Institute of Mathematical Statistics, Monographs, 2001). Finally, applications to different types of data including Microarray, Stock Market and Electoral Processes are presented.

Mathematical Teaching And Learning Support Center

Evelyn Torres Gallardo and Maytee Cruz Aponte, Departamento de Matemáticas, Universidad de Puerto Rico en Humacao.

The primary goal of the Mathematical Teaching and Learning Support Center is to enhance the teaching-learning process by means of addressing different learning styles. In this center we provide the student with different learning tools, which fit their particular learning styles. We will discuss the learning tools and learning strategies used to accomplished this goal.

W^* -Correspondences and Finite Directed Graphs

Víctor M. Vega, The University of Iowa and St. Ambrose University.

Let A be the W^* -algebra, $L^\infty(E^{(0)}, \mu_0)$, where $E^{(0)}$ is a finite set and μ_0 is a probability measure with full support. Let $P : A \rightarrow A$ be a completely positive unital map. In the present context, P is given by a stochastic matrix. We study the properties of P that are reflected in the dilation theory developed by Muhly and Solel in *Int. J. Math.* **13**, 2002.

Let H be the Hilbert space $L^2(E^{(0)}, \mu_0)$ and let $\pi : A \rightarrow B(H)$ the representation of A given by multiplication. Form the Stinespring space $H_1 := A \otimes_P H$, let π_1 be the Stinespring representation $\pi_1(\phi)a \otimes h := \phi a \otimes h$, and form

$$\mathfrak{X} = \mathfrak{L}_A(H, H_1) := \{X : H \longrightarrow A \otimes_P H \mid X\pi(a) = \pi_1(a)X, a \in A\}.$$

Then \mathfrak{X} is a W^* -correspondence over $\pi(A)'$ and P is expressed through a completely contractive representation T of \mathfrak{X} on H . This representation can be dilated to an

isometric representation V of \mathfrak{X} on a Hilbert space that contains H . We show that \mathfrak{X} is naturally isomorphic to the correspondence associated to the directed graph E whose vertex space is E^0 and whose edge space is the support of the matrix representing P - a subset of $E^0 \times E^0$. Further, V is shown to be essentially a Cuntz-Krieger representation of E .

Regresión Logística PLS para la Reducción de la Dimensionalidad en Datos de Microarreglos

José Carlos Vega Vilca, Departamento de Bioestadística y Epidemiología, Escuela Graduada de Salud Pública, Recinto de Ciencias Médicas, Universidad de Puerto Rico.

La tecnología de microarreglos consiste en el análisis del nivel de expresión de decenas de miles de genes en forma simultánea. Esta tecnología genera matrices de datos $X(np)$, donde n es mucho menor que p , y gran necesidad de metodologías para analizar y explotar la información contenida en esos datos, caracterizados por muchas mediciones de variables (genes) y pocas observaciones (experimentos). En esta situación se hace necesaria la aplicación de técnicas de selección de variables y sobre todo de reducción de la dimensionalidad con variables ortogonales entre sí, con el fin de eliminar la multicolinealidad de las variables predictoras, antes de aplicar alguna técnica estadística de análisis multivariado.

Se presentará una generalización de la regresión por mínimos cuadrados parciales (PLS, por sus siglas en inglés) como una técnica de reducción de la dimensionalidad para ser aplicada en problemas de clasificación supervisada; siguiendo los lineamientos trazados por Bastien, Esposito Vinzi y Tenenhaus (2002), quienes propusieron la regresión logística ordinal PLS. Sin embargo lo más común en clasificación supervisada es que las clases no tengan un ordenamiento natural entre sí. Por tal motivo, se presentará la implementación de un algoritmo para construir componentes PLS a partir de la regresión logística nominal.

Summer Undergraduate Mathematical Sciences Research Institute (SUMSRI)

Vasant Waikar, Department of Mathematics and Statistics, Miami University, Oxford, Ohio 45056.

