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2. Itinerario Detallado (Detailed Schedule)

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4:00-9:00	Lobby	**Mesas de Exhibición**
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	MATC 1	*The Random Homotopy Method for Signal Tracking and Global Positioning Systems (GPS)*, Pablo V. Negrón–Marrero.
	MATC 2	*Ternas Consecutivas en Residuos o no Residuos Cuadráticos y sus aplicaciones a sistemas dinámicos discretos*, Leonid Brehsner Sepúlveda Avendaño y Omar Colón–Reyes.
	MATC 3	*Algorithm to measure symmetry and positional entropy of n points*, Dennis G. Collins.
	S 124	*On a curvature related problem and Colombeau's algebras*, Krzysztof Rózga.
	S 125	*Una Caracterización de Triángulos de Heron Especiales*, Ramón L. Matos Berríos.
	S 212	*Estudio del péndulo Simple, una experiencia de aprendizaje*, Carlos Malagón.
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	MATC 2	*Further Results on Tournament Matrices*, Edwin Flórez G and Xuerong Yong.
	MATC 3	*Construcción de conceptos de Geometría Analítica utilizando Cabrí II*, Orlando Planchart Márquez.
	S 124	*La Codiferencial de la Forma de Kähler sobre una Variedad Bandera Maximal*, Marlio Paredes.
	S 125	*An Application of Continuous Wavelet Transform to Solve the Kuramoto-Sivashinsky Equation*, Alexander Urintsev and Gloria Ruiz Valle.
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Horario	Lugar	Actividad
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		Permutations of F_q that are given by binomials and decompose in cycles of length two, Yesenia Cruz.
		Permutations of $\mathbb{Z}_{p^r}$ as interleavers for turbo codes, Joyce Fernández.
		The brachistochrone problem on a vertical plane and over surfaces, Jessica Flores.
		Caracterización de Patrones Espaciales en Microfotografías de Epidermis de Hojas, Melissa López.
		Sistema de simulación por dinámica molecular de interacciones entre nanotubos de carbono de pared sencilla y diferentes polímeros, Myrna Merced.
		Enseñanza Interdisciplinaria en la Practica: La Experiencia de MeCoBi en la UPR–Humacao, Elio Ramos.
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	MATC 2	*La tecnología, los estilos de aprendizaje y la enseñanza de la matemática*, Evelyn Torres–Gallardo.
	MATC 3	*Uso de herramientas tales como mathml y svg para crear objetos de aprendizaje en el web*, Jaime Miranda y Esteban Hernández.
9:00-9:30	A 225	**Apertura Oficial**
9:30-10:30	A 225	**Conferencia Plenaria** *Mathematics for the Genomics Revolution*, Rafael A. Irizarry.
10:30-11:00	Lobby	**Afiches y Merienda**
11:00-11:25		**Conferencias Concurrentes**

Horario	**Lugar**	**Actividad**
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	MATC 2	*A New Fast Finite Field Multiplier*, Edgar Ferrer, Dorothy Bollman, and Oscar Moreno.
	MATC 3	*An Elementary Approach to Ax-Katz, McEliece's Divisibility and Applications to Quasi-Perfect Binary 2-Error Correcting Codes*, Francis Castro, Ivelisse Rubio, Hugues Randriam, Oscar Moreno, and H. F. Mattson.
	S 124	*Discrete objects and splitting closure*, Gabriele Castellini.
	S 125	*Theory of Cosserat Plates. Part I. Mathematical Model with Variation Micro-rotations in the Thickness Direction*, Lev Steinberg and Pedro Madrid.
	S 212	*El conocimiento matemático que se necesita para la enseñanza*, Ana Helvia Quintero.
11:30-11:55		**Conferencias Concurrentes**
	MATC 1	*Imputation methods for microarray data*, Sindy Díaz and Edgar Acuña.
	MATC 2	*On a Problem of Alterations of Digits in Integers*, N. Arroyo and F. Castro.
	MATC 3	*Sistemas dinámicos finitos booleanos y operaciones de puente*, Luis O. Perez y Omar Colon-Reyes.
	S 124	*Torsión de Reidemeister en el Complejo de Khovanov*, Juan Ariel Ortiz–Navarro.
	S 125	*Theory of Cosserat Plates. Part II. Effect of the Variation Micro-rotations in Bending Problem*, Lev Steinberg and Pedro Madrid.
	S 212	*El impacto de los Centros Tutoriales en el Aprovechamiento Académico en los Cursos de Matemáticas: El Caso del Programa de Servicios Educativos en UPR–Bayamón*, Edward A. Caro López.
12:00-1:30	Cafetería	**Almuerzo**
1:30-2:30	A 225	**Conferencia Plenaria** *Nonzero Spectral Flow Forces Bifurcation of Critical Points*, Patrick M. Fitzpatrick.
2:30-2:55		**Conferencias Concurrentes**
	MATC 1	*REU (Research Experience for Undergraduates) in Statistics at Miami University*, Vasant B. Waikar.

Horario	**Lugar**	**Actividad**
	MATC 2	*Finite Field Multiplication via Number Theoretic Transforms*, Dorothy Bollman and Edgar Ferrer.
	MATC 3	*Dickson permutation polynomials that decompose in cycles of the same length*, Ivelisse Rubio, Gary Mullen, Carlos Corrada, and Francis Castro.
	S 124	*On Baire property of sets from the Descriptive Set-Theory viewpoint*, Mehdi Nikpour.
	S 125	*Acoplamiento de modelos de fluidos y acústicos en la simulación de un oscilador de fluidos*, José O. Sotero Esteva, Rogerio Furlan, y Jorge J. Santiago Avilés.
	S 212	*Is there a difference in student performance based on medium of instruction or learning resources?*, White, S.B. and White, J.A..
3:00-3:15	Lobby	**Receso (Café)**
3:15-3:40		**Conferencias Concurrentes**
	MATC 1	*Feature Selection in KDD (Rough set approach*, Frida Coaquira.
	MATC 2	*On Systems of Linear and Diagonal Equation of Degree $p^i + 1$ Over Finite Fields of Characteristic p*, Francis Castro, Ivelisse Rubio, and P. Guan.
	MATC 3	*Fuzzy Information Space Based Voice Processing*, Wladimir Rodríguez.
	S 124	*Regularity in Capacity and the Dirichlet Laplacian*, Mahamadi Warma.
	S 125	*Bifurcation in Three Dimensional Elasticity and Violations of the Complementing Condition*, Errol L. Montes–Pizarro, and Pablo V. Negrón–Marrero.
	S 212	*Student geometric ideas on functions of two variables*, Rafael Martínez Planell, and María Trigueros Gaisman.
3:45-4:10		**Conferencias Concurrentes**
	MATC 1	*Simulación de Monte Carlo para comparar estimadores de regresión en la estimación de totales y razones*, Jairo Alberto Fúquene P..
	MATC 2	*Non-linear finite dynamical systems and its applications* Omar Colón–Reyes and Dorothy Bollman.
	MATC 3	*Técnica de Desarrollo de Sistemas de Objetos (TDSO)*, Flor Narciso e Isabel Besembel.

Horario	**Lugar**	**Actividad**
	S 124	*La Estructura Algebraica Del Espacio De Señales*, Jorge Villamizar y Marlio Paredes.
	S 125	*The Numerical Computation of the Critical Load for Radial Cavitation*, Jeyabal Sivaloganathan and P. V. Negrón–Marrero.
	S 212	*Periodic Solutions of Integro-differential Equations in Vector-valued Function Spaces*, Valentin Keyantuo, Carlos Lizama, and Verónica Poblete.
4:15-4:45	A 225	**Sesión Administrativa**

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

The Poincaré Conjecture and the role of problems in mathematics

John Morgan, Columbia University, New York.

We begin with a discussion of the history of problems in mathematics. We discuss Hilbert's problem list from 1900 and the Clay Millennium problems from 2000. We discuss in general terms the basic notions of topological spaces, dimension, etc. Then we talk about surfaces and their classification. We discuss in general terms the statement of the Poincaré Conjecture and how it is motivated by results for surfaces. Then we discuss the history of attempts to resolve this problem over the last 100 years and some of the vast amount of mathematics that has resulted from these attempts. We then discuss how the solution is derived not from topology but from differential geometry and partial differential equations.

