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1. Itinerario global (global itinerary)

Anf. Enf. es el anfiteatro del edificio de enfermería.

Vest. Quim. es el vestíbulo del edificio de química.

Q denota salones en el edificio de química.

Viernes 2 de marzo de 2012								
Hora	Anf. Enf.	Vest. Quim.	Q124	Q125	Q150	Q151	Q152	Q222
4:30-6:00		Registro						
5:00-7:00		Mesas						
5:00-6:00		Afiches	Sesión temática	Sesiones concurrentes				
5:30-5:55			A. Portnoy	M. Delgado	L. de la Torre	X. Yong		
6:00-6:25			Cruz & Martinez	J. Ayala	K. Rozga	A. Villanueva		
6:30-6:55			L. Cáceres	Y. Rojas	W. Dziobiak	A. Vélez		
7:00-8:00	A. Quintero							
8:00-9:30			Actividad de confraternización - mezzanine - Complejo de Tenis					

Sábado 3 de marzo de 2012								
Hora	Anf. Enf.	Vest. Quim.	Q124	Q125	Q150	Q151	Q152	Q222
7:00-8:15		Registro/Desayuno						
8:00-10:00		Mesas	Sesión temática	Sesiones concurrentes				
8:00-8:25			A. Matzavinos	J. Ayala	E. Suazo	A. Maldonado	F. Piñero	Z. Santiago
8:30-8:55			J. Rivera	R. Macchiavelli	E. McKiernan	M. Schütz	D. Bollman	I. Rubio
9:00-9:25			K. Yong	Y. Aucaille	M. Herrera		E. Morales	F. Castro
9:30-9:55			K. Rios - Soto	C. Barreto	P. Negrón	M. López	R. Ortiz	T. Bartoszynski
10:15-10:30	Bienvenida							
10:30-11:30	C. Frohman							
11:30-1:15			Almuerzo - mezzanine - Complejo de Tenis					
1:30-2:30	S. Suslov							
2:30-3:55		Mesas	Sesión temática	Sesiones concurrentes				
2:30-2:55			A. Sikora	Y. Aucaille	W. Quispe	R. Martinez	D. Collins	J. La Luz
3:00-3:25			J. Kania-Bartoszynska	D. Torres	A. Alvarado	J. Rodriguez	G. Zamba	H. Salas
3:30-3:55			O. Dasbach	G. Vega	H. Perez	R. Martinez	G. McKee	G. Castellini
4:00-5:00		Afiches/Merienda						
4:30		MBI Award						
4:40-5:00			Sesión Admin.					

Afiches - Vestíbulo de Química							
viernes 2 de marzo, 5:00-6:00	W. Colberg K. Lucena	J. Colón E. Méndez	C. Cortés C. Rodriguez	A. de Jesús N. Santiago	Y. García K. Suliveres	C. Gratakos E. Vázquez	
sábado 3 de marzo, 4:00-5:00	W. Alvarez N. Luna	R. Delgado F. Pabón	A. Figueroa Y. Rivera	R. Kvasov L. Robles	T. Laboy J. Vega	R. López A. Waschka	

2. Itinerario detallado (detailed schedule)

Viernes 2 de marzo de 2012		
Hora	Lugar	Actividad
4:30-6:00pm	Vest. Quim.	Registro
5:00-7:00pm	Vest. Quim.	Mesas de auspiciadores
5:00-6:00pm	Vest. Quim.	Afiches
5:30-5:55pm		Conferencias
	Q124	<i>Geometría, olimpiadas matemáticas y educación pre-universitaria</i> Arturo Portnoy
	Q125	<i>Towards a conjecture of non-linear APN functions</i> Moises Delgado Olortegui y Heeralal Janwa
	Q150	<i>Scheduling master-worker divisible tasks</i> Luis de la Torre-Quintana
	Q151	<i>Eigenvalues of graphs and their applications: survey and new results</i> Xuerong Yong
6:00-6:25pm		Conferencias
	Q124	<i>El problema de resolver ecuaciones trigonométricas: un primer acercamiento usando la Teoría APOS</i> Rafael Martínez Planell y Angel Cruz
	Q125	<i>Método cuasi-experimental para la evaluación de un proyecto educativo: AFAMaC matemáticas</i> Jairo Arturo Ayala Godoy y César Barreto
	Q150	<i>On a family of convex solutions for certain hyperbolic PDE</i> Krzysztof Rozga
	Q151	<i>Solución de la ecuación de Schroedinger en un espacio no Euclidiano bidimensional</i> Alfredo Villanueva Cueva
6:30-6:55pm		Conferencias
	Q124	<i>La olimpiada de matemáticas más grande del mundo</i> Luis Cáceres Duque
	Q125	<i>Desarrollo profesional para maestros de matemáticas que incluye resolución de problemas y mentorías</i> Yuri Rojas Ramírez, Luis Cáceres Duque y Raúl E. Macchiavelli
	Q150	<i>Equivalents for a quasivariety of algebraic structures to be generated by a single structure</i> Wieslaw Dziobiak, A. Kravchenko y Piotr Wojciechowski
	Q151	<i>Recent results for variable exponent Sobolev and Maz'ya spaces on non-smooth domains</i> Alejandro Velez-Santiago
7:00-8:00pm	Anf. Enf.	<i>Matemática con sentido: su aprendizaje y enseñanza</i> Ana Quintero
8:00-9:30pm	Mezzanine	Actividad de confraternización
Sábado 3 de marzo de 2012		
7:00-8:15am	Vest. Quim.	Registro & Desayuno
8:00-10:00am	Vest. Quim.	Mesas de auspiciadores

Hora	Lugar	Actividad
8:00-8:25am		Conferencias
	Q124	<i>A stochastic analysis of the motion of DNA nanomechanical bipeds</i> <u>Anastasios Matzavinos</u>
	Q125	<i>Modelos lineales generalizados mixtos con distribución binomial negativa</i> Jairo Arturo Ayala Godoy
	Q150	<i>On soliton solutions for nonlinear Schroedinger equations</i> <u>Erwin Suazo</u>
	Q151	<i>Netflow data visualization framework using custom queries</i> <u>Albert E. Maldonado-Sanchez</u> , Eric Santos, Juan Rodriguez, Gilberto Ramos y José Ortiz-Ubarri
	Q152	<i>A systematic encoder for a class of graph based codes</i> <u>Fernando Piñero</u> , Peter Beelen y Tom Høholdt
	Q222	<i>Asserting parallel computational thinking: a curricular experience</i> <u>Zoraida Santiago</u> , Cynthia Lucena-Roman, Rafael Arce-Nazario y Edus- mildo Orozco
8:30-8:55am		Conferencias
	Q124	<i>Spreading speed and traveling waves solutions for reaction-diffusion mo- dels of STDs for populations in the wild.</i> Fernando Carreon, Joaquin Rivera y Carlos Castillo-Chavez
	Q125	<i>Aplicaciones de modelos lineales generalizados mixtos para el análisis es- tadístico de recuentos de semilla en el Bosque Seco de Guánica</i> <u>Raúl E. Macchiavelli</u>
	Q150	<i>Relating ion channel expression, bifurcation structure, and firing patterns in a biophysical model of a motor neuron</i> <u>Erin C. McKiernan</u> y Marco Arieli Herrera Valdez
	Q151	<i>Instrumenting builds</i> <u>Marko Schütz-Schmuck</u>
	Q152	<i>Primitive graphs and boolean monomial dynamical systems</i> Dorothy Bollman y Omar Colón-Reyes
	Q222	<i>Application of the covering method to divisibility of boolean functions</i> <u>Ivelisse Rubio</u> , Francis Castro y Luis Medina
9:00-9:25am		Conferencias
	Q124	<i>A numerical approximation and parameter estimation for modeling bee pollination of almond orchards</i> Kamuela Yong, Yi Li y Stephen Hendrix
	Q125	<i>Climate change implications on the suitability for Mimosa pigra in Puerto Rico</i> M. Julio Barragán, <u>Yetsabel Auccaille</u> y Wilfredo Robles
	Q150	<i>Improving the Hodgking and Huxley model by taking diffusion into account</i> <u>Marco Arieli Herrera Valdez</u>
	Q152	<i>A fixed point semantics for a family of graph algorithms</i> <u>Einstein Morales</u> y Dorothy Bollman
	Q222	<i>Partial improvement to Moreno-Moreno's theorems</i> <u>Francis Castro</u>
9:30-9:55am		Conferencias

Hora	Lugar	Actividad
	Q124	<i>Epidemic spread of influenza viruses: the impact of transient populations on disease dynamics</i> <u>Karen Rios-Soto</u> , Baojun Song y Carlos Castillo-Chavez
	Q125	<i>Un algoritmo para clasificación no supervisada de datos funcionales</i> <u>César Barreto</u>
	Q150	<i>A continuation method for the computation of fracture surfaces in strain space</i> <u>Pablo V. Negrón Marrero</u> y Jeyabal Sivaloganathan
	Q151	<i>Detección de subgrafos frecuentes</i> <u>Melissa López Serrano</u> y José O. Sotero Esteva
	Q152	τ_2 -Number theory <u>Reyes Ortiz-Albino</u>
	Q222	<i>Funding opportunities in the Division of Mathematical Sciences of the National Science Foundation</i> <u>Tomek Bartoszynski</u>
10:15-10:30am	Anf. Enf.	Bienvenida
10:30-11:30am	Anf. Enf.	<i>Skeins and characters</i> <u>Charles Frohman</u>
11:30-1:30pm	Mezzanine	Almuerzo
1:30-2:30pm	Anf. Enf.	<i>On integrability of nonautonomous nonlinear Schroedinger equations</i> <u>Sergei Suslov</u>
2:30-3:55pm	Vest. Quim.	Mesas de Auspiciadores
2:30-2:55		Conferencias
	Q124	<i>On complete integrability of character varieties of surfaces</i> <u>Adam Sikora</u>
	Q125	<i>Análisis de incertidumbre y sensibilidad: un modelo de transmisión de VIH/SIDA en Puerto Rico</i> Dámaris Santana Morant, Karen-Rios Soto y <u>Yetsabel Aucaille Quispe</u>
	Q150	<i>Objective bayesian dynamic linear model approach to modeling time series in Puerto Rico</i> <u>Walter Quispe</u> y Luis Pericchi Guerra
	Q151	<i>La descomposición genética del problema de graficar funciones de dos variables: resultados de un último ciclo de entrevistas</i> <u>Rafael Martínez Planell</u> y Maria Trigueros Gaisman
	Q152	<i>Measuring the symmetry of a finite group</i> <u>Dennis Collins</u>
	Q222	<i>The higher derived functors of the primitive element functor of quasitoric manifolds</i> <u>José La Luz</u> y David Allen
3:00-3:25pm	Q124	<i>Quatum representations of the mapping class group of a torus</i> <u>Joanna Kania-Bartoszyńska</u> , Michael Fitzpatrick y Charles Frohman
	Q125	<i>Methodological enhancements using "Resampling Sensitivity Rates" for Age-Period-Cohort Robust Bayesian Models for forecasting cancer incidence and mortality</i> <u>David Torres Núñez</u> , Luis Pericchi Guerra y Isabel Ramírez

