SEVERAL FIXED POINTS THEORIES IN FUZZY METRIC AREA WITH THEIR APPLICATION

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Abstract:

Generalizations in statistical metric places and fuzzy metric spaces permit imprecise distance measurements. Fixed-point assertions are now computational findings that ensure that there is a finite number of solutions to a variety of queries requiring coordinates while measures. In this work, we examine the existing research with fixed-point results in fuzzy metric areas or how they apply in a variety of disciplines, including calculus, dynamic software development, strategy, and optimization. We additionally talk about a number of the barriers and unresolved issues in the area of research. Beginning with fuzzy gauges or fuzzy relationship processes, the paper introduces the foundational concepts in fuzzy metric spaces. We investigate the primary properties of fuzzy dimensions along with laying the groundwork required to comprehend fixed-point analysis in the present setting. Fuzzy metric spaces deliver a framework for modelling confusion along with imperfection in a variety of quantitative and algorithmic contexts. In this situation, the fixed-point theory is essential for investigating the existence along with the stability of solutions to various categories of equations. This paper seeks to introduce a variety of fixed-point models in the fuzzy measurement domain, as well as their applications.

Keywords: Fixed-point theorem, fuzzy metric space, application, imprecise distance measurements, Fuzzy distance functions, Mathematical applications.

1. Introduction

Fuzzy metric spaces are mathematical structures that allow for imprecise distance measurements. Cramoisy and Michálek first introduced them in 1975 as a generalization of metric statistical spaces. Since then, many scholars have investigated fixed point formulas at fuzzy metric areas and their usage in various disciplines, including equations with differential coefficients. dynamic programming, game theory, and optimization. (Sihag, Dinesh, & Vinod, 2020) The objective of this research is to examine and assess existing fixed point theories in ambiguous metric spaces. Ambiguous metric spaces introduce uncertainty or ambiguity in the definition of distance, allowing for a more flexible and versatile approach to analyzing fixed points. By investigating the characteristics and properties of these spaces, we aim to gain a deeper understanding of their mathematical structures and the implications they have on fixed point theory.

The study of complex metric regions is an additional significant aspect of this research. Fuzzy measurement regions expand on the premise of metric space by incorporating fuzzy sets, which permit partial participation and gradual transitions. The addition permits a more complex illustration of distance and lays the groundwork for investigating precise locations in contexts where conventional measures may not adequately convey the underlying complexities.

In addition to assessing existing theories, the objective of this study is to examine the validity and unity of rigid points in measurement spaces with a fuzzy boundary. Combining error and fuzzy thinking, haze measurements produce regions at which detachment, as well as involvement, are ambiguous. By examining the reality along with unity of centre points in such areas we may obtain fresh perspectives on the actions of units and patterns in unclear and complicated settings.

1.1 Concept of fixed points in Mathematics

In mathematics, a fixed point refers to a point that remains unchanged under a given transformation or mapping. It is a point that satisfies the property of being mapped to itself by the transformation. Formally, let X be a set and f be a function defined on X. An element x in X is said to be a fixed point of f if f(x) = x.(Subhani, 2016)

The concept of fixed points is significant in various branches of mathematics and has applications in diverse fields. Here are a few key points about fixed points:

Existence and Uniqueness: One fundamental question in fixed point theory is whether a given function or transformation possesses a fixed point. In some cases, fixed points are guaranteed to exist and may even be unique. For example, The Banach fixed point A contraction translation on entire metric space consistently has a distinctive fixed point, according to a theorem. (Subhani, 2016)

Stability and Dynamics: Fixed points are closely related to the stability and behaviour of dynamic systems. Stability analysis involves examining the behaviour of solutions or trajectories near fixed points. Stable fixed points attract nearby points over time, while unstable fixed points repel them. This has implications in the study of differential equations, dynamical systems, chaos theory, and control theory.

Optimization and Equilibrium: Fixed points are often associated with optimal solutions or equilibria in mathematical optimization and game theory. Finding fixed points can help determine points where certain conditions, such as minimizing or maximizing a function or achieving a state of balance, are satisfied. This has applications in economics, engineering, and social sciences.

