

Session : Mathematical Modeling

Sur la modélisation des sondages : Stabilité et sensibilité globale par les méthodes de coefficients de corrélation de rang partiel et d'échantillonnage d'hypercube latin.

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Résumé

Dans cet article, nous présentons un nouveau modèle mathématique qui décrit les opinions d'accord-désaccord lors des sondages. Nous présentons d'abord le modèle et ses différents compartiments. Ensuite, nous utilisons méthode de la matrice de nouvelle génération pour calculer les seuils de stabilité des équilibres. Nous effectuons l'analyse de stabilité des équilibres pour déterminer dans quelles conditions ces points d'équilibre sont stables ou instables. Nous montrons que l'existence et la stabilité de ces équilibres sont contrôlées par les seuils calculés. Enfin, nous effectuons également plusieurs expériences informatiques et statistiques pour valider les résultats théoriques obtenus dans ce travail. Afin d'étudier l'influence de divers paramètres sur ces seuils et d'identifier les paramètres les plus influents, une analyse de sensibilité globale est réalisée sur la base de la méthode du coefficient de corrélation de rang partiel et de l'échantillonnage Hypercube Latin.

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Casablanca Stock Exchange: Stochastic Modeling and Prediction Interval for Future MASI index Values

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Résumé /Abstract :

Since the sixties, debates have been born on the models, which determine the evolution of the stock prices. In this work we will focus on one of the best performances in the region of the Middle East and North Africa (MENA), is Africa's third largest Bourse: Casablanca Stock Exchange (CSE), which had the "Index de la Bourse des Valeurs de Casablanca" (IGB) as an index. IGB was replaced in January 2002 by two indexes: **MASI** (Moroccan All Shares Index) comprises all listed shares, allows investors to follow all listed values and to have a long-term visibility. **MADEX** (Moroccan Most Active Shares Index) comprises most active shares listed continuously with variations closely linked to all the market serves as a reference for the listing of all funds invested in shares.

Firstly, it aims at the investigation of stochastic model to show the variation of MASI index values, and, secondly, we will achieved a prediction interval of 95% of chance for Moroccan index future values. Here, the geometric Brownian motion (stochastic process without mean reversion propriety) is used to model the stochastic variation of MASI index values. In order to calculate models parameters daily close values of the Moroccan index from 02/01/2003 to 05/11/2019 can be taken from Casablanca Stock Exchange and, hence, stochastic models for MASI index variation is to be derived.

KEYWORDS: MASI index, Modeling, Brownian Motion, Casablanca Stock Exchange, Stochastic Process.

Bongard Problems : Image Clustering By Means Of Persistent Homology and Group Equivariant Non Expansive Operators

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Abstract

Bongard problems are a set of 100 visual puzzles posed by M. M. Bongard, where each puzzle consists of twelve images separated into two groups of six images. The task is to find the unique rule separating the two classes in each given problem. The problems were first posed as a challenge for the AI community to test machines ability to imitate complex, context-depending thinking processes using only minimal information. Although some work was done to solve these problems, none of the previous approaches could automatically solve all of them. Our work is a contribution to attack these problems with a different approach, combining the tools of persistent homology alongside with machine learning methods. In this work, we present an algorithm and show that it is able to solve problems involving differences in connectivity and size as examples, we also show that it can solve problems involving a much larger set of differences provided the right G-equivariant operators.

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A SIRF Model for Controlling the Spread of Information

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Abstract :

In this paper, we consider a new discrete-time model that describes the spread of information by shares in some kind of online environment such as Facebook, WhatsApp, Tweeter and other platforms groups. The impact of sharing information on the information amount is investigated, where in the considered model, the information amount is incorporated as a supplement compartment. We consider the possible interactions between individuals and information in the internet, such as posts, images and videos, etc. Theory of control is used to show the effectiveness of our optimal control strategy in reducing the information amount and Sharers in order to control the dissemination of false information that can lead to annoying situations and unstable state of society.

