International Meeting on Applied Mathematics & Evolution

Conferences

La Rochelle Université

MATHEMATIQUES IMAGE APPLICATIONS
UNIVERSITÉ DE LA ROCHELLE

April 16-18, 2019

La Rochelle

The aim of the IMAME conferences is to bring researchers and professionals to discuss recent developments in both theoretical and applied mathematics, to create a knowledge exchange platform between mathematicians. The conference is broad-based, covering all branches of engineering sciences, mathematics and interdisciplinary researches.

Book of abstracts

Symposium supported by the New Aquitaine Region

RÉGION Nouvelle-Aquitaine

Schedule of IMAME 2019

	Tuesday April 16	Wednesday April 17	Thursday April 18
08:00-09:00	Welcome *Orbigny Hall,* *Amphi 300*	Session ``PDE Analysis'' *C24*	Session ``PDE Analysis'' *C24*
09:00-10:00	**Plenary 1** *Ampli 300*	**Plenary 3** *Ampli 300*	**Plenary 5** *Ampli 300*
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Introduction

Dear Participants,

It is our pleasure to welcome you in La Rochelle during the International Meeting on Applied Mathematics & Evolution IMAME 2019. The present conference, already third in a row, is organized by the MIA Lab, La Rochelle University, and hosted by Faculty of Sciences and Technologies in La Rochelle France.

The first IMAME 2012 and the second IMAME 2016 were organized by the Moulay Ismaïl University, Faculty of Sciences and Technics of Errachidia, Morocco. Both conferences provided a platform for knowledge exchange between mathematicians and both were a success. We really think that we will maintain this new tradition with the La Rochelle's event.

Today we have a pleasure of hosting a large group of researchers from various areas of mathematics and its applications. Such a wide spectrum of participants' interest certainly will stimulate inspiring and productive discussions during sessions and informal meetings[1].

We would like to express our thanks to all participants. We wish you to have a good professional experience, enjoying old and new friends as well as your stay in La Rochelle!

The Organizing Committee

[1] You will find many places in the Faculty, comfortable seats inside or garden seats outside, for impromptu discussions. During all the conference, rooms C26-C27, 2nd floor of Orbigny building, are also reserved for possible work sessions. Do not hesitate to contact a member of the organization for other requirements.

The committees

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Part II

Plenary talks

Aerosol modeling in the respiratory system

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ABSTRACT

In this talk we will present contributions around the modeling of particle transport and deposition in the respiratory system. Therapeutic sprays or polluting particles fall into the category of fine sprays and can therefore be described by mesoscopic kinetic equations. The fluid-particle system is then a system that strongly couples the Navier-Stokes equations and the Vlasov equation. In particular, we would like to understand what influences deposition during the inspiration phase: by taking into account the feedback force of the spray on the fluid for particles whose inertia is sufficiently large or by taking into account particle growth radius by humidification. Finally, models describing the dynamics of the fluid-particle interaction during the entire respiratory cycle in the whole bronchial tree will be introduced. The obtained model can then be calibrated to take into account physiological, geometrical heterogeneities or even specificities of inhaled aerosols and give good results in comparison with experimental deposition data obtained on healthy rats.

Deterministic models for asset pricing

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Keywords: Ordinary differential equations for asset pricing; Price dynamics; Asset flow; Dynamical system approach to mathematical finance

ABSTRACT

I will give an overview on deterministic asset pricing models. I will present asset flow differential equations used for modeling a single asset market involving a group of investors. Later on, the model will be extended for a two-asset market system. Derivation of models are based on the assumption of the finiteness of assets (rather than assuming unbounded arbitrage) in addition to investment strategies that are based on either price momentum (trend) or valuation considerations. Finally, an example from real market will be discussed.

