UNIVERSIDAD DE COSTA RICA

CIMPA Centro de Investigación en Matemática Pura y Aplicada

XXIV SIMMAC

Simposio Internacional de Métodos Matemáticos Aplicados a las Ciencias

International Symposium on Mathematical Methods Applied to the Sciences

Programa y Resúmenes
20 al 23 de febrero, 2024,
Liberia, Guanacaste, Costa Rica

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XXIV SIMPOSIO INTERNACIONAL DE MÉTODOS MATEMÁTICOS APLICADOS A LAS CIENCIAS

20-23 DE FEBRERO, 2024 / FEBRUARY 20-23TH, 2024

AGRADECIMIENTOS

El Centro de Investigación en Matemática Pura y Aplicada (CIMPA) de la Universidad de Costa Rica, agradece a las siguientes instituciones y entidades que ayudaron e hicieron posible la realización del XXIV Simposio Internacional de Métodos Matemáticos Aplicados a las Ciencias:

- Rectoría de la Universidad de Costa Rica.
- Vicerrectoría de Acción Social de la Universidad de Costa Rica.
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- Sociedad Latinoamericana de Clasificación y Análisis de Datos (SoLCAD).
- Banco Nacional.
- Coopenae.

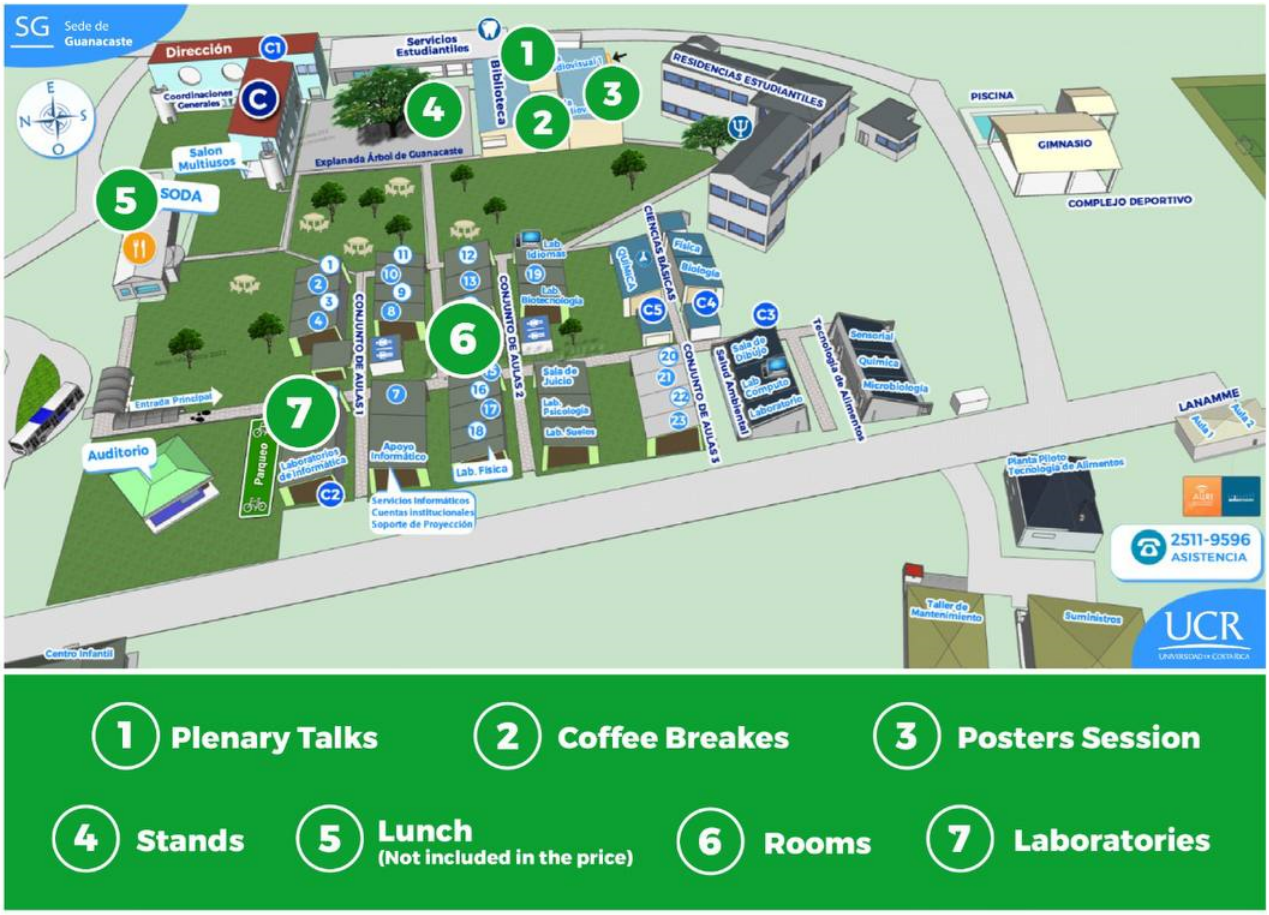
Adriana Sánchez Chavarría
Coordinador, SIMMAC

Localización / Location

Aulas / *Rooms*

Aula 1 / *Room 1*	En la biblioteca / *in the library (Plenary Talks)*
Aula 2 / *Room 2*	Localización / *Localization*
Aula 3 / *Room 3*	Localización / *Localization*
Aula 4 / *Room 4*	Localización / *Localization*

Mapa / *Map*



XXIV SIMMAC

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International Symposium on Mathematical Methods Applied to the Sciences

February 20th - 23th, 2024
Liberia, Guanacaste, Costa Rica

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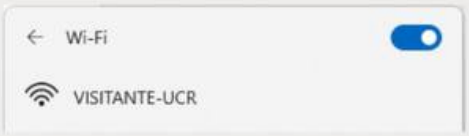

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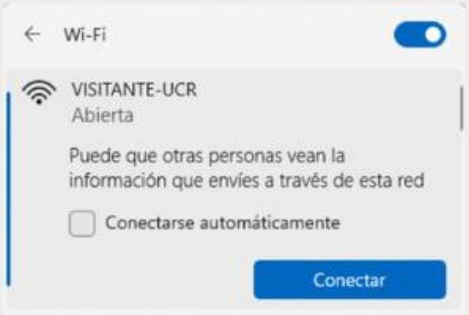

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XXIV Simposio Internacional de Métodos Matemáticos Aplicados a las Ciencias

XXIV International Symposium on Mathematical Methods Applied to Sciences

XXIV SIMMAC Martes / Tuesday 20th

Room 1	Room 2	Room 3	Room 4
8:00 --> Inscripciones / Inscription			
9:30 10:00 Inauguración / Opening ceremony			
10:00 10:30 Café / Coffee break			

11:00 12:00 Opening Plenary Talk / Conferencia Inaugural

Chou, Shu Wei

Modelos lineales parciales aditivos con error simétrico autorregresivo para datos de series temporales

Chair: *Javier Trejos*

12:00 13:30 Tiempo para almuerzo / Time for lunch.

Room 1					Room 2					Room 3					Room 4				
Session			**EsTM1**	**Estadística Multivariada / Multivariate Statistics 1**	Session			**Fis1**	**Física / Physics 1**	Session			**TC1**	**Teoría de Control / Control Theory**	Session			**ElFi1**	**Métodos de Elementos Finitos / Finite Element Methods**
Chair:				Greivin Hernández	Chair:				*Francisco Frutos*	Chair:				*Javier Trejos*	Chair:				Juan Gabriel Calvo
1	13:30	14:00	Díaz, Arturo J.	Multivariate Control Chart with Guaranteed IC performance and Cautious Parameter Learning	4	13:30	14:00	Barquero, Josh	First magnetohydrodynamic simulations of jets and radiative feedback from a massive star	7	13:30	14:00	Fournier, Arnau	Boundary null controllability of convection-diffusion equations with constraints on the state and application to the identification	10	13:30	14:00	Quiroz, Darwi	Local discontinuous Galerkin method with linearly implicit IMEX-RK time discretizations for the numerical solution of
2	14:00	14:30	Vazquez, Héc	Estudio de asociación entre la forma biológica de hojas de árboles y aspectos genéticos de la especie	5	14:00	14:30	Mora, Alexand	An approximate model and computations for the orbits around a non rotating compact object with mass and magnetic	8	14:00	14:30	Vides, Fredy	Switched economic system dynamics identification using topologically controlled reservoir computers	11	14:00	14:30	Colmenares, E	Analyzing Bioconvection: An Application of Banach-Based Mixed Finite Element Methods
3	14:30	15:00	Gomez-Rodrig	The Effects of Economic Shocks on Heterogeneous Inflation Expectations	6	14:30	15:00	Solano, Diego F	Equatorial circular motion in a Kerr-like spacetime	9	14:30	15:00	#N/D	#N/D	12	14:30	15:00	Careaga, Julio	Banach spaces-based mixed finite element methods for a model of poroelasticity coupled with the heat equation
15:00	15:30	Café / Coffee break													Cambio: Aula 1 / Switch Room 1				
Cambio: Álgebra Lineal Numérica					Session			**Fis2**	**Física / Physics 2**	Session			**Alg1**	**Álgebra / Algebra - Tutorial**	Session			**AlgNu**	**Álgebra Lineal Numérica / Numerical Linear Algebra**
					Chair:				*Francisco Frutos*	Chair:				*Adriana Sánchez*	Chair:				Juan Gabriel Calvo
Aula 1					13	15:30	16:00	González, Amy	Holography and Mathematics	15	15:30	16:00	Lopez-Permoutl	Extensions of infinite dimensional modules based on amenable bases and related topics	17	15:30	16:00	Soto, Juan Pal	Approximating a bivariate function using {\it B-splines} and the matrix equation $AXB=C$.
Switch: Linear numerical algebra					14	16:00	16:30	Macias, Jorge S	On the solution of some elliptic systems of partial differential equations of the Schrödinger type	16	16:00	16:30			18	16:00	16:30	Sánchez, Sam	A new approach for estimating the pseudoinverse of a third-order tensor and its application in image processing
Room 1						16:30	17:00				16:30	17:00			19	16:30	17:00	Soto-Quiros, F	Expanding the Utility of Singular Value Decomposition in Image Processing: Novel Applications and Techniques

XXIV Simposio Internacional de Métodos Matemáticos Aplicados a las Ciencias

XXIV International Symposium on Mathematical Methods Applied to Sciences

XXII SIMMAC: Miércoles / Wednesday 21th

Room 1	Room 2	Room 3	Room 4
	Session SD1 **Sistemas Dinámicos y Teoría Ergódica /Dynamical Systems**	Session GT1 **Topología y Geometría / Geometry and Topology 1**	
	Chair: Adriana Sánches	Chair: Ronald Zúñiga	
	20 09:00 09:30	23 09:00 09:30 Rubinstein, Yanir — Mahler's and Bourgain's conjectures viewed through complex geometry	
	21 09:30 10:00 Funeza, William — Complexity in Networks of Piecewise Contractive Transformations	24 09:30 10:00 Schmitt, Alexande — Compactifications of the moduli space of principal bundles on smooth curves	
	22 10:00 10:30 Méndez, Héctor — Productos sesgados caóticos y operadores de convolución	25 10:00 10:30 Oliveira, André — Lie algebroid connections degenerating onto twisted Higgs bundles	
10:30 11:00 Café / Coffee break			
Session EstC1 **Estadística Computacional / Statistical Computing**	Session SD2 **Sistemas Dinámicos y Teoría Ergódica /Dynamical Systems**	Session GT2 **Topología y Geometría / Geometry and Topology 2**	Session Biom1 **Matemática Biológica / Biomathematics 1**
Chair: Javier Trejos	Chair: Adriana Sánches	Chair: Ronald Zúñiga	Chair: Jennifer Loria
26 11:00 11:30 Rengifo, Camilo — A robust methodology for incomplete information in tables to two classification ways	28 11:00 11:30 Salgado, Lucian — Sensitivity and historic behavior for continuous maps	30 11:00 11:30 Collier, Brian — Higgs bundles and complex hyperbolic structures on disk bundles	32 11:00 11:30 Alvarez, Ernest — The Closest Tree Algorithm for Explaining Ancestral Data
27 11:30 12:00 Duarte, Roberto — Comparación de estimadores robustos para los parámetros de una distribución Beta.	29 11:30 12:00 Marchesin, Mar — A Family of Linear Stable Equilibria in the Sun-Earth-Sail Problem	31 11:30 12:00 Brambila–Paz, Let — Twisted Brill-Noether Theory	33 11:30 12:00 Sanchez, Fabio — A nonlinear relapse model with disaggregated contact rates: analysis of a forward-backward bifurcation
12:00 13:30 Tiempo para almuerzo / Time for lunch.			
Room 1	**Room 2**	**Room 3**	**Room 4**
Session DSc1 **Ciencia de Datos / Data Science 1**	Session MNPD **Métodos Numéricos para PDEs / Numerical Methods for PI**	Session Alg1 **Álgebra / Algebra - Tutorial**	Session Mod1 **Modelación Matemática / Mathematical Modeling 1**
Chair: Luis Amaya	Chair: Juan Gabriel Calvo	Chair: Chair-Alg1	Chair: Alexander Ramírez
34 13:30 14:00 Trejos, Javier — Multidimensional scaling by particle swarm optimization	37 13:30 14:00 Sequeira, Filánc — New Banach spaces-based fully-mixed finite element methods for pseudostress-assisted diffusion problems	40 13:30 14:00 Lopez-Permouth, — Extensions of infinite dimensional modules based on amenable bases and related topics	43 13:30 14:00 Arteaga, Jose Ri — Introduction to Mathematical Models Applied to Medicine
35 14:00 14:30 Gallardo, Eugen — Aspectos relacionados con la permanencia y la graduación del estudiantado: el caso de la Escuela de Estadística de la Universidad	38 14:00 14:30 Macias-Diaz, Jo — On the numerical solution of the fractional Fermi-Pasta-Ulam-Tsingou equation	41 14:00 14:30	44 14:00 14:30
36 14:30 15:00 Beltrán, Beatriz — Análisis de sentimientos con PLN para el problema de deserción escolar en nivel universitario	39 14:30 15:00 Solano, Manuel — A dissimilar mesh discretization for hybridizable discontinuous Galerkin schemes applied to interface problems	42 14:30 15:00 Chicas, Gabriel Al — Some properties of Morava's group of extensions	45 14:30 15:00 Cardona, Kerin — Identification of Dynamical Systems: An Integrated Approach Based on Sparsity, Regularization and Low Rank
15:00 15:30 Café / Coffee break	**Poster session / sesión de carteles**		
Session DSc2 **Ciencia de Datos / Data Science 2**	Session ElFi2 **Métodos de Elementos Finitos / Finite Element Methods 2**	Session Anal1 **Análisis y Probabilidad / Analysis and Probability**	Session Mod1 **Modelación Matemática / Mathematical Modeling 1**
Chai	Chai Chair-Elfi2	Chai Dario Mena	Chai Alexander Ramírez
46 15:30 16:00 Funez, William — Analysis of the forced propensity to migrate in Honduras using machine learning methods	49 15:30 16:00 Sanchez, Manu — New symplectic discontinuous Galerkin methods for Maxwell Equations	52 15:30 16:00 Mendoza-Torres, — Improper Integration and Fourier Analysis	55 15:30 16:00 Arteaga, Jose Ricardo — Introduction to Mathematical Models Applied to Medicine
47 16:00 16:30 Berlioz, Luis — Text mining the arXiv with LLMs	50 16:00 16:30	53 16:00 16:30 Arredondo, Juan — An example of fractality in the theory of integration	56 16:00 16:30
48 16:30 17:00 Rueda, Maria d — Inference from non-probabilistic surveys through data integration	51 16:30 17:00	54 16:30 17:00 Bonnini, Stefano — Comparative longitudinal analysis of hormonal concentrations and morphometric measurements between	57 16:30 17:00 Reinecke, Jost — Continuous Time Modeling with Criminological Panel Data: An Application to the Longitudinal Association between

XXIVSimposio Internacional de Métodos Matemáticos Aplicados a las Ciencias

XXIV International Symposium on Mathematical Methods Applied to Sciences

XXIV SIMMAC: Jueves/Thursday 22

Cambio: Aula 2 Room 1 Switch Room 2

Session					
Chair:			DSc3	Ciencia de Datos / Data Science - Tutorial 1	Adriana Sánchez
58	09:00	09:30			
59	09:30	10:00		Alfaro, Marcela	Análisis de Datos Reproducible con R
60	10:00	10:30			
	10:30	11:00	Café / Coffee break		

Cambio: Aula 1 Room 2 Switch Room 1

Session					
Chair:			MEst1	Modelos Estadísticos / Statistical Modeling 1	Shu Wei
61	09:00	09:30	Solis, Maikol		Machine Learning-Driven COVID-19 Early Triage and Large-Scale Testing Strategies Based on the
62	09:30	10:00	Macías, Néstor		Effect of social food modeling with healthy virtual models on school-age children's selection of
63	10:00	10:30	López, Erasmo		Prevalence of cardiometabolic risk in a national sample of Costa Rican youth using the waist-

Room 3

Session					
Chair:			Anal2	Análisis y Probabilidad / Analysis and Probability	Dario Mena
64	09:00	09:30	Cambronero, Sa		On the supremum of a family of set functions
65	09:30	10:00	Campos, José D		Quadratic variation for cylindrical martingale-valued measures
66	10:00	10:30	Fonseca-Mora,		Stochastic integration with respect to infinite dimensional semimartingales

Room 4

Session					
Chair:			Biom2	Matemática Biológica / Biomathematics 2	Greivin Hernández
67	09:00	09:30	Villalobos, Mari		Curve Fitting for pandemic data using Generalized Logistic Regression
68	09:30	10:00	López-Estrada, J		Early unveiling of coronary stenosis by no invasive mean
69	10:00	10:30	Loría, Jennifer		Vaccine Efficacy Estimation Quantified by a Mathematical Model.

11:00 12:00 **Plenary Talk 2 / Conferencia plenaria 2**

Harris, Pamela

Secuencias multicomplejas de malabares y la función de partición de Kostant

Chair: *Adriana Sánchez*

12:00 13:30 Tiempo para almuerzo / Time for lunch.