I have been a co-director of SUMSRI at Miami (an REU in math and statistics) for the last seven years. This is funded by NSA and NSF. I also have directed the statistics research projects at SUMSRI for the last seven years. I will discuss the nature and content of these research projects as well as the overall working of SUMSRI its goals and the results.

Dirichlet and Neumann boundary conditions: What is in between?

Mahamadi Warma, University of Puerto Rico, Department of Mathematics (Rio Piedras Campus), PO Box 23355 San Juan PR 00931-3355 (USA).

Let $\Omega \subset \mathbb{R}^N$ be a bounded domain with Lipschitz boundary. Let T_D and T_N be respectively the semigroups generated by the Dirichlet Laplacian and the Neumann Laplacian on $L^2(\Omega)$. We characterize all (nonlinear) semigroups which are between those two semigroups.

5 Afiches (*Posters*)

Line Graphs of Zero Divisor Graphs

*Camil I. Aponte, University of Puerto Rico at Rio Piedras,
Patrice S. Johnson, and Nathan A. Mims.*

Let $L(\Gamma(\mathbb{Z}_n))$ be the line graph of $\Gamma(\mathbb{Z}_n)$, where $\Gamma(\mathbb{Z}_n)$ is the zero-divisor graph whose vertices are the nonzero zero-divisors of \mathbb{Z}_n , and such that two vertices u, v are adjacent if n divides uv . The authors determine when $\overline{\Gamma(\mathbb{Z}_n)}$ and $L(\Gamma(\mathbb{Z}_n))$ are Eulerian. Moreover, studies are done on the diameter, girth, trees, planarity, center, eccentricity, clique, chromatic number, and the existence of Hamiltonian cycles for $L(\Gamma(\mathbb{Z}_n))$.

A model for the dynamics of a kite with an arbitrary lift coefficient

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Advisor: Pablo V. Negrón³⁴, University of Puerto Rico at Humacao.*

In this paper we consider a generalization of a model for kite flight studied by Adomaitis (SIAM Review September 1989). In that paper the lift coefficient C_l is taken as $b \sin 2\theta$ where θ is the angle that the string of the kite, assumed to be completely straight, makes with the horizontal. In our analysis we assumed on C_l only properties observed experimentally in wind tunnels, namely that C_l is concave downward. We show that in this general scenario there can be multiple turning points for the curve of steady states as a certain parameter (inversely proportional to the square of wind

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speed) changes. We show as well that there can be multiple branches of stable steady states solutions and Hopf bifurcations.

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The Structure of Zero-Divisor Graphs

*Natalia I. Córdova, University of Puerto Rico at Rio Piedras,
Clyde Gholston, Helen A. Hauser.*

Let $\Gamma(\mathbb{Z}_n)$ be the zero-divisor graph whose vertices are the nonzero zero-divisors of \mathbb{Z}_n , and such that two vertices u, v are adjacent if n divides uv . Here, the authors investigate the size of the maximum clique in $\Gamma(\mathbb{Z}_n)$. This leads to results concerning a conjecture posed by S. Hedetniemi, regarding the core of $\Gamma(\mathbb{Z}_n)$, vertex colorings of $\Gamma(\mathbb{Z}_n)$ and $\overline{\Gamma(\mathbb{Z}_n)}$, and values of n for which $\overline{\Gamma(\mathbb{Z}_n)}$ is Hamiltonian. Additional work is done to determine the cases in which $\Gamma(\mathbb{Z}_n)$ is Eulerian.

Monomial permutations that decompose in cycles of Length 2

*Louis Cruz Ubiles, University of Puerto Rico at Humacao, Department of Mathematics, Humacao, PR 00791-4300,
Advisor: Ivelisse Rubio, University of Puerto Rico at Humacao.*

A permutation is a reordering of the elements of a set. It is known that a monomial ax^i produces a permutation of a finite field F_q if and only if $\gcd(i, q-1) = 1$. We study the cyclic decomposition of permutations of F_q given by monomials ax^i . In particular, we study a necessary and sufficient conditions on the coefficient a and the exponent i to obtain permutations that decompose in cycles of length two. We prove that ax^{q-2} decomposes in cycles of length two for all $0 < a < q$. We also characterize the coefficients of some other monomials so that the permutation decompose in cycles of length 2.