Mathematics for the Genomics Revolution

Rafael A. Irizarry, John Hopkins Bloomberg School of Public Health.

The completion of the human genome project has revolutionized biology and science in general. The information gained from this project along with powerful new technologies has led to de so-called Genomics Revolution and has transformed biology to be a much more quantitative science. Mathematical models have been extremely important in physics, chemistry, and, to some extent, biology. However most biological processes of interest are far to complex for these models to be useful. The impact of Mathematics, and more specifically Statistics, on the Genomics Revolution has been through the development of powerful data analysis techniques, many of which rely on empirically motivated models. In this talk I will give some examples of useful tools developed to aid in the analysis of data produced by one of the most widely used technologies: microarrays.

Nonzero Spectral Flow Forces Bifurcation of Critical Points

Patrick M. Fitzpatrick, University of Maryland at College Park.

For a one-parameter family of nonlinear operators $F\colon \mathbf{R}\times H \to H$, where H is a real Hilbert space, suppose that for every parameter λ, $h = 0$ is a solution of the equation

$$F(\lambda,\, h) = 0. \tag{1}$$

Given an interval $[a,\, b]$ in the parameter space an important problem is to determine conditions that guarantee that there are nontrivial solutions of equation (1) (that is, solutions $(\lambda,\, h), h \neq 0$) that bifurcate for the trivial branch $[a,\, b] \times \{0\}$. The data that is presented is the path of linearizations with respect to h at $h = 0$, that is, the path of linear operators

$\lambda \mapsto L_\lambda \in \mathcal{L}(H)$,

$$\{L_\lambda\}_{\lambda \in [a,\, b]} \textit{ where each } L_\lambda \equiv \frac{\partial F}{\partial h}(\lambda,\, h)|_{h=0}.$$

In the case that each operator $F(\lambda, \cdot)$ is variational, that is , there is a real-valued functional $\varphi\colon \mathbf{R} \times H \to \mathbf{R}$ such that $F(\lambda, h) = \nabla_h \varphi(\lambda, h)$, equation (1) has the form

$$\nabla_h \varphi(\lambda, h) = 0$$

so one is studying critical points and each linearization

$$L_\lambda = Hess_h \varphi(\lambda, h)|_{h=0} \textit{ is a self-adjoint operator.}$$

For $H = \mathbf{R}^n$, two theorems of Krasnoselskii describe sufficient conditions, in terms of the eigenvalues of L_λ at the end-points of $[a,\, b]$, for bifurcation: in the general case, a change in the parity of the number of negative eigenvalues forces bifurcation while in the variational case only a change in the number of negative eigenvalues forces bifurcation. In the infinite dimensional case, under the assumption that each linearization L_λ is Fredholm of index 0, two bifurcation theorems will be described where properties of the whole path of linearizations, not just of the end-points of the path, forces bifurcation. These will be compared with two local (in the parameter space) bifurcation theorems of Rabinowitz. In the **variational case**, an invariant associated with paths of self-adjoint Fredholm operators called **spectral flow** will be described in the context of a bifurcation theorem established in work with Jacobo Pejsachowicz and Lázero Recht.

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.*)

On a Problem of Alterations of Digits in Integers

N. Arroyo, Department of Education, University of Puerto Rico at Rio Piedras, and F. Castro, Department of Mathematics, University of Puerto Rico at Rio Piedras.

In the book The USSR Olympiad Problem Book appear the following problem: Which integers have the following property? If the final digit is deleted, the integer is divisible by the new number. In this note we give a new proof of this result and we generalize this result. We answer the following for $k = 2$ and $k = 3$: Which integers have the following property? If the final k digits are deleted, the integer is divisible by the new integer. We also prove that the number of integer satisfying the previous property is finite.

Finite Field Multiplication via Number Theoretic Transforms

Dorothy Bollman , Department of Mathematical Sciences, University of Puerto Rico, Mayagüez and
Edgar Ferrer, PhD. CISE Program, University of Puerto Rico, Mayagüez.

Mastrovito has shown that multiplication, $c = a \cdot b$, in a finite field $GF(2^m)$ can be performed by a matrix-vector product, $c = Mb$ where b and c are represented by vectors over Z_2 and M is a certain $m \times m$ matrix of 0s and 1s depending on a that has come to be known as the Mastrovito matrix. In this work we show that a slight rearrangement of the rows of M yields a Toeplitz matrix which in turn can be embedded in a ciruculant matrix, thus allowing us to express multiplication in $GF(2^m)$ in terms of cyclic convolution via a number-theoretic transform. This result gives an algorithm whose operation count is $O(m\ log\ m)$ mod p operations for some prime p in lieu of the $O(m^2)$ bit operations in the Mastrovito algorithm.

El impacto de los Centros Tutoriales en el Aprovechamiento Académico en los Cursos de Matemáticas: El Caso del Programa de Servicios Educativos en UPR–Bayamón

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

El Proyecto de Servicios Educativos en UPR-Bayamón existe a partir de 1982 creado por fondos federales de Título IV. Éste, es uno de apoyo académico, ofreciendo entre otros servicios tutorías a los estudiantes que toman cursos en las áreas de matemáticas, español, inglés, biología y química. Entre los participantes de este programa, están los estudiantes de nuevo ingreso con necesidad académica que cumplen con algunos de los siguientes requisitos; su familia es una de ingresos económicos limitados, son la primera generación de estudiante universitario en su hogar u obtuvieron puntuaciones en el examen de entrada ofrecido por el College Board inferiores a parámetros establecidos por el programa.

Establecemos una ecuación de regresión no lineal, para estimar la probabilidad de aprobar (obtener A, B ó C) los cursos de matemática , en los primeros dos semestres, a base de las variables independientes. Se utilizan variables dicótomas para identificar características en los estudiantes, incluyendo la participación en el proyecto, de manera que podamos comparar a los estudiantes admitidos al programa con aquellos que no participaron pero tenían perfiles académicos similares a los anteriores.

Las variables independientes son : género, puntuaciones en el examen de entrada ofrecido por el College Board , promedio de escuela secundaria, tipo de escuela de procedencia, escolaridad de los padres, ingreso familiar, número de créditos matriculados en el semestre que tomó el curso, profesor que dictó el curso y programa académico de aceptación.

Se determina la significancia estadística y el peso de cada variable independiente en la estimación de las probabilidades de aprobación. Utilizamos el modelo estadístico no lineal "probit", para el análisis de una base de datos de expedientes de estudiantes de nuevo

ingreso, que incluye tanto estudiantes participantes como no participantes del programa.

Discrete objects and splitting closure

Gabriele Castellini, Department of Mathematics, University of Puerto Rico at Mayagüez.

The notion of splitting closure operator was recently introduced by Brümmer, Giuli and Holgate as a categorical approach to the notion of splittable space introduced by Arhangel'skii. We push the categorical approach even further by showing that the notion of splitting closure operator on a category $\mathcal{X}$ is part of a Galois connection between closure operators on $\mathcal{X}$ and subcategories of $\mathcal{X}$ that defines the notion od discrete objects of a closure operator. Moreover, this setup can be "dualized" in order to define a notion of cosplitting closure that is also related to the indiscrete objects of a closure operator.

An interesting consequence of the above is that the two Galois connections give rise as a composition to a third Galois connection that can be used as a generalization of torsion theories in algebra and connectedness and disconnectedness in topology.

All the above concepts and results are discussed and examples are provided.

On Systems of Linear and Diagonal Equation of Degree $p^i + 1$ Over Finite Fields of Characteristic p

Francis Castro, Department of Mathematics, University of Puerto Rico at Río Piedras, Ivelisse Rubio, Department of Mathematics, University of Puerto Rico at Humacao, P. Guan, Department of Mathematics, University of Puerto Rico at Río Piedras.

