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5:30–6:20	Panel						
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2 Itinerario Detallado (Detailed Schedule)

Horario	Lugar	Actividad
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4:00-8:00	Vestíbulo Teatro	**Mesas de Exhibidores**
5:30-6:20	Teatro	**Panel**: *Bioestadística: Oportunidades de Aprendizaje, de Investigación y Desarrollo Profesional*, Rafael Irizarry, Roberto Rivera, Erick Suarez, Luis Raúl Pericchi
6:30-7:00	Teatro	**Inauguración**
7:00-7:50	Teatro	**Conferencia Plenaria**: *Opportunities in the Actuarial Profession* Luis O. Maldonado
8:00–10:00	Museo Casa Roig	**Actividad Social**: Coro de Cámara UPRH Exhibición: *La casa en la casa*, por Antonio Martorell Entremeses
Sábado		
7:30-9:30	Vestíbulo Teatro	**Inscripción y Registro**
7:00-9:00	Vestíbulo Teatro	**Desayuno**
8:00-8:25		**Conferencias Concurrentes**
	CA 212	*Majority logic decoding is a sensitive method for analyzing (RNA-Seq) data* Humberto Ortiz–Zuazaga
	CA 215	*Dynamics of a three particle array under Lennard–Jones type forces with a constraint of fixed area* Pablo V. Negrón–Marrero
8:30-8:55		**Conferencias Concurrentes**
	CA 212	*Progress towards the conjecture on APN functions and absolute irreducibility of polynomials* Heeralal Janwa
	CA 213	*WeBWorK: herramienta costoefectiva de asignaciones en linea* Edwin Flores
	CA 214	*Bayesian approach to valuation of executive stock options* John Villaviencio–Mattos
	CA 215	*Well–posedness of degenerate integro–differential equations with infinite delay in Banach spaces* Rafael Aparicio
9:00-9:25		**Conferencias Concurrentes**
	CA 210	*Modelo para diseñar la interacción humano-computadora (MODIHC) para aplicaciones móviles en Android* Flor Narciso

Horario	Lugar	Actividad
	CA 211	*EmbalsesPR: Una aplicación en linea para monitorear en tiempo real los embalses de Puerto Rico* Elio Ramos
	CA 212	*Value Sets of Binomials over Finite Fields* Alberto Cáceres
	CA 213	*Entendimiento de derivada direccional de funciones de dos variables* Rafael Martínez Planell
	CA 214	*The Spatial Spread of Dengue Fever: A Diffusion Model for the Impact of the Latent Period on Disease Dissemination* Juan R. Meléndez Álvarez
	CA 215	*On the Milstein Method for Stochastic Differential Equations with Markov Switching* Son Nguyen
9:30-9:55		**Conferencias Concurrentes**
	CA 210	*Optimization and Filtering on Lie Groups and some applications in geometric scene reconstruction in presence of noise and outliers* Rémi Mégret
	CA 211	*Advances in Biomathematics Research at UPR Cayey* Mayteé Cruz–Aponte
	CA 212	*Improvement to Chevalley's Theorem for function fields of characteristic p* Francis Castro
	CA 213	*Didáctica de la variación y el análisis de los discursos docentes* Waldo A. Torres Vázquez
	CA 214	*On matrices with Jordan Form decomposition in an orthonormal basis* Alvaro Lecompte–Montes
	CA 215	*Global regularity for solutions of nonlocal Robin problems in a class of "bad" domains* Alejandro Vélez-Santiago
10:00-11:00	Vestíbulo Teatro	**Afiches / Posters**
		Automated phenotyping of patient EMR Data: feature extraction and selection Rolando J. Acosta Nuñez
		Análisis computacional entre matrices esparzas y los métodos del gradiente Cesar Fernando Bolaños Revelo
		Modeling Wolbachia Transmission in Natural Populations of Anopheles Mosquitoes Katherine A. Cartagena De Jesús

Horario	Lugar	Actividad
		Platelet counts and their effect on patient outcomes with patent ductus arteriosus (PDA) Lorena Cristal
		Investigating crime data in Puerto Rico through statistical analyses Jean C. Galán–Rivera
		Modelos de cazador–presa: una nueva estrategia de persecución Anthony Gómez Fonseca
		Effect of Distraction and Alzheimer's Disease in Simulated Driving Based on Four Methods of Data Reduction Jansel Herrera
		String matching: a data structure approach Shariemar López Vázquez
		Modeling a Herpes Gladiatorum Outbreak in a Wrestling Summer Camp Kevin L. Molina–Serrano
		Counting large prime numbers Adriana Morales
		Decomposition of quasinormal matrices in Jordan form Sheilamarie Moreno-Horta
		A model for the control of dengue fever with the use of GMM Josue Olivieri
		Congruence classes for Gaussian Integers Johann Rivera–Panas
		A Mathematical Epidemiological Model to Study the Impact of the Prodrome Period on Herpes Simplex Viruses Epidemics Emmie Román
11:00-11:50	Teatro	**Conferencia Plenaria**: *The Bright Future of Applied Statistics* Rafael Irizarry
12:00–1:00	Plazoleta frente al Teatro	**Almuerzo**
1:00-1:50	Teatro	**Conferencia Plenaria**: *Finite field algorithms for reconfigurable computing* Dorothy Bollman
2:00-2:25		**Conferencias Concurrentes**
	CA 210	*The Kronecker Coefficients* Rosa Orellana

Horario	**Lugar**	**Actividad**
	CA 211	*Modeling and Simulation of Properties/Processes in Atoms, Molecules, and Materials from their Electrons and Nuclei Building Blocks* Juan M. López Encarnación
	CA 212	*Construction and analysis of multidimensional periodic array* Ivelisse Rubio
	CA 213	*Entendimiento de la relación entre plano tangente y diferencial de una función de dos variables* Rafael Martínez Planell
	CA 214	*Bayesian rescue for the troubled scientist, or how to calibrate classical significance tests* María–Eglée Pérez
	CA 215	*On a generalization of Cusick-Li-Stănică's conjecture* Oscar E. González
2:30-2:55		**Conferencias Concurrentes**
	CA 210	*A combinatorial approach to studying singularities of Hessenberg varieties* Erik Insko
	CA 211	*Solving Physicochemical Problems with Computational Quantum Chemistry* Juan A. Santana
	CA 212	*Reduced linear modular systems, finite fields and Oscar Moreno* Edusmildo Orozco
	CA 213	*Errores matemáticos cometidos por los estudiantes universitarios en el estudio de funciones exponenciales y logarítmicas* Wanda Velázquez Rosado
	CA 214	*Fraud and Forensic Accounting using Benford's Law in Bayesian Analysis approach* David Torres Núñez
	CA 215	*Arithmetic Differential Subgroups of Gl_n* Alfonso E. Heras–Llanos
3:00-3:25		**Conferencias Concurrentes**
	CA 210	*The q-analog of Kostant's partition function and the highest root of the simple Lie algebras* Pamela E. Harris
	CA 211	*Computational Design of Dyes for Water-Splitting Dye-Sensitized Cells* Dalvin D. Méndez-Hernández
	CA 212	*Multidimensional Periodic Costas Arrays: Enumeration and Symmetries* Rafael Arce–Nazario

Horario	**Lugar**	**Actividad**
	CA 213	*Modules to introduce Cybersecurity knowledge in the CS curriculum* José Ortiz–Ubarri
	CA 214	*Análisis de datos usando Regresión Multivariante Múltiple por Minimos Cuadrados Parciales (Regresión PLS)* José C. Vega Vilca
	CA 215	*Modular periodicity of exponential sums of symmetric Boolean functions* Luis A. Medina
3:30-3:55		**Conferencias Concurrentes**
	CA 210	*Construction of root systems for reflection* Alexander Diaz–Lopez
	CA 211	*The Effect of Non Exponential Distributed Infectious Period in Stochastic Age-of-Infection Epidemiological Models* Emmanuel J. Morales–Butler
	CA 212	*Monomial involutions over finite fields with f fixed points* Natalia M. Pacheco–Tallaj
	CA 213	*Algunas coordenadas de la matemática educativa en Puerto Rico* Orlando Planchart Márquez
	CA 214	*Elastic vibration of fractal cylinders* Lev Steinberg and Mario Zepeda
	CA 215	*Minimum rank of n–dimensional hypercube cut–complex* Hetor D. Torres–Aponte
4:00-4:30	CA 211	**Sesión Administrativa**
4:30–∞	Vestibulo Adm. de Empesas	Actividad Social

3 Charlas Plenarias / Plenary Talks

The Bright Future of Applied Statistics

Rafael Irizarry, Harvard T.H. Chan, School of Public Health

It is a great time to be an applied statistician. Statistics has already been at the center of many exciting accomplishments of the 21st century. Sabermetrics has become a standard approach and inspired the Hollywood movie Money Ball. A PhD Statistician led the team that won the Netflix million dollar prize. Nate Silver et al. proved the pundits wrong by, once again, using statistical models to predict election results almost perfectly. R has become a widely used programming language. In academia, the number of statisticians becoming leaders in fields like environmental sciences, human genetics, genomics, and social sciences continues to grow. The unprecedented advances in digital technology during the second half of the 20th century has produced a measurement revolution that is transforming the world. Many areas of science are now being driven by new measurement technologies and many insights are being made by discovery-driven, as opposed to hypothesis-driven, experiments. The current scientific era is defined by its dependence on data and the statistical methods and concepts developed during the 20th century provide an incomparable toolbox to help tackle current challenges. In this talk I will give several specific example including one from own research in the biomedical sciences.

Finite field algorithms for reconfigurable computing

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

In this talk I briefly survey the research done by me and my students in collaboration with or inspired by Dr. Oscar Moreno. The main focus is on efficient implementations of finite field arithmetic on field programmable gate arrays (FPGAs). It is not uncommon to encounter algorithms that are optimal for CPU-based implementations, but that are not necessarily the best approach for FPGAs implementations. We describe several finite field algorithms suitable for FPGA implementations, including algorithms for interpolation over $GF(2^n)$, finite field multiplication, and elliptic curve point multiplication, whose FPGA implementations are up to 100 times faster than other known CPU–based implementations.

Keywords: reconfigurable computing, FPGA, finite field, elliptic curve point multiplication

Opportunities in the Actuarial Profession

Luis O. Maldonado, Milliman, Inc., Philadelphia

Actuaries are experts in evaluating the likelihood of future events and designing creative ways to reduce the likelihood of undesirable events. They are leading professionals whose basic task is finding ways to manage risk. In the first part of this talk I will describe some of the basic analytical and inter personal skills needed to become an actuary, as well as how to become an actuary. On

the last part of my presentation I will discuss the financial impact of treatment options for different medical conditions and risk assessment models, which are typical examples of the projects managed by health actuaries.