Cambio: Aula 2 Room 1 Switch Room 2

Session					
Chair:			DSc4	Ciencia de Datos / Data Science - Tutorial 2	Adriana Sánchez
70	13:30	14:00			
71	14:00	14:30		Villegas-Diaz, R	API development with R
72	14:30	15:00			

Cambio: Aula 1 Room 2 Switch Room 1

Session					
Chair:			MNPD	Métodos Numéricos para PDEs / Numerical Meth	Juan Gabriel Calvo
73	13:30	14:00	Gómez, Bryan A		Twofold saddle-point formulation of Biot poroelasticity with stress-dependent diffusion
74	14:00	14:30	Muñoz, Rolando		Numerical analysis of the Davey-Stewartson system
75	14:30	15:00	Medina, Iliana E		Optimizing the bio-activity of magnetic nanomaterials (MNMs) in hyperthermia cancer

Room 3

Session					
Chair:			Riesgo	Riesgo / Risk	Alvaro Guevara
76	13:30	14:00	Rangel, Jennifer		Más allá de los gráficos: Explorando las matemáticas en el Algorithmic Trading.
77	14:00	14:30	Schubert, Leo		Risk limitation in portfolio optimization
78	14:30	15:00	Quirós, Tatiana		Transformando la banca con Machine Learning: Score de crédito para PYMES

Room 4

Session					
Chair:			Mod1	Modelación Matemática / Mathematical Modeling 1	Alexander Ramírez
79	13:30	14:00			
80	14:00	14:30		Arteaga, Jose Ri	Introduction to Mathematical Models Applied to Medicine
81	14:30	15:00	Segura, Esteban		Transformando la banca con Machine Learning: Score de crédito para PYMES

Room 5

15:00 15:30 Café / Coffee break

Room 1

Session					
Chair:			DSc5	Ciencia de Datos / Data Science 5	Alexander Ramírez
82	15:30	16:00	Amaya-Briceño,		Classification of Guanacaste districts using free access geospatial data.
83	16:00	16:30	Hernández, Edg		Quantifying uncertainty of a geometric goodness of fit measure.
84	16:30	17:00			

Room 2

Session					
Chair:			Comp1	Computación Científica / Scientific computing	Juan Gabriel Calvo
85	15:30	16:00	Delgado, Alejan		Measuring, Simulation and Evaluation of Room Impulse Responses Associated with
86	16:00	16:30	Fallas-Monge, J		FroImPro Toolbox: Aplicaciones de la norma de Frobenius en el procesamiento de imágenes y
87	16:30	17:00			

Room 3

Session					
Chair:			Alg1	Álgebra / Algebra - Tutorial	Dario Mena
88	15:30	16:00			
89	16:00	16:30		Lopez-Permouti	Extensions of infinite dimensional modules based on amenable bases and related topics
90					

Room 4

Session					
Chair:			Opt1	Optimización / Optimization	Mario Villalobos
91	15:30	16:00	Ramírez, Javier		Constraint Satisfaction Method in Natural Language Processing Problems
92	16:00	16:30	Weng-Law, And		Accelerated methods for nonsmooth convex structured minimization problems
93	16:30	17:00	Hernández, Fer		Algorithms, efficient implementations, and their utility in the industry: Generalized

Room 5

Session					
Chair:			IRMM	Mesa redonda Mujeres en Matemática /	Samaria Montenegro
15:30	16:00				
16:00	16:30		Montenegro, Samaria		Mesa redonda Mujeres en Matemática / Women in Mathematics Roundtable
16:30	17:00				

XXII Simposio Internacional de Métodos Matemáticos Aplicados a las Ciencias

XXII International Symposium on Mathematical Methods Applied to Sciences

XXII SIMMAC Viernes / Friday 23th

Cambio: Aula 2 Room 1 Switch Room 2

Session / Chair			DSc3	Ciencia de Datos / Data Science - Tutorial 1	Adriana Sánchez
94	09:00	09:30			
95	09:30	10:00	Alfaro, Marcela	Análisis de Datos Reproducible con R	
96	10:00	10:30			
	10:30	11:00	Café / Coffee break		
	11:00	12:00	**Plenary Talk 3 / Conferencia plenaria 3**		

Villar, Soledad

Simetrías en inteligencia artificial

Chair: *Alexander Ramírez*

	12:00	2:00	Tiempo para almuerzo / Time for lunch.		

Cambio: Aula 2 Room 1 Switch Room 2

Session / Chair			DSc4	Ciencia de Datos / Data Science - Tutorial 2	Adriana Sánchez
103	13:30	14:00			
104	14:00	14:30	Villegas-Diaz, Robei	API development with R	
105	14:30	15:00			
	15:00	15:30	Café / Coffee break		
	15:30	16:30	**Closing Plenary Talk / Conferencia de Clausura**		

Ramírez, Kattia

To be anounce

Chair: *Adriana Sánchez*

16:30 Clausura / Closing session

Cambio: Aula 1 Room 2 Switch Room 1

Session / Chair			MEst2	Modelos Estadísticos / Statistical Modeling 2	Shu Wei	
97	09:00	09:30	Hidalgo, Hugo G.	Regional and local trend significance of precipitation and temperature extremes in Central America: the		
98	09:30	10:00	Canales, Eduardo S	Bayesian multi-level modeling for the touristic expenditure in Honduras.		
99	10:00	10:30	Alfaro, Eric Jose	Uso de herramientas estadísticas para la generación de escenarios climáticos en la vertiente Caribe de		

Session / Chair:			Riesgo	Mesa redonda Riesgo / Risk Roundtable	Alvaro Guevara	
106	13:30	14:00				
107	14:00	14:30	Guevara, Alvaro	Mesa redonda Riesgo / Risk Roundtable		
108	14:30	15:00				

Room 3

Session / Chair:			MNPD	Métodos Numéricos para PDEs / Numerical Methods for	Chair-MNPD3	
109	13:30	14:00				
110	14:00	14:30	Salazar, Jorge Luis	Non-blanced finite finite differences and adaptive gradient optimizers: an application to full waveform seismic		
111	14:30	15:00	Calvo, Juan Gabriel	Robust domain decomposition methods for highcontrast multiscale problems on irregular domains		

Room 4

Session / Chair:			TN1	Teoría de números y combinatoria / Number Theory and	Dario Mena	
100	09:00	09:30	Camacho, Catalina	Cartier points of genus 3 and 4 curves		
101	09:30	10:00	Barquero, Adrián A	Efficient computation of the overpartition function and applications		
102	10:00	10:30	Lacy, Allan	Dynatomic Galois groups for a family of quadratic rational maps		

Session / Chair:			TN2	Teoría de números y combinatoria / Number Theory and	*Dario Mena*	
112	13:30	14:00	Piza, Eduardo	Balanced Incomplete Block Designs: theory and computer search		
113	14:00	14:30				
114	14:30	15:00				

Programa / Program

Lunes / Monday, 24

8:00 – ∞: Inscripciones / Registration: `UCR - Liberia`.

Martes/Tuesday, 20

8:00 – ∞: Inscripciones / Registration.

9:00 – 10:30 : Inauguración / Opening ceremony `Room / aula 1`.

10:30 – 11:00 : Café / Coffee break.

11:00 – 12:00 Session: Opening Plenary Talk / Conferencia Inaugural (conf1): `Room / aula 1`.

CHOU, S.: Modelos lineales parciales aditivos con error simétrico autorregresivo para datos de series temporales (pág. 47).

12:00 – 13:30 Tiempo para almuerzo / Time for lunch.

13:30 – Session: Estadística Multivariada / Multivariate Statistics 1 (EstM1): `Room/aula 1`.

13:30– 14:00 DÍAZ, A. & CORDERO, Á.E. & TERCERO, V.G.: Multivariate Control Chart with Guaranteed IC performance and Cautious Parameter Learning (pág. 51).

14:00– 14:30 VAZQUEZ, H. & ALDAMA, A.: Estudio de asociación entre la forma biológica de hojas de árboles y aspectos genéticos de la especie (pág. 116).

14:30– 15:00 GOMEZ-RODRIGUEZ, F.: The Effects of Economic Shocks on Heterogeneous Inflation Expectations (pág. 60).

13:30 – Session: Física / Physics 1 (Fis1): `Room/aula 2`.

13:30– 14:00 BARQUERO, J. & KUIPER, R. & OLIVA, A.: First magnetohydrodynamic simulations of jets and radiative feedback from a massive star (pág. 30).

14:00– 14:30 MORA, A.: An approximate model and computations for the orbits around a non rotating compact object with mass and magnetic dipole (pág. 84).

14:30– 15:00 SOLANO, D. & FRUTOS, F.: Equatorial circular motion in a Kerr-like spacetime (pág. 111).

13:30 – Session: Teoría de Control / Control Theory (TC1): `Room/aula 3`.

13:30– 14:00 **[CANCELED]** FOURNIER, A. & LARROUY, J.: Boundary null controllability of convection-diffusion equations with constraints on the state and application to the identification of boundary pollution parameters (CANCELADA).

14:00– 14:30 VIDES, F.: Switched economic system dynamics identification using topologically controlled reservoir computers (pág. 117).

13:30 – Session: Métodos de Elementos Finitos / Finite Element Methods 1 (ElFi1): `Room/aula 4`.

13:30– 14:00 QUIROZ, D. & HENRÍQUEZ, I.Y: Local discontinuous Galerkin method with linearly implicit IMEX-RK time discretizations for the numerical solution of the BCRE model (pág. 88).

14:00– 14:30 COLMENARES, E.: Analyzing Bioconvection: An Application of Banach-Based Mixed Finite Element Methods (pág. 49).

14:30– 15:00 CAREAGA, J.: Banach spaces-based mixed finite element methods for a model of poroelasticity coupled with the heat equation (pág. 45).

15:00 – 15:30 : Café / Coffee break.

15:30 – Session: Física / Physics 2 (Fis2): `Room/aula 2`.

15:30– 16:00 GONZÁLEZ, A. & GONZÁLEZ, R.: Holography and Mathematics (pág. 62).

16:00– 16:30 MACIAS, J. & DELGADO, B. & GALLEGOS, A.: On the solution of some elliptic systems of partial differential equations of the Schrödinger type (pág. 75).

15:30 – Session: Álgebra / Algebra - Tutorial (Alg1): `Room/aula 3`.

15:30– 16:30 LOPEZ-PERMOUTH, S.: Extensions of infinite dimensional modules based on amenable bases and related topics (pág. 73).

15:30 – Session: Álgebra Lineal Numérica / Numerical Linear Algebra (AlgNu1): `Room/aula 4`.

16:00– 16:30 SÁNCHEZ, S. & SOTO, J.P.: A new approach for estimating the pseudoinverse of a third-order tensor and its application in image processing (pág. 103).

Miércoles/Wednesday 21

09:00 – Session: Sistemas Dinámicos y Teoría Ergódica /Dynamical Systems and Ergodic Theory 1 (SD1): `Room/aula 2`.

09:30– 10:00 FUNEZA, W.: Complexity in Networks of Piecewise Contractive Transformations (pág. 56).

10:00– 10:30 MÉNDEZ, H.: Productos sesgados caóticos y operadores de convolución (pág. 82).

09:00 – Session: Topología y Geometría / Geometry and Topology 1 (GT1): `Room/aula 3`.

09:00– 09:30 RUBINSTEIN, Y.: Mahler's and Bourgain's conjectures viewed through complex geometry (pág. 96).

09:30– 10:00 SCHMITT, A.: Compactifications of the moduli space of principal bundles on smooth curves (pág. 104).

10:00– 10:30 OLIVEIRA, A.: Lie algebroid connections degenerating onto twisted Higgs bundles (pág. 86).

10:30 – 11:00 : Café / Coffee break.

11:00 – Session: Estadística Computacional / Statistical Computing (EstC1): `Room/aula 1`.

11:00– 11:30 RENGIFO, C. & ARCINIEGAS, S. & GARCÍA, M.: A robust methodology for incomplete information in tables to two classification ways (pág. 95).

11:30– 12:00 DUARTE, R.: Comparación de estimadores robustos para los parámetros de una distribución Beta. (pág. 52).

11:00 – Session: Sistemas Dinámicos y Teoría Ergódica /Dynamical Systems and Ergodic Theory 2 (SD2): `Room/aula 2`.

11:00– 11:30 SALGADO, L.: Sensitivity and historic behavior for continuous maps (pág. 100).

11:30– 12:00 MARCHESIN, M.: A Family of Linear Stable Equilibria in the Sun-Earth-Sail Problem (pág. 80).

11:00 – Session: Topología y Geometría / Geometry and Topology 2 (GT2): `Room/aula 3`.

11:00– 11:30 COLLIER, B.: Higgs bundles and complex hyperbolic structures on disk bundles (pág. 48).

11:30– 12:00 BRAMBILA-PAZ, L.: Twisted Brill-Noether Theory (pág. 38).

11:00 – Session: Matemática Biológica / Biomathematics (Biom1): `Room/aula 4`.

11:00– 11:30 ALVAREZ, E.: The Closest Tree Algorithm for Explaining Ancestral Data (pág. 26).

11:30– 12:00 SANCHEZ, F.: A nonlinear relapse model with disaggregated contact rates: analysis of a forward-backward bifurcation (pág. 101).

12:00 – 13:30 Tiempo para almuerzo / Time for lunch.

13:30 – Session: Ciencia de Datos / Data Science (DSc1): `Room/aula 1`.

13:30– 14:00 TREJOS, J. & BAZÁN, V.: Multidimensional scaling by particle swarm optimization (pág. 115).

14:00– 14:30 GALLARDO, E.: Aspectos relacionados con la permanencia y la graduación del estudiantado: el caso de la Escuela de Estadística de la Universidad de Costa Ric (pág. 57).

14:30– 15:00 BERNÁBE, M. & BELTRÁN, B. & MARTÍNEZ, G, & GONZÁLEZ: Análisis de sentimientos con PLN para el problema de deserción escolar en nivel universitario (pág. **??**).

13:30 – Session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 1 (MNPD1): `Room/aula 2`.

13:30– 14:00 SEQUEIRA, F.: New Banach spaces-based fully-mixed finite element methods for pseudostress-assisted diffusion problems (pág. 109).

14:00– 14:30 MACIAS-DIAZ, J.: On the numerical solution of the fractional Fermi-Pasta-Ulam-Tsingou equation (pág. 78).

14:30– 15:00 SOLANO, M.: A dissimilar mesh discretization for hybridizable discontinuous Galerkin schemes applied to interface problems (pág. 110).

13:30 – Session: Álgebra / Algebra (Alg2): `Room/aula 3`.

13:30– 14:30 LOPEZ-PERMOUTH, S.: Extensions of infinite dimensional modules based on amenable bases and related topics (cont.) (pág. 73).

14:30– 15:00 CHICAS, G.: Some properties of Morava's group of extensions (pág. 46).

13:30 – Session: Modelación Matemática / Mathematical Modeling 1 (Mod1): `Room/aula 4`.

13:30– 14:30 ARTEAGA, J.: Introduction to Mathematical Models Applied to Medicine (pág. 29).

14:30– 15:00 CARDONA, K.: Identification of Dynamical Systems: An Integrated Approach Based on Sparsity, Regularization and Low Rank Approximation (pág. 44).

15:00 – 15:30 : Café / Coffee break.

15:30 – Session: Ciencia de Datos / Data Science 2 (DSc2): `Room/aula 1`.

15:30– 16:00 FUNEZ, W. & OCAMPO, H.D.: Analysis of the forced propensity to migrate in Honduras using machine learning methods (pág. 55).

16:00– 16:30 BERLIOZ, L.: Text mining the arXiv with LLMs (pág. 35).

16:30– 17:00 RUEDA, M.: Inference from non-probabilistic surveys through data integration (pág. 97).

15:30 – Session: Métodos de Elementos Finitos / Finite Element Methods 2 (ElFi2): `Room/aula 2`.

15:30– 16:00 SANCHEZ, M.: New symplectic discontinuous Galerkin methods for Maxwell Equations (pág. 102).

15:30 – Session: Análisis y Probabilidad / Analysis and Probability (Anal1): `Room/aula 3`.

15:30– 16:00 MENDOZA-TORRES, F. & ARREDONDO, J.H.: Improper Integration and Fourier Analysis (pág. 83).

16:00– 16:30 ARREDONDO, J.: An example of fractality in the theory of integration (pág. 28).

16:30– 17:00 BONNINI, S. & CORAIN, L. & GRAIC, J.M.: Comparative longitudinal analysis of hormonal concentrations and morphometric measurements between bovine females and hermaphrodites during postnatal development (pág. 37).

15:30 – Session: Modelación Matemática / Mathematical Modeling 2 (Mod2): `Room/aula 4`.

15:30– 16:30 ARTEAGA, J.: Introduction to Mathematical Models Applied to Medicine (pág. 29).

16:30– 17:00 REINECKE, J. & ERDMANN, A. & VOELKLE, M.: Continuous Time Modeling with Criminological Panel Data: An Application to the Longitudinal Association between Victimization and Offending (pág. 94).

Jueves/Thursday 22

09:00 – Session: Ciencia de Datos / Data Science - Tutorial 1 (DSc3): `Room/aula 1`.

09:00– 10:30 ALFARO, M.: Análisis de Datos Reproducible con R (pág. 25).

09:00 – Session: Modelos Estadísticos / Statistical Modeling 1 (MEst1): `Room/aula 2`.

09:00– 09:30 SOLIS, M. & PASQUIER, C. & VILCHEZ, V.: Machine Learning-Driven COVID-19 Early Triage and Large-Scale Testing Strategies Based on the 2021 Costa Rican Actualidades Survey (pág. 112).

09:30– 10:00 MACÍAS, N.: Effect of social food modeling with healthy virtual models on school-age children's selection of healthy and unhealthy food and drink items (pág. 76).

10:00– 10:30 LÓPEZ, E.: Prevalence of cardiometabolic risk in a national sample of Costa Rican youth using the waist-height anthropometric indicator (pág. 70).

09:00 – Session: Análisis y Probabilidad / Analysis and Probability 2 (Anal2): `Room/aula 3`.

09:00– 09:30 CAMBRONERO, S. & CAMPOS, J.D.: On the supremum of a family of set functions (pág. 42).

09:30– 10:00 CAMPOS, J. & CAMBRONERO, S.: Quadratic variation for cylindrical martingale-valued measures (pág. 43).

10:00– 10:30 FONSECA-MORA, C.: Stochastic integration with respect to infinite dimensional semimartingales (pág. 54).

09:00 – Session: Matemática Biológica / Biomathematics 2 (Biom2): `Room/aula 4`.

09:00– 09:30 VILLALOBOS, M.: Curve Fitting for pandemic data using Generalized Logistic Regression (pág. 118).

09:30– 10:00 LÓPEZ-ESTRADA, J.: Early unveiling of coronary stenosis by no invasive mean (pág. 72).

10:00– 10:30 LORÍA, J.: Vaccine Efficacy Estimation Quantified by a Mathematical Model. (pág. 74).

10:30 – 11:00 : Café / Coffee break.

11:00 – Session: Plenary Talk 2 / Conferencia plenaria 2 (Conf2): `Room / aula 1`.

11:00– 12:00 HARRIS, P.: Secuencias multicomplejas de malabares y la función de partición de Kostant (pág. 67).

12:00 – 13:30 Tiempo para almuerzo / Time for lunch.

13:30 – Session: Ciencia de Datos / Data Science - Tutorial 2 (DSc4): `Room/aula 1`.

13:30– 14:00 VILLEGAS-DIAZ, R.: API development with R (pág. 120).

13:30 – Session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 2 (MNPD2): `Room/aula 2`.

13:30– 14:00 GÓMEZ, B.: Twofold saddle-point formulation of Biot poroelasticity with stress-dependent diffusion (pág. 59).

14:00– 14:30 MUÑOZ, R. & MACÍAS, J.E. & REGUERA, N.: Numerical analysis of the Davey-Stewartson system (pág. 85).

14:30– 15:00 MEDINA, I.: Optimizing the bio-activity of magnetic nanomateriasl (MNMs) in hyperthermia cancer treatment using mathematical modeling (pág. 81).

13:30 – Session: Riesgo / Risk (Riesgo1): `Room/aula 3`.

13:30– 14:00 RANGEL, J.: Más allá de los gráficos: Explorando las matemáticas en el Algorithmic Trading. (pág. 93).

14:00– 14:30 SCHUBERT, L.: Risk limitation in portfolio optimization (pág. 106).

