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Editorial

Special Issue: Fixed-Point Theory and Its Applications, Dedicated to the Memory of Professor William Arthur Kirk

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Fixed-point theory is a rapidly growing area of research. In this Special Issue, we present sixteen papers authored by a select group of authors who are experts in this theory. These papers cover a wide spectrum of important problems and topics relevant to current research interests. Mixed-dimensional integral equations with a strongly symmetric singular kernel are considered in [1]. Generalized metric space endowed with the Hadamard product are studied in [2]. Article [3] is devoted to an approach using nonlinear integral equations with a symmetric and nonsymmetrical kernel in two dimensions. KRH-interpolative-type contractions are studied in [4]. Article [5] contains three convergence results for iterates of nonlinear mappings in metric spaces with graphs. Uniform convexity in variable exponent Sobolev spaces is studied in [6]. A fixed-point theorem in Lebesgue spaces of variable integrability is reported in [7]. Normed algebras and the generalized Maligranda–Orlicz lemma are discussed in [8]. A common fixed-point theorem and projection method for a Hadamard space are considered in [9]. Article [10] contains the best proximity point results for multi-valued mappings in a generalized metric structure. The existence of a fixed point and convergence of iterates for self-mappings of metric spaces with graphs are obtained in [11]. In article [12], a fixed-point method is applied in nonlinear fractional differential equations with integral boundary conditions. Article [13] is devoted to fixed points of α-modular nonexpanive mappings in modular vector spaces. Common fixed-point results of tower mappings in (pseudo)modular metric spaces are obtained in [14]. Fixed-point theorems for generalized Meir–Keeler-type nonlinear mappings with applications in fixed-point theory are established in [15]. An enhanced double-inertial forward–backward splitting algorithm for variational inclusion problems is studied in [16].

In the following text, we comment on the main goals and results of these contributions.

The first paper, "Computational Techniques for Solving Mixed (1 + 1) Dimensional Integral Equations with Strongly Symmetric Singular Kernel", describes an effective strategy based on the Lerch polynomial method for solving mixed integral equations (MIEs) in position and time with a strongly symmetric singular kernel. The quadratic numerical method (QNM) is applied to obtain a system of Fredholm integral equations (SFIE), then the Lerch polynomial method (LPM) is applied to transform the SFIE into a system of linear algebraic equations (SLAE). The existence and uniqueness of the integral equation's solution are discussed using Banach's fixed-point theory. Moreover, the convergence and stability of the solution and the stability of the error are discussed. Several examples are given to illustrate the applicability of the presented method. The Maple program is used to obtain the results. A numerical simulation is carried out to determine the efficacy of the methodology, and the results are given in symmetrical forms. Related results can be found in [17–24].

In the second paper, "Banach Fixed-Point Theorems in Generalized Metric Space Endowed with the Hadamard Product", the authors prove some Banach fixed-point theorems in generalized metric space where the contractive conditions are endowed with the Hadamard product of real symmetric positive definite matrices. Since the condition that a matrix A converges to zero is not needed, this produces stronger results than those of

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Perov. As an application of their results, they study the existence and uniqueness of the solution for a system of matrix equations. Related results are discussed in [25–32].

In the third paper, "Approach via Nonlinear Integral Equations with Symmetric and Nonsymmetrical Kernel in Two Dimensions", the second type of two-dimensional nonlinear integral equation (NIE) with a symmetric and nonsymmetrical kernel is solved in a Banach space. The authors use a numerical strategy that uses hybrid and block-pulse functions to obtain the approximate solution of the NIE in a two-dimensional problem. With this aim, the two-dimensional NIE will be reduced to a system of nonlinear algebraic equations (SNAE). Then, the SNAE can be solved numerically. This study focuses on showing the convergence analysis for the numerical approach and generating an estimate of the error. Examples are presented to prove the efficiency of the approach. Related results can be found in [33–35].

In the fourth paper, "Recent Advancements in KRH Interpolative-Type Contractions", the focus is to conduct a comprehensive analysis of the advancements made in the understanding of interpolative contraction, building upon the ideas initially introduced by Karapinar in 2018. The authors develop the notion of interpolative contraction mappings in the case of nonlinear Kannan interpolative, Reich–Rus–Ciric interpolative, and Hardy–Roger interpolative contraction mappings based on controlled function and prove some fixed-point results in the context of controlled metric space, thereby enhancing current understanding in this particular analysis. Furthermore, they provide a concrete example that illustrates the underlying drive for the investigations presented in this context. An application of the proposed nonlinear interpolative contractions in the Liouville–Caputo fractional derivatives and fractional differential equations is provided. Related results can be found in [36–39].

In the fifth paper, "Three Convergence Results for Iterates of Nonlinear Mappings in Metric Spaces with Graphs", the author proves an extension of the result of his joint work with D. Butnariu and S. Reich (2007), which shows that if a self-mapping of a complete metric is uniformly continuous on bounded sets and all its iterates converge uniformly on bounded sets, then this convergence is stable in the presence of small errors. This paper contains an extension of this result for the self-mappings of a metric space with a graph. Related results can be found in [40–47].

In the sixth paper, "Uniform Convexity in Variable Exponent Sobolev Spaces", the authors study the modular convexity of the mixed norm in various spaces and provide examples of sufficient conditions. Related results can be found in [48–51].

