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1 Itinerario global (global itinerary)

AE es el Edificio de Administración de Empresas
El Mezzanine es en el complejo de las canchas de tenis.

Viernes 27 de febrero de 2015		
Hora	Pasillo	AE242
5:00-6:00		Registro en el vestíbulo
5:00-7:00	Mesas	
6:00-6:55		Panel ex-olímpicos
7:00-8:00		M. Falk de Losada
8:15-10:00	Actividad de confraternización en el Mezzanine	

Sábado 28 de febrero de 2015						
Hora	Pasillo	AE 242	AE 233	AE 234	AE 235	AE 236
7:30-8:00	Registro y Desayuno en el Vestíbulo					
8:00-8:30		Bienvenida				
8:30-9:30		F. Morgan				
9:30-11:30	Mesas		Sesiones concurrentes			
9:30-9:55			E. Lozano	M. Cruz	P. Cholak	P. Torres
10:00-10:25			F. Narciso	D. Pérez	P. Albin	A. Calvo
10:30-10:55			E. Orozco	M. Zepeda	G. Castellini	S. Huanca
11:00-11:25			A. Bustillo	R. Kvasov	X. Martínez	J. Vega
11:30-12:25	Almuerzo en el Mezzanine					
12:30-1:30		A. Aceves				
1:30-2:55	Mesas		Sesiones concurrentes			
1:30-1:55			O. Medina	P. Negrón	M. Delgado	W. Rolke
2:00-2:25			J. Rivera	J. Cajigas	C. Serna	Y. Humaran
2:30-2:55			J. Koutis	A. Alvarado	R. Barrios	L. Hernández
3:00-3:25			W. Quispe	S. Orizaga	A. Díaz	
3:30-4:30	Afiches					
4:00-4:30			Sesión Admin.			

2 Resúmenes de conferencias plenarias (invited talks)

Modeling in nonlinear photonics

Alejandro Aceves, Southern Methodist University

The last few years, we have experienced substantial advancements in Optics and Photonics which have been identified as essential technologies with incredible economic and social impact. Recent findings at the fundamental level on the optical properties of graphene and the notion of Parity Time symmetry as it extends to optics and photonics as well as progress made in engineering meta-materials, have led to research aimed to build smaller, faster on more efficient devices over an ever larger range of frequencies. Historically the modeling in nonlinear waves as it applies to optics and photonics have had important contributions, highlighted by the theoretical discovery of optical solitons. In this talk I will present examples where mathematical modeling has helped advance knowledge in the dynamics of light propagating in state of the art photonic structures.

Retos matemáticos: derecho del estudiante, deber del profesor

María Falk de Losada, Universidad de Nariño

Se muestra que los retos matemáticos son tan antiguos como la matemática misma, que se está reconociendo el derecho de todo estudiante a enfrentar matemática retadora, y el papel central que juegan los maestros en ésta formación. Se exploran algunas formas en que esto se puede lograr y se resalta el deber de los sistemas educativos y del profesor para esforzarse a lograrlo.

Soap bubbles in space with density

Frank Morgan, Williams College

In 1884 Schwarz proved that a round soap bubble provides the least-area way to enclose a given volume of air. In 2000 Hutchings, Ritoré, Ros, and I proved that the familiar double bubble that forms when two soap bubbles come together provides the least-area way to enclose and separate two given volumes of air. An important modern variation places a positive density on space that weights area and volume, with surprising and puzzling effects on the shape of optimal soap bubbles.

3 Resúmenes de conferencias concurrentes (concurrent talks)

A topological interpretation of analytic torsion on manifolds with cusps

Pierre Albin, University of Illinois at Urbana-Champaign

Frederic Rochon, Université du Québec à Montréal

David Sher, University of Michigan

The analytic torsion of a Riemannian manifold is a spectral invariant of its Hodge Laplacian. Its Reidemeister torsion is a topological invariant generalizing the Alexander polynomial of a knot. A deep theorem of Cheeger and Muller (conjectured by Ray and Singer) proved that, for smooth compact manifolds, these two invariants coincide. There has since been a lot of work trying to extend

this relation to noncompact spaces. I will report on our recent success establishing the equality on noncompact spaces with cusp ends, such as hyperbolic manifolds of finite volume.

Keywords: Geometric analysis, Spectral geometry, Algebraic topology

MAXWELL-LDGp3D: An object oriented discontinuous Galerkin framework for electromagnetism

Arlin Alvarado, UPRM

Paul Castillo, UPRM

MAXWELL-LDGp3D: is a program package for solving three-dimensional problems arising in electromagnetism; particularly, models based on Maxwell's equations in frequency domain. The software is based on the formulation of the classical and penalized Local Discontinuous Galerkin (LDG) method in complex variables and support different boundary condition such as Dirichlet, Neumann, Robin, periodic, absorbing conditions and the perfectly matched layer (PML) technique. The principal operators of the method are described using tensor notation. The computational framework developed makes use of some of the method's properties such as high order approximations, variable order by cell and unstructured conforming meshes for 3D geometries. A series of standard experiments and more realistic applications are presented to validate the code.