Hora	Lugar	Actividad
	Q150	<i>Using a mathematical model of the spread of Mimosa pigra in Puerto Rico to estimate cost-effectiveness of alternative control measures</i> M. Julio Barragán, Iván Henríquez, <u>Arlin Alvarado</u> y Wilfredo Robles
	Q151	<i>Programación de horarios usando algoritmos genéticos</i> Jesus Rodriguez Rodriguez y Pedro Vasquez Urbano
	Q152	<i>The work of a biostatistician and graduate school requirement in biostatistics</i> <u>Gideon Zamba</u>
	Q222	<i>Eigenvalues and hypercyclicity in omega</i> <u>Hector Salas</u>
3:30-3:55pm	Q124	<i>A plumbing of state surfaces, and the colored Jones polynomial</i> <u>Oliver Dasbach</u> y Cody Armond
	Q125	<i>ROI pattern recognition using Markov random fields</i> <u>Giovany Vega Viera</u> y Carlos Corrada Bravo
	Q150	<i>A reliability study of square wave bursting β-cells with noise</i> Jiaoyan Wang, Jianzhong Su, <u>Humberto Perez Gonzalez</u> y JonathanRubin
	Q151	<i>Análisis de actividades para graficar funciones de dos variables usando los “momentos de estudio” de la teoría antropológica de lo didáctico</i> <u>Rafael Martinez Planell</u> y Maria Trigueros Gaisman
	Q152	<i>Mathematica 8 in education and research</i> <u>Ginger McKee</u>
	Q222	<i>Interior operators and topological separation</i> <u>Gabriele Castellini</u> y Edwin Murcia

3. Resúmenes de conferencias plenarias (invited talks)

Matemática con sentido: su aprendizaje y enseñanza

Ana Quintero, Departamento de Matemáticas, Universidad de Puerto Rico - Río Piedras

En la conferencia se analiza cómo se aprende la matemática y cómo este conocimiento debe llevarnos a cambiar la forma como tradicionalmente se ha enseñado esta disciplina. Junto a los principios del aprendizaje comunes con otras disciplinas, se discuten las particularidades del aprendizaje matemático. Se ejemplifican estos principios con la descripción del desarrollo cognoscitivo de varios conceptos matemáticos, mostrando a su vez los cambios que este desarrollo requieren de la enseñanza.

Keywords: educación

Skeins and characters

Charles Frohman, Department of Mathematics, University of Iowa

The Kauffman bracket skein relation is a linear relation between knot diagrams that differ at a single crossing. It can be used to compute the Jones polynomial effectively. I will explain the relationship between the Kauffman bracket skein relation and the Cayley-Hamilton identity for 2×2 matrices of determinant 1. This leads to defining algebras from knot diagrams on surfaces that are deformations of character rings of surface groups. I will then give a geometric explanation of the Jones polynomial in terms of character varieties of surface groups. The first 30 minutes of the talk should be accessible to a general audience, the next 20 will require some acquaintance with algebraic and symplectic geometry.

Keywords: skein, Jones polynomial, Kauffman bracket

On integrability of nonautonomous nonlinear Schroedinger equations

Sergei Suslov, Department of Mathematics, Arizona State University

We show, in general, how to transform nonautonomous nonlinear Schroedinger equation with quadratic Hamiltonians into the standard autonomous form that is completely integrable by the familiar inverse scattering method in nonlinear science. Derivation of the corresponding equivalent nonisospectral Lax pair is outlined. Applications to bose condensates and plasma physics are discussed.

Keywords: nonautonomous nonlinear equation

4. Sesiones temáticas (mini symposiums)

4.1. Solución de problemas (problem solving)

Geometría, olimpiadas matemáticas y educación pre-universitaria

Arturo Portnoy, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico en Mayagüez

Se presentará un resumen sobre el pobre estado de la geometría en la educación pre-universitaria, en contraste con su importancia dentro de las olimpiadas matemáticas. Además se hablará sobre temas

dentro de la geometría plana de importancia fundamental en la preparación para estas competencias, y se ilustrará con problemas de olimpiadas internacionales y otras competencias.

Keywords: geometría, olimpiadas matemáticas, educación pre-universitaria

El problema de resolver ecuaciones trigonométricas: un primer acercamiento usando la Teoría APOS

Rafael Martinez Planell, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico - Mayagüez

Angel Cruz, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico - Mayagüez

Esto es una presentación de un estudio que está comenzando. Primero hacemos un breve recuento de los resultados en la literatura de matemática educativa relativos a las funciones trigonométricas. Luego, discutimos algunos elementos de una descomposición genética preliminar y el instrumento que usamos para ponerla a prueba. Después examinamos los resultados de un primer ciclo de entrevistas y lo que éstos aportan al estudio. Terminamos discutiendo los próximos pasos a seguir en el estudio.

Keywords: APOS, trigonometría, ecuaciones trigonométricas, esquema

La olimpiada de matemáticas más grande del mundo

Luis Cáceres Duque, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico en Mayagüez

La Olimpiada Canguro Matemático es la olimpiada internacional de matemáticas en donde participa el mayor número de estudiantes. Se presentará la estructura de esta olimpiada y algunas estadísticas relacionadas a los países participantes. Se hará un análisis de los problemas de matemáticas que aparecen en esta olimpiada.

Keywords: olimpiadas

4.2. Matemática biológica (mathematical biology)

A stochastic analysis of the motion of DNA nanomechanical bipeds

Anastasios Matzavinos, Department of Mathematics, Iowa State University

We formulate and analyze a Markov process modeling the motion of DNA nanomechanical walking devices. We consider a molecular biped restricted to a well-defined one-dimensional track and study its asymptotic behavior. Our analysis allows for the biped legs to be of different molecular composition, and thus to contribute differently to the dynamics. Our main result is a functional central limit theorem for the biped with an explicit formula for the effective diffusivity coefficient in terms of the parameters of the model. A law of large numbers, a recurrence/transience characterization and large deviation estimates are also obtained. Our approach is applicable to a variety of other biological motors such as myosin and motor proteins on polymer filaments. This is joint work with Iddo Ben-Ari and Alexander Roitershtein.

Keywords: DNA nano-devices; molecular motors; controlled random walks; Markov additive processes; law of large numbers; recurrence-transience criteria; large deviations; central limit theorem; regeneration structure

Spreading speed and traveling waves solutions for reaction-diffusion models of STDs for populations in the wild.

Fernando Carreon, Department of Mathematics, University of Michigan

Joaquin Rivera, Department of Mathematics, Colgate University

Carlos Castillo-Chavez, Mathematical and Computational Modeling Sciences Center, Arizona State University

In the talk, I will discuss a Susceptible-Infected-Susceptible (SIS) model for the spatial-spread of sexually transmitted diseases (STD), in spatially mobile heterosexually active populations. First, we will consider a single strain SIS reaction-diffusion model with density dependent recruitment rates. Then, we will reformulate the model to include multiple competing strains of the same pathogen. I will demonstrate the existence of a minimal speed at which the disease spreads to a non-infected region in the form of a traveling wave. Finally, I will discuss a single-strain model with multiple stages of infections.

Keywords: mathematical epidemiology, traveling waves, linear determinacy

A numerical approximation and parameter estimation for modeling bee pollination of almond orchards

Kamuela Yong, Applied Mathematical and Computational Sciences, The University of Iowa

Yi Li, Department of Mathematics and Statistics, Wright State University

Stephen Hendrix, Department of Biology, The University of Iowa

California's almond industry, valued at \$1.9 billion per year depends on successful cross-pollination. Almond growers mainly depend on honey bees, although other insects are being investigated as alternatives due to honey bee declines. Our objective is to model the movements of honey bees to determine if in the presence of other pollinators, honey bees will forage in less favorable areas of a tree and its surroundings. We use the SKT model (1979) which describes the density of two species in a 2D environment of variable favorableness with respect to intrinsic, self, and cross-diffusions. This model is applied to almond pollination by honey bees and other pollinators with environmental favorableness based on empirical data measuring the attractiveness of the canopy for honey and other pollinators. We found cross-diffusion effects of other pollinators on honey bees result in honey bees foraging in less favorable areas of a tree and the area surrounding a tree. We hypothesize that increased honey bees in unfavorable environments will increase the probability of movement to a different variety of tree, thereby increasing successful pollination and fruit production. Using empirical data, we estimate the diffusion parameters using COPASI and compare with the model.

Keywords: mathematical biology

Epidemic spread of influenza viruses: the impact of transient populations on disease dynamics

Karen Rios-Soto, Mathematical Sciences Department, University of Puerto Rico at Mayagüez

Baojun Song, Mathematical Sciences, Montclair State University

Carlos Castillo-Chavez, Mathematical and Computational Modeling Science Center, Arizona State University

We introduce a model that incorporates the interactions between migratory and local bird populations and their role on dispersal and persistence of avian diseases. A metapopulation framework based on a system of nonlinear ordinary differential equations is used to study the transmission dynamics and control of avian influenza. A simplified version of the mathematical model involving a three flock system of bird populations is analyzed. Epidemiological time scales and singular perturbation methods are used to reduce the dimensionality of the model. Results show that mixing of local (resident) and migratory (transient) bird populations play an important role on the patterns of disease spread.

Acknowledgements: Math. Biosc., Vol 8, Number 1 (2011), 201-224.

Keywords: epidemic models, epidemiological time scales, singular perturbation theory; avian influenza

4.3. Topología en dimensión 3 (topology in dimension 3)

On complete integrability of character varieties of surfaces

Adam Sikora, Department of Mathematics, SUNY Buffalo

It is known that the trace functions of a maximal set of disjoint simple closed curves on a closed surface make its $SL(2, \mathbb{C})$ -character variety into a completely integrable dynamical system and, hence, lead to a system of action-angle coordinates. We prove an analogous statement for rank 2 Lie groups. Time permitting we will discuss the application of this result to quantization of character varieties.

Keywords: quantum invariants

Quantum representations of the mapping class group of a torus

Joanna Kania-Bartoszyńska, Division of Mathematical Sciences, National Science Foundation

Michael Fitzpatrick, Mathematics, The University of Iowa

Charles Frohman, Mathematics, The University of Iowa

Mapping class group of a surface consists of isotopy classes of diffeomorphisms of the surface onto itself. The Kauffman bracket is a quantum invariant of links. We will describe a topological quantum field theory underlying the Kauffman bracket, and the quantum representations of the mapping class group of a surface obtained from this theory. We show that the quantum projective representations of a once punctured torus, which are defined at roots of unity, extend continuously to the whole circle.

Keywords: Kauffman bracket skein module, mapping class group of a surface

A plumbing of state surfaces, and the colored Jones polynomial

Oliver Dasbach, Department of Mathematics, Louisiana State University

Cody Armond, Department of Mathematics, Louisiana State University

For a given knot or link L the colored Jones polynomial is a sequence of one variable Laurent polynomials $J(N,L)$, indexed by a number N . For certain classes of links one can extract a power series $T(L)$ from the sequence $J(N,L)$ such that the first N coefficients of $T(L)$ coincide with the first N coefficients of $J(N,L)$. In the case of the figure-8 knot $T(L)$ is essentially the Dedekind eta-function.

We study the link invariant $T(L)$, and we describe a plumbing on certain surfaces in the knot complement, and its effect on $T(L)$.