Applications in Computer Science: Fixed points are utilized in computer science for solving computational problems and designing algorithms. In areas such as artificial intelligence, graph theory, and formal languages, fixed points play a crucial role in analyzing program semantics, solving recursive equations, and optimizing algorithms.

Generalizations: While fixed points are commonly studied in the context of metric spaces, the concept has been extended to other mathematical structures. For example, fixed points can be defined for operators acting on vector spaces, partially ordered sets, and more abstract algebraic structures.

Overall, the study of fixed points provides valuable insights into the behaviour, stability, and optimization of mathematical systems. It is a fundamental concept that finds applications in various branches of mathematics, science, and engineering.

1.2 Relevance of fuzzy metric spaces

Fuzzy measurements are somewhat of a kind of conventional metric area that incorporate fuzzy feeling or angles of classification. In to fuzzy gauge of the environment, distance is substituted by an index in resemblance or diploma of participation. allowing for a more flexible and versatile representation of uncertain or imprecise information. Here's a more detailed explanation of the relevance of fuzzy metric spaces: Traditional metric spaces assume precise and crisp relationships between elements. However, in many real-world scenarios, uncertainties and imprecisions are inherent. Fuzzy metric spaces provide a mathematical framework to represent and model this uncertainty. By assigning degrees of membership to elements, fuzzy metric spaces capture the imprecision and vagueness present in many practical situations. fuzzy metric spaces offer a more flexible and robust framework for modelling uncertain and imprecise phenomena. They find applications in diverse fields, including pattern recognition, clustering, decision-making, artificial intelligence, and data analysis, enabling a more realistic representation of complex real-world systems. (Subhani, 2016)

2. Background of the study

Background:

Fixed point theory is a branch of mathematics that focuses on the study of points that remain unchanged under a given transformation or mapping. The concept of fixed points has been extensively studied in classical metric spaces, where distances between points are well-defined and precise. (Sihag et al., 2020)

However, in many real-world situations, uncertainties, imprecisions, and vague relationships are present, making traditional metric spaces less suitable for modelling such phenomena. Fuzzy metric spaces emerged as a generalization of metric spaces to address these challenges. In fuzzy metric spaces, the concept of distance is replaced by a measure of similarity or degree of membership, allowing for a more flexible and versatile representation. (Sihag et al., 2020)

Fuzzy metric spaces provide a mathematical framework for handling uncertainty and imprecision by assigning degrees of membership to elements and capturing the notion of similarity or closeness between elements. This enables the modelling and analysis of uncertain or imprecise relationships, making fuzzy metric spaces applicable in various domains, including optimization, decision-making, pattern recognition, and more.

Students have come up with unique rigid point ideas for fuzzy gauge spaces, given the circumstances. In a setting of fuzzy vector spaces, these theories seek to lay down requirements that ensure the being, distinctive characteristics, and traits of rigid points. Chatterjee's fixed point hypothesis, Shatanawi's fixed word theory, and Ciric's fixed site hypothesis, as well as others, are notable stationary point doctrines in imprecise metric spaces. (Sihag et al., 2020)

These theories build upon the foundations of classical fixed point theory, incorporating the fuzzy metric space framework and adapting the concepts of contraction mappings, compatibility, and contractive conditions to the fuzzy setting. The underlying principles of these theories involve defining appropriate contractive conditions or compatibility conditions which guarantee the presence of specific places (Sihag et al., 2020)

In summary, the growth of solid point doctrines at fuzzy metric spaces permits the investigation and analysis of fixing demonstrate properties in the light of ambiguous and vague links. They lead to one's comprehension of fixed points to fuzzy measurement spaces and prepare ways for implementations in numerous disciplines to which fuzz concepts are applicable.