14:30– 15:00 QUIRÓS, T.: Transformando la banca con Machine Learning: Score de crédito para PYMES (pág. 89).

13:30 – Session: Modelación Matemática / Mathematical Modeling 3 (Mod3): `Room/aula 4`.

13:30– 14:30 ARTEAGA, J.: Introduction to Mathematical Models Applied to Medicine (pág. 29).

14:30– 15:00 SEGURA, E. & VIDES, F. & VARGAS-AGÜERO, C.: A Subspace Method for Time Series Anomaly Detection in Cyber-Physical Systems (pág. 107).

15:00 – 15:30 : Café / Coffee break.

15:30 – Session: Ciencia de Datos / Data Science 5 (DSc5): `Room/aula 1`.

15:30– 16:00 AMAYA-BRICEÑO, L.: Classification of Guanacaste districts using free access geospatial data. (pág. 27).

16:00– 16:30 HERNÁNDEZ, E.: Quantifying uncertainty of a geometric goodness of fit measure. (pág. 64).

15:30 – Session: Computación Científica / Scientific computing (Comp1): `Room/aula 2`.

15:30– 16:00 DELGADO, A. & ABARCA, J.: Measuring, Simulation and Evaluation of Room Impulse Responses Associated with Acoustic Fields with Rectangular Geometry (pág. 50).

16:00– 16:30 FALLAS-MONGE, J. & SOTO-QUIRÓS, J.P. & CHAVARRÍA-MOLINA, J.: FroImPro Toolbox: Aplicaciones de la norma de Frobenius en el procesamiento de imágenes y videos (pág. 53).

15:30 – Session: Álgebra / Algebra - Tutorial (Alg1) (Cont.): `Room/aula 3`.

15:30– 16:30 LOPEZ-PERMOUTH, S.: Extensions of infinite dimensional modules based on amenable bases and related topics (pág. 73).

15:30 – Session: Optimización / Optimization (Opt1): `Room/aula 4`.

15:30– 16:00 RAMÍREZ, J. & TORRES, J.M. & LAUREANO, A.L.: Constraint Satisfaction Method in Natural Language Processing Problems (pág. 91).

16:00– 16:30 WENG-LAW, A.: Accelerated methods for nonsmooth convex structured minimization problems (pág. 121).

16:30– 17:00 HERNÁNDEZ, F. & PALACIOS, W.J.: Algorithms, efficient implementations, and their utility in the industry: Generalized Vehicle Routing Problem (GVRP) (pág. 65).

15:30 – Session: Mesa redonda Mujeres en Matemática / Women in Mathematics Roundtable (MRMM): `Room/aula 5`.

15:30– 17:00 MONTENEGRO, S: Mesa redonda Mujeres en Matemática / Women in Mathematics Roundtable

15:30 – Session: Mesa redonda Mujeres en Matemática / Women in Mathematics Roundtable (MRMM): `Room/aula 5`.

Viernes/Friday 23

09:00 – Session: Ciencia de Datos / Data Science - Tutorial 1 (cont.)(DSc3): `Room/aula 1`.

09:00– 10:30 ALFARO, M.: Análisis de Datos Reproducible con R (pág. 25).

09:00 – Session: Modelos Estadísticos / Statistical Modeling 2 (MEst2): `Room/aula 2`.

09:00– 09:30 HIDALGO, H.: Regional and local trend significance of precipitation and temperature extremes in Central America: the problem of spatial correlation (pág. 68).

09:30– 10:00 CANALES, E. & MATAMOROS, A.A.: Bayesian multi-level modeling for the touristic expenditure in Honduras. (pág. **??**).

10:00– 10:30 ALFARO, E.: Uso de herramientas estadísticas para la generación de escenarios climáticos en la vertiente Caribe de Costa Rica durante Setiembre-Octubre. (pág. 24).

09:00 – Session: Teoría de números y combinatoria / Number Theory and combinatory 1 (TN1): `Room/aula 4`.

09:00– 09:30 CAMACHO, C.: Cartier points of genus 3 and 4 curves (pág. 40).

09:30– 10:00 BARQUERO, A.: Efficient computation of the overpartition function and applications (pág. 32).

10:00– 10:30 LACY, A.: Dynatomic Galois groups for a family of quadratic rational maps (pág. 69).

10:30 – 11:00 : Café / Coffee break.

11:00 – 12:00 Session: Plenary Talk 3 / Conferencia plenaria 3 (Conf3): `Room/aula 1`.

VILLAR, S.: Simetrías en inteligencia artificial (pág. **??**).

12:00 – 13:30 Tiempo para almuerzo / Time for lunch.

13:30 – Session: Mesa redonda Riesgo / Risk Roundtable (Riesgo2): `Room/aula 2`.

13:30– 14:00 GUEVARA, A: Mesa redonda Riesgo / Risk Roundtable

13:30 – Session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 3 (MNPD3): `Room/aula 3`.

14:00– 14:30 SALAZAR, J. & ITURRARAN-VIVEROS, U.: Non-blanced finite finite differences and adaptive gradient optimizers: an application to full waveform seismic inversion (pág. 98).

14:30– 15:00 CALVO, J. & GALVIS, J.: Robust domain decomposition methods for highcontrast multiscale problems on irregular domains (pág. 39).

13:30 – Session: Teoría de números y combinatoria / Number Theory and combinatory 2 (TN2): `Room/aula 4`.

13:30– 14:00 PIZA, E. & SEGURA, E.: Balanced Incomplete Block Designs: theory and computer search (pág. 87).

15:00 – 15:30 : Café / Coffee break.

15:30 – 16:30 Session: Closing Plenary Talk / Conferencia de Clausura (Conf4): `Room / aula 1`.

RAMÍREZ, K.: To be anounce (pág. 92).

16:30 – 17:00 : Closing / Clausura

Contributions List[1]

[1] In strict alphabetic order according to the name of the author of the contribution.

Uso de herramientas estadísticas para la generación de escenarios climáticos en la vertiente Caribe de Costa Rica durante Setiembre-Octubre.[I]

Communication / Ponencia

ALFARO, ERIC JOSE[II]

Costa Rica

In a recent paper, Alfaro et al. (2023) used simple statistical tools to generate seasonal climate scenarios during the precipitation decrease observed in the Central American Caribbean slope during September and October. They used a set of 31 daily records from rain gauge stations, filling the missing data by Auto Regressive and Principal Components methods (Ureña et al. 2016). Then, records were filtered using a triangular moving averaged low pass filter of 31 days. In each daily record, the months from July to November were examined to find the values of the minimum, the date of the minimum, the onset and the demise, duration, and intensity of the middle autumn decrease or MAD. The occurrence of any temporal or spatial trend in these characteristics of the events was explored using linear regression and different climatic indices were correlated using the Spearman correlation to explore their relationship with different climate variability sources that modulates the Central American climate. Finally, 3 x 3 contingency tables were used to present the climate scenarios for the Limon port in Costa Rica, using Montecarlo technique to account for its significance. Results showed that this methodology could be used by stakeholders to account for local impacts under different climate variability scenarios, helping them also for planning and management.

Keywords: Auto Regressive and moving average filters, principal component analysis, linear regression, contingency table, Montecarlo, Climate Variability.

References

[1] Alfaro, E. J., Alvarado, L. F., Fallas, B. G., Mora, N. P., & Hidalgo, H. G. (2023). Caracterización climática y análisis de mecanismos moduladores del descenso de las lluvias en la vertiente Caribe de América Central durante septiembre-octubre (Climatic characterization and the analysis of the mechanisms that modulate the rainfall decreases during September-October in the Central American Caribbean slope). Revista de Ciencias Ambientales. 58(1), 1-24.

[2] Ureña, P., Alfaro, E. J., & Soley, F. J. (2016). Propuestas metodológicas para el rellenado de datos ausentes en series de tiempo geofísicas. Guía práctica de uso. Documento técnico. Centro de Investigaciones Geofísicas, Escuela de Física y Centro de Investigaciones en Ciencias del Mar y Limnología, Universidad de Costa Rica. http://www.kerwa.ucr.ac.cr/handle/10669/28888

[I] Viernes/Friday 23, 10:00-10:30, Room/aula 2, session: Modelos Estadísticos / Statistical Modeling 2

[II] Universidad de Costa Rica, Escuela de Física, Costa Rica, erick.alfaro@ucr.ac.cr

Análisis de Datos Reproducible con R[I]

Short course / Curso corto

ALFARO CÓRDOBA, MARCELA[II]

Costa Rica

El análisis de datos reproducible es esencial para garantizar la transparencia, colaboración y validez de los resultados de cualquier reporte. Además, es una es- trategia para evitar repetir procesos internos en una empresa, y para documentar los distintos análisis que se llevan a cabo periódicamente en una organización. En este curso, describiremos las técnicas fundamentales para crear y compartir análisis de datos reproducibles utilizando el lenguaje de programación R, el paquete de control de versiones git y la plataforma de colaboración GitHub.

Contenido

- Introducción al Análisis de Datos Reproducible (Día 1: 30 minutos) ¿Quées el análisis de datos reproducible y por quées importante? Venta- jas y desafíos de la reproducibilidad en el análisis de datos. Herramientas y conceptos clave: Quarto y control de versiones.
- Fundamentos de Quarto (Día 1: 1 hora)

  Integración de código R y texto narrativo. Estructura y sintaxis de Quarto. Generación de informes dinámicos y visualmente atractivos. Incorporación de gráficos y tablas interactivas.
- Control de Versiones con Git y GitHub (Día 2: 1 hora) Introducción a Git: seguimiento de cambios y colaboración. Creación y clonación de repositorios en GitHub. Integración de Quarto y Git para seguimiento de versiones. Colaboración en proyectos de análisis de datos.
- Práctica y uso de Herramientas de OpenAI (Día 2: 30 minutos) Desarrollo de un proyecto corto de análisis de datos desde cero. Extra: uso de herramientas de OpenAI para facilitar el proceso.

  Este curso está diseñado tanto para principiantes en análisis de datos como para aquellos que deseen mejorar sus habilidades en reproducibilidad utilizando R, tanto en industria como en investigación. Al finalizar el curso, las personas participantes estarán listas para crear análisis de datos robustos, transparentes y fácilmente compartibles con sus colegas.

Requisitos

- Conocimientos básicos de programación en R.
- Traer su propia laptop con R, git y RStudio instalados (instrucciones de instalación serán proporcionadas previamente).
- Tener una cuenta personal en GitHub.

[I] Jueves/Thursday 22, 09:00-09:30, Room/aula 1, session: Ciencia de Datos / Data Science - Tutorial 1
[II], Costa Rica,

The Closest Tree Algorithm for Explaining Ancestral Data[I]

Communication / Ponencia

ÁLVAREZ GONZÁLEZ, ERNESTO[II]

México

The closest tree algorithm is a tool that associates a metric to the set of distributions of patterns of nucleotides of a set of species coming from a common ancestor. In the presence of parameters, this technique can be hard to use. However, M.A. Steel, M.D. Hendy, L.A. Székely, and P.L. Erdos provide in 1992 an approximation formula that reduces the number of operations when estimating the model of evolution of a set of species. We illustrate the use of this formula in the case of three species having a tripod tree as a model of evolution. We also provide an algebraic proof to the approximation formula."

References

[1] Steel, M.A., Hendy, M.D., Székely, L.A., and Erdös, P.L. (1992). "Spectral Analysis and a Closest Tree Method for Genetic Sequences". Appl. Math. Lett., 5(6), 63-67.

[2] Chor, B., Hendy, M.D., Snir, S. (2006). "Maximum Likelihood Jukes-Cantor Triplets: Analytic Solutions". Mol. Biol. Evol., 23(3), 626-632.

[3] Álvarez, E. (2023). "Adaptation to the Closest Tree method for a Two State Quartet to Jukes-Cantor Tripod Trees". Revista de Matemática: Teoría y Aplicaciones., 30(1), 69-85.

[4] Álvarez, E., and Balam, R. (2021). "Computation of the Observed Spectral Sequence Spectrum for Nucleotide Sequence Alignments". In. CorlessR.M., Gerhard J., Kotsireas I.S. (eds) Maple in Mathematics Educationand Research. MC 2020. Communications in Computer and InformationScience. Springer, Cham., 1414 , 34-47.

[I] Miércoles/Wednesday 21, 11:00-11:30, Room/aula 4, session: Matemática Biológica / Biomathematics 1

[II] Universidad Autónoma "Benito Juárez" de Oaxaca, México, eralvarez.cat@uabjo.mx

Classification of Guanacaste districts using free access geospatial data.[I]

Communication / Ponencia

AMAYA-BRICEÑO, LUIS EDUARDO[II]

Costa Rica

Every day, within data analysis, the use of geospatial data becomes more relevant; these allow us to show a more complete picture of events (IBM, 2023). They are not always easily accessible, either due to cost of them or computational management.Using geospatial data, we share our experience in the characterization of the districts of the province of Guanacaste, Costa Rica. This with the objective of being able to contrast with existing indices at the cantonal level, such as the human development index (UNDP, 2022) or the of consumer confidence prepared by the University of Costa RicaTo do this, we collect information related to social variables (schools, hospitals), economic variables (bars, restaurants, malls, banks) and religious (churches), this information was provided by Google Maps (Cloud, 2023) using a free plugin called Import from Web.Once the information was collected, tabulated and cleaned, an analysis of principal components and a classification using k-means. The results found allow us to observe the formation of classes of districts that They are comparable with what was observed or that can be validated with instruments such as the aforementioned indices.

Keywords: geospatial data, google cloud, human development index, classification.

[I] Jueves/Thursday 22, 15:30-16:00, Room/aula 1, session: Ciencia de Datos / Data Science 5

[II] University of Costa Rica, Costa Rica, luis.amaya@ucr.ac.cr

An example of fractality in the theory of integration[I]

Communication / Ponencia

ARREDONDO RUIZ, JUAN[II]

México

The mathematical formalism in Quantum Mechanics obeys an inequality in the framework of the Fourier transform defined as an unitary operator on the Hilbert space of square Lebesgue integrable functions. The inequality has an interpretation in Physics known as the Heisenberg Uncertainty Principle. It manifests itself in the realm of integrable functions in the generalized sense. Furthermore, it seems to be related to a same structure, that is repeated at different scales.

Keywords: Generalized integration, Uncertainty Principle.

References

[1] A NECESSARY CONDITION FOR HK-INTEGRABILITY OF THE FOURIER SINE TRANSFORM FUNCTIONJuan H. Arredondo, Manuel Bernal, Maria G. MoralesCzechoslovak Mathematical JournalIssue dedicated to the memory of Professor Jaroslav KurzweilAccepted for publication

[I] Miércoles/Wednesday 21, 16:00-16:30, Room/aula 3, session: Análisis y Probabilidad / Analysis and Probability

[II] Universidad Autónoma Metropolitana-I Basic Science and Engineering Division Department of Mathematics, México, iva@xanum.uam.mx

Introduction to Mathematical Models Applied to Medicine[I]

Short course / Curso corto

ARTEAGA BEJARANO, JOSE RICARDO[II]

Colombia

The basic concepts of continuous models that can be mathematically represented by simple equations or systems of dynamic differential equations will be discussed. The minicourse is divided into three parts.Part 1: Models associated with population growth dynamics, such as the Malthus, Verhulst (logistic), and Allee effect models, will be addressed. The concepts of equilibria and their stability will be explored.Part 2: Models of species interaction and epidemiological models, along with their structures and dynamics, will be covered. The Lotka-Volterra model and the Generalized Lotka-Volterra model will be discussed in the section on species interaction models. Examples discussed in this part will include the predator-prey model and a simple model for the intestinal biota. In the section on epidemiological models, models associated with direct transmission of diseases will be discussed. Examples of such models include the SIR, SEIR, and some derivatives that incorporate control compartments such as treatment and vaccination.Part 3: A model for studying drug concentration in the blood plasma will be discussed. Both the case of a single dose and the case of multiple doses will be addressed. This second problem opens the doors to understanding a type of mathematical analysis based on the combination of two concepts: continuous models and discrete models, which can be treated using a relatively recent concept known as Time Scale Calculus [Boh01].The minicourse has no special requirements and is aimed at first-semester university students, whether in medicine, sciences, engineering, or other fields, who have an interest in the applications of mathematics.

Keywords: modelos, ecuaciones dinamicas, TSC.

References

[Boh01] Bohner, M. and Peterson, A., *Dynamic equations on time scales, an introduction with applications*, Birkh{a} user, 2001.

[I] Miércoles/Wednesday 21, 13:30-14:00, Room/aula 4, session: Modelación Matemática / Mathematical Modeling 1

[II] Universidad de los Andes, Bogotá, Colombia. Departamento de Matemáticas, Colombia, jarteaga@uniandes.edu.co

First magnetohydrodynamic simulations of jets and radiative feedback from a massive star[I]

Communication / Ponencia

BARQUERO ALVARADO, JOSHUA[II] KUIPER, ROLF[III] OLIVA MERCADO, ANDRÉ[IV]

Costa Rica

The study of massive protostars requires the explicit use of numerical simulations that allow us to follow the early stages of events defining the evolution of these stellar objects. This project aims to understand the complex processes occurring within the accretion material falling onto the star and the various dynamics within the molecular cloud. To achieve this, we utilize the state-of-the-art program known as PLUTO, combined with modules enabling us to solve the equations for magnetohydrodynamics, radiation, photo-ionization, and self-gravity. Consequently, we conduct our study to comprehend the impact of these modules on the star by running different simulations with alternating modules enabled. Finally, we compare the changes these modules induce in the star's evolution and the final properties of the massive star.Protostellar outflows alone limit stellar mass growth in an accretion scenario with a finite mass reservoir. Radiative feedback dominates the latter stages of stellar formation around the zero-age main sequence. Specifically, we observe that radiation forces restrain gravitational infall toward the disk, affect the magneto-gravito-centrifugal equilibrium, and completely halt stellar accretion, resulting in a star with a mass of approximately 45 M? at around 100 kyr. While photoionization widens the bipolar outflow cavities and reduces the gravitational infall momentum by about 50%, it does not limit stellar mass accretion until later stages, resulting in a star with a mass of approximately 45 M? at around 120 kyr. In contrast, simulations that do not implement radiative interactions from these modules continue to accrete material at this time, and we report masses of approximately $75M?$.

Keywords: stars: formation - stars: massive, stars: winds, outflows - Methods: numerical - magnetohydrodynamics (MHD).

References

[1] Kuiper, R., Yorke, H. W., & Mignone, A. (2020). Makemake+ Sedna: a continuum radiation transport and photoionization framework for astrophysical newtonian fluid dynamics. The Astrophysical Journal Supplement Series, 250(1), 13.

[2] Oliva, A., & Kuiper, R. (2023). Modeling disks and magnetic outflows around a forming massive star-II. Dynamics of jets from massive protostars. Astronomy & Astrophysics, 669, A81.

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[I] Martes/Tuesday 20, 13:30-14:00, Room/aula 2, session: Física / Physics 1

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Efficient computation of the overpartition function and applications[I]

Communication / Ponencia

BARQUERO SÁNCHEZ, ADRIÁN ALBERTO[II]

Costa Rica

The representation of integers as sums of special families of integers has been a central topic in number theory since antiquity. In this talk we will look at one such way of representing integers, called overpartitions. In particular, we develop a method to compute efficiently the overpartition function, which counts the number of overpartitions of a given integer and we use our method to establish many new congruences similar to the ones found by Ramanujan for the partition function. This is joint work with Gabriel ColladoValverde, Nathan C. Ryan, Eduardo Salas-Jimenez, Nicolás Sirolli and Jean Carlos Villegas-Morales.