Keywords: Local Discontinuous Galerkin method, Discontinuous Galerkin methods, high order Finite Element, computational electromagnetism, numerical simulation

Máximo común $\tau_{(n)}$ -factor, cuando \mathbb{Z} es $\tau_{(n)}$ -átomico

Roxana Barrios, Universidad de Puerto Rico Recinto Universitario de Mayaguez

Reyes Ortiz, Universidad de Puerto Rico Recinto Universitario de Mayaguez

En el 2007, Reyes Ortiz presentó una extensión de la definición del máximo común divisor, el cual denotó como $\tau_{(n)}\text{-gcd}$ entre dos números enteros. Las condiciones establecidas eran muy fuertes e incluso no se puede garantizar la existencia del mismo cuando $|n| \geq 2$. Ortiz sugirió debilitarlas y así, surge el concepto del $\tau_{(n)}\text{-mcd}$, el cual se considera como el $\tau_{(n)}$ -factor común más grande con respecto a la relación de orden " \leq ". Es posible demostrar la existencia del $\tau_{(n)}\text{-mcd}$ para todo n , pero calcular el mismo no es tan trivial. Luna y Ortiz pudieron caracterizar con fórmulas el $\tau_{(n)}\text{-mcd}$ cuando $n \in \{0, 1, 2, 3, 4\}$, lamentablemente no tuvieron tiempo de analizar los casos para $n \geq 5$. Los mismos son casos que tienen un mayor nivel de dificultad por la cantidad de clases de equivalencia. Por ende, para dar una idea presentamos los otros casos para los cuales \mathbb{Z} es $\tau_{(n)}$ -átomico, es decir $n \in \{5, 6, 8, 10\}$. Para ello se usan técnicas desarrolladas por Ortiz y Serna en teoría de factorizaciones generalizadas.

Keywords: Teoría de números, $\tau_{(n)}$ -factorización, gcd

Parallel watermarking of images

Alcibiades Bustillo, University of Puerto Rico at Mayaguez

Einstein Morales, University of Puerto Rico at Mayaguez

Doroty Bollman, University of Puerto Rico at Mayaguez

While the internet has made it possible for the consumer to easily obtain images, audio, video, etc. in

digital form, it has also made it easier to illegally obtain copyrighted material. Digital watermarking is a partial solution to this problem. Because of the ever increasing enormity of the flow of information, it becomes necessary to watermark files, and in particular images, in the least amount of time possible. For this reason it is natural to turn to parallel computing. In this work we implement a simple watermarking algorithm in the frequency domain by applying the inverse discrete cosine algorithm (DCT) to a linear combination of the DCTs of matching 8X8 blocks of the greyscale host and watermark images. The DCT and its inverse are implemented using a minimal number of multiplications and additions. This algorithm is “embarrassingly parallel”, i.e., requires no communication between its parallel components and the techniques applied here could be applied to other frequency domain watermarking algorithms. We compare the performance of three different implementations, in openMP, MPI, and CUDA.

Acknowledgement: The authors gratefully acknowledge the use of the Extreme Science and Engineering Discovery Environment (XSEDE), which is supported by National Science Foundation grant number ACI-1053.

Keywords: parallel computing, digital watermarking, discrete cosine transform, frequency domain

A block algebraic multilevel preconditioner for discontinuous Galerkin discretizations

Jesús M. Cajigas, University of Puerto Rico Mayagüez Campus

Paul Castillo, University of Puerto Rico Mayagüez Campus

Algebraic multilevel preconditioners are a common and effective way to accelerate the convergence of linear solvers. A block algebraic multilevel technique for discontinuous Galerkin discretizations is discussed. The proposed preconditioner is tested with symmetric positive definite matrices obtained from the Local Discontinuous Galerkin spatial discretization applied to elliptic partial differential equations in three dimensional domains. Numerical experiments include matrices from high order approximations and domains with rough coefficients. Results show a drastic reduction of the iteration count as the number of cycles and smoothing sweeps are increased.

Keywords: LDG methods, multilevel, preconditioners

Regresión semi-paramétrica con Distribución Beta y efectos aleatorios

Adriana Calvo, Universidad de Puerto Rico - Mayagüez

Raúl E. Macchiavelli, Universidad de Puerto Rico - Mayagüez

Algunos estudios generan datos que son tasas, proporciones o probabilidades, restringidos de forma continua en el intervalo $(0, 1)$. La regresión Beta ofrece ventajas para estos casos: la interpretación directa de los resultados, ya que no es necesario el uso de transformaciones, y la facilidad para modelar asimetrías puesto que la distribución puede tomar diversas formas si se varían sus parámetros de escala y localización. Los modelos de regresión semi-paramétricos proporcionan una herramienta eficaz en el modelamiento de los datos, dado que permite un mayor aprovechamiento de la información. La incorporación de técnicas de suavizado como splines en el modelamiento con regresión beta y efectos aleatorios permiten realizar una mejor aproximación a la curva de regresión generando estimaciones más precisas. En este trabajo se presentan tres modelos de regresión semi-paramétricos cuyas matrices de diseño asociadas a los efectos se construyen mediante splines, la distribución condicional de la variable de interés dados los efectos aleatorios es Beta y se asume que los efectos aleatorios son normalmente distribuidos; estos modelos de regresión Beta se construyen mediante la combinación de B-splines en la parte fija; con B-splines, P-splines o Radial Smoothing en la parte aleatoria. Por medio de simulaciones

se selecciona el modelo que mejor se ajuste a los datos según el Criterio de Información Bayesiano (BIC) y el modelo que mejor prediga según el criterio de Error Absoluto Integrado Medio (MIAE). Finalmente se aplican los resultados obtenidos a estudios de severidad de enfermedades en cultivos de guineo en Puerto Rico.

Keywords: Modelos semi-paramétricos, Regresión Beta, Splines, Radial Smoothing.

Interior operators and the functorial property

Gabriele Castellini, Dept. of Mathematical Sc., UPRM

A generalization to an arbitrary category of the classical notion of topological closure was introduced in the early 80's and it was used to extend to a general environment most of the classical topological notions like, separations, connectedness and compactness, for instance.