4 Mini–simposios / Mini–symposia

4.1 Algebraic and Enumerative Combinatorics

Algebraic and enumerative combinatorics provide tools and techniques that aid in the understanding of abstract mathematical structures. One of the advantages to using combinatorics is that the concepts can often be easy to explain to those with limited mathematical backgrounds, yet the developments can greatly impact the fields to which they are applied, as they often lead to new discoveries and greater understanding of mathematical structures. In this session we explore these techniques and how they have helped shape the areas of representation theory, graph theory, algebraic geometry, and group theory. In particular, Rosa Orellana will give an introduction of algebraic and enumerative combinatorics and talk about her research in the area, Erik Insko will link combinatorics to objects in algebraic geometry, Pam Harris will link combinatorics with Lie theory, and Alexander Diaz-Lopez will link combinatorics with Coxeter groups and root systems.

The Kronecker Coefficients

Rosa Orellana, Dartmouth College.

One of the main open problems in combinatorial representation theory of the symmetric group is to obtain a combinatorial interpretation for the Kronecker coefficients. The Kronecker coefficients are obtained when we decompose the tensor product of two irreducible representations of the symmetric group. This talk is a survey of recent results on the Kronecker coefficients.

A combinatorial approach to studying singularities of Hessenberg varieties

Erik Insko, Florida Gulf Coast University.

Hessenberg varieties are flag varieties that are of interest to algebraic geometers, algebraic group theorists, algebraic representation theorists, and numerical analysts. Examples of Hessenberg varieties include the Springer fibers, Peterson variety, and the toric variety associated to the Weyl Chambers in each Lie type. In this talk we explore the connection between the algebraic combinatorics of the symmetric group and the singularities of regular nilpotent and subregular semisimple Hessenberg varieties.

The q-analog of Kostant's partition function and the highest root of the simple Lie algebras

Pamela E. Harris, United States Military Academy.

Kostant's partition function counts the number of ways to represent a particular vector (weight) as a nonnegative integral sum of positive roots of a Lie algebra. For a given weight the q- analog of Kostant's partition function is a polynomial where the coefficient of q^k is the number of ways the weight can be written as a nonnegative integral sum of exactly k positive roots. In this paper we determine generating functions for the q-analog of Kostant's partition function when the weight in question is the highest root of the classical Lie algebras of types B, C, and D, and the exceptional Lie algebras of type G_2, F_4, E_6, E_7, and E_8. This is joint work with Erik Insko and Mohamed Omar.

Construction of root systems for reflection

Alexander Diaz–Lopez, University of Notre Dame.

Given a Coxeter system one can define a root system in a real vector space. In this talk we consider extensions of Coxeter systems, denoted reflection systems, where we allow generators to have order greater than two (and impose some conditions on the orders of products of generators). Examples include Coxeter systems, free groups, cyclic groups, among others. We construct root systems in real vector spaces for these reflection systems, and discuss whether several properties that are true for Coxeter systems are also true for reflection systems.

4.2 Interdisciplinary Computational Advances at the UPR-Cayey Laboratory of Modeling, Simulations, and Theory

In this thematic session we present several projects that we are working collectively at our modeling and simulation laboratory that include interdisciplinary research among cryptography, coding, physics, chemistry, biology, and life sciences. The speakers are local faculty at our campus. The topics we will present are those related with past and ongoing projects and future work we are planning while building our computational laboratory robustness.

Advances in Biomathematics Research at UPR Cayey

Mayteé Cruz–Aponte, Laboratory of Modeling, Simulations, and Theory, Department of Mathematics–Physics, University of Puerto Rico at Cayey.

My goal is to increase the interdisciplinary research at our department in the area of Biomathematics. I have a research team of 11 undergraduate students working on 5 different projects that are been sponsored by PR NASA Space Grant, RISE, PR LSAMP, BRIC, several students are taking research credits for the research experiences as part of the INTD course sponsored by the Institute of Interdisciplinary Research at our Institution. We are developing mathematical

models of metapopulation networks that connect regions to investigate the spread of disease and possible alternatives to mitigate the spread using social distancing measures, treatment, vaccination and/or spread of information to guide the community. We focus on different diseases such as Avian Influenza, sexually transmitted diseases like Chlamydia, and vector borne diseases such as Chikungunya and Dengue. One of our teams is also working on endocrine models by constructing a network of population of cells to study dynamics and mechanisms of glucose toxicity in the progression of diabetes mellitus.

Keywords: epidemiology, Chikungunya, Dengue, diabetes mellitus, chlamydia, Avian influenza, metpopulation

Modeling and Simulation of Properties/Processes in Atoms, Molecules, and Materials from their Electrons and Nuclei Building Blocks

Juan M. López Encarnación, Laboratory of Modeling, Simulations, and Theory, Department of Mathematics–Physics, University of Puerto Rico at Cayey.

In this talk, the predictive/understanding power of ab initio and density functional theory electronic structure Quantum-Hamiltonian approaches in modeling and simulation of properties/processes of the ordinary-matter are shown. Here, we focus on the results (published/unpublished) obtained by us in the last 4 years exploring issues on:

1) Atoms: electronic energy levels, transition probabilities, and electron-atom collision processes of highly ionized heavy atoms with astrophysical and/or laboratory plasma interest;

2) Molecules/Atomic-Clusters: atomic structures, energetics, thermodynamics, dynamical simulations, and the elucidation of the paradigmatic chemical reaction mechanisms; and

3) Materials: electronic/atomic/crystal structures, electron-transport, infrared spectroscopy, and catalysis on extended systems.

These studies demonstrate how powerful and cost-effective modeling and simulation techniques can be addressing physical/chemical problems, especially, in cases where the experiments are physically limited and/or very expensive.

Keywords: density functional theory, ab initio molecular dynamics, electronic structure, catalysis, multiferroic tunnel junctions

Solving Physicochemical Problems with Computational Quantum Chemistry

Juan A. Santana, Laboratory of Modeling, Simulations, and Theory, Department of Chemistry, University of Puerto Rico at Cayey.

Computational Quantum Chemistry (CQC) plays a key role in advancing fundamental understanding in chemistry and materials sciences. This field is rapidly growing thanks to developments in computational infrastructure and robust algorithms and software. In this talk, I will give a brief general overview of CQC along with some recent applications in catalysis and materials sciences. I

will show my efforts and applications of CQC methods to solve various physicochemical problems. The focus will be on problems related to electrocatalytic systems and ionic defects in transition metal oxides.

Keywords: Density Functional Theory, Quantum Monte Carlo, Electrocatalysis, Ionic defects, Fuel cells, Li-ion batteries

Computational Design of Dyes for Water-Splitting Dye-Sensitized Cells

Dalvin D. Méndez-Hernández, Laboratory of Modeling, Simulations, and Theory, Department of Chemistry, University of Puerto Rico at Cayey.

Producing solar fuels from sustainable resources (e.g., $CO_2$and H_2O) remains a great technological challenge. Dye-sensitized water-splitting photo-anodes (DSWSPAs) have recently emerged as promising components of photocatalytic solar cells that could provide a viable solution to this difficult task. Theoretical and computational chemistry can aid in the design of new dyes capable of both photosensitizing a semi-conductor and catalyzing water oxidation, which are essential parts of DSWSPAs. Because electron transfer (ET) reactions are paramount in these processes, we explored simple methodologies that allow the prediction of ET rates and ET driving forces through redox potentials. Comparison between experimental and theoretical values will be presented and discussed.

Keywords: homo lumo correlation, redox potential, Marcus theory

The Effect of Non Exponential Distributed Infectious Period in Stochastic Age-of-Infection Epidemiological Models

Emmanuel J. Morales–Butler, Laboratory of Modeling, Simulations, and Theory, Department of Mathematics–Physics, University of Puerto Rico at Cayey.

In the field of infectious disease epidemiology, the assessment of model robustness outcomes plays a significant role in the identification, reformulation, and evaluation of preparedness strategies aimed at limiting the impact of catastrophic events (such as pandemics or the deliberate release of biological agents) or used in the management of disease prevention strategies, or employed in the identification and evaluation of control or mitigation measures. To address this issue our research group is working on developing an application aimed to assess the quantitative and qualitative impact of the disease stage distribution assumptions in stochastic age-of-infection SIR-type models on model based predictions and conclusions in an epidemiological study. Preliminary results from three hypothetical cases absence of control intervention, a single intervention and two interventions will be shown.

Keywords: Infectious disease epidemiology, Epidemic Models, Control interventions, Stochastic modeling.

4.3 The legacy of Oscar Moreno to the development of computational mathematics in Puerto Rico

In this series of contributed presentations we pay a humble tribute to Professor Oscar Moreno who sadly passed away on July 14, 2015. Professor Moreno was an internationally renowned mathematician that contributed greatly to the development of computational mathematics in Puerto Rico, not only by his extensive list of publications, but also through the mentoring and nurturing of many young mathematicians and collaborations with faculty from different universities. The talks in the various sessions under this title are examples of that influence, past and still going in the present.

(Talks in alphabetical order using the last name of the speaker.)

Multidimensional Periodic Costas Arrays: Enumeration and Symmetries

José Ortiz–Ubarri, Departament of Computer Science, University of Puerto Rico at Río Piedras.
Rafael Arce–Nazario, Departament of Computer Science, University of Puerto Rico at Río Piedras.

Costas arrays with three or more dimensions were introduced by Drakakis (208) and extended to elementary abelian groups by Moreno and Tirkel (2011). These multidimensional periodic Costas arrays over elementary abelian groups (MPCA) have potential applications such as digital watermarking of video and combined video and audio.

We present two generators for the group of symmetries of such arrays: one defined by permutations on the dimensions and the other by shear (addition) on dimensions. We explored efficient implementations to enumerate MPCAs using field programmable gate arrays (FPGAs) and graphical processing units (GPUs). From the enumeration results, we observed that the two generators characterize the group of symmetries. Hence, we conjecture that these generators characterize the group of symmetries of the generic $(m + 1)$-dimensional periodic Costas arrays over elementary abelian groups $(Z_p)^m$.