Keywords: colored Jones polynomial

5. Resúmenes de conferencias concurrentes (concurrent talks)

Netflow data visualization framework using custom queries

Albert E. Maldonado-Sanchez, Department of Computer Science, University of Puerto Rico at Rio Piedras

Eric Santos, Department of Computer Science, University of Puerto Rico at Rio Piedras

Juan Rodriguez, Department of Computer Science, University of Puerto Rico at Rio Piedras

Gilberto Ramos, Department of Computer Science, University of Puerto Rico at Rio Piedras

José Ortiz-Ubarri, Department of Computer Science, University of Puerto Rico at Rio Piedras

In this work we are applying visualization analytic techniques using open source visualization tool-kits to help analyse and visualize huge data networks and their structures. Using visualizations techniques we aim to find the best ways to present the data, making it possible to understand a big portion of what is happening or what needs closer inspection in a network, just by looking at a display. In a field that requires quick response to threats and constant analyzing of huge amounts of data, the ability to have the information quickly and understandable is crucial.

In our current work we are implementing a custom query system to give users more control over what data is displayed. We mean to give users control of the type of data, the time, and from where the data is displayed. This will provide benefits to system administrators like being able to analyze the data in a desired period of time, inspecting anomalies and identify the exact moment where something went wrong.

Acknowledgements: Thanks to the High Performance Computing facility (HPCf) staff for the advice and support, especially to Ramon Sierra, Humberto Ortiz-Zuazaga, and William Caban

Keywords: netflow, visualization, open source framework, queries

Recent results for variable exponent Sobolev and Maz'ya spaces on non-smooth domains

Alejandro Velez-Santiago, Department of Mathematics, University of Puerto Rico at Humacao

Let $\Omega \subseteq \mathbb{R}^N$ be a general bounded domain, and let μ be a finite Borel measure supported on the boundary $\partial\Omega$. The main purpose of this talk consists on the discussion of recent results concerning

the Sobolev space $W^{1,p(\cdot)}(\Omega)$ and the generalized Maz'ya space $W_{p(\cdot),q(\cdot)}^1(\Omega, \partial\Omega, d\mu)$. We present some trace results for Sobolev functions, provided that Ω , $p(x)$, and μ fulfill some properties. In addition, we define the corresponding generalized Maz'ya spaces of variable exponent, and obtain embedding results similar as in the constant case. Some relations between the variable exponent Maz'ya spaces and the variable exponent Sobolev spaces are also achieved. At the end we give an application of the previous results for the well-posedness of a class of quasi-linear equations with variable exponent, which are of major importance in the study of differential equation with the non-standard growth condition.

Keywords: extension domains, upper d -Ahlfors measure, variable exponent Sobolev spaces, variable exponent Maz'ya spaces, traces

Solución de la ecuación de Schroedinger en un espacio no Euclidiano bidimensional

Alfredo Villanueva Cueva, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico - Mayagüez

Se han estudiado en gran medida soluciones de la ecuación de Schroedinger para espacios Euclidianos, a la fecha se tienen muchos resultados que se centran en aumentar la complejidad del Hamiltoniano. La motivación aquí es por el contrario, aumentar la complejidad del espacio, es decir, trabajamos en espacios no Euclidianos, específicamente en un espacio bidimensional de curvatura no constante. Para esto usaremos algunas ideas hechas en el espacio de Darboux tipo I.

Keywords: ecuacion de Schroedinger, espacio de Darboux, espacios no euclidianos

Using a mathematical model of the spread of Mimosa pigra in Puerto Rico to estimate cost-effectiveness of alternative control measures

M. Julio Barragán, Department of Agricultural Economics and Rural Sociology, University of Puerto Rico - Mayagüez

Iván Henríquez, Department of Mathematical Sciences, University of Puerto Rico - Mayagüez

Arlin Alvarado, Department of Mathematical Sciences, University of Puerto Rico - Mayagüez

Wilfredo Robles, Department of Crop and Environmental Sciences, University of Puerto Rico - Mayagüez

We want to use a mathematical simulation model to evaluate the cost-effectiveness of alternative measures aimed at controlling the spread of invasive species *Mimosa pigra* in Puerto Rico. The simulation model we use takes explicit account of dispersal mechanisms of the invasive species as well as landscape heterogeneity. It consists of a computational framework (MDiG) that uses cellular automata to simulate short distance dispersion and draws from several probability distributions to simulate long distance dispersion. The impact of the environment on the survival of the invasive species is modeled with the use of a suitability map. Both modeling components are set up in a GIS framework. We chose plausible dispersion parameter values from the literature and took the survival probabilities to be the predicted suitability index estimated by Barragán, et al. (2011). We assumed an initial spatial distribution of the species and ran the model for 20 successive periods computing the infested area after each period. We repeated this procedure 100 times and computed, for each period, the average infested area. We then computed the average infested area at period 20 over the 100 repetitions. We used this simulation as our control. We then defined two alternative control measures. Each control treatment had a cost per unit of area and reduced the survival probability of the weed in the area where it was used. One control measure was more effective than the other in reducing the probability of survival, but was also costlier. For each control measure, we defined two alternative control policies.

Each control policy consisted of a choice of pixels where the treatment would be applied. Each control policy had a budget constraint. In each case we run a complete simulation as above and compared the average invested area with that obtained with the control. Both the choice of treatment and decision of where to apply the treatment had an impact on the effectiveness of the control measures.

Acknowledgements: Project USDA TSTAR-132

Keywords: dispersal, simulation, invasive species, Mimosa pigra, MDiG, control, economics, cost-effectiveness

Un algoritmo para clasificación no supervisada de datos funcionales

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La estadística multivariada ofrece diversas herramientas que permiten realizar un análisis para ciertos conjuntos de datos. Sin embargo surge una rama de la estadística en la cual se dejan de observar conjuntos de datos de forma puntual y se empieza a pensar en conjuntos de datos que consisten en funciones como tal. Es decir, se deja de pensar en un conjunto de puntos que representan cierta característica y se empieza a pensar en una función que representa una característica en el transcurso de un continuo. Por tal razón, es útil investigar la extensión de las herramientas del campo multivariado al de los datos funcionales. En este trabajo se realiza una propuesta para la clasificación no supervisada para datos funcionales. Esta propuesta consta de dos etapas, una de suavización, en la cual se busca obtener una función que describa a un conjunto de puntos discretos tomados sobre un continuo, el cual en la mayoría de los casos es el tiempo. En la segunda etapa, se lleva a cabo la clasificación, en la cual a partir de los coeficientes obtenidos en la suavización que describen la función, se realiza la clasificación usando un método no supervisado. Los resultados obtenidos son comparables y hasta mejoran los tradicionales, de acuerdo a las medidas de validación usada.

Keywords: analisis de datos funcionales, clasificación no supervisada, clustering

Methodological enhancements using “Resampling Sensitivity Rates” for Age-Period-Cohort Robust Bayesian Models for forecasting cancer incidence and mortality

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Age-Period-Cohort (APC) dynamic models are a powerful tool in Predictive Epidemiology for estimating the present (cancer data has unavoidable delays) and forecasting both incidence and mortality by age and gender, classified by primary cancer tumor. We present a methodological improvement in the definition of the model and provide valuable tools to assess the adequacy of the model, and to estimate its hyper-parameters using a novel algorithm called Resampling Sensitivity Rates (RSR) and develop ways to use its predictions to evaluate the completeness of a Cancer Registry in a given period. The dynamic autoregressive models, used in most predictive epidemiology problems, are function of age-period-cohort (APC). Robust priors were fitted using Bayesian methods, replacing the unreliable, but very often used, Inverted Gamma distribution for variances. We propose to use the family of Scaled-Beta 2 distributions to robustly model the variances in the models. This family shows at the same time heavy tails and sensible (bounded) behavior at the origin. Guidance about assessment of

hyper-parameters is given by RSR. We found that this leads to a stable convergence of the model at the Markov Chain Monte Carlo (MCMC) implementation. Also a procedure of Bayesian cross-validation is implemented to assess the validity of the predictions (without using the data twice) and also goodness of fit measures are provided. Predictions and its intervals, per age bracket of the dynamical hierarchical model, are used to assess the completeness of the data recollection and data screening. In regions, such as Puerto Rico, on which there is no report of race, a measure of completeness not race-based is unavoidable.

Acknowledgements: Cancer Registry of Puerto Rico, Merck.

Keywords: resampling, predictive epidemiology, bayesian statistics, Markov chain, Monte Carlo methods, scaled-beta 2, robust analysis

Measuring the symmetry of a finite group

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A method is given to measure the symmetry of any finite group according to the author's 2007 (2011) patent and examples are presented. For example, the dihedral group of the square of order eight has SYM Dih4(6) symmetry SYM = 122, and the quaternion group of order eight has SYM symmetry = 282. The two non-isomorphic groups of order four have the same SYM symmetry 7.

Keywords: finite group, symmetry

Primitive graphs and boolean monomial dynamical systems

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A boolean monomial dynamical system is a fixed point system if and only if every strongly connected component of the dependency graph is primitive. Furthermore, the transient of each fixed point is equal to the exponent of the corresponding component of the dependency graph. Thus the problem of finding transients in boolean monomial dynamical systems is equivalent to the problem of determining exponents of primitive graphs. However, there is no known formula for determining either transients or exponents. In this ongoing work we seek to determine the exponent of a special class of primitive graphs, which in turn, corresponds to the simplest class of nonlinear systems. We give an upper bound for the exponent of such a primitive graph in terms of the Frobenius function. We conjecture that this bound is actually achieved, thus implying that the problem of determining the transient of a boolean monomial dynamical systems is NP hard.

Keywords: primitive graph, boolean monomial dynamical systems

A fixed point semantics for a family of graph algorithms

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Dorothy Bollman, Department of Mathematical Sciences, University of Puerto Rico - Mayagüez

By a well known theorem of Haskell Curry, recursion can be expressed in terms of fixed points. In this work we consider a family of graph algorithms whose fixed point versions follow very naturally from their recursive formulations. These include breadth first search, transitive closure, strongly connected

components, and exponents of primitive graphs, among others. We discuss the fixed point versions of some of these algorithms, as well as their complexities, and we comment on their implementations in the functional language Haskell.

Keywords: recursion, fixed points

Relating ion channel expression, bifurcation structure, and firing patterns in a biophysical model of a motor neuron

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Neurons show incredible diversity in their firing patterns. Even the same identified neuron can display distinct electrical activity. We developed a two-dimensional, electrodiffusion-based model to explore what features of neuronal firing can be reproduced by changing the density and activation kinetics of identified delayed rectifier potassium channels. We find that small changes in channel density are able to reproduce activity resembling the main firing profiles observed in neural recordings, including delayed firing, previously thought to require the presence of a transient potassium current in many neurons. Changes in activation kinetics of the potassium channels produce additional features of electrical activity, such as action potentials which ride on a plateau. We use bifurcation analysis to describe the qualitatively different transitions between rest and spiking states that result from variations in channel density, thereby exposing a connection between ion channel expression, bifurcation structure, and diverse firing patterns in a biophysical model of membrane potential dynamics.