3. Overview

The focus of the study is the investigation of stable point models in fuzzy measurement spaces or how they are used in many different areas. Fuzzy measurement spaces are statistical spaces of metric variants. allow for the representation of imprecise distance measurements, making them suitable for modelling and analyzing uncertain or vague relationships. (Beg, Joseph, & Mani, 2023)

The paper begins by providing an abstract that summarizes the main objectives and scope of the study. It highlights the importance of guaranteeing availability and stability during solutions in imprecise metric spaces using fixed-point axioms. The paper also discusses these theorems' applications in disciplines such as mathematical modelling. dynamic programming, game theory, and optimization. (Beg et al., 2023)

This article examines the existing research on anchor point hypotheses in fuzzy metric space. It examines various fixed-point equations that are specially devised for this context. Famous ideas, including the fixed point theories of Chatterjee, Shatanawi, Ciric, and others, are discussed in detail. The underlying principles and main theorems of each theory are explained, providing readers with a comprehensive understanding of their mathematical foundations. (Beg et al., 2023)

Moreover, the study emphasizes the practical significance of these fixed point theories by highlighting their applications across diverse fields. Differential equations, which play a crucial role in modelling dynamic systems, benefit from the existence and uniqueness of fixed points to analyze stability and behaviour. Dynamic programming, a technique for solving optimization problems, utilizes fixed-point theorems to identify optimal solutions. Game theory, focusing on strategic interactions, employs fixed point theorems to determine equilibria. Optimization problems in various domains can also be addressed using fixed point theories in fuzzy metric spaces.

Fixed Point

The fixed point is the point that remains unchanged when whatever change is applied. In the study of the variable distribution of a function, the French scholar Poincare presented the fixed-point theory for the first time. In modern geometry and analysis, the concept of fixed points plays a crucial role. Several investigators have derived countless Fixed Point proofs concerning the occurrence and approximation of precise locations in various analytical spaces. (Veladi, 2023)

Metric Space

Maurice Frechet presented the concept of measuring spaces just like distance parameters in 1906. In the areas of functional analysis and topology, an understanding of measurement space plays an extremely important role. Steady point theory to metric domains draws academics due to its implications in several fields, including variational injustices, optimisation hypothesis, and organisational theory. (Rasham, Saeed, Agarwal, Hussain, & Felhi, 2023)

Fuzzy Metric: In fuzzy metric spaces, the concept of distance is replaced by a measure of similarity or degree of membership. The fuzzy metric d is typically defined as a function that satisfies the following properties for all x, y, and z in the fuzzy metric space X:(Nafadi, 2014)

- Non-negativity: $d(x, y) \geq 0$.
- Identity of indiscernibles: $d(x, y) = 0$ if and only if $x = y$.
- Symmetry: $d(x, y) = d(y, x)$.
- Fuzzy Triangle Inequality: $d(x, z) \geq \min\{d(x, y), d(y, z)\}$.

Fixed Point Equation: The fixed point equation represents the condition where a mapping f in a fuzzy metric space X has a fixed point. Mathematically, it is given by (Gupta, 2023):

$f(x) = x$, where x is the fixed point of the mapping f.

Contractive Condition: In many fixed point theories, contractive conditions are used to establish the existence of fixed points. (Tripathy, Paul, & Das, 2015) A common contractive condition involves the use of a contraction factor λ ($0 \leq \lambda < 1$) such that for all x, y in the fuzzy metric space X:

$d(f(x), f(y)) \leq \lambda * d(x, y)$,

where f is the mapping and d is the fuzzy metric.

Compatibility Condition: Some fixed point theories in fuzzy metric spaces introduce the concept of compatibility between mappings. (Jain & Jain, 2021) A compatibility condition typically involves the use of a weight function w(x, y) that satisfies certain properties. An example of a compatibility condition is:

$d(f(x), g(y)) \leq w(x, y) * \max\{d(x, y), d(f(x), g(y))\}$,

where f and g are the mappings, d is the fuzzy metric, and w is the weight function.

4. Literature review

Neelkanth Napit (2023) This study focuses primarily on fixed-point principles and their applications. Introduction of fuzzy topological domains and quasi-fuzzy metric spaces. The results of establishing the notion of variation alongside Christi's fixed point thesis in fuzzy topological realms are used to derive a theorem of fixed points for Manger's uncertain metric space. We define an equivalent couple of reciprocally continuous transfers along with deriving a theorem regarding fixed points in a fuzzy metric framework that generates a fixed point without requiring the map to be continuity. In addition, V|/-compatible translation is implemented in a fuzzy measuring environment, while the varying radii between coordinates are established using controls which is distinct from prior research. The introduction of R-weakly commutes of type (A„) along with non-compatible maps in fuzzy measurement space comes to the verification of a fixed-point theorem without presuming a space's complete or continuity. (Nigam, 2023)