References

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Applications of deep learning to partial differential equations

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ABSTRACT

Neural networks have been game changers in many optimization and classification problems. Google, Facebook and Nvidia have written highly optimized and user-friendly open source toolboxes with which it is easy to assess to potentials of deep learning on control, inverse and classification problems for distributed systems. On the other hand the mathematical results which certify that the problems are solved are few.
In this talk we will try to survey the mathematical results available and present applications on three classes of problems:

- Classification of linear PDEs
- Identification of parameters for fluid structure problem and for the Heston model in finance
- Computation of solutions of linear parabolic PDE in high dimensions

Two-scale homogenization for micro-resonant evolution problems

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Keywords: High-contrast two-scale Homogenization, Defects and Eigenmodes

ABSTRACT

Macroscopic dynamic response of heterogeneous media can be very different from that of conventional media, often due to effects of "micro-resonances". Mathematically this leads to studying homogenization of PDEs with a 'critically' scaled high contrast, where the resulting two-scale asymptotic behaviour appears to display a number of interesting effects. We will review some background, as well as some more recent developments and applications. One is two-scale analysis of general "partially-degenerating" periodic PDE systems [1], where strong two-scale resolvent convergence appears to hold under a rather generic decomposition assumption, implying in particular (two-scale) convergence of semigroups with applications to a wide class of evolution problems, both parabolic and hyperbolic. Another is [2], where we establish error bounds for eigenvalues and eigenmodes due to a localized defect in a high-contrast periodic medium, which mathematical problem is motivated in part by formation of localized modes in photonic crystal fibers. Finally, we will briefly review a most recent generic approach for establishing high-contrast operator error bounds, as well as additional effects when the micro-resonances display certain randomness.

References

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Mathematical modeling with time scales and its application in epidemiology

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Keywords: Dynamic equations on time scales; Deterministic epidemic model; Closed-form solution; Time-varying coefficients; Asymptotic behavior.

ABSTRACT

We investigate an epidemic model based on Bailey's continuous differential system. In the continuous time domain, we extend the classical model to time-dependent coefficients and present an alternative solution method to Gleissner's approach. If the coefficients are constant, both solution methods yield the same result. After a brief introduction to time scales, we formulate the SIR (susceptible-infected-removed) model in the general time domain (including the continuous, the discrete, and hybrid cases) and derive its solution. In the discrete case, this provides the solution to a new discrete epidemic system. The last part is dedicated to the analysis of the limiting behavior of susceptible, infected, and removed, which contains biological relevance.

This talk is based on the paper [1] by Martin Bohner, Sabrina Streipert and Delfim F. M. Torres.

References

[1] M. Bohner, S. Streipert and D. F. M. Torres, Exact solution to a dynamic SIR model, Nonlinear Anal. Hybrid Syst. **32** (2019), 228–238.

Part III

Invited oral communication

Learning dynamical systems from partial observations

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Keywords: Machine learning; Dynamical systems; Atmospheric and oceanic physics

ABSTRACT

We consider the problem of forecasting complex, nonlinear space-time processes when observations provide only partial information on the system's state. We propose a natural data-driven framework, where the system's dynamics are modelled by an unknown time-varying differential equation, and the evolution term is estimated from the data, using a neural network. Any future state can then be computed by placing the associated differential equation in an ODE solver. We first evaluate our approach on shallow water and Euler simulations. We find that our method not only demonstrates high quality long-term forecasts, but also learns to produce hidden states closely resembling the true states of the system, without direct supervision on the latter. Additional experiments conducted on challenging, state of the art ocean simulations further validate our findings, while exhibiting notable improvements over classical baselines.

Part IV

Oral communications

Mathematical behaviour of terrestrial gamma-ray flashes

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Keywords: Light curve fitting; Maximum likelihood; Density functions; Stochastic processes; TGFs

ABSTRACT

We model the time profile of terrestrial gamma-ray flashes (TGFs) with five different probability density functions, the very widely used lognormal distribution function and four other deterministic and stochastic probability densities. To determine the goodness of fit for each density function, we use the maximum likelihood method. Having previously applied this method with success [1] to two data sets (from the CGRO/BATSE and the FERMI/GRM satellites/instruments), we apply our modeling and analysis to TGF time profiles recorded by the AGILE and RHESSI satellites. We here present the results of our work with conclusions about the usefulness of such a method to physical problems that lend themselves to it as well as about what the results indicate regarding the nature (stochasticity) of the TGF phenomenon, which remains an unsolved problem in the field.

References

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Variational problems involving distributed-order fractional derivatives

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Keywords: Distributed-order fractional derivative; Euler–Lagrange equation; Numerical methods

ABSTRACT

In this work, we extend some fractional calculus of variations results by considering functionals depending on distributed-order fractional derivatives. Using variational techniques, we deduce optimal necessary conditions of Euler–Lagrange type. We also study the case where integral and holonomic constraints are imposed. Finally, a numerical procedure is given to solve some proposed problems.