Acknowledgements: Sandra Berger, Stefanie Ryglewski, Carsten Duch, Sharon Crook

Keywords: neuron, ion channel, excitability, bifurcation, dynamical systems

On soliton solutions for nonlinear Schroedinger equations

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For nonlinear Schroedinger equation with variable coefficients we construct soliton-like solutions for certain choices of the coefficients, including important examples such as bright and dark solitons and Jacobi elliptic and second Painlevé transcendental solutions, which are important for current research in nonlinear optics and Bose-Einstein condensation. Also we show an example of existence of L^∞ finite time blowup for subcritical NLS. In the linear case we are able to construct the fundamental solution explicitly. We will give several examples inspired from solvable cases of the Riccati equation and emphasize an example involving Airy functions. A large part of the results presented have been done in joint work with Sergei K. Suslov.

Keywords: soliton solutions, nonlinear Schroedinger equations

A systematic encoder for a class of graph based codes

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Graph based codes is an important class of codes in coding theory because they have an improved decoding algorithm. However, efficient encoding of Graph Based codes remains an open problem. In this work, we give a set of information positions and a set of systematic functions which allow us to perform systematic encoding for a particular class of graph based codes.

Keywords: graphs, codes, encoding, algebraic geometry, finite fields

Partial improvement to Moreno-Moreno's theorems

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In this work, we will introduce the p -weight degree of a polynomial over finite field with respect to a subset of the variables of the polynomial. Using the p -weight degree of a polynomial with respect to a subset of the variables of the polynomial, we improve the results of Moreno-Moreno (**Improvements of the Chevalley-Waring and the Ax-Katz theorems**, *Amer. J. Math.*) for polynomial equations and for exponential sums over finite fields. We prove that our results cannot be improved in general because a family of polynomials where our bounds are attained is provided. Our results give a p -adic version of the results of Cao in **Dilation of Newton Polytope and p -adic Estimate**, *Discrete Comput. Geom.* and **A Partial Improvement of the Ax-Katz Theorem**, *J. Num. Theory*. Combining our result with a result of Cao-Sun (**A Reduction for Counting the Number of Solutions of the General Diagonal Equations over Finite Fields**, *Finte Fields and Their Appl.*), we give an improvement to the p -divisibility of the general diagonal equation. This result generalizes the main result in **Optimal divisibility for certain diagonal equations over finite fields**, *J. Ramanujan Math. Soc.*.

Keywords: p -divisibility, finite fields

Interior operators and topological separation

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A notion of separation with respect to an interior operator in topology is introduced and some basic properties are presented. In particular, it is shown that this notion of separation with respect to an interior operator gives rise to a Galois connection between the collection of all topological spaces and the collection of all interior operators in topology. Characterizations of the fixed points of this Galois connection are given and examples are provided.

Keywords: interior operator, Hausdorff separation, Galois connection

The work of a biostatistician and graduate school requirement in biostatistics

Gideon Zamba, Department of Biostatistics, The University of Iowa

This talk presents an overview of Statistics and Biostatistics, and the window of opportunities they present to young mathematicians. The presentation further elaborates on the specific area of Biostatistics and advises on the mathematical and computational pre-requisites needed for Masters' and Ph.D. degrees in Biostatistics. This talk is not technical.

Keywords: biostatistics

Mathematica 8 in education and research

Ginger McKee, Academic Initiatives, Wolfram Research

If you haven't seen Mathematica lately, you will be surprised to see how suitable Mathematica is for projects and course examples in any mathematics or STEM field.

My talk is given in Mathematica, and a big part of what I will discuss is the exciting new free-form input in Mathematica 8.

Attendees with no prior experience report that this talk helps with getting started using Mathematica language and workflow. With improvements like the new free-form input and expanded areas like finance, statistics, engineering, software development, and image processing, even the most advanced users report learning quite a bit from attending this talk. All attendees will receive an electronic copy of the examples, which can be adapted to individual projects.

Keywords: computer graphics, symbolic computing, statistics, probability, differential equations, data analysis

ROI pattern recognition using Markov random fields

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An approach to signal analysis is to divide the problem into two steps: data reduction, and analysis on the reduced data. The data reduction step tries separate the background noise from the data of interest. This separation is usually made by identifying regions of interest (ROIs) in the signal, which usually are areas containing outliers within the signal. In the second step, these ROIs are then classified and their spatial relation gets analyzed in order to extract a conclusion from said signal. In signals with many mixed elements, the performance of said conclusion is intrinsically dependent on the "goodness" of the ROI classification.

We present a method for classifying these ROIs by using Markov random fields (MRFs) as templates, and apply it to the problem of detecting a specie's call song in an audio recording. These MRFs are able to model the local energy structure within a ROI and, as such, determine a probability it being a particular note within the specie's song.

Acknowledgements: ARBIMON for providing the data

Keywords: pattern recognition, rois, Markov random fields

Eigenvalues and hypercyclicity in omega

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Let X be a Fréchet space. Recall that $T \in \mathcal{L}(X)$ is said to be hypercyclic if there is $x \in X$ such that $\{T^n x : n = 0, 1, 2, 3, \dots\}$ is dense in X .

Let \mathbb{K} be either \mathbb{C} or \mathbb{R} . The space $\omega = \mathbb{K}^{\mathbb{N}}$ is the countably infinite product of \mathbb{K} endowed with the product topology. The operators (linear and continuous) from ω into itself will be denoted, as usual, by $\mathcal{L}(\omega)$. We will identify the operators with their representing matrices with respect to the canonical basis $\{e_k : k = 1, 2, \dots\}$ where the k -th coordinate of e_k is 1 and all the others are zero.

ω is perhaps the most elementary infinite dimensional Fréchet space. In some sense its topology is the most similar to a finite dimensional vector space.

We define the class of upper staircase matrices on ω . Such matrices have a plethora of eigenvalues and eigenvectors, and they are hypercyclic. We show that countably many strictly upper triangular matrices on ω which are also upper staircase have a common hypercyclic subspace. This last result partially extends a theorem of Bès and Conejero.

Acknowledgements: I would like to thank professors Dorothy Bollman and Juan Bès for very useful conversation. I would also like to thank both referees of RACSAM for their insightful comments.

Keywords: hypercyclicity, omega

A reliability study of square wave bursting β -cells with noise

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Reliability of spike timing has been a hot topic recently. However reliability has not been considered for bursting behavior, as commonly observed in a variety of nerve and endocrine cells, including β -cells in intact pancreatic islets. In this paper, reliability of β -cells with noise is considered. A method to numerically study reliability of bursting cells is presented. Reliability of a single cell will decrease as noise level becomes larger. The reliability of networks of β -cells coupled by gap junctions or synaptic excitation is investigated. Simulations of the network of β -cells reveal that increasing noise level decreases the reliability. But the reliability of the network is higher than that of single cell. The effect of coupling strength on reliability is also investigated. Reliability will decrease when coupling strength is small and increase when coupling strength large.

Keywords: square wave bursting, reliability, gap junction coupling, synaptic coupling.

Application of the covering method to divisibility of boolean functions

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Moreno-Moreno introduced a combinatorial method, called the covering method, which provides an elementary way to estimate the divisibility of exponential sums over the binary field. Using this method,

they gave an improvement to Ax's theorem for the binary case. Recently, Castro-Randriam-Rubio-Mattson generalized the use of the covering method to any finite field providing an elementary approach to compute the p -divisibility of exponential sums of polynomials over prime fields. The authors obtained several bounds which unify and improve a number of previous results in this direction. Castro-Medina-Rubio used the covering method to compute the exact 2-divisibility of exponential sums of boolean functions with prescribed leading monomials and, as an application, families of boolean functions that are not balanced, and sufficient conditions for the solvability of systems of boolean equations were given. These results generalized previous known results for the binary field.

In this paper, we consider families of boolean functions where the number of minimal coverings is greater than one. This case is much harder than the cases previously considered, where the families have only one minimal covering. Using the covering method, we compute the exact 2-divisibility of exponential sums of polynomials where the leading monomials are symmetric. Also, we compute the exact 2-divisibility of exponential sums of deformations of symmetric or homogeneous boolean functions.

Keywords: exponential sums, boolean functions

Modelos lineales generalizados mixtos con distribución binomial negativa

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El modelo lineal generalizado mixto (MLGM) es un modelo muy utilizado con efectos aleatorios. Es una buena alternativa para los modelos lineales mixtos tradicionales cuando no se satisface el supuesto de distribución normal.

En este trabajo se estudian algunas propiedades de los modelos lineales generalizados mixtos cuando la distribución condicional de las observaciones es Binomial Negativa y la distribución de efectos aleatorios es normal. Comparamos estas propiedades con las de los modelos lineales generalizados mixtos con distribución condicional Poisson.

La distribución binomial negativa ha sido ampliamente utilizada para modelos de recuentos, y es la alternativa estándar para recuentos Poisson con sobredispersión, mediciones repetidas y datos correlacionados. Los MLGMs utilizando la distribución condicional binomial negativa pueden ser muy útiles para modelos de recuentos, posibles correlaciones y sobredispersión.

Se estudian algunas de las propiedades de este modelo, tales como la distribución marginal inducida, sus momentos, y la relación entre las distribuciones condicionales que definen el modelo y la distribución marginal inducida. Muchas de estas propiedades se estudian por medio de simulaciones en R y SAS, ya que son analíticamente intratables.

Finalmente, aplicamos estos modelos a un problema real basado en los resultados encontrados en un estudio sobre recuentos de semillas recolectadas en trampas en el bosque seco de Guánica (Puerto Rico) entre 2006 y 2008 bajo distintos tratamientos.

Acknowledgements: Raúl Macchiavelli, Ph.D.

Keywords: modelos lineales

Método cuasi-experimental para la evaluación de un proyecto educativo: AFAMaC matemáticas

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AFAMaC matemáticas, es un proyecto abarcador de mejoramiento profesional con un componente amplio de apoyo para el maestro de matemáticas llevado a cabo por el Departamento de Ciencias Matemáticas del Recinto Universitario de Mayagüez y el Departamento de Educación de Puerto Rico. En este proyecto participan maestros de 4^{to} a 12^{mo} grado de escuelas públicas y privadas de los distritos escolares de Mayagüez, Hormigueros, Rincón, Aguada, Moca y San Sebastián.

La característica principal del proyecto es que es uno con énfasis en contenido matemático y un mejoramiento profesional continuo y sostenido. El proyecto tiene un componente de evaluación muy importante siguiendo el modelo general de evaluación de proyectos educativos (diagnóstico, formativo y sumativo) junto con un estudio cuasi-experimental para medir resultados tanto en los maestros participantes como en sus estudiantes.

Acknowledgements: Raúl E. Macchiavelli, Luis Cáceres Duque

Keywords: educación

Programación de horarios usando algoritmos genéticos

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El Departamento de Ciencias Matemáticas de la Universidad de Puerto Rico en Mayagüez ofrece sobre 210 secciones distribuidas en 13 salones regulares, dos laboratorios y dos anfiteatros. Es un proceso difícil el programar las clases de los cursos en los horarios establecidos debido a las limitaciones físicas, variación en la cantidad de créditos de los cursos, satisfacción de los pedidos de los profesores, entre otros.

El problema se puede plantear usando programación lineal que está muy relacionado a un problema de asignación, sin embargo su solución en tiempo real para el problema de asignar las clases a los profesores es computacionalmente imposible debido a que las variables son enteras. Una alternativa a la solución a este problema es desarrollar heurísticas cuyo objetivo es determinar un horario de clases que satisfaga la mayor cantidad de preferencias de profesores, como: preferencia de clases, bloques de horario y salones que permitan obtener la mejor solución en un tiempo razonable.