Both GPU and FPGA implementations rely on Costas array symmetries to reduce the search space and perform concurrent explorations over the remaining candidate solutions. The fine grained parallelism utilized to evaluate and progress the exploration, coupled with the additional concurrency provided by the multiple instanced cores allowed the FPGA (XC5VLX330-2) implementation to achieve speedups of up to 30× over the GPU (GeForce GTX 580).

Acknowledgements: Dr. Ortiz-Ubarri was partially supported by the UPR-RP FIPI funds. Dr. Arce-Nazario was partially supported by NSF Grant Number CNS-0923152. The content dealing with the symmetry generators was done in collaboration with Oscar Moreno, Andrew Z. Tirkel, and Solomon W. Golomb Thanks to Glen Edwards of Convey Computer for his engineering support in the HC-1 implementations and Tahirí Laboy and Jonathan Vélez for their help in the GPU implementations.

Keywords: Costas arrays, GPU, FPGA, periodic

Value Sets of Binomials over Finite Fields

Alberto Cáceres, University of Puerto Rico at Humacao, Department of Mathematics.

By the known Lagrange Interpolation, any mapping defined on a finite field $F = F_q$ into itself is representable as a polynomial. A *permutation polynomial* (PP) over a finite field is a polynomial $f(x) \in F[x]$ which, upon evaluation, becomes a permutation of F , i.e., a one-to-one function. PPs are of interest in coding theory, cryptography and general algebra.

The Dickson-Hermites (1920) is the best known criterion to decide if a polynomial is a PP; but its high powers make it unworkable, even for small fields. Research has then turned its attention to the study of the *value sets* of polynomials, i.e., the range and its size of the induced function. General bounds on the size of value sets are already known. For monomials and some particular polynomials their sizes have already been calculated.

In this work we evaluate the size of the value sets of binomials of the form $aX^r + bX^{q-1-r}$ when r and $q-1$ are coprime. Base field is either a prime or an extension field. These computations lead us to improve some of the known bounds on value sets and clear the way for the search of new PPs.

Improvement to Chevalleys Theorem for function fields of characteristic p

Francis Castro, Department of Mathematics, University of Puerto Rico at Río Piedras.
Ivelisse Rubio, Department of Computer Science, University of Puerto Rico at Río Piedras.

In Moreno-Moreno (1995) they introduced the ground field method to estimate divisibility of exponential sums. Using this elementary method, several authors have obtained improvements to classical results in p–divisibility of equations. In algebra, a Chevalley type of theorem implies that certain polynomial equations in sufficiently many variables over a field have solutions. Carlitz (1951) proved that any nonconstant polynomial in n–variables of degree d over a function field of characteristic p has a nontrivial solution whenever $n > d^2$ and the constant term of the polynomial is zero. We use the ground field method to improve this result: any nonconstant polynomial in n–variables of degree d over a function field of characteristic p has a nontrivial solution whenever $n > \sigma_p(d)d$ and the constant term of the polynomial is zero, where $\sigma_p(d)$ is the p–weight of d.

Progress towards the conjecture on APN functions and absolute irreducibility of polynomials

Moises Delgado, Department of Mathematics, University of Puerto Rico at Cayey.
Heeralal Janwa, Department of Mathematics, University of Puerto Rico at Río Piedras.

An almost perfect nonlinear (APN) function (necessarily a polynomial function) on a finite field $\mathcal{F}$ is called exceptional APN, if it is also APN on infinitely many extensions of $\mathcal{F}$. In this talk we will consider the most studied case of $\mathcal{F} = \mathcal{F}_{2^n}$. APN functions have central applications in cryp- tography among several other disciplines. A conjecture of Janwa-Wilson and McGuire-Janwa-Wilson (1993/1996), settled in 2011, was that the only monomial exceptional APN functions are the

monomials x^n, where $n = 2k+1$ or $n = 2^{2^k} - 2^k + 1$ (the Gold or the Kasami exponents, respectively). Aubry, McGuire and Rodier conjectured that the only exceptional APN function is one of the monomials just descried. One of our results is that all functions of the form $f(x) = x^{2^k+1} + h(x)$ (for any odd degree $h(x) \neq 2^l + 1$ with $(k, l) = 1$), are not exceptional APN, extending substantially several recent results towards the resolution of the stated conjecture. One ingredient in deriving this result is the proof we present of our earlier conjecture on the relatively primeness of exceptional multivariate polynomials in the Gold case.

Up until now, the main tool used by most researchers in the study of exceptional APN functions, has been the method of Janwa, McGuire and Wilson to prove the absolute irreducibility of multivariate polynomials. The algorithmic approach of McGuire and Wilson is based on intersection multiplicity theory and Bezouts theorem, and computations initiated by Janwa and Wilson. Our techniques of establishing absolute irreducibility rely on repeated hyperplane intersections, linear transformations, reductions, and the known APN monomial functions. We apply the estimates of Weil, Bombieri, Deligne, Lang-Weil, Ghorpade-Lachaud on rational points on varieties over finite fields to demonstrate exceptional properties. The absolute irreducible hypersurfaces are related to hyper-plane sections of Fermat varieties, and are of independent interest.

We will also discuss applications of our results in the construction of algebraic geometric codes, cryptography, combinatorics, finite geometry, sequence design, Ramanujan graphs and exponential sums.

Reduced linear modular systems, finite fields and Oscar Moreno

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

A reduced linear modular system (RLMS) is a finite dynamical system over a finite field and, in previous works, it has been shown that its structure resembles the cyclic structure of a linear modular system. In this talk I discuss some results concerning the structure of such systems in the case when the minimal polynomial defining a RLMS is a nontrivial power of an irreducible polynomial over a finite field and present a connection with Lucas' theorem and the Chinese remainder theorem. In this presentation I also acknowledge the influence of Dr. Oscar Moreno in my professional life.

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

Majority logic decoding is a sensitive method for analyzing (RNA-Seq) data

Humberto Ortiz–Zuazaga, Department of Computer Science, University of Puerto Rico at Rio Piedras

Oscar Moreno de Ayala was my PhD advisor and a long-time friend of my family. During my PhD, we developed a method of analyzing microarray data using majority logic decoding (MLD), a simple, discrete technique from information theory applied to a bioinformatics problem. We present an extension of MLD to the analysis of next-generation RNA-Seq data. In MLD, the expression of each gene in an experiment is compared across conditions, producing a "call" of upregulated, unchanged or downregulated. Each replicate is called separately, and the resulting calls are tallied,

with the most frequent call winning. We apply MLD analysis to a simulated differential gene expression RNA-Seq experiment and compare to a typical statistical analysis with linear models. Our MLD technique results in a markedly improved false positive rate.

Monomial involutions over finite fields with f fixed points

Francis Castro Department of Mathematics, University of Puerto Rico, Río Piedras
Carlos CorradaDepartment of Computer Science, University of Puerto Rico, Río Piedras
Natalia M. Pacheco–Tallaj, University of Puerto Rico High School, Río Piedras
Ivelisse Rubio, Department of Computer Science, University of Puerto Rico, Río Piedras

Permutations of finite fields have important applications in cryptography and coding theory. Involutions are permutations that decompose in cycles of length 2 or 1 (fixed points). Since involutions are its own inverse, they are of particular interest because the implementation used for coding can also be used for decoding. We present results on involutions of finite fields defined by monomials that have f fixed points. This work has its roots in the work by Moreno and Rubio (1990).

Construction and analysis of multidimensional periodic arrays

Rafael Arce, Department of Computer Science, University of Puerto Rico, Río Piedras
Francis Castro, Department of Mathematics, University of Puerto Rico, Río Piedras
José Ortíz, Department of Computer Science, University of Puerto Rico, Río Piedras
Ivelisse Rubio, Department of Computer Science, University of Puerto Rico, Río Piedras

In order to use arrays in digital watermarking and cryptography, the arrays need to be robust to attacks and there is a need to measure the complexity of the arrays. For periodic sequences (one-dimensional arrays), the linear complexity is defined as the degree of the minimal polynomial that generates the sequence. We present a generalization of the definition of linear complexity to determine linear complexity of multidimensional arrays and present tight bounds on the linear complexity of arrays generated by the Moreno-Tirkel construction.

5 Paneles de Discusión / Discussion Panels

5.1 Bioestadística: Oportunidades de Aprendizaje, de Investigación y Desarrollo Profesional

Rafael Irizarry, Harvard T.H. Chan, School of Public Health.
Roberto Rivera, Universidad de Puerto Rico en Mayagüez.
Erick Suarez, Universidad de Puerto Rico, Recinto de Ciencias Médicas.
Luis Raúl Pericchi, Departamento de Matemáticas, Universidad de Puerto Rico en Río Piedras.

La bioestadística y su impacto en la biología, medicina y salud pública ha experimentado un desarrollo exponencial. El panel describirá oportunidades de estudio, investigación y desarrollo

profesional en esta disciplina, dentro y fuera de Puerto Rico.

Reconocimientos: Este panel esta auspiciado por el "PR Chapter of the American Statistical Association" y la "ASA Biometrics Section".

6 Charlas Concurrentes / Concurrent Talks

(In alphabetical order using the last name of the speaker.)

Well–posedness of degenerate integro–differential equations with infinite delay in Banach spaces

Rafael Aparicio, Department of Mathematics, University of Puerto Rico at Río Piedras.
Valentine Keyantuo, Department of Mathematics, University of Puerto Rico at Río Piedras.

We are concerned with a class of degenerate integro–differential equations of second order in time in Banach spaces. We characterize their well–posedness using operator valued Fourier multipliers. These equations are important in several applied problems in physics and material science, especially for pheno ena where memory effects are important. One such domain is viscoelast city. We focus on the periodic case and we treat vector-value Lebesgue, Besov and Trieblel–Lizorkin spaces. We note that in t e Besov space context, the results are applicable in particular to the scale of vector- alued H ölder spaces C^s , $0 < s < 1$. The definition of well-posedness we adop is a modification of the one used so far in the special cases. This definition is consistent with the works that have appeared so far on the subject. Thus, our results have as corollaries those obtained by several authors for first and second order integro–differential equations in the degenerate as well as non-degenerate cases.

WeBWorK: herramienta costoefectiva de asignaciones en linea

Edwin Flores, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico en Mayagüez.

Con el avance de la tecnología muchas universidades han incorporado herramientas comerciales de asignaciones/quices/exámenes en línea como apoyo a sus cursos. Algunas herramientas populares son: *WebAssing*: North Carolina State University, *MathLab*: Pearson Education, Aplia: Cengage Learning, *ALEKS*: McGraw Hill Education y *EducoSoft*: Dr. Man M. Sharma.