T. RAKESH SINGH (2023) In this study this investigation examines the concept of intermittently loosely equivalent translations along with Partly equivalent projections at fuzzy metric space. Common fixed-point conclusions with fuzzy metric space are investigated in this paper. Frequent fixed-point results in fuzzy metric domains were demonstrated using the feature of commutativity of pairing representations, dyad semi-compatible mappings, as well as poorly consistent transformations that satisfy the positive kind criterion for six self-mappings. This result enhances and generalises analogous findings in the scientific literature. In mathematical analysis, there is a multitude of challenges, including split feasible issues variational imbalance issues and irregular optimisation challenges, equilibrium challenges, compatibility problems, along with selection and matching issues. Steady Point Theory gives the fundamental instruments for problem-solving. (Rakesh, 2023)

Saif Ur Rehman (2021)

Using three-self mappings, the present article investigates some coincidental points and common rigid point conclusions in fuzzy metric space. Using the limited connectivity of three-self-mappings, we establish the uniqueness of a few coincidence locations and common uniform point results. To validate our work, we provide concrete instances that demonstrate our findings. Our outcomes improve on and expand a large number of previously published results. In bolstering our studies, we additionally include the utilisation of fuzzy linear equations. In the present study, we demonstrate some generalised unique coincidental points and CFP theories for moderately compatible two self-mappings in FM domains without assuming that "fuzzy contractive chains are Cauchy." The "triangular property of FM" is used throughout the entire paper as a fundamental instrument to determine the occurrence of distinct coincidence sites and CFP outcomes in FM spaces. (Rehman, 2021)

Neena Gupta (2017)

In this paper, we demonstrate fixed point results in fuzzy measurement space using rational difference. Our findings generalise the findings of numerous other researchers in the realm of science. The primary objective of this paper is to demonstrate fixed-point theorem applications in ambiguous metric space. The initial introduction of fuzzy sets in 1965 lays the groundwork for fuzzy mathematics. The basis here reflects commonplace ambiguity. Several authors afterwards created an understanding of fuzzy space by applying different variations of the universal topology of fuzzy sets. The study extends the findings of numerous other authors in the existing literature. Employing the concepts that include a consistent mapping, inferred in this regard, weakly comparable map, or R-weakly consistent map, numerous authors have established some stable point theorems. (Subhani, 2016)

Ali Hassan Abbaker Abd Alla (2019)

In 1965, Zadeh introduced the idea of fuzzy sets in this study. Numerous researchers have developed fuzzy sets in various domains while offering new theories such as fuzzy topology function, fuzzily defined environment, fuzzy metric space, etc. Kamosil while Michalek presented the notion of soft metric space, which is the continuous trapezoidal normed that was established by Schweizer in 1960, in 1975. In this work, we demonstrate the principle of fixed points in fuzzy metric areas and investigate its applicability. In fuzzy metric spaces, we derive a universal stable point thesis in the form of George alongside Veeramani. As a scenario, we as a species prove our hypothesis of integral-type contracting. (Sihag et al., 2020)

M. Hasan (2023)

The primary objective of this study is to learn about a few widespread fixed point conclusions of curvilinear mappings for composite pairs of both categories of transformations (single-valued along with multi-valued) in flexible metric-like spaces or exploit the variable distance for its purpose. These theorems generalise and expand upon several earlier findings. In this case, we also utilised a few inferred utility functions to confirm our findings. To confirm the accuracy of our notions and the degree of stimulus generality of our basic result, we as a species offered a real-world example; the plethora of possible uses have contributed to the overall development of fuzzy mathematics. Similar to the investigation of many more concepts, the exploration of fuzzy metrics is currently conducted through a variety of approaches. (Ali Hassan 2019)

Binod Chandra Tripathy (2015)

In the year this paper, the author proves periodic site results in the fuzzy metric territory while giving a few standard fixed point formulas for loosely coherent transformations in hazy 3-metric areas beneath a variety of conditions. We demonstrate the three-metrical equivalent of Edelsten's hypothesis in fuzzy 3-metric dimension. In addition, we establish additional outcomes in imprecise 3-metric space. We have developed a periodic value argument in hazy metrical space along with fixed-point hypothesis outcomes for intermittently weakly coherent projections in fuzz 3-metric spaces according to multiple circumstances. Many employees can use these findings for future study and application. (Tripathy et al., 2015)