[I]Viernes/Friday 23, 09:30-10:00, Room/aula 4, session: Teoría de números y combinatoria / Number Theory and combinatory 1

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Análisis de sentimientos con PLN para el problema de deserción escolar en nivel universitario[I]

Communication / Ponencia Virtual

BERNÁBE LORANCA, MARIA BEATRIZ[II] BELTRÁN MARTÍNEZ, BEATRIZ[III]
MARTÍNEZ GUZMÁN, GERARDO[IV] GONZÁLEZ VELÁZQUEZ, ROGELIO[V]

México

La educación es importante para un desarrollo individual y social. Sin embargo, para que la educación sea de calidad requiere del cumplimiento de requisitos y de ciclos de escolaridad que aseguren la obtención de los conocimientos necesarios dependiendo de la edad del estudiante. Un problema que ha sido identificado en los distintos niveles educativos es la deserción escolar, que en términos amplios se refiere al abandono prematuro del sistema educativo. Tal renuncia generalmente comienza como un alejamiento gradual, pero recurrente, que culmina en la separación total de los estudios. Los factores que involucran la deserción escolar no excluyen ninguna etapa del ciclo educativo, por el contrario, se hacen presentes desde los primeros niveles de la educación infantil hasta los últimos [Moschner and Britos, 2020].El término de deserción se encuentra relacionado con el fracaso del estudiante en terminar un determinado plan de estudios e incluso con el bajo rendimiento en los cursos. Esta definición puede ser prematura si no se consideran otros aspectos porque depende del enfoque que se tenga, el cual puede ser individual (refiriéndose al institucional), entonces, la deserción puede entenderse como el abandono de los estudios sin haber sido concluidos, pero bien puede ser una mejor alternativa o transición hacia sus verdaderos objetivos que han sido recién descubiertos, caso contrario puede ser un fracaso [Valero Cajahuanca et al., 2022, Pascua-Cantarero, 2016].La deserción universitaria puede ser causada por una variedad de factores que afectan a los estudiantes y consecuentemente los llevan a abandonar sus estudios. Algunos de los factores que contribuyen a la deserción universitaria incluyen problemas económicos, falta de apoyo familiar, dificultades académicas, problemas de salud, falta de motivación, responsabilidades familiares y laborales, falta de sentido de pertenencia, problemas de adaptación, problemas de planificación, etc. En este punto, no se señalan los factores puntuales y es aquí donde este trabajo se sitúa: para identificar factores específicos, se procede a obtener información de las opiniones de los usuarios en Twitter para posteriormente organizarla y categorizarla con Procesamiento de Lenguaje Natural (PLN) y realizar un análisis de sentimientos [Qiu et al., 2020].Con la información disponible en la red, es posible realizar distintos estudios como de tendencias o estimaciones, entre otros. Entre las técnicas más populares para abordar problemas de esta magnitud, se encuentran aquellas enmarcadas dentro PLN, entendida como una rama de la Inteligencia Artificial que ayuda a las computadoras a entender, interpretar y manipular el lenguaje humano, y al mismo tiempo, busca establecer la brecha entre la comunicación humana y el entendimiento de las computadoras, así, PLN toma elementos prestados de muchas disciplinas, incluyendo la ciencia de la computación y la lingüística computacional [Chowdhary, 2020].

Una de las aplicaciones del PLN es el análisis de comentarios de Twitter respecto a un tema específico. En este artículo, se ha mirado el problema de las causas de deserción desde la perspectiva de los usuarios

[I] Miércoles/Wednesday 21, 14:30-15:00, Room/aula 1, session: Ciencia de Datos / Data Science 1

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de Twitter, de tal manera que al crear diccionarios y procesarlos con un análisis de sentimientos, es posible distinguir las causas divergentes y asociarlas a las categorías que se dictan en la literatura [Belinkov and Glass, 2019].Para desarrollar el proyecto, se identificaron palabras claves del problema para proceder a descargas de Twitter. Una vez contando con información suficiente, se aplicó el algoritmo de clasificación Naive Bayes, el cual, al apoyarse en el Teorema de Bayes con una suposición de independencia entre los predictores, genera la bifurcación deseada. Naive Bayes es fácil de construir y particularmente útil para conjuntos de datos muy grandes.

Keywords: Deserción escolar, análisis de sentimientos, PLN, algoritmos de clasificación, análisis de comentarios.

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Text mining the arXiv with LLMs[I]

Communication / Ponencia

BERLIOZ, LUIS[II]

Honduras

We present a small update to an ongoing project that aims at automatically generating a glossary of all mathematical terms by applying text-mining techniques on the arXiv website. Using an established methodology that obtains training examples from the LaTeX source code of mathematical articles in the arXiv, we obtain enough data to finetune a large language model (LLM).The methodology has two independent stages that are fully described in previous work. The first stage consists of parsing the LaTeX source code in search of paragraphs labeled as definitions by the macro `\begin{definition}...\end{definition}`. The second stage uses the content of freely available websites like Planetmath (https://planetmath.org/), The Stacks project (https://stacks.math.columbia.edu/) and Wikipedia. Every article in these websites has a title and many of them contain a definition section. Each definition is annotated by searching for the title in the text of the definition. The training data produced in the first stage is used to train a binary text classifier and the data from the second stage is used to train a single-category NER model. We have successfully trained three types of model: bag-of-words, LSTMs and more recently, Transformer based LLMs.The resulting models are able to identify definitions and the terms being defined in them. In this presentation, we describe the results obtained during the training and inference process using LLMs, and compare them to previous benchmarks obtained with neural and bag-of-words methods. This includes significant improvements obtained by using transformer based models compared to LSTM networks. Lastly, the resulting dataset of mathematical terms and definitions is described, and a rudimentary search engine (https://efedequis.xyz/argot/) is showcased.

Keywords: text mining, large language models, mathematical knowledge management, natural language processing.

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[I] Miércoles/Wednesday 21, 16:00-16:30, Room/aula 1, session: Ciencia de Datos / Data Science 2

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Comparative longitudinal analysis of hormonal concentrations and morphometric measurements between bovine females and hermaphrodites during postnatal development[I]

Communication / Ponencia

BONNINI, STEFANO[II] CORAIN, LIVIO[III] GRAIC, JEAN-MARIE[IV]

Italia

The freemartin syndrome is the most common form of intersexuality in the bovine species. The goal of this study consists of analyzing bovine blood hormonal concentrations and morphometric measurements from postnatal to adultness. Specifically, we carry out a two-sample test in order to compare the trajectories of hormonal and morphometric variables over time of the two populations defined by sex. Moreover, we wish to identify the variables with respect to which the two populations differ and the time of the change point. The adopted methodology is nonparametric and based on the permutation approach. We define the multivariate and longitudinal problem as a multiple test and solve it through the application of a combined permutation test. Indeed, the problem can be broken down into several partial tests corresponding to different components of the multidimensional response and different time points (ages). A suitable combination of the p-values of the partial tests provides a test statistic for the overall testing problem.

Keywords: freemartin syndrome, permutation test, non-parametric combination.

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[I] Miércoles/Wednesday 21, 16:30-17:00, Room/aula 3, session: Análisis y Probabilidad / Analysis and Probability

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Twisted Brill-Noether Theory[I]

Communication / Ponencia

BRAMBILA-PAZ, LETICIA[II]

México

Classical Brill-Noether theory for line bundles is well understood. In this talk I will recall the main known results on the Brill-Noether Theory for vector bundles of higher rank and present the new results obtained with Peter Newstead on the Twisted BrillNoether theory.

Keywords: Brill-Noether theory, Line Bundles, Moduli Spaces, Vector Bundles.

[I]Miércoles/Wednesday 21, 11:30-12:00, Room/aula 3, session: Topología y Geometría / Geometry and Topology 2

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Robust domain decomposition methods for highcontrast multiscale problems on irregular domains[I]

Communication / Ponencia

CALVO, JUAN GABRIEL[II] GALVIS, JUAN[III]

Costa Rica

We present a domain decomposition preconditioner for second-order elliptic partial differential equations that handles coefficients with high-contrast and multiscale properties, and is suitable for irregular subdomains. We will present partition of unity functions and appropriate eigenvalue problems that enrich usual coarse spaces. We demonstrate that the condition number of the preconditioned systems is bounded with a bound that is independent of the contrast, and include selected numerical experiments that confirm the robustness of our preconditioner.

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[I] Viernes/Friday 23, 14:30-15:00, Room/aula 3, session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 3

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Cartier points of genus 3 and 4 curves[I]

Communication / Ponencia

CAMACHO NAVARRO, CATALINA[II]

Costa Rica

Let X be a smooth projective genus g curve over a field k of characteristic $p > 0$. The Torelli map associates X with its Jacobian J_X, a principally polarized abelian variety of dimension g. The map embeds the moduli space $\mathcal{M}_g$ of curves of genus g into $\mathcal{A}_g$, the moduli space of principally polarized abelian varieties of dimension g over k. In consequence, it allows us to study the stratification of $\mathcal{M}_g$ by looking at the group scheme structure of $J_X[p]$, the p-torsion part of the Jacobian. This is called the Ekedahl–Oort stratification. There are two main invariants associated to $J_X[p]$: the p-rank and the a-number. The first one is the integer f such that $\#J_X[p](k) = p^f$. The second one is the rank of the Cartier operator on $H^0(X, \Omega^1_X)$. A classic result proved by Ekedahl (1987) shows that a curve can only have a-number equal to g if $g \leq \frac{1}{2}(p^2 - p)$. This result was later improved by Re (2001) and Zhou (2017). Baker (2000) provides an alternate proof of the original result, based on the existence of what he defines as Cartier Points.We say that $P \in X(\overline{k})$ is a Cartier point if the hyperplane of regular differentials of X vanishing at P is stable under the Cartier operator. If X has a-number $0 \leq a < g$ then there is an upper bound on the number of Cartier points of X. We are interested in determining whether these bounds are attained when X is non-ordinary, and the relation to f and a.Baker's work implies that Cartier points can give information on the structure of the p-torsion part of the Jacobian. However, so far this concept remains mainly unstudied. In this paper we explore the behavior of Cartier points on non-hyperelliptic genus 3 and 4 curves. To do this, we construct a database of curves defined by quartic polynomials in the first case, and by a cubic and quartic polynomials in the second one. Then we explicitly compute the Hasse–Witt matrix using results from Kudo and Harashita (2017) and Celik et al. (2018), and classify the curves by p-rank, a-number, and number of Cartier points.

Keywords: cartier points, genus 4, a-number, p-rank, Hasse-Witt Matrix.

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[I] Viernes/Friday 23, 09:00-09:30, Room/aula 4, session: Teoría de números y combinatoria / Number Theory and combinatory 1

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On the supremum of a family of set functions[I]

Communication / Ponencia

CAMBRONERO, SANTIAGO[II] CAMPOS, JOSE DAVID[III]

Costa Rica

This talk deals with the concept of set function supremum for families of set functions in a general setting. Under different conditions on the family of set functions and the family of sets on which those functions are defined, the concept is the right choice in order to obtain the least upper bound of the family.

Keywords: set function supremum, admissibility, signed measures.

[I]Jueves/Thursday 22, 09:00-09:30, Room/aula 3, session: Análisis y Probabilidad / Analysis and Probability 2

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Quadratic variation for cylindrical martingale-valued measures[I]

Communication / Ponencia

CAMPOS, JOSÉ DAVID[II] CAMBRONERO, SANTIAGO[III]

Costa Rica

We focus on the definition of a quadratic variation for cylindrical orthogonal martingalevalued measures defined on Banach spaces. Sufficient and necessary conditions for the existence of such a quadratic variation are provided. Moreover, several properties of the quadratic variation are explored, as the existence of a quadratic variation operator. In the case of a separable Hilbert space, we delve into the relationship between our definition of quadratic variation and the intensity measures defined by Walsh (1986) for orthogonal martingale measures with values in separable Hilbert spaces.We first introduce the concept of cylindrical martingale-valued measures and study some of its properties. This concept is a hybrid between the definitions of cylindrical martingale and of martingale-measure. Indeed, in this case we have a family $(M(t, A) : t = 0, A?A)$ such that, for each $A?A, (M(t, A) : t = 0)$ is cylindrical square integrable martingale on a Banach space X and $M(t,)$ is an L 2 - valued finitely additive measure on A for each $t = 0$. Our treatment of cylindrical martingale-valued measures is centered around the concepts of (predictable) quadratic variation. In fact, the main purpose of the construction is to be able to develop a stochastic calculus for cylindrical martingale-valued measures which admit such a quadratic variation. The talk is based on a join work with C. A. Fonseca-Mora 3 and D. Mena 4

Keywords: cylindrical martingale-valued measures, quadratic variation, random measures, vector measures.

[I] Jueves/Thursday 22, 09:30-10:00, Room/aula 3, session: Análisis y Probabilidad / Analysis and Probability 2

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Identification of Dynamical Systems: An Integrated Approach Based on Sparsity, Regularization and Low Rank Approximation[I]

Communication / Ponencia

CARDONA MEJÍA, KERIN OMAR[II]

Honduras

Constructing models based on data is an essential part of applications in science and engineering. Systems identification consists of a set of techniques developed to build mathematical models of dynamical systems using observed data.Due to the breakthrough in computer science, high-dimensional data has emerged in many fields of science, engineering, humanities, and economics. Faced with this, sparse models represent one of the best alternatives.The main idea is to assume that the parameter vector contains many exactly zero or sufficiently small components. In this project, applications of some theoretical and computational techniques presented in [Vides, 2019, Vides, 2021] are presented, for the regularized and sparse approximation of dynamical systems based on data in the sense proposed by [Markovsky, 2006, Markovsky, 2019].The research addressed in this project covers both linear and non-linear models, with applications in engineering, science and econometrics. Specifically, the properties of regularization and sparsity are integrated into the approximation of the parameters, with emphasis on the approximation of low rank.It is important to note that the results obtained are independent of a specific representation of the system and do not assume input-output data partitions. These aforementioned methodologies are subjected to comparison through numerical simulations and real-world dataset applications.

Keywords: System identification, autoregressive models, low rank approximation, sparsity and regularization, time series analysis.

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[I] Miércoles/Wednesday 21, 14:30-15:00, Room/aula 4, session: Modelación Matemática / Mathematical Modeling 1

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Banach spaces-based mixed finite element methods for a model of poroelasticity coupled with the heat equation[I]

Communication / Ponencia

CAREAGA, JULIO[II]

Chile

A new banach-based mixed finite element formulation for a model of poroelasticity describing a homogeneous porous medium coupled with a heat equation is presented. The poroelasticity equations are based on the Biot's model for a mixture of incompressible grains and interstitial fluid, and the heat of the fluid is modeled by a stationary convection-diffusion equation. Among the unknowns of the mixed finite element approach are the non-symmetric pseudostress tensor, the fluid velocity, a Darcy-type of velocity, the pressure, and temperature. The weak formulation is analyzed by means of three coupled systems written in saddle-point configurations comprising formulations of the perturbed type. A result of existence and uniqueness of solutions is shown by employing a fixed-point strategy and with the help of the Babuška-Brezzi theory and Banach theorem. Furthermore, we utilize appropriate finite-dimensional subspaces to approximate the three systems using associated mixed finite element methods. We address the well-posedness of the coupled scheme through a fixed-point approach, establishing the discrete version of the existence and uniqueness result similarly to the continuous case. Finally, we present numerical findings demonstrating the efficiency of the proposed model and the complete numerical scheme, validating the theoretical convergence rates.

Keywords: Poroelasticity, heat equation, perturbed saddle-point, mixed finite elements, fixed point problem.

[I]Martes/Tuesday 20, 14:30-15:00, Room/aula 4, session: Métodos de Elementos Finitos / Finite Element Methods 1

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Some properties of Morava's group of extensions[I]

Communication / Ponencia

CHICAS REYES, GABRIEL ALEXANDER[II]

El Salvador

Ext groups have a central place in homological algebra since the early origins of this discipline. The relationship between Ext and group extensions is also well-known and due to Nobuo Yoneda. In this paper, we start with an overview of the classical theory of extensions of abelian groups, followed by the description of a special example, namely Ext(Q,Z). This example has a natural relationship with J. Morava's theory of "rigidified extensions" (2013). After studying Morava's ideas in detail, we present some original computations with these groups.

Keywords:
homological algebra, extension groups, topological groups, solenoids.

References

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[I] Miércoles/Wednesday 21, 14:30-15:00, Room/aula 3, session: Álgebra / Algebra

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Modelos lineales parciales aditivos con error simétrico autorregresivo para datos de series temporales[I]

Plenary Talk / Conferencia Plenaria

CHOU CHEN, SHU WEI[II]

Costa Rica

Estos modelos se destacan por ser regresión semi-paramétrica, ofreciendo flexibilidad en el ámbito de la modelación. En la presente charla, se abordan estos modelos con errores autorregresivos simétricos, utilizando regresión penalizada mediante splines aplicados a datos de series temporales. Se discuten los detalles del modelo, su estimación, y se presentan las limitaciones al realizar pronósticos, así como las propuestas para prever valores a futuro. Finalmente, se exponen varias aplicaciones utilizando estos enfoques.

[I]Martes/Tuesday 20, 11:00-12:00, Auditorium / Auditorio, session: Opening Plenary Talk / Conferencia Inaugural

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Higgs bundles and complex hyperbolic structures on disk bundles[I]

Communication / Ponencia

COLLIER, BRIAN[II]

Estados Unidos

In this talk I will describe how certain complex variations of Hodge structure are holonomies of complex hyperbolic structures on bundles over a Riemann surface. Our key tool for constructing the geometric structure and parameterizing the space of geometric manifolds which arise in this fashion are Higgs bundles. This is based on joint work with Zach Virgilio.

Keywords: Higgs Bundles, Hyperbolic Structures, Moduli Spaces, Vector Bundles.

[I]Miércoles/Wednesday 21, 11:00-11:30, Room/aula 3, session: Topología y Geometría / Geometry and Topology 2

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Analyzing Bioconvection: An Application of Banach-Based Mixed Finite Element Methods[I]

Communication / Ponencia

COLMENARES, ELIGIO ANTONIO[II]

Chile

In this presentation, we introduce a new fully-mixed finite element approach for a stationary generalized bioconvection model, integrating Navier-Stokes equations with a cell conservation equation. This model characterizes the hydrodynamics and microorganism concentration within a viscous, incompressible culture fluid, where viscosity varies with concentration. Our method incorporates the velocity gradient, the associated Bernoulli stress tensor, concentration gradient, and an adapted vectorized Bernoulli tensor to handle the concentration's Robin boundary condition. The resulting mixed variational formulation includes these four additional unknowns alongside the original velocity and concentration variables. We reformulate this formulation as a fixed point equation and employ Shauder and Brouwer theorems to analyze solvability for both continuous and discrete schemes. Specifically, we adopt Raviart-Thomas spaces for the Bernoulli tensor and its vector version for the heat equation, employing piecewise polynomials for velocity, concentration, and their gradients. Finally, we derive optimal a priori error estimates and present numerical examples to showcase the fully-mixed scheme's performance, affirming the theoretical rates of convergence.