WeBWork es un sistema creado por los profesores Michael Gage y Arnold Pizer de la Universidad de Rochester. Es de código abierto, fácilmente instalable, robusto, de bajo costo y contiene una gran base de datos de problemas, disponibles inmediatamente después de la instalación. Una de sus mayores fortalezas es la integración de un CAS (Computer Algebra System) llamado MathObject el cual permite que el programador se enfoque en el problema matemático y no en la forma o sintaxis a la hora de crear problemas. Esto lo hace particularmente útil pues acepta cualquier respuesta equivalente del usuario en la solución. Su principal misión es hacer que el estudiante practique y obtenga una retroalimentación inmediata, algo muy importante que, en muchos casos por el escaso tiempo en la sala de clase, se deja a un lado. Lo recio de su programación hace que

muchas personas en el mundo creen problemas. Actualmente se cuenta con más de treinta mil problemas disponibles.

Sus creadores lograron integrar otras herramientas de código abierto bien diseñadas como *MathJax* para la visualización de la notación matemática en cualquier navegador, y *LaTeX* , el lenguaje para escribir la parte simbólica de los problemas. Igualmente crearon un dialecto del lenguaje de programación *Perl* llamado *Problem Generator* (PG) el cual se encarga de la estructura de cada problema.

En esta charla mostraré las principales fortalezas de WeBWork, dónde encontrarlo y cómo instalarlo. Realizaré una demostración de cómo manejarlo y escribiré el código de un problema concreto para que los asistentes accedan a solucionarlo.

Agradecimientos: A Arturo Portnoy, profesor UPRM, quien encontró esta poderosa herramienta y, por medio del Departamento de Ciencias Matemáticas del RUM, me contrató en verano de 2014 para programar problemas dándome la oportunidad de aprender su lenguaje.

Palabras clave: Sistema de asignaciones en línea, Programación de problemas matemáticos, MathJax, LaTeX, Perl, Lenguaje geneador de problemas PG.

On a generalization of Cusick-Li-Stănică's conjecture

Oscar E. González, Department of Mathematics, University of Puerto Rico at Río Piedras.
Francis Castro, Department of Mathematics, University of Puerto Rico at Río Piedras.

An n-variable Boolean function F is a function defined over $\mathbb{F}^n$ with values in $\mathbb{F}$, the finite field with two elements. Such a function is balanced iff $|\{x \in \mathbb{F}^n \,|F(x) = 1\}| = 2^{n-1}$. Cusick-Li-Stănică's conjecture classifies the balanced elementary symmetric Boolean functions. More precisely, it states that the only non-linear balanced elementary symmetric Boolean functions are the ones of degree 2^l and $2^{l+1}D - 1$ variables, where $l, D \in \mathbb{N}$.

In Arce, Castro and Rubio proposed a generalization of this conjecture, which concerns elementary symmetric functions defined over ${\mathbb{F}_p}^n$ with values in $\mathbb{F}_p$. Here a function $\sigma_{n,k}$ is balanced iff $|\{x \in \mathbb{F}_p^n : \sigma_{n,k}(x) = i\}| = p^{n-1}$ for $0 \leq i \leq p-1$. The generalization of Cusick-Li-Stănică's conjecture is as follows: *There are no nonlinear balanced elementary symmetric functions over $\mathbb{F}_p$ except for degree $k = p^l$ and $p^l D - 1$-variables with $D \not\equiv 1 \bmod p$ where l, D are positive integers.* This is an extension of the original conjecture in the sense that by taking $p = 2$ the original conjecture is obtained. In this talk we discuss some results related to the generalization of Cusick-Li-Stănică's conjecture. In particular we verify the veracity of the generalized conjecture for many families of functions.

Acknowledgements: The presenting author was partially supported as a student by NSF-DUE 1356474 and the Mellon-Mays Undergraduate Fellowship.

Keywords: elementary symetric functions, balanced functions, Cusick-Li-Stănică's conjecture

Arithmetic Differential Subgroups of Gl_n

Alfonso E. Heras–Llanos, Department of Mathematics, University of New Mexico – Valencia Campus.

A remarkable and special Galois Theory appears from the study of arithmetic analogue of ordinary differential equations; where functions are replaced by integers, the derivative operator replaced by the "Fermat quotient operator" and differential equations are replaced by arithmetic differential equations. The main result of this presentation will be the study of a very special class of arithmetic subgroup of Gl_n. These subgroups are arithmetic analogues of the differential algebraic groups of E.R. Kolchin and P. Casidy. As a by-product, we found more analogies between the ordinary differential operator and the Fermat Quotient Operator, such as the chain rule and the product rule. We will also introduce a set of functions, that we call Leibniz Systems. These functions "generate" some examples of the differential subgroups of Gl_n.

Keywords: Arithmetic Differential Equations, Galois Groups, General Linear Group, Fermat Quotient Operator.

On matrices with Jordan Form decomposition in an orthonormal basis

Alvaro Lecompte–Montes, Department of Mathematics, Inter American University of Puerto Rico, San Germán Campus.

Matrices with Jordan Form decomposition $A = UJU^*$, for U unitary and J in Jordan Form, can be called quasinormal matrices, because this class includes normal matrices. Column vectors of matrix U give an orthonormal basis of generalized eigenvectors of A. We have found two conditions that are equivalent and can be tested beforehand. The first condition is that the commutator with the adjoint matrix, $K = AA^* - A^*A$, is tripotent. That is: $K^3 = K$. The second one is that for the projection $P = (K^2 + K)/2$, it is $AP = PAP$. The second one could be a consequence of the first, but it has yet to be proven. Both properties are necessary and if they are met, there is a method that iteratively reduces a matrix A to matrices A_i, each one with the same properties and same eigenvalues than A but shorter Jordan cycles, until a normal matrix A_p results, for p the order of the largest Jordan cycle in A. This last matrix can be diagonalized using Schurs method, in which the quadratic form $q(x) =< A_p x|A_p x >$ is maximized. The maximum is attained for x the eigenvector of largest eigenvalue of A. Other eigenvectors and eigenvalues are obtained iteratively, by reduction to the subspace orthogonal to the already determined eigenvectors. Schurs method, when applied to any matrix, gives the decomposition: $A = USU^*$, with U unitary and S upper triangular. For normal matrices, matrix S is diagonal and has better approximations for the eigenvalues and eigenvectors than the algebraic method through the roots of the characteristic polynomial. Returning to A, its generalized eigenvectors are then generated by backtracking the former reduction, and we can calculate its final Jordan decomposition. Our method avoids difficulties in the localization of near or repeated roots of the characteristic polynomial that make the Cayley-Jordan algebraic method unsuitable for numerical calculations. It is also better than Schurs method directly applied to A, because small errors when localizing degenerated eigenvalues may introduce non-null terms in upper parts of Schurs matrix S. Here, the Jordan form J is always reached.

Acknowledgements: Some of the ideas were proposed by students in the abstract algebra course of March-May 2014.

Keywords: matrix algebra, normal matrix, matrix diagonalization, Jordan form decomposition Schur form decomposition.

Entendimiento de derivada direccional de funciones de dos variables

Rafael Martínez Planell, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico en Mayagüez
Maria Trigueros Gaisman, Departamento de Matemáticas, Instituto Tecnológico Autónomo de México
Daniel McGee, Kentucky Center for Mathematics

Se aplica la teoría APOE (Acción-Proceso-Objeto-Esquema) para estudiar el entendimiento de los estudiantes de la derivada direccional de funciones de dos variables. Se establece una conjetura, llamada descomposición genética, de las principales construcciones mentales que un estudiante puede hacer para llegar a entender esa noción. La conjetura se pone a prueba con entrevistas semi-estructuradas a 26 estudiantes que acababan de completar un curso de calculo multivariable. Las entrevistas exploran las construcciones mentales específicas que los estudiantes pueden hacer y las que les causan dificultad. La conjetura, que se llama una descomposición genética, se basa principalmente en la noción elemental de una pendiente, donde se usa el plano tangente para computar cambio vertical. El resultado del estudio sugiere como mejorar la descomposición genética para que responda mejor a observaciones de las construcciones mentales que los estudiantes hacen y también sugiere como mejorar actividades para ayudar a los estudiantes a hacer las construcciones mentales en las que mostraron dificultad.

Palabras clave: Enseñanza del cálculo, APOS, función de dos variables, Derivada direccional

Reconocimiento: La participación de este investigador está parcialmente financiada por La Asociación Mexicana de Cultura A.C.

Entendimiento de la relación entre plano tangente y diferencial de una función de dos variables

Rafael Martínez Planell, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico en Mayagüez
Maria Trigueros Gaisman, Departamento de Matemáticas, Instituto Tecnológico Autónomo de México
Daniel McGee, Kentucky Center for Mathematics

Se aplica la teoría APOE (Acción-Proceso-Objeto-Esquema) para estudiar el entendimiento de los estudiantes de la relación entre plano tangente y diferencial. Se establece una conjetura inicial, llamada descomposición genética, de construcciones mentales que un estudiante puede hacer para

llegar a entender planos, plano tangente, y el diferencial de una función de dos variables. Esta se pone a prueba usando entrevistas semi-estructuradas con 26 estudiantes que recién habían completado un curso de cálculo multivariable. Los resultados del estudio sugieren que los estudiantes tienden a no relacionar estas ideas por su cuenta y sugieren formas de mejorar la descomposición genética para ayudar a que los estudiantes obtengan un mejor entendimiento.

Palabras clave: Enseñanza del cálculo, APOS, función de dos variables, plano tangente, diferencial

Reconocimiento: La participación de este investigador está parcialmente financiada por La Asociación Mexicana de Cultura A.C.

Modular periodicity of exponential sums of symmetric Boolean functions

Francis Castro, Department of Mathematics, University of Puerto Rico at Río Piedras
Luis A. Medina, Department of Mathematics, University of Puerto Rico at Río Piedras

This work considers the periodicity modulo p (p odd prime) of exponential sums of symmetric Boolean functions. Bounds and relations are obtained for the period modulo p of these exponential sums. The concept of avoiding primes is also introduced. This concept and the bounds presented in this work are used to show that some classes of symmetric Boolean functions are not balanced. In particular, every elementary symmetric Boolean function of degree not a power of 2 and less than 2048 is not balanced. For instance, the elementary symmetric Boolean function in n variables of degree 1292 is not balanced because the prime $p = 176129$ does not divide its exponential sum for any positive integer n. Finally, it is showed that for some symmetric Boolean functions, the set of primes avoided by the sequence of exponential sums contains a subset that has positive density within the set of primes.