Given an arbitrary category \mathcal{X} and a class of monomorphisms \mathcal{M} , the property that given a morphism $f : X \mapsto Y$ and an \mathcal{M} -subobject $m : M \mapsto X$, the direct image under f of the closure of m is less than or equal to the closure of the direct image of m , yields an important property, called the functorial property of closure operators. This property has played a crucial role in the development of the theory of categorical closure operators.

Recently, a categorical notion of interior operators has been introduced with the aim of trying to find out whether the success of closure operators in an arbitrary category could be repeated or even improved by this new notion. However, after some analysis it became clear that contrarily to the topological case, interior operators do not seem to be as powerful as closure operators in an arbitrary environment. Actually, a main handicap of interior operators is their lack of functoriality. In this talk we will analyze this particular aspect in details.

Keywords: Interior operator, functorial property, open morphism

Every FIP real computes a 1-generic

Peter Cholak, Notre Dame

Rod Downey Victoria University

Greg Igusa Notre Dame

One of the equivalent statements of the axiom of choice (AC) is the finite intersection principle. This principle says that every family of sets has maximal (under inclusion) subfamily with finite intersection property (FIP) (every finite intersection is nonempty). Gödel and Cohn showed that AC is independent from the standard axioms of mathematics (ZF). Cohn invented the notion of forcing and Cohn generics to show the failure of AC is consistent with ZF. Here we study effective notions of FIP and Cohn generics in terms of the Turing degrees. We show that the FIP degrees and Cohn 1-generic degrees are the same. We will discuss a few related results and some corollaries.

Acknowledgements: This work was partially supported by a grant from the Simons Foundation (#315283 to Peter Cholak). Downey was supported by the Marsden Fund of New Zealand. Research was (partially) completed while the authors were visiting the Institute for Mathematical Sciences, National University of Singapore in 2014.

Keywords: Finite intersection principle, Cohn 1-generic, Turing degrees.

Mitigating effects of vaccination on influenza outbreaks given constraints in stockpile size

and daily administration capacity

Mayteé Cruz-Aponte, Universidad de Puerto Rico en Cayey

Erin C. McKiernan, Centro de Investigación Sobre Enfermedades Infecciosas, Instituto Nacional de Salud Pública

Marco A. Herrera-Valdez, Centro de Investigación Sobre Enfermedades Infecciosas, Instituto Nacional de Salud Pública

Influenza viruses are a major cause of morbidity and mortality worldwide. Vaccination remains a powerful tool for preventing or mitigating influenza outbreaks. Yet, vaccine supplies and daily administration capacities are limited, even in developed countries. Understanding how such constraints can alter the mitigating effects of vaccination is a crucial part of influenza preparedness plans. Mathematical models provide tools for government and medical officials to assess the impact of different vaccination strategies and plan accordingly. However, many existing models of vaccination employ several questionable assumptions, including a rate of vaccination proportional to the population at each point in time.

We present a SIR-like model that explicitly takes into account vaccine supply and the number of vaccines administered per day and places data-informed limits on these parameters. We refer to this as the nonproportional model of vaccination and compare it to the proportional scheme typically found in the literature.

The proportional and non-proportional models behave similarly for a few different vaccination scenarios. However, there are parameter regimes involving the vaccination campaign duration and daily supply limit for which the non-proportional model predicts smaller epidemics that peak later, but may last longer, than those of the proportional model. We also use the non-proportional model to predict the mitigating effects of variably timed vaccination campaigns for different levels of vaccination coverage, using specific constraints on daily administration capacity.

The non-proportional model of vaccination is a theoretical improvement that provides more accurate predictions of the mitigating effects of vaccination on influenza outbreaks than the proportional model. In addition, parameters such as vaccine supply and daily administration limit can be easily adjusted to simulate conditions in developed and developing nations with a wide variety of financial and medical resources. Finally, the model can be used by government and medical officials to create customized pandemic preparedness plans based on the supply and administration constraints of specific communities.

Keywords: vaccination, influenza, epidemiology, mathematical modeling

New families of absolutely irreducible polynomials for cryptographic algorithms

Moises Ricardo Delgado, UPR-Cayey

The absolute irreducibility of the $n - 3$ degree polynomial $G(x, y, z) = [f(x) + f(y) + f(z) + (x + y + z)] / (x + y)(x + z)(y + z) \in F_{2^n}[x, y, z]$, where f is a polynomial function of degree n , $f : F_{2^n} \rightarrow F_{2^n}$, plays an important role in the classification of APN functions. APN functions have important applications in cryptography when they are used as components of block ciphers. The more interesting cases are the polynomials f of degree $n = 2^k + 1$, $n = 2(2^k) - 2^k + 1$ (called Gold and Kasami numbers, respectively). In this talk we show some new infinite absolutely irreducible families for the Gold case and some particular examples for the Kasami case. We show how this last case is the much more complex one.

Keywords: almost perfect nonlinear, absolutely irreducible, block cipher, cryptography

***W*-graphs over non-commutative rings**

Alexander Díaz-López, University of Notre Dame

Matthew Dyer, University of Notre Dame

Given a Coxeter system (W, S) , a W -graph is a graph, together with additional information that encodes a representation of the Hecke algebra associated to W , called the τ representation. Given an Iwahori-Hecke datum D I define pre- D -graphs, a generalization of W -graphs, and construct representations of Hecke algebras on quotient path algebras (QPA) over suitable quivers. When the pre- D -graph is given by a W -graph, I discuss the relationship between these representations and the τ representations. Several important examples are discussed, including the QPA associated to the universal pre- D -graph, as well as cases where the obtained QPA is isomorphic to the ideal of the asymptotic Hecke algebra associated to the reflection representation.