Keywords: programación lineal, problema de asignación, horarios, heurísticas

The higher derived functors of the primitive element functor of quasitoric manifolds

José La Luz,

David Allen,

Let P be an n dimensional, q neighborly simple convex polytope. For each P and a particular map of lattices $\lambda : \mathbb{Z}^m \rightarrow \mathbb{Z}^n$, where m is the number of facets of P , there are corresponding manifolds

$M^{2n}(\lambda)$ called quasitoric manifolds. These manifolds are a generalization of smooth projective varieties. We are interested in certain invariants of the homology of these spaces called the derived functors of the primitives. These functors are extremely hard to compute and are of interest to homotopy theory because of their link to the calculation of the homotopy groups of $M^{2n}(\lambda)$. We describe a result on the independence of λ on the derived functors of the primitives over the same P and briefly describe their interest to homotopy theorists.

Keywords: quasitoric manifolds, toric spaces, higher derived functors of the primitives

On a family of convex solutions for certain hyperbolic PDE

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A family of convex solutions of $\Phi_{xx} - f(x)\Phi_{yy} = 0$, for $x > 0$ and $y \in \mathbb{R}$, where f is positive and continuously differentiable in $(0, \infty)$, is discussed. It consists of all convex solutions of that equation which are of the form $\Phi(x, y) = p(x)q(y)$.

It is observed that a nonlinear part of convexity conditions in case of $f' \leq 0$ is related to an asymptotic behavior of $p(x)$ and $p'(x)$ as $x \rightarrow \infty$. Then, under an additional assumption that $\lim_{x \rightarrow \infty} f(x) > 0$, a satisfactory description of the set of all the functions p , which determine convex $\Phi(x, y)$ via the formula $\Phi(x, y) = p(x)q(y)$, is obtained. These functions $\Phi(x, y)$ are convex entropies for the corresponding p-system.

Keywords: p-systems, convex entropies

Scheduling master-worker divisible tasks

Luis de la Torre-Quintana, Science and Technology, UMET

A periodic scheduler for load-divisible jobs that are implemented in a Single Program Multiple Data (SMPD) style and conform to the master-worker paradigm is introduced. The scheduler minimizes the job Makespan under a maximal periodic production constrain termed Scheduler. This work considers only homogeneous clusters. Work underway shows that a similar scheduler is possible for heterogeneous clusters, but within a theoretical framework that departs significantly from the one presented in this work. This work discusses some experiments that used a MATLAB implementation of the scheduler to fine tune C++/MPI SMPD master worker programs to a motif finding problem.

Keywords: scheduling, divisible task, make-span

Improving the Hodgking and Huxley model by taking diffusion into account

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Excitable cells display transmembrane currents created by fast ionic transport through channels. These currents are typically simulated in terms of electrical drift without diffusion following the classical model of Hodgkin and Huxley. Formulations for currents that take diffusion into account are more realistic and capable of displaying experimentally observable phenomena that conductance-based models cannot reproduce. Conductance-based currents are shown to be linear approximations of drift-diffusion

currents. However, since conductance-based models of membrane potential include different currents, they are not just first-order approximations of models based on drift-diffusion currents. Bifurcation analysis and numerical simulations show that the two approaches predict qualitatively and quantitatively different behaviors in the dynamics of membrane potential. In fact, two neuronal membrane models with identical populations of ion channels, one written with conductance-based currents, the other with drift-diffusion currents, are non topologically equivalent. In particular, these models are different in their responses to excitatory synaptic input across different levels of ion channel expression. In general, the electrophysiological profiles of membranes modeled with drift-diffusion and conductance-based models having identical ion channel populations are different, potentially causing the input-output and computational properties of networks constructed with these models to be different as well. The drift-diffusion formulation is thus proposed as a theoretical improvement over conductance-based models that may lead to more accurate predictions and interpretations of experimental data at the single cell and network levels.

Acknowledgements: Joceline Lega, University of Arizona

Keywords: electric drift; electro-diffusion; conductance-based; excitability; ion channel; ion channel expression; bifurcation analysis; membrane potential; Neurophysiology

Instrumenting builds

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We want to statically extract accurate information from existing source code. For this extraction we instrument the build process of the source code. We consider several instrumentation techniques, compare their characteristics and limitations, and discuss the results we obtain by rewriting program executions using our library of wrapper functions. While the latter technique is generally applicable to any build process invoking separate compilers, we test it with builds of the NetBSD operating system, which consists a large, legacy code base with a complex build process.

The instrumentation we propose is an essential component in applications ranging from accelerating the build process, through quality assessment of the source code structure, to refactoring and translating legacy source code to OO languages.

Keywords: software engineering, reengineering,

Detección de subgrafos frecuentes

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La detección de subgrafos frecuentes en un grafo es un problema cuyo estudio ha adquirido auge desde la década pasada. Tiene aplicaciones en áreas que van desde el modelaje de relaciones sociales, redes informáticas, hasta la bioinformática y quimioinformática. Podemos encontrar en la literatura definiciones variadas del término subgrafos frecuentes. Todas dependen, en última instancia, de la definición de una medida de apoyo S_G y un umbral $\sigma \in \mathfrak{R}$. Para cada grafo G , se define la medida $S_G : \{P\} \rightarrow [0, \infty)$ donde $\{P\}$ denota un conjunto de grafos a ser detectados como subgrafos de G . Se requiere que S_G sea antimonótona: $P_1 \subset P_2 \implies S_G(P_1) \geq S_G(P_2)$. Se declara un grafo P como frecuente si $S_G(P) > \sigma$.

El problema del subgrafo frecuente se formula comúnmente como, dado un conjunto de posibles

subgrafos P de G , encontrar aquellos que son frecuentes en G . De interés teórico se puede mencionar el caso en que $\{P\} = \{K_n\}$ donde K_n es un clique de orden n . De interés práctico podemos pensar en P como un banco de datos que almacena aminoácidos o relaciones bioquímicas. También común, aunque menos frecuente, es la definición del problema como el detectar aquellos grafos G para los cuales un grafo P dado es un subgrafo. En ambas variantes, y en este contexto general, el problema es un caso especial del problema de isomorfismo de grafos que se sabe que es NP-completo.

En el problema abordado en este trabajo los grafos son no dirigidos. Sus vértices tienen etiquetas y se le ha asignado peso a sus aristas. Decimos que P es subgrafo de G si es isomorfo a un subgrafo inducido por un subconjunto de vértices de G . Se utiliza la medida de apoyo $S_G : \{P\} \rightarrow [0, 1]$, $S_G(P) := |\bigcup_{G' \subset G, P \cong G'} G'|/|G|$. Se toma como $\{P\}$ el conjunto de todos los subgrafos conexos de G inducidos por sus vértices.

En este trabajo se analiza un algoritmo para la detección de subgrafos frecuentes de un grafo G dado por un método en el que se hace crecer los candidatos a subgrafos frecuentes P añadiendo vértices.

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Keywords: teoría de grafos, isomorfismo, minería de datos

Towards a conjecture of non-linear APN functions

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Heeralal Janwa, Department of Mathematics, University of Puerto Rico at Rio Piedras

Let the field $L = F_q$, with $q = 2^n$ for some positive number n . A function $f : L \rightarrow L$ is said to be **almost perfect nonlinear** (APN) on L if for all $a, b \in L$, $a \neq 0$, the equation

$$f(x + a) + f(x) = b \tag{1}$$

have at most 2 solutions on L .

An APN function $f : L \rightarrow L$ is called exceptional APN if it is also APN on infinitely many extensions of L . It was conjectured that the only exceptional APN functions are the monomials $f(x) = x^{2^k+1}$ and $f(x) = x^{2^{2k}-2^k+1}$, called the Gold function and Kasami-Welch function respectively. It is proved that any polynomial function of odd degree is not exceptional APN provided it is not a Gold function or a Kasami-welch function. In this work we contribute to the conjecture by providing new infinite families of Gold degree polynomials which can not be exceptional APN. We also provide some results for families of Kasami-Welch degree polynomials.

Keywords: almost perfect non-linear, cryptography, differential attacks

A continuation method for the computation of fracture surfaces in strain space

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

Jeyabal Sivaloganathan, Department of Mathematical Sciences, University of Bath, Bath UK

In this talk we discuss the numerical aspects of computing the onset of cavitation-type material instabilities in solids. To model this phenomenon we use nonlinear elasticity to allow for the large, potentially infinite, stresses and strains involved in such deformations. On two previous papers, the authors introduced the concept of *volume derivative* which can be used to characterize the critical boundary displacements for cavitation. If a body occupies the region $\Omega \in \mathbb{R}^n$, and \mathbf{Ax} for $\mathbf{x} \in \Omega$ represents an affine boundary displacement for such a body, then the volume derivative $G(\mathbf{A})$ measures

the amount of energy (positive or negative) required to open a hole of unit volume in the given material. For a large class of materials, the *onset of cavitation-type material instabilities* can be characterized as the zero level set of G .

The bulk of the computational work in computing the zero level set of G is on the evaluation of the volume derivative $G(\mathbf{A})$ for many boundary displacements \mathbf{A} . Each evaluation of G requires the solution of a large-scale constrained optimization problem which we accomplish by combining three different numerical techniques, namely, regularization, penalization and a gradient flow iteration. This procedure for evaluating G forms the basis for the *continuation method* that we describe for approximating the zero level set of G . We present some preliminary results for two dimensional problems ($n = 2$) that show the effectivity of the continuation method for computing the zero level set of G versus the more direct approach of using a contour finding routine.

Acknowledgements: This research was sponsored in part by an International Joint Project Grant from the Royal Society of London and by the Partnership for Research and Education in Materials (PREM) program of the University of Puerto Rico at Humacao.

Keywords: cavitation, volume derivative, fracture surface, continuation method

La descomposición genética del problema de graficar funciones de dos variables: resultados de un último ciclo de entrevistas

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María Trigueros Gaisman, Matemáticas, Instituto Tecnológico Autónomo de México

En estudios anteriores aplicamos la teoría APOS y la teoría de representaciones semióticas para entender cómo los estudiantes construyen la noción de función de dos variables. Eso nos ha permitido establecer una descomposición genética de este concepto que está apoyada por datos resultantes de varios ciclos de observaciones. En esta presentación comenzamos resumiendo los resultados que tienen que ver con el entendimiento geométrico de los estudiantes y como estos se reflejan en la descomposición genética. Luego de esto, examinamos los resultados de un último ciclo de estudio sobre el mismo tema llevado a cabo el verano pasado. Esto nos permite refinar la descomposición genética del concepto de función de dos variables que hemos obtenido hasta el momento.

Keywords: APOS, descomposición genética, función de dos variables, representaciones

Análisis de actividades para graficar funciones de dos variables usando los “momentos de estudio” de la teoría antropológica de lo didáctico

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Este es un estudio de la organización didáctica de un grupo de actividades diseñadas para ayudar a los estudiantes a graficar funciones de dos variables. El estudio aplica el modelo de “los momentos de estudio” de la teoría antropológica de lo didáctico para analizar las actividades. Las actividades se proponen ayudar a los estudiantes a hacer construcciones en las que, en estudios anteriores hemos hallado, tienen dificultad. Como esos estudios están basados en la teoría APOS y la teoría de representaciones semióticas, el presente estudio puede verse como un ejemplo de una forma en que pueden usarse diferentes perspectivas teóricas, sin violar sus principios básicos, para obtener una actividad pedagógica de utilidad.