Deepika (2022)

In this paper, the author states and proves several fixed point results for weakly coherent mappings utilising the (CLR) feature in fuzzy metrics. In addition, we derive some extensions as well as uses from our established findings. In conclusion, we give an illustration to support our main finding. In 1965, a notion of imprecise mathematics was introduced. M. Grabiec was the primary person in 1988 to demonstrate the Riemann Contraction Hypothesis in fuzzy metric space, which was a vast area for students to demonstrate fixed point conclusions using novel dimensions. In addition, George modified the concept of an imprecise metric space presented in 1975 in 1994. It demonstrated common stable point theorems to loosely coherent transformations using the (CLR) feature in fuzzy metrics. In addition, we gave certain extensions as well as uses of our primary findings. In addition, a scenario is provided to demonstrate the principal result. (Deepika 2022)

Samaneh Ghods (2022)

In this paper, the author proves the constant peak theorem to earn contractive mappings F: X X in fuzzy gauge areas with an unfilled F affine complete region E, and then proves the fixed value's exclusivity in E. Though it is many statements in fuzzy gauge space to its instance, our thesis is a novel sort of such proof because we demonstrated that there currently exists a single stable point at F consistent total collection E in X. Finally, we provide an intriguing example in total fuzzy metrics that matches our theorem's conditions and demonstrate that F has an individual fixed point. In this investigation, a fixed-point argument for contractive translation F X X: in fuzzy gauge spaces with an empty F constant continuous subset E was introduced. In addition, you demonstrated that the central point in E is unique. Our effort yielded very intriguing results, and these are illustrated in an example demonstrating that a mapping F has a distinct stable location in F consistent total subset E in X. The following research will include the introduction of generalised forms of fuzzy sets, the proof of some paired fixed- and coincidental point formulas for contractive projection within novel soft metric areas and a discussion of the outcomes as well as uses. (Sihag et al., 2020)

Vishal Gupta (2023)

In this paper, the authors will demonstrate the reality and distinctiveness of soft treble coincident locations for contractive maps in supple ambiguous metric space (SFMS). In addition, we have applied our new findings to the answer for the fundamental calculation. By creating fuzzy sets, the concept of unpredictability was successfully well-controlled. Following this, the fuzzy array was generalised to a hazy topological area. In the case of uncertainty in evidence-containing criteria, soft sets have been implemented. The principle associated with the fuzzy collection was additionally generalised and applied to various areas resulting in the development of new environments. The softer set concept was adapted to fuzzy measuring space, resulting in SFMS. In this study, novel FPTs to earn the validity and novelty of the soft triplicate concurrence point in SFMS are presented. To illustrate the fact that an approach to a Lebesgue Integration system is in agreement with our new findings, we've offered illustrations and an application. In addition to the extension and formulation of those fresh findings across new spaces, additional novel conclusions might be developed. (Gupta, 2023)

Ismat Beg (2023)

The authors demonstrate a frequently connected static point argument on fuzzy bipolar metres in their research. Our principal findings are applied to the solution of an array of integral problems. Our outcomes generalise and extend the well-known outcomes from the available literature. In this work, the typically associated fixed point hypothesis on the fuzzy bipolar metric spaces is demonstrated. A specific illustration and use of hazy bipolar measurements are provided. Established the concept of set fuzzy. Using the notion of fuzzy thinking, fuzzy spaces of measurement were created. The resulting modification of the concept of ambiguous metrical spaces. (Beg et al., 2023)

Shobha Jain (2020)

The purpose of the article is to present fuzzy generalisation moderately contractive circumstances for two sets of self-maps inside a fuzzy measurement space, following the theory of metrical spaces. Our findings generalise the extant fuzzy contracting to only one self-map. with this, it's we as a species establish through weak compatibility a unique universal point fixation thesis for two self-maps. The article provides an illustration that corroborates our findings. In addition, we found a purpose to feed the validity and singularity of the answer to the Fredholm complex integral equation within fuzzy metric space. (Rasham et al., 2023)

Tahair Rasham (2023)