References

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New bounds for the signless Laplacian spread

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Keywords: Matrix spread; Signless Laplacian spread; Signless Laplacian matrix

ABSTRACT

Let G be a simple graph. The signless Laplacian spread of G is defined as the maximum distance of pairs of its signless Laplacian eigenvalues. This talk, based on the work referred in [1], presents some new bounds, both lower and upper, for the signless Laplacian spread. Several of these bounds depend on invariant parameters of the graph. We also use a min-max principle to find several lower bounds for this spectral invariant.

References

[1] E. Andrade, G. Dahl, L. Leal, M. Robbiano, New Bounds for the Signless Laplacian Spread. *Linear Algebra and its Applications*, 566: 98-120, 2019.

Stability and Neimark–Sacker bifurcation analyses of a discrete-time predator-prey system with Leslie Type

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Keywords: Difference equation; Stability; Flip bifurcation; Neirmark–Sacker bifurcation

ABSTRACT

The dynamical behaviors of a discrete-time predator-prey system with Leslie type will be presented. First, the existence of the positive equilibrium point of the discrete system is shown, and the conditions are set so that this point can be stable. Then, the conditions of existence for flip bifurcation and Neimark-Sacker bifurcation arising from this positive equilibrium point are determined. More specifically, these bifurcations are driven by using the center manifold theorem and normal form theory by choosing the integral step size as a bifurcation parameter. Finally, some numerical simulations will be presented to support and extend the theoretical results.

References

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Asset price dynamics for a two-asset market system

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Keywords: Asset price dynamics, asset flow model, stability of price dynamics, market dynamics, equilibrium price, cyclic behavior

ABSTRACT

We present a mathematical model for a market involving two stocks which are traded within a single homogeneous group. It is assumed that the market consists of a fixed amount of cash and stocks and that the trading group is affected by trend and valuation motivations while selling or buying each asset, but follows a strategy in which the buying of an asset depends on the other asset's price while the selling does not. We analyze the stability of equilibrium points of the model which is obtained through a dynamical system approach, and determine the conditions on parameters for stability. Moreover, we argue the existence of periodic solutions through a Hopf bifurcation by choosing the momentum coefficient as a bifurcation parameter within this setting. Finally, we give examples and numerical simulations to support and extend the analytical results.

References

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Optimal Lagrangian control of Korteweg–de Vries: a shallow water pollution problem

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Keywords: Optimal control; Lagrangian controllability; Korteweg-de Vries equation; Pontryagin's conditions; shallow water pollution.

ABSTRACT

This work is devoted to a shallow water pollution problem. We are interested in the following nonlinear Korteweg-de Vries equations:

$$\partial_t \eta + \partial_x \eta + \partial_{xxx} \eta + \eta \partial_x \eta = 0,\ (x,t) \in (0,L) \times (0,T) \tag{1}$$

$$\eta(0,t) = v_1(t)\ ,\ \eta(L,t) = v_2(t)\ ,\ \partial_x \eta(L,t) = v_3(t),\ t \in (0,T) \tag{2}$$

$$\eta(x,0) = \eta_0(x),\ x \in (0,L) \tag{3}$$

where the amplitude of the wave η, triggered by an action $v = (v_1, v_2, v_3)$ controlled on the boundary, enables to move polluted particles in a channel towards a treatment plant. It has been proved in [1] that equations (1)-(3) are Lagrangian controllable, by using the N-solitons solution.
The aim of this work is to prove that we can also minimize the cost of the action which generates the wave. To this aim, we introduce and study an optimal control problem. If the existence of a pattern enabling to lead the Lagrangian controllability has already been obtained, there is no guarantee of its uniqueness. The main interest of the optimal control theory is to determine, among all of these patterns, those who can minimize the chosen objective.
We prove the existence of an optimal solution for our problem and provide the Pontryagin's necessary optimal conditions.

References

[1] L. Gagnon, Lagrangian controllability of the 1-D Korteweg-de Vries equation. *SIAM J. Control Optim.*, 54(6), 3152–3173, 2016.

