2025 Taiwan-Japan Joint Workshop

on Nonlinear Analysis and Optimization

TJWNAO2025

PROGRAM

&

ABSTRACTS

Organized by

Yosuke Araya

Jein-Shan Chen

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Tamaki Tanaka

Yurihonjo, Akita, JAPAN

27-28 June 2025

Preface

As we all know, nonlinear analysis and optimization play a very important role in solving various nonlinear problems in real-world applications. The main aim of the international conference "2025 Taiwan-Japan Joint Workshop on Nonlinear Analysis and Optimization (TJWNAO2025)" is to continue and deepen friendships between Taiwanese and Japanese researchers and to exchange mathematical idea and recent topics on nonlinear analysis and optimization. On behalf of the organizing committee of TJWNAO2025, we welcome you cordially to participate in this conference held at Yurihonjo, Akita, Japan on 27-28 June in 2025.

The invited speakers in the international conference TJWNAO2025 are mainly from three parties as follows:

(I) Taiwan side Speakers:

- Prof. Lai-Jiu Lin (林來居) National Changhua University of Education, Taiwan
- Prof. Jein-Shan Chen (陳界山) National Taiwan Normal University, Taiwan
- Prof. Yu-Lin Chang (張毓麟) National Taiwan Normal University, Taiwan
- Prof. Wei-Shih Du (杜威仕) National Kaohsiung Normal University, Taiwan
- Prof. Tone-Yau Huang (黃同瑤) Feng Chia University, Taiwan
- Prof. Chih-Sheng Chuang (莊智升) National Chiayi University, Taiwan
- Dr. You-Wei Chen (陳佑威) National Taiwan University, Taiwan

(II) Japan side Speakers:

- Prof. Tamaki Tanaka (田中 環) Niigata University, Japan
- Prof. Toshiharu Kawasaki (川崎 敏治) Nihon University, Japan
- Prof. Toshikazu Watanabe (渡辺 俊一) Tokyo University of Information Sciences, Japan

- Prof. Ellen Hidemi Fukuda (福田　エレン秀美)　Kyoto University, Japan
- Prof. Yousuke Araya (荒谷　洋輔)　Akita Prefectural University, Japan
- Prof. Yuto Ogata (小形　優人)　Kanazawa Gakuin University, Japan
- Ryota Iwamoto (岩本　崚汰)　Niigata University, Japan
- Shunya Matsumori (松森　俊哉)　Akita Prefectural University, Japan
- Kohei Yoshikawa (吉川　航平)　Akita Prefectural University, Japan

(III)　Other countries Speakers (via Zoom)

- Prof. Andreas Heinrich Hamel　Free University of Bozen-Bolzano, Italy
- Prof. Erdal Karapınar　Atilim University, Türkiye
- Dr. Pradeep Kumar Sharma　University of Delhi, India

Akita Prefecture is located in the mountainous area of northern Honshu, Japan, and faces the Sea of Japan to the west. It has a unique natural environment and there are many tourist attractions in the prefecture, as well as many nationally famous local folk arts and festivals, as well as a variety of activities, which are full of charm. We hope all of the participants can enjoy this special experience in Akita during the conference TJWNAO2025. Thank you very much for your participation and enjoy the conference all together.

TJWNAO2025 Organizers

Yosuke Araya

Jein-Shan Chen

Wei-Shih Du

Tamaki Tanaka

2025 Taiwan-Japan Joint Workshop on Nonlinear Analysis and Optimization

Akita Prefectural University

June 27-28, 2025

Organized by

Yosuke Araya, Akita Prefectural University, Japan

Jein-Shan Chen, National Taiwan Normal University, Taiwan

Wei-Shih Du, National Kaohsiung Normal University, Taiwan

Tamaki Tanaka, Niigata University, Japan

Table 1: Schedule on June 27, 2025. Place: Akita Prefectural University (Honjo-Campus) GII-609