This work has applications to coding theory since permutations are used to construct error correcting codes such as, for example, turbo codes and multi-user codes. Permutations that decompose in cycles of length two are particularly useful because they are their own inverse and this gives an implementation advantage.

Acknowledgement: This research was sponsored in part by the National Security Agency (NSA) under grant number H98230-04-C-0486.

Interleavers for Error Correcting Codes

*Joyce M. Fernández, University of Puerto Rico at Humacao, Department of Mathematics, Humacao, PR 00791-4300,
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Error control codes are used to protect digital information from errors that might occur during transmission. We are interested in the construction of interleavers for Turbo codes and codes for multi-user systems. In the Turbo codes application, the interleaver permutes the information symbols; in the multi-user application, the interleaver distinguishes each user. Interleavers for Turbo codes constructed with certain monomials x^i have proved to have good performance; we believe that we can obtain classes of good interleavers when we consider monomials with coefficients different from one. In this research, we study some properties of permutations of \mathbb{Z}_p , p prime, obtained using monomials ax^i . Properties such as the dispersion, the spreading and the distance between permutations are associated to the performance of the codes.

Acknowledgement: This research was sponsored in part by the National Security Agency (NSA) under grant number H98230-04-C-0486.

Sistemas Dinámicos Probabilísticos

*Mariely Angeli Hernández Morales, Universidad de Puerto Rico en Cayey,
Advisor: Alicia Aviño, Universidad de Puerto Rico en Cayey.*

Un sistema dinámico es un par (X, f) donde X es el conjunto y f es la función actuando en X . Si X es finito tenemos un Sistema Dinámico Finito (FDS). Además estudiamos los sistemas dinámicos finitos con n funciones actuando en el mismo conjunto X , con las probabilidades asignadas a esta función. Este nuevo concepto es en algún sentido una generalización muy sencilla al concepto de Redes Booleanas Probabilísticas (PBN) introducidas por I. Smulevich y compañeros], ya que usamos un conjunto X que no es necesariamente centrado en $\{0, 1\}$ y las funciones no son booleanas. Pero aplicamos todos los resultados y definiciones al PBN particularmente porque este modelo se ha estado usando para describir las redes genéticas y tiene aplicaciones terapéuticas.

En los FDS la pregunta más importante es describir los espacios de estados de los sistemas. Aquí le damos la importancia a la idea de las transformaciones de unas redes a otras sin perder todas las propiedades en particular la distribución de probabilidades. Siguiendo este objetivo desarrollamos el concepto de Homomorfismo y Homiomorfismo de Sistemas Dinámicos Probabilísticos (PDS) ya que este concepto trae propiedades de una red a otra.

An Optimization Problem for a $\text{Na}^+\text{-K}^+\text{-2Cl}^-$ Cotransporter Model

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Advisor: Mariano Marcano³⁶, Department of Mathematics, University of Puerto Rico at Río Piedras.

An optimization technique was used to compute parameter sets that lead to solutions in agreement with experimental results for a kinetic model of a $\text{Na}^+\text{-K}^+\text{-2Cl}^-$ cotransporter. A cotransporter is an enzyme that mediates the transport of the ions from the cytosol to the lumen and vice versa through a cell membrane. The model parameters consist of reaction rates, disassociation constants and binding constants, and ion concentrations. The model consists of a system of ordinary differential equations (ODE) for different enzymatic states. From the steady-state solution of the ODE system the net fluxes J_M are computed. For different concentration values, the optimization problem seeks a set of parameters within the parameter ranges that yields values of J_M close, in the Least Squares sense, to the values reported in the literature. The model equations and the optimization problem were solved numerically and different optimization algorithms were used to solve the optimization problem.

Comparación de Rendimiento entre Técnicas de Recuperación de la Información

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Consejero: Luis Gabriel Jaimes, Universidad de Puerto Rico en Humacao.