Keywords: Boolean Functions, Exponential Sums, Pisano Periods

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Optimization and Filtering on Lie Groups and some applications in geometric scene reconstruction in presence of noise and outliers

Rémi Mégret, University of Puerto Rico at Mayagüez.
Guillaume Bourmaud, IMS, University of Bordeaux, CNRS.
Audrey Giremus, IMS, University of Bordeaux, CNRS.
Yannick Berthoumieu, IMS, University of Bordeaux, CNRS.
Marc Arnaudon, IMB, University of Bordeaux, CNRS.
Eduardo Bayro–Corrochano, CINVESTAV, Guadalajara.

In this talk we discuss new generic algorithms for parameter estimation on Lie group manifold: intrinsic Newton optimization and Iterated Extended Kalman Filtering. Lie Groups are useful in

a variety of applications to model non Euclidean geometrical entities such as angle SO(2), rotation SO(3), rigid body transformation SE(3), homographies SL(3), similarities Sim(n) or spinors Spin(n). The proposed algorithms provide an intrinsic modeling of uncertainty which can be leveraged to obtain robust estimation from geometrical data corrupted by noise and outliers. Results that show improvement over state-of-the-art on applications such as: automatic alignment of images in presence of ambiguities, tracking the 3D pose of a wearable camera from the video it captured and merging multiple 3D point clouds will be presented.

Keywords: Lie Group, Optimization, Filtering, Computer Vision, Image Alignment, 3D tracking, 3D reconstruction

The Spatial Spread of Dengue Fever: A Diffusion Model for the Impact of the Latent Period on Disease Dissemination

Juan R. Meléndez Álvarez, Department of Mathematics, University of Puerto Rico at Mayagüez.
Karen Ríos-Soto, Department of Mathematical Sciences, University of Puerto Rico at Mayagüez.

Dengue fever is an endemic disease of the tropical zones, transmitted by the infected female Aedes Aegypti mosquito. The virus characterizes by its ability to reduce the CD4 cells and its symptoms may included high fever, headache, and vomit. In this work, we model the spatial spread of dengue fever using a system of partial differential equations (PDEs) of reaction-diffusion type. The populations under study are the human population and the A. Aegypti mosquito population. The human population is stratified into susceptible, infected and recovered individuals where as the mosquito population is divided into susceptible, does with latent infections and infected A. Aegypti mosquitoes. The latent period (an intrinsic biological characteristic) has not been included in previous mathematical models of reaction-diffusion type for vector borne diseases. For the model under study we show traveling wave solutions and compute numerically the minimal velocity of disease wave propagation, while dynamical system theory was implemented to study the wave stability. For the spatial homogeneous case the stability of equilibrium were established by the threshold condition R_0; known as the basic reproductive number of the disease. Numerical simulations to obtain the wave front profile of the PDEs system were performed using a finite difference method in one dimension. Values for the epidemiological parameters were obtained from previous work (with data from dengue fever in Puerto Rico). Our study will provide an insight to understand vector-host disease spatial dissemination.

Modelo para diseñar la interacción humano-computadora (MODIHC) para aplicaciones móviles en Android

Flor Narciso, Departamento de Ciencias Matemáticas, Universidad de Puerto Rico en Mayagüez

El modelo para diseñar la de interacción humano-computadora (MODIHC) permite diseñar todos los aspectos que intervienen en la interacción entre un humano y una computadora cuando se están desarrollando sistemas o aplicaciones de software. MODIHC se compone de varios componentes relacionados entre si: Usuarios, Ambiente de Trabajo, Tecnología, y Funcionalidad del Sistema. En esta charla se presenta una actualización realizada a MODIHC, en particular a sus

componentes Usuarios, Ambiente de Trabajo y Tecnología para el desarrollo de la Interacción Humano-Computadora (HCI), por sus siglas en inglés) de aplicaciones móviles sobre la plataforma Android.

Para el propósito de este trabajo, los dispositivos móviles se definen como un dispositivo portátil de computación que consta de una pantalla táctil con conexión a Internet, tales como teléfonos inteligentes, consolas de juegos portátiles, reproductores de audio portátiles, tabletas, computadoras portátiles, entre otros. Por lo tanto, la contribución de este modelo consisten en poner a la disposición de los desarrolladores de software, un modelo que toma en consideración los aspectos de HCI en el desarrollo de aplicaciones móviles en Android.

Keywords: software engineering, user centered design, human computer interaction, mobile apps, handheld devices, hybrid apps, android platform

Dynamics of a three molecule array under Lennard–Jones type forces with a constraint of fixed area

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

We study the dynamical problem for a system of three particles in which the inter–particle forces are given as the gradient of a Lennard–Jones type potential. Furthermore we assume that the three particle array is subjected to the constraint of fixed area. The corresponding mathematical problem is that of a dynamical system over the manifold determined by the area constraint. The corresponding static problem have been studied by Negrón–Marrero and Lopez-Serrano (2015) where it is shown that there exists a critical area such that if the area of the array is smaller than this critical value, the stable equilibrium configuration of the array corresponds to an equilateral triangle. However, if the area of the triangle is bigger than the critical area, the stable equilibrium configuration of the array is not a symmetric one. In this paper we study the corresponding dynamical problem. In particular we study numerically the stability of the system around its equilibrium points, and using the recently introduced measure of chaos by Hunt and Ott (2015), we study numerically the possibility of chaotic behavior for this system.

Acknowledgements: This research was sponsored in part by the NSF–PREM Program of the UPRH (Grant No. DMR–1523463).

Keywords: dynamical system, equilibrium points, Lennard–Jones potential, chaos

On the Milstein Method for Stochastic Differential Equations with Markov Switching

Son Nguyen, Department of Mathematics, University of Puerto Rico at Rio Piedras.
Tuan Hoang and George Yin, Department of Mathematics, Wayne State University
Dung Nguyen, Department of Mathematics, University of Technologies at HCM City

This talk is concerned with numerical solutions to stochastic differential equations with Markov switching in which both continuous dynamics and discrete events coexist. So far, in order to solve

this type of equations numerically, Euler-Maruyama scheme seems to be the only method. Despite of its simplicity, the convergence rate of this scheme is 1/2, which is quite slow. By using a general Ito formula and estimating the stopping times when the discrete events occur, we propose a new scheme called Milstein method which gives convergence rate one under mild conditions.

Keywords: Numerical methods, stochastic differential equations.

Modules to introduce Cybersecurity knowledge in the CS curriculum

José Ortiz–Ubarri, Departament of Computer Science, University of Puerto Rico at Río Piedras.
Humberto Ortiz–Zuazaga, Departament of Computer Science, University of Puerto Rico at Río Piedras.
Patricia Ordoñez, Departament of Computer Science, University of Puerto Rico at Río Piedras.
Rafael Arce–Nazario, Departament of Computer Science, University of Puerto Rico at Río Piedras.

In this talk we present a set of modules that can be used to instill Cybersecurity knowledge throughout the CS curriculum. The modules are being developed as part of the Academics and Training for the Advancement of Cybersecurity Knowledge in Puerto Rico (ATACK PR) project whose objective is to develop Cybersecurity research and education in PR. The modules introduce topics such as password cracking, input validation, SQL injection, code audit, digital forensics, and reverse engineering to supplement the knowledge that is acquired through the standard CS courses. Furthermore these modules serve to motivate students to experience the theoretical concepts of the course in an applied and engaging manner. Currently the project has modules that can be used in the Introduction to Programming, Database Design, Operating Systems, High Level Languages, and Compilers courses.

Acknowledgements: This work was partially supported by NSF Grant Number DUE-1438838.

Keywords: Cybersecurity, computer science education

Bayesian rescue for the troubled scientist, or how to calibrate classical significance tests

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

In recent years there has been an important discussion on the validity of methods for Null Hypothesis Significance Testing (NHST). As a worrying consequence of this controversy, statistical inference methods are losing the trust of sectors of the scientific community, as it is reflected by the recent editorial of *Basic and Applied Social Psychology* (Trafimow and Marks, 2015) banning the use of procedures as p-values, confidence intervals and related methods from the papers published in BASP. As the editors remark, "In the NHSTP, the problem is in traversing the distance from the probability of the finding, given the null hypothesis, to the probability of the null hypothesis, given the finding". Increasingly large sections of the scientific community are speaking load and clear: p-values should no longer be the deciding balance of science.

In an attempt to link simple and effective Bayesian procedures easily available to practitioners, we extend on the ideas in Pérez and Pericchi (2014), and introduce calibrations of p-values that not only provide an asymptotical behavior coherent with that of a Bayes factor, but also allow interpreting them as bounds of the posterior probability for the null hypothesis. For this we build on objective lower bounds presented, for example, in Sellke, Bayarri and Berger (2001) but include an adjustment with the sample size for controlling the asymptotic behavior. P-values may be bad, but they are available for virtually any statistical model. Calibration of p-values, may ironically be the fastest way to popularize the use of Bayes Factors.

Keywords: Null Hypothesis Significance Testing (NHST), p-value, Bayes factor.

Algunas coordenadas de la matemática educativa en Puerto Rico

Orlando Planchart Márquez, Departamento de Ciencias y Tecnología, Universidad Interamericana de Puerto Rico.

Esta exposición se fundamentará en la investigación de mi autoría Una aproximación a la Matemática Educativa en Puerto Rico? la cual tuvo como propósito indagar los entornos fundamentales de la educación matemática en Puerto Rico. Dicho trabajo se integró como un capítulo, en el libro "La educación matemática en el siglo XXI", publicado por el Instituto Politécnico Nacional de México, en octubre de 2015. Este trabajo se planteó a partir de las siguientes interrogantes, entre otras: ¿Cómo se puede caracterizar la Matemática educativa o la Educación matemática? ¿Cuál es la visión que se tiene de la Matemática educativa? ¿Cuál es la vinculación o acercamiento de los docentes de matemática de Puerto Rico con los enfoques y teorías educativas que se desarrollan en Suramérica, Centroamérica y el Caribe, y Norteamérica? ¿Cómo se forman los maestros y profesores de matemática en Puerto Rico?