One of the most important questions in number theory is to find properties on a system of equations that guarantee solutions over a field. This type of question is called of the *Chevalley type* and there are many results related to this. In this work we consider the following problem over finite fields: To find the minimum number of variables such that

$$\begin{aligned} x_1 + \cdots + x_n &= \beta_1 \\ x_1^d + \cdots + x_n^d &= \beta_2 \end{aligned}$$

has a solution over $\mathbf{F}_{p^f}$ for any $(\beta_1, \beta_2) \in \mathbf{F}_{p^f}^2$. We denote this number by $\delta(d, p^f)$.

For the case where $p > 3$, it has been known for a long time that $\delta(1, 2, p^f) = 3$. When $p = 3$ it was proved by Cohen(1957) that $\delta(1, 2, 3^f) = 4$. We prove that, for $p > 3$, $\delta(1, p^i + 1, p^f) = 3$ if and only if $i \neq 2i$.

We also give conditions on the coefficients to guarantee solutions of the following system of polynomials equations:

$$\begin{aligned} a_1 x_1 + a_2 x_2 + a_3 x_3 &= \beta_1 \\ b_1 x_1^{p^i+1} + b_2 x_2^{p^i+1} + b_3 x_3^{p^i+1} &= \beta_2 \end{aligned}$$

over $\mathbf{F}_{p^f}$ for any $(\beta_1, \beta_2) \in \mathbf{F}_{p^f}^2$.

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

An Elementary Approach to Ax-Katz, McEliece's Divisibility and Applications to Quasi-Perfect Binary 2-Error Correcting Codes

Francis Castro, Department of Mathematics, University of Puerto Rico at Río Piedras and
Ivelisse Rubio, Department of Mathematics, University of Puerto Rico at Humacao,
Hugues Randriam,, Ecole nationale supérieure des télécommunications, 46 rue Barrault, 75634 Paris Cedex 13 – France,
Oscar Moreno, Department of Computer Science, University of Puerto Rico at Río Piedras, and
H. F. Mattson, Jr., Electrical Engineering and Computer Science, Syracuse University CST 2-179, Syracuse, New York.

There are several results on the divisibility of the number of solutions to systems of equations; some examples are the results by Ax-Katz, Moreno-Moreno, McEliece and Adolphson-Sperber. These results have been widely used in applications to coding theory and cryptography. However, the methods used to obtain these and other related results required advanced mathematics techniques such as p-adic analysis, the theorem of Stickelberger and Newton Polyhedra.

Moreno-Castro-Mattson gave an elementary proof of the Moreno-Moreno result for characteristic 2 that uses the covering method. In the present paper we estimate the divisibility of exponential sums, for arbitrary characteristic, using a generalization of the covering method. This new generalization allows us to give a completely elementary proof of Moreno-Moreno's result for any characteristic and improvements to Ax-Katz and Adolphson-Sperber's results over the prime field. We use integer linear programming to estimate the divisibility of system of polynomial equations. We show that this method has the advantage of being algorithmic and easy to program and, as a consequence, we prove that all binary primitive cyclic codes $\mathcal{C}_n$ with two zeros and minimum distance 5 are quasi-perfect for $n \leq 2^{12} - 1$.

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

Feature Selection in KDD (Rough set approach)

Frida Coaquira, Department of Mathematics, University of Puerto Rico at Mayagüez.

Rough sets theory is a method for KDD processing based on partition. Knowledge discovery is the nontrivial extraction of implicit, previously unknown and potentially useful information from data. Kdd process include many steps, from preprocessing to conclusion. Cleaning data is a preprocessing step that reduces the problem and offer better condition

to analysis. Feature extraction is a form to reduce the dimensionality of the problem. There are two principal reasons to reduce the dimensionality of the features in a Kdd task: cost minimization and classification accuracy. After feature selection the classifier will be faster according to new dimensionality, and elimination of the redundancy. Rough set approach is used to analyze the feature and keep only the principals feature. There are many procedures for feature subset generation (Complete, heuristic and random), Rough set theory offer us the accuracy according to class label like a feature evaluation function. The new subset of feature leads to new data base where realize the kdd task, these could be classification, regression or other analyzes.

Non-linear finite dynamical systems and its applications

Omar Colón–Reyes and Dorothy Bollman, Department of Mathematics, University of Puerto Rico at Mayagüez.

In this talk we will present necessary and sufficient conditions for a family of non-linear finite dynamical systems to be fixed point systems. Applications to Control Theory will be presented as well.

Algorithm to measure symmetry and positional entropy of n points

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

A method and algorithm is given to measure the symmetry (SYM= global symmetry) of n points. No other attempt to do this task is known at present, as all known present methods to describe symmetry break into different incomparable cases according to the kind of symmetry (mirror vs rotational and so on). The algorithm is based on counting the number of "elementary symmetric recognition acts,.°r having two distances $d(A, B)$ and $d(C, D)$ be equal within a given tolerance t. The same algorithm can be adapted to measure "un-normalized positional entropy deficit"(=UPED) and positional entropy of n points. These (SYM and UPED) quantities represent a "missing link.°r "holy grail"(of a minor sort) connecting symmetry with order/disorder with entropy, since for small occupation numbers ($1 \leq k \leq 4$) they come out almost the same. Here the occupation number k is the number of equal distances in the figure for a given value d. The algorithm can be added via software to imaging devices, such as computer graphs programs or cameras to solve problems of defect detection, say in gems, or object detection. It should contribute to improved symmetry applications similar to the introduction of interchangeable parts in manufacturing, since any figure has the same symmetry measure in any setting, and any two figures can be compared as to their symmetry. The program can be expanded to cover the case of similar figures through calculating ratios and cases of graph theory by working with a partial set of distances.

Typically symmetry is handled on a piece-meal basis, by working with translational or mirror or rotational symmetry through the location of symmetry axes or centers, which

must be calculated separately for each case. Mathematically, this procedure can lead to the complicated construction of various symmetry groups as outlined by Jablan (1995). Attempts to work with partial symmetry have led to even more complicated mathematical structures such as groupoids (cf. Weinstein and Johnson). An earlier attempt to measure symmetric order by the author, which agrees in simple cases with the present method, is covered in Collins, 2005, which gave the definition of "tropical"symmetric order as "number of equal distances from each object, added together. The first (reference) distance does not count . .. "It was found that working with reference distances could be avoided by counting number of pairs of equal distances, since one reference distance plus one equal distance counts as one pair of equal distances.

As stated in the article by Reid (2006) most imaging problems can be solved at present by "proper knowledge, hardware, software, and tweaking"(p.18). It remains to be seen whether the new approach described here changes the way symmetry is done or represents an alternate curiosity, much as the rotary (Wankel) engine.

Alexander (2002) counts the number of "local symmetries"(p.189); however this method appears to be infeasible (take exponential complexity) for large n since it involves considering all subsets, plus there is no indication of how to count local symmetries in more than one dimension.

The term "distance entropy."occurs with respect to the "distance transform"in the work by Kia; however the terms refer to different calculations from this algorithm, involving edge effects.

Imputation methods for microarray data

Sindy Díaz and Edgar Acuña, Department of Mathematical Sciences, University of Puerto Rico, Mayagüez.

A review of recent imputation methods for microarray data will be given. The effect of the imputation methods in three well known datasets will be shown.

A New Fast Finite Field Multiplier

Edgar Ferrer, PhD. CISE Program, University of Puerto Rico, Mayagüez,
Dorothy Bollman, Department of Mathematical Sciences, University of Puerto Rico, Mayagüez, and
Oscar Moreno, Department of Computer Science, University of Puerto Rico, Rio Piedras.

We present a method for implementing a fast multiplier for finite fields $GF(2^m)$ generated by irreducible trinomials of the form $\alpha^m + \alpha^n + 1$. We propose a design based on the Mastrovito multiplier which is described by a parallel/serial architecture that computes a multiplication in m clock cycles by using only bit-adders (XORs), bit-multipliers (ANDs), and shift registers. This approach exploits symmetries and subexpression sharing in Mastrovito matrices in order to reduce the number of operations, and hence computation time

in our FPGA implementation. According to preliminary performance results, our approach performs efficiently for large fields and has potential for a variety of applications, such as cryptography, coding theory, and the reverse engineering problem for genetic networks.