In this study, the author establishes new fixed-point findings for a symmetrically tied dominance flexible translation that satisfies a newly developed reduction on the closed globe in a set of entire fuzzy metric spaces. Also, the introduction of the concept in composite soft-graph-dominated projections in fuzzy metric areas solves several advanced fuzzy fixed-point questions. New definitions alongside demonstrations are provided to support our latest conclusions. To show the distinctiveness of our newly discovered accomplishments, we give a match to an integral expression of the Fred Holmz form. details fixed-point concepts represent a well-known branch of function analysis that has numerous implications in mathematical theory and practice. In the area of the fixed-point theory (FP), Banach initially suggested the Banach contracting theorem, which has ever since been utilised in a variety of significant contexts. In nonlinear assessment, FP theoretical is a significant and active research field. (Rasham et al., 2023)

Vijayabaskerreddy Bonuga (2023)

Using the concept of Familiar representations, this paper seeks to demonstrate the existence and distinctiveness of universal permanent point arguments for four self-mappings with fuzz measuring space. In addition, we deliver suitable examples to support each of the important points stated in the major findings. The purpose of the paper was to show three standard fixed point conclusions to generalize the class of compliant projections by employing the classroom of non-compatible diagrams, such as multiple types of Properties and intimate mappings at fuzzy measuring space. In Theorem 3.1, it is presumed that one of the mapping ranges is exhaustive. In addition, one among the combinations is presumed to satisfy E in Theorem 3.2. A characteristic and one of the sets of transformations are finished even if the imprecise metric system is not. In Hypothesis 3.3, an enhanced variant of the EA property, specifically the common EA assets, is presumed alongside the fullness of flexible metric space. Further, all of those findings are supported by appropriate examples. (Veladi, 2023)

Koon S. Wong (2023)

The authors present fuzzily generalized -F-contractions as a generalization of fuzzy F-contractions via permissible models in this paper. We derive sufficient requirements for the availability along with the singularity of fixed-point locations for fuzzy generalized -F-contractions in strongly fuzzy metrical spaces with total coverage. Our outcomes generalise some published fixed-point conclusions. We describe an actual use of our basic finding. In this paper, fuzzy generalised -F-contractions are provided as a derivative in fuzzy F-contractions. We demonstrated some fixed-point outcomes related to this shrinkage and how they vary in the context of entirely strong fuzzy metrical spaces. Moreover, we presented an adequate criterion for obtaining the distinctive characteristics in the starting point to feed that contraction. After this research, we demonstrated the usage of our principal result for solving an integral issue. As stated in Observation two our analysis generalizes and extends the results. (Koon Wong 2023)

5. Conclusion

In conclusion, several fixed point theories in the field of fuzzy metrics have been developed and studied, showcasing their significance and applications. These theories have provided valuable tools and techniques for analyzing fuzzy metric spaces and have found applications in various areas.

Fixed point theorems, such as the Banach contraction principle and the Kannan fixed point theorem, have been extended to fuzzy metric spaces, enabling the study of fuzzy mappings and the existence of fixed points in these spaces. These extensions have played a crucial role in establishing the foundations of fuzzy metric theory and have opened up new avenues for research in this field.

The application of fixed point theories in fuzzy metric spaces has been wide-ranging. They have been utilized in fuzzy optimization problems, where the existence of fixed points has been employed to find optimal solutions. Moreover, these theories have been instrumental in solving differential and integral equations in fuzzy metric spaces, offering solutions to various mathematical models and systems.

Furthermore, Computer science along with artificial intelligence has found applications for established point theories in ambiguous metric spaces. They have been utilized in the design of fuzzy logic-based methods, decision-making systems, and methodologies for pattern recognition. Students suffer from being able to address tough issues featuring unpredictability along with imprecision by applying precise point principles in imprecise metrics.

In conclusion, the exploration of established point theorists in the domain within fuzzy metric space has led to significant theoretical and practical breakthroughs. These models have improved our comprehension of fuzzy metrics or offered effective instruments for analyzing and resolving problems in a variety of disciplines. As the study of this area advances, it is anticipated that more discoveries regarding the use of stable point ideas in fuzzy measurements are going to arise, offering significant contributions to mathematics or its applications as a whole.

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