Numerical simulation is performed to investigate several scenarios before and after the use of our strategy of control, furthermore, sensitivity analysis of the information amount on parameters is discussed.

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Optimal control problem of a tuberculosis model in multi region with spatial dynamics

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Résumé /Abstract :

In this work, we propose a tuberculosis multi-regions discrete time model, in this model an infected population is divided into two categories ; symptomatic infected individuals represented by the I variable, and asymptomatic infected individuals, people who are not yet infectious, or those who are just exposed to infection, represented by the variable E. In these models, an infected population recovers with no immunity, and then, it moves immediately to the susceptible compartment once it becomes recovered, For this, we devise a multiregions SEIR discrete time model which describes infection dynamics when an epidemic is emerging in regions that are connected with their neighbors by movement. Next, we propose two controls strategies that focus on maximizing the number of recovered individual, in the targeted region, and minimizing the number of exposed and infected individual coming from the neighborhood of this targeted region. Theoretically, we have proved the existence of optimal controls, and we have given a characterization of controls in terms of states and adjoint functions based on a discrete version of Pontryagin's maximum principle. To illustrate the theoretical results obtained, we propose numerical simulations for several scenarios.

Keywords: Multi-region, Spatial SEIR model, Optimal control.

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Existence results for fractional p-Laplacian problems.

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Résumé/Abstract

Recently, there is an increasing interest in the study of nonlinear partial differential equation related to nonlocal operator. Very recently the operator p-fractional Laplacian; $(-\Delta)_p^s$ has been much studied and its generalisation has attracted a lot of attention, this is due to the fact that this class of operators appear in different physics models and other fields of application involving non local effects.

In this talk we are concerned with the existence of solutions for a class of quasilinear elliptic problems driven by the fractional p-Laplacian operator with homogeneous Dirichlet boundary data. As a particular case we study the following problem :

$$\begin{cases} (-\Delta)_p^s u = f(x, u) \text{ on } \Omega, \\ u = 0 \text{ in } \mathbb{R}^n \setminus \Omega. \end{cases} \quad (1)$$

Where Ω is a bounded domain with smooth boundary contained in \mathbb{R}^n , and the datum f is smooth enough.

The main point studied in this talk is to present the necessary functional framework as well as the notion of solution we will work with and some auxiliary results, then we will prove the existence and the uniqueness result of the solution in term of the regularity of the term source f .

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Exact determinations of maximal output admissible set for a class of semilinear discrete systems

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Abstract. In the present paper, we consider the semilinear system defined by

$$\begin{cases} x(i+1) = Ax(i) + f(x(i)), & i \geq 0 \\ x(0) = x_0 \in \mathbb{R}^n \end{cases}$$

and the corresponding output signal $y(i) = Cx(i)$, $i \geq 0$, where A is a $n \times n$ matrix, C is a $p \times n$ matrix and f is a nonlinear function. An initial state $x(0)$ is output admissible with respect to A , f , C and a constraint set $\Omega \subset \mathbb{R}^p$, if the output signal $(y(i))_i$ associated to our system satisfies the condition $y(i) \in \Omega$, for every integer $i \geq 0$. The set of all possible such initial conditions is the maximal output admissible set $\Gamma(\Omega)$. In this paper we will define a new set that characterizes the maximal output set in various systems (controlled and uncontrolled systems). Therefore, we propose an algorithmic approach that permits to verify if such set is finitely determined or not. The case of discrete delayed systems is taken into consideration as well. To illustrate our work, we give various numerical simulations.

Key words: Discrete-time, output admissible set, semilinear system, asymptotic stability, uncontrolled system ,controlled system, delayed system..