Acknowledgement: This research is supported by grant NIH-MBRS (SCORE) S06-GM08102

Further Results on Tournament Matrices

Edwin Flórez G and Xuerong Yong, Department of Mathematics, University of Puerto Rico at Mayagüez.

Tournament matrices have been considered by several authors during the past decades. In this work we extend to deal with the eigenvalues properties of r-tournament matrices. By modifying the techniques introduced by S. Kirkland (published in Linear Algebra Appl. Vol. 361, 2003), we first obtain a new bound of the Perron value for almost regular tournament matrices. We then explore the r-partite tournaments, which is based on the updated results given by Yi-Zheng Fan and Jiong-Sheng Li on 2-tournament matrices (published in SIAM Matrix Analysis Appl, Vol.24, No. 2). We show that the algebraic multiplicity of its zero eigenvalues and the number of distinct eigenvalues of these matrices have similar properties to the ones of 2-partites. We derive new results and also improve the previous ones.

Simulación de Monte Carlo para comparar estimadores de regresión en la estimación de totales y razones

Jairo Alberto Fúquene P., Departamento de Matemáticas, Universidad de Puerto Rico en Mayagüez.

Se presenta el concepto de estimador de regresión para la estimación de un total poblacional bajo el diseño M.A.S. y los modelos heterocedástico sin intercepto y homocedástico con intercepto dados por Särndal, Swensson & Wretman (1992). Además, se muestra un estimador de razón construido en este trabajo con dos estimadores de regresión por medio del método de linealización de Taylor. Finalmente, mediante simulación de Monte Carlo, se comparan las propiedades del estimador propuesto por Horvitz–Thompson, cinco estimadores de regresión para la estimación de un total y el estimador de razón.

Periodic Solutions of Integro-differential Equations in Vector-valued Function Spaces

Valentin Keyantuo, Department of Mathematics, University of Puerto Rico at Rio Piedras,
Carlos Lizama, Departamento de Matemática, Universidad de Santiago de Chile, and Verónica Poblete, Departamento de Matemática, Universidad de Santiago de Chile.

Operator-valued Fourier multipliers are used to study well-posedness of integro-differential equations in Banach spaces. Both strong and mild periodic solutions are considered. Strong

well-posedness corresponds to maximal regularity which has proved very efficient in the handling of nonlinear problems. We are concerned with a large array of vector-valued Lebesgue–Bochner spaces L^p. The results are applied to various classes of nonlinear integral and integro-differential equations.

Acknowledgement: The first author is supported in part by Convenio de Cooperación Internacional (CONICYT) Grant # 7060064 and the second author is partially financed by FONDECYT Grant #1050084.

A Population Model with Age Distribution for San German, Puerto Rico

Alvaro Lecompte Montes and Jorge Serrano Mojica, Department of Mathematics, Inter American University of Puerto Rico at San German .

Mathematical population models of a single specie with age distribution attempt to predict the distribution pattern with age of a population along time, by its own internal dynamic. A simple model based in the von Foerster equation with a logistic term can be accurate in many circumstances and it has the advantage of being simple enough to be susceptible of mathematical analysis. New offspring are calculated based in birth ratios from their parents. We followed this approach with the human population of San German, Puerto Rico, according to the census data since 1950. The data suggest that migration has been the main factor in population change for this small city in last decades, with young adults leaving from and middle aged coming into. As migration can be accepted as caused by excess or defect of population in relation to the capacity of the location, the logistic form could approximately explain the observed pattern for rates of growth after the statistical calculation of the parameters. The population distribution of near future could then be obtained by integration in steps of the logistic equation. The pattern of an aged population emerges for the next decades. The model can be readily adapted to similar populations.

Computación Cuántica

Javier Luque, Departamento de Matemáticas, Universidad de Puerto Rico en Rio Piedras.

La teoría de la computación cuántica es uno de los más importantes desarrollos recientes (Feynman, R. P. "Simulating Physics with Computers"Intl. J. Theo. Phys. 21 (1982), 467-488, Deutsch, D. "Quantum Computation and Quantum Information"Proc. Roy. Soc. Lond. A400 (1985), 97-117).

Mientras un bit clásico solo admite dos estados 0 y 1, un bit cuántico, un qbit, puede existir en una superposición de varios estados, representando simultáneamente todos ellos. Operaciones con qbits se aplicarían simultáneamente a los múltiples estados que representan, obteniéndose un paralelismo inalcanzable clásicamente.

Problemas intratables clásicamente no lo son para los conjeturados ordenadores cuánticos. Un importante problema, teórico y práctico, para el que no se conocen algoritmos eficientes

es la factorización de enteros. En su dificultad se basan los sistemas criptográficos más usados. Clásicamente, se sospecha que no es NP-completo, por lo que se piensa que es P. Sin embargo, en 1994 Peter W. Shor descubrió un algoritmo para computadoras cuánticas que es polinomial en tiempo (Algorithms for quantum computation: Discrete logarithms and factoring, Proc. 35nd Annual Symposium on Foundations of Computer Science (Shafi Goldwasser, ed.), IEEE Computer Society Press (1994) 124-134).

Se presentarán los principios y resultados básicos, y las potencialidades de la Computación Cuántica, un campo en el que en los últimos años, ha habido un gran incremento de actividad, tanto académica como industrial.

Estudio del péndulo Simple, una experiencia de aprendizaje

Carlos Malagón, Universidad Interamericana, Recinto de Ponce.

La presentación se basará en el estudio del péndulo simple, en la relación entre la longitud y el periodo. Al modelar la relación entre estas variables (longitud y periodo) y comparar con la ecuación teórica se mostró a los estudiantes una manera dinámica y didáctica de hallar experimentalmente la aceleración de gravedad. En esta actividad educativa se utilizaron foto censores, la interfase y la computadora lo que permitió recoger los datos de una manera automatizada dentro del laboratorio del curso de física general. Se explicará como se analizaron los datos y las gráficas a través de la hoja electrónica EXCEL.

Student geometric ideas on functions of two variables

Rafael Martínez Planell, Department of Mathematics, University of Puerto Rico at Mayagüez and,
María Trigueros Gaisman, ITAM, México.

The notion of a multivariable function is of fundamental importance in mathematics and its applications. However there are not many research studies probing student understanding of this notion. While there are many studies that deal with the general idea of a function, few make use of the particularities of multivariable functions to explicitly study how students build their understanding about them. This lack of research findings in turn limits understanding of student learning of the main ideas of the multivariable calculus. It must be acknowledged that there are many published articles that focus on the implementation of new classroom material for the teaching of different aspects of multivariable calculus. However, these are not theory-based research studies and while many of the materials developed seem to be of the highest quality, the best one can do without a solid theoretical underpinning is hope that they do a better job in aiding student understanding than traditional materials. This is a report of a study that uses APOS theory as theoretical framework to study how students learn about functions of two variables. The study does not include the use of any particular technological tool or any graphing utility to work on new teaching materials.

A very brief introduction to the basics of APOS theory will be presented. It will be followed by a particular genetic decomposition for functions of two variables. This is a conjecture

of how students go about building their knowledge of two-variable functions, together with a description of the main elements needed to successfully guide the students to a full understanding of the concept. A written instrument was designed to enable us to test the different components of the genetic decomposition. A small group of students was chosen and interviewed using the written instrument as a basis. The results were used to improve the instrument and the revised instrument was then applied to a larger group of students who were also interviewed. The interviews were transcribed and analyzed independently by the two researchers, and conclusions were then negotiated between them. Results from the written instrument and follow up student interviews will be discussed, particularly as they relate to the proposed genetic decomposition. The end product will be a new genetic decomposition that more accurately describes how students may construct their knowledge of functions of two variables, and will also be presented. This decomposition may then be used to guide successful pedagogical interventions, and new research studies.

Una Caracterización de Triángulos de Heron Especiales

Ramón L. Matos Berríos, Departamento de Ciencias Naturales, Universidad de Puerto Rico en Carolina.