Keywords: group theory, Coxeter groups, representation theory, Hecke algebras

El concepto de límite utilizando el lenguaje de los números infinitesimos

Luz Marina Hernández, Universidad de Puerto Rico en Río Piedras

El propósito de este trabajo es destacar las virtudes metodológicas y matemáticas que se utilizaron para descifrar complejidades que conlleva la comprensión de un concepto tan importante y abstracto en el estudio del cálculo I, como es el límite de una función.

La presentación corresponde a una parte del trabajo de investigación: “La enseñanza y el aprendizaje de cálculo I utilizando el lenguaje de los números infinitesimales”. Para realizar el estudio se utilizó el diseño de Investigación en Acción para documentar la práctica educativa en la sala de clase, con un enfoque fenomenológico. El interés para llevar a cabo la investigación fue determinar si el estudio del cálculo empleando infinitesimales mejoraba el aprendizaje del concepto de límite.

El trabajo de campo se realizó en la Facultad de Ciencias Naturales de la Universidad de Puerto Rico, Recinto de Río Piedras. Los participantes fueron los estudiantes matriculados en la sección de cálculo I, cuyo profesor asignado por el Departamento de Matemáticas utilizaría como método de enseñanza el análisis infinitesimal. Los estudiantes no tenían conocimiento previo de esto. El número de participantes fueron los 32 estudiantes matriculados en el curso, quienes manifestaron interés por la investigación que se quería llevar a cabo y dieron su consentimiento-asentimiento para formar parte del estudio.

Para recopilar y validar información se utilizaron, entre otros, entrevistas al profesor del curso, información y documentos contenidos en el Blog “Cálculo de López Verano”, observación participante y no participante, ensayo reflexivo de los estudiantes y el estudio de artefactos: pruebas de competencias y de comprensión del concepto de límite. Además, los artefactos se administraron a los estudiantes de otra sección de cálculo I, que estudió el límite utilizando el método tradicional: el análisis estándar, con el propósito de poder establecer algunas comparaciones.

Los hallazgos mostraron que existe una ventaja cognitiva en el estudio del concepto del límite con infinitesimos, porque la comprensión del concepto depende de la idea de una cantidad estar infinitamente cerca de otra, idea que los estudiantes manifestaron fue muy útil para internalizar el significado de infinitamente pequeño e infinitamente grande y entonces desarrollar el concepto y la teoría de límites de funciones sobre esta idea sencilla e intuitivamente clara, concluyendo el estudio que la comprensión del concepto de límite sí mejora cuando los estudiantes lo aprenden utilizando el lenguaje de los números infinitesimos.

Keywords: función, infinitesimal, aprendizaje, enseñanza

Reducción de la dimensionalidad para optimizar la clasificación de datos funcionales

Shirley Yohany Huanca Ochoa, Universidad de Puerto Rico Recinto Universitario de Mayagüez

Edgar Acuña Fernández, Universidad de Puerto Rico Recinto Universitario de Mayagüez

Con el paso del tiempo y con el continuo avance de la tecnología, los estadísticos se han enfrentado a la necesidad de desarrollar nuevos métodos para extraer información significativa de forma rápida y eficiente en grandes conjuntos de datos, tal como son los datos funcionales. Este tipo de datos corresponden a una observación aleatoria en un intervalo; y por tanto son tratados teóricamente utilizando las definiciones y propiedades de curvas; así como computacionalmente a través de técnicas de minería de datos, considerándolos como vectores de alta dimensión. Es en este sentido que, la aplicación de algunos de los métodos de reducción de dimensionalidad será recomendable previo a cualquier análisis sobre estos datos. En esta técnica una representación de tamaño finito es usada para cada curva, superando así el problema de la alta dimensionalidad. En este trabajo se comparan dos procedimientos de selección de características con un método comúnmente usado de reducción de dimensionalidad para datos funcionales. Todo esto en el ámbito de la clasificación supervisada. Los resultados se presentarán utilizando dos conjuntos de datos reales.

Keywords: Análisis de Datos Funcionales, Selección de Variables, B-Splines, Clasificación Supervisada

El entendimiento del concepto de la fracción que poseen los maestros en formación para el nivel elemental: parte de un todo y medida

Yuitza Humaran, Universidad de Puerto Rico en Arecibo

Se efectuó una investigación con el propósito de explorar y describir el entendimiento del concepto de la fracción que poseía un grupo de maestros en formación para el nivel elemental. Se investigó si el participante identificaba e interpretaba diferentes representaciones de las fracciones. Las representaciones que se consideraron fueron las de una fracción como: una parte de un todo, una razón, un cociente, un operador y una medida. Para llevar a cabo el estudio se construyó una prueba de 30 preguntas abiertas (6 para cada representación). La prueba se administró a 29 maestros en formación para el nivel elemental de una unidad del sistema universitario público de Puerto Rico. El 10% (3 de 29) de los participantes demostró tener un entendimiento profundo del concepto de la fracción; el 3% (1 de 29) un entendimiento moderado; y el 87% (25 de 29) uno limitado. Se discutirán los resultados generales y en específico los relacionados a las representaciones de parte de un todo y de la medida.

Keywords: Fracciones, entendimiento, maestros en formación

Sparsification: a powerful tool for numerical linear algebra

Ioannis Koutis, University of Puerto Rico-Rio Piedras

Dense matrices can be approximated arbitrarily well by sparse matrices, in certain well-defined ways. We survey recent impressive progress in the area of matrix sparsification, and review some of its applications in the design of faster algorithms for key problems in numerical linear algebra and scientific computing. We also discuss how these faster numerical routines yield significant speedups for classical graph-theoretic problems.