Keywords: educación matemática, funciones de dos variables, APOS, teoría antropológica de los didáctico, momentos de estudio

Aplicaciones de modelos lineales generalizados mixtos para el análisis estadístico de recuentos de semilla en el Bosque Seco de Guánica

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Los estudios ecológicos a menudo se realizan de manera compleja, y los análisis estadísticos deben incluir todos los aspectos del diseño. Los modelos lineales generalizados mixtos constituyen una herramienta de modelación muy flexible que permiten incorporar efectos aleatorios y trabajar con distintas distribuciones en la familia exponencial. Además, mediante funciones de enlace apropiadas, permiten interpretar parámetros de interés en una escala apropiada. Por ejemplo, si los datos son recuentos, los valores posibles de la media serán positivos, y la función de enlace logarítmica garantizará que los valores predichos para la media serán positivos. Se realizó un estudio para analizar los patrones de recuentos de semilla recolectadas en trampas en un bosque seco caribeño (Guánica, Puerto Rico) degradado por el uso agrícola y por fuegos. En este bosque se seleccionaron cuatro sitios con distinta historia de perturbación (causada principalmente por intervención humana: cultivos, quema y siembra de pastos para uso ganadero, etc.). En cada sitio se identificaron cinco tipos de vegetación en un gradiente de degradación (pastizal exótico abierto, bosque exótico con pastos exóticos en el sotobosque, bosque exótico con sotobosque leñoso, bosque nativo con pastos exóticos en el sotobosque, bosque nativo con sotobosque leñoso). En cada tipo de vegetación y sitio se ubicaron aleatoriamente cinco trampas de semillas, y las semillas se recolectaron mensualmente durante un año. Se analizan los recuentos de semilla de *Leucaena* sp. usando un modelo lineal generalizado mixto con distribución binomial negativa. Se discuten las características del modelo, cómo se incorporan los distintos aspectos del diseño, y se discuten los resultados obtenidos.

Keywords: modelos estadísticos, datos ecológicos, modelos lineales generalizados mixtos

τ_2 -Number theory

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Se analiza la teoría de números en una restricción de la multiplicación usual. Se considera el τ_n -producto, el cual permite que dos elementos se pueden multiplicar si y sólo si n divide su diferencia; equivalentemente si pertenecen a la misma clase de equivalencia módulo n . Aunque se pueden dar muchos resultados en general, por el factor tiempo nos enfocamos en el caso $n = 2$, para el cual definimos las nociones de factorizaciones, elementos irreducibles, primo, divisibilidad, GCD, MCD y algunas funciones aritméticas. También presentamos resultados sobre la conexión de las τ_2 -factorizaciones τ -atómicas y la teoría de grafos. Este es un trabajo en progreso entre el autor y sus estudiantes subgraduados.

Keywords: factorización, teoría de números

Funding opportunities in the Division of Mathematical Sciences of the National Science Foundation

Tomek Bartoszyński, Division of Mathematical Sciences, National Science Foundation

I will discuss the funding opportunities for mathematical sciences at the National Sciences Foundation and talk about the review process and proposal preparation.

Keywords: funding, proposals

Objective bayesian dynamic linear model approach to modeling time series in Puerto Rico

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In recent years there has been an increasing interest in the application of state space models in time series analysis, considered output of dynamic system perturbed by random disturbances. A Dynamic Linear Models (DLM) is the simple case of State Space Model considering a Gaussian prior for the p -dimensional state vector at time $t = 0$

$$\theta_0 \sim N_p(m_0, C_0)$$

together with a pair of equations for each time $t \geq 1$.

$$Y_t = F_t \theta_t + v_t, \text{ with } v_t \sim N_m(0, V_t)$$

$$\theta_t = G_t \theta_{t-1} + w_t, \text{ with } w_t \sim N_p(0, W_t)$$

forms a DLM; We analyze monthly time series during 1999 to 2011, separating family and commercial consumption of electricity and we also calculate the dynamic regression functions of gasoline price VS consumption of electricity, in different scenarios.

Keywords: dynamic linear models, objective bayes, time series, gaussian prior

Equivalents for a quasivariety of algebraic structures to be generated by a single structure

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Piotr Wojciechowski, Department of Mathematical Sciences, University of Texas at El Paso

We present some equivalent conditions for a quasivariety \mathcal{K} of algebraic structures to be generated by a single structure. The first such condition, called the *joint embedding property* was found by Maltsev in 1966. It says that if $A, B \in \mathcal{K}$ are nontrivial, then there exists $C \in \mathcal{K}$ such that A and B are embeddable into C . The most transparent equivalent condition presented in this talk is: \mathcal{K} is closed under free products. The use of the presented equivalent conditions will be illustrated.

Keywords: quasivariety, algebraic structures

Eigenvalues of graphs and their applications: survey and new results

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The topic belongs to the combination of discrete mathematics, matrix analysis, and spectral graph theory. The eigenvalues of a graph are defined to be the eigenvalues of its adjacency matrix. Although there has been much work on studying the eigenvalues of graphs and their applications in the past decades, research into the spectra of graphs with applications in applied sciences is still in its infancy and there is much concern that is not well-understood.

In this presentation, starting with an introduction of the framework and its development, we summarize the most recent representative results which show the applications in numerous applied sciences. We then present our new results about the graphs that have multiple eigenvalues, etc. One of our motivations is due to an open problem which recently has been paid much attention.

Acknowledgements: Thanks to UPRM.

Keywords: spectra of graphs, adjacency matrix, Toeplitz matrix

Climate change implications on the suitability for *Mimosa pigra* in Puerto Rico

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Environmental conditions are important determinants of the survival of species. Because the environment changes over space, one would expect a corresponding spatial gradient in the presence/absence of an invasive species. This correspondence is important when evaluating the susceptibility of certain regions to the invasion of foreign pests or when predicting the impact of environmental change on existing living organisms. In the present study we use a suitability map for *Mimosa pigra* in Puerto Rico estimated by Barragán et al. (2012) using spatially indexed data on presence/absence, minimum and maximum temperatures, and precipitation. The authors estimated a logistic regression in R with presence/absence as the dependent variable and minimum and maximum temperatures and precipitation as the independent variables. Based on this model, we computed elasticities, defined as the percent change in the predicted suitability index over the percent change in each variable, for both the values of the independent variables at each pixel and for the average value of the independent variables. Three elasticity maps were generated in ArcGIS using the former data. When using average data, the elasticity was highest and negative for precipitation. Maximum temperature had a low but positive elasticity. We used these results to predict the suitability map corresponding to the new environmental conditions present after a hypothetical climate change exercise.

Acknowledgements: Project USDA TSTAR-132

Keywords: suitability map, logistic regression, climate change, GIS, invasive species, *Mimosa pigra*

Análisis de incertidumbre y sensibilidad: un modelo de transmisión de VIH/SIDA en Puerto Rico

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Este trabajo de investigación se realizó con el propósito de estudiar el comportamiento del VIH/SIDA en Puerto Rico usando modelos epidemiológicos. Ajustamos el modelo matemático determinístico propuesto por Blower et al. (1991) a los datos disponibles para Puerto Rico para evaluar los factores que afectan la prevalencia del virus en Puerto Rico. Este modelo está diseñado para evaluar el efecto epidemiológico de la transmisión heterosexual y la transmisión entre usuarios de droga intravenosa (UDI), tomando en cuenta parámetros de conductas de riesgo tales como: la tasa de intercambio de inyectables por año (en mujeres y hombres UDI), y la tasa de cambio de parejas sexuales por año (en mujeres que son UDI y sexualmente activas y en hombres UDI y sexualmente activos), y tasa de cambio de parejas sexuales por año (en mujeres No-UDI y en hombres No-UDI). También se consideran parámetros epidemiológicos como: la eficiencia de transmisión del VIH por inyectable dado que el inyectable está infectado, eficiencia de transmisión heterosexual por contacto sexual dado que la pareja está infectada, el tiempo promedio de incubación del virus y el tiempo promedio de sobrevivencia en adultos. Usando el modelo estimamos el número de casos acumulados de SIDA en adultos en Puerto Rico para los próximos diez años a partir del año 2010 e identificamos los parámetros que contribuyen más a la incertidumbre de estos estimados usando análisis de incertidumbre y análisis de sensibilidad. Estos métodos requieren estimados de los parámetros para Puerto Rico y su desempeño depende de la eficiencia con la que se explore el espacio muestral de estos parámetros. El método de muestreo por Hipercubo Latino Seaholm et al. (1988), Blower y Dowlatabadi (1994) se ha utilizado con este fin. Proponemos una modificación a este método usando secuencias de Halton aleatorizadas que resultó ser más eficiente en el análisis de sensibilidad en nuestro modelo para Puerto Rico en cuanto a la identificación de parámetros importantes que contribuyen a la incertidumbre de los estimados y en ocasiones con respecto a la convergencia del promedio de las algunas de distribuciones de interés. El análisis de sensibilidad reveló que los parámetros de entrada importantes que afectan el número de casos acumulados de SIDA en Puerto Rico, para los próximos diez años son la eficiencia de transmisión del VIH, el tiempo promedio de incubación del virus del VIH y la tasa de cambio de parejas sexuales para mujeres que usan droga intravenosas y son sexualmente activas.

Keywords: análisis de incertidumbre, análisis de sensibilidad

Desarrollo profesional para maestros de matemáticas que incluye resolución de problemas y mentorías

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Durante los últimos siete años se ha implantado el programa de desarrollo profesional AFAMaC para maestros de matemáticas de escuelas elementales, intermedias y superiores del oeste de Puerto Rico. El proyecto está predicado en dos características importantes: su intensividad, en términos del

número de horas contacto con los maestros, y su enfoque en contenido. Las estrategias de aprendizaje incluyen la resolución de problemas, la producción de materiales educativos, distintos tipos de mentoría, y el apoyo para actividades en el salón de clases y para actividades extracurriculares. El programa tiene importantes componentes de evaluación y disseminación.

Acknowledgements: El proyecto AFAMaC es auspiciado por el programa MSP del Departamento de Educación.

Keywords: desarrollo profesional, resolución de problemas, mentorías, evaluación

Asserting parallel computational thinking: a curricular experience

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The beginning of the twenty first century ushered a new reality where the scale of computational problems requires solutions involving concurrency at multiple levels of hardware/software abstraction. This is the reality that the next generations of computer science graduates will be facing. However, it is well known that most of the traditional computer science programs in most of the universities are not adequately prepared for producing graduates with the required competencies that respond to these new demands. This paper presents the strategies, methods, experiences and lessons learned at the Department of Computer Science of the University of Puerto Rico at Río Piedras to respond to these realities by permeating our undergraduate curriculum with parallel computational thinking.

Keywords: computational thinking, parallel computing, curricular development

6. Resúmenes de afiches (posters)

On the determination of photo-actuation effects for polymer/MWCNT composited fiber based cantilever

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Composite fibers combining MWCNT and Sodyum dodecyl sulfate (SDS) have been produced in the laboratory by the electrospinning technique. These fibers exhibit photo-actuation properties (S. Rosa, J.P. Crespo 2011). In this project we use a model from nonlinear elasticity to determine the forces and internal torques that induce the photo-actuation effect. We use an inverse method in which starting from the the deformation of the fiber, obtained from digitized pictures of the bend fiber, the corresponding forces and torques are calculated.

