UNIVERSIDAD DE PUERTO RICO
Recinto de Río Piedras
Departamento de Matemáticas

SIDIM XXXIII

SEMINARIO INTERUNIVERSITARIO DE INVESTIGACIÓN EN CIENCIAS MATEMÁTICAS

Scan me

23 y 24 de Marzo de 2018

Conferencias Plenarias:

Dr. Luis Cáceres - UPR-Mayagüez
"*Estrategias en Solución de Problemas de Olimpiadas Matemáticas*"

Dra. Rosa C. Orellana - Dartmouth College
"Products of symmetric group characters"

Dr. Enrique Zuazua - DeustoTech-Bilbao & UAM-Madrid
"Control dinámico: Avances, retos y aplicaciones"

GLOBAL PROGRAM

Friday March 23, 2018	
Time	
16:00-18:00	Register
18:30-19:00	Inauguration
19:00-19:50	Plenary Talk - Luis Cáceres
20:00-21:00	Social Activities

Saturday March 24, 2018						
Time	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6
7:00-9:00	Breakfast					
7:30-9:30	Register					
8:00-4:00						
8:00-8:25			R. Reyes	G. Polanco		
8:30-8:55	S. Nguyen	C. Dennis	J. Orozco	X. Martínez	D. Torres	L. Hernández
9:00-9:25	G.Gomez	M. Marcano	M. Delgado	O. Colon	P. Rodriguez	A. Quintero
9:30-9:55	C. Carvajal	R. Kvasov	F. Pinero	M. Santana	M. Perez	W. Velázquez
10:00-11:00	Posters					
11:00-11:50	Plenary Talk - Enrique Zuazua					
12:00-13:00	Lunch					
13:00-13:50	Plenary Talk - Rosa C. Orellana					
14:00-14:25	S. Klajbor	A. Carrillo	I. Rubio	C. Trujillo	O. Medina	M. Gonzalez
14:30-14:55	A. Velez	H. Cortez	L. Sepulveda	R. Emamy	R. Mégret	M. Gonzalez
15:00-15:25	E. Alvarez	M. Robles	R. Del Valle	O. Tomaiconza	I. Rodriguez	E. Orozco
15:30-16:00	R. Aparicio	L. Shan	L. González	J. De Jesús	I. Dávila	D. Collins
16:00-17:00	Permanent Committee Meeting					

GLOBAL PROGRAM

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7:00-9:00	Breakfast					
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8:00-4:00						
8:00-8:25			50	57		
8:30-8:55	1	28	27	17	38	55
9:00-9:25	37	24	8	51	45	54
9:30-9:55	25	21	39	23	6	15
10:00-11:00	Posters					
11:00-11:50	Plenary Talk - Enrique Zuazua					
12:00-13:00	Lunch					
13:00-13:50	Plenary Talk - Rosa C. Orellana					
14:00-14:25	14	7	44	4	31	47
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15:30-16:00	3	41	56	16	35	12
16:00-17:00	Permanent Committee Meeting					

Contents

Plenary Talks
Room A-211

Estrategias en Solución de Problemas de Olimpiadas Matemáticas

Luis Cáceres
Universidad de Puerto Rico, Recinto de Mayagüez

March 16, 2018

Abstract

Se presentan algunas estrategias para solucionar problemas de matemáticas con énfasis en problemas de Olimpiadas Matemáticas. Los ejemplos se muestran dentro del contexto de diferentes Olimpiadas Matemáticas Internacionales y van desde problemas simples para grados de primaria hasta problemas avanzados para los grados superiores.

Friday
March 23
7:00pm
A211

Control dinámico: Avances, retos y aplicaciones

Enrique Zuazua
DeustoTech-Bilbao and UAM-Madrid

March 16, 2018

Abstract

En la mayoría de las aplicaciones no sólo nos enfrentamos al reto de modelar (típicamente por medio de ecuaciones diferenciales) y el análisis y la simulación de estos modelos, sino también en la necesidad de controlar y diseñar.

Y el desarrollo exitoso de herramientas computacionales adecuadas para el control y el diseño no se puede lograr simplemente superponiendo el estado del arte en diferentes sub-disciplinas.

En esta conferencia presentamos algunos de los últimos trabajos desarrollados en nuestro grupo, motivados por diferentes aplicaciones (tales como la minimización boom sónico en la aeronáutica o la dinámica colectiva.

Nos centraremos principalmente en los siguientes tres temas

- La propiedad Turnpike: largos horizontes de control
- Modelos que dependen de los parámetros
- La necesidad de preservar algunas restricciones naturales del control o del estado.

Esta conferencia ha sido concebida para una amplia audiencia. En consecuencia, se evitarán tecnicismos innecesarios y se presentarán algunas perspectivas para futuras investigaciones.

Saturday
March 24
11:00am
A211

Products of symmetric group characters

Rosa C. Orellana
Dartmouth College

March 16, 2018

Abstract

One of the main open problems in combinatorial representation theory of the symmetric group is to obtain a combinatorial interpretation for what are known as the Kronecker coefficients. These coefficients arise when when we decompose the tensor product of irreducible representations of the symmetric group. This talk is a survey of recent progress towards a combinatorial rule for these coefficients.

Saturday
March 24
1:00pm
A211

Room 1
C-204

Mean field systems with multi-classes (SIDIM 2018)

Son Luu Nguyen University of Puerto Rico, Rio Piedras
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March 2, 2018

Abstract

This talk focuses on stochastic systems of weakly interacting particles containing different populations represented by multi-class. The dynamics of each particle depends not only on the empirical measure of the whole population but also on those of different populations. The limits of such systems as the number of particles tends to infinity are investigated. We establish the existence, uniqueness, and basic properties of solutions to the limiting McKean-Vlasov equations associated to the systems and then obtain the rate of convergence of the sequences of empirical measures to their limits in terms of pth Monge-Wasserstein distance.

Saturday
March 24
8:30am
C204

Keywords: Mean-field model, stochastic differential equation, McKean-Vlasov equation

References

[1] N. Fournier and A. Guillin, On the rate of convergence in Wasserstein distance of the empirical measure, *Probability Theory and Related Fields* 162, 707-738, 2015.

[2] M. Huang, R. P. Malhame, and P. E. Caines, Large population stochastic dynamic games: closed-loop McKean-Vlasov systems and the Nash certainty equivalence principle, *Communications in Information & Systems* 6, 221-252, 2006.

[3] J.-M. Lasry and P.-L. Lions, Jeux *à* champ moyen. I - Le cas stationnaire, *Comptes Rendus Mathematique* 343, 619-625, 2006.

[4] A.-S. Sznitman, *Topics in propagation of chaos*. Ecole dEte de Probabilites de Saint-Flour XIX - 1989. Ed. by P.-L. Hennequin. Berlin, Heidelberg: Springer Berlin Heidelberg, 165-251, 1991.

[5] C. Villani, *Optimal Transport: Old and New*, Grundlehren der mathematischen Wissenschaften, Springer Berlin Heidelberg, 2016.

Stability of Monomial Dynamical Systems Over Finite Field (SIDIM 2018)

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March 14, 2018

Abstract

In 2005, Colón and others gave necessary and sufficient conditions for a monomial dynamical system over a finite field to be a fixed point system, that is, all cycles are of the length of one. Moreover, in 2009, Ocasio, Colón and others gave necessary and sufficient stabilization conditions for a boolean monomial dynamical system. We make use of such criteria to study the concept of stability over n-tuple cartesian product of the field $\mathbb{F}_q$, where $n = 2$ and $q = 2^r + 1$ prime with $r \geq 1$. This work contains necessary and sufficient conditions to determine when a monomial dynamic control system with a unique control variable over $\mathbb{F}^2_{2^r+1}$ is stabilizable.

Saturday
March 24
9:00am
C204

Keywords: Fixed point systems, linear dynamical systems, loop number, stabilizable

References

Domain Descomposition Method for a Electromagnetic Problem.

Carlos Carvajal, Department of Mathematical Sciences
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March 2, 2018

Abstract

This presentation deals the case low-frequency time harmonic Maxwell equations for heterogeneous media in bidimensional domains, motivated by the paper [1]; in [2] this problem three-dimensional is studied. We study The Dirichlet-Neumann method, where due the need to know the values in the interface boundary appears the Steklov-Poincaré operator and the importance and the link between this operator and the iterative method Richardson. A finite element domain decomposition approach is proposed for the numerical approximation of the exact solution. This leads to an iteration-by-subdomain procedure, which is proven to converge.

Keywords: Low frequency time harmonic Maxwell, Heterogeneous media, Bidimensional bounded domains equations, Steklov-Poincaré operator, Finite elements.

Saturday
March 24
9:30am
C204

References

[1] Rodríguez, A. A. (2001). Heterogeneous time-harmonic Maxwell equations in bidimensional domains. Applied mathematics letters, 14(6), 753-758.

