Society for Industrial and Applied Mathematics - Mexico Section Annual Meeting 2021

June 21 - 23 , 2021
Mexican Research Center in Mathematics (Cimat)
Virtual Meeting

Organizing Committee:

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- Miguel Ángel Moreles Vázquez (Cimat)
- Jorge X. Velasco Hernández (Imate-UNAM-Juriquilla, MexSIAM Vice-President).
- Irma García Calvillo, (UAdeC, MexSIAM Secretary).
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3. Diseño, Grabación y MC
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4. Facturación
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5. Becarios
    - Ruth Ivonne Escobedo Carranza
    - Carlos Bruno Rodriguez Martinez
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Acknowledgements

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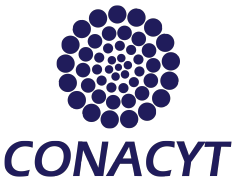

Location:

This year, the meeting is virtual. The hosting institution is the Mexican Research Center in Mathematics

https://siam2021.eventos.cimat.mx

https://mexsiam.org/annual-meeting-2021

Summarized program (Central Standard Time Zone, CST)

Horario

	Sesión 1	Sesión 2	Sesión 3	Sesión 4
	Lunes			
9:00-9:30	Opening Ceremony			
9:30-10:00				
10:00-10:30	AAP1	DP1	SC1	CC1
10:30-11:00	AAP2	DP2	SC2	CC2
11:00-12:00	Characterizing the dynamics of COVID-19 transmission using multiple mathematical approaches and novel data sources *Dr. Mauricio Santillana*			
12:00-12:30	Coffee break			
12:30-13:00	EI1	DP3	FD1	CC3
13:00-13:30	EI2	DP4	FD2	CC4
13:30-14:00	EI3	DP5	FD3	AAP3
14:00-14:30	EI4	DP6	FD4	AAP4
14:30 - 15:00	EI5	DP7		AAP5
14:30-16:00	Lunch			
16:00-16:30	Posters	Posters	Posters	Posters
16:30-17:00	Posters	Posters	Posters	Posters
17:00-18:00	Threshold Parameters in Ecology and Epidemiology *Dr. Pauline van den Driessche*			
18:00-18:30	Free	Free	Free	Free

	Sesión 1	Sesión 2	Sesión 3	Sesión 4
	Martes			
9:00-9:30	ME1	HC1	AAP6	OM1
9:30-10:00	ME2	HC2	AAP7	OM2
10:00-10:30	ME3	HC3	AAP8	OM3
10:30-11:00				
11:00-12:00	Mathematics and the Integration of theories in Ecology *Dr. Pablo A. Marquet*			
12:00-12:30	Coffee break			
12:30-13:00	TDA1	HC4	PE1	OM4
13:00-13:30	TDA2	HC5	PE2	OM5
13:30-14:00	TDA3	HC6	PE3	ES1
14:00-14:30	TDA4	HC7	PE4	ES2
14:30 - 15:00			PE5	ES3
14:30-16:00	Lunch			
16:00-16:30	Posters	Posters	Posters	Posters
16:30-17:00	Posters	Posters	Posters	Posters
17:00-18:00	Discontinuous Galerkin Methods for Modeling Porous Media: Theory and Simulations *Dr. Béatrice Rivière*			
18:00-18:30	Business Meeting	Business Meeting	Business Meeting	Business Meeting

	Sesión 1	Sesión 2	Sesión 3	Sesión 4
	Miércoles			
9:00-9:30	PH1	HT1	MP1	DS1
9:30-10:00	PH2	HT2	MP2	DS2
10:00-10:30	PH3	HT3	MP3	DS3
10:30-11:00	PH4	HT4	MP4	DS4
11:00-12:00	Ocean surface waves and ocean-atmosphere interactions *Dr. Francisco J. Ocampo Torres*			
12:00-12:30	Coffee break			
12:30-13:00	PH5	ES4	MP5	DS5
13:00-13:30	PH6	ES5	MP6	DS6
13:30-14:00	PH7	ES6	MP7	DS7
14:00-14:30	PH8	ES7	MP8	DS8
14:30 - 15:00	PH9	ES8		DS9
14:30-16:00	Lunch			
16:00-16:30		HT5		
16:30-17:00		HT6		
17:00-18:00	Geostrophic turbulence and the formation of large scale structure *Dr. Edgar Knobloch*			
18:00-18:30	Closing Remarks	Closing Remarks	Closing Remarks	Closing Remarks

Detailed Program

Central Standard Time Zone (CST)

Monday, June 21st

Time	Activity	Chair
9:00 – 10:00	**Opening Ceremony**	Pedro Uribe
	Session 1: Applied Analysis and Probability	Miguel Angel Moreles
10:00 – 10:30	Sergio Gomez. *Title:Unified framework for conservative discontinuous Galerkin methods for nonlinear Schrödinger equations*	AAP1
10:30 – 11:00	Ulises Velasco-García. *Title: Numerical methos for the direct non-linear Fourier transform of the Non Linear Schrödinger Equation.*	AAP2
	Session 2: Dinámica Poblacional y Enfermedades Infecciosas	Mayra Núñez
10:00 – 10:30	Mayra Núñez López. *Title: Estimación de la tasa de migración en una red epidémica.*	DP1
13:00 – 11:00	Esteban Abelardo Hernandez Vargas *Title: Dynamical Characterization of Antiviral Effects in COVID-19.*	DP2

Monday, June 21st

Time	Activity	Chair
9:00 – 10:00	**Inauguration**	Pedro Uribe
	Session 3: SIAM Student Chapter at UNAM	Raul Esquivel
10:00 – 10:30	Ernesto Iglesias Rodríguez. *Title: Reiterated homogenization with applications to nanofluids.*	SC1
10:30 – 11:00	Cesar Alberto Rosales Alcantar. *Title:Generalized quasi-geostrophy for moist spatially anisotropic atmospheric flows with phase changes* .	SC2
	Session 4: Ciencia Computacional	Norberto Vera
10:00 – 10:30	Ismael Herrera-Revilla. *Title: The DVS-DDM: A very effective approach for processing Partial Differential Equations of Pure and Applied Science.*	CC1
10:30 – 11:00	Norberto Carmen Vera Guzmán. *Title: FORMULACIÓN DE UN MODELO DE FLUJO EN MEDIOS POROSOS FRACTURADOS UTILIZANDO DESCOMPOSICION DE DOMINIO.*	CC2

Monday, June 21st

Time	Activity	Chair
11:00 – 12:00	**Plenary talk:** Dr. Mauricio Santillana. *Title: Characterizing the dynamics of COVID-19 transmission using multiple mathematical approaches and novel data sources.*	Jorge Velasco
12:00 – 12:30	**Coffee Break**	

Dr. Mauricio Santillana
Harvard University

Mauricio Santillana is Director of the Machine Intelligence Lab at the Harvard Medical School. He is an applied mathematician expert in mathematical modeling and scientific computing. He specializes in the analysis of big data sets in multiple contexts to understand and predict the behavior of complex systems. He has also worked in the design and analysis of numerical methods to solve partial differential equations. His research interests include the designing and implementing novel ways to track epidemics in real-time using data from Google, Twitter, Facebook, UpToDate (digital disease detection), the impact of climate change on disease burden in Africa and Mexico. He has also conducted research in atmospheric pollution transport modeling, climate modeling, modeling of floods due to hurricanes and population dynamics.

Monday, June 21st

Time	Activity	Chair
	Session 1: Enfermedades Infecciosas Emergentes:	David Baca
12:30 – 13:00	David Baca Carrasco. *Title: Target Reproduction Number y medidas de control para enfermedades.*	EI1
13:00 – 13:30	Nancy Leticia Gonzalez Morales. *Title: Mathematicial model of dengue multiserotype interactions.*	EI2
13:30 – 14:00	Mayra Rosalia Tocto Erazo. *Title:Efecto de la movilidad diaria de las personas sobre la dinámica del dengue.*	EI3
14:00 – 14:30	Gabriel Adrián Salcedo Varela. *Title: Comportamiento umbral de un modelo de planta vector-huésped estocástico: virus del rizo amarillo del tomate.*	EI4
14:30 – 15:00	Ignacio Barradas Bribiesca. *Title: La Modelación Matemática de Epidemias: ¿cuál es el mejor modelo?*	EI5

Monday, June 21st

Time	Activity	Chair
	Session 2: Dinámica Poblacional y Enfermedades Infecciosas	Mayra Núñez
12:30 – 13:00	Luis Franco Pérez. *Title: Global dynamics of a full mosquito population model*	DP3
13:00 – 13:30	Joaquin Delgado Fernández. *Title: Bifurcations in a minimal model of cancer. The effect of vascularization.*	DP4
13:30 – 14:00	José Roberto Romero Arias *Title: Interacciones ecológicas y sociales relacionadas con la obtención de agua dulce*	DP5
14:00 – 14:30	Melissa Ponce Sosa. *Title: Continuous model of tumor angiogenesis.*	DP6
14:30 – 15:00	Moisés Santillán Zerón *Title: Dinámica poblacional de una comunidad artificial de bacterias silvestres.*	DP7

Monday, June 21st

Time	Activity	Chair
	Session 3: Computational fluid dynamics problems with interfaces	Miguel Angel Uh
12:30 – 13:00	Miguel Angel Uh Zapata. *Title: An immersed boundary neural network for solving elliptic equations.*	FD1
13:00 – 13:30	Sheng Xu. *Title: Computing particle collisions in a fluid by the immersed interface method.*	FD2
13:30 – 14:00	Hammouti Abdelkader *Title: Fluid-solid modelling with heat and mass transfer and their applications in environmental studies.*	FD3
14:00 – 14:30	Reymundo Ariel Itzá Balam *Title: A level-set/finite-volume method based on a central interpolation scheme.*	FD4

Monday, June 21st

Time	Activity	Chair
	Session 4: Ciencia Computacional	Ursula Iturraran
12:30 – 13:00	Gerardo Hernández Dueñas. *Title: Bathymetry and friction estimation from transient velocity data for 1D shallow water flows in open channels with varying width.*	CC3
13:00 – 13:30	Ursula Iturraran-Viveros *Title: Finite differences in triangular meshes*	CC4
	Session 4: Applied Analysis and Probability	Pablo Moreira
13:30 – 14:00	Pablo Enrique Moreira Galván. *Title: Complete Systems of Scalar Schrödinger Operator Using Complex Quaternions and Transmutation Theory.*	AAP3
14:00 – 14:30	Dr. Jaime Eduardo Martínez Sánchez. *Title: Approximations of the Ultimate Ruin Probability in the classical risk model using the Banach's Fixed-Point Theorem and the Conti.*	AAP4
14:30 – 15:00	Víctor Hugo Vázquez Guevara. *Title: On the Asymptotics of a Minimal Random Walk with complete memory via a martingale approach*	AAP5

Monday, June 21st

Time	Activity	Chair
	Posters Day 1:	Gerardo Hernández
16:00 – 17:00	Jesús Ramón Carmona Jáquez. *Title: A geo intelligent computing system to predict academic performance at college students.*	
16:00 – 17:00	Alicia Margarita de la Mora Cebada. *Title: Finite Element Method with Optimal Functions applied to the Linear Elasticity Equation.*	
16:00 – 17:00	Francisco Javier Sánchez Bernabe. *Title: On a 3D Navier-Stokes Equations Analytical Solution.*	
16:00 – 17:00	Mónica Tapia Gaspar. *Title: Método de Homogeneización Asintótica para el Cálculo de Propiedades Efectivas en un Material Nanocompuesto en Tres Dimensiones.*	
16:00 – 17:00	Yoanh Espinosa Almeyda . *Title: Effective properties of three-phase magneto-electro-elastic fiber-reinforced composites by a semi-analytical approach.*	
16:00 – 17:00	Hugo Enrique Júnez Ferreira *Title: Ventajas del Análisis Geoestadístico 3-D de la carga hidráulica en un acuífero*	

Monday, June 21st

Time	Activity	Chair
17:00 – 18:00	**Plenary talk:** Dr. Pauline van den Driessche (CAIMS-SCMAI Research Prize (2019),University of Victoria). *Title: Threshold Parameters in Ecology and Epidemiology.*	Jorge Velasco

Dr. Pauline van den Driessche, CAIMS-SCMAI Research Prize (2019)
University of Victoria

Pauline van den Driessche is a mathematician, Emeritus Professor of the University of Victoria and Fellow of the Society for Industrial and Applied Mathematics 2013. She was the recipient of the Canadian Applied and Industrial Mathematical Society Research prize in 2019, given in recognition of her contributions to mathematical epidemiology and matrix analysis, and the high impact of her work in many areas of applied mathematics. Her research program includes the study of stability in biomathematical models and matrix analysis, mathematical biology, especially models in epidemiology and ecology, matrix analysis, especially stability and combinatorial matrix analysis. Her broad applied and theoretical research interests range from disease transmission models, global stability of dynamical systems, backward bifurcation to stability properties of sign pattern matrices, nonnegative matrices, matrix algebra, combinatorial matrix analysis and network models

Tuesday, June 22nd

Time	Activity	Chair
	Session 1: Methods in Ecology	Daniel Olmos
9:00 – 9:30	Edwin Fernando Duque Marín. *Title: Influence of impulsive irrigation supply on fruit tree growth.*	ME1
9:30 – 10:00	Lili Guadarrama Bustos. *Title: Diagnosis of diseases in plants using Gaussian Mixture Models and Probabilistic Saliency*	ME2
10:00 – 10:30	Tzitlali Gasca Ortiz. *Title: Inverse problems to determine the diffusion and dispersion coefficients of Lake Zirahuén, Mexico.*	ME3
	Session 2: Health Care Applications	Irma García
9:00 – 9:30	Roger Z. Ríos. *Title: The Kidney Exchange Problem: Models and Algorithms.*	HC1
9:30 – 10:00	Héctor Gabriel Acosta Mesa . *Title: Neuroevolution in Medical Image Processing.*	HC2
10:00 – 10:30	Juana Julieta Noguez Monroy. *Title: Machine Learning for the early detection of Type 2 Diabetes*	HC3

Tuesday, June 22nd

Time	Activity	Chair
	Session 3: Applied Analysis and Probability	Jorge Velasco
9:00 – 9:30	Pablo Alexei Gazca Orozco. *Title: A Semismooth Newton Method for Bingham Flow.*	AAP6
9:30 – 10:00	JORGE ALFREDO ESQUIVEL AVILA. *Title: A differential inequality and the blow-up of its solutions.*	AAP7
10:00 – 10:30	José Luis Herrera-Aguilar. *Title: Mathematical aspects for a 3 dimensional flame reconstruction.*	AAP8
	Session 4: Topics on numerical Ocean Modelling	Miguel Angel Moreles
9:00 – 9:30	Federico Angel Velazquez Muñoz. *Title: Numerical simulation of internal tide in the Gulf of California .*	OM1
9:30 – 10:00	Fabricio Otoniel Pérez Pérez. *Title: Numerical simulation of one-dimensional sea surfaces using the KLS representation.*	OM2
10:00 – 10:30	Danalie de los Angeles Azofeifa Chaves . *Title: A parallel implementation of the HDG method for elliptic equations and application to a nonhydrostatic ocean slice model.*	OM3

Tuesday, June 22nd

Time	Activity	Chair
11:00 – 12:00	**Plenary talk:** Dr. Pablo A. Marquet (Pontificia Universidad Católica de Chile). *Title: Mathematics and the Integration of theories in Ecology.*	Jorge Velasco
12:00 – 12:30	**Coffee Break**	

Dr. Pablo A. Marquet
Pontificia Universidad Católica de Chile

Pablo A. Marquet is Director of the Department of Ecology at the Pontificia Universidad Católica de Chile. He is a biologist amply recognized for his contributions in the fields of macroecology, theoretical ecology, conservation, and global change; the scaling of abundance in communities, the evolution of body size on landmasses; connecting body size to area, evolution, and fitness, metapopulation models in dynamic landscapes, the emergence of power laws in ecology and, social complexity, and the impact of climate change upon biodiversity. He is Fellow of the Ecological Society of America, a member of the Chilean Academy of Science, The National Academy of Sciences, The American Academy of Arts and Sciences, and The World Academy of Sciences. His program has as a central aim to understand biological complexity using tools from mathematics, physics, biology and anthropology.