En este trabajo se ilustran los resultados obtenidos utilizando tres técnicas clásicas de recuperación de información en documentos no estructurados: el método booleano, el vectorial, y el probabilístico. Se muestra una comparación entre el rendimiento y los resultados de los tres algoritmos utilizando como entrada una colección de documentos de prueba del proyecto HERMES de la Universidad de la Américas en México.

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Modelos Basados en Agentes del Mecanismo de Producción y Control de las Células Sanguíneas en el Cuerpo Humano

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Advisor: Elio Ramos, University of Puerto Rico at Humacao.

Traditionally, dynamical systems with delay are formulated mathematically using continuous models based on Delayed Differential Equations (DDE). We are developing a model of a delayed dynamical system, namely the mechanism of blood cells production and control in the human body, using an agent based simulation. In the agent based approach we use a reductionism approach where we start with an initial population of mature blood cells that evolve on time by the combined effect of production of young cells and decay of mature cells. In this context the maturation period from young to mature cells is associated with a delay parameter (τ) which introduces a delay in the dynamics of the system. The model will be calibrated with an standard continuous DDS namely the Mackey-Glass model. Also we will use this model to simulate the dynamics of blood cells with blood diseases. With our approach it's relatively simple to incorporate more realistic elements in the model as the introduction of a modulation in the delay parameter.

Acknowledgement: This research was sponsored in part by the National Security Agency (NSA) under grant number H98230-04-C-0486.

A Computational Model of Mars Craters-Size Frequency Distribution

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Advisor: Elio Ramos, University of Puerto Rico at Humacao.

We present a computational model that reproduces essential features of the frequency distribution vs. diameter, of the 42,000 craters contained in the Barlow's Mars Catalog. The model, based in the Monte Carlo method, assumes that the martian surface is a two dimensional grid and simulates the crater formation process due to the meteor's impacts, of different diameters, falling uniformly at random locations. The diameters of the simulated meteors were randomly generated from a power law distribution (slope=-4) where smaller meteors are more frequent than larger meteors. The simulation takes into consideration the reduction of craters numbers as a function of time caused by the impact of large meteors falling over small craters already formed (obliteration). The model provides a simple and natural explanation for the presence of different slopes in the observed log-log plot of numbers (N) vs. diameter (D).

Acknowledgement: This research was sponsored in part by the National Security

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Utilización de la estadística bayesiana para probar la existencia de reversión a la media en el índice de valores de Puerto Rico

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Consejeros: Marta Álvarez y Javier Rodríguez, Universidad de Puerto Rico en Río Piedras.

En esta investigación se estudió el comportamiento del Índice de Valores de Puerto Rico (Puerto Rico Stock Index, PRSI) para horizontes de inversión de corto y largo plazo. Los datos usados fueron el precio de cierre mensual de este índice desde diciembre 1995 a diciembre 2004. Se utilizó estadística bayesiana mediante la implementación del Muestreo de Gibbs para generar las varianzas de los rendimientos del PRSI y determinar mediante la prueba del “Variance Ratio” (VR) si existe reversión a la media. Luego de realizar la prueba, se encontró que no existe evidencia estadística de reversión a la media para los horizontes estudiados. Este resultado concuerda con otros estudios donde se demuestra mediante el uso de la estadística clásica que los rendimientos mensuales del PRSI exhiben paso aleatorio.

A splitting technique for the advection-diffusion equation

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Advisor: Mariano Marcano³⁹, University of Puerto Rico at Río Piedras.

The advection–diffusion equation was solved by two different methods: an unsplitting method, which applied the Crank-Nicolson method to the entire equation, and a splitting technique, which applied the Crank-Nicolson method to the diffusion part of the equation and a flux-limiter method to the advection component. Both methods behaved very similar for large values of the diffusivity but as the diffusivity decreased the approximations from the unsplitting method exhibited oscillations which were not associated to the solutions of the equation. The order of convergence was two for both methods. Finally, the splitting technique was used to approximate the solution of the model equations for the dispersion of solute in a renal tubule.

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