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

Keywords: actuator, carbon nanotube, cantilever

Modeling pollutant dispersion around an obstacle in shallow waters

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A model for pollutant propagation in an ideal flow around an obstacle will be described. It is assumed that the 2D steady state model of an ideal fluid is incompressible and has no circulation. Based on these assumptions the velocity of the fluid can be represented by the stream function and modeled by the Laplace equation, while the pollutant propagation is modeled by the advection equation. We present the MATLAB code that shows how we use the finite difference method along with the SOR iterative scheme to obtain the velocity of the fluid and how we modify the diffusion model to model the pollutant move in the direction of the variable wind. Our analysis will account for the change in upstream velocity of the fluid and the shape of the obstacle.

Acknowledgements: R. White

Keywords: flow, pollutant

Funciones aritméticas para factorizaciones modulares

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Las funciones aritméticas $\tau(x)$ y $\sigma(x)$ son algunas a las que se les ha dado un mayor énfasis en el estudio de los divisores de un entero. Con ellas sabemos cual es el número de factores de una factorización prima y la suma de ellos. Este proyecto tiene como intención principal expandir estas funciones aritméticas a los productos modulares o τ_n -productos. En este reporte se analizan los casos para $n = 0$ y 1 , y aún está en proceso el caso $n = 2$, para el cual se pudo identificar una función aritmética mas refinada que sólo busca los factores τ_2 -atómicos. También se analizaron estas funciones en el caso de factorizaciones comaximales sobre \mathbb{Z} .

Keywords: factorizaciones, funciones aritméticas

Un entorno integrado para la simulación de componentes moleculares de nanodispositivos

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La dinámica molecular es una técnica de simulación que se utiliza para, entre otras cosas, simular prototipos de componentes para nanodispositivos. Crear sistemas para este tipo de simulaciones es difícil, especialmente si involucra muchas moléculas diferentes y/o si hay que crear archivos de coordenadas, topología y configuración desde el comienzo. En este afiche se presenta una aplicación en desarrollo que asiste al usuario en la creación de simulaciones de sistemas moleculares, en su ejecución y en su análisis.

El interfaz gráfico de esta aplicación provee ventanas tituladas ‘construcción’, ‘parámetros de fuerza’, ‘preparación de entorno’, ‘minimización’ y ‘simulación’. La ventana ‘construcción’ se concentra en la combinación de moléculas para la simulación proveyendo al usuario un menú colapsable con diferentes moléculas, un diálogo para añadir sus propias moléculas y un mecanismo para colocarlas en las posiciones deseadas. La ventana de ‘parámetros de fuerza’ se usa para editar los campos de fuerza que regulan las interacciones entre átomos. La ventana de ‘preparación de entorno’ permite establecer las condiciones de frontera y solvatar el sistema. La ventana de ‘minimización’ calcula posiciones para las moléculas de modo que su conformación corresponda a un mínimo local de la función de potencial. La ventana de ‘simulación’ tiene como meta hacer todo lo posible para correr una simulación con éxito. También incluye herramientas para el monitorear la simulación.

Acknowledgements: Proyecto auspiciado por el programa UPR-Penn PREM, NSF-DMR-0934195.

Keywords: dinámica molecular, interfaces gráficos, GUI

Grafos de las factorizaciones modulares

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La conexión entre factorizaciones modulares y la teoría de grafos fue introducida por Ortiz y Lucena. Su motivación salió de un trabajo de grafos de factores irreducibles hecho por CoyKendal. En este proyecto se intenta clasificar los grafos de τ_n -factores τ_n -irreducibles. Se usan resultados de los primeros autores y se observa algunos patrones de los grafos de τ_2 -factores τ_2 -irreducibles, los que ayudaron a encontrar una caracterización. O sea, se puede identificar si un grafo tiene una τ_2 -factorización τ_2 -atómica asociada con el grafo dado. Este proyecto es un trabajo en progreso e intenta desarrollar una caracterización para los grafos de τ_n -factores τ_n -irreducibles.

Keywords: factorizaciones, grafos

R-ortogonalidad de cuadrados latinos generados por polinomios de permutación

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Un cuadrado latino de orden n es una matriz $n \times n$ cuyas entradas son n elementos distintos y en la cual los elementos de cada fila y de cada columna no se repiten. En nuestra investigación estudiamos diferentes propiedades de los cuadrados latinos y su relación con polinomios de permutación. Específicamente la relación de ortogonalidad de cuadrados latinos cuya primera columna es dada por polinomios de permutación.

Keywords: cuadrado latino, ortogonalidad, permutación

Hierarchical analysis of music and spider silk using category theory

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Complex hierarchical structures composed of simple basic building blocks form the basis of most biological materials. The comprehension of these materials is mostly done by understanding its structure in a top-down approach. Here we show that with a simple analogy between seemingly different fields it is possible to gain insights in general principles and properties. Specifically, we showcase that material science exhibits comparable properties as classical music in terms of hierarchical structures, functionality and mutability. As a comparative tool we utilize an application of mathematical category theory called ontology logs (olog). Ologs provide an illuminative system representation by expressing knowledge in a conceptual map that follows a rigorous mathematical formulation based on category theory. We exemplify these similarities with a case study of classical music and spider silk which intrigued scientists for a long time. We draw connections on several levels of hierarchy and identify similar patterns that govern the structure of these two hierarchical systems. The analogy developed will enable further understanding of natural and novel protein based materials and show that seemingly disparate fields such as material science and classical music are closely related.

Keywords: biological materials, music, category theory

Distinguishing communication patterns of parallel codes using machine learning algorithms

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Parallel computing is essential in computer sciences as it allows for faster and larger computations like in areas of high energy physics and climate studies. In this investigation, we studied how communication patterns of parallel codes look different from each other with the use of classification algorithms from machine learning. Classification algorithms build models on past observations and then we can use these models to predict which class new observations are in. The three classification algorithms we used were: Decision Tree, Nearest Neighbor, and One-attribute Rule. Decision Tree is the primary algorithm for this investigation. We found that different codes or classes were easier to classify than others. We had variable success depending on which algorithm we used for tests.

Acknowledgements: Dr. Juan Meza, Dr. David Bailey, Orianna DeMasi

Keywords: parallel computing, classification algorithms, machine learning

Función de Euler para factorizaciones modulares

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En teoría de números las funciones aritméticas siempre han sido de gran interés por sus consecuencias. Entre ellas la función de Euler (ϕ), indica la cantidad de factores menores y relativamente primos

al número en cuestión. Este proyecto intenta definir la misma idea pero en la teoría de τ_n -factorizaciones o factorizaciones modulares. Se sabe que las τ_1 -factorizaciones son las factorizaciones usuales, por ende la función de Euler usual coincide con la de la teoría de τ_1 -factorizaciones. Se han observado mas de cerca algunos patrones para $n = 0$ y se presentan algunos resultados preliminares. Esto es un trabajo en progreso, que intenta extender y entender la misma noción para $n \geq 2$ en la teoría de factorizaciones modulares.

Keywords: factorizaciones, Euler function

Caracterización de texturas utilizando un turista caminante determinístico

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En este trabajo se implementó el método del Turista Caminante Determinístico (TCD) y su aplicación a la caracterización de texturas en un conjunto de imágenes. El método del TCD consiste en colocar un caminante en cada una de los pixeles de la imagen y establecer una regla en donde los caminantes se mueven a los pixeles vecinos en donde el contraste es mínimo o máximo evitando regresar a vecinos que se hallan visitado recientemente según un cierto parámetro de memoria. A partir de los recorridos de cada uno de los caminantes se géneró un grafo del cual se extrajeron características tales como: grado promedio, largo del recorrido promedio, entropía, y coeficientes de aglomeración. Resultados preliminares indican que la utilización de una regla de máximo contraste y un parámetro de memoria igual a 5 permite obtener características con la mejor capacidad de discriminación, siendo la característica de entropía la mejor de todas.

Keywords: análisis de textura, reconocimiento de texturas, caminante determinístico

Group and symmetry of quantum harmonic oscillators

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We discuss the maximum kinematical invariance group of the quantum harmonic oscillator from a view point of the Riccati and Ermakov-type systems. The invariance group of generalized driven harmonic oscillator is shown to be isomorphic to the corresponding Schroedinger group of the free particle. Additionally, we present a six-parameter family of the square integrable wave functions for the simple harmonic oscillator, which cannot be obtained by the standard separation of variables. They are given by the action of the corresponding maximal kinematical invariance group on the standard solutions.

Keywords: harmonic oscillator, wave functions

Producto modular y su conexión con grafos II

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Recientemente se ha encontrado una conexión entre las teorías de grafos y de factorizaciones. Este trabajo se ha enfocado particularmente en el caso de las τ_n -factorizaciones y la teoría de grafos. En otras palabras, en la factorización donde sólo se pueden multiplicar elementos que estan en la misma

clase de equivalencia, su diferencia es divisible por n ó equivalentemente su diferencia pertenece al ideal principal generado por n . Presentamos ejemplos, propiedades y patrones de las τ_n -factorizaciones ó τ_n -productos para los módulos 2, 3, 4 y 5. También, se presenta una caracterización de los grafos irreducibles módulo n .

Keywords: factorizaciones, grafos

Improved prediction accuracy of whole genome prediction by increasing marker density and sample size

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Personalized medicine requires accurate predictions of genetic predisposition to diseases. Recent studies suggest that Whole Genome Prediction (WGP) could be an effective method to develop such predictions. However, little is known about the factors affecting the accuracy. Using data from the Framingham Heart Study, the effect of the number of markers (p) and of the number of individuals (n) used to train models on the prediction accuracy applied to (cohort, sex and age-adjusted) adult height were evaluated. Models were evaluated over a grid of values of p ($p=0.2K$ to $400K$, K =thousand) and of n ($n=3K, 5K, 7K, 8.5K$), and prediction accuracy (R^2 =squared correlation) was evaluated on 10 different testing datasets, each comprising 480-520 individuals. Using $p=400K$ and $n=8.5K$ R^2 averaged 0.28. This is slightly higher than what other studies using WGP have found for this trait ($R^2=0.25$, Makowsky et al., PLoS Genetics, 2011) and much higher than what have been obtained using models based on subsets of SNPs selected from GWAS ($R^2=0.10$, Lango Allen et al., Nature, 2010). R^2 increased monotonically with respect to p and n : using $n=8.5K$, $R^2=.11, .18, .26, .28$, for $p=3.5K, 14K, 100K$ and $400K$, severally. And with $p=400K$, $R^2=.16, .17, .22, .25, .28$ for $n=3K, 5K, 7K$ and $8.5K$, severally. It was concluded that a large number of variants are needed to capture genetic differences for this trait and that WGP can potentially yield accurate predictions of complex traits; however, a large sample size is required to realize this potential.

