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Editorial

Mathematical modeling and computational methods

Applied Mathematics is an area in which important societal problems are analyzed and solved. Other areas, such as Physics, Chemistry, Computer Science, Medicine Engineering, etc. observe the advances in Applied Mathematics in order to known new tools and procedures to be applied in their areas, improving the current methodologies and solving new challenges.

Journal of Computational and Applied Mathematics gives us the opportunity to publish this special issue which includes a wide range of topics related to mathematical modeling in engineering, life sciences and human behavior. The aim of this issue is to offer a collection of papers that covers many relevant and modern aspects about the state of several aspects on the art of computational methods and mathematical modeling, giving a rather fair picture of the current research interests in these scientific fields. Many of the papers presented in this special issue were selected among the works presented at the International Conference Mathematical Modeling in Engineering & Human Behavior 2016. This conference took place in Valencia (Spain) at the Instituto Universitario de Matemática Multidisciplinar of the Universitat Politècnica de València from July 18-th to 20-th of 2016.

The selected papers of this special issue study, develop and apply diverse mathematical tools of different areas, from differential equations to graph theory. Specifically, these topics are the following: Mathematical Modeling in Engineering and Life Sciences, Financial Mathematics, Iterative Methods for Solving Nonlinear Models, Optimization Problems, Random Difference and Differential Equations and Applications, Numerical Analysis for Ordinary and Partial Differential Equations, Integro-Differential Equations, Numerical Linear Algebra and Integer Linear Programming.

The issue opens with several contributions devoted to iterative methods. These schemes have proven their usefulness for solving nonlinear problems in the last decades, which have been applied in the resolution of particular science and technologycal problems. The paper [1] deals with an interesting problem, the construction of numerical methods for approximating simple roots on nonlinear equations, continuing the work in the literature to produce methods that do not involve derivatives. It is worth noting that the authors present a general method to derive optimal eight-order schemes, in the sense of Kung–Traub conjecture, from a fourth-order one of Steffensen type. Some particular cases are shown in order to show its usefulness. In the same context, the authors of [2] design a family of higher order iterations, free from second derivative, for solving nonlinear equations. Their theoretical, computational and dynamical aspects are fully investigated and theorems are established to provide their order of convergence and asymptotic error constant. It is observed that the family includes sixth order methods and for a particular case its eighth order can be achieved.

Two works are devoted to design iterative methods with memory. Manuscript [3] deals with iterative method with memory for solving nonlinear equations. The author presents a variant of Cordero-Torregrosa method and a new technique to construct the self-accelerating parameter of the new method, which does not increase the computational cost of the iterative method. He proves the order of convergence of the new scheme with memory and confirms the results with numerical experiments. On the other hand, an Ostrowski-type method with memory is proposed in [4] for solving nonlinear equations. To this end, the author first presents an optimal fourth-order Ostrowski-type method without memory and based on it, an Ostrowski-type method with memory is given by using a simple self-accelerating parameter. The new self-accelerating parameter is constructed by a novel way and has the properties of simple structure and easy calculation. From the comparison with some known methods, it is observed that the new method occupies less computing time.

The known and widely used Newton's method plays and important role in all these papers. In addition, in the context of Banach spaces several contributions are made. Paper [5] deals with the semilocal convergence of Newtons method. The authors propose a center Lipschitz condition for the second derivative of the operator in a different point from that where Newtons method starts. This allows to obtain different starting points for Newtons method and modify the domain of starting points. On the other hand, in paper [6], the authors also discuss the semilocal convergence of a class of double step secant method on Banach space. It is remarkable that, under some reasonable assumptions, the semi-local convergence result for the method is given. Moreover, some numerical results are given to check the effectiveness of the method. The generalized

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Newton method, proposed by Mangasarian in 2007, for solving NP-complete absolute value equation, is modified in [7] proving its numerical stability and its second-order convergence. The convergence conditions proposed by the authors are weaker than those of other known iterative methods, hence this method can be applied to a broad range of problems.

In the area of nonlinear systems we can found manuscript [8]. In it, the authors give a highly-efficient iterative method of order eight for solving nonlinear systems. The new method shows a higher efficiency than the existing methods, and it's interesting the fact that the order can be easily increased with additional steps with the same structure and involving only one new functional evaluation. Moreover, the new method proposed shows good convergence properties in the provided examples.