Arnold diffusion and stochastic Hamiltonian systems

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Keywords: Stochastic Hamiltonian systems, Arnold diffusion

ABSTRACT

We discuss a stochastic analogue of the Arnold diffusion phenomenon introduced by V.I. Arnold in his 1964 seminal paper [1], for stochastic Hamiltonian systems. We first remind the definition of a stochastic Hamiltonian system. We then develop variational numerical integrators for these systems in the spirit of geometric numerical integration. We then construct a stochastic Arnold model and discuss its dynamics using simulations. This work is done with Hlne Pihan-Behars.

References

[1] V.I. Arnold, Instability of dynamical systems with several degrees of freedom. *Soviet Math. Dokl.*, 5, pp. 581-585, 1964.

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Matrix covering and A-interval matrices

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Keywords: Combinatorial matrix theory; Covering

ABSTRACT

This talk is based on work with Richard A. Brualdi (University of Wisconsin). The main goal of the presentation is to present some basic and interesting covering type of problems for a given matrix. A classical such example is König's covering problem for a matrix (or bipartite graph). Some new covering problems are discussed, and connections to certain matrix factorizations are pointed out. This includes the very important concept of nonnegative matrix factorization.

References

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Entropy solutions of a quasilinear degenerated elliptic unilateral problems with L^1 data and without sign condition

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Keywords: Weighted Sobolev spaces; Quasilinear degenerated unilateral problems; Non-variational inequalities

ABSTRACT

In this paper, we will be concerned with the existence of solutions for strongly nonlinear degenerated elliptic unilateral problems associated to the equation $A(u) + g(x, u, \nabla u) + H(x, \nabla u) = f$, where A is Leray-Lions operator acting from $W_0^{1,p}(\Omega, w)$ to its dual. On the nonlinear term $g(x, s, \xi)$, we assume growth condition on ξ and without assuming the sign condition on s, while the function $H(x, \xi)$, which induces a convection term, is only growing at most as $|\xi|^{p-1}$. The right-hand side f belongs to $L^1(\Omega)$.

References

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On bounded solutions for nonlinear parabolic equations with a lower-order term and degenerate coercivity

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Keywords: Nonlinear parabolic equations, regularity of solutions, lower-order perturbation, degenerate coercivity, entropy solutions

ABSTRACT

In this paper, we give some regularity results of solutions for some nonlinear parabolic equations with degenerate coercivity. We will show that the presence of some lower order terms has a regularizing effect on the solutions. We also give summability results for irregular data.

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On fractional differential inclusions with non local boundary conditions

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Keywords: Fractional differential inclusions; Young measures; Bolza and relaxation problems; Subdifferential operators

ABSTRACT

The main purpose of this paper is to study a class of boundary value problem governed by a fractional differential inclusion in a separable Banach space E

$$\begin{cases} D^{\alpha}u(t) + \lambda D^{\alpha-1}u(t) \in F(t, u(t), D^{\alpha-1}u(t)),\ t \in [0,1] \\ I_{0^+}^{\beta}u(t)\,|_{t=0} = 0, \quad u(1) = I_{0^+}^{\gamma}u(1) \end{cases}$$

in both Bochner and Pettis settings, where $\alpha \in]1,2]$, $\beta \in [0, 2-\alpha]$, $\lambda \geq 0, \gamma > 0$ are given constants, D^{α} is the standard Riemann-Liouville fractional derivative, and $F : [0,1] \times E \times E \to 2^E$ is a closed valued multifunction. Topological properties of the solution set are presented. Applications to control problems and subdifferential operators are provided.

A p-Laplace equation model for document image enhancement

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Keywords: Document image; nonlocal operators; parabolic PDE; p-Laplacian.

ABSTRACT

Inspired by the p-Laplacian operator and the nonlocal methods investigated in the context of image restoration [1][2], we outline two novel approaches to enhance document images by reducing the effects of the non-uniform illumination. Theoretical results encompassing existence and uniqueness of a solution to proposed problems are presented. To highlight the efficiency and the accuracy of our proposed methods, the numerical experiments are implemented and compared with some existing models in the literature.