	Speaker	Title	Chair
09:30 | 09:40	*The Opening Ceremony*		
10:00 | 10:50	Tamaki Tanaka	On scalarization methods for sets and generalized cone-continuity for set-valued maps	Lai-Jiu Lin
10:50 | 11:30	Yuto Ogata	Calculation methods for robustness of feasibility via set characterization functions	Ellen Hidemi Fukuda
11:30 | 12:40	*Lunch*		
12:40 | 13:00	Kohei Yoshikawa	Multi-period portfolio optimization model for the new NISA scheme and human capital	Yuto Ogata
13:00 | 13:20	Shunya Matsumori	A numerical example in Markov decision process with interval-valued transition probability	You-Wei Chen
13:20 | 13:50	Ryota Iwamoto	Set-Valued Fan-Takahashi Inequalities with Set-Relations Based on Scalarization Methods	Shin-ya Matsushita
13:50 | 14:00	*Tea Break*		
14:00 | 14:40	Ellen Hidemi Fukuda	Recent results in vector optimization: applications and methods	Jein-Shan Chen
14:40 | 15:20	Yousuke Araya	Conjugate duality in set optimization via nonlinear scalarization	Chih-Sheng Chuang
15:20 | 16:00	Pradeep Kumar Sharma	Directional Derivative for Set-valued Maps with Weighted Set Order Relations (Via Zoom)	Chih-Sheng Chuang
16:00 | 18:30	*Discussion and Dinner*		
18:30 | 19:10	Erdal Karapınar	Discussions on the recent results in metric fixed point theory (Via Zoom)	Yousuke Araya
19:10 | 19:50	Andreas Hamel	Multivariate quantiles via set optimization (Via Zoom)	Yousuke Araya

Table 2: Schedule on June 28, 2025. Place: Yurihonjo City Cultural Center KADARE (Kenshu room1 &2)

	Speaker	Title	Chair
09:10 | 10:00	Lai-Jiu Lin	Applications of Proximal Point Algorithms to Characterize The Existence Convergence of Zero Point Problems	Tamaki Tanaka
10:00 | 10:40	Tone-Yau Huang	Second-ordered Wolfe type and Mond-Weir type duality models for the complex multi-objective fractional programming	Tamaki Tanaka
10:40 | 10:50	*Tea Break*		
10:50 | 11:30	Toshiharu Kawasaki	Fixed point theorem for weighted generalized pseudocontractions in metric spaces	Tone-Yau Huang
11:30 | 12:10	Chih-Sheng Chuang	Some algorithms for the inverse mixed variational inequality problems in Hilbert spaces	Yu-Lin Chang
12:10 | 13:10	*Lunch*		
13:10 | 13:50	Jein-Shan Chen	Novel constructions for closed convex cones through inequalities and support functions	Tamaki Tanaka
13:50 | 14:30	You-Wei Chen	β-dimensional sharp maximal function and its applications	Toshikazu Watanabe
14:30 | 15:10	Yu-Lin Chang	Mean Inequalities associated with circular cones	Wei-Shih Du
15:10 | 15:20	*Tea Break*		
15:20 | 16:00	Toshikazu Watanabe	On fixed point theorem in rectangular b-metric menger space	Toshiharu Kawasaki
16:00 | 16:40	Wei-Shih Du	On generalized Meir-Keeler type conditions: New existence results and applications	Toshiharu Kawasaki
16:40 |	*The Closing Ceremony*		
17:30 |	*Banquet (Goaikyo)*		

On scalarization methods for sets and generalized cone-continuity for set-valued maps

Tamaki Tanaka
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Abstract. A composite function is a function which is the nesting of two or more functions to form a single new function. Such operation frequently preserves several mathematical properties of each nested function. For instance, a composition of continuous maps is continuous on topological spaces. From the view point of vector optimization and set optimization, this kind of inheritance by composite operations is important and useful to prove extended results and to get characterizations of optimal solutions through scalarization. This is a typical approach by which optimization problems with vector-valued or set-valued maps can be easily handled by converting vectors or sets into real numbers; see [2] and [3, 4].

Therefore, it is interesting to investigate the inheritance of cone continuity for set-valued maps via general scalarization functions for sets shown in [1].

On the other hand, by transforming set relations to twofold scalar optimization problems of some (real-valued) characterizing functions, the set-relations in [7] can be established by solving real-valued twofold optimization problems; see [5]. For each of the six set-relations, some necessary conditions and sufficient conditions are established on the negativity or the nonpositivity of the associated twofold scalar problems.

The aim of this talk based on [1, 5] is to intrduce the mechanism by which composite functions of a set-valued map and a scalarization function transmit semicontinuity of parent set-valued maps through several scalarization functions for sets, and to show the method how to characterize the set-relation through some characterizing functions for the convex cone.