Estudio de los triples de enteros consecutivos que generan triángulos de Heron. Se determinan los triples consecutivos que satisfacen la condición anterior. Además, existen relaciones entre el perímetro y el área de los triángulos mencionados, así como también para el perímetro y el área en la sucesión de los triángulos de Heron inducidos por los tríos de números naturales consecutivos y sus múltiplos. Se establecen relaciones lineales recursivas y fórmulas explícitas. Es una investigación motivada por otros trabajos relacionados con los triángulos pitagóricos generados por tríos pitagóricos consecutivos.

Uso de herramientas tales como mathml y svg para crear objetos de aprendizaje en el web

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Se presentarán distintas actividades creadas con estas herramientas donde el estudiante puede afinar sus destrezas en las distintas áreas. El uso de estas herramientas permite generar expresiones y gráficas que contengan símbolos matemáticos no disponibles en el ASCII code y además generar bancos de ejercicios con un simple código generador.

Bifurcation in Three Dimensional Elasticity and Violations of the Complementing Condition

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

In this presentation we will discuss a relationship we have noticed between violations of the complementing condition and bifurcation in the context of elasticity. 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 conditions. When the CC holds the linear boundary value problem has many important functional analytic properties that simplifies its study. However, we have observed that in several nonlinear boundary value problems from three dimensional elasticity violations of the complementing condition of their corresponding linearization along a known trivial solution is associated to the existence of infinite sequences of bifurcation points that accumulates precisely at points where the CC fails. This is actually consistent with previous physical interpretations of violation of the CC as associated with oscillatory instabilities at the boundary, but it may also suggests a limitation in the theory of elasticity based on first order gradients to model such phenomena. We will briefly present some of our results and also open problems on which we are presently working.

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Técnica de Desarrollo de Sistemas de Objetos (TDSO)

Flor Narciso e Isabel Besembel, Universidad de los Andes, Facultad de Ingeniería, Escuela de Ingeniería de Sistemas, Departamento de Computación, Mérida 5101, Venezuela, Department of Mathematics, University of Puerto Rico at Humacao.

La Técnica de Desarrollo de Sistemas de Objetos (TDSO) permite la especificación y documentación de clases de objetos, constituyendo una herramienta apropiada para el diseño de software orientado por objetos. Est´a basada en el método deductivo (MEDEE) utilizado para analizar, especificar, documentar, diseñar y probar sistemas programados, y en la metodología de modelado de objetos OMT (Objectoriented modeling technique), que describe todo el proceso de modelado de clases de objetos. Del primero contiene todas las fases. De la segunda se toman algunos diagramas que fueron adaptados para TDSO y que soportan todos los constructos de la orientación por objetos. TDSO incluye una guía para el desarrollo de las pruebas de los métodos y operaciones de una clase, utilizando el paradigma de la programación orientada por objetos.

Mediante representaciones tabulares, TDSO permite definir el universo de clases y tipos de datos abstractos (TDAs); definir cada clase en términos de sus atributos, la especificación sintáctica y semántica de sus métodos y las declaraciones de las instancias de la clase, TDAs, atributos y/o variables que serán utilizadas en el escenario de pruebas de la especificación

semántica. Además, TDSO permite especificar formalmente los métodos de una clase.

The Random Homotopy Method for Signal Tracking and Global Positioning Systems (GPS)

Pablo V. Negrón–Marrero, Department of Mathematics, University of Puerto Rico at Humacao.

Global positioning systems have become very popular in the last few years. They are used nowadays for travelling, exploration, navigation, etc.. The 24 satellite system on which GPS systems are based was originally developed for military purposes during the 1980's. A GPS system works as follows: the person interested in determining its location on the earth employs a *receiver* that reads or gets information from the satellite system. The satellites constantly send information on their current times and positions. With this information the receiver can compute the distances to the satellites. On an ideal situation, the receiver can determine its position over the surface of the earth from the information of three satellites, by computing a point on the intersection of three spheres whose radii can be determined from the information received from the satellites and the traveling speed of the signal. However, signal degradation due to atmospheric considerations, differences in the satellite's onboard clocks, and other physical factors, makes it necessary to process the information of at least four satellites.

On a global positioning system, the satellites play a passive rol in the sense that they send information on their current times and position, and is up to the receiver to compute its position. On the other hand in a tracking situation, the "satellites" now assume the rol of receivers or sensors, and only register the times when the signal from the unknown source is received or detected by them. This could be the situation, for example, if one is interested in the location where a shot was fired, or to determine the location of a cellular telephone call. With the times recorded by the sensors, and using the relative time differences among them, one can find the location of the signal.

In this paper we discuss the mathematics of a three dimensional GPS system and that of a two dimensional tracking system. Both problems lead to the consideration of polynomial systems of equations. Thus we give an overview of the theory and practical issues behind one of the most effective methods for solving polynomial systems: the random homotopy method.

Both GPS and tracking system problems are of an inter disciplinary nature. For there successful solution, a good understanding of physics, engineering, and mathematics is required. We discuss some of the physics behind each problem, but emphasize on the mathematics (analytic geometry, algebraic curves) and numerics (homotopy methods) needed to tackle each of them. Thus the material in this paper could be used to motivate further discussions or projects in an applied mathematics course.

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On Baire property of sets from the Descriptive Set-Theory viewpoint

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In Descriptive Set-Theory, Baire property of subsets of a topological space is a property like Borel, dense, nowhere dense, and dense in itself... properties. In this talk, after giving its definition, I try to characterize the Baire property and some of its direct applications, from the Descriptive Set-Theory viewpoint, by using the concept of ideal (in its Set-Theoretic sense). Through the process, some interesting concepts and theorems are expressed.

Torsión de Reidemeister en el Complejo de Khovanov

Juan Ariel Ortiz–Navarro, Department of Mathematics, University of Iowa.

La construcción de la torsión de Reidemeister se puede aplicar al complejo utilizado para computar la homología de Khovanov para nudos o enlaces. Al hacer esto se define una forma de volumen en la homología de Khovanov. Esta forma de volumen se transforma correctamente bajo las movidas de Reidemeister y genera un volumen invariante en la Homología de Khovanov. En este trabajo se utiliza esto para estudiar invariantes de nudos. En esta presentación mostraremos la invariante y la calcularemos para algunos ejemplos.

La Codiferencial de la Forma de Kähler sobre una Variedad Bandera Maximal

Marlio Paredes, Escuela de Ciencias y Tecnología, Universidad del Turabo, PR.

En este trabajo presentamos una fórmula para calcular la codiferencial de la forma de Kähler sobre una variedad bandera maximal

$$\mathbb{F}(n) = \frac{U(n)}{U(1) \times \cdots \times U(1)}.$$

El interés por conocer esta fórmula es el de usarla para estudiar métricas cosimplécticas sobre las variedades bandera maximales, puesto que la condición para que una métrica sea cosimpléctica es que la codiferencial de la forma de Kähler sea nula. El resultado aquí presentado hace parte de un reciente artículo del propio autor.

Objective Bayesian Analysis of Hardy-Weinberg Equillibrium

María-Eglée Pérez and Luis Raúl Pericchi, Department of Mathematics, University of Puerto Rico at Rio Piedras.

There is a growing consensus about the need of developing Bayesian methods for hypothesis testing. This is specially true for the analysis of large datasets, where most frequentist methods reject any null hypothesis just because the size of the data.

Even though assessment of Hardy-Weinberg equillibrium is one of the basic problems in population genetics, it is far for being closed from the statistical point of view, as recent efforts in this direction prove. This is a specially challenging problem for the Bayesian hypothesis testing methods, as a precise null hypothesis has to be tested.

In this work, we propose an objective Bayesian approach based on a recent refinement of the BIC (Bayesian Information Criterion), the "Generalized Bayesian Information Criterion"(GBIC) (Berger et al, 2006), using Lindley's parametrization and a null orthogonal reparametrization (Kass and Vaidyanathan 1992). Results obtained are compared to those obtained using frequentist methods and ranges of proper prior distributions.