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Modeling algal blooms due to swine CAFOs in Eastern North Carolina

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Keywords: Mathematical Modeling, Systems of Differential Equations, CAFO

ABSTRACT

Dramatic strides have been made in treating human waste to remove pathogens and excess nutrients before discharge into the environment, to the benefit of ground and surface water quality. Yet these advances have been undermined by the dramatic growth of Confined Animal Feeding Operations (CAFOs) which produce voluminous quantities of untreated waste. Industrial swine routinely produce waste streams similar to that of a municipality, yet these wastes are held in open-pit lagoons which are at risk of rupture or overflow. Eastern North Carolina is a coastal plain with productive estuaries which are imperiled by more than 2000 permitted swine facilities housing over 9 million hogs; the associated 3,500 permitted manure lagoons pose a risk to sensitive estuarine ecosystems, as breaches or overflows send large plumes of nutrient and pathogen-rich waste into surface waters. Such anthropogenic nutrient loading can wreak havoc on estuarine environments, leading to both short-term and long-term fisheries losses, as well as human health risks. Understanding the relationship between nutrient pulses and surface water quality in coastal environments is essential to effective CAFO policy formation, yet the literature on linkages between nutrient loading and water quality in estuaries is not well developed. In this work, we develop a system of ODEs to model algae growth in a coastal estuary due to a manure lagoon breach. We explore the sensitivity of the algal bloom life cycle to perturbations in key parameters and provide recommendations for environmental policy.

A review of variational multiscale methods for multiphysics flow problems

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Keywords: Variational multiscale methods; Two-levels method; Multiphysics flows

ABSTRACT

This talk presents a review of the Variational Multiscale (VMS) methods, which have been proposed for turbulence modeling for the approximation of the incompressible Navier-Stokes equations, [1, 2]. VMS methods have been using not only for turbulent flow modeling, but also for blood flow modeling and weather prediction. There are many realizations of VMS methods have been introduced for multiphysics flow problems. According to VMS, the scale separations of the unknown flow fields are defined by projections by using finite element methods, [3]. Based on this principle, VMS methods have been used to stabilize the unresolved small scales in flow problems with a subgrid eddy viscosity. In particular, the derivation of the VMS models is considered in detail and some numerical examples for the Navier Stokes equations and natural convection equations are presented, [4]. Numerical results for the model problems and novel benchmarks show the promises of the VMS methods.

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Geometric construction of splines on Grassmann and Stiefel manifolds

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Keywords: Grassmannian; Stiefel manifold; geodesics; quasi-geodesics; splines

ABSTRACT

Grassmann and Stiefel manifolds have featured prominently in many popular applications from vision and learning, in which the basic elements of the data are sets of vectors instead of vectors [4]. The nonlinearity of such spaces makes it difficult to apply traditional techniques that primarily rely on Euclidean analysis. Thus, obtaining efficient and reliable generalizations of iterative methods on Euclidean spaces to nonlinear spaces has been frequently required by the vision and learning community. Our purpose here is to give a simple geometric algorithm to generate splines that prescribe certain positions and orientations at certain times [2]. Explicit expression for geodesics and quasi-geodesics will be crucial for the spline construction [1, 3]. Each spline segment is obtained by a convex combination of two components via a smoothing function, that is responsible for guaranteeing the smoothness of the resulting spline at the knot points.

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Fractional differential equations and Volterra–Stieltjes integral equations of the second kind

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Keywords: Fractional Differential Equation, Volterra–Stieltjes Integral Equation, Generalized Midpoint Rule

ABSTRACT

In this work, we construct a method to find approximate solutions to fractional differential equations involving fractional derivatives with respect to another function. The method is based on an equivalence relation between the fractional differential equation and the Volterra–Stieltjes integral equation of the second kind. The generalized midpoint rule is applied to solve numerically the integral equation and an estimation for the error is given. Results of numerical experiments demonstrate that the satisfactory and reliable results could be obtained by the proposed method.

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Hegselmann–Krause model on time scales with a predictive control

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Keywords: Opinion dynamics; Consensus formation; Predictive Control; Time Scales Calculus

ABSTRACT

The aim of this talk is to analyse the behavior of the Hegselmann-Krause model of opinion dynamics on time scales with a predictive control [1]. Numerical simulations show that the predictive control mechanism has the ability to steer the system to attain a consensus. Moreover, faster consensus speed is observed when compared with the classical model [2, 3, 4].