[2] Alonso, A., & Valli, A. (1997). A domain decomposition approach for heterogeneous time-harmonic Maxwell equations. Computer methods in applied mechanics and engineering, 143(1-2), 97-112.

[3] Alonso, A., & Valli, A. (1999). An optimal domain decomposition preconditioner for low-frequency time-harmonic Maxwell equations. Mathematics of Computation of the American Mathematical Society, 68(226), 607-631.

[4] Monk, P. (1992). Analysis of a finite element method for Maxwell?s equations. SIAM Journal on Numerical Analysis, 29(3), 714-729.

[5] Quarteroni, A., & Valli, A. (1996). Domain decomposition methods for partial differential equations.

[6] Toselli, A., & Widlund, O. (2006). Domain decomposition methods-algorithms and theory (Vol. 34). Springer Science & Business Media.

[7] Rodríguez, A. A., & Valli, A. (2010). Eddy Current Approximation of Maxwell Equations: Theory, Algorithms and Applications (Vol. 4). Springer Science & Business Media.

[8] Monk, P. (1992). Analysis of a finite element method for Maxwell's equations. SIAM Journal on Numerical Analysis, 29(3), 714-729.

[9] Alonso, A., & Valli, A. (1999). An optimal domain decomposition preconditioner for low-frequency time-harmonic Maxwell equations. Mathematics of Computation of the American Mathematical Society, 68(226), 607-631.

Stability of Relative Equilibria and Isomorphic Vector Fields

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February 28, 2018

Abstract

Isomorphic vector fields were introduced by Hepworth in his study of vector fields on differentiable stacks [1]. While originating in the realm of stacks, this notion can be useful in the study of equivariant dynamics on manifolds. In particular, we argue in favor of the usefulness of replacing an equivariant vector field by an isomorphic one in order to study the nonlinear stability of relative equilibria. We use this idea to obtain a criterion for nonlinear stability. As an application, we sketch how to use this criterion to obtain Montaldi and Rodríguez-Olmos's criterion for stability of Hamiltonian relative equilibria on symplectic manifolds [2].

Saturday
March 24
2:00pm
C204

Keywords: equivariant dynamical systems, Hamiltonian dynamics, differentiable stacks

References

[1] R. Hepworth. Vector fields and flows on differentiable stacks. *Theory Appl. Categ.* **22** (2009), 542-587.

[2] J. Montaldi, M. Rodríguez-Olmos. Hamiltonian relative equilibria with continuous isotropy. **arXiv:1509.04961 [math.DS]**

Approximation of quasi-linear Koch-type fractal energy functionals on varying Hilbert spaces

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March 9, 2018

Saturday
March 24
2:30pm
C204

Abstract

We consider a quasi-linear evolution equation with dynamical boundary conditions in a two-dimensional domain with Koch-type fractal boundary. We consider suitable approximating pre-fractal problems in the corresponding pre-fractal varying domains. We show existence and uniqueness results, and then we prove that the pre-fractal solutions converge via the Mosco convergence of the energy functional in varying Hilbert spaces.

Keywords: Venttsel' problems, Nonlinear energy forms, Koch snowflake domain, p-Laplacian

References

[1] S. Creo, M. R. Lancia, A. Vélez - Santiago, P. Vernole. Approximation of a nonlinear fractal energy functional on varying Hilbert spaces. *Comm. Pure Appl. Anal.* **17** (2018), 647–669.

[2] M. R. Lancia, A. Vélez - Santiago, P. Vernole. Quasi-linear Venttsel' problems with nonlocal boundary conditions on fractal domains. *Nonlinear Analysis: Real World Applications* **35** (2017), 265–291.

[3] A. Vélez - Santiago. Quasi-linear variable exponent boundary value problems with Wentzell-Robin and Wentzell boundary conditions. *J. Functional Analysis* **266** (2014), 560–615.

Blow-up of mild solutions for a nonlinear of abstract Volterra equation of convolution type

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February 21, 2018

Abstract

Our aim in this talk is the study of existence and uniqueness of a local mild solution as well as an extension property for the following nonlinear Volterra equation of convolution type

$$u(t) = \int_0^t a(t-s)[Au(s) + f(s,u(s)]ds + u_0, \quad t \in [0,T],$$

where A is a closed linear operator with dense domain D(A) defined on a Banach space X, $a \in L^1_{loc}(\mathbb{R}_+)$, $u_0 \in X$ and the nonlinear term $f : \mathbb{R}_+ \times X \to X$ satisfies a locally Lipschitz condition. Moreover, we guarantee the existence of global mild solution or blow up of maximal local mild solutions.

This class of abstract Volterra integral equations, or equivalent forms of it, arises in early studies of integral equations [1, 2]. In such cases, typically the operator A corresponds to the Laplacian, defined in some smooth domain $\Omega \subset \mathbb{R}^N$. One of the main motivations for the analysis of such equations originates by their applicability in the modeling of anomalous diffusion processes, heat conduction with memory and diffusion of fluids in porous media, among other fields of interest [3, 4, 5].

Saturday
March 24
3:00pm
C204

Keywords: Volterra integral equations; local and global; extension and blow up; mild solutions

References

[1] T. Burton. Volterra Integral and Differential Equations, 2nd Edition. Elsevier, Amsterdam, 2005.

[2] Ph. Clément and G. Da Prato. *Existence and regularity results for an integral equation with infinite delay in a Banach space.* Integr. Equ. Oper. Theory **11** (1988), 480–500.

[3] G. Gripenberg, S.-O. Londen and O. Staffans. *Volterra integral and functional equations.* Encyclopedia of Mathematics and its Applications, 34. Cambridge University Press, Cambridge, 1990.

[4] J. Kemppainen, J. Siljander, V. Vergara and R. Zacher. *Decay estimates for time-fractional and other non-local in time subdiffusion equations in* $\mathbb{R}^d$. Math. Ann. **366** (3–4) (2016), 941–979.

[5] J. Prüss. Evolutionary Integral Equations and Applications. Modern Birkhäuser Classics. Birkhäuser/Springer, Basel, 2012.

Lp-Maximal regularity for a class of degenerate integro-differential equations with infinite delay in Banach spaces

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Valentin Keyantuo University of Puerto Rico, Department of Mathematics, Faculty of Natural Sciences
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Saturday
March 24
3:30pm
C204

January 31, 2018

Abstract

We use operator valued Fourier multipliers to obtain characterizations for well-posedness of a large class of degenerate integro-differential equations of second order in time in Banach spaces. We treat vector-valued Lebesgue spaces. The equation under consideration are important in several applied problems in physics and material science, in particular for phenomena where memory effects are important.

Keywords: Well-posedness, maximal regularity, operator-valued Fourier multiplier, R-boundedness, Lebesgue-Bochner spaces

References

[1] F. Alabau-Boussouira, P. Cannarsa, D. Sforza. *Decay estimates for second order differential equations with memory.* J. Differential Equations. **25** (2008), 1342-1372.

[2] W. Arendt, C.J.K. Batty, M. Hieber and F. Neubrander. *Vector-valued Laplace Transforms and Cauchy Problems*. Monographs in Mathematics. **96**. Basel: Birkhäuser Verlag, 2001.

[3] Ph. Clément, B. de Pagter, F. A. Sukochev, M. Witvliet. *Schauder decomposition and multiplier theorems.* Studia Math. **138** (2000), 135-163.

[4] C. M. Dafermos. *Asymptotic stability in viscoelasticity*. Arch. Rational Mech. Anal. **37** (1970), 297-308.

[5] C. M. Dafermos. *Wave equations with weak damping*. SIAM J. Appl. Math. **18** 1970 759-767.

[6] M. Girardi, L. Weis. *Operator-valued Fourier multipliers and the geometry of Banach spaces.* J. Funct. Anal. **204** (2) (2003), 320-354.

[7] V. Poblete and R. Ponce. *Maximal L_p-regularity for fractional differential equations on the line*, Math. Nachr. **290** (2017), 2009-2023.

[8] L. Weis. *Operator-valued Fourier multiplier theorems and maximal L_p-regularity.* Math. Ann. **319** (2001), 735-758.

Room 2
C-206

A mathematical model of a kidney cell with volume regulation

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Dr. Mariano Marcano Department of Computer Science, University of Puerto Rico mariano.marcano@upr.edu

March 2, 2018

Abstract

Saturday
March 24
8:30am
C206

The thick ascending limb (TAL) of the Henle's loop is a segment of the nephron (the kidney's functional unit), which cells play an important role in renal physiology. They are responsible for maintaining the balance of the extracellular fluid volume and sodium, the urinary concentration mechanism, among other important functions. These cells have a cell volume regulation (CVR) mechanism to counteract radical changes in its cytosolic volume. The CVR can be divided in two different processes: the regulatory volume increase (RVI) process, which avoids excess cell shrinkage, and the regulatory volume decrease (RVD) process, which protects the cell from excess swelling. We developed a mathematical model of a TAL cell that includes the CVR mechanism. To simulate the CVR mechanism we formulated two volume dependent step control functions, one function to simulate RVI process and another to simulate RVD process. Finally, we fitted the resulting model to experimental data where the TAL cells were exposed to different changes in sodium amount.