Sistemas dinámicos finitos booleanos y operaciones de puente

Luis O. Perez y Omar Colón–Reyes, Departamento de Matemáticas, Universidad de Puerto Rico en Mayagüez.

Definiremos la noción de puentes entre dos grafos dirigidos. El grafo que se origina, X_f, define un sistema dinámico $f : \mathbb{Z}_2^n \to \mathbb{Z}_2^n$, no-lineal, sobre el cuerpo con dos elementos $\mathbb{Z}_2$. Usaremos un invariante llamado el "Loop Number"que aplicado a X_f nos ayuda a proveer condiciones necesarias y suficientes para que f sea un sistema de punto fijo.

Large Modern Designs and Monitoring of Randomized Clinical Trials by Bayesians Methods

Luis Raúl Pericchi Guerra, University of Puerto Rico at Rio Piedras and Universidad Simón Bolívar, and
David Torres Núñez, University of Puerto Rico at Rio Piedras.

The Bayesian approach to the design and monitoring of randomized controlled trials has been the focus of attention in recent years, by scientists medical personnel and regulatory agencies. There are several articles that argue each of the philosophical aspects that solve a variety of problems on the health care evaluation and clinical trials. Here we review some of the designs and monitoring of randomized clinical trials aspects and discuss the advantage of the Bayesian over frequentist approaches.

Construcción de conceptos de Geometría Analítica utilizando Cabrí II

Orlando Planchart Márquez, Universidad Interamericana Recinto de Ponce.

En la enseñanza de la matemática ha ganado terreno la construcción de los conceptos con medios visuales y programas interactivos, especialmente con las computadoras y calculadoras. Esto permite que los estudiantes, junto al profesor, participen de clases dinámicas y constructivista. Por tal motivo, la conferencia tiene como objetivos: a) presentar la construcción de las figuras básicas de geometría analítica (parábolas, elipses e hipérbolas) a

partir de la idea de lo que representa el lugar geométrico, b) analizar el contexto teórico en que se inscriben estas estrategias de enseñanza y c) presentar diferentes representaciones que ofrece el programa Cabrí II.

El conocimiento matemático que se necesita para la enseñanza

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

El conocimiento matemático de los maestros se concentra en reglas y algoritmos. Basado en esta situación se promueven talleres y seminarios que apoyan el desarrollo conceptual de la matemática en los maestros. Ahora bien, al promover el desarrollo conceptual, se enfatizan principios del aprendizaje en general, sin tomar en cuenta los principios que surgen del desarrollo de los conceptos matemáticos. Este estudio explora los resultados de un taller que enfatiza los principios del aprendizaje en general, para analizar sus fortalezas y debilidades.

Los resultados del estudio muestran que los principios generales del aprendizaje son importantes pero no suficientes. Es necesario también tomar en cuenta los principios que surgen de la materia bajo estudio, en este caso la matemática. Se proponen los principios de la Matemática Realista para atender este aspecto.

Fuzzy Information Space Based Voice Processing

Wladimir Rodríguez, Departamento de Computación, Facultad de Ingeniería, Universidad de Los Andes Mérida, Venezuela.

A new approach for analyzing the similarity of dynamical systems is presented with applications to the analysis of voice. This approach is based on a fuzzy information space representation of the trajectories of the voice signal. The similarity between the segments of voice signal is determined based on similarity measures of the corresponding fuzzy information space representation. We present an application of the method to vowels recognition in the samples (amplitude-time) space.

On a curvature related problem and Colombeau's algebras

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

A surface S given by $z = u(x, y)$, where u is a sufficiently smooth function, possesses an induced Riemannian metric structure, $ds^2 = dx^2 + dy^2 + du^2$. If its curvature is everywhere zero then S has the following property: for each of its points there exists a neighborhood which can be isometrically flattened.

On the other hand there are nonsmooth surfaces with the latter property. The simplest among them are given by certain continuous and piecewise linear functions. To be able to determine for them ds^2 and next the curvature, we employ Colombeau's algebras of generalized functions. And so a piecewise smooth function $u(x, y)$ is identified with the

corresponding generalized function and the operations of differentiation and multiplication are performed according to the rules of Colombeau's algebras. Consequently, the components of the metric and curvature are generalized Colombeau's functions.

However, in general the curvature components of such a surface S do not vanish. That fact can be explained in terms of the association relation (equivalence relation) in Colombeau's algebras: there are many metric structures on S which are equivalent to $ds^2 = dx^2 + dy^2 + du^2$, however there is one among them, not necessarily $ds^2 = dx^2 + dy^2 + du^2$, for which the curvature is zero, where by the curvature we mean now an appropriate curvature density.

We consider the following problem. Given a continuous and piecewise-linear function $u\,(x, y)$, its graph S and a class of metrics associated with $ds^2 = dx^2 + dy^2 + du^2$, determine a necessary and sufficient conditions under which the curvature of a metric is zero.

It turns out that necessity of those conditions requires linear independence of certain systems of generalized Colombeau's functions, which are products of distributions involved in the process. We prove linear independence of those systems in case of one out of three important variants of Colombeau's algebras and present the zero curvature conditions.

Dickson permutation polynomials that decompose in cycles of the same length

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Let F_q, be the finite field with q elements, $a \in F_q$. The *Dickson polynomial* $D_i(x, a)$ *of degree* i is defined by $D_i(x,a) = \sum_{j=0}^{\lfloor \frac{i}{2} \rfloor} \frac{i}{i-j}\binom{i-j}{j}(-a)^j x^{i-2j}$, where $\lfloor\rfloor$ is the greatest integer function. It is well known that, for $a \neq 0$, $D_i(x, a)$ permutes F_q if and only if $gcd(i, q^2 - 1) = 1$. For $a = 0$, $D_i(x, 0) = x^i$ permutes F_q if and only if $gcd(i, q - 1) = 1$.

In this work, for certain families of Dickson permutation polynomials, we present the necessary and sufficient conditions on the degree of the polynomial in order to obtain a permutation that decomposes in cycles of the same length.

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Ternas Consecutivas en Residuos o no Residuos Cuadráticos y sus aplicaciones a sistemas dinámicos discretos

Leonid Brehsner Sepúlveda Avendaño y Omar Colón–Reyes, Departamento de Matemáticas, Universidad de Puerto Rico en Mayagüez.

Presentaremos el conteo de N ternas consecutivas en residuos o no residuos cuadráticos para primos de la forma $p \equiv 3 \bmod 4$. Para primos de la forma $p \equiv 1 \bmod 4$, demostramos que el número hallado es $N \bmod p$. Dicho conteo nos permite descubrir , entre otras cosas, la distribución de residuos cuadráticos sobre ciertos cuerpos finitos. Usaremos esta distribución junto con la teoría de polinomios de permutación para proveer condiciones necesarias y suficientes para que un sistemas dinámico discreto no sea de punto fijo.

The Numerical Computation of the Critical Load for Radial Cavitation

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Pablo V. Negrón–Marrero, Department of Mathematics, University of Puerto Rico at Humacao.

The phenomena of void formation on bodies in tension have been observed among others by Gent and Lindley (1958) in laboratory experiments. (See also Gent (1990) for a review on cavitation in rubber.) Ball (1982) showed in the context of nonlinear elasticity, that void formation or "cavitationçan decreased the (potential) energy of a body in tension when the tension is sufficiently large. In fact for a spherical body composed of isotropic material, when the tension is sufficiently large, the purely radial deformation that opens a hole at the center of the ball, is a global minimizer among such deformations. We refer to Horgan and Polignone (1995) for a nice account of cavitation in nonlinear elasticity.

A very important problem here is that of characterizing or computing the critical tension at which cavitation occurs. As cavitation can point the initiation of fracture or rupture on a body, the computation of such critical tension is a very important one from the structural design point of view. This problem has been studied extensively in the past but we mention here the works of Hill (1957), Beatty (1967), Stuart (1993), and Polignone and Horgan (1993). In this paper we describe a numerical scheme for computing the critical load for cavitation. We give examples for specific materials and compare our numerical computations with some previous analytical results.