Keywords:

Bioconvection model, Boussinesq equations, fully–mixed formulation, fixed point theory, finite element methods, a priori error analysis.

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[I] Martes/Tuesday 20, 14:00-14:30, Room/aula 4, session: Métodos de Elementos Finitos / Finite Element Methods 1

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Measuring, Simulation and Evaluation of Room Impulse Responses Associated with Acoustic Fields with Rectangular Geometry[I]

Communication / Ponencia

DELGADO CASTRO, ALEJANDRO[II] ABARCA LÓPEZ, JOSUÉ[III]

Costa Rica

In this work, the acoustics of a room with rectangular geometry are studied by means of the analysis of its impulse responses. The acoustic parameters obtained from these in situ measurements are compared with thoes extracted from a simulation software, where the linear equations associated with sound propagation models are solved using numerical methods.A comparison between the real measurements and the simulations is then stablished in order to determine the impact of aproximating an omnidirectional source with a directional one, and to evaluate the benefit of ratating a directional source as a way to mimick an omnidirectional speaker.

Keywords: Room acoustics, impulse responses, acoustic measurements, simulation of acoustic fields, acoustic parameters

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[I] Jueves/Thursday 22, 15:30-16:00, Room/aula 2, session: Computación Científica / Scientific computing

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Multivariate Control Chart with Guaranteed IC performance and Cautious Parameter Learning[I]

Communication / Ponencia

DÍAZ PULIDO, ARTURO JAVIER[II] CORDERO FRANCO, ÁLVARO EDUARDO[III]
TERCERO GÓMEZ, VICTOR GUSTAVO[IV]

México

Quality management is of utmost importance in modern manufacturing and service industries, and Statistical Process Monitoring (SPC) has emerged as a powerful tool for enhancing process quality. While control charts have been extensively used for univariate data to detect process shifts and out-of-control points, many real-world scenarios involve multiple interrelated variables that impact process performance. To address this, we propose a multivariate SPC technique to effectively monitor and improve process quality. In this work, we present the development of a multivariate CUSUM control chart with guaranteed IC (in-control) performance and cautious parameter learning. The developed control chart exhibits good results in detecting moderate to large shifts in process location. To achieve this, we employ guaranteed IC performance, ensuring that false alarms are minimized under parameter estimation. Additionally, we adopt cautious parameter learning strategies to handle unknown parameter variations effectively. Our approach, validated through simulation and utilizing R software, proves highly effective in maintaining control and detecting significant changes in process location.

Keywords: Multivariate SPC, Cautious Learning, Guaranteed IC performance, Distribution-free.

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[I] Martes/Tuesday 20, 13:30-14:00, Room/aula 1, session: Estadística Multivariada / Multivariate Statistics 1

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Comparación de estimadores robustos para los parámetros de una distribución Beta.[I]

Communication / Ponencia

DUARTE RIVERA, ROBERTO CARLOS[II]

Honduras

En este articulo implementamos dos estimadores robustos aplicados a la estimación de los parámetro de una distribución Beta. El primero es un estimador basado en la transformación integral de probabilidad (MI) y el segundo el estimador de divergencia de potencia de densidad mínima (MDPDE). Ambos estimadores resultan ser casos particulares de M-estimadores lo cual nos permite determinar su distribución asintótica, con esto podemos realizar una comparación sistemática de los estimadores robustos y los de máxima verosimilitud en términos de eficiencia relativa, error cuadrático medio y cubrimiento empírico bajo distintos escenarios en los cuales las muestras contienen cierto porcentaje de contaminación.Además a través de la función de influencia estudiamos la robustez de los estimadores obtenidos y se muestran algunas aplicaciones con datos reales.

Keywords: Estimación Robusta, Transformación integral de probabilidad, Divergencia de potencia de densidad mínima, Función de influencia.

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[I] Miércoles/Wednesday 21, 11:30-12:00, Room/aula 1, session: Estadística Computacional / Statistical Computing

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FroImPro Toolbox: Aplicaciones de la norma de Frobenius en el procesamiento de imágenes y videos[I]

Communication / Ponencia

FALLAS-MONGE, JUAN JOSÉ[II] SOTO-QUIRÓS, JUAN PABLO[III]
CHAVARRÍA-MOLINA, JEFFRY[IV]

Costa Rica

FroImPro Toolbox es un conjunto de funciones desarrolladas en MATLAB por parte de los autores de la ponencia, para resolver un conjunto de problemas en procesamiento de imágenes y video. Estas aplicaciones son generadas mediante problemas de optimización cuya función objetivo se escribe en términos de la norma de Frobenius. En concreto, el toolbox abarca las aplicaciones de: construcción de filtros para remover ruido de una imagen, factorización no negativa de matrices aplicada a la reconstrucción de imágenes, aproximación de la matriz de rango bajo mediante el algoritmo BRP y su aplicación a la compresión de imágenes, algoritmo GoDec aplicado a la detección de variaciones en un conjunto de imágenes y, finalmente, algoritmo K-SVD aplicado a la reconstrucción de imágenes con pixeles perdidos. El objetivo de la presentación es divulgar las bondades del toolbox, que es de acceso libre, mediante la presentación de ejemplos concretos de las diferentes aplicaciones mencionadas previamente.

Keywords: Toolbox, Matlab, procesamiento de imágenes y videos, norma de frobenius.

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[I] Jueves/Thursday 22, 16:00-16:30, Room/aula 2, session: Computación Científica / Scientific computing

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Stochastic integration with respect to infinite dimensional semimartingales[I]

Communication / Ponencia

FONSECA-MORA, CHRISTIAN[II]

Costa Rica

This talk develops some aspects of stochastic integration in locally convex spaces with respect to infinite dimensional semimartingales.We start by providing a general construction for a real-valued stochastic integral where we assume no particular properties on the locally convex space nor on the semimartingales. Our approach follows a non-standard construction via tensor products. Later, we restrict our attention to the case when the semimartingales takes values in a space of distributions (more generally, in the dual of a nuclear space) and provide a characterization of the integrands as locally bounded predictable processes. Further properties of the stochastic integral as stochastic integration by parts and stochastic Fubini theorem are discussed. An extension of the theory to vector-valued stochastic integrals for semimartingales in spaces of distributions is also given. We finalize with some applications of our theory to the existence and uniqueness of solutions to linear stochastic evolution equations in spaces of distributions

Keywords: stochastic integral, semimartingale, locally convex space.

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[I] Jueves/Thursday 22, 10:00-10:30, Room/aula 3, session: Análisis y Probabilidad / Analysis and Probability 2

[II] University of Costa Rica, School of Mathematics, Costa Rica, christianandres.fonseca@ucr.ac.cr

Analysis of the forced propensity to migrate in Honduras using machine learning methods[I]

Communication / Ponencia

FUNEZ IZAGUIRRE, WILLIAM ALBERTO[II] OCAMPO MERAZ, HENRY DAVID[III]

Honduras

In this work analyzes the problem of forced migration in Honduras, which is a complex phenomenon involving multiple political, economic and social factors. This analysis is based on the database of the Migration Early Warning System (SAT-M) of World Vision Honduras (WVH). For this purpose, data analysis and machine learning techniques such as logistic regression, principal component analysis (PCA), decision tree and artificial neural networks are used in order to estimate the SAT-M Migration Propensity Index, and thus, understand the main causes of forced migration in Honduras. Data analysis and numerical experiments are performed in R and Python languages, using specialized libraries for data analysis and visualization and efficient implementation of machine learning models. The results obtained allow a better understanding of the phenomenon of forced migration in Honduras and offer useful tools for decision making and the formulation of public policies that contribute to improve this problem.

Keywords: Migration, machine learning, deep learning, data analisys.

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[I] Miércoles/Wednesday 21, 15:30-16:00, Room/aula 1, session: Ciencia de Datos / Data Science 2

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Complexity in Networks of Piecewise Contractive Transformations[I]

Communication / Ponencia

FUNEZ IZAGUIRRE, WILLIAM ALBERTO[II]

México

Dynamic complexity is a topic of great significance in the field of dynamical systems theory and nonlinear dynamics. Networks of piecewise contractive transformations are a type of mathematical model used to describe the evolution of complex systems in biological contexts. In this context, complexity refers to the diversity and richness of behaviors that can emerge in these networks. As complexity increases, systems exhibit emergent phenomena, non-trivial properties, and unpredictable behaviors. The presence of multiple stable states, bifurcations, strange attractors, and phase transitions becomes evident as the complexity of these networks grows. Piecewise contractive transformation networks are particularly fascinating due to their ability to capture the nonlinearity and nonuniformity of real dynamical systems. These networks consist of a collection of transformation functions that act on a state space, where each function is contractive within a subset of the space. This contraction property ensures that the network tends to bring states closer to a set of stable attractors. Understanding complexity in these networks is fundamental for analyzing and predicting complex phenomena in a wide range of scientific disciplines. In this talk, we will present the complexity behavior of a low-dimensional network of contractive transformations as a function of the contractivity parameter, and we will relate this behavior to the structure of attractors. This exercise has allowed us to generate a series of conjectures that we are currently working on.

Keywords: Keywords: Dynamic complexity, nonlinear dynamic systems, attractors.

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[I] Miércoles/Wednesday 21, 09:30-10:00, Room/aula 2, session: Sistemas Dinámicos y Teoría Ergódica /Dynamical Systems and Ergodic Theory 1

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Aspectos relacionados con la permanencia y la graduación del estudiantado: el caso de la Escuela de Estadística de la Universidad de Costa Rica[I]

Communication / Ponencia

GALLARDO, EUGENIA[II]

Costa Rica

Ponencia (30 minutos) Monge-Zúñiga, Adriana[1] Gallardo-Allen, Eugenia[2] Costa Rica Este trabajo tiene como propósito analizar la permanencia y la graduación del estudiantado de la carrera de bachillerato en Estadística con relación a diversas características sociodemográficas y académicas La información que se analizará corresponde al periodo 2013-2022. Los datos son tomados del Sistema de Información Institucional de Autoevaluación y Gestión de la Calidad (SIIAGC) de la Universidad de Costa Rica. Las variables incluidas en el análisis son: edad, sexo, provincia, cantón y distrito de procedencia, tipo de ingreso (primer ingreso, traslado), nota de admisión, colegio de procedencia, los años de duración para graduarse, graduación de honor y si es estudiante exclusivo de la carrera, rendimiento académico. Para realizar el análisis se aplicarán técnicas de estadística multivariada como lo son: análisis de sobrevivencia, regresión de cox y árboles de decisión, entre otras. [1] Universidad de Costa Rica, Escuela de Estadística [2] Universidad de Costa Rica, Escuela de Estadística

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[I] Miércoles/Wednesday 21, 14:00-14:30, Room/aula 1, session: Ciencia de Datos / Data Science 1

[II] Universidad de Costa Rica, Costa Rica, eugenia.gallardo@ucr.ac.cr

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Twofold saddle-point formulation of Biot poroelasticity with stress-dependent diffusion[I]

Communication / Ponencia

GÓMEZ VARGAS, BRYAN ANDRÉS[II]

Costa Rica

In this talk, we present a new stress/total-pressure formulation for poroelasticity that incorporates the coupling with steadynonlinear diffusion modified by stress. This nonlinear problem is written in mixed-primal form, which combines a perturbedtwofold saddle-point system with an elliptic problem. We analyze the continuous formulation within the framework of abstractfixed-point theory and Fredholm alternative for compact operators. A mixed finite element method is proposed, and its stabilityand convergence are rigorously analyzed. We also provide a few representative numerical examples to illustrate the effectivenessof the proposed formulation. The resulting model can be used to study the steady case of waste removal in the brain, providinginsight into the transport of solutes in poroelastic structures under the influence of stress.

Keywords: stress-altered diffusion, poroelasticity, perturbed saddle-point, mixed finite elements.

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[I] Jueves/Thursday 22, 13:30-14:00, Room/aula 2, session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 2

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The Effects of Economic Shocks on Heterogeneous Inflation Expectations[I]

Communication / Ponencia

GOMEZ-RODRIGUEZ, FABIO[II]

Costa Rica

We use a functional approach to study the effects of economic shocks on the distribution of U.S. household inflation expectations. Contractionary monetary policy shocks have no effect on average short- and medium-run inflation expectations. The impact on the average, however, masks distributional effects, as more households expect negative inflation and fewer expect moderate inflation. Government spending shocks raise average short-run inflation expectations by increasing the proportion of households with high inflation expectations.Personal income tax shocks raise only medium-run inflation expectations. Gasoline price shocks increase average inflation expectations for both short-run and medium-run, but with different distributional consequences.

Keywords: Inflation expectations, household survey, functional autoregression, functional impulse responses, transmission of economic shocks.

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[I] Martes/Tuesday 20, 14:30-15:00, Room/aula 1, session: Estadística Multivariada / Multivariate Statistics 1

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Holography and Mathematics[I]

Communication / Ponencia

GONZÁLEZ VALENZUELA, AMY GABRIELA[II] GONZÁLEZ GONZÁLEZ, RODRIGO[III]

México

The general objective is to describe mathematically the reproduction process of a hologram, special surface on which a three-dimensional image created by applying a specific type of laser beam is printed, transmitted or reflected. In particular, the reproduction phase of a transmission hologram is briefly described, whose model is the well-known wave equation with a solution given in the Kirchhoff form, the process is geometrically illustrated and the importance of the Complex Analysis in order to obtain a conclusion about it is observed.

Keywords: hologram, laser, wave equation, Kirchhoff, stationary phase.

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[I] Martes/Tuesday 20, 15:30-16:00, Room/aula 2, session: Física / Physics 2

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Secuencias multicomplejas de malabares y la función de partición de Kostant[I]

Plenary Talk / Conferencia Plenaria

HARRIS, PAMELA[II]

Estados Unidos

Las secuencias multicomplejas de malabares son generalizaciones de secuencias de malabares (las cuales describen lanzamientos de pelotas a alturas discretas) que especifican una configuración inicial y terminal de pelotas y permite tener múltiples pelotas a cualquier altura discreta particular. Por otro lado, la función de partición de Kostant es una función vectorial que cuenta el número de formas en que se puede expresar un vector como combinación lineal entera no negativa de un conjunto fijo de vectores. ¿Qué tienen en común estas dos familias de objetos combinatorios? ¡Ven a esta charla para averiguarlo!

[I]Jueves/Thursday 22, 11:00-12:00, Auditorium / Auditorio, session: Plenary Talk 2 / Conferencia plenaria 2

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Quantifying uncertainty of a geometric goodness of fit measure[I]

Communication / Ponencia

HERNÁNDEZ AVILA, EDGAR JAVIER[II]

Costa Rica

This study provides formal statistical validation of a geometric goodness of fit measure, by employing a hypothesis test and a global envelope, to determine whether a data point cloud is a complete spatial randomness process (CSR). We use the alpha shape complex of a data point cloud in $\mathbb{R}^2$ to generate a map of this measure. Then we establish a null hypothesis which corresponds to a CSR process, using two different test statistics and Monte Carlo tests. One of these test statistics is used to build a global envelope that delimits a region within which the null hypothesis cannot be rejected. We provide some theoretical and datasets examples to illustrate this procedure.

Keywords: complete spatial ramdoness process, goodness of fit, hypothesis test, alpha shape complex, Monte Carlo tests.

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[I] Jueves/Thursday 22, 16:00-16:30, Room/aula 1, session: Ciencia de Datos / Data Science 5

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Algorithms, efficient implementations, and their utility in the industry: Generalized Vehicle Routing Problem (GVRP)[I]

Communication / Ponencia

HERNÁNDEZ GÓMEZ, FERNANDO JOSÉ[II] PALACIOS LÓPEZ, WILMER JOSÉ[III]

Nicaragua

The Generalized Vehicle Routing Problem (GVRP) has experienced significant development in the field of Operations Research, and its impact on the industry is relevant both in logistics and transportation. This variant of the Classic Vehicle Routing Problem (VRP) groups customers into clusters and only allows visiting one customer per group. Although it has been less studied, the GVRP involves determining optimal routes for vehicles that must serve various locations with constraints such as time windows, vehicle capacity, and types of services, among others.In this research, heuristic algorithms based on successive approximations are proposed and applied to address the GVRP, along with meta-heuristics and techniques such as ant colony optimization, tabu search, and genetic algorithms, among others. Moreover, generalizations have been proposed that consider multiple depots and heterogeneous demands. Additionally, artificial intelligence and machine learning are incorporated to adjust routes in real-time, and environmental aspects are explored, considering carbon emissions and energy consumption.The integration of emerging technologies, such as the Internet of Things and vehicular communication, has improved the coordination and efficiency of routing. Metaheuristic, heuristic, automation, and artificial intelligence approaches have demonstrated substantial improvements in efficiency and solution quality, reducing distance and delivery time.In conclusion, the GVRP has evolved towards more innovative and sustainable approaches, combining generalizations, advanced optimization techniques, machine learning, and emerging technologies. It continues to be an area of interest for the scientific and industrial community, aiming to optimize resources and improve logistics and transportation in the future.

Keywords: Algorithms, Heuristics, Metaheuristics, Optimization, Vehicle Routing, GVRP (Generalized Vehicle Routing Problem).

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[I] Jueves/Thursday 22, 16:30-17:00, Room/aula 4, session: Optimización / Optimization

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Secuencias multicomplejas de malabares y la función de partición de Kostant[I]

Plenary Talk / Conferencia Plenaria

HARRIS, PAMELA[II]

Estados Unidos

Las secuencias multicomplejas de malabares son generalizaciones de secuencias de malabares (las cuales describen lanzamientos de pelotas a alturas discretas) que especifican una configuración inicial y terminal de pelotas y permite tener múltiples pelotas a cualquier altura discreta particular. Por otro lado, la función de partición de Kostant es una función vectorial que cuenta el número de formas en que se puede expresar un vector como combinación lineal entera no negativa de un conjunto fijo de vectores. ¿Qué tienen en común estas dos familias de objetos combinatorios? ¡Ven a esta charla para averiguarlo!

[I]Jueves/Thursday 22, 11:00-12:00, Auditorium / Auditorio, session: Plenary Talk 2 / Conferencia plenaria 2

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Regional and local trend significance of precipitation and temperature extremes in Central America: the problem of spatial correlation[I]

Communication / Ponencia

HIDALGO, HUGO G.[II]

Costa Rica

Climate change can bring trends, not only in the annual averages of precipitation (P) and temperature (T), but also in the extreme events at daily or shorter time scales. For example, it has been found that in the CIGEFI meteorological station there are significant increasing trends in:

(a) percentage of warm nights,

(b) percentage of warm days,

(c) annual minimum of the daily maximum temperature, and

(d) annual maximum of the daily maximum temperature.

Since a local urban station as this, can be affected by other factors besides climate change, such as the Òheat islandÓ effect, we worked with spatial P and T data from the region. However, gridded data or relatively close station data have high spatial correlation and trend significance must be assessed with caution. For this reason, we used a trend significance identification system based of the Man-Kendall test and Monte Carlo simulations. We showed the results for spatial high-resolution datasets known as CHIRPs and CHIRTs. Many T indices showed global (i.e. regional) significance, while P extreme indices show less significant trends. This work is of key significance for the assessment of possible impacts of extreme events associated with climate change in the region.

Keywords: Negishi approach, Banach spaces, Banach manifolds, singular economies.