Keywords: Numerical Linear Algebra, Graph Sparsification, Matrix Sparsification

Analytical modeling of vibration of micropolar plates

Roman Kvasov, University of Puerto Rico at Aguadilla

Lev Steinberg, University of Puerto Rico at Mayaguez

This paper presents a mathematical model for the vibration of micropolar elastic plates. This model is based on the proposed generalization of Hellinger-Prange-Reissner (HPR) variational principle for the linearized micropolar (Cosserat) elastodynamics. The modeling of the plate vibration is based on the HPR variational principle for the dynamics of Cosserat plates, which incorporates most of assumptions of the authors' enhanced mathematical model for Cosserat plate deformation. The dynamic theory of the plates obtained from the dynamic variational principle includes dynamics equations, constitutive relations. The preliminary computations of the rectangular plate vibration demonstrate the influence of plate size effect on the natural frequencies compare with simple elastic plates. The computations also show how natural frequencies of micropolar plate converge to classic Mindlin-Reissner plates.

Keywords: Cosserat materials, plate vibration, frequencies of transverse micro-vibration, variational principle.

Stereoscopic 3D anaglyph video system

Elio Lozano Inca, University of Puerto Rico at Bayamón

In this project a 3D anaglyph video system will be implemented to integrate it in new research area in computer science department at UPRB. This system will be based on two cameras and two computing devices and it will create three dimensional anaglyph video in real time. The algorithm in one computing-camera device will take a picture from the video buffer and send it to the other computing-camera device which will show both the left and right images in different color to create the three dimensional anaglyph image. For this project an open computer vision library will be used to capture the left and right images. The objectives of this project in the hardware will be the correct selection of the computing devices, cameras, and hardware peripherals to build the left-side and right-side of the video system. In the software side the objective is setting the system and implementing algorithms to get stereoscopic 3D anaglyph images in real time. Finally, experiments will be performed to test the proposed video system.

Keywords: Stereoscopic 3D, Anaglyph, Video System

The principal rank characteristic sequence and the enhanced principal rank characteristic sequence

Xavier Martinez-Rivera, Iowa State University

A *principal* submatrix of an $n \times n$ matrix B is a submatrix of B lying in rows and columns indexed by a set $\alpha \in \{1, 2, \dots, n\}$, and it is denoted by $B[\alpha]$. An *order k principal* minor is the determinant of a $k \times k$ principal submatrix. The *principal minor assignment problem* asks the following question: can we find an $n \times n$ real symmetric matrix having prescribed principal minors. An attempt to simplify this problem led to the introduction of two sequences for a symmetric or Hermitian matrix. The *principal rank characteristic sequence* of an $n \times n$ symmetric matrix B is $r_0]r_1 \cdots r_n$, where, for $k = 1, 2, \dots, n$, $r_k \in \{0, 1\}$ and $r_k = 1$ if and only if B has a nonzero order k principal minor, i.e., if and only if it has a nonsingular $k \times k$ principal submatrix, while $r_0 = 1$ if and only if B has a 0 on its main diagonal (otherwise $r_0 = 0$). The *enhanced principal rank characteristic sequence* of an $n \times n$ symmetric (or complex Hermitian) matrix B is $\ell_1 \ell_2 \cdots \ell_n$, where, instead of focusing on the existence of a nonsingular

principal submatrix, a term ℓ_k on the sequence is A (N) if all (none) of the $k \times k$ principal submatrices are nonsingular, and if some but not all are nonsingular, then $\ell_k = S$. Results regarding the attainability of certain classes of sequences are introduced, and restrictions for some subsequences to appear in an attainable sequence are discussed.

Keywords: minor, rank, symmetric matrix, pr-sequence, epr-sequence, principal rank characteristic sequence, enhanced principal rank characteristic sequence

A hierarchical semantic memory model for classification of motion capture data

Ollantay Medina, University of Puerto Rico at Cayey

Vidya Manian, University of Puerto Rico at Mayaguez

This study describes a novel approach for supervised classification of motion capture data. A hierarchical semantic memory transforms a skeleton wireframe input sequence and learns a hierarchical representation based on a general framework for treatment of space time data through a dimensionality reduction process. The model has several advantages as a classifier, such as minimal preprocessing of data, single-scan learning of training set, high classification accuracy with even just one instance per class in the training set, and a short running time.

Keywords: supervised classification, motion classification, space time data

Formalización del modelo para diseñar la interacción humano-computadora (MODIHC)

Flor Narciso, Universidad de Puerto Rico, Recinto Universitario de Mayaguez, Mayaguez, Puerto Rico

Gustavo Valero, Capgemini S.A., Oviedo, España

En este artículo se presenta la formalización del Modelo para Diseñar la interacción Humano-Computadora, denominado MODIHC, el cual permite diseñar los aspectos involucrados entre un humano y una computadora cuando se están desarrollando productos de software. Se describen los cuatro componentes que conforman el modelo, Usuarios, Ambiente de Trabajo, Tecnología y Funcionalidad del Sistema, en términos de sus objetivos, productos y metodologías, métodos, técnicas y herramientas apropiadas para la obtención de estos productos, así como las relaciones entre ellos y con el diseñador de software. Esta nueva definición de MODIHC garantiza la creación de productos de software usables, seguros, útiles, efectivos y eficientes.