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A fluid model for cell motility

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Keywords: Cell motility; Free boundary problem; Cahn-Hilliard; Hele-Shaw

ABSTRACT

One of the most remarkable features of eukaryotic cells is their ability to reach and sustain an asymmetric shape either spontaneously or in response to environmental cues. This cellular property, called front-rear polarization, results from a symmetry breaking in its organization required for efficient cell migration. Motile cells have however evolved and optimized different motile modes. Malignant cells use the same motility mechanisms during cancer progression. Hence, cell migration has two opposite faces: essential to the immune response, allowing leukocytes to patrol the whole body, it is also responsible for the spreading of tumor cells (metastasis).

In this talk I shall present some theoretical and computational studies of free-boundary problems to describe cell motility. In a first step, I shall describe our approach, which is inspired from [1, 4], that allows describing the internal structures linked to migration as an active fluid. In this approach, the active character appears through boundary terms, which makes its original. Then, we shall see that the marker concentration obeys to a non-linear and non-local convection-diffusion equation, where the convection field corresponds to the fluid advection field. Finally, the marker distribution on the domain boundary exerts a feedback loop on the fluid [3]. Then following [2, 5], I shall present a class of minimal versatile models, designated as active Hele-Shaw models. These models consist in the coupling in the boundary term of the Hele-Shaw model with a PDE stated on the free evolving domain to describe the active character of its cytoskeleton. Some numerical simulations in 2D will be presented in rigid domain and also in deformable domain.

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Perspectives of the para-model control of HIV models

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Keywords: Biomedical control, model-free control, intelligent PI control

ABSTRACT

The model-free control approach [1] has been designed as a robust controller to overcome difficulties of tuning classical controllers when the processes to be controlled are not "well-modeled". In this work, we present first the real-time model-free based control of the predator-prey like model that describes the evolution of the HIV-1 model [2]. The perspectives towards the model-free based optimal control of the SICA model [3] are then discussed and preliminary results are presented. The proposed feedback control $\mathcal{C}_\pi$ [2] drives biological models and shall optimize the model response according to their real-time feedbacks. The control law is:

$$\mathcal{C}_\pi : (y, y^*) \mapsto u_k = \int_0^t K_i \varepsilon_{k-1} d\tau \Big|_{k-1} \underbrace{\left\{ u^i_{k-1} + K_p (k_\alpha e^{-k_\beta k} - y_{k-1}) \right\}}_{u^i_k} \quad (1)$$

where: y^* is the output reference trajectory of the models to be optimized; K_p, K_I are real positive tuning gains; $\varepsilon_{k-1} = y^*_k - y_{k-1}$ is the tracking error.

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Using deep learning for PDEs identification

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Keywords: PDE; Machine Learning, Deep Neural Network

ABSTRACT

This work concerns the type recognition and the parameters identification of some classical PDEs (reaction, convection, diffusion equations). To this aim, we have developed a methodology based on deep neural networks [1] for which the input data are simulation results. The preliminary results show that this technique easily recognizes the type of the PDE (over 98 %) and obtains a correct accuracy (about 1e-3) of its parameter. The exploration of simulations by unsupervised methods (t-SNE [2], autoencoders) reveals their intrinsic dimension and gives an overview of the architecture necessary for the neural network to be effective.

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Curved layer path planning on a 5-axis 3D printer

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Keywords: Additive manufacturing; 3D printing; Curved path planning; Splines

ABSTRACT

During the last decades, 3D printing has emerged as a new technology and is now widely used to produce a wide variety of objects in several engineering areas [1]. While standard 3D printers usually consider three degrees of freedom (with movements along the x, y, and z axes), a five degrees of freedom printer, with movements along the three usual axes together with two additional degrees of freedom at the printing table (allowing it rotation and tilt), allows to build more complex and reliable objects [2]. However, this increase in the printing freedom requests for new printing approaches, namely when addressing deposition path planning. In this work we address an approach to print complex objects, taking advantage of five degrees of freedom printers. We consider curved layer path planning where polygons obtained in the slicing stage are approximated by linear and cubic splines. We provide an example with an aeronautic object to illustrate the proposed approach.

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Homogenization of the demagnetizing field operator in two-component composite with interfacial flux jump

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Keywords: Demagnetizing field; Homogenization; Periodic unfolding method; Composite materials; imperfect interface.