Any iterative method applied to a polynomial produces a rational operator. The dynamical study of this operator gives us important information about the stability of the method. In [9] it is analyzed the dynamical anomalies of a parametric family of iterative schemes designed by Kou et al. The study of fixed points and their stability, joint with the critical points and their associated parameter planes, show the richness of the class and allow authors to find members of it with excellent numerical properties, as well as other ones with very unstable behavior. Authors confirm their theoretical findings by some test functions.

Other numerical techniques for solving different problems in some areas of Numerical Analysis are also analyzed. For example, two contributions study different aspects of population models. In [10], the production of red blood cells, also known as erythropoiesis, is analyzed by means of a numerical method applied to a population model with growth factors. This study may have implications to the treatment of marrow diseases and its evolution. Population models in general with a finite life span are analyzed. The method could be useful to obtain the survival probability that will surely be of interest in social and epidemiological studies. In [11], the authors consider the numerical approximation of the survival probability in the case of an unbounded mortality rate related to a finite life-span in age-structured population models. Their numerical approach is based on the approximation of the integral that characterizes this probability function by means of an appropriate quadrature rule. The convergence of this approximation is proved and numerical experiments confirm the theoretical results.

On the other hand, manuscript [12] deals with the construction and computation of numerical solutions of a coupled mixed partial differential equation system arising in concrete carbonation problems. The moving boundary problem under study is firstly transformed in a fixed boundary one, allowing the computation of the propagation front as a new unknown that can be computed together with the mass concentrations of CO_2 in air and water. The stability, the consistency and qualitative properties of the numerical solution are established.

In paper [13] an extension of the generalized equivalence theory for the simplified P_N equations using a finite element method is presented. This extension presents several advantages from diffusion theory. It produces precise results for both pin and assembly averaged values without using advanced reconstruction methods.

In the area of Financial Mathematics, in [14] a finite difference approach together with a bivariate Gauss–Hermite quadrature technique is developed for partial-integro differential equations related to option pricing problems on two underlying asset driven by jump-diffusion models. Authors prove that the proposed explicit finite difference scheme is consistent, conditionally stable and positive. They apply the theoretical results to European and American options. Paper [15] is devoted to provide an approach, in the framework of a jump-diffusion commodity market model, to estimate the functions of the risk-neutral processes from the market data, even when a closed-form solution is not available. The main advantage of the proposed methodology is the use of non-parametric estimation techniques that allows to avoid the restrictions of the model under consideration.

It is known that differential equations and partial differential equations are used for modeling many problems in different areas of researcher. In addition, random and stochastic differential equations have demonstrated to be powerful tools to model a number of problems in epidemiology, engineering, etc. Studies related with epidemiological problems have been treated in several works.

In [16] authors propose higher-order methods to solve a SEIR model for malware propagation. These methods are obtained using extrapolation techniques combined with nonstandard finite difference (NSFD) schemes. Additionally, authors consider different procedures to control the error in the discrete schemes. The theoretical results are illustrated by means of numerical experiments in order to compare different strategies in the adaptation of the variable step length.

In [17], one proposes a system of delay differential equations model to analyze the plant virus propagation. In [18], the authors propose a nonlinear differential model to describe the dynamics between the tumor cells and the main BMU cells (osteoclasts and osteoblasts). The model is based on a power law functional that represents the paracrine signaling between the BMU cells along with a logistic growth for cancer cells. The paper includes stability analysis and interesting results regarding biological information related to the success or failure of the invasion of bone metastasis. Finally, in [19] one proposes a predictive model able to perform an early detection of central segregation severity in continuous cast steel slabs. The study presents a novel hybrid algorithm, based on support vector machines (SVMs) in combination with the particle swarm optimization (PSO) technique, for predicting the centerline segregation from operation input parameters determined experimentally in continuous cast steel slabs.

The author in [20] establishes the exactly determined open interval of positive parameter λ in which the nth order impulsive singular equation has two infinite families of positive solutions. Under some conditions, the proposed results improve and extend many recent ones. The presented approach is largely based on the theory of fixed point index, transformation technique and Holder's inequality.