Keywords: Cell mathematical model, Cell volume regulation, Control

References

[1] Julio A Hernández and Ernesto Cristina. Modeling cell volume regulation in nonexcitable cells: the roles of the Na^+ pump and of cotransport systems. *American Journal of Physiology-Cell Physiology*, 275(4):C1067-C1080, 1998.

[2] P Komlosi, A Fintha, and PD Bell. Unraveling the relationship between macula densa cell volume and luminal solute concentration/osmolality. *Kidney international*, 70(5):865?871, 2006.

[3] David B Mount. Thick ascending limb of the loop of Henle. *Clinical Journal of the American Society of Nephrology*, 9(11):1974-1986, 2014.

[4] Aniel Nieves-González, Chris Clausen, Mariano Marcano, Anita T Layton, Harold E Layton, and Leon C Moore. Fluid dilution and efficiency of Na^+ transport in a mathematical model of a thick ascending limb cell. *American Journal of Physiology-Renal Physiology*, 304(6):F634-F652, 2013.

A kidney mathematical model with water and sodium regulation

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March 2, 2018

Abstract

One of the kidney functions is to maintain the body water and sodium within ranges compatible with life. In order to balance the blood volume and sodium content, hormones regulate certain permeability values in the membranes of the nephrons, which is the kidney's functional unit. Further, the nephron possesses a feedback mechanism that regulates the entering fluid flow as a function of the sodium concentration at a specific location of the nephron, known as the Tubuloglomerular Feedback (TGF). I will present a mathematical model of the kidney that 1) includes the TGF mechanism and 2) regulates water and sodium excretion by controlling two parameters, which represent the percentages of two hormones. Hence, depending on the person ingestion the model is able to produce different types of urine from dilute to concentrated. This model framework is suitable for studying body volume and sodium regulation by using optimal control.

Saturday
March 24
9:00am
C206

Keywords: Mathematical model, Kidney model, Feedback and control

References

[1] Mariano Marcano, Anita T. Layton, and Harold. E. Layton, An Optimization Algorithm for a Distributed-Loop Model of an Avian Urine Concentrating Mechanism, *Bull. Math. Biol.*, 68(7):1625–1660, 2006.

[2] EB Pitman and HE Layton. Tubuloglomerular feedback in a dynamic nephron. *Communications on Pure and Applied Mathematics*. 42(6):759-87, 1989.

Numerical Simulation of Dislocation in Cosserat Elastic Plates

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March 2, 2018

Abstract

Saturday
March 24
9:30am
C206

In this talk we present the numerical simulation of a dislocation incorporated into a Cosserat plate. The simulation is based on the mathematical model for bending of Cosserat elastic plates recently developed by the authors. The dislocation is modeled by a sequence of domains that converge to the point of the dislocation and by a residual force distributed around that point. The resulted plate deformation is calculated using the Finite Element method. We also discuss a possible effect of the dislocation on a hole incorporated into the plate.

Keywords: dislocation, residual force, stress concentration, Cosserat plate, Finite Element

References

[1] Kvasov R., Steinberg L., Lev Steinberg, Modeling of Size Effects in Bending of Perforated Cosserat Plates, Modelling and Simulation in Engineering, Volume 2017 (2017).

[2] Kvasov R., Steinberg L., Numerical Modeling of Micropolar Elastic Plates, Thin-Walled Structures (69): 67-78 (2013).

[3] Steinberg L., Kvasov R., Enhanced Mathematical Model for Cosserat Plate Bending, Thin-Walled Structures (63): 51-62 (2013).

COSEPARATION WITH RESPECT TO AN INTERIOR OPERATOR IN TOPOLOGY

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February 8, 2018

Saturday
March 24
2:00pm
C206

Abstract

Motivated by the results obtained in the paper [1], concerning the notion of separation for an interior operator in topology, the notion of I-coseparation for an interior operator I in topology is introduced. A few examples that illustrate the behavior of this notion are presented for concrete interior operators in topology. Subsequently, it is determined which topological properties are closed under this notion, hence it is obtained in particular that the I-coseparated topological spaces are closed under direct images of continuous functions and quotient spaces but they are not closed under topological sums and topological subspaces.

It is proved that the notion of I-coseparation generates a Galois connection between the class of all interior operators in topology and the conglomerate of all the subclasses of topological spaces. Using this result, a commutative diagram of Galois connections that shows the relationship between the notions of I-separation and I-coseparation is presented. Finally it is proved that a characterization of the I-coseparated spaces in terms of separators, analogous to the one presented in [1] for the notion of I-separation, is not possible.

Keywords: Separation, Coseparation, Interior Operator, Galois Connection, Topology

References

[1] G. Castellini and E. Murcia. "*Interior Operators and Topological Separation"* Topol. Appl. 160, 663-705, 2013.

[2] G. Castellini. "*Categorical Closure Operator"*. Mathematics: Theory and Applications, Birkhäuser, Boston, 2003.

[3] J. Munkres. "*TOPOLOGY"* Prentice-hall, second edition, 2002.

Interior Operators and T_1 Topological Spaces

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Gabriele Castellini Mathematical Sciences
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February 28, 2018

Saturday
March 24
2:30pm
C206

Abstract

A general notion of T_1-separation with respect to an arbitrary interior operator is introduced in the category **Top** of topological spaces. This is done by means of the concept of categorical interior operator as in [1] and [2]. This naturally yields a dual notion of T_1-coseparation. Each of these two notions produces a Galois connection between categorical interior operators in **Top** and subclasses of topological spaces. These two Galois connections are studied and it is shown that their composition can be described as a classical Galois connection defined in terms of the concept of constant function. This can be easily illustrated with a commutative diagram of Galois connections.

Keywords: Categorical interior operator, Galois connections, Topology, T_1-separation

References

[1] G. Castellini, E. Murcia, “Interior operators and topological separation", *Topology and its Applications*, **160** (2013), 1476-1485.

[2] G. Castellini, J. Ramos, “Interior operators and topological connectedness", *Quaestiones Mathematicae*, **33** (2010), 1-15.

On an Infinite Family of Satellite Knots of Closed Braids in the Solid Torus and its Jones Polynomial

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Mentor: Iván Cardona Torres Department of Mathematics
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Undergraduate student: Tatiana Castro Department of Computer Science tatiana.castro1@upr.edu

March 20, 2018

Saturday
March 24
3:00pm
C206

Abstract

Knot theory has been recurring as an area of mathematical research since the 19th century but its popularity has grown and continues to grow since the 1980's. Being the classification of knots the main aim of knot theory, we study the best methods of determining equivalence in an infinite family of knots in the solid torus which are trivial in $\mathbb{S}^3$. We satellite the knots in the new family with lassos as companion knots and show that the satellite knots K, have trivial Alexander Polynomial, $\Delta_K(t) = 1$. Furthermore, we show that Kauffman Bracket for the knots in the new family, a Laurent Polynomial in a single variable A, is a recursive relation. Finally, we infer that, given the Kauffman Bracket's relation, the satellite knots will have different Jones Polynomial.

Keywords: Satellitle Knots, Knot Polynomial, Lasso

References

[1] Adams, C. C. (2004). The knot book: an elementary introduction to the mathematical theory of knots. American Mathematical Soc.

[2] Hepworth, Richard. Notes on Knot Theory

[3] Jiménez Pascual, A. (2016). On lassos and the Jones polynomial of satellite knots. Journal of Knot Theory and Its Ramifications, 25(02), 1650011.

Expanders, Extensions of Groups and Hadamard manifolds (SIDIM 2018)

Lin Shan Department of Mathematics, UPRRP
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March 6, 2018

Abstract

In this talk, we will briefly recall expanders, coarse embedding, groups extensions. Then we will present a work ongoing about non-coarse embeddability of expanders into certain groups extensions.

Saturday
March 24
3:30pm
C206

Keywords: expanders, coarse embedding, groups extensions

References

[1] G. Arzhantseva and R. Tessera, Relatively expanding box spaces with no expansion, preprint, arXiv:1402.1481 (2014).

[2] L. Shan, A concentration theorem of expanders on Hadamard manifolds, Journal of Functional Analysis 263 (2012) 109-114.