ABSTRACT

We study the homogenization of a demagnetizing field operator in a periodic composite material formed by two constituents, separated by an imperfect interface Γ^ϵ on which we prescribe the continuity of the conormal derivatives and a jump of the solution proportional to the conormal derivative, by means of a function of order ϵ^γ. We use the periodic unfolding method (see [1], [2] and [3]) to identify the limit problem for three cases, $-1 < \gamma \leq 1$, $\gamma < -1$ and $\gamma = -1$. These cases are handled separately and they lead to different limit problems

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Measure differential inclusions with multifunctions monotone in time

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Keywords: Measure differential inclusion; Bounded variation; Excess function

ABSTRACT

The purpose of this work is to present the existence of bounded variation solutions for the measure differential problem

$$dx(t) \in G(t, x(t))dg(t), \qquad x(0) = x_0,$$

where X is a real Banach space, $G : [0,1] \times X \to \mathcal{P}_k(X)$ is a compact-valued multifunction and $g : [0,1] \to \mathbb{R}$ is of bounded variation (dg is the distributional derivative of g which is a Borel measure). It will be also proved that the solution set of our problem can be obtained by the solution sets of approximating problems (when the problems are driven by some measures dg_n converging to the measure dg). The announced results generalize the results in [2] since the bounded variation assumption involves the excess function between sets $e(A,B) = \sup\{\inf_{b\in B} \|a - b\| : a \in A\}$ instead of the Hausdorff distance $H(A,B) = max(e(A,B), e(B,A))$. The main tool is the selection principle proved using the excess function in [1]. In particular, the case of a multifunction monotone w.r.t. the first argument and Lipschitz-continuous w.r.t. the second one is covered.
Having in mind that the theory of measure differential equations allows one to study dynamical systems with a mix continuous-discrete behavior, our results might be used to get new results for dynamic problems on time scales or for impulsive differential problems (as in [3]).

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Optimality system of the nonlocal thermistor problem with Atangana–Baleanu fractional time derivative

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Keywords: Optimality conditions; Optimal control

ABSTRACT

We study an optimal control problem associated to a fractional nonlocal thermistor problem [3] involving Atangana-Baleanu fractional time derivative [1, 2]. We first prove the existence and uniqueness of solution. Then, we show that the optimal control exists. Hence we give the optimality system that characterizes the control.

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Optimal control of malaria transmission

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Keywords: Optimal control; malaria model; optimization methods

ABSTRACT

In this work we consider the malaria transmission model proposed in [1] and propose optimal control problems where the objective is to minimize the number of infected individuals and mosquitoes, generalizing the work developed in [2]. A sensitivity and cost-effectiveness analysis are performed in order to establish which of the control measures is the most appropriate for different epidemic scenarios.

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Weak solutions to a spatio-temporal fractional Landau–Lifshitz–Bloch equation

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Keywords: Landau–Lifshitz–Bloch equation; Fractional differential equations; Weak Caputo derivative; Fractional Laplacian; FaedoGalerkin; Weak solution

ABSTRACT

We deal with global existence of weak solutions of a time-space fractional Landau–Lifshitz–Bloch equation involving the weak Caputo derivative and a fractional Laplacian. We use Faedo–Galerkin method with some commutator estimates in order to prove global existence of weak solutions for the model. The uniqueness is also discussed in a special one dimensional case.

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Modeling underground flows in shallow aquifers

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Keywords: Asymptotic analysis; Richards problem; Dupuit approximation

ABSTRACT

In this work, we present a class of new efficient models for water flow in shallow aquifers, giving an alternative to the classical 3D-Richards model. Its derivation is guided by two ambitions: any new model should be low cost in computational time and should still give relevant results at every time scale. We thus keep track of two types of flow occurring in such a context and which are dominant when the *ratio* thickness over longitudinal length is small: the first one is dominant in a small time scale and is described by a vertical 1D-Richards problem; the second one corresponds to a large time scale, when the evolution of the hydraulic head turns to become independent of the vertical variable. They are coupled along an artificial level below which the Dupuit hypothesis holds true (*i.e.* the vertical flow is instantaneous) in a way ensuring that the global model is mass conservative. We prove using asymptotic expansions that the 3D-Richards problem and each model of the class behave the same at every considered time scale (short and large) in thin aquifers. The results are illustrated by numerical simulations to compare several models of the class and the original 3D-Richards problem.