[I] Viernes/Friday 23, 09:00-09:30, Room/aula 2, session: Modelos Estadísticos / Statistical Modeling 2

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Dynatomic Galois groups for a family of quadratic rational maps[I]

Communication / Ponencia

LACY MORA, ALLAN[II]

Costa Rica

For every nonconstant rational function ? ? Q(x), the Galois groups of the dynatomic polynomials of ? encode various properties of ? that are of interest in the subject of arithmetic dynamics. We study here the structure of these Galois groups as ? varies in a particular one-parameter family of maps, namely the quadratic rational maps having a critical point of period 2. In particular, we provide explicit descriptions of the third and fourth dynatomic Galois groups for maps in this family. This is joint work with David Krumm.

[I]Viernes/Friday 23, 10:00-10:30, Room/aula 4, session: Teoría de números y combinatoria / Number Theory and combinatory 1

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Prevalence of cardiometabolic risk in a national sample of Costa Rican youth using the waist-height anthropometric indicator[I]

Communication / Ponencia

LÓPEZ LÓPEZ, ERASMO[II]

Costa Rica

Central obesity is known as an indicator of cardiometabolic risk, but better anthropometric measures than Body Mass Index (BMI) are needed to detect it. Waist-to-height ratio (WHtR) is an indicator of central adiposity and a strong predictor of cardiometabolic risk. Objective: To determine the prevalence of cardiometabolic risk in a representative sample of Costa Rican children and adolescents. Patients and Method: Cross-sectional and descriptive study carried out with 2,684 students from 64 educational centers in Costa Rica. Validated questionnaires were applied to the students and their weight, height, and waist circumference were determined. Weight and body fat percentage of the students were determined with a Tanita model SC-331 S (without column). Height was measured with a SECA stadiometer model 217. The abdominal circumference was estimated using a tape measure. BMI and WHtR were calculated for each participant. The behavior of the indicator WHtR was analyzed with logistic regression models. All procedures were approved by the Ethics Committee of INCIENSA. Results: There was a strong and positive correlation between waist circumference and BMI ($r = 0.748$, $p < 0.001$, 56% of shared variance), and a positive and moderate correlation between WHtR and BMI ($r = 0.611$, $p < 0.01$, 37% of shared variance). Conclusions: A third part of the student population of elementary, middle, and high schools (31.8%) is at cardiovascular and metabolic risk

Keywords: Cardiometabolic Risk, Waist-to-Height Ratio, Children, Adolescents.

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[I] Jueves/Thursday 22, 10:00-10:30, Room/aula 2, session: Modelos Estadísticos / Statistical Modeling 1

[II] Colegio Técnico Profesional de Upala, Costa Rica, erasmolopezlopez@gmail.com

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Early unveiling of coronary stenosis by no invasive mean[I]

Communication / Ponencia

LÓPEZ-ESTRADA, JESÚS[II]

México

Coronary Artery Disease (CAD), the most prevalent form of heart disease, results from the formation of atherosclerotic plaques within the coronary arteries, causing heart attacks and leading to 360,000 annual deaths in the US (Cecil Essentials of Medicine E-Book, Elsevier, Health Sciences, 2021.Sect.2 Chap.8). Diagnosis before symptom onset, typically a heart attack, is challenging. Traditional detection methods for coronary stenosis are invasive, such as fluoroscopy femoral catheterization or multidetector computed tomography. So, the problem of identifying an obstruction within a fluid duct has several applications, one of which is in medicine, where the presence of stenosis in coronary vessels poses a life-threatening disease. In this talk, we present a continuous setting and study the inverse problem of identifying an obstruction contained in a 2D duct for Stokes viscous flow, which become turbulent post obstruction and hitting the boundary (modeling with Dirichlet and Navier-slip boundary conditions), generating an acoustic wave. To be precise, using acoustic wave measurements at certain points on the exterior of the duct, we can identify the location, extent, and height of the obstruction. Thus, our framework offers an external approach to solving this inverse-obstacle problem. Synthetic examples are used to verify the effectiveness of the proposed numerical formulation.

[I] Jueves/Thursday 22, 09:30-10:00, Room/aula 4, session: Matemática Biológica / Biomathematics 2

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Extensions of infinite dimensional modules based on amenable bases and related topics[I]

Short course / Curso corto

LOPEZ-PERMOUTH, SERGIO ROBERTO[II]

Estados Unidos

The workshop will consist of three parts:
1. Basis notions of amenability, congeniality, and simplicity of bases.
2. Amenable and simple bases over polynomial algebras.
3. Amenable and simple bases over non-commutative algebras with emphasis on graph-magma algebras.

Keywords: amenable bases, congenial bases, simple bases, algebras of polynomials, graph-magma algebras.

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[I] Martes/Tuesday 20, 15:30-16:00, Room/aula 3, session: Álgebra / Algebra - Tutorial

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Vaccine Efficacy Estimation Quantified by a Mathematical Model[I]

Communication / Ponencia

LORÍA, JENNIFER[II]

Costa Rica

The objective of this talk is to analyze the sensitivity of the estimated vaccine efficacy (EV) in relation to the corresponding clinical trial (CE). More precisely, using a simple mathematical model, we aim to exhibit the existence of a strong sensitivity in the estimation of vaccine efficacy in relation to the difference between the moment in which the clinical study begins and the maximum intensity of the outbreak.

Keywords: Estimated vaccine efficacy, Sensitivity, Deterministic models.

References

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[I] Jueves/Thursday 22, 10:00-10:30, Room/aula 4, session: Matemática Biológica / Biomathematics 2

[II] CIMPA, UCR y Escuela de Matemática, Universidad de Costa Rica, Costa Rica, jenniferdelosange.loria@ucr.ac.cr

On the solution of some elliptic systems of partial differential equations of the Schrödinger type[I]

Communication / Ponencia

MACIAS MEDINA, JORGE SIGFRIDO[II] DELGADO, BRICEYDA[III]
GALLEGOS, ARMANDO[IV]

México

Elliptic partial differential equations are important in various areas of mathematical physics. As examples, we can mention the classical Poisson's and Laplace's equations, as well as the time-independent version of Schrödinger's equation. In this talk, we will consider the latter system in two spatial dimensions. Advection will be included in the form of singular space-dependent coefficients. The mathematical model extends the classical time-independent Schrödinger equation in polar coordinates, and the purpose of the talk will be to derive a transmutator operator for that system. The results will be as general as possible. In particular, we will be investigate the bi-axially symmetric Helmholtz equation and will construct a transmutation operator for that system.

Keywords: Transmutator operators, Schrödinger equation, Time-independent partial differential equations, bi-axially symmetric Helmholtz equation.

References

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[I] Martes/Tuesday 20, 16:00-16:30, Room/aula 2, session: Física / Physics 2

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Effect of social food modeling with healthy virtual models on school-age children's selection of healthy and unhealthy food and drink items[I]

Communication / Ponencia

MACÍAS MEDINA, NÉSTOR EDGARDO[II]

México

Child obesity is a significant issue in Mexico, primarily caused by consuming unhealthy foods and beverages. Previous research showed the presence of peer-influenced children´s food choices. The present study aimed to investigate whether school-age children's food selections changed with the exposition to a healthy virtual peer. For this, we used Minecraft video game in an elementary school in Mexico, conducting two similar experiments. The first experiment involved twenty virtual food items and four drinks, while the second experiment included thirty-two virtual food items and the same drinks. In both experiments, half of the options were healthy, each with an option unhealthy counterpart. Thirteen 5th-grade students participated in Experiment 1, and twelve students in Experiment 2 in a design experimental ABA´B´ where A condition was taken as Baseline. Each participant underwent a two-day session, where on Day 1, they were taught the basic controls of Minecraft. On Day 2, they engaged in a selection task, instructed to choose three foods and one drink out of twenty-four trials at the two virtual restaurants, which alternate by trial. During the task, the participants were asked to choose alone (Condition A and A´) or followed to see a video that showed healthy choices of the virtual model in the same virtual restaurant at the game. In Experiment 1, favorable increases in healthy food selections were observed after the participants saw the healthy choices of the virtual model on video and were alone again. Experiment 2 showed an increase in the selections of healthy food and drinks after the participants watched the videos with the food and drink choices of the virtual model. Future experiments should consider using healthy virtual peers with school-age children while also considering the number of healthy and unhealthy foods used.

Keywords: Food selections, Virtual peer Social, food modeling, School-age, children Healthy selections.

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[I] Jueves/Thursday 22, 09:30-10:00, Room/aula 2, session: Modelos Estadísticos / Statistical Modeling 1

[II] Universidad Autónoma de Aguascalientes, México, nestor.macias@edu.uaa.mx

[4] Timm, N. H. (1975). Multivariate analysis with applications in education and psychology (No. 04: QA278, T5.). Monterrey, California: Brooks/Cole Publishing Company.

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On the numerical solution of the fractional Fermi-Pasta-Ulam-Tsingou equation[I]

Communication / Ponencia

MACIAS-DIAZ, JORGE EDUARDO[II]

México

In this work, we consider a partial differential equation that extends the well-known Fermi–Pasta–Ulam–Tsingou chains from nonlinear dynamics. The continuous model under consideration includes the presence of both a damping term and a polynomial function in terms of Riesz space-fractional derivatives. Initial and boundary conditions on a closed and bounded interval are considered in this work. The mathematical model has a fractional Hamiltonian which is conserved when the damping coefficient is equal to zero, and dissipated otherwise. Motivated by these facts, we propose a finite-difference method to approximate the solutions of the continuous model. The method is an explicit scheme which is based on the use of fractional centered differences to approximate the fractional derivatives of the model. A discretized form of the Hamiltonian is also proposed in this work, and we prove analytically that the method is capable of conserving or dissipating the discrete energy under the same conditions that guarantee the conservation or dissipation of energy of the continuous model. We show that solutions of the discrete model exist and are unique under suitable regularity conditions on the reaction function. We establish rigorously the properties of consistency, stability and convergence of the method. To that end, novel technical results are mathematically proved. Computer simulations that assess the capability of the method to preserve the energy are provided for illustration purposes.

Keywords: continuous Fermi–Pasta–Ulam–Tsingou media sep conservative fractional wave equation, Riesz space-fractional equations, energy-preserving method, fractional centered differences.

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[I] Miércoles/Wednesday 21, 14:00-14:30, Room/aula 2, session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 1

[II] Universidad Autónoma de Aguascalientes, México, jemacias@correo.uaa.mx

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A Family of Linear Stable Equilibria in the Sun-Earth-Sail Problem[I]

Communication / Ponencia

MARCHESIN, MARCELO DOMINGOS[II]

Brazil

The collinear libration point of the Sun-Earth Circular Restricted Three-Body Problem (CR3BP), L3 is located opposite to the Earth with respect to the Sun. Whereas several space missions have been launched to the other two collinear equilibrium points, i.e., L1 and L2, the region around L3 is so far unexploited essentially because of the severe communication limitations caused by Sun's blocking location. By using an adequate size, location and attitude of a solar sail, the equilibrium point can be displaced from its original location to allow direct communication between the satellite and Earth. This paper presents several families of artificial equilibria located on the semi-space which is permanently opposite to Earth in relation to the Sun, but which allows direct communication with Earth. We present a family of such equilibria which are linearly stable and therefore very useful for space missions.

Keywords: restricted 3-body problem, stability, solar sail dynamics restricted 3-body problem, stability, solar sail dynamics.

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[I] Miércoles/Wednesday 21, 11:30-12:00, Room/aula 2, session: Sistemas Dinámicos y Teoría Ergódica /Dynamical Systems and Ergodic Theory 2

[II] Federal University of Minas Gerais - Brazil (Ufmg), Brazil, mdm@mat.ufmg.br

Optimizing the bio-activity of magnetic nanomateriasl (MNMs) in hyperthermia cancer treatment using mathematical modeling[I]

Communication / Ponencia

MEDINA RAMÍREZ, ILIANA ERNESTINA[II]

México

Despite the extensive academic and clinical research efforts for implementing new therapies, cancer remains a major worldwide cause of morbidity and mortality. Local magnetic hyperthermia using magnetic nanomaterials (MNMs) and stable alternating magnetic fields is a promising strategy to destroy cancerous cells. The efficiency of the hyperthermia treatment depends on numerous variables, such as the composition of MNMs, their size, size distribution, magnetic properties, magnetic field, and viscosity of exposure media. In this study, we combine theoretical and experimental approaches to investigate the suitability of magnetic fluid hyperthermia (MFH) for cancer therapy. We evaluate the heating capacity of CoFe2O4-Cit and CuFe2O4-Cit MNMs. A complete computational model is developed in this study to investigate the survival rate of malignant cells for a proposed geometric model after the intratumoral injection of MNPs. The mathematical model incorporates the transport of nanofluid inside the bio-tissue, the heat generation of MNPs during ablation, the heat transfers of bio-tissue, and the cell death probability based on the Arrhenius model.

Keywords: Mathematical modeling, Numerical Simulation, Hyperthermia, Magnetic nanomaterials.

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[I] Jueves/Thursday 22, 14:30-15:00, Room/aula 2, session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 2

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Productos sesgados caóticos y operadores de convolución[I]

Communication / Ponencia

MÉNDEZ GÓMEZ, HÉCTOR BRYAN[II]

Costa Rica

Sea X un espacio de Fréchet complejo separable, (A, μ) un espacio de probabilidad, $T\colon X \longrightarrow X$ un operador lineal continuo, $f\colon A \longrightarrow A$ un mapeo ergódico con respecto a la medida μ y $h\colon A \longrightarrow \mathbb{C}$ un función $L^1(\mu)$. El mapeo

$$P\colon A \times X \longrightarrow A \times X \text{ definido por } P(a.x) = (f(a), h(a)Tx)$$

se dice que es un producto sesgado del operador T.Los productos sesgados proporcionan una rica fuente de sistemas dinámicos cuya dinámica varía a medida que evoluciona el estado de los sistemas. Se puede pensar en un producto sesgado como un sistema dinámico que depende de un parámetro que se perturba a medida que el sistema se desarrolla de una manera particular.Presentamos algunos resultados de dinámica de productos sesgados de operadores de convolución $T\colon H(\mathbb{C}) \longrightarrow H(\mathbb{C})$ definidos en el espacio de funciones enteras. Vamos a probar que los productos sesgados de T son topológicamente transitvos, débilmente mezclantes, mezclantes y además caóticos en sentido de Devaney bajo varias hipótesis (débiles) en la función defindа en el producto segado.Nos interesamos en el estudio de la dinámica discreta de ciertos productos sesgados, donde la primer coordenada consiste de un sistema no-lineal en un espacio métrico compacto, y en la segunda coordenada tenemos un sistema inducido por múltiplos de un solo operador de convolución en $H(\mathbb{C})$.Este es un trabajo conjunto con F. Martínez, F. Rodenas y A. Peris

Keywords: caos, débilmente mezclante, operadores de convolución, productos sesgados, transitividad topológica caos, débilmente mezclante, operadores de convolución, productos sesgados, transitividad topológica.

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[I] Miércoles/Wednesday 21, 10:00-10:30, Room/aula 2, session: Sistemas Dinámicos y Teoría Ergódica /Dynamical Systems and Ergodic Theory 1

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Improper Integration and Fourier Analysis[I]

Communication / Ponencia

MENDOZA-TORRES, FRANCISCO JAVIER[II] ARREDONDO, JUAN HÉCTOR[III]

México

In this talk we will present some results obtained in the Fourier Analysis using new integration theories. Initially, we will review the history of the close relationship between the different integrals and the properties of the Fourier transform. Our contribution to Fourier Analysis has been made using mainly the Henstock-Kurzweil integral, which was developed by Jaroslav Kurzweil and Ralph Henstock at the end of the 1960s. The use of this integral allows us to prove the validity of fundamental results on spaces of functions that have no inclusion relationship with the space of integrable Lebesgue functions on which, as is known, have been developed many of the fundamental results of the Fourier transform. Among the results that we will present is the Riemann-Lebesgue Lemma for functions of bounded variation of one and several variables that are not Lebesgue integrable. Some other properties obtained by the authors are published in the bibliography references.

Keywords: Fourier transform, Improper integration, Henstock-Kurzweil integral, Bounded variation function.

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[I] Miércoles/Wednesday 21, 15:30-16:00, Room/aula 3, session: Análisis y Probabilidad / Analysis and Probability

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An approximate model and computations for the orbits around a non rotating compact object with mass and magnetic dipole[I]

Communication / Ponencia

MORA CHAVERRI, ALEXANDER ANDRÉS[II]

Costa Rica

Tener modelos aproximados y cálculos computacionales en Relatividad General es muy importante debido a las complejidades de las ecuaciones. En la mayoría de los sistemas es muy difícil obtener una solución exacta. Este trabajo presenta un modelo aproximado y cálculos para las órbitas alrededor de un objeto compacto no giratorio con masa, dipolo magnético. Obtenemos la desviación de la luz, el corrimiento al rojo gravitacional, la precesión del perihelio y el retraso de segundo orden en la cantidad (Mu0) y el parámetro magnético a de un objeto compacto utilizando la métrica de Gutsunaev-Manko. Encontramos que nuestras soluciones se reducen al caso simple de un objeto compacto sin rotación o dipolo magnético cuando el parámetro magnético es suficientemente pequeño.

[I]Martes/Tuesday 20, 14:00-14:30, Room/aula 2, session: Física / Physics 1

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Numerical analysis of the Davey-Stewartson system[I]

Communication / Ponencia

MUÑOZ DE LUNA, ROLANDO[II] MACÍAS DÍAZ, JORGE EDUARDO[III]
REGUERA LÓPEZ, NURIA[IV]

México

We will consider the Davey-Stewartson system of equations (DSS), which describes the evolution of surface water waves. We will determine the conservation properties for the continuous case using analytic tools, and propose a discretization of the system that preserves analogous quantities. We will present a method for numerically approximating solutions to the DSS, prove its convergence and stability properties, and implement it computationally.

Keywords: Davey-Stewartson system, fluid dynamics, conservation law, numerical methods.

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[I] Jueves/Thursday 22, 14:00-14:30, Room/aula 2, session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 2

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Lie algebroid connections degenerating onto twisted Higgs bundles[I]

Communication / Ponencia

OLIVEIRA, ANDRÉ[II]

Portugal

Out of a given holomorphic Lie algebroid L on a compact Riemann surface X, one can consider a corresponding L-connection on a vector bundle over X. This naturally degenerates onto a (twisted) Higgs bundle on X. Via a generalization of the classical construction by Simpson of lambda-connections, such degeneration induces an associated one at the level of moduli spaces, using the so-called L-Hodge moduli space. We use this to study geometric and topological properties of the moduli spaces of L-connections on X, as simple as their dimension or more complicated like their motivic class. This is based on joint work with David Alfaya.

Keywords: Higgs Bundles, Hodge Theory, Moduli Spaces, Vector Bundles.

[I] Miércoles/Wednesday 21, 10:00-10:30, Room/aula 3, session: Topología y Geometría / Geometry and Topology 1

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Balanced Incomplete Block Designs: theory and computer search[I]

Communication / Ponencia

PIZA, EDUARDO[II] SEGURA, ESTEBAN[III]

Costa Rica

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n this contribution to SIMMAC XXIV we introduce the basic theory of balanced incomplete block designs (BIBDs) and some methods and algorithms to generate them. BIBDs have their origin in practical applications in the field of experimental designs in agronomy. They also have deep theoretical applications in the field of non-Euclidean geometry, as well as in the field of combinatorics, since they can be employed, among other things, for the construction of finite projective planes, finite afine planes and Hadamard matrices of special orders. We use heuristic optimization methods to find some new hitherto unpublished BIBDs of moderate size, particularly the nonadditive BIBD(15,56,21,6,7), which we construct from a simulated annealing algorithm. We performed a comparison of our algorithms against some others reported in the specialized literature.