Tuesday, June 22nd

Time	Activity	Chair
	Session 1: Topology in Data Science	Esteban Hernandez
12:30 – 13:00	Esteban Abelardo Hernandez Vargas *Title: The shapes of the immune system during infectious diseases*	TDA1
13:00 – 13:30	Jesús Rodríguez Viorato *Title: Describing math documents' topological structure*	TDA2
13:30 – 14:00	Antonio Rieser *Title: Applied topology from a classical point of view*	TDA3
14:00 – 14:30	Hugo Cabrera Ibarra *Title: Estudio de la estructura secundaria del ARN usando gráficas*	TDA4
	Session 2: Health Care Applications	Irma García
12:30 – 13:00	Rodolfo Mendoza Gómez *Title: Optimization models for the planning of services in a public healthcare system*	HC4
13:00 – 13:30	Jessica Beltrán Márquez *Title: Image classification with deep learning to support disease diagnosis*	HC5
13:30 – 14:00	Jesús Alejandro Navarro Acosta *Title: Machine learning approaches for psychological assessment of mexican professors and students during COVID-19 pandemic*	HC6
14:00 – 14:30	Ana Kristhel Esteban López *Title: Modelo Continuo en EDP's de la Angiogenesis Inducida por Tumor*	HC7

Tuesday, June 22nd

Time	Activity	Chair
	Session 3: The role of the viscous stress tensor in poroelasticity	Pratap N. Sahay
12:30 – 13:00	Pratap N. Sahay and Tobias M. Müller. *Title: Slow Shear Wave in Poroelasticity.*	PE1
13:00 – 13:30	Josué G. González, Pratap N. Sahay and Tobias M. Müller. *Title: Importance of the fluid viscous stress tensor in shear wave propagation across material discontinuities.*	PE2
13:30 – 14:00	Selene Solorza-Calderón *Title: The role of fluid viscous stress tensor on attenuation of torsional vibrations in a poroelastic cylinder.*	PE3
14:00 – 14:30	Gabriel Mejia Ruiz *Title: Time domain signature of poroelastic slow shear*	PE4
14:30 – 15:00	Tobias Mueller *Title: Slow P-wave to slow S-wave conversion acts as dynamic permeability*	PE5
	Session 4: Topics on numerical Ocean Modelling	Miguel Angel Moreles
12:30 – 13:00	Gerardo Hernández Dueñas. *Title: Oceanic Sub-mesoscale Wave-Vortical Interactions and Their Effect on Scalar Transport*	OM4
13:00 – 13:30	José Alejandro Butanda Mejía *Title:Bathymetry Reconstruction Using Inverse Shallow Water Models in One Dimension.*	OM5

Tuesday, June 22nd

Time	Activity	Chair
	Session 4: Modeling in Earth Sciences	Markus Gross
13:30 – 14:00	Jonas D. De Basabe, Janaki Vamaraju, Mrinal K. Sen and Mary F. Wheeler. *Title: An Analysis of the High-Order Enriched Galerkin Method for Wave Propagation*	ES1
14:00 – 14:30	Abel Palafox González . *Title: Bayesian B-spline surrogate model on 2D gravity data inversion.*	ES2
14:30 – 15:00	Valdés-Moreno Beatriz, De Basabe Jonás D. y Pérez-Flores Marco A. *Title: Modelado 2D y 3D de campos electromagnéticos en el dominio del tiempo con aplicaciones a la exploración del subsuelo* .	ES3

Tuesday, June 22nd

Time	Activity	Chair
	Posters Day 2:	Daniel Olmos
16:00 – 17:00	Ledyz Cuesta Herrera. *Title: Modelo matemático celular de infección viral con respuesta lítica dependiente de mutación.*	
16:00 – 17:00	Cynthia Marlen Díaz Márquez. *Title: Inteligencia artificial aplicada para el pronóstico del desempeño académico de estudiantes universitarios. .*	
16:00 – 17:00	Iván Méndez Cruz. *Title: Construcción de Parametrizaciones de Regiones Planas Irregulares.*	
16:00 – 17:00	Ana Kristhel Esteban López. *Title: Modelo Continuo en EDP's de un Tumor .*	
16:00 – 17:00	Julián González Trinidad. *Title: Integración de la Carga Hidráulica, Profundidad de Captación y la Calidad del Agua para la Identificación de los Sistemas de Flujo en un Acuífero.*	
16:00 – 17:00	Adolfo Ayuso Hernández . *Title: Simple closed-form property expressions of two metafluids composed of periodic arrays of transversely isotropic elastic fibres embedded in an ideal fluid.*	
16:00 – 17:00	Francisco J. Sánchez Bernabe *Title: Estudio de una solución analítica de las Ecuaciones de Navier-Stokes*	

Tuesday, June 22nd

Time	Activity	Chair
17:00 – 18:00	**Plenary talk:** Dr. Béatrice Rivière (Rice University). *Title: Discontinuous Galerkin Methods for Modeling Porous Media: Theory and Simulations.*	Miguel Angel Moreles
18:00 – 18:30	**Business Meeting**	MexSIAM Officers

Dr. Béatrice Rivière
Rice University

Beatrice Riviere is a Noah Harding Chair and Professor in the Department of Computational and Applied Mathematics at Rice University. She received her Ph.D. in 2000 from the University of Texas at Austin. Her other degrees include a Master in Mathematics in 1996 from Pennsylvania State University and an Engineering Diploma in 1995 from Ecole Centrale, France. She is the author of more than one hundred scientific publications in numerical analysis and scientific computation. Her book on the theory and implementation of discontinuous Galerkin methods is highly cited. Her research group is funded by the National Science Foundation, the oil and gas industry and the Gulf Coast Consortia for the Quantitative Biomedical Sciences. Dr. Riviere has worked extensively of the development and analysis of numerical methods applied to problems in porous media and in fluid mechanics. Her current research deals with the development of high-order methods in time and in space for multiphase

multicomponent flows (in rigid and deformable media); the modeling of pore scale flows for immiscible and miscible components; the numerical model of oxygen transport in a network of blood vessels; the analysis of PDE-based neural networks for image segmentation and the design of iterative solvers. She has graduated a total of seventeen Ph.D. students, with eight working in academia, eight in industry and one in national labs. Dr. Riviere is an associate editor for the SIAM Journal on Scientific Computing, for Results in Applied Mathematics and a member of the editorial board for Advances in Water Resources. Dr. Riviere is a SIAM Fellow (Class of 2021). She has been actively involved with SIAM for several decades. She currently serves as the President of the SIAM TX-LA Section. She was elected Chair of the Activity Group on Geosciences from 2020 to 2021. She is also an active member of AWM and USACM.

Wednesday, June 23rd

Time	Activity	Chair
	Session 1: Modeling COVID-19 for decision making in Public Health.	Roberto Saenz
9:00 – 9:30	Mario Santana Cibrian. *Title: What is the best mathematical model to describe an epidemic?*	PH1
9:30 – 10:00	Manuel Adrian Acuña Zegarra. *Title: Behavioral changes and their effect on epidemic modeling.*	PH2
10:00 – 10:30	Marcos Aurelio Capistrán Ocampo. *Title: Lessons learned while modeling the COVID-19 pandemic.*	PH3
10:30 – 11:00	Discussion.	PH4
	Session 2: Homogenization Techniques for heterogeneous materials	Raul Esquivel
9:00 – 9:30	Raul Patricio Esquivel Sirvent *Title: Generalized Maxell-Garnett technique for different-shaped inclusions..*	HT1
9:30 – 10:00	Reinaldo Rodríguez Ramos. *Title: Maxwell's scheme for the evaluation of effective electro-elastic properties with different inclusion shapes.*	HT2
10:00 – 10:30	Federico J Sabina. *Title: Complex effective transport properties of multi-phase fibre composites*	HT3
10:30 – 11:00	Luis Mochán. *Title: Nonlocal Metamaterials.*	HT4

Wednesday, June 23rd

Time	Activity	Chair
	Session 3: Modelación matemática de flujo y transporte en medios porosos	G. Herrera, M. Hernandez
9:00 – 9:30	Graciela Herrera Zamarrón. *Title: Algunos ejemplos de modelación estocástica en aguas subterráneas.*	MP1
9:30 – 10:00	Guillermo de Jesús Hernández García & Gustavo Berumen Saldívar *Title: Experiencia actual de modelación con Modflow*	MP2
10:00 – 10:30	Mario Alberto Hernandez Hernandez. *Title: Análisis piezométrico del acuífero en explotación de la porción sur de la Cuenca de México mediante estimaciones geoestadísticas.*	MP3
10:30 – 11:00	Martín A. Díaz Viera. *Title: Estimación de la presión capilar en pruebas de centrífuga usando un modelo de flujo bifásico en medios porosos.*	MP4
	Session 4: Difusión sobre superficies: estudio teórico y numérico	Aldo Ledesma
9:00 – 9:30	Aldo Ledesma Durán. *Title: Revisión: Modelos geométricos de difusión mesoscópica sobre superficies..*	DS1
9:30 – 10:00	Elizabeth Alejandra Ortiz Duran. *Title: Simulación de Patrones de Turing en Superficies con Curvatura.*	DS2
10:00 – 10:30	Ivan Santamaria-Holek. *Title: Entropic Effects of Interacting Particles Diffusing on Spherical Surfaces.*	DS3
10:30 – 11:00	Héctor Juárez Valencia . *Title: Finite element solution of the Laplace-Beltrami equation on surfaces .*	DS4

Wednesday, June 23rd

Time	Activity	Chair
11:00 – 12:00	**Plenary talk:** Dr. Francisco J. Ocampo Torres (CICESE). *Title: Ocean surface waves and ocean-atmosphere interactions.*	Miguel Angel Moreles
12:00 – 12:30	**Coffee Break**	

Dr. Francisco J. Ocampo Torres
CICESE

Oceanographer from Marine Science School of University of Baja California (1980), MSc in Physical Oceanography from CICESE (1982), and PhD from Oceanography Department, University of Southampton (1989), with more than 40 years experience with studies of ocean surface wave dynamics and related processes. Research Scientist in Physical Oceanography Department of CICESE, with permanent position since 1994. Author or co-author of more that 40 scientific articles published in peer review journals, mainly associated with ocean surface wave dynamics and applications, air-sea interaction with emphasis in carbon dioxide and momentum transfer between the ocean and atmosphere. Research interest is very much related to perform detailed observations of the most relevant physical variables associated with the dynamics of the sea surface, making use of modern devices ranging from ADCP and turbulent velocity detectors, to optical cameras and radars on-board of satellites or airplanes, as well as deployed along the coast. More recently with great interest in ocean wave energy and the potential conversion to practical uses, dealing with resources evaluation and with the development of experiments in the laboratory and at sea, to make progress on designing and building new devices to convert the ocean wave energy. Supervisor or co-supervisor of about 30 graduate

students (11 PhD, and 21 MSc), mainly form the Physical Oceanography Graduate programe at CICESE. Active member of the WISE (Waves in Shallow Environments) group since 1994, and of its Scientific Committee of since 2014. Member of the Mexican Academy of Science since 2000, and of the Mexican National System of Researchers, at Level 3 since 2016.

Wednesday, June 23rd

Time	Activity	Chair
	Session 1: Modeling COVID-19 for decision making in Public Health.	Marcos Capistrán
12:30 – 13:00	SAUL DIAZ INFANTE VELASCO. *Title: COVID-19 optimal vaccination policies:a modeling study on efficacy, natural and vaccine-induced immunity responses*	PH5
13:00 – 13:30	Valeria Soto Mendoza. *Title: Aprendizaje automático para la valoración psicológica de estudiantes y profesores durante la pandemia*	PH6
13:30 – 14:00	José Alberto Guzmán Torres. *Title: Prediction of critical COVID-19 patients in Mexico supporting in its clinical history using a Multilayer Perceptrons Model*	PH7
14:00 – 14:30	Rodolfo Guadalupe Blanco Rodríguez. *Title: Computational simulations of cell immune response dynamic for severe and critical cases of COVID-19*	PH8
14:30 – 15:00	Kernel Enrique Prieto Moreno. *Title: On mobility trends analysis of COVID-19 dissemination in Mexico City.*	PH9

Wednesday, June 23rd

Time	Activity	Chair
	Session 2: Modeling in Earth Sciences	Jonas D. De Basabe
12:30 – 13:00	Cruz Hernández Favio y Gallardo Delgado Luis Alonso. *Title: 3D Modeling of natural source electromagnetic fields*	ES4
13:00 – 13:30	Erik Gallardo Romero, Diego Ruiz Aguilar (CICESE). *Title: Análisis de efectos topográficos en datos magnetotelúricos mediante el modelado 3D con mallas no estructuradas.*	ES5
13:30 – 14:00	Raul U. Silva, Jonas D. De Basabe y Mrinal K. Sen. *Title: Cooperative Gravimetric and Elastic Full Waveform Inversion.*	ES6
14:00 – 14:30	Vanesa Magar. *Title: Evaluation of in-stream renewable energy resources with shallow-water models: case studies in the Gulf of California.*	ES7
14:30 – 15:00	Markus Sebastian Gross. *Title: Challenges in high resolution wind forecasts and scope for machine learning.*	ES8

Wednesday, June 23rd

Time	Activity	Chair
	Session 3: Modelación matemática de flujo y transporte en medios porosos	Guillermo Hernández
12:30 – 13:00	Hugo E. Júnez Ferreira, C. Octavio Robles Rovelo, Carlos Bautista Capetillo, Julián González Trinidad, Graciela Herrera Zamarrón. *Title: Use of bivariate geostatistics for hydraulic conductivity estimation*	MP5
13:00 – 13:30	Nelly Lucero Ramírez Serrato *Title: Evaluación de la relación entre los daños por subsidencias y el espesor de arcillas correspondiente, para la CDMX.*	MP6
13:30 – 14:00	Daniel Castañon Quiroz. *Title: A two-phase geothermal model with fracture network and multi-branch wells for geothermal simulation.*	MP7
14:00 – 14:30	Julián González Trinidad *Title: Metodología para el diseño de redes de monitoreo de agua subterránea basada en geoestadística espacial y ruta crítica*	MP8

Wednesday, June 23rd

Time	Activity	Chair
	Session 4: Difusión sobre superficies: estudio teórico y numérico	Aldo Ledesma
12:30 – 13:00	Pavel Castro Villareal. *Title: Efectos geométricos inducidos en dinámica browniana.*	DS5
13:00 – 13:30	Guillermo Chacón-Acosta. *Title: Influencia de la geometría sobre la difusión en canales estrechos sobre superficies y en variedades tubulares.*	DS6
13:30 – 14:00	Inti Pineda Calderón. *Title: El método de Kalinay y Percus para estudiar la difusión cuasi-unidimensional en tubos con fronteras parcialmente absorbentes.*	DS7
14:00 – 14:30	Diana Assaely León Velasco. *Title: Numerical Solutions of the Laplace-Beltrami equations on surfaces on* $\mathbb{R}^3$.	DS8
14:30 – 15:00	Conclusions	DS9

Wednesday, June 23rd

Time	Activity	Chair
	Session 2: Homogenization Techniques for heterogeneous materials	Raul Esquivel
16:00 – 16:30	Adolfo Ayuso Hernández. *Title: Simple closed-form property expressions of two metafluids composed of periodic arrays of cubic elastic fibres embedded in an ideal fluid* .	HT5
16:30 – 17:00	Rogelio Oscar Caballero Pérez. *Title: Closed form expressions for the effective properties of laminates with non-uniform imperfect contact.*	HT6

Wednesday, June 23rd

Time	Activity	Chair
17:00 – 18:00	**Plenary talk:** Dr. Edgar Knobloch (University of California - Berkeley) . *Title: Geostrophic turbulence and the formation of large scale structure.*	Gerardo Hernández
18:00 – 18:30	**Plenary talk:** Concluding Remarks.	

Dr. Edgar Knobloch
University of California - Berkeley

Edgar Knobloch is a professor at the Department of Physics, U.C. Berkeley since 1978. Dr. Knobloch obtained his Ph.D. from Harvard University (1978). Dr. Knobloch has been fellow of SIAM and the American Physical Society; he has received the Larmor (John's College, Cambridge) and the Chaire d'Excellence Pierre de Fermat Prizes; and has been a Baylis Scholar, J.F. Kennedy Scholar and Junior Fellow (Harvard U.), Alfred P. Sloan Research Fellow, Rosenbaum Fellow (Isaac Newton Institute), NZIMA Maclarin Fellow (U. of Auckland, New Zealand); he has received the Doctor Honoris Causa from the Université Paul Sabatier (France) and from Universidad Politécnica de Madrid. His research interests center on nonlinear dynamics of dissipative systems. These focus on bifurcation theory, particularly in systems with symmetries, transition to chaos in such systems, low-dimensional behavior of continuous systems and the theory of nonlinear waves. Applications include pattern formation in fluid systems, reaction-diffusion systems, and related systems of importance in geophysics and astrophysics. He is also interested in the theory of turbulent transport and the theory of turbulence. Edgar is the author of approximately 370 refereed papers, with h-index = 49 (Web of Science) and h-index = 61 (Google citations).

Titles and abstracts

Title: Unified framework for conservative discontinuous Galerkin methods for nonlinear Schrödinger equations .

Sergio Gomez .

University of Pavia.

Abstract:
In this talk we present a family of fully discrete methods preserving the discrete version of two important physical invariants for the nonlinear Schrödinger (NLS) equation with generalized potential and their extension to N strongly coupled nonlinear Schrödinger (N-CNLS) systems. These methods combine a class of symmetric discontinuous Galerkin (dG) methods as spatial discretization and modified Crank-Nicolson time marching schemes. For N-CNLS systems, in order to avoid solving a global nonlinear system, involving all the components of the vector field at each time step, a conservative nonlinear splitting method is proposed. Conservation of the mass for each component and total energy is formally proven for the semi-discrete and fully-discrete methods. Conservation and accuracy of the proposed methods are numerically validated on a series of benchmark problems. In particular, for the minimal dissipation version of the Local Discontinuous Galerkin (md-LDG) method; using a special projector operator, the approximated initial energy of the system exhibits a convergence with order $h^{(2p+2)}$ when polynomial approximations of degree p are used.

Title: Numerical methos for the direct non-linear Fourier transform of the Non Linear Schrödinger Equation .

Ulises Velasco-García.

Universidad Autónoma de Querétaro .

Abstract:
In this talk we focus on the direct non-linear Fourier transform for the Non Linear Schrödinger Equation, which reduces to the study of the Zakharov-Shabat (Z-S) system [1,2,3] of the form

$$\begin{pmatrix} v_1'(x) \\ v_2'(x) \end{pmatrix} = \begin{pmatrix} -i\lambda & q(x) \\ -q*(x) & i\lambda \end{pmatrix} \begin{pmatrix} v_1(x) \\ v_2(x) \end{pmatrix},$$

where $v_{1,2}$ are unknown complex functions, λ is the spectral parameter, the complex-valued function $q(x)$ is the potential, $*$ is the complex conjugation and i is the imaginary unit. Since the Z-S system reduces to Sturm-Liouville equations we show, under a few restrictions for the potential, the spectral parameter power series [4] and the analytic approximation of transmutations operators [5] representations for the solutions of the Z-S system and the corresponding nonlinear Fourier coefficients.

Finally we show numerical experiments, properties and numerical advantages of each method. [1] M. J. Ablowitz, H. Segur. Solitons and th Inverse Scattering Transform. *1st ed. Society for industrial and applied mathematics (SIAM), 2000*. [2] M. I. Yousefi, F. R. Kschischang. Information transmission using the nonlinear Fourier transform, part I: Mathematical tools. *Submitted to IEEE transactions on information theory. ArXiv:1202.3653v2*. [3] J. K. Shaw. Mathematical principles of optical fiber communications. *SIAM, May 1, 2004-93 pages*. [4] V. V. Kravchenko, R. M. Porter. Spectral parameter power series for Sturm-Liouville problems. Mathematical Methods in the Applied Sciences. *Special Issue: Complex-Analytic Methods. Volume 33, Issue 4, pages 459-468, 15 March 2010*. [5] V. V. Kravchenko, S. M. Torba. Analytic approximation of transmutation opperators and applications to highly accurate solution of spectral problems. *Journal of Computational and Applied Mathematics, Volume 275, February 2015, Pages 1-26*.

Title: Estimación de la tasa de migración en una red epidémica .

Mayra Núñez López .

Instituto Tecnológico Autónomo de México .