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Part V

Poster session

A communication platform for GDDS using multicriteria analysis method and a negotiation protocol

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Keywords: Multicriteria Analysis; Performance; Scoring method; preference function; Promethee II; Group Decision Support System (GDSS); Negotiation Protocol

ABSTRACT

We propose a group decision support system to solve communicative problems and conflict resolutions in a multicriteria group decision support system.

We propose a generic architecture of a multicriteria group decision support system, articulating mainly a communication platform and a negotiation protocol to manage the conflicts between decision-makers which integrate a multicriteria analysis method. The proposed negotiation protocol use a scoring mathematical method to evaluate negotiated object [1]:

$$score(i) = \sum_{decision\_makerj} wj \times (nbActions + 1 - rank(i)) \qquad (1)$$

where i stands for a negotiated object, wj for the weight of each decision maker, $nbActions$ for the negotiated object numbers, $rank(i)$ for the negotiated object rank.

As for the analysis method Promethee II the approach allows ranking the negotiated object according to the preferences of the decision makers through various formulas of evaluation using the performance of the actions and a preference function.

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On consensus for multiagent systems with DoS attack on hybrid time domains

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Keywords: Multiagent systems; Consensus; Hybrid domains

ABSTRACT

In the paper multiagent systems under DoS attack are considered. We provide convergence results to ensure the consensus in the system under the attack. Since DoS attack is usually unpredictable with respect to duration of time and lasts one second or more, we examine the problem on hybrid time domains.

On chaos behaviour of nonlinear Lasota equation in Lebesgue space

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Keywords: Lasota equation; Chaos; Stability

ABSTRACT

We concern the asymptotic behaviour of the dynamical systems induced by Lasota equation in the form

$$\frac{\partial u}{\partial t} + c(x)\frac{\partial u}{\partial x} = F(u).$$

We study chaoticity in the sense of Devaney and strong stability of the system. In the article series we described asymptotic properties of the linear version of Lasota equation in various functional spaces: Hölder, L^p and Orlicz ones. Now, by the construction of the operator in the separable space we can formulate the relations between the solutions of the linear equation and its nonlinear version in Lebesgue space L^p. The aim of this paper is to generalize the results of [1] and give the conditions of chaos in the sens of Devaney for nonlinear Lasota equation.

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Numerical solution of a one-dimensional diffusion equation subject to nonlocal boundary conditions using Legendre spectral method

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ABSTRACT

The first discussions and analyses of partial differential equations with non-local boundary conditions emerged in 1963 with J.R. Cannon [2], and J.G. Batten [1], separately. Over the last two decades, a considerable amount of attention has been focused to the development, and implementation, of numerical methods in order to obtain approximate solutions of time-dependent partial equations with non-local boundary conditions.
In this work, the problem of solving the one-dimensional diffusion equation specific to non-local boundary conditions is considered. Combined with the Crank–Nicolson scheme in temporal discretization, Legendre spectral method is applied to spatial discretization for the numerical resolution of the problem under consideration. Numerical tests are given to illustrate the accuracy and computational efficiency of the proposed method.

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SWCNH/diamond-ethylene glycol nanofluid flow over a wedge, plate and stagnation point - solar energy application

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Keywords: SWCNH-diamond nanoparticles; Stagnation point flow; Inducted magnetic field; Nonlinear radiation

ABSTRACT

Present attempt reports the characteristics of nonlinear radiation and induced magnetic field on the forced convective Falkner-Skan flow of Single-Walled Carbon NanoHorn(SWCNH)/diamond-ethylene glycol(EG) and water nanofluid over a wedge, plate, and stagnation point. The following fluid velocity and temperature equations are important in this study.

$$\frac{\Pr f'''}{(1-\phi)^{2.5}\left((1-\phi)+\phi\left(\frac{\rho_s}{\rho_f}\right)\right)}+m\left((1+Pr)^{4n}-(f')^2\right)+\frac{m+1}{2}f\,f''$$
$$+\beta_{mp}\left(m(g')^2-\frac{m+1}{2}gg''-m(1+Pr)^{4n}\right)=0 \quad (1)$$

$$\Pr\, g'''M_{mp}+\frac{m+1}{2}\left(g''f-gf''\right)=0 \quad (2)$$

Results exhibit that SWCNH nanoparticle has a higher heat transfer compared with diamond nanoparticle. Increasing the nanoparticle volume fraction with the suspensions of SWCNH and diamond nanoparticles enhances the temperature over the wedge, plate and stagnation point.