Acknowledgements: Gustavo de los Campos and Hemant Tiwari

Keywords: genetics, statistics

Un modelo computacional de la dinámica poblacional de mosquitos transmisores de enfermedades

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En este proyecto se desarrolló un modelo computacional basado en agentes (agent based model) para simular la dinámica poblacional de mosquitos y su papel en la transmisión de enfermedades. El modelo, espacialmente explícito, pretende servir de herramienta para explorar diferentes escenarios de control de la población. En el mismo, se modeló el ciclo de vida de mosquitos (hembras y machos) así como los lugares de depósito de huevos. Además, se consideró la interacción de éstos con los seres humanos. El modelo, desarrollado con el lenguaje de programación NetLogo, es lo suficientemente general para poder adaptarse a poblaciones de diferentes especies de mosquitos y enfermedades.

Keywords: simulación, modelado computacional, modelos basados en agentes, dinámica poblacional

Evolutionary analysis of disease associated mutations of fibroblast growth factor receptor 3 (FGFR3) gene

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The central focus of this research was to achieve a better understanding of the genetics of disease and provide assistance with the identification of disease-associated genes. Information from interspecific alignments can indicate amino acid residues in gene products that are likely to produce disease if mutated in humans. Disease mutation data and homologous gene sequences were analyzed for one disease-associated human gene: Fibroblast Growth Factor Receptor 3 (FGFR3). This protein is important for the cellular processes such as the regulation of cell growth and division, formation of blood vessels, and others. The FGFR3 gene is located on the short (p) arm of chromosome 4 at position 16.3. In this study the association between the prevalence of disease mutations and the extent to which corresponding amino acid sites in other species have been conserved throughout evolutionary history were determined. Using available information from online databases, data for single base pair replacement mutations observed in FGFR3 gene were obtained. The elimination of frequency information prevents bias in the results of properties of commonly observed mutations over those less frequently reported for a specific genetic disease. In humans, mutations are more abundant than in other species. The disease-associated amino acid changes are overabundant at conserved residues. Chemical differences of these disease-associated amino acid changes are more radical than the commonly encountered polymorphic amino acid variation found in humans or permitted by natural selection throughout evolutionary history.

Acknowledgements: Dr. Juan Arratia, Dr. Luis de la Torre, Carol Williams, Greg McInnes

Keywords: bio-informatics, statistics

Modular maximum factor and modular greatest factor

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The main goal of this work is to determine the differences between the Greatest Common Divisor (GCD) and Maximum Common Divisor (MCD) on unusual factorizations on \mathbb{Z} , as for example the modular factorizations or τ_n -factorizations. The definition of MCD and GCD coincide in the theory of τ_1 -factorizations or the usual multiplication. We defined the MCD of any two numbers nonzero nonunit integers in the theory of τ_0 -factorization; and discuss some of the properties of the MCD on $\tau_0 \subseteq \mathbb{Z}^\# \times \mathbb{Z}^\#$. R. M. Ortiz showed that the GCD does not always exists for the theory of τ_n -factorizations. He suggested to consider an alternative definition, similar as the MCD. This is a work in progress and the idea is to check whether the MCD in the theory of τ_n -factorization always exists or not.

Keywords: factorizations, factors, GCD

Missing class of solutions to the quantum harmonic oscillator

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We present a missing class of solutions to the time-dependent Schroedinger equation for the simple harmonic oscillator in one dimension. These solutions are complemented by an intriguing computer-

animated aspect, namely the phase space oscillations of the electron density and the corresponding probability distribution of the particle linear momentum. As a result, a visualization of the Heisenberg Uncertainty Principle is demonstrated with these animations. Important in this research is the that this six-parameter family of the square integrable wave functions for the simple harmonic oscillator, cannot be obtained by the standard separation of variables. They are given by the action of the corresponding maximal kinematical invariance group on the standard solutions.

Keywords: harmonic oscillator, wave functions

Finite element modeling of bending of micropolar plates

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In this work, the numerical modeling of bending of micropolar elastic plates is presented. The discretization is applied to a new theory of micropolar elastic plates, which is based on a generalization of a well known Reissner plate theory. The theory provides the governing bending system of equations that consists of six second order partial differential equations. The case of hard simply supported macro and free micro boundary condition includes the combinations of high order derivatives, which are difficult to approximate for arbitrary domains. We show that for the case of rectangular micropolar plates, the boundary conditions can be split into simpler forms of Dirichlet, Neumann and mixed type. The bending of rectangular micropolar plates was successfully simulated for a plate made of syntactic foam and the numerical results are shown to be consistent with the previously obtained analytical solution. The numerical algorithm was shown to also work for some nonrectangular plates and the results of the simulation are provided. We also solve the three-dimensional bending problem for a simple rectangular domain and calculate the error of the approximation of the three dimensional objects by the presented model, compared to the original 3D Micropolar theory.

Acknowledgements: Joint work with Lev Steinberg

Keywords: numerical modelling, discretization

Factorizaciones en ideales

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En el 2006 Anderson y Frazier, en la búsqueda de crear la teoría de factorizaciones generalizadas, definen τ_S como un ejemplo, donde $S \subseteq D^\#$ y D es un dominio integral. Tales fueron presentadas, brevemente analizadas, pero no se profundizó al respecto. Este proyecto analiza un caso particular, donde S es un ideal, en \mathbb{Z} . Se usa \mathbb{Z} pues es un dominio de ideales principales, pero la idea se puede extender en general para ideales en un dominio integral.

Keywords: factorizaciones

Enumeración de arreglos de costas de tres dimensiones

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Por sus aplicaciones en comunicaciones ópticas, marca de agua digital para video, y en audio y video combinados, los arreglos de costas multidimensionales ameritan estudio. Al igual que encontrar arreglos de costas de dos dimensiones, encontrar arreglos de costas de tres dimensiones por búsqueda exhaustiva es un problema de complejidad factorial. Este proyecto intenta acelerar la búsqueda de estos arreglos con la utilización de la arquitectura de computación CUDA, que permite paralelizar el problema y de esa forma aprovechar la optimización en rendimiento que ofrece el uso de múltiples núcleos provistos por las unidades de procesamiento gráfico (GPU). Se espera poder llevar esta implementación a arreglos de costas con dimensiones mayores.

Keywords: costas, CUDA, GPU, computación paralela

Binding mode interaction between isoalantolactone and dengue virus

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Dengue virus is transmitted by the bite of a mosquitos commonly the *Aedes aegypti*. This type of virus is an endemic transmission very common in Puerto Rico. Because of this, citizens have had an involvement in the control of breeding sites at their homes and from a distance; their protection against the virus has been through using insecticides. There has yet to be discovered a cure for this atrocious disease. Control of dengue today remains a challenge. Dengue virus has four serotypes (I-IV). The aim of this project is to determine the binding mode interaction between Isoalantolactone and with an Envelope Glycoprotein from dengue II. The methods used are based on Autodock 4.2. Autodock was developed to provide a procedure for predicting the interaction of small molecules with macromolecular targets. Docking simulations has been used to determine active sites within the Envelope Glycoprotein. The results suggest that there are potentially two active sites within the protein. I'm aiming in finding a ligand that will have a more affective binding interaction to eliminate the virus more efficiently by using the procedure in Autodock.

Acknowledgements: Michael Cato

Keywords: computational chemistry

A look into the logistic map

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A simple equation that models the number of organisms in a population over time, as the ratio of the existing population and the environment's maximum population capacity, is provided by the logistic map

$$f(P) = kP(1 - P)$$

where $f(P)$ is the number of organisms in a population after one unit of time, $k \geq 0$ is the growth constant, and P is the number of organisms in the population before that one unit of time. In other words, the number of organisms in a population in the first unit of time is measured by the first iteration of the logistic map. Thus, the n^{th} iteration of the logistic map is the number of organisms in the population after n units of time. We simulated this model in Maple 15 and found that for almost any growth constant in $[4, \infty)$ the population leaves $[0,1]$ and that for any growth constant in $[0, 3)$ the population eventually settles to an equilibrium. For almost any growth constant in $[3,4)$, where we focused our research, two things happen: first, the number of organisms in the population changes with a chaotic behavior or, second, the population eventually oscillates between fixed values. We used the bisection method to approximate the bifurcation points, i.e. the growth constants at which the period of the oscillations doubles, and found that the ratio of the differences between these points approaches the Feigenbaum constant. We also found oscillations with periods that are not a power of two for growth constants further from 3. At these growth constants, there exist oscillations with an arbitrary period, but only a certain number of these oscillations are stable.

Keywords: chaos theory, population modelling, logistic map

Search algorithms for highly non-linear Boolean functions

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The purpose of this research work is to find efficient methods to search Boolean functions with high non-linearity (the high non-linearity is calculated by using Walsh-Hadamard transforms). For this we use four main algorithms: the hill-climbing search algorithm, the simulated annealing search algorithm, the genetic algorithm and the genetic algorithm mixed with the hill-climbing algorithm. The hill climbing algorithm alone would only accept higher values as the iterations went by and at a certain point it would stick to a value thinking that it was the best solution when it wasn't. The simulated annealing algorithm takes lower solutions than the current one with a certain probability, the disadvantage was that some of the values that may lead to better solutions can get eliminated with a certain probability. The genetic algorithm alone allows us to create a population of genes that can be cross bred or mutated with a certain probability. With this algorithm we obtain good solutions but it takes a lot of time to compute it. By using the C++ programming language we implemented these algorithms and determined which one of them produced the best solutions. We found that the algorithm with the best output was the genetic algorithm mixed with the hill-climbing algorithm. This one created new sequences at each iteration and if the solution of that sequence was higher than the

last one we accept it., if not, we discard it. After finding the highest solution in a determined number of iterations, the sequence with the best solution is taken and we evaluate it with the genetic algorithm saving us time and number of runs. Finally, we are experimenting with an inverse method of searching where we apply the mentioned search heuristics on Walsh-Hadamard spectrums (rather than Boolean functions).

Keywords: Walsh-Hadamard transforms, algorithms, high non-linearity Boolean functions

Estudios de severidad de enfermedades en cultivos de plátano y banano en Puerto Rico mediante modelos no lineales mixtos con distribución beta

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Existen muchas situaciones en las que se involucran variables aleatorias con algún tipo de porcentaje, proporción o fracción. Muchos estudios han demostrado que los modelos de regresión lineal no son apropiados para modelar este tipo de datos. Sin embargo, la distribución beta es muy útil para modelar datos que se encuentran restringidos continuamente en el intervalo $(0,1)$ y que además pueden ser explicados por otras variables a través de una estructura de regresión. Debido a esto, Ferrari y Cribari-Neto (2004) propusieron un modelo de regresión beta lineal en el que la variable respuesta está distribuida como una beta usando una parametrización diferente de su función de densidad, obteniendo así, una estructura de regresión para la media de la respuesta con un parámetro de precisión constante. En este trabajo extendemos esta teoría, proponiendo un modelo de regresión beta no lineal mixto, donde estudiamos sus propiedades mediante simulación y las comparamos con las obtenidas por un modelo de regresión no lineal mixto asumiendo distribución normal. Finalmente, aplicamos estos resultados a estudios de severidad (cantidad relativa de tejido afectado en un momento dado) de enfermedades en cultivos de plátano y banano en Puerto Rico, donde se estima usualmente el porcentaje del área de la hoja afectada. Comparamos los resultados del ajuste del modelo asumiendo que el índice de severidad se distribuye beta y normal.

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Keywords: modelos no lineales mixtos, distribución beta, curvas de progreso de la enfermedad

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