Abstract:

La mayoría de los brotes epidémicos recientes en el mundo tienen como desencadenante un fuerte componente migratorio como se ha evidenciado en la reciente pandemia de Covid-19. En este trabajo abordamos el problema de la migración de poblaciones humanas y su efecto sobre las reinfecciones de patógenos en el caso del dengue, utilizando un modelo de metapoblación susceptible-infectado-susceptible (SIS) de cadena de Markov sobre una red. Nuestro modelo postula una tasa de contacto general que representa una medida local de varios factores: el tamaño de la población de hosts infectados que llegan a una ubicación determinada en función del tamaño total de la población, la incidencia actual en ubicaciones vecinas y la conectividad de la red donde la enfermedad se propaga.

Title: Dynamical Characterization of Antiviral Effects in COVID-19 .

Esteban Abelardo Hernandez Vargas .

Instituto de Matematicas, Unidad Juriquilla, UNAM .

Abstract:
The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has paralyzed our societies, leading to self-isolation and quarantine for several days. COVID-19 is a major threat to humans, with alarming levels of spread and death. Although there are many mathematical models developed at the

epidemiological level for COVID-19, more efforts at the host level are needed to understand the replication cycle of SARS-CoV-2 and its interactions with the immune system. Mathematical models will play a central role in deciphering what experimental data sets hide, thus uncovering the missing pieces of how SARS-CoV-2 can escape immune system responses. This talk will be interdisciplinary, teaching basic concepts of immunology and virology. Subsequently, using different mathematical tools, possibilities of how SARS-CoV-2 interacts and influences the immune system will be discussed. Additionally, based on the developed host models we present dynamical characterization of antiviral effects in COVID-19, providing in this way necessary condition for the development of new antivirals.

Title: Generalized quasi-geostrophy for moist spatially anisotropic atmospheric flows with phase changes .

Cesar Alberto Rosales Alcantar .

Universidad Nacional Autónoma de México.

Abstract:
In [1], quasi-geostrophy was generalized for anisotropic rotating flows in the dry case. The model was derived using asymptotic analysis in terms of the Rossby number ϵ and assuming certain assumptions. In this work, we extend that approach by taking moist and phase changes into the dynamics. Our limiting equations assume a large vertical scale with non-vanishing leading vertical velocity. The resulting model is multi-scale where the averaged moist and equivalent potential temperature evolve over a slow timescale and the fluctuations evolving on a fast timescale. In this talk, we will discuss other generalizations (see e.g. [2]) where the vertical and horizontal scales are comparable, and the vertical velocity is $O(\epsilon)$. This is joint work with Gerardo Hernandez-Duenas.

[1] Sprague, M., Julien, K., Knobloch, E., and Werne, J. (2006). Numerical simulation of an asymptotically reduced system for rotationally constrained convection. Journal of Fluid Mechanics, 551:141-174.

[2] Smith, L. M. and Stechmann, S. N. (2017). Precipitating quasigeostrophic equations and potential vorticity inversion with phase changes. Journal of the Atmospheric Sciences, 74(10):3285–3303.

Title: The DVS-DDM: A very effective approach for processing Partial Differential Equations of Pure and Applied Science.

Ismael Herrera-Revilla .

Geofísica, UNAM .

Abstract:
Mathematical models of many systems of interest, including very important continuous systems of Engineering and Science, are constituted by a great variety of boundary-value problems (BVP) of partial differential equations, or systems of such equations, whose solution methods are based on the computa-

tional processing of large-scale algebraic systems. Furthermore, the incredible expansion experienced by the existing computational hardware and software has made amenable to effective treatment problems of an ever-increasing diversity and complexity, posed by engineering and scientific applications. Parallel computing is outstanding among the HPC tools, especially at present when further increases in hardware speed have reached insurmountable barriers. The most effective manner of applying parallel processing to partial differential equations is domain decomposition methods (DDM). Ideally, such procedures are most effective when the system-matrices are block-diagonal. Unfortunately, standard (or, canonical) DDMs do not satisfy such a condition. This invited talk is devoted to present the DVS-DDM, a non-canonical approach, recently introduced by IHR and co-workers, which possesses such a property.

I. DESCRIPCIÓN DE LA INNOVACIÓN La Computación, además de ser la innovación introducida en el Siglo XX que más ha transformado la vida humana, es un poderoso instrumento para la ciencia tanto en sus aspectos fundamentales como en sus aplicaciones prácticas. Por otra parte, la increíble expansión habida tanto en el equipo de cómputo (hardware) como en los códigos computacionales (software) ha permitido tratar en forma efectiva problemas de diversidad y complejidad que crecen permanentemente. Entre las nuevas herramientas computacionales destaca las computadoras en paralelo, especialmente en los últimos años en que ya no ha sido posible aumentar la velocidad de procesamiento de los elementos básicos que integran al equipo de cómputo; (Ley de Moore) Para la aplicación del cómputo a la ciencia pura y aplicada, la clave es la solución numérica de sus ecuaciones diferenciales parciales. Consecuentemente, la comunidad internacional (es decir, mundial) ha trabajado intensamente desde hace muchos años en el desarrollo de métodos efectivos resolver tal clase de ecuaciones por medio del cómputo en paralelo. Las principales dificultades del cómputo en paralelo son la transmisión de información entre el gran número de procesadores que integran al equipo paralelizado de cómputo, así como su coordinación. En el estudio de esta clase de problemas pronto se percataron de que para el tratamiento de ecuaciones diferenciales los métodos de descomposición de dominio (DDM, o simplemente DD) son los más efectivos. Para desarrollarlos, en 1988 se funda al organización DDM y desde entonces la comunidad internacional ha trabajado intensamente en desarrollarlos. De esa manera se inició la escuela mundial de métodos de descomposición de dominio y a sus métodos los denominaremos canónicos, en alusión a que se ajustan a los cánones prevalentes en la actualidad. Los métodos IHR constituyen una innovación no canónica, pues se aparta de los cánones. El rasgo característico principal de estos métodos de descomposición de dominio radica en la forma de la matriz del sistema de las ecuaciones discretas; dicha matriz es diagonal por bloques para los métodos IHR, mientras que ella no posee esta propiedad cuando se deriva con los métodos canónicos.

Title: FORMULACIÓN DE UN MODELO DE FLUJO EN MEDIOS POROSOS FRACTURADOS UTILIZANDO DESCOMPOSICION DE DOMINIO .

Norberto Carmen Vera Guzmán .

Instituto de Geofísica, UNAM.

Abstract:

En este trabajo se presenta una forma de abordar un problema de flujo en medios porosos fracturados (macrofracturas) utilizando descomposición de dominio por medio de dos modelos mixtos acoplados, uno en 2D y otro en 1D. Para hacer esto, consideramos el dominio original en 2D y su mallado correspondiente. Con base en este mallado, replanteamos el problema original como un conjunto de subproblemas utilizando descomposición de dominio. En el proceso de descomposición de dominio se definen fronteras internas de cada subdominio e interfases entre cada par de ellos, dando lugar a una línea poligonal en 1D que es definida como parte de la red de fracturas del dominio. En cada una de estas interfases se plantea un modelo mixto de flujo en 1D, acoplado con dos problemas mixtos de flujo en 2D (problemas en los bloques) y tambien, acoplados con los problemas mixtos vecinos en 1D (cuando los haya). El resultado final es un conjunto de problemas mixtos planteados en 2D para los bloques o subdominios, y otro conjunto de problemas mixtos en 1D planteados para las interfases entre cada par de bloques y con sus respectivos vecinos en 1D, todos ellos acoplados y comunicados por condiciones de transmisión de presión y flujo de masa. Los dos conjuntos de problemas se resuelven utilizando Elemento Finito Mixto. Se presentan resultados preliminares.

Title: Characterizing the dynamics of COVID-19 transmission using multiple mathematical approaches and novel data sources.

Mauricio Santillana .

Harvard University .

Abstract:
TBA

Title: Target Reproduction Number y medidas de control para enfermedades .

David Baca Carrasco .

Instituto Tecnológico de Sonora .

Abstract:
En la modelación matemática de enfermedades, un concepto relevante a analizar es el número reproductivo básico (R0). Este parámetro proporciona información respecto a lo agresiva que es una enfermedad y permite inferir respecto de las posibles medidas de control que a la postre permitirán disminuir las incidencias de la misma. Sin embargo, en ciertos modelos, la estructura de R0 es algebraicamente muy compleja, lo que no permite hacer un análisis adecuado del mismo. Una herramienta útil para abordar estos casos es la del Target Reproduction Number (TS), el cual, es también un parámetro umbral y que permite determinar si es posible controlar la enfermedad actuando solo en algún subconjunto de entradas de la matriz de siguiente generación. Así, en esta charla se presenta un análisis de estos dos conceptos y se ilustra la bondad de TS a través de un ejemplo.

Title: Mathematicial model of dengue multiserotype interactions .

Nancy Leticia Gonzalez Morales .

Universidad Nacional Autónoma de México .

Abstract:
Classical mathematical models for the study of dengue serotype transmission dynamics incorporate two serotypes, and others account for four serotypes,but up to secondary infections. I present a mathematical approach to study dengue serotype interactions and their possible effect on serotype patterns cocirculation based on parameters associated with changes in the host susceptibility due to previous infections. I incorporate these changes in the reinfection rates, referring reinfection as an epidemiological term that allows, besides reinfections by the same serotype, subsequent infections by different serotypes. In order to do so, I assume that cross reactions elicit by the host immune system trigger changes in host susceptibility to acquire reinfections.

Title: Efecto de la movilidad diaria de las personas sobre la dinámica del dengue .

Mayra Rosalia Tocto Erazo .

Universidad de Sonora .

Abstract:
La movilidad de las personas juega un rol importante en la propagación de enfermedades infecciosas. A una escala urbana, las personas se trasladan diariamente a sus lugares de trabajo, escuelas, entre otras actividades diarias. En esta plática exploraremos un enfoque para incluir la movilidad periódica diaria de manera explícita en un modelo vector-huésped de dos parches basado en sistemas de ecuaciones diferenciales ordinarias. Aplicamos el modelo a datos de un brote de dengue de 2010 en Hermosillo, Sonora, para estudiar tres escenarios de movilidad urbana: i) cuando no se considera la movilidad entre los parches, ii) cuando los residentes de cada parche pasan diariamente el 75% de su tiempo en su lugar de residencia y iii) cuando los residentes de cada parche pasan diariamente el 50% de su tiempo en su lugar de residencia. Usamos un enfoque bayesiano para estimar algunos parámetros del modelo y comparar los escenarios de movilidad.

Title: Comportamiento umbral de un modelo de planta vector-huésped estocástico: virus del rizo amarillo del tomate. .

Gabriel Adrián Salcedo Varela .

Universidad de Sonora .

Abstract:
Las enfermedades en los cultivos presentan un riesgo importante para el productor, tales reducir la cosecha, menor calidad y limitan la disponibilidad de materia prima. En esta charla formulamos un modelo estocástico vector-host para la enfermedad del virus del rizo amarillo en el tomate. Analizamos la dinámica del modelo y verificamos nuestros resultados con simulaciones numéricas. Probamos que el modelo presenta extinción o persistencia vía las intensidades de ruido.

Title: La Modelación Matemática de Epidemias: ¿cuál es el mejor modelo? .

Ignacio Barradas Bribiesca .

Cimat .

Abstract:
Se presentan datos reales de epidemias, en especial de Covid19, y se muestra cómo es posible ajustar a ellos diversos modelos, dependiendo de premisas realistas. Si se varía la ventana de tiempo, la escala o aun detalles menores, es posible que algún modelo diferente ajuste mejor los datos. Se discuten diferentes alternativas para tomar una decisión útil que permita que el modelo seleccionado tenga algunas propiedades descriptivas y, de ser posible, predictivas.

Title: Global dynamics of a full mosquito population model .

Luis Franco Pérez .

Universidad Autónoma Metropolitana - Cuajimalpa .

Abstract:
The global dynamics of a mosquito population model is presented. This model asummes different intrinsic features of mosquito's life cycle such the Allee effect and intraespecific competition for resources in the enviroment during the larvae stage. Unlike other models tackling some these phenomena, the present model discusses all together in order to stablish which of them have the main role in it population behaviour. Bifurcations and a "basic reproduction number" are discussed, both not being established in a classical way. Simulations are included in order to have a deeper discussion.

Title: Bifurcations in a minimal model of cancer. The effect of vascularization. .

Joaquin Delgado Fernández .

Departamento de Matemáticas, UAM-Iztapalapa .

Abstract:

In this work, we study an extension of the minimal model of cancer due to Delisi and Resigno, themodel includes an avascular tumor and further vascularization. The model considers nutrients supply of a spherical tumor through capillaries. The response to this phenomenon positively impacts the proliferation of cancer cells, and negatively to lymphocytes. The conditions for the existence of bifurcations of the type saddle-node, Hopf, and Takens Bogdanov are shown, as well as the bifurcation diagram around the non-degenerate Takens Bogdanov bifurcation. The implications of this system characterize the phases of immunoediting theory. This is a joint work with Eymard Hernández (Posgrado en Ciencias Naturales e Ingeniería, UAM-C) and Ivonne Hernández-Martinez (UACM-Plantel San Lorenzo Tezonco)

Title: Interacciones ecológicas y sociales relacionadas con la obtención de agua dulce .

José Roberto Romero Arias .

IIMAS .

Abstract:
Garantizar la seguridad y el uso sustentable del agua dulce es uno de los mayores desafíos a los que se enfrenta la humanidad, ya que es indispensable para todos los seres vivos y esencial para la producción de alimentos y la estabilidad económica global. Las conductas individuales o colectivas sin ningún criterio de equidad y responsabilidad en el uso del agua generalmente diezman a la misma sociedad y a los ecosistemas. Por ello, se han promovido varios procesos para el manejo y desarrollo coordinado del agua, la tierra y otros recursos relacionados, con la finalidad de maximizar el bienestar social y económico bajo una forma equitativa del uso del recurso y sin comprometer los ecosistemas vitales. En ese sentido, en este simposio mostraremos como la implementación de un modelo matemático con interacciones simples entre la sociedad, el gobierno y el recurso, provee la exploración de escenarios que permiten la implementación de estrategias de sustentabilidad.

Title: Continuous model of tumor angiogenesis .

Melissa Ponce Sosa .

Instituto de Matemáticas UNAM .

Abstract:
A quantitative model is studied that describes the formation of capillaries emerging from a main blood vessel at the beginning of angiogenesis of a solid tumor. Vascular flare-ups occur due to cell migration in response to angiogenic factors released by cancer cells. This response is related to chemotactic and hapotactic phenomena induced by angiogenic factors. 1. Chemotaxis is cell migration directed towards a region where a gradient of chemoattractants occurs. 2. Haptotaxis is cell migration directed towards a chemo-attractor gradient around immobilized ligands. These phenomena are modeled by a system of Diffusion-Reaction equations coupled to kinetic equations related to the production of

angiogenic factors and fibronectin.

Title: Dinámica poblacional de una comunidad artificial de bacterias silvestres .

Moisés Santillán Zerón .

Cinvestav.

Abstract:
Se presentan resultados experimentales y de modelado matemático concernientes a la dinámica poblacional de una comunidad artificial de bacterias silvestres, la cual consiste de tres cepa interactuantes: una antagonista, una susceptible y una resistente. Los resultados se discuten desde los puntos de vista ecológico y de enfermedades infecciosas.

Title: An immersed boundary neural network for solving elliptic equations. .

Miguel Angel Uh Zapata .

CIMAT, Unidad Mérida .

Abstract:
This work follows the ideas of the physical-inform neural networks to approximate the solutions of two-dimensional elliptic equations with singular forces on arbitrary domains using the immersed boundary method. Numerical simulations of regular solutions are initially analyzed in order to deeply investigate the performance of such methods. In the case of singular forces, the analytical solution is continuous but the normal derivative on the interface has a discontinuity. This discontinuity is incorporated into the equations as a source term with a delta function which is approximated using a Peskin's approach. The performance of the proposed method is analyzed for different interface shapes and domains. Results demonstrate that the immersed boundary neural network can approximate accurately the analytical solution for elliptic problems with and without singularity.

Title: Computing particle collisions in a fluid by the immersed interface method. .

Sheng Xu .

Southern Methodist University, USA .

Abstract:
Particle collisions in fluids are ubiquitous, but to compute the collision dynamics in a Navier-Stokes flow remains challenging. In addition to capturing the two-way coupling between the fluid and the particles, a key difficulty is to resolve the collision dynamics mediated by the flow. The gap be-

tween particles during collision is minuscule. This introduces a small length scale which needs to be resolved simultaneously with the flow at the large scale. Our goal is to develop a numerical scheme that is accurate and efficient in computing the Navier-Stokes flow around moving particles while taking into account the effect of the lubrication forces on the collisions. Our method integrates the immersed interface method with the lubrication theory in a way that directly couples all three parts, the bulk flow, the flow in the gap, and the dynamics of the freely moving particles. We present a general algorithm for computing the collision. To test the method, we study four fundamental cases involving normal and tangential collisions, so that we can compare numerics against analytic solutions in the lubrication layer. In addition, we provide the lubrication solution needed for computing collisions between surfaces of any shapes in arbitrary relative motions, so that the method can be applied to other cases.

Title: Fluid-solid modelling with heat and mass transfer and their applications in environmental studies. .

Hammouti Abdelkader .

Laboratory for Hydraulics and Environment, INRS-ETE, Canada .

Abstract:
In a worldwide context of increasing energy cost and the urge for an accelerated transition to greener and renewable energy, understanding and mastering processes of fluid dynamics, applied to energy industry, is of major importance. In fact, an enhanced mastering of these complex flows would contribute to lower their energy consumption and environmental footprint. In this talk, an overview of different numerical multiphysics and multiscale approaches will be presented to tackle these subjects and to better understand all the intricate couplings at play in these flows with fluid/solid interactions : hydrodynamic and thermal contributions.

Title: A level-set/finite-volume method based on a central interpolation scheme. .

Reymundo Ariel Itzá Balam .

CIMAT Unidad Mérida .

Abstract:
In this talk, we introduce a second-order unstructured finite-volume method developed to solve a conservative level-set equation in two- and three-dimensional geometries. An interpolation method based on a central scheme is applied for the approximations at the cell faces. The capabilities of the proposed scheme are validated using several 2D and 3D tests. Results show that the present numerical method is quite suitable for working within the smooth framework. Moreover, this method yields very accurate results in interface-capturing problems such as the single vortex deformation.

Title: Bathymetry and friction estimation from transient velocity data for 1D shallow water flows in open channels with varying width .

Gerardo Hernández Dueñas .

Instituto de Matemáticas, UNAM-Juriquilla .