Room 3
A-233

New constructions of Differentially δ-Uniform Functions (SIDIM 2018)

Roberto Reyes, University of Puerto Rico, Río Piedras,
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Heeralal Janwa, University of Puerto Rico, Río Piedras,
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March 20, 2018

Saturday
March 24
8:00am
A233

Abstract

Differentially $\delta-$*uniform* functions over a finite field are polynomial functions that are highly non-linear and are immune to differential cryptanalytic attacks, when they are used in S-boxes to build secure cryptosystems. They also arise in other areas of mathematics such as combinatorics and finite geometries. The *differentially* 2 $-$*uniform* functions are called Almost Perfect Nonlinear (APN) functions. We will present new approaches to the construction of new APN and *differentially* 4 $-$*uniform* families. Very few trinomial families are known. Our new constructions yield new trinomial families. In addition, we will give algorithms that, when implemented in SAGE, give us further concrete examples. We also show that they have high non-linearity.

Keywords: Finite fields, differentially δ-uniform functions, trinomial families, exponential sums, Walsh transform, FFT.

Covering radius of codes from Hermitian Curves

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March 2, 2018

Abstract

In this work we present our main results on the covering radius of the Hermitain codes H_m. One of our key results is that in the range $2g_\chi = q^2 - q \leqslant m < q^3 - q^2$, we can derive the exact covering radius of H_m, under the condition of maximality. Some of the specific cases indicate that the maximality condition is true, and that would imply that we would have exact covering radius for most of the Hermitian codes. No previous results on the covering radius of Hermitian codes were known. Here, we give new lower bounds on the covering radius of Hermitian codes and determine their exact values in some cases. In the derivation of these results, we use the upper bounds on the covering radius of AG codes given by Janwa and our previously derived lower bounds, and some other previously known results. We also use some results about maximal and optimal codes, and, the length function $n_q(k,d)$ from known tables of Grassl and of Maruta.

Saturday
March 24
8:30am
A233

Keywords: Genus, Covering Radius, Weierstrass-gap, Divisor, Rational point, Riemann-Roch Space

References

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A New Criterion for Absolute Irreducibility of Projective Hypersurfaces in Characteristic 2

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March 7, 2018

Saturday
March 24
9:00am
A233

Abstract

The absolute irreducibility of multivariate polynomials is a crucial property for many applications in pure and applied mathematics. Testing of such property is extremely difficult, and only few criteria exist. In this talk, we will present a new criterion for testing absolute irreducibility of multivariate projective hypersurfaces in characteristic 2. Our criterion is derived from some well known fundamental theorems from algebraic geometry [5]. As a concrete application of our criteria, we will prove theorems that will advance the proof of the exceptional APN conjecture [1]. In particular, we will provide infinite families of absolutely irreducible normalized hyperplane sections of Fermat-varieties related to Gold and Kasami-Welch degree polynomials. This contribution continues our ongoing contributions to the resolution of this conjecture as presented in Delgado and Janwa [3, 2, 4].

Keywords: absolute irreducibility, Max Noether's theorem, Gold numbers, Kasami-Welch numbers, APN functions, exceptional APN functions, exceptional APN conjecture

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On the parameters of Schubert cell codes

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March 4, 2018

Abstract

In this article we discuss the basic parameters of Schubert cell codes. A Schubert cell is an affine subspace of a Schubert variety of the Grasmannian. These parameters may be described in terms of certain combinatorial structures.

Keywords: Grassmannian, Schubert cells, Linear codes

Saturday
March 24
9:30am
A233

An improvement of a theorem of Carlitz

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March 8, 2018

Abstract

We improve a result of Carlitz about the number of variables needed for a system of polynomial equations with coefficients in $\mathbb{F}_q[X]$ to have non-trivial solutions by considering the p-weight degree of the polynomials. By providing infinite families of polynomials we illustrate that our improvement is significant and, in general, is tight.

Saturday
March 24
2:00pm
A233

Keywords: Carlitz, Solvability, non-trivial solutions, p-divisibility

CLOSED FORMULAS FOR EXPONENTIAL SUMS OF SYMMETRIC POLYNOMIALS OVER GALOIS FIELDS

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Saturday
March 24
2:30pm
A233

February 21, 2018

Abstract

Exponential sums have applications to a variety of scientific fields, including, but not limited to, cryptography, coding theory and information theory. Closed formulas for exponential sums of symmetric Boolean functions were found by Cai, Green and Thierauf in the late 1990's. Their closed formulas imply that these exponential sums are linear recursive. The linear recursivity of these sums has been exploited in numerous papers and has been used to compute the asymptotic behavior of such sequences. In this article, we extend the result of Cai, Green and Thierauf, that is, we find closed formulas for exponential sums of symmetric polynomials over any Galois fields. Our result also implies that the recursive nature of these sequences is not unique to the binary field, as they are also linear recursive over any finite field. In fact, we provide explicit linear recurrences with integer coefficients for such sequences. As a byproduct of our results, we discover a link between exponential sums of symmetric polynomials over Galois fields and a problem for multinomial coefficients which similar to the problem of bisecting binomial coefficients

Keywords: functions, trapezoid functions, symmetric polynomials, exponential sums, recurrences

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Path-Cyle Decomposition of Subgraphs of Eulerian Graphs

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March 10, 2018

Saturday
March 24
3:00pm
A233

Abstract

Given a partition of the edge set of a simple eulerian graph, we have the following question... Is there an eulerian tour of the graph that traces a path-cycle decomposition for each part of the edge partition? Through a sequence of directional changes called kappa-transformations, any eulerian tour can be modified into any another tour of the same graph. Using this characterization we study the pathologies inherited by the initial tour and its subsequent kappa-transformations in preventing the set of subgraphs, defined by the edge partition, to be path-cycle decomposed by the tour or its subsequent kappa-transformations.

Keywords: eulerian graph, eulerian tour, edge decomposition, snag, poset

References

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Involuciones de Cuerpos Finitos Obtenidos por Binomios (SIDIM 2018)

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March 15, 2018

Abstract

Las permutaciones de cuerpos finitos tienen aplicaciones desde cifrados de voz hasta teoría de computabilidad y criptografía. En la mayoría de estas aplicaciones, las permutaciones y sus inversas son grabadas en memoria. Es importante encontrar permutaciones con un *memory footprint* pequeño y que sean fáciles de implementar. Una buena opción es utilizar permutaciones que son involuciones, es decir que sean su propia inversa. En [5] se encontraron condiciones necesarias y suficienteas para que el binomio $x(x^{\frac{q-1}{2}}+a)$ sea permutación en $\mathbb{F}_q$, y en [1] se encontraron condiciones necesarias y suficientes en el coeficiente a para que $x^{\frac{q-3}{2}}(x^{\frac{q-1}{2}}+a)$ sea involución de $\mathbb{F}_q$. Queremos encontrar condiciones necesarias y suficientes en m y a para que los binomios de la forma $x^m(x^{\frac{q-1}{2}}+a)$ sean involución de $\mathbb{F}_q$.

Saturday
March 24
3:30pm
A233

Keywords: Cuerpos finitos, Involuciones, Binomios

References

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Room 4
A-231

Continuous Distributions Arising from the Three Gap Theorem (SIDIM 2018)

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March 20, 2018

Saturday
March 24
8:00am
A231

Abstract

The well known Three Gap Theorem states that there are at most three gap sizes in the sequence of fractional parts $\{\alpha n\}_{n\leq N}$. The main discovery in our work is that if we average over a short interval $[\beta,\beta+\eta]$, the distribution becomes continuous. Moreover, this continuous distribution is universal in the sense that it is the same for any α and any interval around β. Under these circumstances one would expect that the above averaging process would introduce enough randomness in the sequence so that the limiting distribution would be Poissonian. We will prove that, surprisingly, this is not the case.

Keywords: Three Gap Theorem, Farey Fractions, Continuous Distribution, Uniform Distribution Theory.

References

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The quasi principal rank characteristic sequence

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February 28, 2018

Abstract

A *principal* minor of a matrix is the determinant of a (square) submatrix whose row and column indices are the same. The *enhanced principal rank characteristic sequence* (*epr-sequence*) of an $n \times n$ real, symmetric matrix B is $\ell_1 \ell_2 \cdots \ell_n$, where ℓ_k is `A` (respectively, `N`) if all of (respectively, none of) the principal minors of order k are nonzero [1]; if some but not all are nonzero, then $\ell_k =$ `S` (see [1]). Due to the numerous applications of principal minors, epr-sequences have received considerable attention since their introduction, although they are still far from being completely characterized.

An *almost-principal* minor of a matrix is the determinant of a (square) submatrix whose row and column indices differ in exactly one index. Motivated by the fact that principal and almost-principal minors have applications in algebraic geometry, statistics, theoretical physics and matrix theory [2], we have introduced a new sequence that extends the epr-sequence by also taking into consideration the almost-principal minors of the matrix [2]. A minor of a matrix is *quasi-principal* if it is a principal or an almost-principal minor. The *quasi principal rank characteristic sequence* (*qpr-sequence*) of an $n \times n$ real, symmetric matrix is $q_1 q_2 \cdots q_n$, where q_k is `A` (respectively, `N`) if all of (respectively, none of) the quasi-principal minors of order k are nonzero [2]; if some but not all are nonzero, then $q_k =$ `S` (see [2]).