Keywords: balanced incomplete block designs, combinatorics, heuristic combinatorial optimization, simulated annealing.

[I] Viernes/Friday 23, 13:30-14:00, Room/aula 4, session: Teoría de números y combinatoria / Number Theory and combinatory 2

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Local discontinuous Galerkin method with linearly implicit IMEX-RK time discretizations for the numerical solution of the BCRE model[I]

Communication / Ponencia

QUIROZ, DARWIN EDISNIEL[II] HENRÍQUEZ, IVÁN YESSEL[III]

Honduras

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In this work we apply the local discontinuous Galerkin (LDG) method in combination with linearly implicit IMEX Runge-Kutta methods to approximate the solution of the BCRE model. The model consists of two nonlinear partial differential equatio ns that describe the surface dynamics of sand piles. The scheme used allows the computational cost to be considerably reduced because at each time step only one system of linear equations is required to be solved. The results of different numerical experiments are presented to verify the order of convergence of the method.

Keywords: LDG method, Linearly Implicit IMEX Runge-Kutta methods, BCRE model.

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[I] Martes/Tuesday 20, 13:30-14:00, Room/aula 4, session: Métodos de Elementos Finitos / Finite Element Methods 1

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Transformando la banca con Machine Learning: Score de crédito para PYMES[I]

Communication / Ponencia

QUIRÓS MUÑOZ, TATIANA[II]

Costa Rica

El uso de metodologías innovadoras de machine learning en la generación de modelos matemáticos ha transformado significativamente el sector bancario, generando beneficios sustanciales en la toma de decisiones crediticias. La adopción de enfoques más sólidos ha conducido a la creación de modelos de clasificación más precisos. Sin embargo, este avance ha venido acompañado de un dilema en las discusiones de los altos mandos en la banca: la falta de explicabilidad e interpretabilidad del modelo y las decisiones de acceso al crédito que genera.

En esta charla se presentarán detalles metodológicos sobre la creación de un score para el acceso a crédito para micro, pequeña y mediana empresa (PYME) para un banco comercial en Costa Rica. Para abordar el tema de la interpretabilidad, se han introducido perspectivas de interpretabilidad local y global, destacando el método GamiNet como un ejemplo perfeccionado para redes neuronales. Desarrollado en los últimos años, GamiNet busca mantener la robustez de un enfoque de red neuronal feedforward generalizada con múltiples subredes aditivas. Cada subred consta de varias capas ocultas, permitiendo capturar efectos principales e interacciones por pares. Este enfoque no solo subsana la falta de interpretabilidad y explicabilidad, sino que también demuestra superioridad del método ya que mantiene una precisión competitiva en comparación con métodos clásicos de aprendizaje automatizado, como bosques aleatorios.

Los datos y el detalle de los modelos a presentar son recogidos y transformados para su tratamiento estadístico y académico de forma agregada, y no es posible identificar información de clientes particulares.

Keywords: Banca, Score de crédito, Caja negra, Red Neuronal, GamiNet, Bosques Aleatorios.

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[I] Jueves/Thursday 22, 14:30-15:00, Room/aula 3, session: Riesgo / Risk

[II] Actuaria egresada de la Maestría de Métodos Matemáticos y sus Aplicaciones de la Universidad de Costa Rica y desarrolladora senior de Modelos Matemáticos en Banco Nacional de Costa Rica., Costa Rica,

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Constraint Satisfaction Method in Natural Language Processing Problems[I]

Communication / Ponencia

RAMÍREZ RODRÍGUEZ, JAVIER[II] TORRES MORENO, JUAN MANUEL[III]
LAUREANO CRUCES, ANA LILIA[IV]

México

A Constraint Satisfaction Problem (CSP) is defined by a set of variables $X_1, X_2, ..., X_n$, and a set of constraints $c_1, c_2, ..., c_m$. Each variable X_i has a domain D_i of possible values, and each constraint c_i involves a subset of variables and specifies the allowed combinations of values for each subset. A *state* of the problem is defined by an assignment of values to some or all of the variables; an assignment that does not violate any constraint is called a *valid* assignment, and a *complete* assignment includes all the variables. A solution to a CSP is a complete assignment that satisfies all the constraints. The set of all possible assignments for a CSP is represented using a search tree. Algorithms differ in how they traverse the search tree to find solutions: backtracking, backjumping, conflict-directed backjumping, and so on. Different natural language processing problems that have utilized this methodology for their resolution will be presented.

Keywords: Constraint Satisfaction, Exact methods.

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[I] Jueves/Thursday 22, 15:30-16:00, Room/aula 4, session: Optimización / Optimization

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To be announce[I]

Plenary Talk / Conferencia Plenaria

RAMÍREZ, KATTIA[II]

Costa Rica

To be announce

[I] Viernes/Friday 23, 15:30-16:30, Auditorium / Auditorio, session: Closing Plenary Talk / Conferencia de Clausura
[II], Costa Rica,

Más allá de los gráficos: Explorando las matemáticas en el Algorithmic Trading.[I]

Communication / Ponencia

RANGEL MADARIAGA, JENNIFER[II]

México

El Algorithmic Trading, ha experimentado una fascinante evolución desde sus incipientes comienzos hasta convertirse en un pilar fundamental de los mercados financieros modernos. Con el advenimiento de la era digital y el acceso a una cantidad masiva de datos financieros,los algoritmos de trading han experimentado un crecimiento exponencial en complejidad y rendimiento. Los algoritmos iniciales, basados principalmente en enfoques de análisis técnico, han dado paso a modelos más avanzados que emplean técnicas de análisis cuantitativo, cualitativo y aprendizaje automático (machine learning) para identificar patrones y tendenciasen los datos del mercado. Actualmente, los algoritmos de trading utilizan no solo datos históricos de precios y volúmenes, sino también información en tiempo real, noticias financieras y datos macroeconómicos para tomar decisiones de trading más precisas y oportunas. Mailagaha Kumbure et al. (2022) Además, la implementación de infraestructuras de alta velocidad y el uso de algoritmos de alta frecuencia han llevado la velocidad de ejecución a niveles sin precedentes, permitiendo a los participantes del mercado capitalizar en microsegundos las oportunidades de arbitraje y ventajas competitivas. Aldridge (2013) Es así que, en este trabajo nos encontramos desarrollando un modelo de predicción de la dirección del precio de un activo financiero con ayuda del modelo de aprendizaje supervisado llamado Support Machine Vector(SVM), el cual, según la literatura Huang et al.(2005) ha dado buenos resultados, sin embargo, nuestro trabajo desea incorporar transacciones en tiempo real incluyendo todos los costos que derivan de la operación y mantenimiento delas posiciones en un ambiente de inversión de tipo scalping. A la fecha, podemos compartir elestado del arte de este tipo de problemática, describir algunas interrogantes en el desarrollo y compartir los primeros pasos de la investigación.

Keywords:
FALTAN DATOS

[I] Jueves/Thursday 22, 13:30-14:00, Room/aula 3, session: Riesgo / Risk

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Continuous Time Modeling with Criminological Panel Data: An Application to the Longitudinal Association between Victimization and Offending[I]

Communication / Ponencia

REINECKE, JOST[II] ERDMANN, ANKE[III] VOELKLE, MANUEL[IV]

Alemania

Background: Criminological research shows that there is nearly always a strong and positive association between delinquency and being a victim of crime. This so-called victim-offender overlap is one of the most consistent and best documented findings in criminology.However, examinations using longitudinal panel data are rather scarce. Previous analysesbased on latent growth and cross-lagged panel models showed that the developments ofvictimization and offending are parallel processes that expose similar stability and mutualinfluence over the period of adolescence and early adulthood (Erdmann & Reinecke, 2018).

Keywords: Continuous time modeling, panel analysis, R, ctsem, juvenile delinquency, longitudinal data.

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[I] Miércoles/Wednesday 21, 16:30-17:00, Room/aula 4, session: Modelación Matemática / Mathematical Modeling 2

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A robust methodology for incomplete information in tables to two classification ways[I]

Communication / Ponencia

RENGIFO, CAMILO[II] ARCINIEGAS ALARCÓN, SERGIO[III]
GARCÍA PEÑA, MARISOL[IV]

Colombia

We describe imputation strategies resistant to outliers, through modifications of the simple imputation method proposed by Krzanowski and assess their performance. The strategies use a robust singular value decomposition, do not depend on distributional or structural assumptions and have no restrictions as to the pattern or missing data mechanisms. They are tested through the simulation of contamination and unbalance, both in artificially generated matrices and in a matrix of real data from an experiment with genotype-by-environment interaction. Their performance is assessed by means of prediction errors, the squared cosine between matrices, and a quality coefficient of fit between imputations and true values. For small matrices, the best results are obtained by applying robust decomposition directly, while for larger matrices the highest quality is obtained by eliminating the singular values of the imputation equation.

Keywords: Imputation, Singular Value Decomposition, regularized methods.

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[I] Miércoles/Wednesday 21, 11:00-11:30, Room/aula 1, session: Estadística Computacional / Statistical Computing

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Mahler's and Bourgain's conjectures viewed through complex geometry[I]

Communication / Ponencia

RUBINSTEIN, YANIR[II]

Estados Unidos

Mahler's Conjectures date back to the 1930's while Bourgain's Conjectures to the 1980's. They both speculate that the cube and simplex are minimizers of certain functionals related to volumes of convex bodies. While these problems are phrased purely in terms of (real) Euclidean space, recently it has been realized that they are deeply related to fundamental notions of several complex variables as well as complex geometry. Based on joint works with B. Berndtsson and V. Mastrantonis

Keywords: Higgs Bundles, Hyperbolic Structures, Moduli Spaces, Vector Bundles.

[I]Miércoles/Wednesday 21, 09:00-09:30, Room/aula 3, session: Topología y Geometría / Geometry and Topology 1

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Inference from non-probabilistic surveys through data integration[I]

Communication / Ponencia

RUEDA GARCÍA, MARIA DEL MAR[II]

España

For many years, national statistical agencies have been using probability surveys to meet information needs about a population of interest. In recent years, other data sources have been increasingly explored due to, among other reasons: the decrease in response rates in probability surveys, the high cost of obtaining data, the desire to access statistics. in real time and the proliferation of non-probabilistic data sources.This presentation will address the problem of how to take advantage of data from a non-probabilistic source (web survey, administrative records, social networks,...) while preserving a valid statistical inference framework.The most important data integration methods such as Propensity Score Adjustment, Statistical matching, assisted model estimation, calibration or robust double estimation will be reviewed, discussing the main characteristics of each approach, and some real applications are presented.

Keywords: Surveys, non probability samples, integration.

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[I] Miércoles/Wednesday 21, 16:30-17:00, Room/aula 1, session: Ciencia de Datos / Data Science 2

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Non-blanced finite finite differences and adaptive gradient optimizers: an application to full waveform seismic inversion[I]

Communication / Ponencia

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Costa Rica

Full Waveform Inversion (FWI) has long been a straightforward and reliable tool in the field of geophysics for generating subsurface images. In this study, we integrate a highly efficient and innovative Non-balanced Finite Differences (NBFD) scheme for seismic wave propagations, coupled with robust adaptable gradient optimization methods with decay, to create a powerful and efficient FWI methodology.Due to their structure the Non-balanced Finite Differences schemes, significantly reduce the computational time compared to traditional finite difference schemes and facilitate the computation of weights or coefficients for the Finite Diferences (FD) operators in the spatiotemporal domain, inducing a linear dispersion relationship in the frequency domain.Furthermore, the adaptable gradient optimizers with decay have demonstrated high precision and performance when tested in Deep Learning. By employing them in conjunction with the frequency Multiscaling technique in our methodology, we aim to accelerate the convergence of FWI while maintaining stability and avoiding issues of local minima congestion.The results obtained in this study are compared with those achieved through conventional FWI using standard stepped finite differences and various optimization methods. Our findings demonstrate that the utilization of an Non-balanced finite differences scheme in a stepped or staggered grid leads to significant improvements(with respect to time computation and accuracy) compared to the results of similar studies.

Keywords: Full-Waveform Inversion, Non-Balanced Finite Differences, Adaptive Weight Decay methods, Multiscaling, Dynamic simultaneous sources approach.

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[I] Viernes/Friday 23, 14:00-14:30, Room/aula 3, session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 3

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Sensitivity and historic behavior for continuous maps[I]

Communication / Ponencia

SALGADO, LUCIANA SILVA[II]

Brazil

We introduce a notion of sensitivity with respect to a continuous real-valued bounded map which provides a sufficient condition for a continuous transformation, acting on a Baire metric space, to exhibit a Baire generic subset of points with historic behavior(also known as irregular points). The applications of this criterion recover, and extend,several known theorems on the genericity of the irregular set, in addition to yielding anumber of new results, including information on the irregular set of geodesic flows, in both negative and non-positive curvature, and semigroup actions.

Keywords: Baire metric space, historic behavior, transitivity, sensitivity.

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[I] Miércoles/Wednesday 21, 11:00-11:30, Room/aula 2, session: Sistemas Dinámicos y Teoría Ergódica /Dynamical Systems and Ergodic Theory 2

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A nonlinear relapse model with disaggregated contact rates: analysis of a forward-backward bifurcation[I]

Communication / Ponencia

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Costa Rica

Throughout the progress of epidemic scenarios it is expected to have different average daily contact behavior for individuals that are at different health classes. This contact heterogeneity has been studied in recent adaptive models and it allows to better captures the inherent differences across health statuses. Diseases with reinfection bring out more complex scenarios and they offer an important application in which to consider contact disaggregation. Therefore, we developed a nonlinear differential equation model to explore the dynamics of relapse phenomena and contact differences across health statuses. Our incidence rate function is formulated, taking inspiration from recent adaptive algorithms. It incorporates contact behavior for individuals in each health class. We use constant contact rates at each health status for our analytical results and prove conditions for different forward-backward bifurcation scenarios. The relationship between the different contact rates heavily influences these conditions. Numerical examples highlight the effect of temporarily recovered individuals and initial conditions on infected population persistence.

Keywords: nonlinear relapse, nonlinear incidence, mathematical model, backward bifurcation, adaptive behavior.

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[I] Miércoles/Wednesday 21, 11:30-12:00, Room/aula 4, session: Matemática Biológica / Biomathematics 1

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New symplectic discontinuous Galerkin methods for Maxwell Equations[I]

Communication / Ponencia

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Chile

We present a new class of discontinuous Galerkin methods for the space discretization of the time-dependent Maxwell equations whose main feature is the use of time derivatives and/or time integrals in the stabilization part of their numerical traces. These numerical traces are chosen in such a way that the resulting semidiscrete schemes exactly conserve a discrete version of the energy. We introduce four model ways of achieving this and show that, when using the mid-point rule to march in time, the fully discrete schemes also conserve the discrete energy. Moreover, we propose a new three-step technique to devise fully discrete schemes of arbitrary order of accuracy which conserve the energy in time. The first step consists in transforming the semidiscrete scheme into a Hamiltonian dynamical system. The second step consists in applying a symplectic time-marching method to this dynamical system in order to guarantee that the resulting fully discrete method conserves the discrete energy in time. The third and last step consists in reversing the above-mentioned transformation to rewrite the fully discrete scheme in terms of the original variables.

Keywords: Time-Dependent Maxwell's Equations, Discontinuous Galerkin Methods, Energy-Conserving Methods.

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[I] Miércoles/Wednesday 21, 15:30-16:00, Room/aula 2, session: Métodos de Elementos Finitos / Finite Element Methods 2

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A new approach for estimating the pseudoinverse of a third-order tensor and its application in image processing[I]

Communication / Ponencia

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Costa Rica

A third-order tensor is a three-dimensional array of numbers (real or complex) organized by: rows, columns and tubes. Given $\mathcal{A} \in \mathbb{R}^{m\times n\times p}$, the tensor $\mathcal{A}^+ \in \mathbb{R}^{n\times m\times p}$ is the T-pseudoinverse of $\mathcal{A}$, which satisfies the following properties: $\mathcal{A} *_c \mathcal{A}^+ *_c \mathcal{A} = \mathcal{A}$, $\mathcal{A}^+ *_c \mathcal{A} *_c \mathcal{A}^+ = \mathcal{A}^+$, $(\mathcal{A} *_c \mathcal{A}^+)^T = \mathcal{A} *_c \mathcal{A}^+$ y $(\mathcal{A}^+ *_c \mathcal{A})^T = \mathcal{A}^+ *_c \mathcal{A}$. This work presents a new approach for approximating the pseudoinverse of a third-order tensor. Iterative methods commonly used for estimating the pseudoinverse of matrices will be employed to extend to third-order tensors. On the other hand, the c-product will be considered as a tensor multiplication operation. Furthermore, we will demonstrate that for any tensor taken arbitrarily, the set of iterative methods converges to the T-pseudoinverse of that tensor. The research aims to avoid dealing with complex numbers that could introduce noise in the calculation of the T-pseudoinverse of a tensor, for this reason, the discrete cosine transform will be applied to the third dimension of a tensor, allowing the extraction of a tensor with only real entries. Finally, the set of generated iterative methods will be used in the noise removal of color images and grayscale videos as an application of third-order tensors in image processing.

Keywords: Three-dimensional tensor, T-pseudoinverse, c-product, Iterative methods, Image procesing.

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[I] Martes/Tuesday 20, 16:00-16:30, Room/aula 4, session: Álgebra Lineal Numérica / Numerical Linear Algebra

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Compactifications of the moduli space of principal bundles on smooth curves[I]

Communication / Ponencia

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Alemania

Given a (connected smooth projective) curve X over the complex numbers and a (complex) reductive linear algebraic group G, such as a general or special linear group, or an orthogonal or symplectic group, one may study the classification problem of principal G-bundles on X. For $G = GL_r(\mathbb{C})$, this problem is equivalent to the classification problem of vector bundles of rank r on X. A vector bundle of rank r on X has another discrete invariant, namely its degree which determines its topological type. It is well-known that, if the genus of X is positive, then the vector bundles of fixed rank r and degree d cannot be classified by discrete data and, if, moreover, r is at least two, form an unbounded family. To this end, Mumford and Seshadri introduced the concept of stability and semistability of vector bundles and constructed moduli spaces for stable and semistable vector bundles on X of fixed rank and degree, the latter being projective. Ramanathan extended this work to principal G-bundles for arbitrary connected reductive structure groups. More generally, there is also a moduli space that classifies pairs (X, P), consisting of a smooth projective curve X and a semistable principal G-bundle on X. Here, the genus g of X and the topological type of P have to be fixed. This moduli space is projective relative to the moduli space of smooth curves of genus g. Finally, let us mention that, if G is simple and simply connected, the Picard group of the moduli space of semistable principal G-bundles on a curve X is isomorphic to the additive group of the integers, and, the spaces of global sections of multiples of the ample generator have found interpretations as spaces of conformal blocks (Beauville-Laszlo, Faltings, Kumar-Narasimhan-Ramanathan). In view of degeneration techniques, it is natural to ask, if the moduli space of semistable principal bundles on smooth curves of genus g can be compactified relative to the moduli space of stable curves of genus g. One possibility is letting principal bundles degenerate to possibly singular objects on non-smooth stable curves. For $G = GL_r(\mathbb{C})$, the singular objects that one needs are torsion free sheaves of uniform rank r. The moduli space of torsion free sheaves on stable curves was constructed by Pandharipande. Bhosle and the speaker proposed to consider singular principal G-bundles on stable curves in order to get projective moduli spaces, and Munoz-Castaneda and the speaker have recently completed the construction of the moduli space of singular principal G-bundles on stable curves. Another possibility is to construct compactifications with the help of spaces of conformal blocks. For special linear and symplectic groups, this was done by Manon, Belkale-Gibney, and Wilson. The resulting spaces do not have apparent interpretations as moduli spaces. Yet, Wilson found an interesting relation between the conformal block compactification and the compactification via singular principal G-bundles. In the talk, we will review the work of Munoz-Castaneda and the speaker, try to give some key words from the theory of conformal blocks, and discuss the relation among the different approaches.