Abstract:
The shallow water equations (SWE) model a variety of geophysical flows. Flows in channels with rectangular cross sections may be modelled with a simplified one-dimensional SWE with varying width. Among other model parameters, information about the bathymetry and friction coefficient is needed for the correct and precise prediction of the flow. In this talk, we propose to solve the inverse problem to estimate the bathymetry and the Manning's friction coefficient from transient velocity data. This is done with the aid of a cost functional which includes the SWE through Lagrange multipliers. The solution is obtained by solving the constrained optimization problem by a continuous descent method. Numerical tests will shown to show the merits of the algorithm. This is joint work with Miguel Angel Moreles and Pedro Gonzalez-Casanova.

Title: Finite differences in triangular meshes .

Ursula Iturraran-Viveros .

Universidad Nacional Autonoma de Mexico .

Abstract:
Traditional finite-differences are designed for rectangular grid elements. In this work we propose the calculation of weights suitable for finite differences with equilateral triangular elements. This is based on the approximation of first and second order partial difference using bivariate Lagrange interpolation polynomials obtaining weights for different size of stencils. This approach gives the advantage of having a similar accuracy with respect to traditional square meshes but with less points in the grid. We show some dispersion plots and some numerical results.

Title: Complete Systems of Scalar Schrödinger Operator Using Complex Quaternions and Transmutation Theory .

Pablo Enrique Moreira Galván .

Anáhuc Querétaro.

Abstract:
Consider the equation

$$(-\Delta + w)g = 0 \tag{1}$$

in $\Omega \subseteq \mathbb{R}^3$ where Δ is the Laplacian and w and g are complex-valued functions. We assume that $g \in C^2(\Omega, \mathbb{C})$. The operator $-\Delta + w$ is known as the *Schrödinger operator*. Using complex quaternions and Transmutation theory, we are able to find a complete system of solutions of the Schrödinger equation, when w has a specific form and Ω has a certain type of symmetry.

Title: Approximations of the Ultimate Ruin Probability in the classical risk model using the Banach's Fixed-Point Theorem and the Continuity of the Ruin Probability .

Dr. Jaime Eduardo Martínez Sánchez .

Tecnológico de Monterrey, Campus MTY (ITESM-MTY).

Abstract:
In this work, we propose two methods to approximate the ultimate ruin probability in the classical risk model or Cramer-Lundberg model when claim' sizes have some arbitrary continuous distribution. First, we approximate the ultimate ruin probability using the Banach's Fixed-Point Theorem and second, we show that there is continuity of the ruin probability, under certain probabilistic metrics, to obtain other approximation. Numerical examples when claim sizes have distribution light and heavy tailed are provided.

Title: On the Asymptotics of a Minimal Random Walk with complete memory via a martingale approach.

Víctor Hugo Vázquez Guevara .

Benemérita Universidad Autónoma de Puebla.

Abstract:
In this, paper we discuss an approach based on martingale theory in order to achieve asymptotic results for the; so call, Minimal Random Walk, which is a non Markovian random walk that poses a complete memory of its own past. Results provided consists of Laws of Large Numbers, Quadratic Strong Laws, Central Limit Theorems and Laws of Iterated Logarithm.

Title: A geo intelligent computing system to predict academic performance at college students. .

Jesús Ramón Carmona Jáquez .

Universidad Autónoma de Chihuahua (UACH).

Abstract:

The phenomenon of early school leaving is a constant problem at Latin American universities. In the case of Mexico this phenomenon impacts the public funds that each university receives (principal fund resource), the economic resources are assigned using the terminal proficiency that is measured by the number of graduated students against the number of students enrolled at each generation. A big number of factors plays a role in this early school leaving phenomenon, like the demographics (georeferenced data), academic history and factors of equality and inclusiveness. In this work we propose a convolutional Neural Network model to predict the academic future of the students for the next scholar period. We trained our model using data of 8 generations of students from the Universidad Autónoma de Chihuahua, obtaining results around the 90% of effectiveness, this results translate to a more efficient administration of the tutoring program inside the university, helping this to increase the number of graduate students.

Title: Finite Element Method with Optimal Functions applied to the Linear Elasticity Equation .

Alicia Margarita de la Mora Cebada .

Universidad Nacional Autónoma de México .

Abstract:
FEM-OF is based on an algebraic theory for the solution of partial differential equations in the space of discontinuous piecewise defined functions, proposed by I. Herrera. The spaces of functions are optimal since optimal base functions satisfy the homogeneous differential operator and optimal trial functions satisfy the homogeneous adjoint differential operator. Matlab programs (prototypes) were implemented that solve Linear Elasticity equations in 2D and 3D with Dirichlet boundary conditions. Cubic Hermite polynomials were used to approximate the optimal functions. For the symmetric differential operator, the order of convergence of FEM-OF is the same as the standard Finite Element Method, it was observed that the numerical solution with FEM-OF has a higher precision. It was also observed that FEM-OF reduces the number of degrees of freedom and generates better structured matrices than standard FEM. The use of cubic Hermite polynomials allowed us to obtain directly as a solution both the displacements and their derivatives, that is, the deformations, both of them with the same order of convergence.

Title: On a 3D Navier-Stokes Equations Analytical Solution .

Francisco Javier Sánchez Bernabe .

Universidad Autónoma Metropolitana .

Abstract:
Examples of analytical solutions for incompressible fluid have been proposed. For instance, Poiseuille flow in annular section, flow past a sphere with low Reynolds numbers, a two-dimensional solution

found by G.I. Taylor in 1923, and more recently, a family of solutions in three dimensions was constructed by Ethier and Steinman in 1994. In this paper, we report a three-dimensional solution wich is, at some extend, physically plausible, and with fairly simple boundary conditions for the associated pressure. Analytical solutions provide benchmarks to test new numerical methods for Navier-Stokes. Moreover, since our proposed solution is time dependent, several discretization schemes can be compared, even with different viscosities.

Title: Método de Homogeneización Asintótica para el Cálculo de Propiedades Efectivas en un Material Nanocompuesto en Tres Dimensiones .

MONICA TAPIA GASPAR .

Tecnológico de Monterrey Campus CEM.

Abstract:
El modelado matemático de nanomateriales es un inmenso campo de investigación en desarrollo debido a la enorme demanda en el diseño de nuevos materiales nanocompuestos, que tienen amplias aplicaciones en la industria automotriz y la industria aeroespacial. La formulación del Método de Homogeneización Asintótica (MHA) tiene un enfoque de enorme alcance para estimar las propiedades efectivas globales del compuesto. Las propiedades efectivas de materiales elásticos reforzados con nanoinclusiones de diferentes formas geométricas son modeladas mediante un método semi-analítico basado en el MHA y el Método de los Elementos Finitos (MEF). El efecto de las diferentes orientaciones de los refuerzos (fibras) influye en el comportamiento mecánico del compuesto cuando este se somete a esfuerzos que generan deformaciones. Se estudian dos casos diferentes de compuestos reforzados por "Fibras alineadas" (fibras orientadas en una sola dirección) y compuestos reforzados por "Fibras desalineadas"(fibras orientadas en diferentes direcciones). Los resultados obtenidos mediante la aplicación matemática del método de SAFEM demuestran que este es un método novedoso y con un alcance muy amplio para el cálculo de las propiedades efectivas elásticas de materiales nanocompuestos. Además, se reportan comparaciones con resultados teóricos reportados en la literatura del campo de los métodos de estimación de propiedades efectivas elásticas.

Title: Effective properties of three-phase magneto-electro-elastic fiber-reinforced composites by a semi-analytical approach .

Yoanh Espinosa Almeyda .

Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas. Universidad Nacional Autónoma de México.

Abstract:
Multi-phase composites have been receiving great attention in the literature due to the wide field of applications. Different approaches have been applied to determine the effective moduli of fiber-

reinforced composites (FRC). In this work, a semi-analytical method is developed to predict the effective magneto-electro-elastic properties of three-phase periodic composite reinforced by unidirectional, infinitely long, and concentric cylindrical fibers with square transversal distribution. The semi-analytical method is developed combining the two-scale asymptotic homogenization method (AHM) and the finite element method (FEM). The analytical formulation of the local problems and effective properties are obtained by means of the AHM. Local problems are solved by FEM via the principle of minimum potential energy. The effect of interphase thickness and the fiber material properties on effective moduli is analyzed. Comparisons between AHM solved via the theory of complex variable and the semi-analytical approach are carried out. Good agreement is obtained. The potential use of the combined AHM and FEM will allow the treatment of very complex microstructures.

Title: Ventajas del Análisis Geoestadístico 3-D de la carga hidráulica en un acuífero.

Hugo Enrique Júnez Ferreira .

Universidad Autónoma de Zacatecas "Francisco García Salinas" .

Abstract:
Hugo E. Júnez-Ferreira*, G. S. Herrera**, J. González-Trinidad*, Mario Alberto Hernández**, Ana Isabel Veyna*, José Luis Lezama**. *Universidad Autónoma de Zacatecas "Francisco García Salinas". **Universidad Nacional Autónoma de México. De manera natural, la geoestadística evolucionó de sus aplicaciones iniciales para la estimación espacial de variables del medio ambiente a la caracterización en espacio-tiempo, encontrándose en particular diversas aplicaciones de esta última para describir la dinámica de variables hidrológicas en diversas regiones del mundo. Para el caso de la hidrogeología, la configuración espacial de los niveles y la calidad del agua usualmente se representa mediante curvas de un mismo nivel (piezométrico, potenciométrico o de concentraciones, según sea el caso), lo cual significaría tener el mismo valor de la variable para toda la vertical, algo contradictorio a la teoría de sistemas de flujo en las que la presencia de zonas de recarga, tránsito y descarga para cada sistema requiere de una caracterización en 3-D. En el presente trabajo, se presenta un caso de aplicación de técnicas geoestatísticas en 3-D para la estimación de la carga hidráulica dentro de un acuífero. Los resultados son bastante alentadores ya que las estimaciones en planta, los cortes y el diagrama de vallas obtenidos permitieron identificar los patrones asociados a los sistemas de flujo, y aquéllas zonas de flujo ascendente producido por la extracción intensiva del agua del subsuelo, aspectos que bajo una visión 2-D son complicados de visualizar, y que en no pocos casos llevan a interpretaciones incorrectas. Desafortunadamente en México se tiene relativamente poca información de registros constructivos y operación de los pozos existentes para poder aprovechar este tipo de técnicas de estimación en 3-D que permitan una mejor descripción del ciclo hidrológico y sus cambios asociados a la influencia antropogénica.

Title: Threshold Parameters in Ecology and Epidemiology .

Dr. Pauline van den Driessche (CAIMS-SCMAI Research Prize (2019))

University of Victoria .

Abstract:
Target reproduction numbers are defined and shown to unify threshold parameters in population biology, including the net reproductive value used in ecology and the basic reproduction number used in epidemiology. Both algebraic (using matrices) and graphical (using weighted digraphs) approaches to computing target reproduction numbers are developed. Knowledge of these target reproduction numbers is demonstrated to aid in measuring the change of certain model parameters in order to protect endangered species (e.g., salmonoids), control invasive species (e.g., scentless camomile) and to determine disease control strategies (e.g., for cholera).

Title: Influence of impulsive irrigation supply on fruit tree growth. .

Edwin Fernando Duque Marín .

Universidad Católica del Maule- Chile .

Abstract:
The increase in temperatures and the presence of extreme climatic phenomena, together with the decrease in raindirectly impactact on agricultural systems, since water is one of the limiting factors in crop growth in semi-arid climatic areas. Then, the artificial application of water through irrigation is becoming necessary to satisfy the water demands of the fruit trees to avoid productivity loss. Any error in the irrigation strategy can generate a detrimental effect on the physiology and growth of trees. Thus, modeling the irrigation strategy is vital because it allows us to understand fruit trees' growth dynamics through a mathematical model. The main objective of this work is to simulate the trees response when considering water supply through periodic impulsive irrigation cycles.

Title: Diagnosis of diseases in plants using Gaussian Mixture Models and Probabilistic Saliency .

Lili Guadarrama Bustos .

CIMAT .

Abstract:
A simple and robust approach is presented for plant disease diagnosis by means of a neural network through images of plants even in uncontrolled environments, identifying and quantifying the colors associated with the diseases for the purpose of estimating the portion of the plant that has presence of diseased tissue. In order to improve the performance of the neural network, Gaussian Mixture Models and Probabilistic Saliency are used to accurately segment the plant from the background of an image.

Title: Inverse problems to determine the diffusion and dispersion coefficients of Lake Zirahuén, Mexico. .

Tzitlali Gasca Ortiz .

Universidad Michoacana de San Nicolás de Hidalgo.

Abstract:
Lake Zirahuén is one of the most important water bodies in the state of Michoacán, Mexico. The Lake is an important freshwater source but also a sink for pollutants and runoff. In present years it has severely suffered from natural but above all anthropogenic eutrophication. In this study, we present results of the parameter estimation of the dispersion and diffusion coefficients for Lake Zirahuén. From images of a dye tracer experiment the area and the velocity field were obtained to estimate the horizontal diffusion coefficient solving the inverse problem of the advection-diffusion equation. Also from the calculated areas of the dye patch and by solving the inverse problem the dispersion coefficient ($D = at^b$) was obtained, in this case the determination of the parameters (a, b) was made solving the inverse problem adjusting the hydrodynamical model outputs with the observed areas by minimizing the error.

Title: The Kidney Exchange Problem: Models and Algorithms .

Roger Z. Ríos .

UANL .

Abstract:
The application of Operations Research in the medical field has been the key to save more lives in a variety of decision-making problems. With the aid of mathematical models and algorithms developed for specific problems, we can now develop plans and policies, and take decisions that can lead to optimal or near optimal solutions. This is the case of the Kidney Exchange Problem (KEP) addressed in this talk. The KEP is a combinatorial optimization problem arising in the context of transplant programs that allows the exchange of kidneys between two or more incompatible patient-donor pairs. The KEP aims at maximizing the number of transplants in a given PDP compatibility graph. Finding cycles or paths in a graph of PDPs leads to finding feasible pairs that can benefit from kidney exchange between pairs. The KEP has been studied from many angles for the past 15 years. Many studies have shown the tremendous impact and benefit of this type of programs in terms of dramatic reductions to organ waiting lists, and therefore saving the lives of many people. Nation-wide kidney exchange programs have been successfully developed in a few countries; however, in many developing countries, including Mexico, nation-wide programs do not exist. For instance, the kidney waiting list in Mexico is over 17,000 and growing at a very fast rate. In this talk, we will give a brief introduction to the KEP, its basic models and solution algorithms. In addition, a case study of optimal kidney transplant

assignments in the state of Nuevo Leon, Mexico, is presented. The study, carried out by using data from Mexican population and hospitals, pretends to assess the potential impact of implementing a kidney exchange program in Mexico.

Title: Neuroevolution in Medical Image Processing. .

Héctor Gabriel Acosta Mesa .

Universidad Veracruzana .

Abstract:
Neuroevolution in Medical Image Processing. Minisimposium Health Applications. Diagnostic imaging is carried out in different fields of medical practice. Highly qualified specialists carry out the interpretation of these images. It is desirable to have automated systems that support experts in this arduous task; however, the development of these systems involves the construction of models trained from examples. Nowadays one of the most widely used machine learning paradigms for this purpose are artificial neural networks. The implementation of these learning schemes involves two fundamental processes. The first is the description of the architecture of the neural network, the second, the training of the weights of the network. The latter has been well studied and solved by gradient optimization techniques, while the establishment of the network structure has generally been solved by trial and error, by manual construction of the architecture. Recently, proposals have emerged for methods that automatically generate the topology of these neural network architectures with evolutionary computing algorithms. These algorithms represent networks by genes that evolve to create new architectures that best explains the information. In this talk, the basic principles of neuroevolution operation will be shown, as well as some applications that we have made in the area of medical imaging.

Title: Machine Learning for the early detection of Type 2 Diabetes .

Juana Julieta Noguez Monroy .

Tecnológico de Monterrey.

Abstract:
Diabetes mellitus or type 2 is a chronic and serious disease that occurs when the levels of glucose in the blood rise above the limits because the patient's body cannot produce the hormone insulin or the amount produced is insufficient. In its initial stage, it does not produce symptoms and when it is detected late and not treated properly it causes serious health complications such as heart attack, blindness, kidney failure, amputation of the lower extremities, and premature death. In Mexico, diabetes mellitus occupies one of the first two places as a cause of general death. In this talk, we will talk about a study of the most widely used machine learning techniques worldwide and their effectiveness in detecting Type 2 Diabetes and about a research proposal for the Mexican population, in collaboration with the General Hospital of Mexico "Eduardo Liceaga", based on the use of public health databases.

Title: A Semismooth Newton Method for Bingham Flow .

Pablo Alexei Gazca Orozco .

FAU Erlangen-Nürnberg.

Abstract:
We propose a semismooth Newton method for non-Newtonian models of incompressible flow where the constitutive relation between the shear stress and the symmetric velocity gradient is given implicitly; as a motivating example we consider the Bingham model for viscoplastic flow. The proposed method avoids the use of variational inequalities and is based on a particularly simple regularisation for which the (weak) convergence of the approximate stresses is known to hold. The system is analysed at the function space level and results in mesh-independent behaviour of the nonlinear iterations.

Title: A differential inequality and the blow-up of its solutions .

JORGE ALFREDO ESQUIVEL AVILA .

UNIVERSIDAD AUTONOMA METROPOLITANA .

Abstract:
We analyze the blow-up of the solutions of an ordinary differential inequality, useful to prove non-existence of global solutions of evolution equations. We extend and improve previous results.

Title: Mathematical aspects for a 3 dimensional flame reconstruction .

José Luis Herrera-Aguilar .

Universidad Autónoma de Chihuahua, UACH .

Abstract:
In this talk we review the mathematical aspects of a 3D flame reconstruction using an easy and efficient method starting from a 2D projection of hot gases flame. The projection was obtained using the schlieren optical technique with a flame as a test object. The reconstruction process was based on the hypothesis of cylindrical symmetry of the temperature spatial distribution in the flame. The schlieren images were integrated linearly in the horizontal direction to obtain the temperature distribution projection of flame. The method proposed in this work to reconstruct the 3D characteristics of flame, only requires the calculation of the outer product of one sample row of the temperature distribution by its own transpose sample row of the temperature distribution to obtain one temperature slice. After to obtain a collection of temperatures slices at different heights can be reconstructed the temperature

distribution in the volume of flame. It was evaluated the mean error in the calculations of temperature intensity in the flame under the cylindrical symmetry assumption obtaining an accuracy of 96% which validates the efficiency of method. It was found a good agreement between the flame temperature data obtained from the schlieren measurements and the direct measurements using a thermocouple.