La metodología se basó por una parte, en realizar entrevista a tres profesores, Ana Helvia Quintero (profesora de la Universidad de Puerto Rico, Recinto de Río Piedras), Dr. Omar Hernández (Profesor Universidad de Puerto Rico, Recinto de Río Piedras) y el Prof. Joaquín Padovani (Profesor Universidad Interamericana de Puerto Rico, Recinto de San Germán), todos con valiosas trayectorias en el campo de la educación matemática; y por otra parte, revisión de artículos, documentos e investigaciones.

En dicha investigación se consideraron los siguientes temas: la educación matemática en Puerto Rico, líneas de investigación en Educación en Matemática, papel de las universidades en la formación de maestros y profesores, la Prueba PISA, relación de la educación matemática con Latinoamérica, con Estados Unidos y otros países, eventos y revistas de matemática educativa, y acercamientos a otros temas.

EmbalsesPR: Una aplicación en linea para monitorear en tiempo real los embalses de Puerto Rico

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

EmbalsesPR es una aplicación en línea para monitorear los niveles de los embalses en Puerto Rico. La misma surgió ante la necesidad de automatizar y agilizar el proceso de obtener los niveles de

los embalses durante la sequía del año 2015. Fue desarrollada en el lenguaje de programación R y la interfaz gráfica utiliza rutinas del paquete Shiny. Accediendo el portal embalsespr.uprh.edu, y al toque de un botón, cualquier ciudadano puede obtener la ultima actualización de los niveles generados por los instrumentos del servicio geológico de los EU (USGS). El portal genera un mapa geográfico interactivo en el cual se pueden visualizar, simultáneamente, los estados de los 11 embalses en Puerto Rico así como series de tiempo para cada uno de ellos. La ultima versión de embalsesPR utiliza estructuras de datos distribuidas con el fin de paralelizar el proceso de adquisición de datos en arquitecturas con procesadores multi–núcleo.

Elastic vibration of fractal cylinders

Lev Steinberg, Department of Mathematical Sciences, University of Puerto Rico at Mayagüez.
Mario Zepeda, Department of Mathematical Sciences, University of Puerto Rico at Mayagüez.

In this talk we present our study of vibrations of fractal elastic circular cylinders. The equations for vibrations were derived from the modified balance laws of fractal media and linearized version of constitutive and strain equations. For this case we obtained the analogous of torsional, longitudinal and transverse wave equations of fractal cylinders in terms of the fractional derivate. The basic equations include a recently established definition of fractional derivative with classical properties. Interesting properties of these vibrations will be discussed during the talk

Keywords: fractal derivatives, fractal continuum, conservation laws, elastic waves

Minimum rank of n–dimensional hypercube cut–complex

Hetor D. Torres–Aponte, Graduate Business School, University of Puerto Rico at Rio Piedras.
M.Reza Emamy–K., Department of Methematics, University of Puerto Rico at Rio Piedras.
Leslie Hogben, Department of Mathematics, Iowa State University.

Let Q_n be a n-dimensional hypercube. A hypercube *cut-complex* is the subgraph induced by the set of vertices on one side of the hyperplane when a $(d1)$-hyperplane cuts some edges in Q_n. The minimum rank of a simple graph G is the smallest possible rank over all real symmetric matrices whose ijth entry (for $i \neq j$) is nonzero exactly when $\{i, j\}$ is an edge in G. The minimum rank of selected cut–complexes of Q_n is presented, including the family defined by the Cartesian product of $(n-2)$–dimensional hypercube and a path with three vertices denoted by $Qn2\Box P_3$. Furthermore all cut complexes of small order hypercubes have been calculated.

Acknowledgements: This research was partially supported by Iowa State University and National Science Foundation – Alliance Grant DMS-0502354.

Keywords: hypercube, cut-complex, minimum rank, cartesian product

Fraud and Forensic Accounting using Benford's Law in Bayesian Analysis approach

David Torres Núñez, Instituto de Estadística y Sistemas Computadorizados de Información, Universidad de Puerto Rico en Rio Piedras.

Fraud and Forensics account had been high a priority in terms of avoiding criminal behavior by stakeholders. Using cutting–edge statistical tools one can improve the detection of fraud in bank accounts. We are using Hierarchical Bayesian models and Benford's Law to detect fraud in bank accounts. Examples with the working methodology will be presented. This method provides robust and easy to implement methodologies to assist professionals in the detection of fraud. Models of classical hypothesis testing were used and compared with the goodness of Bayesian models adjustment.

Keywords: Bayesian Statistics, Markov Chain Monte Carlo Methods, Scaled-Beta 2, Robust analysis, Forensics Account, Hierarchical Bayes, Benford's Law

Didáctica de la variación y el análisis de los discursos docentes

Waldo A. Torres Vázquez, Departamento de Matemática-Física, Universidad de Puerto Rico en Cayey

El propósito de esta investigación es construir argumentaciones teóricas para caracterizar discursos docentes que aportan al aprendizaje de la noción matemática de variación. Enmarcado en la filosofía interaccionista, el análisis cualitativo de los discursos docentes en tres clases de nivel universitario se realizó usando un diseño de Análisis de Discurso, complementado con un enfoque de Teoría Emergente. Se estudió el discurso con énfasis en la identificación de intenciones y contextos para la producción de significados, siempre en relación con las epistemologías personales de los docentes, los registros semióticos, los valores y las hipótesis que configuran su forma de comunicación. En particular, analizamos la lógica principal que caracterizó cada discurso docente y se diseñaron las trayectorias discursivas de cada clase. Además, desciframos las reglas meta-discursivas que definen, para cada profesor, qué es la variación y cómo se aprende.

Los resultados de esta investigación ponen de relieve la importancia que tiene una identidad discursiva de negociación para crear las condiciones que favorezcan la construcción de significados. Los discursos docentes que son flexibles y democráticos contribuyen a aumentar la motivación de los estudiantes para crear discursos propios, negociar normas socio matemáticas y crear una cultura de reflexión e investigación. Estas características de los discursos, en sus formas verbal y no verbal, promueven la discusión de argumentos intersubjetivos que, en síntesis, contribuyen a una comprensión compartida de los temas bajo estudio.

Los silencios reflexivos, el tono coloquial, la pregunta retórica y el lenguaje social inclusivo, entre otros aspectos, contribuyen a consolidar un proyecto de influencia mediante el cual se promueven las construcciones de conocimiento. En el caso específico de la noción de variación, las construcciones de los estudiantes se pueden apoyar con un discurso simple y directo que se ancle en procesos de tanteo y error, con atención al registro semiótico numérico y a la negociación de palabras claves para describir el cambio.

Palabras clave: discursos docentes, patrones discursivos, didáctica de la variación

Análisis de datos usando Regresión Multivariante Múltiple por Minimos Cuadrados Parciales (Regresión PLS)

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En la construcción de un modelo de Regresión Múltiple o Regresión Multivariable Múltiple basado en una matriz de variables predictoras X, de orden $n \times p$, y una matriz de variables dependientes Y de orden $n \times q$ se pueden presentar dos problemas: multicolinealidad y alta dimensionalidad de sus variables predictoras ($n < p$). En este trabajo se presenta la metodología Regresión por Cuadrados Mínimos Parciales (regresión PLS, por sus siglas en inglés) como solución a los problemas planteados. La metodología PLS transforma las variables predictoras en variables artificiales llamadas componentes o variables latentes, las cuales son ortogonales (sin multicolinealidad) y permiten hacer una reducción de la dimensionalidad del espacio de variables predictoras. Luego usando solamente las variables latentes se construye el modelo de regresión estimado. El objetivo del presente trabajo es difundir la teoría y aplicación de la regresión PLS, ampliamente usada en un ?área de la química llamada Quimiometría, para que pueda ser aplicada como herramienta estadística en toda disciplina que trabaja con datos caracterizados por muchas variables medidas sobre cada uno de pocos sujetos.

En este estudio se hace una discusión del trabajo de H. Abdi (2010), Partial Least Squares Regression and Projection on Latent Structure Regression (PLS Regression); se presenta el algoritmo NIPALS (Nonlinear Iterative PArtial Least Squares) desarrollado por H. Wold (1966). La aplicación es ilustrada mediante ejemplo práctico para cada caso presentado: regresión múltiple y regresión multivariable múltiple con evaluación del modelo ajustado mediante validación cruzada. Se desarrollaron programas en lenguaje R para tal efecto.

Palabras claves: multicolinealidad, reducción de la dimensionalidad, algoritmo NIPALS.

Errores matemáticos cometidos por los estudiantes universitarios en el estudio de funciones exponenciales y logarítmicas

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En el estudio se investigaron los errores matemáticos que cometen los estudiantes al realizar ejercicios relacionados con funciones exponenciales y logarítmicas. Los resultados de varias investigaciones indican las limitaciones y los errores que cometen los estudiantes al estudiar diferentes temas de matemáticas (Konyalioglu, 2011; Shabanifar y Konyalioglu, 2013). Específicamente, se han

señalado las limitaciones que muestran los estudiantes en funciones exponenciales y logarítmicas (Khan y Chishti, 2011). Entre los errores que cometieron los estudiantes se encuentran: el no aplicar correctamente las propiedades de los logaritmos; no expresar correctamente la forma exponencial y logarítmica; y no expresar correctamente la notación científica.

El analizar los posibles errores que cometen los estudiantes al realizar ejercicios sobre este tema, es de suma importancia pues si los estudiantes no tienen el entendimiento de conceptos previos, afectará adversamente su desempeño en el aprendizaje de conceptos más avanzados. Además, el conocer las maneras de razonar de los estudiantes ayudará al profesor a usar mejores estrategias de enseñanza.

En este estudio participaron estudiantes matriculados en el curso Métodos Cuantitativos para Administración de Empresas I que ofrece Universidad de puerto Rico, Recinto de Río Piedras, durante el primer semestre del año académico 2015-2016. La metodología utilizada en este estudio consistió en la recopilación de los datos que se obtuvieron de la administración de una prueba corta sobre el tema de funciones exponenciales y logarítmicas.

Se analizaron los datos del desempeño de los alumnos en la prueba y se comparó el rendimiento usando las variables de: género, si eran de nuevo ingreso o no, entre otros. Además, se categorizaron los errores cometidos por los estudiantes al llevar a cabo los ejercicios de la prueba. Se utilizaron dos metodologías estadísticas: la prueba chi cuadrado y el análisis de regresión logística (Almog y Ilany, 2012).