Keywords: Interacción Humano-Computadora, Interfases de Usuario, Diseño Centrado en el Usuario

Minimal energy configurations of finite molecular arrays

Pablo V. Negrón-Marrero, University of Puerto Rico at Humacao

Melissa López-Serrano, University of Puerto Rico at Rio Piedras

The basic model in molecular dynamics simulations consists of particles or molecules interacting between them due to attracting or repulsive forces given by a certain inter molecular potential. An important question in MD simulations is whether a given uniform configuration remains stable or not as a certain parameter like volume or temperature of the mixture is changed. In this paper we address this question in the rather simpler scenarios of a planar array of three particles and that of four particles in a tetrahedron. For a general class of inter molecular potentials we give conditions for the homogeneous configuration of the array to be stable (a minimizer of the potential energy of the system). When the

homogeneous configuration becomes unstable we show, using techniques from bifurcation theory, that there exist non-homogeneous configurations which satisfy the first order necessary conditions for an optimum of the potential energy.

Acknowledgements: This research was sponsored in part by the NSF-PREM Program of the UPRH (Grant No. DMR-0934195).

Keywords: potential energy, constrained optimization, bifurcation theory

Nonlinear spatio-temporal instability regime for electrically forced viscous jets

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This paper considers the problem of nonlinear instability in electrically driven viscous axisymmetric jets with respect to spatial and temporal growing disturbances in the presence of a uniform or non-uniform applied electric field. The mathematical modeling for the jets, which uses the original electrohydrodynamics equations (Melcher and Taylor 1969), is based on the nonlinear mechanics that govern the liquid jet due to tangential electric field effects. At the linear stage, we found that a particular jet of fluid could exhibit the Rayleigh and Conducting flow Instabilities for the spatial and temporal evolution of the disturbance. For the nonlinear regime of the problem, we studied the resonant instability and nonlinear wave interactions of certain modes that satisfy the dyad resonant condition. The nonlinear wave interactions in the jet provided a significant change in the fluid flow properties that extend notably the available understanding of the problem at the linear stage. It was found that the nonlinear resonant instability provides an amplifying effect on the magnitude of the disturbances which evolves the jet to reduce significantly its radius at a shorter axial location. For the case of higher viscosity fluid, the electric field in the jet was found to be increasing spatially and temporally when nonlinear wave interactions were taken into account during the resonant instability. The resulting nonlinear solutions for the jet thickness, jet's electric field, jet's surface charge and jet velocity are presented and discussed.

Keywords : wave interaction, resonant instability, spatial instability.

An application of Lucas's theorem

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Lucas' Theorem is a classical result that gives a straightforward method for computing a binomial coefficient modulo a prime number p . It states that $\binom{m}{n} \equiv \binom{m_0}{n_0} \binom{m_1}{n_1} \cdots \binom{m_d}{n_d} \pmod{p}$, where $m = m_0 + m_1p + m_2p^2 + \cdots + m_dp^d$ and $n = n_0 + n_1p + n_2p^2 + \cdots + n_dp^d$ are the base- p representations of nonnegative integers m and n , respectively.

Let α be any nonzero element of a finite field \mathbb{F}_p of characteristic p . A *Jordan block* with value α of size n , $J(\alpha, n)$, is the upper triangular $n \times n$ matrix with α in the main diagonal, all 1's in the diagonal above it, and 0's elsewhere. Let $S = J(\alpha, n)$ and M be a nonsingular matrix over \mathbb{F}_p that commutes with S . In order to compute the cyclic structure of certain reduced linear modular systems, it is useful to determine whether M is a power of S or not. That is, we need to determine if $M = S^j$ for some positive integer j . We show that this problem can be reduced to solving a certain system of congruences and apply Lucas' theorem to obtain necessary and sufficient conditions for its solution and a formula for a solution when it exists.

Keywords: Lucas' theorem, reduced linear modular system, finite field

Computational modeling of glucose toxicity in pancreatic beta-cells as a development factor in type II diabetes

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Type 2 Diabetes is a chronic condition characterized principally by insulin resistance, which describes the cells inability to respond appropriately to excess glucose in the body. According to various studies, β -cells play an important role in the progression of this condition, given that they are the sole producers of insulin. Any shift favoring apoptosis over β -cell replication will exacerbate the existence of insulin resistance and result in a more aggressive advancement of the condition. As insulin resistance develops, excessive amounts of glucose start building up in the blood, which can lead to an event known as glucotoxicity, which accelerates β -cell apoptosis. The deleterious effects brought upon by glucotoxicity, are mediated through another mechanism know as oxidative stress. Due to a low production of anti-oxidant enzymes in these cells, β -cells tend to be especially susceptible to this type of stress. Utilizing differential equations we will create a mathematical model in which we can track the deteriorative effects that glucotoxicity and oxidative stress have on β -cells, how this affects the progression of the Type 2 Diabetes, and to what extent can the condition be reversible.

Keywords: beta cells, diabetes, glucose, mathematical modeling

Towards probabilistic inference and learning in Bayesian networks using MapReduce

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Bayesian networks are probabilistic graphical models used for studying probabilistic dependencies among variables of interest. It is used frequently in Artificial Intelligence, Machine Learning, Statistics and Expert Systems. Exact probabilistic inference in a Bayesian network is computationally complex. In the worst case, algorithms for estimate those probabilities are NP-hard, since the size of the conditional probability table grows exponentially in the number of parents in the network as the input data size increases, on the other hand, parameter learning of Bayesian network from large incomplete dataset can be very compute-intensive, there are at least two bottlenecks, namely the potentially huge data set size and the requirement for computation and memory resources. Thus sequential parameter learning and exact probabilistic inference for large and complex network becomes challenging even in the case of complete data. In order to speed up the process of inference and learning, is necessary run parts of the network in parallel. In this presentation we explore the application of a MapReduce based distributed computing framework, Hadoop, to Bayesian network model to speed up the parameter learning for complete data via Bayesian update, incomplete data using classical Expectation Maximization algorithm and for exact probabilistic inference via Junction tree algorithm. Both analytical and experimental results show gains in speed up and parameter quality.