Title: Numerical simulation of internal tide in the Gulf of California .

FEDERICO ANGEL VELAZQUEZ MUÑOZ.

UNIVERSIDAD DE GUADALAJARA .

Abstract:
"A three-dimensional, primitive equations, numerical ocean model is developed for the simulation of tidal flow over the complex bathymetry of the Gulf of California in an enclosed ocean with realistic stratification. The model was forcing with the principal tidal constituents and the model output provides the sea surface height, temperature, salinity and current velocity components each hour in the entire domain. The results of the model shows that in the region between the Islands, in the Midriff Archipelago, the internal tidal waves produce an increase in current speeds and high internal kinetic energy concentration that is dissipated toward the northern gulf resulting in significant changes in temperature and salinity. During their propagation, these internal tidal waves disintegrated into groups of short, high amplitude, strongly nonlinear waves, resulting in strong vertical and horizontal mixing. Finally, the agreement of the numerical results and in-situ measurements are discussed."

Title: Numerical simulation of one-dimensional sea surfaces using the KLS representation .

FABRICIO OTONIEL PÉREZ PÉREZ .

CIMAT.

Abstract:
Consider a stochastic signal z with autocorrelation R and power spectral density S. Given S, there exists an optimal orthogonal set of basis functions that fits z. This is because of the Karhunen-Loève (KL) spectral decomposition, in which an eigenvalue problem is expressed as a first-kind integral equation with kernel R (Basilevsky, 1994). For a given Slepian frequency c, this problem admits a solution in terms of the prolate spheroidal wave functions (PSWFs), leading to the KLS representation (Slepian-Pollack, 1961). In (Sclavounos, 2012), the KLS representation of one-dimensional sea surface elevations z is proposed. Consequently, our work starts with two software implementations: 1) the PSWFs according to (Osipov, 2013), and 2) the numerical algorithm of (Sclavounos, 2012). But unlike (Sclavounos, 2012), we compute the eigenvalues of the integral operator via (Osipov, 2014), whose small magnitudes allow the numerical simulation of z. A comparison between the KLS representation and the Fourier representation reveals that both SWHs are comparable.

Title: A parallel implementation of the HDG method for elliptic equations and application to a nonhydrostatic ocean slice model .

Danalie de los Angeles Azofeifa Chaves .

CIMAT .

Abstract:
The convection-diffusion-reaction equation appears in many CFD applications. For its numerical solution, we develop a parallel implementation of a Hybridized Discontinuous Galerkin Method. As an application, we consider a pressure splitting scheme to solve a non-hydrostatic two dimensional ocean slice model. We find satisfactory approximations on coarse grids.

Title: Mathematics and the Integration of theories in Ecology .

Pablo A. Marquet .

Pontificia Universidad Católica de Chile .

Abstract:
La integración de teorías es de gran importancia para el avance científico, ya que en principio un mismo fenómeno o fenómenos relacionados debieran ser descritos por teorías afines o una misma teoría general. Desafortunadamente, la tendencia en las ciencias ecológicas ha sido de una continua proliferación de teorías. Sin embargo, existen ejemplo de teoría que cumplen con ciertos criterios que llamamos eficientes y que serían susceptibles de ser integradas. En esta charlas discutiré las características fundamentales de estas teorías y el rol fundamental de las matemáticas en la integración de las mismas. Por último, presentaré la integración de la teoría de metacomunidades y la genética poblacional por medio de un modelo de difusión.

Title: The shapes of the immune system during infectious diseases.

Esteban Abelardo Hernandez Vargas .

Instituto de Matematicas, Unidad Juriquilla, UNAM .

Abstract:
Pathogens have important implications in many aspects of health, epidemiology, and evolution. Topological Data Analysis (TDA) is used here to help in identifying the behaviour of a biological system from a global perspective. Using data sets of the immune response during influenza-pneumococcal co-infection in mice, we employ here the mapper algorithm to simplify and visualise high dimensional

data sets. Persistent shapes of the simplicial complexes of the data in the three infection scenarios were found: single viral infection, single bacterial infection, and co-infection. The immune response was found to be distinct for each of the infection scenarios and it was uncovered that the immune response during the co-infection has three phases and two transition points.

Title: Describing math documents' topological structure .

Jesús Rodríguez Viorato.

CONACyT - CIMAT.

Abstract:
The number of submissions to the arXiv database has been growing exponentially from 2000 in January 1995 to 17000 in March 2021. With this increasing amount of articles, more automated tools are required to process and analyze these documents to help researchers to find related work or to understand research trends and directions. We applied topological techniques to try to uncover hidden structures or patterns on Arxiv's math manuscripts. In this talk, we present a detailed analysis of our findings.

Title: Applied topology from a classical point of view .

Antonio Rieser .

CONACYT - CIMAT Guanajuato .

Abstract:
There have been a number of attempts to extend the realm of application of algebraic topological tools to discrete spaces such as graphs, digital images, and point clouds, which one more typically encounters in computer science and data analysis. In each of these theories, one of two strategies has typically been taken. In topological data analysis, one usually replaces the original space with one or more topological spaces that one hopes will retain the relevant topological information in the original set. In various approaches to discrete or digital topology, we find instead different attempts to develop algebraic topology from scratch for some class of discrete objects of interest, proceeding largely by analogy with classical algebraic topology. In this work, we propose a third option: we generalize algebraic topology to categories which contain both the topological spaces classically treated by classical homotopy theory, but which also include as objects the more discrete and combinatorical spaces of interest in applications. The advantage here is that there are now non-trivial 'continuous maps' from classical topological spaces to the discrete spaces (given the appropriate structure), and one may then compare the resulting topological invariants on each side functorially. We find that there are a number of possible such categories, each with its own particular homotopy theory and associated homologies, and, additionally, that there is a generalization of the coarse category which allows finite sets to be non-trivial (i.e. not 'coarsely' equivalent to a point). We will give an overview of these theories and

several applications, discussing the advantages and disadvantages of each.

Title: Estudio de la estructura secundaria del ARN usando gráficas.

Hugo Cabrera Ibarra.

Instituto Potosino de Investigación Científica y Tecnológica.

Abstract:
Siguiendo el trabajo de T. Schlick y colaboradores, mediante el uso de gráficas, es posible estudiar la estructura secundaria del ácido ribonucleico, ARN. Representar el ARN de esta manera es útil en su análisis ya que permite encontrar unidades modulares que se repiten y, con ello, la posibilidad de aplicar aspectos combinatorios para diseñar nuevo ARN. El reciente descubrimiento de ARN no codificantes reguladores reaviva el interés en su estructura y funcionalidad. En esta plática se darán ideas básicas para, dada la estructura secundaria del ARN, generar las gráficas asociadas. Analizaremos algunas cadenas largas de ARN no codificante (lncRNA) de Saccharomyces cerevisiae, SC, que es una levadura, y se les asociará una gráfica. Estas gráficas pueden ser un auxiliar en el estudio de su funcionalidad y clasificación. Así mismo, en el caso de otras cadenas de ARN de Saccharomyces cerevisiae, pueden ayudar al indicar si cuentan con las unidades modulares detectadas lo cual sería un indicio de ser lncRNA.

Title: Optimization models for the planning of services in a public healthcare system .

Rodolfo Mendoza Gómez .

Universidad Autónoma de Nuevo León.

Abstract:
Participa en minisimposium "Health Applications". The planning of healthcare infrastructure for public services requires the maximization of resource efficiency. Access and quality of services are essential in public healthcare services in developing countries such as Mexico. Operations research tools can help in the decision-making process for the location and upgrading of services. For this purpose, we proposed a problem for the regionalization of primary healthcare units in a multi-institutional system. This problem minimizes the total travel distance of the demand allocation for a capacitated service. A second problem is proposed for the location of new healthcare units and the upgrading of the current facilities. This model integrates a set of basic services that includes outpatient medical service, nutrition consultation service, dental care service, psychological service, clinical analysis, and imaging services. These problems are empirically assessed with case studies based on the State of Mexico. The results show the usefulness of the proposed models and the possibility of applying them in the entire Healthcare System.

Title: Image classification with deep learning to support disease diagnosis .

Jessica Beltrán Márquez .

Instituto Politécnico Nacional-CITEDI-CONACYT.

Abstract:
During the last years, there has been an increase in computational resources, such as speed and memory, that has allowed the development of deep learning for image classification, including medical images. These advances make it possible to support disease diagnostic through automatic systems. In this work, presented in the Health Applications mini-symposium, it is shown the use of a deep neural network to classify optical coherence tomography images to advance in the identification of retinopathies. The results show the potential of these techniques for the future development of systems to support the diagnosis process.

Title: Machine learning approaches for psychological assessment of mexican professors and students during COVID-19 pandemic .

Jesús Alejandro Navarro Acosta .

Universidad Autónoma de Coahuila .

Abstract:
This work describes the validation of the results of a psychological test applied to teachers and students in isolation due to the COVID-19 pandemic in the state of Coahuila, Mexico. The objective of this work is to apply machine learning techniques to validate an instrument that measures negative emotions and feelings, as well as cognitive bias or deviation of thinking about education and the pandemic in isolation. For the fulfillment of the objective, an instrument was applied in electronic format that was disseminated in the state of Coahuila, the users respond and the database is generated, which, after its pre-processing, is analyzed using the combination of Random Forest (RF) and Support Vector Machines (SVM); obtaining as a result the relevance or not of some of the items from the tests, thereby giving an internal validity to the instrument. The experimental results show that the proposed methodology is capable of selecting the most relevant predictor variables. In this way, satisfactory results were obtained in the classification and prediction of psychological diagnoses. On the other hand, although the implemented techniques are robust and reliable, they present limitations in terms of the observation of the other types of validity: construct, external, among others; which could limit its use. Although, in the field of psychometry there are various classic strategies, the proposed methodology based on the combination of machine learning techniques for the analysis and validation of this type of tests, favors the growth of options to improve diagnoses and consequently the treatment of psychological ailments. Para el minisimposium "Health Applications".

Title: Slow Shear Wave in Poroelasticity .

Pratap N. Sahay and Tobias M. Müller .

Departamento de Sismología, Centro de Investigacíon Científica y de Eduacíon Superior de Ensenada .

Abstract:
The Brinkman term extension of the Darcy equation, which brings the fluid viscous stress tensors in the macroscopic description of fluid flow in a porous medium, is well accepted. Nevertheless, for wave propagation in a porous medium, the fluid viscous stress term is missing in the Biot theory. It is widely accepted that by modifying the fluid mobility term of the Biot theory via the JKD correction, one captures the fluid viscous stress tensor in the poroelastic wave equation. However, it turns out that both the Biot theory and its JKD extension lack a term, which can capture shear restoring force in fluid; hence, they are incomplete. Therefore, to complete, fluid viscous stress tensor must upscale into macroscopic constitutive relation. The de la Cruz-Spanos poroelasticity theory constructs the governing macroscopic equations by volume averaging the underpinning pore-scale equations of the solid and fluid phases and, in this manner, also naturally upscales fluid viscous stress tensor. The Biot theory is a particular case of this framework when fluid viscous stress tensor is turned off. Due to the presence of fluid viscous stress terms, an additional shear wave, namely, slow shear wave, emerges at the macroscale as an out-of-phase shear motion of the constituent phases. This process is distinct from the fast shear wave, the in-phase shear motion of the constituent phases that is akin to the shear wave of elasticity. The slow shear wave is a diffusive wave and attenuated within half a wavelength of its point of origin. In this talk, the nature of slow shear wave is presented as a prelude to the talks to follow that discuss its impact on wave propagation in heterogeneous settings.

Title: Importance of the fluid viscous stress tensor in shear wave propagation across material discontinuities .

Josué G. González, Pratap N. Sahay and Tobias M. Müller .

Centro de Investigación Científica y de Educación Superior de Ensenada.

Abstract:
We solve the boundary value problem of a normally-incident, horizontally polarized S-wave onto the planar contact of a porous medium and a solid half-space using the de la Cruz-Spanos (dCS) poroelasticity theory. This allows us to analyze the role of the slow shear wave, which is the macroscopic expression for the fluid vorticity, in the reflection/transmission problem of shear wave propagation. We show that the standard modeling recipe based on Biot's theory, or Biot theory combined with a viscodynamic operator, violates the no-slip condition between solid-frame and fluid saturant at the contact. This unphysical prediction can be rectified by incorporating the fluid viscous stress tensor into the constitutive equations, as stipulated in the dCS theory. We conclude that the fluid viscous stress tensor in the macroscopic poroelasticity theory guarantees the preservation of the no-slip boundary condition and hence renders the boundary value problem fully determined and physically meaningful.

Title: The role of fluid viscous stress tensor on attenuation of torsional vibrations in a poroelastic cylinder .

Selene Solorza Calderon .

Universidad Autónoma de Baja California .

Abstract:
The force excitation of standing modes in a poroelastic cylindrical core is an active area of experimental research to investigate the properties of rock in the sub-resonance frequency regime. Although tremendous strides have been made in the recent past in instrumentation for such experimental studies, modeling observed attenuation has been challenging. The Biot theory underpredicts the observed attenuation. The likely cause may be the missing fluid stress tensor in the Biot theory; as a result, the unaccounted slow shear process may very well cause the underestimation of attenuation by the Biot theory. To get an insight into the role of the viscous stress tensor on observed attenuation in forced oscillation experiments, in this work, I have analyzed the torsional eigenmodes of a poroelastic cylinder within the viscosity-extended framework of poroelasticity due to de la Cruz and Spanos (dCS theory). I find the fast torsional waves based upon Biot theory present lower attenuation and higher phase velocity than those from the dCS theory.

Title: Time domain signature of poroelastic slow shear .

Gabriel Mejia Ruiz .

Centro de Investigación Científica y de Educación Superior de Ensenada.

Abstract:
Unlike Biot theory, the de la Cruz Spanos (dCS) theory incorporates the fluid viscous stress tensor in the poroelastic constitutive equation. As a consequence, this theory predicts a slow shear wave. To study slow shear wave, this work presents the analytical solution in time domain of the dCS equation with and without the viscous stress tensor in the nearfield for a fluid injection point source and examines the contribution of the slow shear wave. We observe that the slow shear amplitude strongly decreases in the immediate vicinity of the source location. Further away from the source location but still in the nearfield zone, we observe that the slow P-wave amplitude is substantially diminished due to the energy partitioning into the slow S process. Additionally, the slow S wave can be generated by conversion scattering in heterogeneous media. To study mode conversion into this slow shear process at a planar contact, this work presents the finite-difference time-domain numerical solution of the dCS equations with and without the viscous stress tensor for two half-spaces in contact. We conclude that computing the numerical solution without the viscous stress tensor in a 6 degrees of freedom description using two vector fields, as it is often reported in poroelasticity literature, is erroneous and mathematical ill-posed. This is because, in the absence of the viscous fluid stress tensor, there are two redundant

degrees of freedom, and thus the restoring shearing force in the fluid is not generated. This is joint work with Gabriel Mejía, Pratap. N. Sahay & Tobias M. Muller.

Title: Slow P-wave to slow S-wave conversion acts as dynamic permeability .

Tobias Mueller .

CICESE.

Abstract:
Modeling wave propagation in poroelastic media is based on macroscopic equations, such as those proposed by Biot. It is clear, however, that some microstructural information must enter into the computation of the macroscopic parameters. One example, is the flow permeability. Though it is a macroscopic quantity, it is commonplace to express permeability estimates using microstructural descriptors.

From a wave-propagation point of view, there is also a temporal upscaling involved. If the wave frequency is high enough, then the flow permeability will lose its meaning. This phenomenon is often captured by postulating a generalized Darcy law with a frequency-dependent (so-called dynamic) permeability.

Within the de la Cruz-Spanos (dCS) poroelasticity theory, the dynamic permeability can be modeled as conversion scattering process from the slow compressional wave into the slow shear wave. The slow shear exists due to the incorporation of the fluid viscous stress tensor in the constitutive equation of the dCS theory and accounts for viscous dissipation through vorticity diffusion in the fluid phase.

This stochastic dynamic permeability model accounts for pore-scale heterogeneity through the two-point correlation function. Using digitized images of rocks samples at micro-meter resolution, we extract the correlation function and predict the dynamic permeability.

Title: Oceanic Sub-mesoscale Wave-Vortical Interactions and Their Effect on Scalar Transport .

Gerardo Hernández Dueñas .

Instituto de Matemáticas, UNAM-Juriquilla.

Abstract:
The mechanisms driving lateral dispersion in the ocean on scales of $100\ m - 10km$ remain, by and large, not well identified. Dominant motions in this regime, known as the submesoscale, are internal waves and vortical motions. These two components have similar spatial scales but evolve on different temporal scales. Small-scale vortical mode are susceptible to instabilities and may not be as long-lived as their larger-scale geostrophic counterparts. While vortices are more efficient at dispersing a passive tracer than waves, the role of the latter remains less well understood. In this talk, we will present simulations using a set of intermediate models to identify the role of various non-linear interactions between

vortical and wave motions. These intermediate models range from the quasi-geostrophic model which only includes PV/PV/PV nonlinearities and GGG model with only wave/wave/wave nonlinearities to the full Boussinesq model which retains all. Statistics such as energy transfer spectra and diffusivity will be shown to identify the effect of different non-linear interactions on scalar transport.

Title: Bathymetry Reconstruction Using Inverse Shallow Water Models in One Dimension .

José Alejandro Butanda Mejía .

CIMAT .

Abstract:
In this talk we are going to analyze the inverse problem of bathymetry re- construction associated with the problem of surface flows governed by shallow water equations in channels with vertical walls and uniform width (Saint-Venant equations). In the proposed methodology an inverse problem arises naturally, which we are going to face with the adjoint method. The inverse problem is posed as an optimization problem in Hilbert spaces. Using non-linear analysis techniques we develop descent methods, thus obtaining an analytical expression for the gradient of the functional to be minimized. It should be mentioned that the methodology we have developed is applicable for the recovery of parameters inherent to the problem we are modeling. The numerical solution for both the direct and the inverse problems is ob- tained by means of the Galerkin Discontinuous method, which has been very successful in approximating solutions of hyperbolic partial differential equations. Using this numerical approach we have been able to reconstruct bathymetries of different kinds, paying special attention to bathymetries associated with prob- lems of tidal waves and discontinuous bathymetries.