Palabras claves: Errores matemáticos, Funciones exponenciales y logarítmicas, Precálculo

Global regularity for solutions of nonlocal Robin problems in a class of "bad" domains

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We consider the solvability of linear elliptic equations with nonlocal Robin boundary conditions, defined (in the generalized sense) on a bounded $W^{1,r}$–extension domain whose boundary is an upper d–set, for an appropriate $d \geq 0$. Then, we extend the fine regularity theory for weak solutions of the elliptic equations with the above boundary condition, known for bounded Lipschitz domains, to bounded $W^{1,r}$–extension domains whose boundaries are upper d–sets, by showing that such weak solutions are globally H lder continuous. Consequently, we generalize substantially the class of bounded o domains where weak solutions of boundary value problems of Robin type may be uniformly continuous (up to the boundary).

Keywords: $W^{1,r}$–extension domains, upper d–Ahlfors measure, Robin boundary conditions, Nonlocal boundary conditions, Weak solutions, Hölder continuity.

Bayesian approach to valuation of executive stock options

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For the absence of liquidity, executive stock options are valued at less, and often far less than Black–Scholes values, this view assumes the condition that option holders are price takers and therefore cannot influence the payoffs of their options. Hsiao and Chance (2014) incorporate the executive's effort to valuation of executive stock options

$$S^*_{idt} = S_{idt} q^{\delta}_{idt}, \quad q_{idt} \geq 1,$$

where S_{idt} is the executive's belief of the true value of the stock after taking the effort into account at time idt, S_{idt} is the stock price on date idt with minimum effort equal to one, q_{idt} is the measure of executive effort from period $t = 0$ to idt, and δ is the measure of the executive's perception of his quality, which is the elasticity of the stock price with respect to his effort, $\delta \geq 0$. We use a distribution for this variable under Bayesian approach and we will compare with the results obtained by the authors.

Keywords: Stock Options, Black-Scholes, Bayes Approach

7 Carteles / Posters

(In alphabetical order using the last name of the presenter.)

Automated phenotyping of patient EMR Data: feature extraction and selection

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Personalized medicine is a medical model that uses an individuals genetic profile to guide decisions made in regard to the prevention, diagnosis and treatment of a disease. For this, genetic and phenotype data needs to be collected in such a way that allows one to make gene disease associations. Approaches to collect genetic data in massive amounts have proved successful in the past, but the same is not true for phenotype data. Although some work has been done in the collection of phenotype data, this work looks poor when compared to all the information available for genetic data. The focus now turns to an approach that successfully collects phenotype data in such a way that its possible and efficient to make the associations.

The goal of the project is the development of a diseases classification model for EMR notes. With the use of public medical sources, electronic medical records and the application of a natural language processing algorithm we were able to extract key concepts that were related to a disease of interest. The ones studied in this project were Obesity, Migraine, Septic Arthritis, Giant Cell Arteritis and Osteoarthritis. We use the statistical software package R to perform a note level screening test and a patient level screening test of the concepts that were going to be use to train the model. The Bonferroni Correction, the Benjamini–Hochberg Correction and a Permutation Test were implemented to account for a multiple testing problem faced because of the amount of concepts associated with the diseases that were studied. Results from this process were accurate with the literature.

Análisis computacional entre matrices esparzas y los métodos del gradiente

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La modelación matemática de una gran parte de problemas de fenómenos reales se sustenta en el desarrollo de ecuaciones diferenciales. La solución analítica a estas ecuaciones en algunos casos es dispendiosa o insoluble, siendo necesarias soluciones numéricas que en general durante el proceso de discretización relacionan matrices de altas dimensiones con una gran cantidad de elementos no nulos, conocidas como matrices esparzas.

En la gran mayoría de métodos numéricos para la resolución de sistemas lineales encontramos los métodos del gradiente, los cuales envuelven una gran cantidad de productos entre matriz por vector. Para aprovechar las cualidades que poseen las matrices esparzas tanto en el almacenamiento como en sus operaciones matriciales, se deben usar estructuras de datos eficientes y que trabajen únicamente con sus entradas no nulas. Entre estas estructuras se encuentran los esquemas de almacenamiento. Algunos de estos esquemas son: "the coordinate scheme (AIJ)", "the compressed sparse rows (CSR)", "the modified sparse rows (MSR)" y "compressed sparse vector (CSV)" donde, cada una de estos al compararse con los otros esquemas puede ser eficiente o ineficiente, dependiendo del problema de aplicación.

En esta presentación, proponemos dar a conocer algunos resultados computacionales respecto a la memoria y tiempos de computo al comparar diversos esquemas de almacenamiento para matrices esparzas en la solución de grandes sistemas lineales resultantes de discretizaciones numéricas tales como: diferencias finitas, volúmenes finitos y elementos finitos, para problemas de fenómenos reales adquiridos en el recurso electrónico "Matrix Market". Los esquemas usados en las comparaciones son: el AIJ, CSR, MSR y CSV para los cuales se utilizaran los métodos del gradiente entre ellos: el gradiente biconjugado, el gradiente biconjugado cuadrado y el gradiente biconjugado establizado. Dependiendo tanto del método de resolución del sistema lineal como de las propiedades de las matrices, en algunas aplicaciones es importante para mejorar la eficiencia computacional seleccionar correctamente el esquema de almacenamiento a emplearse. Además del uso de los almacenamientos, se aplicará el precondicionador de Jacobi en estos métodos.

Agradecimientos: Esta presentación fue impulsado gracias al proyecto de investigación "Análisis teórico y computacional de las propiedades de matrices para ciertas discretizaciones numéricas" de

la Universidad de Nariño.

Palabras Clave: Matrices esparzas, discretizaciones numéricas, producto matriz por vector, métodos del gradiente.

Modeling Wolbachia Transmission in Natural Populations of Anopheles Mosquitoes

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Wolbachia are intracellular bacterial symbionts that infect arthropods via maternal transmission and are known to affect the hosts immune and reproductive systems. Prior research has shown that experimental Wolbachia infections in Anopheles can reduce Plasmodium load by inducing an immunological response. Recently, a new strain of Wolbachia was found in natural populations of the malaria vector Anopheles gambiae. Nevertheless, the host-symbiont interaction between Anopheles and Wolbachia has been poorly studied because of its recent discovery outside of experimental environments. Consequently, in order to improve the efforts towards combating malaria, it is important to understand the relationship between Anopheles, Wolbachia, and Plasmodium. Using mathematical modeling, the aims of this project were to understand the stable prevalence of Wolbachia in natural Anopheles mosquitoes, and predict what factors affect the prevalence of Wolbachia in the Anopheles host.

A model of Wolbachia infection of Anopheles populations was developed including four ordinary differential equations that predicted the number of adult progeny according to sex and Wolbachia infection status after many reproductive cycles. We ran population dynamic simulations in Matlab using data collected in Burkina Faso, and a sensitivity analysis in order to determine which parameters had the greatest impact on the prevalence of Wolbachia in Anopheles populations. The sensitivity analysis showed that the most significant alterations in population dynamics were caused by changes in the proportion of females in their reproductive stage that lay eggs depending on their Wolbachia infection status and the transmission rate in the progeny of infected females. Results from this model can be used to predict reproductive cycles in experiments carried in more controlled environments.

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Keywords: Wolbachia, Anopheles gambiae populations, Plasmodium, infection

Platelet counts and their effect on patient outcomes with patent ductus arteriosus (PDA)

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As a fetus develops, blood passes from the heart through an open aorta to the not yet functional lungs. Once the baby has been delivered, it is expected that the heart closes off the aorta from the pulmonary artery, separating the oxygenated and deoxygenated blood. Sometimes this does not occur, causing a circulatory disorder called patent ductus arteriosus (PDA). This research focuses on premature newborns, who have a higher prevalence of this disorder. Currently, it is unclear to doctors what is the best approach to treating PDA: letting the aorta close on its own, administering medicine (indomethacin), or performing surgery.

Data for 405 preterm newborns was collected at the University of Iowa Hospitals and Clinics. We used logistic regression to examine the relationship between platelet counts in the first 7 days of life and other factors on three clinical outcomes: development of PDA, recovery without intervention, and successful indomethacin treatment. We found a positive correlation between higher platelet counts and better clinical outcomes for the patients. There were interesting dynamics between the early, later, and average platelet counts and their importance in our predictive models.

Investigating crime data in Puerto Rico through statistical analyses

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In an exploratory analysis of PR crime data reported by the police department in 2014, we found that Bayamon is the police region with the largest number of crime events (12,411 crimes) and the second largest crime rate (1,849 crimes per 100,000 inhabitants). Because of its high crime prevalence, we are focusing our analyses in this region. Using a descriptive data analysis, we found that theft is the most frequent type of crime (6,696 crimes, 53.95%) in the region; more than the double of the second type of crime that has occurred, which is burglary (2,453 events, 19.76%). The period between 7:00pm and 8:00pm exhibited the largest number of crimes in Bayamon with 685 crimes (5.5%). In average, about 1.32 crimes occurred per hour in the region. Using georeferentiation we found that the mean centre of the data was located at Bucarabones, Mucarabones, Toa Alta, 00949. The data is clearly clustered in certain areas and boroughs showing some crime hot-spots. The original data had location information in decimal degrees coordinates, so a transformation to eastings/northings coordinates was necessary in order to interpret intensity results in metric units. We used kernel-smoothing techniques to analyze the spatial distribution of crime intensity. To determine the optimal bandwidth for the kernel smoothing we used the Least-Squared Cross-Validation (LSCV) criterion. LSCV found that 12 hectometers is the optimal bandwidth for the kernel smoothing of the study region. We found that crime intensity changes by month, but

the crime hot-spots remains almost equally distributed spatially across time. The results of this research will lead to better understanding of crime pattern in this region and could be used to design public policies by the police department and policymakers.

Acknowledgement: This research was sponsored by the Puerto Rico Louis Stokes Alliance for Minority Participation (PR-LSAMP) research program.

Keywords: data analysis, statistics, point-pattern analysis, RStudio.

Modelos de cazador–presa: una nueva estrategia de persecución

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Considere la situación en que un perro persigue a un conejo. ¿Cuál es la trayectoria que debe seguir el perro para atrapar al conejo? Una pregunta tan sencilla? como esta nos remonta al 1732, a lo que se conoce como el problema de búsqueda original, planteado por el matemático francés Pierre Bouguer. En el problema original, el perseguido (a quien nos referiremos como el conejo) se mueve sobre una línea recta. El perseguidor (a quien nos referiremos como el perro) se mueve hacia la posición del conejo, apuntando directamente hacia el conejo en cada instante de tiempo. Este ha sido el criterio de persecución más utilizado en el modelaje matemático de estas situaciones.