Keywords: Bayesian Networks, Parameter Learning, Exact Inference, MapReduce, Hadoop.

Software engineering agile methodology for small and medium size enterprises

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Universities teach Computer Science with a problem, solving approach, but lack a certain level of team organization. With careful reading and by using the methodology described in this paper, universities and small businesses can create an organized work plan to bring efficiency and simplicity into the work area. When bringing the complexity of a modern agile methodology as a step by step guide, small businesses and universities can easily design, develop, and test their systems in a simple and detailed manner. This will improve student's grades and organization skills while, at the same time will help employees have a supplementary stress free way approach to the software development life cycle.

Keywords: Agile, Development, Software, Team, Methodology, Requirements, Design, Method, Review, Practice, Programming, Develop, Phase, Software Development Lifecycle, Software Engineering

Some features of R you might not yet know

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I will be discussing a number of advanced features of R that are not widely known and could be useful to many R users. In particular i will talk about startup customization using `.First` and `.Rprofile`, using environments and the R packages `Rcpp` and `Rshiny`. I will also discuss a number of small routines that i wrote and use on a daily bases.

Keywords: R,customization,Rcpp,Rshiny

Propiedades de τ -factorizaciones, donde τ es una relación de equivalencia.

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Recientemente, algebraistas como D. D. Anderson, A. Frazier, J. Juett, R. Ortiz, entre otros, han trabajado una teoría de factorizaciones generalizadas sobre dominios integrales, conocida como la teoría de τ -factorizaciones. En esta teoría se estudian los productos donde los factores no unidades están τ -relacionados (τ una relación, generalmente simétrica, definida sobre el conjunto de los elementos distintos de cero y no unidades del dominio integral). La teoría de τ -factorizaciones resume no sólo la teoría usual, sino también los trabajos de factorizaciones en elementos no necesariamente irreducibles. Por ejemplo, factorizaciones en elementos tales como: primos, primales, primarios, rígidos, etc.

Al igual que estos autores, estudiamos la teoría de τ -factorizaciones sobre dominios integrales, pero enfocados en relaciones de equivalencia multiplicativas y que preservan asociados. Mostraremos la existencia de relaciones de equivalencia que satisfacen estas propiedades y algunas extensiones de relaciones de equivalencia que satisfacen propiedades deseadas (como ser multiplicativas o preservar asociados).

Keywords: τ -factorización, relación multiplicativa, relación que preserva asociados.

Semiparametric mixed beta regression with penalized splines for disease severity

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The Severity Index (SI) of Black Sigatoka in banana, measured using the Stover-Gauhl scale, can be considered as a continuous variable in a 0-1 scale. Mixed beta regression has emerged as an appealing alternative to model this type of data. However, when the average and the plant-specific curves in longitudinal data do not follow a parametric form, semi-parametric methods are preferred. We propose a semiparametric mixed beta regression with smooth average curves and plant-specific curves to model disease progress curves. Parameters in the proposed model are estimated via maximum likelihood. The roughness parameters in the penalized splines are chosen using traditional model selection criteria (e.g., BIC or AIC). The proposed semi-parametric method allows to model flexible shapes for disease progress curves, and can be used to compare treatments while taking into account the longitudinal and design structures of the data. We apply the proposed method to model the SI of Black Sigatoka in an experimental banana plantation in Isabela, Puerto Rico. An experiment was carried out to compare different control practices to control Black Sigatoka. The use of the proposed method yields very useful results that allow the plant pathologists and crop managers to understand, monitor and control diseases.

Keywords: beta regression, splines, severity

Análisis de funciones de clasificación supervisada.

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Se presenta una metodología que plantea mecanismos para mejorar las estrategias de análisis en situaciones donde la clasificación supervisada se convierte en herramienta fundamental de decisión empresarial. La necesidad de encontrar la mejor ubicación de nuevos sujetos en uno de dos o más grupos bien definidos de acuerdo a las características del sujeto, es analizada mediante el cálculo de la tasa de error. Se escribieron programas en lenguaje R para calcular la tasa de error de cada uno de nueve clasificadores, usando el método de validación cruzada 10 (Stone, 1974), en 50 permutaciones de los datos en estudio. Para cada uno de los conjunto de datos analizados se demostró, mediante ANOVA, que efectivamente existen diferencias significativas en el promedio de tasas de error de los clasificadores ($pvalue < 0.01$), lo que nos lleva a concluir que el mejor clasificador puede ser cualquiera, condicionado a tener mínima tasa de error.

Keywords: clasificación supervisada, validación cruzada, tasa de error

Scaling laws of deformation and transformation of fractal media

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In this talk we will present an extension of Continuum Mechanics to the fractal media at mesoscopic scale. The Mechanics at this scale considers the material bodies as a fractal media and studies the material deformation and the transformation as well. We assume that the mesoscopic deformation does not affect material structure however the transformation of the fractal media does involve the change of mesoscopic properties. These changes include the variation of characteristics of fractal dimension of internal material structure. We also assume that the forces responsible for these transformations are by definition the configuration stress and couple stress. For the material deformation we will present the integral forms of equations for the conservation of fractional mass, linear and angular momentum in terms of stress and couple stress of deformed fractal bodies. The constitutive formulas for the deformation can be written by analogy with the Cosserat continuum. The conservation laws for the transformation of fractal body will be also discussed. We will show that constitutive formulas for the transformation should include fractional derivatives techniques.

