Preface

Application-Oriented Numerical Computation and Optimization – a Celebration of 60 Years of the IJCM

On a usual rainy day in early May 1964, the first issue of the *International Journal of Computer Mathematics* (IJCM) was published in London, Great Britain. Apparently, mathematicians around the world felt and were excited by the morningtide and shock waves from digital computations, after the success of modern computer hardware configuration and software structures. The twilight of the digital new age inspired the pioneers, and this also led to the birth of the IJCM, even before the invention of the word *numerical analysis*. The first volume of the IJCM consisted of 4 issues, 314 pages of 17 peer-reviewed research papers, and 4 book reviews.

Sixty years have passed. Nowadays, in Volume 100, 2023, the IJCM published 12 issues, 2289 pages of high-quality original research papers and surveys under the leadership of Editors-in-Chief Drs. A. Q. M. Khaliq, C.-H. Lai, Q. Sheng, and the Publisher's Portfolio Manager Mr. J. Robinson. Rigorous peer-reviews continue and both digital and hardcopy print versions are used. With a tradition of paying special attention to less-experienced and emerging young authors, the IJCM continuously remains within the second quartile (Q2) of the Applied Mathematics subject category with Impact Factors (IFs) 1.7 (2023) and 1.5 (5 years prior to 2023), respectively.

Needless-to-mention, application-oriented numerical computations and optimization have been playing a significant role in applied sciences, such as multi-physics, biology, engineering, biomedicine, and artificial intelligence. Over the past decades, research on highly efficient and effective computational procedures and optimization has gained increasing attention in the global community. In this special issue, we bring together researchers from various backgrounds, as well as engineers and computer scientists, to publish their original research results in application-oriented computations and optimization. The 17 manuscripts are carefully selected from a large pool of submissions through rigorous peer-review evaluations.

Instead of emphasizing particular mathematical modeling of nonlinear natural phenomena, this special issue focuses on investigations of analytical and computational features for various types of natural phenomena and applications. Detailed mathematical and numerical analyses are provided for novel new approximation techniques and simulations. Both deterministic and stochastic models arising in nature and society are developed, and pertinent applications to the resolution of practical problems are accomplished. The results are dedicated to the 60 years' service of the *International Journal of Computer Mathematics* published by Taylor & Francis Group.

A large number of our manuscripts concentrate on the mathematical and numerical analysis of differential equations. For instance, one of them [1] studies the popular Heston partial differential equation under the risk-neutral measure in computational finance:

$$V_t + \frac{\nu}{2} S^2 V_{SS} + \frac{\sigma_\nu^2 \nu}{2} V_{\nu\nu} + rSV_S + \kappa_\nu \left(\mu_\nu - \nu\right) V_\nu + \sigma_\nu \nu \rho S V_{S\nu} - rV = 0, \tag{1}$$

where $S \in \mathbb{R}^+$ is the underlying asset and V is the fair price of an option. A gradient-

based optimization strategy is derived. Novel discretization methods of (1) are constructed, analyzed, and simulated on realistic data. On the other hand, several authors [4] focus on the stability, conservation and convergence of numerical approximations of Kawarada-type nonlinear singular reaction-diffusion equations:

$$d(s)\Phi_t = \frac{1}{a^2}\Phi_{ss} + \frac{\epsilon}{(1-\Phi)^{\rho}},$$

where $\Phi(s,t)$ denotes a temperature distribution over physical field $\bar{\Omega}, d(s) \neq 0$ for $s \in \Omega$, and parameters $\epsilon, \rho > 0$. Arbitrary spatial meshes are tested for optimized computations.

Various fractional order ordinary and partial differential equations are also among hot topics in this special issue [2, 3, 5]. For instance, for a stochastic distribution $X(t) : [0,T] \to \mathbb{R}^n,\ n > 0$, Euler-Maruyama algorithms are investigated for solving temporally fractional stochastic equation

$${}_0^C D_t^{\alpha,\lambda} X(t) = f(t, X(t)) + g(t, X(t))\frac{d\tilde{W}}{dt}, \quad t > 0,$$

where ${}_0^C D_t^{\alpha,\lambda} X(t),\ 1/2 < \alpha < 1$, is the Caputo fractional derivative of $X(t)$ defined by

$${}_0^C D_t^{\alpha,\lambda} X(t) = \frac{e^{-\lambda t}}{\Gamma(1-\alpha)} \int_0^t \frac{1}{(t-s)^{\alpha}} d\left(e^{\lambda s} X(s)\right), \quad t \geq 0,$$

functions f, g are sufficiently smooth and $\tilde{W}(t)$ is a dimensionally independent Wiener process on a completely filtered probability space $(\Omega, \mathcal{F}, \mathbb{F} = \{\mathcal{F}_t\}, \mathbb{P}),\ t \geq 0$ [2].

Topics in this special issue also include the following:

- combustion model via the local collocation technique based MTP approximation/domain decomposition;
- highly accurate exponential time differencing methods for partial differential equations of anisotropically functionally graded materials;
- fractional order RLC electric circuit model analysis via Green's function;
- fast compact difference schemes for a time-fractional order Black-Scholes model;
- Haar wavelet-based Galerkin method with error analysis and applications to nonlinear optimal control problems;
- stabilizations of equally lower-order finite element methods for Brinkman equations in porous media;
- solutions of sixth-order explicit schemes for three-dimensional nonlinear wave equations with variable coefficients;
- modified two-parameter matrix splitting iterative method for Helmholtz problems;
- new classes of exponential Runge-Kutta integrators for highly oscillatory systems of differential equations.

The numerical methods and analyses presented in this special issue demonstrate that highly accurate and preservative strategies possess remarkable and reliable performance for solving different differential equations. In addition, the constructions of these powerful methods are flexible in the choice of discrete methods, both in the temporal and spatial directions. Contributed theoretical analysis can also be extended for similar problems in optimization and applications.

This special issue aims to highlight new achievements in the area within a limited scope. The guest editors of this special issue encourage the readers, while enjoying the remarkable results shown in this special issue, to participate in the many research activities in constructing highly accurate and reliable methods, and to continue to support and promote the study of such methods up to a new higher level including deep machine learning in the near future. The guest editors anticipate to see more outstanding research papers and literature reviews in the IJCM for another 60 years!

Finally, the guest editors of this special issue would like to take this opportunity to thank many colleagues, in particular the IJCM editorial team members, who have helped, discussed, and supported the publication of this special issue. Last, but not least, the guest editors wish to thank their families for the marvelous understanding and support during the many sleepless nights in fulfilling their research and editorial goals.

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