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Acoplamiento de modelos de fluidos y acústicos en la simulación de un oscilador de fluidos

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Rogerio Furlan, Departamento de Física y Electrónica, Universidad de Puerto Rico en Humacao, y
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Herramientas computacionales basadas en Métodos de Elementos Finitos han sido aplicadas al estudio de un oscilador miniaturizado de fluidos sin piezas movibles. El aparato bajo estudio está compuesto por una cámara de intercambio, un canal de insumo y dos de salida. Desde hace décadas se conoce que en un un aparato en forma de "V"en el cual el insumo se coloca en la unión inferior el movimiento de fluido tiende a pegarse a una de las paredes laterales, el llamado efecto de Coanda. Canales de retroalimentación colocados en posiciones apropiadas en cada brazo de la "V"desvían parte del flujo de vuelta a la unión, interrumpiendo el efecto de Coanda con el efecto de desviar el flujo hacia el lado contrario del aparato. Allí se repite el proceso análogo, creando así el efecto oscilatorio. Previamente los autores de este trabajo han publicado resultados de simulaciones computadorizadas de este fenómeno basadas en ecuaciones convencionales de tipo Navier–Stokes resueltas numéricamente mediante Métodos de Elementos Finitos que han ayudado a develar detalles sobre cómo opera el fenómeno de Coanda. Un resultado de validación de este estudio fue la corroboración de un modelo $T/2 = \xi L/u$ que relaciona el tiempo de oscilación (T), la distancia entre el retro alimentador y el insumo (L), la velocidad de insumo (u) y una constante experimental ξ. Sin embargo, estos estudios presentan la limitación de que sólo son aplicables a la descripción de flujo de líquidos. Cuando un gas fluye por el aparato hay que considerar un término adicional l/c en el que se influyen el largo del canal de retroalimentación (l) y la velocidad del sonido (c). A la simulación inicial se ha acoplado un modelo de acústica para tomar en cuenta este efecto. La simulación resultante permite predecir configuraciones del aparato con características oscilatorias deseadas para aplicaciones particulares. Experimentos con aparatos de laboratorio sirven de validación del modelo.

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Theory of Cosserat Plates. Part I. Mathematical Model with Variation Micro-rotations in the Thickness Direction

Lev Steinberg and Pedro Madrid, Department of Mathematics, University of Puerto Rico at Mayagüez.

In this talk we shall discuss the bending- twisting problem of elastic plates. The classic bending of elastic plates is well known and described by bi-harmonic differential equations. A system of equations, which takes into account the transverse shear deformation, has been developed by E. Reissner (1944). One of main advantages of Reissner's model is that it is

able to determine the reactions along the edges of a simply supported rectangular plate, where classical theory leads to a concentrated reaction at the corners of the plate. In order to describe deformation of elastic plates that posses grains, particles, fibers, and cellular structures A. C. Eringen (1967) proposed a theory of plates in framework of Cosserat (micropolar) Elasticity Theory. His theory assumes also the variation of micro-rotation in the middle plane. In the case of no micro-rotations the Eringen's theory of plates produces the classic bending problem. In this talk we shall represent a new model of Cosserat plates based on the Reissner's approach.

Theory of Cosserat Plates. Part II. Effect of the Variation Micro-rotations in Bending Problem

Lev Steinberg and Pedro Madrid, Department of Mathematics, University of Puerto Rico at Mayagüez.

In this talk we shall discuss the effect of the Variation Micro-rotations in Bending Problem of elastic plates. We shall discuss our mathematical model of Cosserat plates, which includes the constitutive equations and the equilibrium equations of the plate. The system of the model consists of nine partial differential equations of nine functions, which describes the bending (subsystem of 6 equations) and the twisting (subsystem of 3 equations). In order to illustrate the influence microstructure we considered built-in bending of a rectangular Cosserat plate. The represented numerical examples, which employed the finite difference method, will illustrate the influence microstructure on the bending of a simple rectangular Cosserat plate.

La tecnología, los estilos de aprendizaje y la enseñanza de la matemática

Evelyn Torres–Gallardo, Departamento de Matemáticas, Universidad de Puerto Rico en Humacao.

Un gran número de la población de estudiantes que asiste a nuestras universidades han estado expuestos a diversos elementos de la tecnología. Como parte de las actividades del proyecto "Mathematical Teaching and Learning Support Center", en la UPR– Humacao, hemos diseñado actividades para enseñar el Precálculo utilizando diversos elementos tecnológicos, y atendiendo distintos estilos de aprendizaje. Este proyecto está auspiciado por el "Minority Science and Engineering Improvement Program"(MSEIP) del Departamento de Educación de los Estados Unidos.

An Application of Continuous Wavelet Transform to Solve the Kuramoto-Sivashinsky Equation

Alexander Urintsev and Gloria Ruiz Valle, Department of Mathematics, University of Puerto Rico at Mayagüez.

We use a continuous wavelet built as first derivative of the Gaussian function and the computer algebra system Mathematica to convert the nonlinear Kuramoto-Sivashinsky equation in one-dimensional case to an integro-differential equation for the transformant. Then we formulate a Cauchy problem for this equation that is to be solved by the Galerkin method. The basis functions used for the Galerkin expansion are based on classical orthogonal polynomials introduced by Hermite and Laguerre. In order to calculate the coefficients of this expansion, we propose to solve the system of ordinary differential equations numerically by means of the procedure of integration available in Mathematica system. The results are presented in the form of graphs and tables.

La Estructura Algebraica Del Espacio De Señales

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En este trabajo describimos la estructura matemática del espacio de señales usado en el procesamiento de señales. Mostramos como este espacio admite estructura de álgebra y se presentan varios de los operadores que actúan sobre este espacio que son usados en el procesamiento de señales. Particularmente se muestra que las matrices de todos estos operadores son matrices circulantes.

REU (Research Experience for Undergraduates) in Statistics at Miami University

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In this paper I will describe the working of this REU named the Summer Undergraduate Mathematical Sciences Research Institute or SUMSRI that I have directed for the last eight summers at Miami University. SUMSRI is funded by the National Security Agency (NSA) and the National Science Foundation (NSF). I will also discuss the nature and content of the research papers written by the undergraduates at this REU under my supervision. Some of these papers have won awards in the student paper competition sponsored by the American Statistical Association (ASA).

Regularity in Capacity and the Dirichlet Laplacian

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Given an open set Ω in $\mathbb{R}^N$, we prove that every function u in $H_0^1(\Omega) \cap C(\overline{\Omega})$ is zero everywhere on the boundary $\partial\Omega$ if and only if Ω is regular in capacity. If in addition Ω is bounded, then it is regular in capacity if and only if the mapping $\varphi \mapsto u(\varphi, \Omega)$ from $C(\partial\Omega)$ into $\mathcal{H}(\Omega)$ is injective, where $u(\varphi, \Omega)$ denotes the Perron solution of the Dirichlet problem. Let $\mathcal{R}$ be the set of all open subsets of $\mathbb{R}^N$ which are regular in capacity. Then one can define metrics d_l and d_g on $\mathcal{R}$ only involving the resolvent of the Dirichlet Laplacian. Convergence in those metrics will be defined to be the local/global uniform convergence of the resolvent of the Dirichlet Laplacian applied to the constant function 1. We prove that the spaces $(\mathcal{R}, d_g)$ and $(\mathcal{R}, d_l)$ are complete and contain the set $\mathcal{W}$ of all open sets which are regular in the sense of Wiener (or Dirichlet regular) as a closed subset.

Is there a difference in student performance based on medium of instruction or learning resources?

White, S.B. and White, J.A., Saint Leo University, FL.

This study examined final exam scores of distance-education students who utilized supplemental learning resources and those who did not, as well as final exam grades of students in distance education and traditional students enrolled in a finite mathematics class, to determine if distance education is better, worse, or as good as traditional classroom instruction and to determine if supplemental learning resources are improving distance education. Significant differences were found in student performance between students who utilize MyMathLab® as a learning tool in Finite Mathematics and those who do not take advantage of MyMathLab® through Course Compass. There was no significant difference in final exam scores for students in distance education as compared to traditional instruction.

