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AVIS DE SOUTENANCE

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Présentera ses travaux de recherche en vue de l'obtention du Doctorat en Sciences et Techniques

Intitulé de la thèse :

A Novel Stochastic Modeling for Uncertain Parameters Associated to Complex Mathematical Models; and Neural Network Techniques for Epidemiological Modeling

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Devant le jury :

Membres de jury

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Abstract

Mathematical modeling of complex phenomena is one of the most important research areas in applied mathematics. In the first part of our thesis, we develop a novel stochastic model that increases the efficiency of randomized algorithms for estimating the probability characteristics of mathematical models with uncertain parameters. Those models provide a framework for conceptualizing our ideas about the behavior of complex phenomena in purely heterogeneous media and reaching mathematical conclusions.

More precisely, we define and implement a conditional generator for the reconstitution and the simulation of uncertain parameters random fields. The Palm probabilistic approach, coupled with the Kriging interpolation, will serve as the first proposed method of this reconstitution. The second method of this reconstitution will apply machine learning techniques using Bayesian inference by means of Markov chain Monte Carlo. The main objective is to define a fast and efficient parameter generator when compared to existing methods. In fact, this conditional generation is a key role in achieving a more realistic numerical simulation.

The second part of this thesis attends to the mathematical modeling in the epidemiology field. By developing a novel two-group epidemiological model that is subsequently analyzed and simulated. The general disease-free equilibrium is considered, and sufficient stability and convergence conditions are formulated. Furthermore, a novel deep learning method is employed to approximate the solution by associating the ordinary differential equations governing the model with a neural network. It should be noted that the proposed model can be effectively used to study the spread of diseases such as COVID-19 in populations where individuals have heterogeneous epidemiological behaviors.

Keywords: Conditional generator, Palm process, Bayesian approach, Machine learning, Stochastic modeling, Basic reproduction number; Epidemiological model, Neural networks, Numerical simulation, Stability analysis