In this talk, a complete characterization of the qpr-sequences that are attainable by real, symmetric matrices will be presented. This characterization establishes a contrast between qpr- and epr-sequences, as the latter are still far from being characterized.

Keywords: epr-sequence, qpr-sequence, minor, rank, symmetric matrix, Schur complement.

Saturday
March 24
8:30am
A231

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A Control Theory for Finite Dynamical Systems over Finite Fields

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March 16, 2018

Abstract

Recently, criteria for determining when a certain type of nonlinear discrete dynamical system is a fixed point system have been developed. This theory can be use to determine if certain events modeled by those systems reach a steady state. In this work, we formalize the idea of a "stabilizable" discrete dynamical system. We present necessary and sufficient conditions for a Boolean monomial dynamical control system to be stabilizable in terms of properties of the dependency graph associated with the system. For non-boolean monomial dynamical control systems is still an open problem to find criteria, in order to determine if it is stabilizable. We will present our approach to tackling this problem.

Saturday
March 24
9:00am
A231

Keywords: Finite Fields, Control Theory, Fixed Point Systems

Diagonal entries of the combined matrix of a totally negative matrix

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March 2, 2018

Saturday
March 24
9:30am
A231

Abstract

The combined matrix of a nonsingular matrix A is the Hadamard (entrywise) product $A \circ \left(A^{-1}\right)^T$. This paper deals with the characterization of the diagonal entries of a combined matrix $C(A)$ of a given nonsingular real matrix A. A partial answer describing the diagonal entries of $C(A)$ in the positive definite case was given by Fiedler in 1964. Recently in 2011, Fiedler and Markham characterized the sequence of diagonal entries of the combined matrix $C(A)$ for any totally positive matrix A when the size is 3. For this case, we characterize totally negative matrices and we find necessary and sufficient conditions for the sequence of diagonal entries of $C(A)$, in both cases, symmetric and nonsymmetric.

Keywords: Totally negative matrices, Hadamard product, relative gain array, combined matrix, stochastic matrices

References

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Conjuntos g-Sidon y g-Golomb modulares

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February 21, 2018

Saturday
March 24
2:00pm
A231

Abstract

Sean $n > 1$ un entero positivo, $\mathbb{Z}_n$ denotando el anillo de enteros módulo n, A un subconjunto de $\mathbb{Z}_n$, y g un entero positivo. A se llama un conjunto g-Sidon (módulo n) si para todo $x \in \mathbb{Z}_n$, el número de soluciones de la ecuación $x = a + b$ (mód n), con $a, b \in A$ es a lo sumo g. Similarmente, A es un conjunto (regla) g-Golomb (módulo n) si para todo $x \in \mathbb{Z}_n$, diferente de cero, el número de soluciones de la ecuación $x = a - b$ (mód n), con $a, b \in \mathbb{Z}_n$ es acotado por g. En este trabajo presentamos algunos resultados y problemas abiertos relacionados con las siguientes funciones extremas: $f(+, g, n)$, respectivamente, $f(-, g, n)$, definida como el máximo número de elementos que puede tener un conjunto g-Sidon, respectivamente g-Golomb, módulo n.

Keywords: Sidon sets, Golomb ruler, g-Sidon modular sets, g-Golomb modular rulers

References

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On a lecture notes of Convex Polytopes: A Cartesian system of rotating hyperplanes (SIDIM 2018)

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March 7, 2018

Abstract

A system of rotational hyperplanes in $\mathbb{R}^n$ has been used to form a bridge from convex polytopes to threshold logic that was published in two papers a decade ago. Here we show that this Cartesian system of hyperplanes can be used as a unifying tool in the study of the elements of convex sets and polytopes. As a first model of application we reprove an old basic theorem of Minkowski on closed convex sets, applying this Cartesian system. We also refer to a broader applications that has been appeared as a lecture note on elements of convex polytopes.

Keywords: Convex sets, polytopes, Euclidean geometry.

Saturday
March 24
2:30pm
A231

References

Nonexistence of efficient dominating sets in the Cayley graphs generated by transposition trees of diameter 3 (SIDIM 2018)

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February 28, 2018

Saturday
March 24
3:00pm
A231

Abstract

Let d,n be positive integers such that $d < n$, and let $X_n^{d_n}$ be a Cayley graph generated by a transposition tree of diameter d_n. It is known that every $X_n^{d_n}$ with $d < 3$ splits into efficient dominating sets. The main result of this paper is that X_n^3 does not have efficient dominating sets.

Keywords: Cayley graph, efficient dominating set, sphere packing.

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On the Quotient-Lift Matroid Relation

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February 28, 2018

Abstract

It is well known that a matroid L is a lift of a matroid M if and only if every circuit of L is the union of some circuits of M. The proof of this characterization given in the classic book "Matroid Theory", by James Oaxley, depends heavily on mathematical induction, assumes the elementary quotient construction and is based in the notion of modular cuts of flats. We give a new proof of this characterization based on the notions of cyclic sets and matroid ciclomaticity.

Saturday
March 24
3:30pm
A231

Keywords: Matroid, Matroid Lift, Matroid Quotient, Cyclic Sets, Matroid Cyclomaticity

References

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Room 5
A-229

Extreme Value theory and the Re-assessment in the Caribbean: Lessons from Hurricane Irma and Maria (SIDIM 2018)

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March 20, 2018

Saturday
March 24
8:30am
A229

Abstract

Risk assessment has been the corner stone in resilient planning. Pericchi, Coles and Sissons Conjecture states that standard Gumbel analyses routinely assign near-zero probability to subsequently observed disasters, and that for San Juan, Puerto Rico, standard 100-year predicted rainfall estimates may be routinely underestimated by a factor of two by the Maximum likelihood estimators. Using a extended the San Juan rain data before Hurricane Maria event predictions will be stated using Maximum Likelihood Estimators(MLE) and more generalized Bayesian Models including Hierarchical Modeling to restate the conjecture with more variate models using the Fisher-Tippett distributions. It is shown that using Bayesian Analysis models a more precise results predicting extreme weather events can be established.

Keywords: Fisher Tippett Distribution, Extreme Weather, Bayesian Analysis Modeling.

CREDIBILITY OF BETA ESTIMATES IN INCOMPLETE REGRESSION MODELS – A CASE-STUDY OF NOKIA

Interuniversity Seminar on Research in the Mathematical Sciences (SIDIM 2018)

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March 6, 2018

Saturday
March 24
9:00am
A229

Abstract

A Beta coefficient measures the risk of a stock as an indicator of the strength of the reaction of the stock to changes in the returns of the market portfolio. This coefficient is particularly important, since it may be used by investors to make decisions on the allocation of their investments. A Beta greater than one indicates that the stock has higher volatility than the overall market, perhaps making it undesirable to a risk averse investor. We present a case study to show that even with the same data, market index, period and time interval, the Beta coefficient strongly depends on the choice of model, leaving ample room to the investor to use its knowledge of the company, the market and other variables not included in the model to better capture the investment goals.

Keywords: Beta coefficient, Regression, Investment

References

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Converting P-Values in Posterior Probabilities to Increase the Reproducible Scientific Findings

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February 8, 2018

Saturday
March 24
9:30am
A229

Abstract

We put forward a novel calibration of p values, the *"p Posterior Probability" (pPP)* which maps p values into approximations of posterior probabilities taking into account the effect of sample sizes. We build on the Robust Lower Bound proposed in [1], but we incorporate a simple power of the sample size to make it adaptive to different amounts of data.
We present several illustrations from where it is apparent that the pPP closely approximates exact objective Bayes Factors. In particular, it has the same asymptotics as posterior probabilities but avoiding the problems of "Bayesian Information Criterion" (BIC) for small samples relative to the number of parameters.
We prove that the pPP is consistent as the sample size grows, and that it is information consistent [2] for the canonical Normal case, but with methods that are keen to be generalized. In summary, this is a novel criterion easy to apply, as it only requires a real p value, a sample size and parameter dimensionality. This method is intended to aid the practitioners, who are increasingly aware of the lack of reproducibility of traditional hypothesis testing "findings" but at the same time, lack of concrete simple alternatives. Here is one.

Keywords: p-values, Bayes Factors, Model Selection

References

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Viability of an autonomous agent using reinforcement learning and hierarchical semantic memory

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March 8, 2018

Abstract

In recent years, reinforcement learning (RL) has been behind several breakthroughs in the field of artificial intelligence. RL-based agents learn autonomously to interact with an environment by taking actions in which the goal is to maximize an accumulated reward. Currently, RL is frequently used with neural networks in what is called deep reinforcement learning. Hierarchical Semantic Memory (HSM) is a classifier that uses a neuron model that is different from the one used in typical neural networks. In this study the main aspects of RL will be reviewed in order to outline a future implementation of an autonomous agent in conjunction with HSM.