Title: An Analysis of the High-Order Enriched Galerkin Method for Wave Propagation .

Jonas D. De Basabe, Janaki Vamaraju, Mrinal K. Sen and Mary F. Wheeler .

CICESE, UT-Austin .

Abstract:
The Enriched Galerkin Method is a combination of the continuous and discontinuous versions of the Galerkin method. It was first used to solve elliptic problems and has been extended to solve parabolic and hyperbolic boundary-value problems as well. This method's main feature is that it combines continuous and discontinuous basis functions, where the discontinuous functions are usually low-order polynomials. However, this yields significant numerical errors in the wave-propagation simulations. Here we propose to use high-order continuous and discontinuous basis functions and consider different types of functions for the discontinuous basis. We analyze the accuracy and stability of different combinations of basis functions and show examples of wave propagation in acoustic, elastic, fractured and anisotropic domains, and compare the results with other methods.

Title: Bayesian B-spline surrogate model on 2D gravity data inversion .

Abel Palafox González .

Universidad de Guadalajara .

Abstract:
Gravimetric data inversion problems implicate numerical solution of large dimension, ill-posed inverse problems. Non-uniqueness on solutions is balanced by setting regularizing schemes where regularizing parameters are application dependant. In addition, traditional regularizing schemes promote smoothness on approximating results, leading to over-estimation of source body retrievals. In this work, Gravimetric data inversion problem in a two-dimensional study case is addressed. For this aim, the problem is posed within a Bayesian framework, and a suitable low-dimensional representation for the source object boundary is tailored to a Markov Chain Monte Carlo (MCMC) method. Our parametric representation, based on an interpolating B-spline, allows to estimate source objects reducing smoothing effects.

Title: Modelado 2D y 3D de campos electromagnéticos en el dominio del tiempo con aplicaciones a la exploración del subsuelo .

Valdés-Moreno Beatriz, De Basabe Jonás D. y Pérez-Flores Marco A. .

Centro de Investigación Científica y de Educación Superior de Ensenada; División de Ciencias de la Tierra. .

Abstract:
Los métodos electromagnéticos en la geofísica nos permiten obtener información de las propiedades eléctricas del subsuelo como: la conductividad eléctrica, la permitividad eléctrica y la susceptibilidad magnética. Cada método involucra la medición de la parte real y/o imaginaria del campo eléctrico o magnético medido en un ”receptor electromagnético” debido a una fuente de energía natural o artificial, como puede ser un ”transmisor electromagnético”. Las mediciones de campos electromagnéticos en el dominio del tiempo son interpretadas para encontrar la estructura que explique los datos y modelado o problema directo consiste en calcular la respuesta de una estructura geoeléctrica para un determinado equipo de medición. En este proyecto de investigación exploramos el método de Galerkin Discontinuo (MGD) con penalización interior para el modelado de los campos electromagnéticos en dos y tres dimensiones. El MDG nos permite tener un mejor control sobre las condiciones de frontera de los campos electromagnéticos, además es un método altamente paralelizable y permite una adaptación a geometrías y condiciones de frontera complejas.

Title: Modelo matemático celular de infección viral con respuesta lítica dependiente de mutación .

Ledyz Cuesta Herrera .

Universidad Católica del Maule, Chile..

Abstract:
Información sobre la durabilidad de la inmunidad a la infección por SARS-CoV-2 y los objetivos de las respuestas de las células B y T pueden ayudar al desarrollo continuo de nuevas vacunas y terapias. Por lo tanto, se hace una aplicación del conocimiento actual relevante sobre la inmunidad humoral y celular contra la infección por SARS-CoV-2 en humanos y su aplicación al desarrollo de vacunas. Para llevar a cabo el enfoque matemático en este trabajo, se asume la hipótesis para la población celular afectada con dos respuestas líticas diferentes que conducen a la liberación de partículas virales, a través de un marco Susceptible-Expuesto-Infectado (SEI). Es importante resaltar que se ha tenido en cuenta una competencia parcial entre los dos tipos de respuestas involucradas en el proceso, debido a que una primera respuesta de lisis facilita la activación de una segunda respuesta secretando partículas virales mutadas. Para llevar a cabo el modelamiento matemático a través de un sistema de ecuaciones diferenciales, inicialmente se crea un diagrama ilustrativo con la población total que se divide en cuatro compartimentos según sea: Célula susceptible, Célula infectada, Célula con respuesta de lisis celular, Célula con respuesta de lisis celular con virus mutado, contemplando que todos los compartimentos celulares presentan tasas de muerte resultado de la apoptosis que da inicio tras cumplir su ciclo de vida, además, las diferentes probabilidades de que alguna de las particulares virales liberadas de cada una de las células lisadas ingrese en una célula susceptible. Para derivar la expresión del número reproductivo básico, R_0, se emplea el método clásico de la matriz de próxima generación, probando para este caso ser menor que 1, lo que implica que el número de células infectadas que mueren no es compensado por nuevas infecciones, luego la epidemia a largo plazo es autolimitada. Esto sucede tanto en el subsistema sin mutaciones como en el que involucra la fracción de mutación. Una mayor frecuencia de mutaciones aumenta la tasa de infecciones, siendo evidenciado cuando la proporción de las células con reproducción celular efectiva que contiene virus mutado toma un valor de 0.75. Esto implica que el compartimento que corresponde a célula con respuesta lítica podría omitirse en modelos subsecuentes a menos que el virus mutado posea una mayor capacidad de contagio.

Title: Inteligencia artificial aplicada para el pronóstico del desempeño académico de estudiantes universitarios. .

Cynthia Marlen Díaz Márquez .

Universidad Autónoma de Chihuahua (UACH).

Abstract:
Uno de los principales problemas en la educación superior que México enfrenta son las grandes diferencias sociodemográficas y/o socioeconómicas entre la población, estas diferencias impactan directa-

mente en el desempeño académico. Lo anterior propicia que algunos estudiantes opten por abandonar sus estudios, la solución que se propone en este trabajo es identificar a dichos estudiantes para que la universidad pueda brindarles la ayuda necesaria (programa institucional de inclusión y equidad) para que estos estudiantes logren terminar de manera satisfactoria sus estudios. Se propone un modelo predictivo del estatus académico de los estudiantes de la Universidad Autónoma de Chihuahua (UACH). El modelo se basa en una red neuronal multicapa densa que toma en cuenta factores académicos, sociodemográficos, económicos y de inclusión y equidad; el estudio fue realizado con datos referentes a 20,166 alumnos, de los cuales el 52.03 % son mujeres y 47.96 % son hombres y el 69.23 % tienen entre 18 y 20 años de edad. Los resultados obtenidos permiten predecir con un 96 % de confiabilidad el estatus académico de los estudiantes para el siguiente periodo escolar.

Title: Construcción de Parametrizaciones de Regiones Planas Irregulares .

Iván Méndez Cruz .

Universidad Nacional Autónoma de México.

Abstract:
Algunos métodos numéricos para la solución de ecuaciones diferenciales parciales requieren parametrizaciones de regiones planas complicadas como cuerpos de agua. Estas regiones pueden ser simplemente conexas o tener agujeros. Desarrollamos un método para construir una familia de parametrizaciones de estas regiones. Separamos interactivamente las regiones en subregiones basándonos en su concavidad. Generamos automáticamente mallas estructuradas compatibles sobre las subregiones para obtener las parametrizaciones.

Title: Modelo Continuo en EDP's de un Tumor .

Ana Kristhel Esteban López.

UNIVERSIDAD JUÁREZ AUTÓNOMA DE TABASCO.

Abstract:
El trabajo tiene como objetivo mostrar un modelo matemático de un sistema de ecuaciones diferenciales parciales no lineales, que describe la dinámica de la densidad de células endoteliales que migran a través de un tumor y forman estructuras neovasculares en respuesta a una señal química específica conocida como factor angiogénico del tumor (TAF) mediante un proceso llamado angiogénesis.

Title: Integración de la Carga Hidráulica, Profundidad de Captación y la Calidad del Agua para la Identificación de los Sistemas de Flu .

Julián González Trinidad .

Universidad Autónoma de Zacatecas.

Abstract:
Integración de la Carga Hidráulica, Profundidad de Captación y la Calidad del Agua para la Identificación de los Sistemas de Flujo en un Acuífero Heriberto Morales de Avila, Hugo Enrique Júnez Ferreira, Julián González Trinidad Resumen La presencia, distribución y origen del arsénico (As) y otros elementos traza, disueltos en el agua subterránea representa una preocupación en la población en general que la emplea para satisfacer su consumo doméstico y para el desarrollo de actividades agrícolas, ganaderas, mineras e industriales, entre otras... Mediante estudios de campo, análisis de laboratorio, e interpretación de datos se han podido observar cambios en la composición del agua subterránea de los acuíferos a través del tiempo, sin embargo existe mucha incertidumbre acerca de los mecanismos que los producen. La teoría de sistemas de flujo del agua subterránea permite identificar estas variaciones que sufre el agua al entrar en contacto con el suelo y durante su circulación en el subsuelo, mediante la jerarquización de los tipos de flujo que pueden estar presentes en el acuífero (local, intermedio, regional, mezcla). En la presente investigación se propone una metodología que integra datos de calidad del agua y carga hidráulica recabados para los años 2005 y 2015 para identificar los sistemas de flujo en el acuífero Calera, Zacatecas. , Primeramente se emplea el método de análisis de componente principales (PCA en inglés), para clasificar los pozos en grupos de acuerdo a las concentraciones en el agua de iones mayores (Na+, K+, Ca2+, Mg2+), SDT, elementos pesados como el As, y la temperatura. El análisis conjunto de la distribución de la carga hidráulica, la elevación más profunda de captación (EMPC) calculada con datos de elevación del brocal y profundidad de los pozos, y los parámetros fisicoquímicos del agua captada, dentro de un marco geológico permite complementar la información proporcionada por el PCA. Se analiza con detenimiento las características de cada aprovechamiento, para obtener un panorama de los sistemas de flujo presentes en el acuífero Calera. Adicionalmente, la representación espacial de los datos permite distinguir zonas de recarga, descarga o tránsito. El análisis propuesto permite ofrece una visión robusta de los diferentes regímenes de flujo presentes en el acuífero Calera que puede ser de utilidad para identificar las mejores zonas para captación de agua en la región.

Title: Simple closed-form property expressions of two metafluids composed of periodic arrays of transversely isotropic elastic fibres embedded in an ideal fluid .

Adolfo Ayuso Hernández .

Instituto de Investigaciones en Matemáticas Aplicadas y Sistemas, Universidad Nacional Autónoma de México.

Abstract:
Two periodic arrays of parallel circular cylinders embedded in a matrix are considered. The fibers are filled with transversely isotropic (TI) elastic material, whereas the matrix is an ideal fluid. The asymptotic homogenization method, applied to similar problems where the matrix is also a TI elastic material, pro- duced formulas for the two effective TI elastic composites. By a limit procedure, when

the shear moduli of the matrix tend to zero, the formulas yield very simple expressions for the effective coefficients of the two composites, namely, they are TI metafluids.

Title: Estudio de una solución analítica de las Ecuaciones de Navier-Stokes .

Francisco J. Sánchez Bernabe .

Universidad Autónoma Metropolitana .

Abstract:
Se propone una solución analítica relacionada con un trabajo de Ethier publicado en 1997. La solución propuesta depende del tiempo de manera que se pueden comparar diferentes esquemas de discretización en el tiempo. Además las condiciones a la frontera son de tipo relativamente simple.

Title: Discontinuous Galerkin Methods for Modeling Porous Media: Theory and Simulations .

Dr. Béatrice Rivière .

Rice University.

Abstract:
Discontinuous Galerkin methods have been exponentially used by the scientific community over the last twenty years, for solving a multitude of problems modeled by linear and nonlinear partial differential equations. Due to the lack of continuity constraints between the grid cells, discontinuous Galerkin methods have been shown to be very flexible; for instance, they easily handle local mesh refinement and high order of approximation. The factthat these methods are locally mass conservative makes them particularly suitable for the solution of flow and transport problems in porous media. These problems are of critical importance in many engineering applications such as groundwater flows, hydrocarbons production, and carbon dioxide sequestration. Thanks to the increase in computational resources, scientists are able to model complex multicomponent multiphase problems in heterogeneous and anisotropic porous media. In this talk, we review the class of interior penalty discontinuous Galerkin and the class of hybridizable discontinuous Galerkin methods for solving the miscible displacement, two-phase and three-phase flows problems in heterogeneous media. Accuracy and robustness of the numerical methods are demonstrated. Recent advances in the design of bound-preserving discontinuous Galerkin methods are also presented.

Title: What is the best mathematical model to describe an epidemic? .

Mario Santana Cibrian .

CONACYT - Instituto de Matematicas UNAM.

Abstract:
Several mathematical models have been proposed to describe and predict the pandemic caused by the SARS-CoV-2 virus. These models can be used to asses the efficacy of non-pharmaceutical interventions, to design vaccination strategies, or to evaluate the risk of the reopening the economy, among many other things. With all these models at our disposal, the following question arises: what is the best mathematical model to describe an epidemic? In order to answer this question, this talk explores three types of mathematical models that have been widely used in the fight against the COVID-19 pandemic all over the world. More specifically, the talk will focus on : 1) population growth models, 2) Kermack-McKendrick models, and 3) stochastic process-based models. In each case, the basic characteristics of the models, some recommendations for their implementation and examples with real data from Mexico will be discussed. Special emphasis will be placed on highlighting the strengths and weaknesses of each methodology, as well as the types of questions that these models can answer.

Title: Behavioral changes and their effect on epidemic modeling .

Manuel Adrian Acuña Zegarra.

Universidad de Sonora .

Abstract:
At the date, different clinical aspects of COVID-19 remain unclear. There is more uncertainty than certainty about this pandemic that has hit the world. In this sense, mathematical modeling has had a relevant role in understanding COVID-19 dynamics, in which we can stress the importance of human behavior in disease dynamics. In this talk, we will discuss the connections between COVID-19 modeling and human behavioral change. We will address modeling in the initial stage of the pandemic, after which we will observe the importance of considering key dates to describe the disease dynamics adequately. We will take Mexico City as our study scenario.

Title: Lessons learned while modeling the COVID-19 pandemic .

Marcos Aurelio Capistrán Ocampo .

CIMAT A.C..

Abstract:
In this talk I will present some lessons learned while modeling the COVID-19 pandemic. Epidemic dynamics is non-autonomous, therefore it is not possible to make reliable long term forecasts. Good knowledge of the disease serial interval and an appropriate observation model are fundamental to make inferences. Human behavior influences heavily the epidemics dynamics. Rt models are an active field of research. In the future, good covariates will be useful, for example, text analysis of

medical consultations.

Title: Generalized Maxell-Garnett technique for different-shaped inclusions. .

Raul Patricio Esquivel Sirvent .

Instituto de Física UNAM .

Abstract:
In this work we present a general derivation for the Maxwell-Garnett homogenization technique for a two-phase composite system for the thermal conductivity, but our results are valid for any physical property such as the dielectric function, for example. Our start point is a system made of a homogeneous matrix with thermal conductivity k with a random distribution of inclusions with a thermal conductivity k1. Each of the inclusions has the same shape and volume. Using a perturbative expansion of the constitutive equations (Fourier heat conduction law) along with the conditions that all inclusions are statistically equivalent and statistically independent. Some case studies are presented such as composites with cylinders of elliptical cross sections as inclusions, and composites with toroidal inclusions. We compare our results with other techniques such as asymptotic homogenization to validate our results and discuss possible applications in the control of heat transport.

Title: Maxwell's scheme for the evaluation of effective electro-elastic properties with different inclusion shapes .

Reinaldo Rodríguez Ramos & José Antonio Otero .

Facultad de Matemática y Computación, Universidad de La Habana .

Abstract:
The reinforced piezoelectric composite materials with unidirectional cylindrical fibers periodically distributed in a preferential direction, i.e. x_3-direction are studied. Effective electro-elastic properties of fibrous composites are estimated using the present Maxwell's model, asymptotic homogenization, and semi-analytic finite element methods. Comparisons between these methods are given. This is joint work with José Antonio Otero.

Title: Complex effective transport properties of multi-phase fibre composites .

Federico J Sabina .

Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas, Universidad Nacional Autónoma de México. .

Abstract:
The knowledge of effective transport properties of composites is very important in applications. Homogenization models have been developed for studying multi-phase fibre-reinforced composites (FRC) relevant to transport problems. In particular, the main aim of this work is the prediction of effective transport complex properties of periodic multi-phase FRC with complex constituents and parallelogram unit cells (PUCs) with microstructure by the two-scale asymptotic homogenization method (AHM). Closed-form formulas for effective transport complex properties of periodic multi-phase FRC are given. Examples for three- and four-phase composites are examined. Several examples are analysed including anisotropic interphase effects on the quality of shear effective properties. Also, the anisotropic conductivity of biological tissues comprising tubular cells, in the case of skeletal muscle, are looked upon as a multi-phase FRC. Comparisons with other methods are carried out. Good agreement is obtained. The formulas may be useful as benchmarks for checking experimental and numerical results.

Title: Nonlocal Metamaterials .

Luis Mochán .

Instituto de Ciencias Físicas, Universidad Nacional Autónoma de México.

Abstract:
We generalize a recursive homogenization method for the calculation of the dielectric resrponse of periodic metamaterials of arbitrary composition, number of phases and geometry. The method takes advantage of the symmetry of the field equations under tensorial index permutations and wavevector inversion to build a formalism based on symmetric operators even for dispersive, dissipative and chiral systems. We validate the method applying it to simple systems for which analytical solutions exist. The macroscopic response is in general non-local and together with the macroscopic dispersion relation yields the photonic bands over all the Brillouin zone. Furthermore, from its small-wavevector limit it can yield the local permittivity, permeabililty and optical activity.

Title: Algunos ejemplos de modelación estocástica en aguas subterráneas .

Graciela Herrera Zamarrón .

Instituto de Geofísica, UNAM.

Abstract:
En las últimas décadas se ha reconocido la existencia de gran incertidumbre en el conocimiento de las variables utilizadas en la hidrogeología debido a varios factores, entre los que se encuentran, la gran variabilidad espacial del medio geológico por el que circula el agua, la gran variabilidad espaciotemporal de la recarga, al uso de medios de observación indirecta al tomar mediciones de los parámetros que describen las propiedades del medio poroso y al uso de mediciones escasas. Por este motivo, se

han utilizado los modelos estocásticos para incorporar las fuentes de incertidumbre en la modelación matemática de los fenómenos hidrogeológicos. Para esto se incorporan elementos inciertos en los modelos, por ejemplo, parámetros, esfuerzos, condiciones de frontera y condiciones iniciales. En esta plática se dará un panorama de las aplicaciones realizadas de modelación estocástica en aguas subterráneas por la autora y sus colaboradores usando modelos de flujo y transporte.