Keywords: Fractal Media, Scaling Laws, Cosserat Continuum, Fractional Derivatives

4 Resúmenes de afiches (posters)

Negative Binomial-Lindley distribution for count data with excess of zeros

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The excess of zero counts is one of the causes of overdispersion in count data. Many mixed and compound distributions, such as Poisson-gamma (Negative Binomial), Poisson-inverse Gaussian and Poisson-Lindley, have been studied and proven to have better performance than Poisson in these cases. The Negative Binomial-Lindley (NB-L) has been recently introduced as an alternative for modeling crash data characterized by large amount of zeros. This distribution has properties similar to those of the Negative Binomial (NB), which has shown to have a good performance in overdispersed count data. However, the NB-L complex formulation makes it difficult to extend its application to generalized linear models. The aim of this research is to assess the NB-L distribution goodness of fit to count data by comparing it to the traditional Poisson and Negative Binomial using simulated and real data. The results show that the NB-L outperforms the NB and the Poisson in very few scenarios when the data has 70% of zeros.

Keywords: count data, Negative Binomial-Lindley distribution, Negative Binomial mixture, crash data

Epidemiological model of dengue in Puerto Rico

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Dengue is the most rapidly spreading mosquito-borne viral disease in the world. It's transmitted by several species of mosquito within the genus *Aedes*, principally *Aedes aegypti*. There are four distinct serotypes of the dengue virus (DEN 1, DEN 2, DEN 3 and DEN 4). Symptoms appear in 2-7 days (on an average 4-7 days) after the infective bite. Dengue fever is a flu-like illness that affects infants, young

children and adults. There is no specific treatment for dengue fever. Severe dengue is a potentially lethal complication but early clinical diagnosis and careful clinical management by experienced physicians and nurses often save lives. More than 70% of the disease burden is in South-East Asia and the Western Pacific. In Latin America and the Caribbean, the incidence and severity of disease have increased rapidly in recent years. In Puerto Rico, an estimated yearly mean of 580 disability adjusted life years per million population were lost to dengue between 1984 and 1994. Urbanization, rapid movement of people and goods, favorable climatic conditions and lack of trained staff has all contributed to the global increase of dengue. On this investigation, we plan to create an epidemiological model to describe mathematically the infection in Puerto Rico and create simulations to understand the spreading of the disease.

Keywords: dengue, epidemiology, mathematical modeling

Exact divisibility of exponential sums associated to elementary symmetric Boolean functions

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An n -variable Boolean function F is a function defined over \mathbb{F}_2^n with values in \mathbb{F}_2 , the finite field with two elements. The Boolean function F is balanced if $|\{x \in \mathbb{F}_2^n | f(x) = 1\}| = 2^{n-1}$. This property is important for many applications in cryptography. A function F is balanced if and only if the exponential sum $S(F) = \sum_{x_1, \dots, x_n \in \mathbb{F}_2} (-1)^{F(x_1, \dots, x_n)}$ associated to F is zero. A Boolean function F is called symmetric if its value is not affected by a permutation of its input. On 2008, Cusick, Li and Stănică proposed a conjecture about the non-balancedness of elementary symmetric Boolean functions. In this work, we calculate the exact 2-divisibility of $S(F)$ for some families of elementary symmetric Boolean functions and use it to prove some cases of this conjecture. Our approach is completely elementary.

Acknowledgements: The first and second authors were partially supported as students by NSF-DUE 1356474. **Keywords:** Boolean functions, Cusick-Li-Stănică's conjecture, 2-divisibility

EIP: laboratory experiences for the introduction to programming course

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The experience of students in the CS1 course is crucial in developing their attitude towards CS and their decision to remain in the undergraduate program. Lab exercises should not only be instructive but should strive to convey to the students the applied and fun nature of CS. We present a set of well-structured laboratory experiences that are engaging, applied, meaningful, easily accessible and transferable. Each lab experience provides objects, functions and a graphical user interface that allow the student to focus on basic programming concepts while achieving a meaningful overall task. The programming framework documentation, instructions and evaluation materials will be available in English and Spanish and will provide a turnkey solution that significantly eases an instructor's change

in classroom techniques toward more hands-on, active and engaging courses. We have implemented 24 lab experiences, and have deployed 12 of them in our CS1 course with very positive and encouraging evaluations from our students.

Acknowledgements: This work is partially supported by the National Science Foundation (NSF) under grant number DUE-1245744.

Keywords: computer science education, introduction to programming, laboratory experience.

Modelos epidemiológicos de Chikungunya en Puerto Rico

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El Chikungunya se relaciona con los vectores *Aedes Aegypti* y *Aedes Albopictus* que también transmite el virus del Dengue. Un paciente infectado por este mosquito presenta síntomas comunes como: fiebre, dolores articulares y cansancio. Hasta el momento no existe un tratamiento antiviral para tratar esta enfermedad. Los métodos recomendados son mantener reposo, uso de paracetamol para aliviar la fiebre, y el ibuprofeno, naproxeno, u otro agente anti-inflamatorio no esteroideo (AINE) para aliviar los dolores articulares. El modelo utilizado para describir el contagio de esta enfermedad es te tipo SIR. Este método nos permite analizar la propagación del Chikungunya en Puerto Rico y orientar a la comunidad sobre la prevención.

Keywords: Chikungunya, epidemiology, mathematical modeling

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