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Analysis of an Economic Growth Model with Variable Carrying Capacity

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Résumé/Abstract

In this paper, a kind of nonlinear delayed differential equations which can describe an economic model is considered. In this economy, population is modelled according to a logistically variable carrying capacity and capital's accumulation has a time delay. By choosing time delay as a bifurcation parameter, it is proved that the system loses stability and a Hopf bifurcation occurs when the time delay passes through critical values.

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Problème de contrôle optimal pour un modèle de réaction-diffusion du type SIR

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Résumé/Abstract

Tout au long des siècles et à travers le monde, les épidémies ont marqué l'histoire de l'humanité en occupant le premier rang des causes de mortalités. Elles engendrent des coûts considérables sur les plans socio-économique, démographique, sanitaire et sécuritaire. Pour parer aux ravages occasionnés par les épidémies, la modélisation mathématique est devenue un outil indispensable qui permet aux autorités sanitaires de se préparer à l'avance pour réagir promptement et efficacement si une épidémie est déclarée.

Dans la littérature, plusieurs travaux proposent des modèles à compartiments dans lesquels la population est divisée en différents groupes ayant le même statut vis-à-vis de l'infection. L'un des modèles les plus utilisés est le modèle SIR où la population est divisée en trois classes : les susceptibles ou sains (S), les infectés (I) et les retirés ou guéris (R) ; il est formulé en fonction de l'évolution temporelle de la distribution uniforme des populations dans l'habitat et gouverné par des équations différentielles ordinaires (ODE) (voir, par exemple [1–4]). Bien que cette formulation, sous forme d'ODE, facilite la manipulation et la résolution de ce type de modèle, elle néglige le fait que la propagation des épidémies est étroitement liée à la mobilité des personnes infectées. A titre d'exemple, la mobilité humaine est parmi les principaux modes de transmission du syndrome respiratoire aigu sévère (SRAS), qui a fait plus de 8000 personnes contaminées dans 26 pays à travers 5 continents lors de l'épidémie de 2003 [5].

Dans ce travail, nous proposons une extension plus réaliste du modèle SIR classique qui prend en compte la diffusion spatiale d'une épidémie. Nous formulons un problème de contrôle optimal basé sur un modèle SIR régi par des équations aux dérivées partielles avec des conditions aux limites et qui comporte un terme de contrôle représentant une campagne de vaccination. En utilisant l'approche variationnelle, nous présentons ici les principaux résultats de notre étude mathématique qui porte sur l'existence d'une solution du système d'état et la caractérisation de notre contrôle spatio-temporel optimal qui minimise la densité d'individus infectés et le coût du programme de vaccination. Des résultats numériques qui illustrent l'efficacité de notre approche suivant différents scénarios sont aussi proposés.

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On the stability of intuitionistic fuzzy fractional differential equations

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Abstract

In this paper, we investigate essentially stability theory for the intuitionistic fuzzy fractional differential equations by using notions of Mittag-Leffler stability.we give some sufficient criteria for the stability of trivial solution of the intuitionistic fuzzy fractional differential equation.

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Existence of Entropy Solutions the Anisotropic Elliptic Nonlinear Problem with Measure data in Weighted Sobolev Space

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Abstract

This paper is devoted to study the following nonlinear anisotropic elliptic unilateral problem

$$\begin{cases} Au - \operatorname{div} \phi(u) = \mu & \text{in } \Omega \\ u = 0 & \text{on } \partial\Omega, \end{cases} \quad (1)$$

where the right hand side μ belongs to $L^1(\Omega) + W_0^{-1, \vec{p}'}(\Omega, \vec{\omega}^*)$. The operator $Au = - \sum_{i=1}^N \partial_i a_i(x, u, \nabla u)$ is a Leray-Lions anisotropic operator acting from $W_0^{1, \vec{p}}(\Omega, \vec{\omega})$ into its dual $W_0^{-1, \vec{p}'}(\Omega, \vec{\omega}^*)$ and $\phi_i \in C^0(\mathbb{R}, \mathbb{R})$.