Keywords: Curves, Lie Groups, Moduli Spaces, Principal Bundles, Vector Bundles.

[I] Miércoles/Wednesday 21, 09:30-10:00, Room/aula 3, session: Topología y Geometría / Geometry and Topology 1

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References

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Risk limitation in portfolio optimization[I]

Communication / Ponencia

SCHUBERT, LEO[II]

Alemania

The management of equity funds tries to find an efficient selection of stocks. After these have been determined by optimization procedures, they often have to be adjusted for economic or legal reasons with the consequence that the solutions are no longer efficient. In the case of a publicly offered equity fund, a legal reason can be Article 52(2) of the Directive 2009/65/EC of the European Parliament and of the Council of 13 July 2009 or the KAGB § 206. A part of the directive states e.g. that never more than 10% of the budget can be invested in one share. These rules in total are also known as the 5-10-40 condition. In order to integrate such risk constraints in portfolio optimization, two optimization models have been developed - a quadratic and a linear one. The models were tested using historical return data from the HDAX. The linear model shows that the specifications of the EU Directive achieve the targeted volatility reduction. However, this risk constraint has a price, which can be expressed in terms of the currencies "return loss" or "volatility gain". For the same volatility, the portfolio not constrained by the 5-10-40 condition achieved an annual return that was approximately 10% higher. The "volatility gain" is small around the minimum volatility point (MVP), but can be as high as 25% when portfolios determined under the 5-10-40 condition are compared to unconstrained optimized portfolios at the same return in each case. The quadratic model is based on the approach of H. Markowitz and shows a more flexible way of risk limitation that leads to comparable results.

Keywords: portfolio optimization, portfolio management, 5-10-40 constraint, stochastic programming, quadratic portfolio optimization.

[I] Jueves/Thursday 22, 14:00-14:30, Room/aula 3, session: Riesgo / Risk

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A Subspace Method for Time Series Anomaly Detection in Cyber-Physical Systems[I]

Communication / Ponencia

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Costa Rica

Time series anomaly detection is an important process for system monitoringand model switching, among other applications in cyber-physical systems. In this documentwe present a fast subspace method for time series anomaly detection, with a relatively lowcomputational cost, that has been designed for anomaly detection in real sensor signalscorresponding to dynamical systems. The method consists on taking the time series signalof the system behaving in a normal state, where its time evolution can bedescribed with a Hankel-type trayectory matrix, where the columns of the matrix are segments of the time series.The subspace generated by segments of the time series in normal state may be separatedin subspaces of important and non important information of the signal by applying the SVD on the Hankel matrix.Anomalies of the incoming signal can be detected by projecting on the directions of less important informationof the normal behaved signal. By projecting on this subspace of non important information of the reference signal,if the projection is above certain threshold, it can be classified as an anomaly. We also present some general results corresponding to thetheoretical foundations of our method, together with a prototypical algorithm for time seriesanomaly detection. Some numerical examples corresponding to applications of the prototypicalalgorithm are presented, and some computational tools based on the theory and algorithmspresented in this paper, are provided.

Keywords: Anomaly detection, Hankel matrix, Time series analysis, sensors, signals.

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[I] Jueves/Thursday 22, 14:30-15:00, Room/aula 4, session: Modelación Matemática / Mathematical Modeling 3

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New Banach spaces-based fully-mixed finite element methods for pseudostress-assisted diffusion problems[I]

Communication / Ponencia

SEQUEIRA CHAVARRÍA, FILÁNDER[II]

Costa Rica

In this talk we propose and analyze Banach spaces-based fully-mixed approaches yielding new finite element methods for numerically solving the coupled partial differential equations describing the pseudostress-assisted diffusion of a solute into an elastic material. Two mixed formulations employing the diffusive flux as an additional variable are introduced for the diffusion equation, and the concentration gradient is considered as an auxiliary unknown of the second one of them. The resulting coupled systems are rewritten as equivalent fixed point operator equations, so that the respective unique solvabilities are proved by applying the classical Banach theorem along with the Babuska-Brezzi theory. The nonlinear dependency on the elastic variables of the diffusion coefficient and its source term, as well as the nonlinear dependency on the concentration of the elastic source term, suggest, for appropriate continuous and discrete analyses, that the unknowns be sought in suitable Lebesgue spaces. The associated Galerkin schemes are addressed similarly, and the Brouwer theorem yields the existence of discrete solutions. A priori error estimates are derived for both approaches, and rates of convergence for specific finite element subspaces satisfying the required discrete inf-sup conditions, are established in 2D. Finally, several numerical examples illustrating the performance of the two methods and confirming the theoretical findings, are reported.

Keywords:
FALTAN DATOS

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[I] Miércoles/Wednesday 21, 13:30-14:00, Room/aula 2, session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 1

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A dissimilar mesh discretization for hybridizable discontinuous Galerkin schemes applied to interface problems[I]

Communication / Ponencia

SOLANO, MANUEL[II]

Chile

We propose and analyze a hybridizable discontinuous Galerkin (HDG) method for dissimilar meshes. This type of meshes are common, for instance, when different parts of the domains are triangulated independently, which maygenerate gaps or overlaps between these triangulations. The method considers an HDG discretization on separate meshes and tie them together through appropriate transmission conditions. These transmission conditions are based upon transferring the numerical flux from the first mesh to the second one, and the numerical trace from the second mesh to the first one. Stability and error analysis are shown, where the size of the gap is explicitly written in the estimates. We also present numerical results to validate the theory.

Keywords: Unfitted methods, non-matching grids, interface problems, discontinuous Galerkin.

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[I] Miércoles/Wednesday 21, 14:30-15:00, Room/aula 2, session: Métodos Numéricos para PDEs / Numerical Methods for PDEs 1

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Equatorial circular motion in a Kerr-like spacetime[I]

Communication / Ponencia

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Costa Rica

In this contribution we present the analysis of the equatorial circular motiondescribed by test particles in a Kerr-like metric. This spacetime possess mass,spin, and mass quadrupole moment, andis appropriate to represent compact objects like neutron stars. A comparison of theresults with known metrics such as the Schwarzchild and Kerr cases is alsopresented.Furthermore, the shadow of the compact object and the radius of the photon sphereare obtained along with the Innermost Stable Circular Orbit (ISCO). Lastly, the effective potential is plotted in order to analyse the stability of this type of motion.It should be mentioned that the software Mathematica will be essential to obtain all the numerical results and plots that are necessary to achieve a properanalysis of the equatorial circular motion, specially when it comes to the solving of high order equations.

Keywords: Equatorial circular motion, Kerr-like metric, Numerical analysis, Quadrupole moment.

[I] Martes/Tuesday 20, 14:30-15:00, Room/aula 2, session: Física / Physics 1

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Machine Learning-Driven COVID-19 Early Triage and Large-Scale Testing Strategies Based on the 2021 Costa Rican Actualidades Survey[I]

Communication / Ponencia

SOLÍS, MAIKOL[II] PASQUIER, CARLOS[III] VILCHEZ, VIVIAN[IV]

Costa Rica

The SARS-CoV-2 pandemic emphasized the importance of mass testing for correct data collection and disease control. This study explores the challenges of optimizing testing, in particular with RT-qPCR and its alternatives. We introduce a population-level strategy that uses predictive mechanisms to assess individual contagion risk, considering factors related to the determinants of health. Using the "ctualidades 2021" survey, which sampled 2003 adults, we set classification models, including logistic regression, Random Forest, Gradient Boosting, and XGBoost. With a prevalence of 0.26 in the sample, we adjust the model to explain the outcome of whether the respondent had COVID-19 or not. The model shows sensitivity and specificity values of 0.79 and 0.76, respectively. Through Monte Carlo simulations, we evaluate the economic and epidemiological impacts of various testing strategies such as pooling, retesting and mixing technologies of RT-qPCR, Antigen and RT-LAMP. We discuss how these classification systems could help with the Costa Rican health public policies.

Keywords: SARS-CoV-2 mass testing, Classification models, Determinants of health, Health public policies.

[I] Jueves/Thursday 22, 09:00-09:30, Room/aula 2, session: Modelos Estadísticos / Statistical Modeling 1

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Approximating a bivariate function using *B-splines* and the matrix equation $AXB = C$.[I]

Canceled

SOTO QUIROS, JUAN PABLO[II]

Costa Rica

In this presentation, we present a method for the approximation of a two-dimensional function $f : A \times B \to \mathbb{R}$, where $A \subset \mathbb{R}$ and $B \subset \mathbb{R}$. This approximation of the function f is givne by a function $p : \mathbb{R} \times \mathbb{R} \to \mathbb{R}$ with the following structure:

$$p(x, y) = \sum_{i=1}^{p} \sum_{j=1}^{q} a_{i,j} g_i(x) h_j(y),$$

where $g_i : \mathbb{R} \to \mathbb{R}$ and $h_i : \mathbb{R} \to \mathbb{R}$ are predefined functions, and $a_{i,j} \in \mathbb{R}$. The construction of the function p will be carried out using the following two mathematical concepts:

- *B-splines*, which constitute a set of smoothly defined mathematical functions/curves widely used in applications related to the representation and manipulation of curves and surfaces.
- The generalized matrix approximation (GMA) Problem, which involves the calculation of the matrix X in the context of the least squares problem associated with the matrix equation $AXB = C$, where matrices A, B, and C are known.

The presentation begin with a brief but concise exposition of the fundamental concepts related to *B-splines* and the GMA problem, including illustrative numerical examples. Then, we will describe the procedure for calculating the polynomial $p(x, y)$ using *B-splines* and the GMA problem. Practical examples will be presented for better understanding. Finally, we will explore the application of this method in the approximation of the double definite integral of the function f.

Keywords: B-splines, Matrix Linear Equation, Function approximation.

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[I] Martes/Tuesday 20, 15:30-16:00, Room/aula 4, session: Álgebra Lineal Numérica / Numerical Linear Algebra

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Multidimensional scaling by particle swarm optimization[I]

Communication / Ponencia

TREJOS, JAVIER[II] BAZÁN, VÍCTOR[III]

Costa Rica

Multidimensional scaling (MDS) is a dimension reduction method for representing n points in a low dimension space, given a matrix of $n \times n$ distances or dissimilarities [1]. Several methods have been proposed for solving this problem by the minimization of a minimum sum of squares criterion, called stress; however, these methods usually stack in local minima of stress. We use the particle swarm optimization [3] paradigm for minimizing stress in metric multidimensional scaling. For this, we use particles in a very high dimensional space identifying particles to solutions of the MDS problem and tune the approximation of the optimum by weighting the terms of the iterative velocity equation. The method performs well, and we illustrate the results on several data sets. Comparisons are made with some well-known methods for MDS, as well as with other metaheuristics applied to MDS, such as simulated annealing, tabu search and genetic algorithms [2], [4].

Keywords: Multidimensional scaling, combinatorial optimization, particle swarms, stress minimization, dimension reduction.

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[I] Miércoles/Wednesday 21, 13:30-14:00, Room/aula 1, session: Ciencia de Datos / Data Science 1

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Estudio de asociación entre la forma biológica de hojas de árboles y aspectos genéticos de la especie[I]

Communication / Ponencia

VAZQUEZ, HÉCTOR JAVIER[II] ALDAMA, ALEJANDRO[III]

México

El estudio y la génesis de la forma de los organismos vivos ha representado un reto importante para la ciencia. En este contexto, la morfología clásica busca similitudes y formas propias para cada grupo de organismos; e intenta explicar las formas orgánicas, como variaciones morfológicas de modelos básicos (Aranda, 1997), sin considerar aspectos funcionales o evolutivos. La Morfometría Geométrica aplica herramientas cuantitativas, como el Análisis de Procrustes y el Análisis de Componentes Principales para analizar y comparar secuencias de puntos de referencia de formas biológicas (Bookstein, 1997). La génesis de la forma se explica considerando fatores externos, geográficos, ambientales, evolutivos y genéticos (Taylor, 2021). En esta propuesta se explora la asociación entre la forma biológica de hojas de especies de árboles, aplicando las técnicas de la Morfometría Geométrica y secciones específicas de la secuencia del ADN de genes de cada especie (Williams, 2016).

Keywords: Morfología Geométrica, Genómica, Forma de Hojas, Árboles.

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[I] Martes/Tuesday 20, 14:00-14:30, Room/aula 1, session: Estadística Multivariada / Multivariate Statistics 1

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Switched economic system dynamics identification using topologically controlled reservoir computers[I]

Communication / Ponencia

VIDES, FREDY[II]

Honduras

In this talk, an application of some general results in structured matrix approximation and control theory ([4,5]) to autoregressive representation of switched dynamical economic systems ([5]) is presented. Firstly, a generic nonlinear time delay embedding that extends the notion of Next Generation Reservoir Computer ([2]) is considered for the economic time series data sampled from an economic system under study. Secondly, sparse least squares and structured matrix approximation methods ([5]) are applied to identify approximate representations of the output coupling matrices that will be proven to be topologically controlled by Stiefel manifolds, determining the autoregressive representations ([2,5]) of the dynamic models corresponding to some given economic system under consideration. Prototypical algorithms based on the aforementioned techniques, together with some applications to approximate identification, predictive and prescripitve simulation of dynamic economic systems that may or may not exhibit chaotic behavior are presented. Some connections with dynamic stochastic general equilibrium (DSGE) and dynamic factor models ([1,3]) are outlined.

Keywords: System identification, reservoir computer, switched system, DSGE, Stiefel manifold.

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[I] Martes/Tuesday 20, 14:00-14:30, Room/aula 3, session: Teoría de Control / Control Theory

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Curve Fitting for pandemic data using Generalized Logistic Regression[I]

Communication / Ponencia

VILLALOBOS ARIAS, MARIO ALBERTO[II]

Costa Rica

In this work, a proposal is presented for the estimation of populations using generalized logistic curve fitting. These types of curves are used to study population growth, in this case population of people infected by the Covid-19 virus; and it can also be used to approximate the survival curve used in actuarial and similar studies.

The resulting model could also be used to approximate daily cases and other data related to the pandemic, such as the number of hospitalized and ICU cases. In addition, an adjustment method for the detection of second and subsequent waves is also proposed. Examples are presented for some Latin American countries.

Keywords: COVID-19, nonlinear regression, Logistic regression, curve fitting, trends, forecast.

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[I] Jueves/Thursday 22, 09:00-09:30, Room/aula 4, session: Matemática Biológica / Biomathematics 2

[II] CIMPA and Escuela de Matemática, Universidad de Costa Rica Escuela de Matemática, Universidad de Costa Rica and Instituto Tecnológico de Costa Rica, Costa Rica, mario.villalobos@ucr.ac.cr, marvillalobos@itcr.ac.cr, mario.cr@gmail.com

Simetrías en inteligencia artificial [I]

Plenary Talk / Conferencia Plenaria

VILLAR, SOLEDAD[II]

Estados Unidos

Cualquier representación de datos implica elecciones arbitrarias del investigador. Debido a que esas elecciones son externas al proceso de generación de datos, cada elección conduce a una simetría exacta, correspondiente al grupo de transformaciones que lleva una posible representación a otra. Éstas son las simetrías pasivas; donde los resultados son independientes de la elección del sistema de coordenadas y unidades, fundamentales en física.

En el aprendizaje automático, la simetría pasiva más visible es la simetría de permutación en grafos.

Las simetrías activas son aquellas que deben establecerse mediante observación y experimentación, como invarianza y equivarianza con respecto a rotaciones y translaciones en modelos físicos.

Nuestro objetivo, en esta charla, es explicar el rol de las simetrías en métodos de inteligencia artificial, y los conceptos matemáticos para implementarlas en la práctica.

[I] Martes/Tuesday 20, 11:00-12:00, Auditorium / Auditorio, session: Opening Plenary Talk / Conferencia Inaugural

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API development with R[I]

Short course / Curso corto

VILLEGAS-DIAZ, ROBERTO[II]

Gran Bretaña

Application Programming Interfaces (APIs) are used extensively in a variety of fields; using APIs you can extract information from local and remote servers (e.g., getting tweets from X-previously known as Twitter-), you can upload information to a remote server (e.g., update a dashboard with results from your research), you can interact with hardware (e.g., smart devices that are connected to the internet), and many other applications.The session will introduce you to APIs and what they can do, building up (with practical examples) to you writing your own API in R using the plumber (https://cran.r-project.org/package=plumber) package. The examples on this session will primarily focus on applications in public health; however, the same principles apply to other fields, making it suitable for a wide audience.Topics covered:What is an API? Where are APIs used? How can we use APIs in R? The plumber framework.Writing APIs with plumber in R.Requirements:Basic knowledge of R is expected (you should be able to create functions).

Keywords: R, API.

FALTAN DATOS

[I] Jueves/Thursday 22, 13:30-14:00, Room/aula 1, session: Ciencia de Datos / Data Science - Tutorial 2

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Accelerated methods for nonsmooth convex structured minimization problems[I]

Communication / Ponencia

WENG-LAW, ANDRÉ[II]

Francia

In a Hilbert framework, we introduce a new class of continuous second-order dynamical systems for nonsmooth convex minimization. A main feature of these systems is to produce trajectories that lies in the graph of the subdifferential of the objective, besides combining viscous and geometric damping as well as a time rescaling process. Moreover, they do not incorporate any regularization of the cost function nor smoothing processes.This new class originates from some combination of a continuous Nesterov-like dynamic and the Minty representation of subdifferentials. These models are investigated through first-order reformulations.We prove the weak convergence towards equilibria for the solution trajectory, as well as properties of fast convergence to zero for its velocities. Remarkable convergence rates (in some cases ofexponential-type) are also established for the function values. We additionally state notable properties of fast convergence to zero for the sub-gradients trajectory and for its velocity.We illustrate, through numerical experiments, the effectiveness of our systems (in terms of convergence rates) compared with recently studied continuous models.Next, as discrete counterparts of the proposed continuous models, we derive rapidly convergent inertial algorithms that incorporate a correction term for solving nonsmooth convex structured minimization problems. In spite of their nice formulations, our numerical schemes inherit the good convergence properties of their continuous counterparts. In particular, when numerically implemented on some real-life problem, they outperform both classical and recently investigated algorithms.

Keywords: nonsmooth convex minimization, differential equations, dissipative dynamical systems, Nesterov acceleration, inertial-type algorithm.

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[I] Jueves/Thursday 22, 16:00-16:30, Room/aula 4, session: Optimización / Optimization

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