Title: Experiencia actual de modelación con Modflow .

Guillermo de Jesús Hernández García & Gustavo Berumen Saldívar .

Instituto de Geofísica, Universidad Nacional Autónoma de México.

Abstract:
Presentamos la modelación computacional de flujo en el sistema acuífero de la parte sur de la Cuenca de México, SAPSurCM, con Modflow 6, la más reciente versión del código de modelación tridimensional de flujo de agua subterránea del servicio geológico de los EE. UU., el USGS, por sus siglas en inglés. Se procedió trasladando una versión del dominio del modelo para el código Modflow 2005, la versión previa del USGS. Se hizo uso de la interfaz gráfica Model Muse, que permite la refinación por zonas de celdas de la malla de volúmenes finitos del dominio del modelo. Se traslada el modelo para el estado estacionario así como el modelo para el estado transitorio. Haciendo uso de la herramienta FLOPY para el lenguaje de programación Python se evalúan entre otros, los errores de raíz cuadrática media, RMSE. Se exploró la nueva versión para evaluar el balance por zonas, Zone Budget, y aplicando el paquete de graficación del USGS GW_Chart se logran visualizar los resultados, tales como perfiles de bombeo, de recarga, de aporte por almacenamiento y otros. Se logra una mejor convergencia que evita que se presenten celdas que se secan y entonces se invalidan. Lo anterior se logra mediante una mejor definición del coeficiente de almacenamiento, Ss, e incluir el rendimiento específico, Sy, una nueva opción. Se logró, como parte de esta experiencia, superar varios obstáculos que se presentan con la nueva versión, tanto al cambiar las formulación matemática como al cambiar los formatos de los datos de entrada y de salida.

Title: Análisis piezométrico del acuífero en explotación de la porción sur de la Cuenca de México mediante estimaciones geoestadísticas .

Mario Alberto Hernandez Hernandez .

Instituto de Geofísica - UNAM.

Abstract:
El presente trabajo se centra en el análisis de información piezométrica del acuífero en explotación de la porción sur de la Cuenca de México obtenida del Sistema de Aguas de la Ciudad de México, la Comisión Nacional del Agua y de la Comisión del Agua del Estado de México mediante estimaciones geoestadísticas espaciotemporales del nivel estático (NE). La información recopilada abarca el periodo

de 1968 a 2017, de los cuales se seleccionaron para hacer el análisis los años con 150 o más observaciones, quedando información para el periodo 1974 a 2017 con un número de pozos variable por año (entre 172 y 763). Con esta información se obtuvo un variograma espaciotemporal muestral de los datos del NE, se hizo un ajuste visual de un modelo del tipo producto-suma [1] y validación cruzada, se obtuvo un modelo de tipo esférico (para ambas componentes espacial y temporal), de pepita 0, meseta (4,200 m2 y 194 años2 respectivamente) y alcance (11,000 m y 14 años respectivamente). La validación cruzada mostró un buen ajuste (error medio de 0.02 m y raíz cuadrada del error cuadrático medio de 3.69 m). A partir del modelo espaciotemporal y aplicando una interpolación tipo kriging ordinario, se evaluó la evolución del NE para los años 1997, 2002, 2007, 2012 y 2017, utilizando como apoyo puntos de control que permitieran representar de forma diferenciada los valores obtenidos para la zona de valle y montañas circundantes. Los mapas generados (tipo ráster) fueron posteriormente tratados mediante herramientas SIG, realizando una resta de los valores del NE estimado entre cada periodo interpolado (2002-1997, 2007-2002, 2012-2007, 2017-2012) y entre el primer y último periodo (2017-1997), obteniendo así la evolución del abatimiento en el acuífero. La evolución del NE obtenido mediante las interpolaciones realizadas permite identificar un abatimiento del orden entre 2 y 50 m en el periodo 1997-2017 en zonas bien diferenciadas del acuífero, evolucionando de forma distinta la porción poniente respecto al oriente. En la Zona Metropolitana de la Ciudad de México existe una tendencia a la estabilización, mientras que para los acuíferos de Texcoco y Chalco no es así, posiblemente debido a un conjunto de políticas de extracción a las que ambas zonas han estado sujetas de manera diferenciada, entre ellas, la variación temporal de la localización de los pozos de extracción y de los volúmenes de extracción.

Title: Estimación de la presión capilar en pruebas de centrífuga usando un modelo de flujo bifásico en medios porosos .

Martín A. Díaz Viera .

Instituto Mexicano del Petróleo .

Abstract:
Una de las técnicas más usadas para la estimación de la curva de presión capilar en tapones de roca (escala de centímetros) es el método de la centrífuga, donde una muestra de roca saturada de un fluido relativamente ligero (por ejemplo, aceite), es inmersa en un recipiente con un fluido más pesado (por ejemplo, agua), y se somete a una fuerza centrífuga [1,2]. Recientemente en el Centro de Tecnologías para Exploración y Producción (CTEP) del IMP se ha construido una centrífuga industrial, también conocida como geocentrífuga, con el propósito de estimar curvas de presión capilar a altas aceleraciones (hasta 100 g) y para muestras de roca mayores (hasta medio metro). En este trabajo se presenta un modelo de flujo bifásico ligeramente compresible en 3D que considera el efecto de la fuerza centrífuga para la simulación de las pruebas de laboratorio. Se muestran de manera sistemática las etapas de desarrollo del modelo en los aspectos matemático, numérico y computacional. Finalmente, se valida el modelo usando datos de un caso de estudio publicado [3]. REFERENCIAS [1] Nimmo J.R., Mello, K.A.: Centrifugal Techniques for Measuring Saturated Hydraulic Conductivity,

Water Resources Research, 27, (6), 1991. [2] Forbes, P.: Simple and Accurate Methods for Converting Centrifuge Data into Drainage and Imbibition Capillary Pressure Curves, The Log Analyst, July-August, 1994. [3] Andersen P. O., Skjæveland, S. M., Standnes, D.Ch. :An Analytical Model for Analysis of Capillary Pressure Measurements by Centrifuge, Petrophysics 58 (04): 366?375, August 01 2017.

Title: Revisión: Modelos geométricos de difusión mesoscópica sobre superficies. .

Aldo Ledesma Durán .

Universidad Autónoma Metropolitana Iztapalapa.

Abstract:
Estudiamos los aspectos que influyen en las propiedades de transporte de partículas que se difunden sobre una superficie de poros y superficies irregulares según aspectos geométricos y la perspectiva de observación. Nuestro principal objetivo es relacionar el desplazamiento cuadrático medio de las partículas en la superficie con la concavidad y curvatura de la superficie, la forma de las posibles fronteras o bordes de la superficie, así como la forma y tortuosidad de los poros. Comparamos diferentes nociones para los desplazamientos cuadrados medios en términos de la distancia geodésica sobre la superficie con la registrada en un plano de observación. Destacamos la correspondencia entre predicciones teóricas y simulaciones numéricas en términos de simulaciones de elementos finitos para tiempos cortos y largos de la dinámica difusiva. Discutimos cómo este trabajo contribuye a comprender el verdadero papel de las propiedades de transporte de difusión superficial en el proceso catalítico dentro de materiales porosos y separamos la influencia de otros procesos termodinámicos que afectan la difusión superficial y discutimos cómo sentar las bases para el diseño de nuevos materiales diseñados geométricamente basados con propiedades de transporte en función de su forma.

Title: Simulación de Patrones de Turing en Superficies con Curvatura .

Elizabeth Alejandra Ortiz Duran .

UNAM.

Abstract:
En esta platica hablaremos sobre la teoría de Turing para la formación de patrones en un sistema de tipo reacción difusión sobre superficies con curvatura utilizando el operador de Laplace-Beltrami, que permite integrar el efecto de la curvatura explícitamente en la ecuación. Además, se implementarán y simularan estas ecuaciones en el programa Wolfram Mathematica. Nota: Esta plática es para el mini simposio ‘Difusión sobre superficies: estudio teórico y numérico’

Title: Entropic Effects of Interacting Particles Diffusing on Spherical Surfaces .

Ivan Santamaria-Holek .

UMDI-J Facultad de Ciencias, UNAM Juriquilla .

Abstract:
We present a theoretical study and molecular simulation study on the diffusion of interacting particles embedded on the surface of a sphere. By proposing five different interaction potentials among particles, we perform molecular dynamics simulations and calculate the mean square displacement (MSD) of tracer particles under a crowded regime of high surface density. Results for all the potentials show four different behaviors passing from ballistic and transitory at very short times, to sub-diffusive and saturation behaviors at intermediary and long times. Making use of irreversible thermodynamics theory, we also model the last two stages showing that the crowding induces a sub-diffusion process similar to that caused by particles trapped in cages and that the saturation of the MSD is due to the existence of an entropic potential that limits the number of accessible states to the particles. By discussing the convenience of projecting the motions of the particles over a plane of observation, consistent with experimental capabilities, we compare the predictions of our theoretical model with the simulations showing that these stages are remarkably well described in qualitative and quantitative terms.

Title: Finite element solution of the Laplace-Beltrami equation on surfaces .

Héctor Juárez Valencia .

UAMI .

Abstract:
”The Laplace-Beltrami equation is a generalization of the Laplace operator to functions defined on submanifolds in Euclidean space. In particular, it is useful for modeling diffusion phenomena on surfaces. In this talk we consider a Lagrange linear finite element discretizaci´on of the Laplace-Beltrami equation defined on 3D surfaces. The finite element discretization is a good option not only because we only need to approximate the gradients that occur in the variational formulation, but also because the tangential gradients may be computed by protecting the usual gradient on the surface. The main property is that this projection is well defined and gives a unique value over every element of the computational mesh. This approach allows us to work with the usual cartesian coordinates which may help to get around singularities that appear with certain geometries when ‘natural coordinate’ are employed, like with spherical coordinates.”

Title: Ocean surface waves and ocean-atmosphere interactions .

Dr. Francisco J. Ocampo Torres .

CICESE .

Abstract:
The relevance of ocean surface wave dynamics is briefly shown. Some aspects are acknowledged from the traditional point of view, regarding mainly ship design, coastal and oceanic engineering applications, as well as maritime operations. More recently, interest is well focused at the exchange processes between the ocean and the atmosphere. We are mainly concerned with some of the most important ones, very much related to the influence of ocean surface waves on present challenging issues. One particular issue is the gas transfer across the interface and its potential impact on climate and its changes. Another issue is the upper ocean dynamics and the behavior of surface currents and drift, greatly associated with transport of pollutants and objects on the sea surface. Furthermore, fundamental processes associated with observing the ocean with remote sensors are also a challenging aspect that requires a great knowledge of ocean surface waves. In turns for instance, from ocean surface images acquired with synthetic aperture radars it is possible to indirectly determine the wave directional spectrum, essentially since ocean waves modulate the microwave reflectors, which represent a rather small scale roughness of the very sea surface. The main challenge to estimate the directional wave spectrum is shown and some preliminary results are presented. More related to the upper ocean dynamics, another example of an inverse problem of relevance is also shown, aiming to obtain the fluid velocity field in a layer just beneath the sea surface when acoustic Doppler methods are used.

Title: COVID-19 optimal vaccination policies:a modeling study on efficacy, natural and vaccine-induced immunity responses .

SAUL DIAZ INFANTE VELASCO .

CONACYT-UNIVERSIDAD DE SONORA .

Abstract:
About a year into the pandemic, COVID-19 accumulates more more than two million deaths worldwide. Despite non-pharmaceutical interventions as social distance, mask-wearing, and restrictive lockdown, the daily confirmed cases remain growing. Vaccine developments from Pfizer, Moderna, and Gamaleya Institute reach more than 90 % efficacy and sustain the vaccination campaigns in multiple countries. However, natural and vaccine-induced immunity responses remain poorly understood. There are great expectations, but the new SARS-CoV-2 variants demand to inquire if the Vaccines will be highly protective or induce permanent immunity. Further, in the first quarter of 2021, vaccine supply is scarce. Consequently, some countries that are applying the Pfizer vaccine will delay its second required dose. Likewise, logistic supply, economic and political implications impose a set of grand challenges to develop vaccination policies. Therefore, health decision-makers require tools to evaluate hypothetical scenarios and evaluate admissible responses. Following some of the WHO-SAGE recommendations, we formulate an optimal control problem with mixed constraints to describe vaccination schedules. Our solution identifies vaccination policies that minimize the burden of COVID-19 quantified by the number of disability-adjusted years of life lost. These optimal policies ensure the vaccination coverage of a prescribed population fraction in a given time horizon and preserve hospitalization occupancy below a risk level. We explore via simulation plausible scenarios regarding

efficacy, coverage, vaccine-induced, and natural immunity. Our simulations suggest that response regarding vaccine-induced immunity and reinfection periods would play a dominant role in mitigating COVID-19.

Title: Aprendizaje automático para la valoración psicológica de estudiantes y profesores durante la pandemia (Para el minisimposium: Ma .

Valeria Soto Mendoza .

Centro de Investigación en Matemáticas Aplicadas .

Abstract:
La pandemia provocada por COVID-19 ha dejado secuelas en la salud mental de la población en México, estudiantes y profesores no son la excepción. El aprendizaje automático ha incursionado en el ámbito de la psicología debido a la gran cantidad de datos e información que se genera actualmente. Sin embargo, continúa siendo un problema difícil debido a la alta variación en los datos producto de diversos aspectos como personalidades, nivel socioeconómico, entre muchos otros. Como consecuencia, resulta complicado llegar a un modelo de predicción generalizado. En este trabajo se presenta el análisis de un instrumento para la valoración psicológica de estudiantes y profesores durante la pandemia, empleando técnicas de aprendizaje automático. A través de este análisis, se identificaron variables relevantes que apoyan a los psicólogos en el proceso de validación del instrumento.

Title: Prediction of critical COVID-19 patients in Mexico supporting in its clinical history using a Multilayer Perceptrons Model .

José Alberto Guzmán Torres .

Universidad Michoacana de San Nicolás de Hidalgo.

Abstract:
This study presents a novel approach based on a Deep Learning model to predict the critical patients of COVID-19. This model aims to provide an alternative for identifying patients with high probabilities of death based on their clinical data. The proposed model is supporting on patient's clinical history, where the risk of dying or living is analyzed for the patients. The dataset used in this research is free-access and represents the knowledge of the cases examined in Mexico unto January 2021. The generated model in this study is considered robust due to the massive amount of information analyzed. The model was tested in both a validation set and test set, reaching an accuracy of 93% for the class predicted. The proposed deep neuronal network uses different activation functions and several neurons in each hidden layer. The model shows an impressive accuracy, and it is considered a novel approach due to the predictor variables involved in the analysis.

Title: Computational simulations of cell immune response dynamic for severe and critical cases of COVID-19 .

Rodolfo Guadalupe Blanco Rodríguez .

Instituto de Matemáticas de la UNAM .

Abstract:
COVID-19 is a global pandemic leading high death tolls worldwide day by day. Clinical evidence suggests that COVID-19 patients can be classified as non-severe, severe and critical cases. In particular, studies have highlighted the relationship between the lymphopenia and the severity of the illness, where CD8 + T cells have the lowest levels in critical cases. In our work, we aim to elucidate the key parameters that define the course of the disease deviating from severe to critical case. To this end, several mathematical models are proposed to represent the dynamic of the immune response in patients with SARS-CoV-2 infection. We considered the clearance of viral particles due to CD8 + T cells and NK cells, and also CD4 + T cells as helpers in the proliferation of CD8 + T cells. The best model was considering the viral clearance due only to CD8 + T cell. This model had a good fit to reported experimental data, and in accordance with values found in the literature. Our results suggest that a rapid proliferation of CD8 + T cells leads to the severity of the disease.

Title: On mobility trends analysis of COVID-19 dissemination in Mexico City.

Kernel Enrique Prieto Moreno .

Instituto de Matemáticas de la UNAM .

Abstract:
I present a forecast of the spread of the new coronavirus in Mexico City, which is based on a mathematical model with a metapopulation structure that uses Bayesian statistics and is inspired by a data-driven approach. The daily mobility of people in Mexico City is mathematically represented by an origin-destination matrix using the open mobility data from Google and the Transportation Mexican Survey. This matrix is incorporated in a compartmental model. We calibrate the model against borough-level incidence data collected between 27 February 2020 and 27 October 2020, while using Bayesian inference to estimate critical epidemiological characteristics associated with the coronavirus spread. Given that working with metapopulation models leads to rather high computational time consumption, we do a clustering analysis that is based on mobility trends to work on these clusters of borough separately instead of taken all of the boroughs together at once. This clustering analysis can be implemented in smaller or larger scales in different parts of the world. In addition, this clustering analysis is divided into the phases that the government of Mexico City has set up to restrict individual movement in the city. We also calculate the reproductive number in Mexico City using the next generation matrix method and the inferred model parameters. Our analysis of mobility trends can be helpful when making public health decisions.

Title: 3D Modeling of natural source electromagnetic fields.

Cruz Hernández Favio y Gallardo Delgado Luis Alonso .

Centro de Investigación Científica y de Educación Superior de Ensenada, CICESE .

Abstract:
The Magnetotelluric (MT) method is popular for estimating electrical conductivity inside the Earth because of the ease of measuring electromagnetic fields produced by natural sources on the Earth's surface and the depth of exploration it can reach. Direct 1D and 2D modeling have been sufficiently resolved in the literature, but it has proven unsuitable for domains with structural complexity, such as geothermal areas. For the 3D case, the first proposals emerged two decades ago; however, its application in 3D inversion algorithms is still entirely restricted to just a pair of software available under licenses. It is essential to propose new modeling and three-dimensional inversion of MT data to study complex structural regions such as mineral deposits and geothermal fields. An essential step in solving the 3D inverse magnetotelluric (MT) data problem is to solve direct modeling to simulate the response of electromagnetic fields at the surface correctly and estimate the response function (impedance tensor). This work presents the results of an algorithm developed in GNU FORTRAN that simulates electromagnetic fields in the frequency domain to calculate the magnetotelluric response function. The numerical algorithm solves the second-order differential equation for electric fields (Helmholtz equation) using a finite difference scheme. The boundary conditions that we include are 1D analytical solutions, and an iterative Gauss-Seidel procedure solves the electric fields of the system of equations at different frequencies. The algorithm is validated using synthetic models reported in the literature and comparing with ModEM software.