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A Mathematical Modeling for the Dynamics of a Population of Diabetics and its complications with Effect of living environment using Optimal Control Strategy

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Abstract :

In this paper, We want to develop our model of Kouidere et al [3] talking about Optimal Control Strategy for a Discrete Time to the Dynamics of a Population of Diabetics with Highlighting the Impact of Living Environment, By dividing the complications of diabetes into two types can be treated and the other reached a critical stage. So, we propose an optimal control approach modeling the evolution from pre-diabetes to diabetes without complications, diabetics without complications to both types of complications with the highlighting of negative impact of living environment. We show the existence and characterization of an optimal control and then use a numerical implicit finite-difference method to monitor the size of population in each compartment.

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On nonlinear elliptic equations with singular lower order term

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Résumé/Abstract

We prove existence and regularity results of solutions for a class of nonlinear singular elliptic problems like

$$\begin{cases} -\operatorname{div}\left((a(x) + |u|^q)\nabla u\right) = \frac{f}{|u|^\gamma} & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega, \end{cases}$$

where Ω is a bounded open subset of \mathbb{R}^N ($N \geq 2$), $a(x)$ is a measurable nonnegative function, $q, \gamma > 0$ and the source f is a nonnegative (not identically zero) function belonging to $L^m(\Omega)$ for some $m \geq 1$. Our results will depend on the summability of f and on the values of $q, \gamma > 0$.

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Numerical Simulations of a Quasistatic Frictional Contact Problem with Normal Compliance in Thermo-Electro-Viscoelasticity

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Abstract

We consider a mathematical model which describes the frictional contact between a thermo-electro-viscoelastic body and a conductive foundation. The process is quasistatic and the contact is modelled with normal compliance conditions and Tresca's friction law. This paper continues [2], providing the numerical modelling of the problem supported by numerical simulations. To this end, we present a fully discrete scheme using the finite element method to approximate the spatial variable and the Euler scheme to discretize the time derivatives. The frictional contact conditions are treated by using a numerical approach based on the combination of the penalized method and the augmented Lagrangean method (see [1, 3] for details). Finally, some numerical simulation results are presented in the study of an academic two-dimensional example.

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Nonlinear parabolic equations with singular coefficient and L^1 data

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Abstract :

We introduce a notion of renormalized solution for nonlinear parabolic problems whose model is

$$\frac{\partial u}{\partial t} - \operatorname{div}(a(u)\nabla u) + H(x, t, u, \nabla u) = f \quad \text{in } Q,$$

where the real-valued function a is assumed to be continuous and increasing function defined on $[0, m[$, such that

$$0 < \alpha < a(s) \quad \forall s \in [0, m[; \quad \lim_{s \rightarrow m^-} a(s) = +\infty \quad \text{and} \quad \int_0^m a(s) ds < +\infty,$$

where m is a positive real number. The function $H(x, t, s, \xi)$ is a Carathéodory on $Q \times [0, m[\times \mathbb{R}^N$ with values in \mathbb{R}^+ and f is a nonnegative function in $L^1(Q)$.

Keywords: Nonlinear parabolic equations, singular function, renormalized solutions.

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Exponential stabilization of distributed bilinear parabolic time delay systems

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Résumé/Abstract

We deal with the problem of exponential stabilization for a class of distributed bilinear parabolic systems with time delay in a Hilbert space by means of a bounded feedback control. The exponential stabilization problem of such a system reduces to stabilizing only its projection on a suitable finite dimensional subspace. Furthermore, the stabilizing feedback control depends only on the state projection on the finite dimensional subspace. An explicit decay rate estimate of the stabilized state is given provided that a non-standard weaker observability inequality condition is satisfied. It is also shown that the computation of the stabilizing feedback control can be cast as an optimal control problem. Illustrative examples for partial functional differential equations are displayed.

Keywords : Time delay, Exponential stabilization, Bilinear parabolic systems, Bounded feedback control, Optimal control.

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