Saturday
March 24
2:00pm
A229

Keywords: Reinforcement Learning, Neural Networks, Hierarchical Semantic Memory

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Nanoparticle Segmentation using Machine Learning for the Analysis of Environmental TEM Image Sequences

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Saturday
March 24
2:30pm
A229

Abstract

In this presentation, we describe how machine learning algorithms can be used to segment automatically nanoparticles in images sequences of Environmental Transmission Electron Microscopy (ETEM). Although ETEM provides a powerful way to observe directly the evolution of nanoparticles over time to obtain new insights into their physics, this also corresponds to a large amount of data which cannot easily be analyzed manually.

Due to the high level of noise of ETEM images, the segmentation requires the extraction of multiple visual features to be able to discriminate the particles from the background. Limited supervised annotation can then be used to train a classifier that detects the particles. The ability of Convolutional Neural Network architecture to unify and provide an efficient approach to perform the task will also be discussed. Several approaches will be compared on real data obtained at the Center for Functional Nanomaterials, BNL.

This segmentation, coupled with tracking of the detected particles enables the automatic analysis of the nanoparticles growth rate. This work demonstrates the feasibility of designing a high-throughput automated analysis system for this imaging modality.

Acknowledgement: This project received support from the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Visiting Faculty Program (VFP). This work received support from the Fondos Institucionales para la Investigación (FIPI), University of Puerto Rico, Rìo Piedras.

Keywords: Image segmentation, Machine Learning, Application to Material Science

Honeybee pose detection in video for large scale behaviour analysis

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Saturday
March 24
3:00pm
A229

Abstract

In this work we report the development of a new deep learning method for real time detection, localization and tracking of honeybee body parts from video.

The proposed system builds on the recent advances in computer vision for Human pose estimation using deep learning methods. The Open Pose algorithm was modified to fit the anatomy of honeybees and improve its running time for the target videos. Using this method we obtained 98% recall for part detection and 95% of correct part association. For pollen recognition, the proposed method with pre-alignment of the images using the pose estimation reached 100% accuracy, compared to 96% using only bee location.

Relying on the precision of the detection, tracking was performed using the Hungarian assignation algorithm, matching consecutive frames detections. The metric for distance incorporates not only point wise information, but also the correct association between connected parts such as Thorax and head or Thorax and abdomen.

In honeybees, tracking and studying behaviour in natural conditions is crucial to enhance our understanding of their complex social activities, their biological rhythms and find new explanations for the risk conditions that can be detrimental to hive health. The proposed system opens new possibilities for large scale analysis of video for long periods of time which will contribute to this.

Acknowledgement: This material is based upon work supported by the National Science Foundation under Grants No. 1633164 and 1633184. I. F. Rodriguez acknowledges support from Janelia Visitor Program. T. Giray acknowledges support from Puerto Rico Science and Technology Trust (PRSTRT; 2016-00161, 2017-00164). The authors would like to thank Stephanie Feliciano and Janpierre Aleman who helped with the acquisition at the UPR Agricultural Station of Gurabo of the videos used in the generation of the dataset and Jeffrey Chan who helped with the annotation of the videos.

Keywords: Honeybee behaviour analysis, Computer Vision, Deep Learning, pose estimation, pollen detection.

Parallelizing a Network Flows Visualization Framework

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March 3, 2018

Abstract

High performance data networks such as Science DMZ networks are being deployed in research institutions all over the nation to provide high speed big data transfer among intra and inter institutional collaborations. The amount of network data generated by such networks is very costly to store and/or process to provide network security, network situational awareness, and network forensics. The use of network flows have become more popular to aid provide network security to such networks. We created an API with functions to filter network flows through a web interface and feed the output to web visualizations. The process of network flow selection is costly. We study the performance improvements by including parallelization in the collection of the filtered network flows. We compare performance between quantity in processors, storage spaces, and amount of network flows. Our results show that there is a significant increase in performance after parallelization but processor quantity and I/O must be considered.

Saturday
March 24
3:30pm
A229

Keywords: Parallel computing, Network forensics, Network security

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Room 6
A-227

Cuantificación de la ventaja cognitiva de estudiar límites de funciones utilizando infinitésimos y Cálculo no Estándar con estudiantes del curso Métodos Cuantitativos II para Administración de Empresas.

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Saturday
March 24
8:30am
A227

March 15, 2018

Abstract

En estudios anteriores se ha demostrado la eficacia del método de enseñanza de límites de funciones utilizando infinitesimales para estudiantes del curso de Cálculo I en la facultad de Ciencias Naturales. El objetivo de la investigación que se lleva a cabo actualmente, es determinar si existe ventaja didáctica en enseñar el concepto de límite de una función real, utilizando el lenguaje de los números infinitésimos a estudiantes del curso de Métodos Cuantitativos para Administración de Empresas II de la Facultad de Administración de Empresas.

El propósito del estudio es determinar si las destrezas en el cálculo de límites para los estudiantes, mejora si se utiliza el cálculo infinitesimal para su enseñanza. Tal circunstancia haría que la noción de límite de una función, sea más evidente, de forma tal que los estudiantes entiendan mejor este concepto y puedan determinar con más facilidad límites de funciones.

La eficacia de la enseñanza se medirá con el instrumento: "Prueba de aprovechamiento de límites". La investigación se pretende instrumentar con estudiantes del curso de Métodos Cuantitativos para Administración de Empresas II (MECU 3032), que ofrece el Instituto de Estadística y Sistema Computarizado de Información de la Facultad de Administración de Empresas de la Universidad de Puerto Rico, Recinto de Río Piedras y de las cuales soy la profesora, catedrática auxiliar adscrito a dicha facultad, quien enseña estas secciones.

Para recopilar y validar información se utilizarán exámenes desarrollados en dos modalidades: Cálculo tradicional o estándar y Cálculo infinitesimal.

Para llevar a cabo el análisis de los datos y determinar los hallazgos de investigación se utilizarán medidas estadísticas para la respuesta a la pregunta de investigación: ¿existe una ventaja didáctica en ensañar el concepto de límite de una función real, utilizando el lenguaje de los números infinitésimos a estudiantes del curso de Métodos Cuantitativos para Administración de Empresas II de la Facultad de Administración de Empresas?"

Keywords: límite, función, infinitesimal, aprendizaje, enseñanza, cálculo

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Ideas matemáticas fundamentales para la transición de la escuela a la universidad

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March 15, 2018

Saturday
March 24
9:00am
A227

Abstract

Presentamos los resultados de investigaciones que revelan la forma en que los estudiantes recientemente admitidos a la UPR-RP conciben las propiedades de los números reales y que pueden representar obstáculos al enfrentar los conceptos formales que se pretenden a nivel universitario. Proponemos actividades, enmarcadas en la teoría de la educación matemática realista, para mejorar el entendimiento de las propiedades métricas y geométricas de los reales y el entendimiento de las propiedades de las operaciones. Argumentamos que: (1) el dominio de las ideas matemáticas inherentes a estos aspectos es fundamental para la transición de la escuela a la universidad; y, (2) es posible desarrollarlas dentro de los principios de las competencias para los ciudadanos del siglo XXI de la Organización para la Cooperación y el Desarrollo Económico.

El desempeño de los estudiantes en el primer curso de matemáticas

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February 28, 2018

Saturday
March 24
9:30am
A227

Abstract

En el estudio se investigó el desempeño de los alumnos en el primer curso de matemáticas que ofrece la Facultad de Administración de Empresas de la Universidad de Puerto Rico, Recinto de Río Piedras. Se llevó a cabo un análisis de covarianza (ANCOVA) para comparar el rendimiento en el examen de mitad de curso y el examen final, entre los estudiantes de todas las concentraciones que asistieron al curso Matemática Finita y Precálculo para Administración de Empresas (MECU 3035) versus los que asistieron al curso Métodos Cuantitativos para Administración de Empresas I (MECU 3031), usando como covariable los resultados del aprovechamiento matemático del estudiante en el examen de entrada a la universidad. Ambos cursos integran múltiples estrategias de enseñanza y aprendizaje tales como laboratorio y la integración de la tecnología. El curso MECU 3035 requiere una hora de laboratorio a la semana. Los resultados obtenidos de la investigación aportan al desarrollo de nuevas estrategias de enseñanza de las matemáticas a nivel universitario.