Nuestra investigación tiene como objetivo principal utilizar un nuevo criterio de persecución. Este consiste en que el perro, en vez de apuntar directamente hacia donde ve al conejo, lo hace una distancia más al frente. Esa distancia es proporcional a la separación entre el perro y el conejo en cada instante. El propósito es verificar si esta nueva estrategia reduce el tiempo de captura al compararlo con el criterio utilizado por Bouguer.

Además de estudiar el problema planteado originalmente por Bouguer con el nuevo criterio de persecución, también estudiamos el caso en que el conejo huye a lo largo de una parábola. En las situaciones estudiadas, la utilización del criterio propuesto en esta investigación resulta en un tiempo de captura menor al compararlo con el criterio original de Bouguer. Por consiguiente, la idea de la anticipación en las estrategias de persecución resulta ser más efectiva bajo las condiciones que proponemos en esta investigación.

Effect of Distraction and Alzheimers Disease in Simulated Driving Based on Four Methods of Data Reduction

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Using data collected from a driving simulator at the University of Iowa Hospital and Clinics, we were able to apply four methods of reducing lateral lane position data observed during a 53 second stretch of straight road driving. The four reduction methods were:

a) counting the standard deviation of the lane position;

b) counting the number of lane departures;

c) integrating the area lane departures;

d) the re-centering parameter based on the model proposed by Dawson et al (2010).

Data were available from 69 drivers with Alzheimers disease (AD) and 129 healthy older drivers without. The drivers were exposed to two segments, one control segment meant to be free of distractions, and another segment where the drivers were asked to perform the Paced Auditory Sequential Addition Task (PASAT). Overall, we found that drivers with AD performed worse than healthy subjects, and that the PASAT task influenced driving, but it was unclear whether the effect of PASAT was different between groups.

String matching: a data structure approach

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A suffix array can be described as a lexicographically sorted list of all suffixes of a text. This data structure is essential for applications involving the pattern-matching problem and genome analysis. We have designed and constructed a serial nave implementation of the suffix array, made time complexity analysis of the sorting algorithms, and generated data using different sizes datasets of genome sequences that allowed us to study the efficiency of the different sorting algorithm implementations. The skew algorithm has also been studied. Since this algorithm only works with numbers but our dataset was made up of characters, we built a code that converted a string of characters into integers and designed a ranking system for the different characters in the string. We have also conducted runtime tests to compare the skew algorithm implementation of suffix arrays with our nave construction.At this point we are not aiming at designing the most efficient suffix array algorithm but rather in the experience of studying time complexity. Tests have been

performed on Blue Waters, which contains 22,640 XE6 compute nodes and is one of the fastest supercomputers. Tests have also been performed on LittleFe, which is a complete multi-node portable computational cluster.

Modeling a Herpes Gladiatorum Outbreak in a Wrestling Summer Camp

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One of the most common infections in sports is skin infections or cutaneous infections. An estimated 8.5% of health conditions and injuries in high school sports are related to infectious diseases of the skin where as 21% are estimated in college sports. Athletes may get infectious when they are in direct skin to skin contact with infectious athletes. A common skin infection among wrestling athletes, caused by the herpes simplex virus type 1 (HSV-1) is the Herpes Gladiatorum virus. Although the virus can be treated, it does not have a cure. The lesions or blisters usually appear 7 to 8 days after acquiring the virus but some symptoms could occur before the visible lesions, such as: fever, sore throat, swollen lymph nodes and tingling on the skin. Infected individuals can infect others before the lesions or blisters appear (approximately within 3 days). In this work, we built a system of nonlinear ordinary differential equations to analyze and simulate an outbreak of Herpes Gladiatorum in the J. Robinson Intensive Wrestling Camp. The scope of this work is on two consecutive outbreaks during the summers of 2000 and 2001, where data is available. We stratified the wrestler population into four epidemic states that is: susceptible wrestlers, wrestlers with latent herpes infections, infectious wrestlers with lesions and finally wrestlers on a quiescent state (non-infectious, a dormant form of the virus). At this preliminary stage, we find and analyzed the system equilibrium, compute an expression for the threshold condition of the disease, known as the basic reproductive number and explore some possible scenarios through numerical simulations of the system. Based on the available incidence data we plan to estimate epidemiological parameters of the model as well as the actual basic reproductive number of each outbreak.

Keywords: Herpes Gladiatorum, J. Robinson Intensive Wrestling Camp, nonlinear ordinary differential equations system

Counting large prime numbers

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Large prime numbers are a basic element of keys for digital signature standards such as RSA, which has been standardized by NIST. However, the primes chosen for the RSA digital signature must satisfy a different set of restrictions. The problem arises when trying to generate those large primes with a given(fixed) number L of bits and for them to satisfy the conditions so they are secure enough to withstand a cryptanalytic attack. Are there enough primes available for the purpose

of the RSA? What if more conditions are added? The prime numbers are counted under various assumptions and then the results are expressed as an estimate of the number of the primes as a function of the parameters established by the Federal Information Processing Standards(FIPS) 186-4. The results are analyzed to see to what extent these new requirements reduce the already small pool of available primes and if more conditions can be added.

Acknowledgements: This research was sponsored by The National Institute of Standards and Technology and The National Science Foundation. Special thanks to the Puerto Rico Louis Stokes Alliance For Minority Participation for recommending me to participate in this program.

Keywords: prime numbers, digital signatures, RSA, FIPS 186-4

Decomposition of quasinormal matrices in Jordan form

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Quasinormal matrices are those matrices that can be decomposed into Jordan form in an ortonormal basis. They have been characterized as having the commutator with its adjoint matrix, $K = AA^* - A^*A$, tripotent: $K^3 = K$. In addition, the projector $P = (K^2 + K)/2$ satisfies $AP = PAP$. As a consequence of these properties, the Jordan form of quasinormal matrices can be calculated reducing the matrix A to the subspace orthogonal to P. The new matrix of smaller dimensions has similar properties and the same eigenvalues but shorter Jordan cycles. The method can be iterated until a reduced normal matrix A_p is calculated. This last matrix can be diagonalized following Schurs method. After that, the generalized eigenvectors of A can be recovered from those of A_p. We have programmed the method using the system *Mathematica* and applied it to randomly generated quasinormal matrices. The Jordan form of the matrix is first randomly generated, and later it is rotated to a randomly chosen orthonormal basis. We can recover the Jordan decomposition of the matrix using this method and analyze how it works. The method shows to be more stable than the traditional Cayley-Jordan algebraic method which usually has approximation difficulties with the same type of matrices. Since the Schurs method decompose matrices it into an upper triangular matrix, which has not an exact Jordan form, this method also gives better results than the Schurs when applied directly to A.

Acknowledgements: Some of the ideas were proposed by students in the abstract algebra course of March-May 2014.

Keywords: matrix algebra, normal matrix, matrix diagonalization, Jordan form decomposition Schur form decomposition.

A model for the control of dengue fever with the use of GMM

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Dengue fever is a mosquito borne disease caused by the dengue virus that is primarily transmitted by the genus Aedes aegypti. Puerto Rico has experienced epidemic dengue activity periodically since 1963 with four years of more than 10,000 cases of the disease. The main vector control measure includes the elimination of their nesting places and has been somewhat successful. Innovative research suggests the use of genetically modified mosquitoes to control epidemics of vector borne diseases. In this project a mathematical model was developed that considers both the population dynamics of GMMs and wild type, dengue infected, mosquitoes and the epidemic dynamics of the disease in a human population. The same has six equations that describes the population dynamics and three more equations to describe the epidemic dynamics. A quantitative analysis of the model was done and compared to multiple numerical simulations.

Congruence classes for Gaussian Integers

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Gaussian integers, that is complex numbers with integer real and imaginary parts, have almost the same algebraic properties of integers, including division algorithm. The only exception is that there is not a unique obvious way to express the remainder of a division. Therefore, a nice arithmetic can be done with congruence classes of Gaussian integers that can be useful to develop cryptographic schemes analog to those with integers. Following previous work, we have devised a method to select a unique representative in each congruence class, in which (mod $z = a + bi$) we select a number in the set $Z_d + Z_m i$, where $m = gcd(a, b)$ and $d = (a^2 + b^2)/m$. Operations between representatives of the classes are done by the usual rules of complex integers, and the following two rules:

1) imaginary numbers are reduced to a real plus an imaginary with the congruency $mi \equiv f$ (mod z), where $f = -ka + hb$, for h and k such that $m = ha + kb$. The coefficients h and k can be calculated using Euclids extended algorithm.

2) Each integer can be reduced with the congruency $d \equiv 0$ (mod z).

After these reductions, the set $Z_d + Z_m i$ is closed and forms a ring. Following this definition, we set methods to calculate operations in the ring, determine and generate prime Gaussian integers, modular powers, inverses, calculate the Euler phi function and other useful tools for doing encryption and decryption. The programming has been developed using the system *Mathematica* and applied to numerous examples to proof its performance.

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Keywords: Gaussian integers, congruence classes, complex modular arithmetic, cryptographic codes.

A Mathematical Epidemiological Model to Study the Impact of the Prodrome Period on Herpes Simplex Viruses Epidemics

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Herpes Simplex Viruses (HSV-1 and/or HSV-2) has reached epidemic proportions worldwide in recent years. Approximately 67% of the global population are currently infected with HSV-1 and 16% with HSV-2. HSV are an infection of the skin transmitted by direct contact with the infected area. Typically, HSV-1 is established in the trigeminal ganglion (orofacial), but also can establish in the genital area. On the other hand, HSV-2 is typically established in the dorsal root ganglion and expresses commonly in the genital area. There is no known cure for HSV, but the viruses are not active nor contagious all the time. This phase is known as quiescent. Six to forty-eight hours before visible lesions, HSV are in the prodrome period, where the individual may be infectious and experience constitutional symptoms. There are several bio-mathematical studies on HSV-2, but only few in HSV-1, which none that includes the prodrome period explicitly. The objective of this work is to built a mathematical epidemiological model of non-linear ordinary differential equations to study the impact of the prodrome period on new HSV infections. The model stratifies the population into susceptible individuals, HSV infectious individuals (with lesions), individuals on the prodrome period under primary infection, individuals on the prodrome period under reactivation of the virus and individuals in quiescent state (non-infectious). At this preliminary stage we investigate the system equilibria, the basic reproductive number and other partial results through simulations.

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Keywords: mathematical model, non-linear system, herpes, equilibrium

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