References

[1] P. Dechboon and T. Tanaka, *Inheritance properties on cone continuity for set-valued maps via scalarization*, Minimax Theory and its Applications, **9** (2024), 201–224

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Calculation methods for robustness of feasibility via set characterization functions

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Abstract. Sublinear characterization theorems for set relations are technical tools in considering set comparisons. Characterization functions give dual scalable expression of set relations in the theorems and they are further extension of Gordan's theorem of the alternative ([1]). We can algorithmically calculate values of the function by an optimization solver under some convex situations (e.g. [2]).

In the literature, characterization functions are utilized in the following ways for examples. In set optimization, the functions can perform a direct role in scaling set comparisons (e.g., ([3])). This means that they give conditions to figure out an optimal solution in a given feasible family of sets.

In vecter optimization, they can be used to describe sensitivity analysis. When we consider certain relation of vectors such as preference or ordering, pointwise comparisons are usually weak in insuring reliability or validity against some errors. We have to carefully see cases where a small error causes a large collapse of the relation or an original optimization problem. The characterization functions can help the relation by dealing with an error set including an ideal vector (e.g., [4], [5]).

This talk introduces the characterization theorems to show their geometric architecture and some reduced programs to get their values under specific conditions. As an application to vector optimization, we observe that this characterization can describe sensitivity of the feasibility of a given optimization program against small deviation on its parameters.

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Multi-period portfolio optimization model for the new NISA scheme and human capital

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Abstract. This study proposes a multi-period portfolio optimization model that incorporates human capital, consumption behavior, and the tax-exempt structure of Japan's new NISA scheme. The model uses Conditional Value at Risk (CVaR) to manage downside risk, while accounting for transaction costs and rebalancing limits. Investment decisions are optimized over time under uncertainty in asset prices and interest rates. Numerical experiments simulate 35 years of investment with realistic income patterns and NISA constraints. The results demonstrate stable consumption, conservative risk control, and effective tax-exempt investment utilization under practical scenarios.

A numerical example in Markov decision process with interval-valued transition probability

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Abstract. In the standard Markov decision process, we treat the case that the transition probability of the state varies in some given domain at each time and its variation is unknown or unobservable. In order to analyze such a case, Kurano et al has introduced a new decision model, called a controlled Markov set-chain, based on Markov set-chains, and discussed the optimization problem of the discounted expected rewards under some set-order relations.

In this presentation, we will give a new numerical example which illustrates an average optimal policy maximizes the long-run expected average reward per unit time under some set-order relations.

Set-Valued Fan-Takahashi Inequalities with Set-Relations Based on Scalarization Methods

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Abstract. In convex analysis and optimization theory, Fan-Takahashi minimax inequality plays a key role to solve equilibrium problems and other problems. Let X be a nonempty compact convex subset of a Hausdorff topological vector space and $f\colon X\times X\to\mathbb{R}$. Fan-Takahashi minimax inequality is: if f satisfies the following conditions:

(a) for each fixed $y\in X$, $f(\cdot,y)$ is lower semicontinuous,

(b) for each fixed $x\in X$, $f(x,\cdot)$ is quasi concave,

(c) $f(x,x)\leq 0$ for all $x\in X$,

then there exists $\bar{x}\in X$ such that $f(\bar{x},y)\leq 0$ for all $y\in X$.

About a quarter of a century ago, Georgiev and Tanaka [2] extended the minimax inequality to the form of set-valued maps. After that, Kuwano, Tanaka, and Yamada [4] constructed the result of four types of set-valued minimax inequalities with set relations [3], which are binary relations depending on a given convex cone. However, this result is limited to the case of specific scalarization functions. To obtain more practical results, we need to replace them into more general scalarization functions. In addition, Dechboon and Tanaka [1] proposed generalized semi-continuity to inherit properties of cone continuity for set-valued maps.

The aim of this talk is to explain Fan-Takahashi minimax inequality and our results in detail.

References

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Recent results in vector optimization: applications and methods

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Abstract. Vector optimization involves minimizing or maximizing multiple objective functions under a preference order induced by a closed, convex, and pointed cone. When this cone is the nonnegative orthant, the problem is referred to as multiobjective optimization. In such cases, the goal is to find Pareto or weakly Pareto optimal solutions, which represent trade-offs among the objectives. Among the methods for solving vector or multiobjective optimization problems with theoretical guarantees, we can cite the scalarization techniques, such as the weighting and the ε-constraint methods, as well as the descent-type methods, which are essentially extensions of scalar-valued algorithms to vector-valued settings. In this talk, we present two approaches involving different classes of vector optimization problems.