Keywords: Precálculo, métodos cuantitativos, laboratorios, estrategias de enseñanza

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Examining the Issues that Emerged in the Process of Designing, Implementing, and Reflecting on Lessons (SIDIM 2018)

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March 20, 2018

Abstract

During the last decade, research in mathematics education has shown that teaching mathematics with technology is essential for providing students deeper and stronger conceptual understanding of mathematical ideas (NCTM, AMTE). However, teaching with technology is not an easy endeavor, even more when it is intended to impact student learning in meaningful ways (Zbiek & Hollebrands, 2008). With time we have gained important knowledge regarding effective professional development experiences for teacher, moving from a 'training model' to a 'practicebased model' of professional development. Nowadays, professional development offers teachers opportunities to be participants in the teaching and learning process, working collaboratively with peers on activities closely related to the context of teaching, namely lesson planning, tasks development, student learning, teaching practices, among others. A professional development approach that fits nicely with these descriptions is the Lesson Study, the most common form of professional development for teachers of many content areas in Japan (Lewis & Tsuchida, 1997; Yoshida, 1999). Thus, using a Lesson Study approach to professional development, a group of 18 secondary mathematics teachers were engaged in two cycles of planning, implementing and reflecting on lessons that integrate technology. For the study, the use of technology was expected to be an integral part of the planning sessions since it was required to fulfill the purpose of the professional development. Groups of teachers were formed taking into consideration the grade level the teacher was teaching the following semester as well as the location of the school. I was interested in examining the issues that emerged (mathematical, pedagogical, and technological) in the process of designing, implementing, and reflecting on lessons. The study was framed through the lenses of the TPACK framework. Results of this study suggest teachers that have access to a computer and projector, or to a smart board in their classrooms might feel knowledgeable about how to use those tools for teaching in general. However, the project teachers exhibited severe issues with their knowledge of technology as it relates to the teaching of mathematics. The most important factor to consider is the lack of knowledge about the tools that are available for them to use to teach mathematics. Regarding their knowledge of mathematics, results suggest that when a group of teachers lack a deeper conceptual understanding of the mathematics, they constantly used incorrect vocabulary, and inappropriate definitions. Lacking a deeper knowledge of the mathematics did not allow for the inclusion of more challenging examples in their lessons. In addition, the implementation of the lesson was disorganized and there was a lack connection between the different aspects of the mathematics being taught. When a group showed minimal to no issues with their mathematical knowledge, they seemed to have a deeper understanding of the concepts being discussed, which helped them design a more organized lesson. For these groups, the implementations flowed without any issues, there was no incorrect use of language, and no mathematical errors were found on the board.

Keywords: Mathematics education, TPACK, secondary teachers, practicing teachers, lesson study

Saturday
March 24
2:00pm
A227

What have we Learned on the Design of a Flipped Classroom in an Introductory Statistics College Course? (SIDIM 2018)

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Saturday
March 24
2:30pm
A227

March 20, 2018

Abstract

In recent years the statistics education community has extensively promoted changes to the teaching and learning of statistics in schools and universities. Research has called for active learning environments where students are provided with the tools they need to build a strong statistical understanding, thereby promoting and provoking their statistical thinking. Our introductory statistics courses are given using a lecture format, where a professor/instructor lecture a group of students, and students are passive learners of the statistics. To incorporate active learning strategies into the statistics learning process at our institution we designed a partial Flipped Classroom (FC). It is partial in the sense that we only flipped the classroom for five of the topics being covered in the course and not the whole course. This partial FC has consisted in the use of video lectures outside the classroom, and in-classroom hands-on activities. The hands-on activities were designed to provoke students conceptual understanding of the statistical concept being studied, engaging students in the learning process through in-class active participation of discussions guided by the professor. By flipping the classroom, we were able to use in-class time to engage students in problem-solving activities and whole-class discussions. All the materials that were used for this partial FC were designed by the research team members guided by the GAISE College Report (2016), focused on the educational learning objectives of the topic being taught, and helping our students achieve higher cognitive levels of statistical understanding using the Bloom's Taxonomy. In this talk the results of an experiment to test the effectiveness of the partial FC will be presented. Although we did not find significant differences in the participants' grades and aptitudes towards statistics between the two teaching methods, we found that students embrace the FC approach with enthusiasm. This positive feedback from students is promising as it could be converted into engagement and better academic performance and conceptual understanding.

Keywords: Statistics education, active learning, undergraduate research, flipped classroom.

Explorando la Ciencia de Cómputos para Puerto Rico

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Saturday
March 24
3:00pm
A227

March 2, 2018

Abstract

La ciencia de cómputos nos enseña destrezas, hoy consideradas básicas para todo individuo, no solo para insertarnos en un mercado de oportunidades laborales cada vez más digitalizado, competitivo y globalizado, sino también como un instrumento de movilidad social. Sin embargo, la situación de la educación en ciencia de cómputos (CSE, por sus siglas en inglés) en el sistema de educacíon pública de Puerto Rico es precario.

Desde el año 2014, investigadores de las Facultades de Educación y Ciencias Naturales de la Universidad de Puerto Rico en Río Piedras colaboran con el Departamento de Educación de Puerto Rico y otros proyectos claves subvencionados con fondos de la Fundación Nacional de las Ciencias (NSF, por sus siglas en inglés) para promover la integración de CSE en las escuelas públicas de Puerto Rico, a través de currículos y programas de desarrollo profesional innovadores y pertinentes a la realidad de los puertorriqueños.

El currículo "Explorando la Ciencia de Cómputos" (ECS, por sus siglas en inglés) es un curso introductorio a la ciencia de cómputos diseñado para escuelas secundarias cuyos pilares son la equidad y el aprendizaje por indagación.

En este trabajo presentamos el proyecto "NSF: Exploring Computer Science for Puerto Rico (ECS4PR)", cuya meta principal es establecer una alianza de investigación participativa en educación para apoyar la implantación piloto del currículo ECS y de su programa de desarrollo profesional con adaptaciones linguísticas y culturales relevantes a Puerto Rico.

Keywords: Exploring Computer Science, Currículo, Desarrollo Profesional, Ciencia de Cómputos, Educación

Toward the Thermodynamics and Emergy of Picture and Other Puzzle Solving (SIDIM 2018)

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March 20, 2018

Saturday
March 24
3:30pm
A227

Abstract

This talk follows up on the author's and Scienceman's paper "Clusters of High Transformity Individuals" Chapter 36 in Emergy Synthesis 9. Here instead of substrate being converted into product by a generalization of Michaelis-Menton enzyme kinetics, the interest is in pieces of a puzzle being converted into a finished picture. Other applications involve returning and re-connecting people to their homes after a storm or flood, or restoration of electrical grid after a hurricane, or assembling DNA in one dimension. At the start of putting together a, say 1000-piece puzzle, there are 1000 components, and clusters are gradually built up as pieces are fitted together, until if successful there is only one giant cluster or component with all 1000 pieces (or say the electrical grid is restored). Features of the puzzle, such as border, buildings, trees and sky, correspond to enzymes that aid in getting the puzzle done and their transformity can be measured by the jumps or fraction of the puzzle they help to complete. In doing a puzzle, pre-sorting into, say all the manmade structure pieces or border of a roof and then all the tree pieces leads to jumps in progress of doing the puzzle. Thermodynamically the problem involves completely distinguishable particles as perhaps a modification of Fermi-Dirac statistics, since each piece goes in exactly one place. Attempts to measure entropy can involve measuring the work required to add each piece, and topological properties, such as Betti numbers or number of holes left in each cluster, studied, sometimes in reference to Zipf's law with changing powers.and the Author's previous paper

Keywords: puzzle, Michaelis-Menton, features, cluster, Fisher, Fermi-Dirac, entropy, emergy, SYM, grid.

Posters
Vestíbulo Edificio de Ciencias Naturales

Modeling interventions in causal networks to enrich constraint-based causal search

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February 27, 2018

Saturday
March 24
10:00am
Vestíbulo

Abstract

From uncovering potential cell signaling pathways to modeling weather patterns, causal discovery research seeks to answer a fundamental question of science: What are the underlying causal relationships that determine how a system behaves? Algorithms exist that can discover from data causal relationships in the form of a graphical model; such discovery is possible even in the presence of latent confounding in which two or more variables are causally influenced by a hidden variable. The most successful such methods are based on tests of conditional independence of the measured variables and are called constraint-based methods. Traditionally, these methods can use only observational data wherein all data were passively observed. We implemented and evaluated a constraint-based method that uses both observational data as well as experimental data for which some variables were experimentally manipulated. Our results support that using both types of data significantly improves the accuracy and completeness of causal discovery.

Keywords: Causal Discovery, Graphical Methods, Interventions, Causation

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Application of two to one functions in the creation of 2 error correcting codes (SIDIM 2018)

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March 7, 2018

Saturday
March 24
10:00am
Vestíbulo

Abstract

Error correcting codes are used in communication theory as they help limit information loss. Families of one error correcting codes and their properties have been studied by Hamming about 70 years ago. In this work Hamming codes and their properties (such as minimum distance and weight) are used in order to create a new family of 2 error correcting codes by applying high non-linear function. In particular we utilize the Gold and Kasami functions which are related to 2-error correcting codes of length $2^n - 1$ as studied by Van Lint, Wilson, Janwa and others. We use only the properties of the Gold and Kasami functions and their domains, as well as, multivariate polynomials related to these functions. High non-linear function have also been showed to be involved in the search of 2-1 functions over finite fields. The conclusions reached in our work imply a close relationship between the creation of 2 error correcting codes and the search for 2-1 functions over finite fields.