Title: Análisis de efectos topográficos en datos magnetotelúricos mediante el modelado 3D con mallas no estructuradas .

Erik Gallardo Romero .

Centro de Investigación Científica y de Educación Superior de Ensenada .

Abstract:
Debido a que diversos objetivos de interés en el subsuelo se encuentran en áreas con topografías abruptas, es común que la incorporación inadecuada de la topografía en los modelos geoeléctricos que justifican las observaciones magnetotelúricas conduzca a interpretaciones erróneas. Diversos estudios se han enfocado a investigar el efecto topográfico en las respuestas magnetotelúricas para medios bidimensionales, sin embargo, son pocos los trabajos que han considerado medios en 3D. Lo anterior se debe a que apenas en los últimos años existe la disponibilidad del uso de algoritmos de modelado directo e inverso 3D para la comunidad académica (e.g., ModEM). La mayoría de estos algoritmos resuelven las ecuaciones de Maxwell utilizando la técnica de Diferencias Finitas (DF), por lo que al

usar mallas rectilíneas para representar el dominio de interés, es difícil representar la topografía de manera correcta. La técnica de Elementos Finitos (EF) permite usar mallas no estructuradas conformadas por elementos tetraédricos, que son capaces de representar geometrías complejas como la de una topografía abrupta. Dado que los algoritmos de modelado magnetotelúrico en 3D con EF que se han desarrollado no están disponibles para la comunidad académica, recientemente en el CICESE se desarrolló un algoritmo de modelado magnetotelúrico en 3D con la técnica de EF basado en elementos tetraédricos de orden superior (Gallardo-Romero y Ruiz-Aguilar, in prep.). En el presente trabajo, primeramente se mostrará la implementación del algoritmo de modelado. Una vez validado y para probar la eficiencia del algoritmo, se aplica este nuevo algoritmo para estudiar el efecto topográfico considerando dos diferentes modelos. El primero, considera una montaña de forma trapezoidal y los resultados se comparan con los de Wannamaker et al. (1986). Posteriormente, se estudia el efecto topográfico en datos magnetotelúricos adquiridos en la zona geotérmica de Los Humeros dentro del marco del proyecto GEMex. Tomando en cuenta la topografía real de la zona de estudio, se calculan y evalúan las respuestas magnetotelúricas para la configuración espacial de los sitios adquiridos, considerando diferentes modelos sintéticos 3D. Los resultados se comparan con los obtenidos usando DF (ModEM), mostrando la deficiencia de utilizar mallas rectilíneas en zonas con topografía abrupta.

Title: Cooperative Gravimetric and Elastic Full Waveform Inversion .

Raul U. Silva, Jonas D. De Basabe y Mrinal K. Sen .

CICESE, UT-Austin .

Abstract:
We develop a cooperative scheme based on Elastic Full Waveform Inversion (EFWI) and gravimetric inversion using petrophysical relations that minimizes the misfit between the observed and synthetic data measured at the surface for gravimetric stations and seismograms. This particular combination is motivated by the fact that the horizontal resolution of a model can be resolved by gravity inversion while the vertical resolution can be better estimated from the seismic data. In addition, the sequential inversion of gravity data will add a smoothness constrain to the seismic inversion to reduce spurious artifacts present in EFWI. Our algorithm uses the adjoint-state method for the computation of the gradient needed for EFWI and a constrained Conjugate Gradient Least Squares (CGLS) method for gravimetric inversion subject to the discrepancies between the density and the velocity models using petrophysical-empirical relationships between these properties. We tested our algorithm on 2D synthetic models. In all the examples, the inversion converges, recovering the interface between layers and the top and shape of the higher velocity body, yielding a good fit to the data. Finally, we compare these results with separate inversion and cooperative acoustic Full Waveform Inversion.

Title: Evaluation of in-stream renewable energy resources with shallow-water models: case studies in the Gulf of California .

Vanesa Magar .

CICESE.

Abstract:
Because of the need to diversify the renewable energy matrix and because hydrokinetic renewable energy technologies are mature, many in-stream tidal energy resource studies are available globally. However, there are many questions regarding the sensitivity of tidal power density evaluations to the resolution of the models used and the effect of seabed changes on tidal energy resources. In this presentation, we will synthesize some analyses based on the global model hydrodynamic HYCOM showing the contribution of tides and wind-driven currents to the in-stream power density in the Gulf of California (GoC). We will also show some results based on two regional (one hydrodynamic and one morphodynamic) Delft3D models with 240 m resolution on the Northeastern side of the GoC. The HYCOM model showed that the tides are the dominant contributors to in-stream power density in the GoC, with the Great Island Region and the Upper Gulf of California being priority areas for tidal energy farm developments. Finally, based on the Delft3D simulations, we found that natural seabed evolution is not detrimental to tidal energy production.

Title: Challenges in high resolution wind forecasts and scope for machine learning .

Markus Sebastian Gross .

CICESE .

Abstract:
Wind speed forecasts are needed for site evaluation and the near-real-time estimation of energy production. Higher resolution increases the cost of the simulations. However, not always does higher resolution provide better results. We will discuss some of the reasons for this and present work carried out at the Rumorosa site, Baja California, with a hierarchy of models and different perturbations of the static data. We then apply machine learning to improve the results from a low-resolution forecast and show that this can easily match or exceed the quality of the high-resolution results.

Title: Use of bivariate geostatistics for hydraulic conductivity estimation .

Hugo E. Júnez Ferreira, C. Octavio Robles Rovelo, Carlos Bautista Capetillo, Julián González Trinidad, Graciela Herrera Zamarrón .

Universidad Autónoma de Zacatecas y Universidad Nacional Autónoma de México.

Abstract:
The estimation of the hydraulic parameters of an aquifer such as the hydraulic conductivity is somehow

complicated due to its heterogeneity, on the other hand, field and laboratory tests are both time consuming and costly. Using geostatistical techniques for data assimilation represent an alternative tool for understanding the aquifer behavior in space-time in order to characterize the hydraulic conductivity heterogeneity. In this work, a spatiotemporal bivariate methodology was implemented combining historical hydraulic head data with hydraulic conductivity sparse data in order to obtain an estimate of the spatial distribution of the latter variable. This approach takes advantage of the correlation between the hydraulic conductivity (K) and the hydraulic head (H) behavior through time. In order to evaluate this approach, a synthetic experiment was constructed through a transitory numerical flow-model that simulates hydraulic head values in a horizontally heterogeneous aquifer. Geostatistical tools were used to describe the correlation between simulated spatiotemporal data of hydraulic head and the spatial distribution of the hydraulic conductivity in a group of model nodes. Subsequently, the Kalman filter was used to estimate the hydraulic conductivity values at no sampled sites. The results showed acceptable differences between estimated and synthetic hydraulic conductivity data, with low estimate error variances predominating 1 m2/day2 for K in all cases analyzed, however, the smallest cells number were values above 2 m2/day2 corresponding to the bivariate spatiotemporal case. The best agreement between the estimated errors and the selected model variance (SMSE) values were 0.574 and 0.469 for the all bivariate cases, which suggests that the implemented methodology could be used for reducing calibration efforts, particularly with scarce hydraulic data.

Title: Evaluación de la relación entre los daños por subsidencias y el espesor de arcillas correspondiente, para la CDMX. .

Nelly Lucero Ramírez Serrato .

Laboratorio de Percepción Remota, Departamento de Recursos Naturales, Instituto de Geofísica, UNAM.

Abstract:
La dinámica de cultivo utilizada en la época prehispánica llevó a la construcción de una comunidad dentro de un lago, sin embargo, con el paso del tiempo, las zonas inundadas, los canales internos, así como el resto de las construcciones pasaron a ser una gran ciudad con el crecimiento exponencial de la urbanización, todo esto sin las medidas precautorias ni la gestión adecuada del territorio. El pasado subterráneo de la Ciudad de México ha representado problemas en la deformación de la superficie de manera notoria provocando daños importantes en las estructuras civiles presentes. Estudios previos indican que existe un hundimiento anual de 15 a 25 cm en el Aeropuerto Internacional de la Ciudad de México, 10 cm en el centro y entre 10 a 15 cm en el área sureste de la Ciudad de México. El objetivo de este proyecto es evaluar la relación existente entre el espesor de las arcillas subterráneas y el comportamiento superficial del terreno bajo diferentes metodologías a escala regional y local. Para el nivel regional se compararon modelos de elevación generados entre 2000 y 2018, considerando índice de Posición topográfica y el cálculo de pendientes, resultando en un mapa de posibles sitios de deformación. Por otro lado, se está trabajando con una técnica local de obtención de datos de estructuras para realizar el calculo de deformación a partir de los daños registrados.

Title: A two-phase geothermal model with fracture network and multi-branch wells for geothermal simulation .

Daniel Castañon Quiroz .

University Cote d'Azur.

Abstract:
In order to simulate deep geothermal systems, we present a model which takes into account complex geology including faults and fracture networks acting as major heat and mass transfer corridors and complex physics coupling the mass and energy conservations to the thermodynamic equilibrium between the gas and liquid phases. In addition, the thermal well model used is a simplified version of the "drift flux model" which neglects transient terms, thermal losses and cross flow in the sense that all along the well, the well behaves either as a production or an injection well. The Vertex Approximate Gradient (VAG) scheme is used for the spatial discretisation for the reservoir and fractures, and the parallel code ComPASS is used for the numerical implementation. Moreover, we present a numerical test to verify the convergence of the method, and a real application 3D test case. This work is a joint collaboration with BRGM-France and Storengy.

Title: Metodología para el diseño de redes de monitoreo de agua subterránea basada en geoestadística espacial y ruta crítica .

Julián González Trinidad .

Universidad Autónoma de Zacatecas .

Abstract:
Metodología para el diseño de redes de monitoreo de agua subterránea basada en geoestadística espacial y ruta crítica. Juana Cázares Escareño, Hugo Enrique Júnez Ferreira, Julián González Trinidad, Cruz Octavio Robles Rovelo. Resumen Una alternativa para un uso eficiente del agua subterránea, es la optimización de las redes de monitoreo con los cuales se obtiene información de calidad y niveles del agua, por ejemplo, mediante campañas de tomas de datos que son la principal fuente de información para hacer inferencias acerca del comportamiento hidrológico del agua en el subsuelo. En este trabajo se propone una metodología para el diseño de redes de monitoreo orientadas a la obtención de datos del nivel del agua subterránea de alta representatividad espacial a bajo costo, minimizando las distancias de recorrido entre puntos de monitoreo. Está basada en técnicas geoestadísticas usando el Filtro de Kalman estático y un método de ruta crítica (MRT) que indica la pauta para la adquisición puntual de información. Se usó el MRT del problema del agente viajero (PAV). Para el diseño óptimo de la red de monitoreo mediante el PAV, se estudió el acuífero administrativo Calera ubicado en el estado de Zacatecas, México, considerando 49 pozos, las distancias de conexión entre ellos se obtuvieron de un sistema de información geográfica desarrollado por el Instituto Nacional de Estadística

y Geografía mexicano. La función objetivo fue minimizar la varianza del error en la estimación de la información de la red y los costos del monitoreo asociados al recorrido de los pozos que la conforman. Se evaluaron 4 diferentes opciones, cada una con diferente criterio de optimización, para comparar los resultados con la metodología del PAV usada en este trabajo. Los resultados indican que con la red de monitoreo basada en únicamente la reducción de la varianza del error en la estimación considerando todos los pozos (primer criterio) existe una distancia a recorrer de 1859.87 km. Mientras que la red de monitoreo al considerar 99% de los pozos (segundo criterio) generan una distancia de 1547.85 km. Por otra parte, la red de monitoreo al considerar la reducción de la varianza y optimización de la ruta a seguir de todos los pozos (tercer criterio) en los cuales se consideró un peso de 50/50 respectivamente para las prioridades, generó una distancia de 1683.88 km y, por último, la red de monitoreo siguiendo la metodología propuesta del PAV (cuarto método) que considera la reducción de la varianza del error en la estimación y la optimización de la ruta a seguir para la misma cantidad de pozos que en el segundo criterio, arroja que el 80% de los pozos (39) pueden proveer el 97% de la información confiable ahorrando el monitoreo de 10 pozos y, por lo tanto, distancia recorrida. La distancia a recorrer con la metodología del PAV fue de 1391.95 km, siendo menor en un 25%, 10%, y 17% comparada con el primero, segundo y tercer criterio, respectivamente. La metodología propuesta representa una alternativa de fácil aplicación que coadyuva a minimizar los costos operativos en el monitoreo de pozos.

Title: Efectos geométricos inducidos en dinámica browniana .

Pavel Castro Villareal .

Universidad Autónoma de Chiapas .

Abstract:
El movimiento browniano ocurre como una representación de varios fenómenos que surgen en varios contextos incluyendo la física de partículas elementales, la relatividad general y la materia condensada. En la última década, ha habido un gran interés en el estudio de los procesos difusivos sobre variedades curvas motivado por problemas procedentes de biofísica. En esta ocasión, a través de una descripción hidrodinámica se estudia la dinámica de partículas brownianas activas y pasivas, respectivamente, en una superficie curva dos-dimensional. Se explota la covarianza general de las ecuaciones de evolución asociadas a la densidad de partículas, correspondientes a los sistemas pasivo y activo, con el fin de explorar los efectos de curvatura que surgen en las respectivas dinámicas. En particular, se utiliza un marco local definido por las llamadas coordenadas de Riemann normal para derivar una fórmula general para la distancia geodésica cuadrática media (MSGD), en la situación de curvatura débil, en el caso de partículas no-interactuantes. Las fórmulas correspondientes se escriben en términos de invariantes geométricos que dependen del tensor de curvatura. Se muestran evidencias de la equivalencia de estos sistemas pasivos y no activos, constreñidos a la superficie curva, en el límite de tiempo largo en el caso de partículas no-interactuantes. Finalmente, se discute, a grandes rasgos, el papel que juega la geometría cuando consideramos un sistema de partículas interactuantes. Esta plática es parte del mini simposio del SIAM 'Difusión sobre superficies: estudio teórico y numérico'.

Title: Influencia de la geometría sobre la difusión en canales estrechos sobre superficies y en variedades tubulares.

Guillermo Chacón-Acosta .

Universidad Autónoma Metropolitana Cuajimalpa .

Abstract:
sobre partículas que se difunden en distintos dominios acotados. En primer lugar estudiamos la difusión de partículas que se mueven sobre superficies curvas limitadas dentro de canales estrechos arbitrarios utilizando el enfoque de Kalinay-Percus para proyectar a una dimensión efectiva que da lugar a una ecuación tipo Fick-Jacobs con modificaciones relacionadas con la curvatura de la superficie. También presentamos un método de proyección alternativo aplicado a un canal tridimensional en cuyo caso el coeficiente de difusión se ve afectado por la curvatura y torsión de la línea media. Nota. Esta plática es parte del mini simposio del SIAM 'Difusión sobre superficies: estudio teórico y numérico'.

Title: El método de Kalinay y Percus para estudiar la difusión cuasi-unidimensional en tubos con fronteras parcialmente absorbentes .

Inti Pineda Calderón .

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Abstract:
El método de Kalinay y Percus se ha empleado para obtener de forma sistemática las aproximaciones a diferentes órdenes de los coeficientes de difusión efectivos en regiones confinadas cuasi-unidimensionales. En particular en el caso de la difusión en tubos planos este método ha mostrado su gran utilidad cuando las fronteras longitudinales del sistema son asimétricas, generando incluso una expresión analítica del coeficiente de difusión efectivo. En el presente trabajo se muestra cómo aplicar el método de Kalinay y Percus al problema de un tubo bidimensional cuando las fronteras a lo largo del sistema son parcialmente absorbentes. Cabe destacar que, luego del uso de la técnica de homogenización de fronteras, una frontera parcialmente absorbente puede usarse para modelar una frontera con sitios activos absorbentes, cuya presencia es muy recurrente en varios sistemas de interés sustancial en la biología, en la química y en las aplicaciones industriales. Esta plática es parte del mini simposio del SIAM 'Difusión sobre superficies: estudio teórico y numérico'.

Title: Numerical Solutions of the Laplace-Beltrami equations on surfaces on $\mathbb{R}^3$.

Diana Assaely León Velasco .

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Abstract:
The purpose of this work is to study numerically diffusion processes on surfaces embedded in $\mathbb{R}^3$, these kinds of processes involve the Laplace-Beltrami equation. To solve these problems, we use the backward Euler scheme to discretize time and finite element approximations with first-order polynomials for spatial discretization. In order to illustrate an application, we study the aspects influencing the transport properties of particle diffusion on the surfaces of irregular pores, our interest is how the spatial configuration of the trajectories of the ensemble of particles in the surface affects their effective displacement on the porous medium. Esta plática es para el minisimposium "Difusión sobre superficies: estudio teórico y numérico"

Title: Simple closed-form property expressions of two metafluids composed of periodic arrays of cubic elastic fibres embedded in an ideal fluid .

Adolfo Ayuso Hernández .

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Abstract:
Two periodic arrays of parallel circular cylinders embedded in a matrix are considered. The fibers are filled with cubic (C) elastic material, whereas the matrix is an ideal fluid. The asymptotic homogenization method, applied to similar problems where the matrix is also a C elastic material, produced formulas for the effective C elastic composites. By a limit procedure, when the shear modulus of the matrix tends to zero, the formulas yield very simple expressions for the effective coefficients of the two composites, namely, they are C metafluids.

Title: Closed form expressions for the effective properties of laminates with non-uniform imperfect contact .

Rogelio Oscar Caballero Pérez .

Instituto de Investigaciones en Matemáticas Aplicadas y en Sistemas.

Abstract:
Non-uniform imperfect contact on the interphases of composites can model a wide variety of situations, ranging from irregular delamination patterns to variable surface capacitance or conductivity due to chemical reactions with the environment. In this work, the non-uniformity is modelled via spring-type contact conditions whose proportionality constants are functions of the position on the surface. A modification of the ansatz of Bakhvalov and Panasenko is introduced on the global elliptic problem and the contact conditions in order to separate scales. This allows us to obtain families of

local problems that are analytically solvable systems of EDOS whose solutions depend parametrically of the two spatial variables of the surface of contact. By solving the local problems, we obtain the functionally graded effective coefficients and analyze some limit cases from the recent literature.