mathematics

Editorial

Computational Mathematics and Neural Systems

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This special issue was conceived to explore the latest advancements in the field of computational techniques for solving forward and inverse problems. The real world offers numerous application problems of interest in several fields. Mathematical modelling is the first step to handle real-world problems. Translating application problems into suitable mathematical formulations entails some issues. The derived models are often complex, and they require numerical techniques able to provide the originating application with insightful answers, especially in the presence of uncertainty. Another important aspect that cannot be neglected nowadays is the explosive growth of available data. This has motivated research on artificial neural systems, in several versions, over the last decades. Such kinds of computing systems seem to be able to address the modelling and numerical issues, at least to some extent, in some contexts. In the call for papers, we asked for submissions dealing with fractional systems, uncertain systems, biological neural network modelling, computational learning theories, and analysis of network dynamics applications.

In response to the call for papers, 30 submissions have been received. All submissions have been reviewed by at least three experts in the field. Finally, 10 papers have been accepted for publication in this special issue, all of which are of high quality and well representative of the areas covered by this special issue. This corresponds to an acceptance rate of 30%.

This special issue contains both theoretical works and practical applications in the field of computational mathematics and artificial neural systems. The published papers in this special issue are herein briefly surveyed, following the increasing order of their publication dates.

In [1], a one-dimensional wave equation in generalized form was investigated. The system considered the presence of constant damping and functional anomalous diffusion of the Riesz type. Reaction terms were also considered. The discrete system proved to be dissipative or conservative when damping was present or absent, respectively, in agreement with the continuous model. Some novel technical lemmas were proved and used to establish the stability and the quadratic convergence of the scheme. Various fractional problems with functional forms of the anomalous diffusion of the solution were considered in the numerical experiments.

In [2], a three-dimensional nonlinear reaction-diffusion susceptible–infected–recovered hepatitis B epidemic model was formally discussed. The stability and bifurcation analyses of the mathematical model were rigorously discussed using the Routh–Hurwitz condition. A structure-preserving nonstandard finite-difference time-splitting method was proposed to approximate the solutions of the hepatitis B model. Consistency, stability, and convergence of the technique were analyzed, and several numerical experiments were performed.

In [3], a system of partial differential equations describing the interactions between populations of predators and preys was investigated. The system took into account the effects of anomalous diffusion and the generalized Michaelis–Menten-type reaction,

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and it was extended in various spatial dimensions. Two finite-difference methods were presented in alternative forms. Such schemes were structure-preserving techniques, i.e., they could keep the positive and bounded character of the computational approximations, in agreement with the relevant solutions of the original population model. As formally proved, the schemes were consistent, stable, and convergent. Some computer simulations were provided to study the complex patterns in some two- and three-dimensional predator–prey systems with anomalous diffusion.

In [4], an extension of stability analysis methods for a class of impulsive reaction-diffusion Cohen–Grossberg delayed neural networks was formally discussed. The extended concept was related to the stability of sets. The theoretical achievements on uniform global asymptotic stability and uniform global exponential stability with respect to sets for the model formed the basis for the stability theory of uncertain reaction-diffusion Cohen–Grossberg delayed neural networks and their applications.

In [5], the influence maximization problem (IMP) in complex networks was considered. The authors discussed a refined network centrality measure, a refined shell (RS) index for node ranking, and proposed an algorithm for identifying key node sets, namely the reject neighbors algorithm (RNA). The latter consists of two main sequential parts, i.e., node ranking and node selection. Numerical experiments on real-world network datasets showed the effectiveness of the RNA.

In [6], the authors discussed the efficiency of a numerical scheme to solve a nonlinear time-fractional heat equation with sufficiently smooth solutions, which was previously reported in the literature [*Fract. Calc. Appl. Anal.* 16: 892–910 (2013)]. Unlike that article, the authors used the method of energy inequalities to prove the stability of the scheme and the order of convergence. For the first time, the authors derived suitable energy estimates and a discrete fractional Grönwall inequality, consistent with the discrete approximation of the Caputo fractional derivative.

The article [7] deals with node embedding, which is a representation learning technique, mapping network nodes into lower-dimensional vector space. The authors proposed a two-step node embedding-based solution for the social influence maximization problem (IMP). The proposed approach was based on a revised network-embedding algorithm and clustering. The simulation experiment of single-point contact susceptible–infected–recovered (SIR) and full-contact SIR models on six different types of real network data sets showed the effectiveness of the approach.

In [8], the authors discussed an approximate scheme for solving one-dimensional heat-like and wave-like equations in fuzzy environments based on the homotopy perturbation method (HPM). In particular, the authors formulated the double parametric fuzzy HPM. The convergence of the solution under the developed approximate scheme was proved, and several numerical examples were presented.

In [9], two new methods to solve systems of ordinary differential equations were introduced. The first method was based on the generalized Bernstein functions, obtained by Bernstein polynomials, and the operational matrix of differentiation with the collocation method. The second method relied on the tau method, the generalized Bernstein functions, and operational matrix of differentiation. The absolute errors for both methods were estimated by means of the residual correction procedure. Some application examples were discussed, such as non-homogeneous linear and nonlinear systems, nonlinear stiff systems, and a chaotic system.

In [10], the authors presented new implicit schemes to seek numerical solutions of fuzzy wave equations by using the double parametric fuzzy number form. The stability, the consistency, and hence the convergence of the proposed schemes were formally discussed.

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