Keywords: Error correction, finite Fields, code Theory, non-linear algebra.

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Genomic Discrimination of Sporadic Type 1 and Type 2 Papillary Renal Cancers

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March 1, 2018

Abstract

Saturday
March 24
10:00am
Vestíbulo

Papillary renal cell carcinomas are rare forms of kidney cancer which have been sub-classified into Type 1 (PP1) and Type 2 (PP2) based on the minor phenotypic differences as well as long term outcome. In an attempt to improve discrimination of these two classes of phenotypically similar tumors, genetic profiling has been employed with variable success. In these study, we used exome sequences derived from six PP1 and six PP2 tumors derived from frozen, micro-dissected specimens including DNA from matched blood control specimens. We used a variant calling pipeline to identify deleterious germline and somatic variants (SNV, Indels, CNV) for each tumor. Our hypothesis is a distinct signature of genomic variants can be used to identify and discriminate between these two tumor classes. The DNA exome variants were then subjected to pathway analysis to determine the mechanisms underlying and discriminating between PP1 and PP2 of renal cell carcinoma.

Keywords: Papillary renal cell carcinoma, SNV, CNV, Indels, pathway analysis

Analysis of the Disposal of Chemical Substances in Puerto Rico Using Unsupervised Classification

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March 9, 2018

Abstract

Nowadays contamination and pollution have increased abruptly due to the advances in technology and mass production. This situation is leading to a world crisis in which it is been debated what is most important: environment and health or business profits. Part of the problem is the heavy use of chemical substances and their disposal. Many of these substances fall in the category of carcinogens or metals with harmful effects in human health. By using the database "Toxics Release Inventory(TRI) Data", a combination of unsupervised classification, and maps generation techniques, we processed and identified several clusters of data. These clusters give us insights about counties in Puerto Rico which have been constantly exposed to these chemical substances in a time span of 25 years approximately. This kind of work, in conjunction with a detailed analysis of chemical disposal methods, could serve as a starting point of other studies about how these areas might be affected from an environmental and health-wise point of view.

Keywords: Data Science, Database, Contamination

Saturday
March 24
10:00am
Vestíbulo

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Involuciones de Cuerpos Finitos Obtenidos por Binomios (SIDIM 2018)

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March 15, 2018

Saturday
March 24
10:00am
Vestíbulo

Abstract

Las permutaciones de cuerpos finitos tienen aplicaciones en varios campos de las Matemáticas y Ciencias de Cómputos, como lo es la Criptografía. En específico, las permutaciones que son su propia inversa (involuciones) son de interés porque ofrecen una ventaja al implementarlas. Estudiamos binomios de la forma $x(x^{(p-3)/2}+A)$ con el propósito de encontrar las condiciones para la constante A tal que el binomio sea una involución. Aquí probaremos que esta familia de binomios nunca produce permutaciónes de F_p donde p es primo. Conjeturamos que esto extienda a cualquier cuerpo finito F_q donde q es una potencia de primo y probamos varios casos de esta conjetura.

Keywords: Cuerpos finitos, binomios de permutación, binomios de involución.

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A Primer on Deep Neural Networks and Word Embeddings

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Saturday
March 24
10:00am
Vestíbulo

Abstract

The human brain learns how to identify things without prior knowledge of the features that constitute the task at hand. For example, we can identify a cat in an image without knowing the required dimensions and properties of the cat. Instead, consecutive layers of neurons in our brain help to derive the cat's abstract properties. Artificial Neural Networks are Machine Learning models that attempt to simulate these characteristics of the human brain. Modern day processing power and recent refinements of Artificial Neural Networks have permitted the rise of Deep Artificial Neural Networks, which have been used for many tasks that were not possible before. Among their applications are self-driving cars, text predictions, and image recognition [2]. Another useful application for neural networks is natural language processing [1]; it can be used for Word Embeddings, in which, given a large enough text document, Word2Vec models such as the Skip-gram model use Deep Neural Networks to map the words in the text to a vector space. Word Embeddings have been used to aid with translation and to identify similarities between languages such as English and Mandarin. This is an expository project in which we explore the implications and uses of Deep Neural Networks. Finally, we investigate the possibility of using Word Embeddings to explore the relation between the English and Spanish languages, with an emphasis on analyzing English words frequently used in 'Spanglish' which is the mixing of English and Spanish commonly used by some of the bilingual speaking population. We hope to carry out research on this topic throughout the following semesters.

Keywords: Neural Networks, Deep Learning, Word Embeddings, Spanglish

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Comparison of Storage Formats for Sparse Matrices and Its Application to Solving Linear Systems (SIDIM 2018)

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March 2, 2018

Saturday
March 24
10:00am
Vestíbulo

Abstract

The mathematical modeling of several applications related to sciences or engineering are done using differential equations. However due to the lack of analytical solutions to this equations, is necessary to use some numerical methods to approximate the solution. Generally this approximations are obtained solving iteratively the product matrix by vector or solver linear systems, where the matrix to operate high-dimensional and it has many zero elements when is compared with the number of entries, called sparse matrix. To operate with this kind of matrices must be used efficient data structures than not store null elements in memory with the finally of reduce the computational cost.

In this presentation we show some computational results of solving sparse linear systems derived of numerical discretization using the gradient method and the LU factorization. Storage formats for sparse matrices like CSR (compressed sparse rows), CSR MOD (compressed sparse rows modified), MSR (modified sparse rows) and CSV (compressed sparse vector) are implemented. The sparse matrices were obtained of the electronic resources Matrix Market and of the University of Florida.

Keywords: Sparse matrix, numerical discretization, matrix by vector, storage formats.

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The Variable Exponent Bernoulli Differential Equation (SIDIM 2018)

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March 20, 2018

Saturday
March 24
10:00am
Vestíbulo

Abstract

The aim of this project is to investigate a Bernoulli type first-order ordinary equation with a variable exponent. Where its coefficients $a(x)$, $b(x)$ are continuous functions and $p(x)$ is a continuous and at least once differentiable function in a bounded interval, with $p(x)$ is not 1 for all x. This differential equation is well-known and standard in the case when $p(x) = p$ is a constant. In the following project we give a first attempt to solve this generalized Bernoulli type problem for particular functions $p(x)$. Even for simple types of functions $p(x)$, the solution of this problem cannot be given explicitly, and its formulation is, in most cases, quite complicated. We will also provide some examples of numerical simulations of ODEs of the type presented in this project, and provide comparison of the strict solutions with the numerical ones.

Keywords: Bernoulli Differential Equations, Variable Exponents.

On τ-Factorizations into τ-Primes (SIDIM 2018)

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March 20, 2018

Abstract

This work's focus is on the concept of tau-prime elements in integral domains, as defined in Anderson and Frazier's Generalized Theory of Factorization. In 2010, Anderson gave a characterization of the existence of some types of unique τ-factorizations. But τ-factorizations into τ-primes were not included among his results; hence, our motivation for investigating such factorizations. Our main result is that every nonzero nonunit element in a domain has at most one τ-factorization in τ-primes. As an example, we investigate unusual factorizations on the integers. In particular, we look at factorizations determined by the relation "congruence modulo n", which we denote τ_n. With the help of a completely additive arithmetical function, we precisely characterize which integers have a τ_n-factorization into τ_n-primes.

Saturday
March 24
10:00am
Vestíbulo

Keywords: Factorizations, τ-factorizations, τ-primes, Integral Domains.

On the Characterization of $\tau_{(n)}$ Atoms

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March 9, 2018

Abstract

In [1], Anderson and Frazier define the concept of τ-factorization. Specifically, we can work with the relation $\tau_{(n)}$. These relations have been worked a lot for small values of n. However, it is sometimes difficult to extend findings for small values of n to the relation with a larger n. An example of this is when working with $\tau_{(n)}$ irreducibles. The $\tau_{(n)}$ irreducibles are known for $n = 0, 1, 2, 3, 4, 5, 6, 8, 10, 12$, as seen in [2],[3],and [4]. However, the problem of determining the irreducibles becomes much more difficult the larger n is. In this work, we explicitly determined the $\tau_{(n)}$ irreducibles for $n = 7$ and give a method that determines the irreducibles when both n is prime and $\frac{n-1}{2}$ is prime. Additionally, we define the group $G_{\tau'_{(n)}}$, which is induced by $\tau_{(n)}$, and determine some of its structural properties.

Keywords: τ-factorizations, Atoms, Algebra

Saturday
March 24
10:00am
Vestíbulo

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