5. Afiches (*Posters*)

Permutations that decompose in cycles of length 2 and are given by monomials

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Advisor: Ivelisse Rubio, University of Puerto Rico at Humacao.

In this work we study permutations of finite fields F_q given by monomials ax^i. In particular, we give the necessary and sufficient conditions in the coefficient a and the exponent i to obtain permutations of F_q that decompose into cycles of length 2. We prove that $i = q - 2$ is the only exponent such that ax^i decompose in cycles of length 2 for all $a \neq 0$. We also

prove that $i = (q-3)/2$ is the only exponent such that ax^i decompose in cycles of length 2 for all $a = \alpha^{2k}$, where α is a primitive root and k an integer.

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Permutations of F_q that are given by binomials and decompose in cycles of length two

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We study binomials that give permutations of F_q. In particular, we study the necessary and sufficient conditions to obtain permutations that decompose in cycles of length two. These types of permutations are useful for applications to coding theory and cryptography. We present some binomials that are never permutations and permutation binomials that never decompose in cycles of length two. Furthermore we found the necessary conditions for certain permutation binomials to decompose in cycles of length two.

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Permutations of $\mathbb{Z}_{p^r}$ as interleavers for turbo codes

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Interleavers for error correcting codes are permutations of $\mathbb{Z}_n$. Permutations of $\mathbb{Z}_{p^r}$ constructed from permutations of finite fields F_{p^r} using monomials x^i and the performance of Turbo Codes using them as interleavers have been studied in Corrada and Rubio (2004) and Luis and Pérez (2005). We construct permutations of $\mathbb{Z}_{p^r}$ from permutations of finite fields F_{p^r} that decompose in cycles of length 2 using monomials cx^i. We present results on the dispersion and spreading of these permutations and the performance of Turbo Codes that use them as interleavers.

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The brachistochrone problem on a vertical plane and over surfaces

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The classical Brachistochrone Problem consists of the following: given two points A and B on a vertical plane, find the shape of the curve along which a particle, under the influence of gravity, can slide from A to B in minimum time. This problem was first posed by Johann Bernoulli in 1696 and solved that same year by Newton, Leibniz, the Bernoulli brothers, and L'Hopital. They found that the solution to this problem is given by a curve called a çycloid". For the classical problem we developed a graphical interface in MATLAB where the user can experiment with different types of curves, such as the straight line, parabolic type, exponential type, and a cycloid. The user can also see an actual animation of the particle sliding through the selected curve and the time that it took for it to reach the end point B. We also developed some routines in MATLAB that directly minimize the discretized time integral using the method of steepest descent. These routines compute numerically the curve of minimum descent.

We also studied the Brachistochrone Problem over Surfaces, which consists of finding the curve traced by a particle that slides from point A to point B on a given frictionless surface and under the influence of gravity, in the shortest time. For this problem we also developed some routines in MATLAB that directly minimize the discretized time integral. These routines compute numerically the curve of minimum descent over a given surface. As an example, we construct curves of minimum descent when the surface is given by an inclined plane, for different angles of inclination. We then joined together these curves to construct an envelope or surface of minimum curves.

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Caracterización de Patrones Espaciales en Microfotografías de Epidermis de Hojas

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

Se analizaron imágenes microscópicas de hojas obtenidas del bosque seco de la Isla de Mona. Las imágenes muestran una gran variedad de texturas, patrones espaciales, estructuras celulares y configuración de estomas. El principal objetivo de esta investigación es caracterizar matemáticamente los patrones observados en las imágenes y determinar algunas características que puedan ser utilizadas para su clasificación. Para este propósito, se calculó la lacunaridad (cantidad de espacios vacíos) a diferentes escalas de píxeles para un grupo de imágenes de especies de hojas conocidas. Ademas, se utilizó el método de la matriz de co-ocurrencia del nivel de gris (GLCM) para analizar la distribución espacial y

las texturas observadas. De este metodo se calcularon algunas características tales como: el segundo momento angular (ASM), el contraste, la correlación, el momento de diferencia inverso (ISM), y la entropía. Resultados preliminares indican que el contraste y el momento de diferencia inverso proveen un buen discriminante en las texturas observadas.

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Sistema de simulación por dinámica molecular de interacciones entre nanotubos de carbono de pared sencilla y diferentes polímeros

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La simulación de dinámica molecular es una técnica basada en leyes de la física que permite usar la computadora para estudiar materiales a nivel atómico. En este proyecto hemos construido herramientas computacionales basadas en esta técnica para estudiar la interacción entre nanotubos de carbono (NTC) de pared sencilla y polímetros de distinto tipo. Los nanotubos son placas cilíndricas de carbono que pueden tener un diámetro de 1 nm y un largo de hasta varios centímetros. Son únicos por su tamaño y sus propiedades. Los nanotubos tienen propiedades eléctricas y estructurales que varían dependiendo del diámetro, largo y su quiralidad. También los nanotubos poseen propiedades interesantes como alta fuerza mecánica (pueden ser 60 veces más tensos que el acero) y estabilidad electrónica (pueden acomodar densidades corrientes 1000 veces más arriba que el cobre y la plata). El foco de la investigación científica se concentra en como propiciar la formación de sus distintas variedades ya que se ha descubierto, entre otras propiedades, que su capacidad para conducir electricidad varia dependiendo de la conformación de sus átomos. Otro factor que afecta esa variabilidad es la presencia de otros compuestos químicos. Esa cualidad les hace aptos para la construcción de sensores. Existe evidencia experimental de que, por ejemplo, los híbridos de NTCs a los cuales se les ha adherido ciertas secuencias de ADN de hebra sencilla sirven como sensores de algunos gases, entre ellos gases peligrosos. Combinaciones de NTC con otros polímetros también han mostrado ser útiles para estos propósitos.

El estudio de las interacciones entre los NTCs y polímetros es importante para entender estos fenómenos. La imposibilidad de la manipulación precisa de estos materiales a nivel atómico con las herramientas disponibles en la actualidad hace la simulación por computadora un recurso central en este estudio. Para este interfaz se utilizaron el lenguaje de programación Pyhton. La herramienta computacional presentada aquí provee un interfaz gráfico, fácil de usar, que agiliza la utilización de programado complejo. Este provee, además, un acopio de los parámetros físicos apropiados para este tipo de simulación y funciones de distribución mas apropiadas para este estudio que las que se encuentran en programados de dinámica molecular de uso general.

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Enseñanza Interdisciplinaria en la Practica: La Experiencia de MeCoBi en la UPR–Humacao

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La investigación y la enseñanza interdisciplinaria es una tendencia moderna en las ciencias y las matemáticas aplicadas. En la ultima década hemos visto el desarrollo de areas tales como la ecología computacional en donde se plantean problemas matemáticos y computacionales aplicados a problemas ecológicos. Es por esta razón que el estudiante subgraduado de ciencias naturales que aspire a insertarse en esta tendencia necesita aprender herramientas matemáticas y computacionales para estudiar estos y otros fenómenos complejos. Además, el estudiante subgraduado de matemáticas y computación necesita aprender las herramientas conceptuales para reconocer la complejidad del mundo natural. Presentamos nuestras experiencias en en el desarrollo y enseñanza de un curso subgraduado que integra conceptos ecológicos con técnicas de modelado computacional y matemático. Nuestro enfoque esta basado en la estrategia de co-enseñanza en donde un profesor con formación en ecología (D.F.) y un profesor con formación en matemáticas y computación (E.R) comparten el mismo salon de clases. El mismo se ha estado enseñando de forma experimental en la Universidad de Puerto Rico en Humacao desde el 2002 y ha contado con la participación de estudiantes subgraduados de matemáticas, biología, y química. Desde su primer ofrecimiento el tema central del curso ha sido el de biología de poblaciones, sin embargo, en las ultimas ocasiones se han realizado algunas actualizaciones tales como la inclusion del modelado poblacional a escala espacial asi como de comunidades.

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Índice alfabético