In the seventh paper, "A Fixed-Point Theorem in Lebesgue Spaces of Variable Integrability", the authors establish a fixed-point property for the Lebesgue spaces with variable exponents, focusing on the scenario where the exponent closely approaches 1. The proof does not impose any additional conditions. Some related results are presented in [52–58].

In the eighth paper, "On Normed Algebras and the Generalized Maligranda–Orlicz Lemma", the authors discuss some extensions of the Maligranda–Orlicz lemma. It deals with the problem of constructing a norm in a subspace of the space of bounded functions, for which it becomes a normed algebra, so that the norm introduced is equivalent to the initial norm of the subspace. This is achieved by satisfying the inequality between these norms. The authors show how this inequality is relevant to the study of operator equations in Banach algebras. They study how to equip a subspace of the space of bounded functions with a norm equivalent to a given one, so that it is a normed algebra. They give a general condition for the construction of such norms, which allows us to easily check whether a space with a given norm is an algebra with a pointwise product and the consequences of such a choice for measures of noncompactness in such spaces. Related results can be found in [59–64].

In the ninth paper, "Common Fixed-Point Theorem and Projection Method in a Hadamard Space", the author achieves an equivalent condition to the existence of a common fixed point of a given family of nonexpansive mappings defined in a Hadamard space. Moreover, if the space is bounded, then it is shown that the generating process of the approximate sequence by a specific projection method will stop in finite steps if there is no common fixed point. It is a significant advantage to reveal the nonexistence of a common fixed point in a finite time. Related results can be found in [65–69].

In the tenth paper, "Best Proximity Point Results for Multi-Valued Mappings in Generalized Metric Structure", the authors introduce the novel concept of a generalized distance. Using this generalized distance, the best proximity results are determined. Related results are presented in [70–75].

In the eleventh paper, "Existence of a Fixed Point and Convergence of Iterates for Self-Mappings of Metric Spaces with Graphs", the author, under certain assumptions, establishes the convergence of iterates for self-mappings of complete metric spaces with graphs that are of a contractive type. The class of mappings considered in the paper contains the so-called cyclical mappings introduced by W. A. Kirk, P. S. Srinivasan, and P. Veeramani in 2003 and the class of monotone nonexpansive operators. Related results can be found in [40–47].

The twelfth paper is "Fixed-Point Method for Nonlinear Fractional Differential Equations with Integral Boundary Conditions on Tetramethyl-Butane Graph". The purpose of this study is to prove the existence and uniqueness of solutions to a new family of fractional boundary value problems on the tetramethylbutane graph that have more than one junction node after presenting a labeling mechanism for graph vertices. The chemical compound tetramethylbutane has a highly symmetrical structure, due to which it has a very high melting point and a short liquid range; in fact, it is the smallest saturated acyclic hydrocarbon that appears as a solid at a room temperature of 25 C. With vertices designated by 0 or 1, the authors propose a fractional-order differential equation on each edge of the tetramethylbutane graph. Employing the fixed-point theorems of Schaefer and Banach, they demonstrate the existence and uniqueness of solutions for the suggested fractional differential equation, satisfying the integral boundary conditions. In addition, the stability of the system is examined. Related results can be found in [76–80].

In the thirteenth paper, "Fixed Point of α-Modular Nonexpanive Mappings in Modular Vector Spaces $\ell p(\cdot)$", the authors examine necessary and sufficient conditions for the existence of fixed points for modular nonexpansive mappings. Related results are presented in [52–58].

In the fourteenth paper, "Some Common Fixed-Point Results of Tower Mappings in (Pseudo)modular Metric Spaces", the authors prove the existence and uniqueness of the common fixed point of tower type contractive mappings in complete metric (pseudo)modular spaces involving theoretical relation. However, the newly introduced contraction in this paper further characterizes and explores several existing results in metrical fixed-point theory to their full effect. Some nontrivial supportive examples are given to justify the results. Related results can be found in [81,82].

In the fifteenth paper, "New Fixed-Point Theorems for Generalized Meir–Keeler-Type Nonlinear Mappings with Applications in Fixed-Point Theory", the authors prove new fixed-point theorems for generalized Meir–Keeler-type nonlinear mappings satisfying the condition (DH). As applications, they obtain new fixed-point theorems that generalize and improve several of the results available in the corresponding literature. An example is provided to illustrate and support their main results. Related results can be seen in [83,84].

In the sixteenth paper, "Enhanced Double-Inertial Forward–Backward Splitting Algorithm for Variational Inclusion Problems: Applications in Mathematical Integrated Skill Prediction", the authors introduce a new algorithm that combines forward–backward splitting algorithms with a double-inertial technique, utilizing the previous three iterations. The weak convergence theorem is established under certain mild conditions in a Hilbert space, including a relaxed inertial method in real numbers. An example of infinite dimension space is given with numerical results to support the proposed algorithm. The algorithm is applied to an asymmetrical educational dataset of students from 109 schools, utilizing asymmetric inputs as nine attributes to predict the output as students' mathematical integrated skills. The algorithm's performance is compared with other algorithms in the literature, to demonstrate its effectiveness. Related results are presented in [85–87].

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