The first problem we consider is the vector optimization with continuous real variables and easily projectable constraints. We present the projected gradient method, which is wellsuited suitable for such problems, focusing on the subproblems that must be solved at each iteration. We then discuss the case of matrix-valued objective functions and demonstrate how the method can be applied to problems arising in experiment design applications. In the second part of the presentation, we shift our focus to multiobjective optimization with discrete structure, where many properties valid in the continuous setting no longer hold. We then examine a simple case using the concept of M-convexity, with an application in matching for bipartite graphs. In this case, we show that the entire Pareto set can be explicitly obtained.

Conjugate duality in set optimization via nonlinear scalarization

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Abstract. Set optimization problems, a category of optimization problems, are a natural extension of multi-objective optimization problems and interval analysis. It is an emerging field that has been in the research field for over 20 years. The "set order relation," which is a natural extension of vector ordering, is a kind of preference in social choice theory. In 2014, Ide et al.[4] indicated that multi-objective robust optimization problems can be converted into applications of set optimization problems. Also in 2014, Hamel et al.[3] discovered that a special class of set optimization problems has a lattice structure. The nonlinear scalarization function (utility function) of vectors proposed by Gerstewitz (Tammer)[5] has the advantage of being able to fully characterize Pareto optimal solutions.

In this talk, we present the following topics[1]:

(a) We introduce nonlinear scalarizing techniques for sets as generalizations of Gerstewitz's scalarizing function for the vector-valued case. A detailed historical perspective and analysis of various characterizations of set order relations using nonlinear scalarization are given.

(b) We propose two new notions of set-valued conjugate maps based on lower (l-type) and upper (u-type) set order relations in a Hilbert space setting. This leads to four notions of set-valued bi-conjugate maps and corresponding weak duality theorems.

(c) Using nonlinear scalarizing techniques for sets, we propose strong duality theorems.

In addition, we will introduce the author's latest research results[2].

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Directional Derivative for Set-valued Maps with Weighted Set Order Relations

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Abstract. Directional derivatives of a set-valued map are very useful for deriving first-order necessary and sufficient conditions for set optimization problems. In this talk, we propose a new directional derivative for set-valued maps based on the weighted set order relations. We define a Hausdorff-type distance by means of nonlinear scalarization functions with respect to weighted set order relations and present some of its properties. By utilizing this Hausdorff-type distance, we propose a novel approach to computing the directional derivative of set-valued maps with weighted set order relations. We derive some nice properties from this directional derivative and use them to obtain the necessary and sufficient optimality conditions for the set optimization problem. As we know, the weighted set order relation is a mixture of lower and upper set order relations, the new directional derivative can be treated as a weighting directional derivative to balance out a possible gap in studying set optimization problems with lower and upper set order relations.

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Discussions on the recent results in metric fixed point theory

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Abstract. The aim of this talk is to reveal the dilemmas of the fixed point theorems that were started to be constructed by Banach in 1922. It is possible to transform many of the real-world problems into fixed-point theorems. This shows how the fixed point theory is useful and how huge application potential it has. On the other hand, a lot of results are repeated in this theory, which is of great interest. A substantial part of the new results suggested overlaps with the old results.
To support this observation, I shall share a few examples from the current literature.

Multivariate quantiles via set optimization

Andreas Hamel
Free University of Bozen-Bolzano
Faculty of Economics and Management, Italy

Abstract. What is a quantile, e.g., the median, of a random vector? This simple question does not have a textbook answer yet. In the statistical literature, depth regions and depth functions are used as multivariate substitutes for univariate quantiles and cumulative distribution functions but they are not straightforward generalizations of one-dimensional quantiles and cdf's.
The major difficulty is related to the order relation which is basic for defining quantiles: while in one dimension, only $\leq$ for real numbers makes sense, it is not clear which order should be used in higher dimensions. A new concept for multivariate quantiles is introduced based on vector orders generated by convex cones. A new statistical function, called lower cone distribution function, is defined as an alternative to the joint distribution function and then quantile sets as upper level sets of this function. In this way, quantile functions become set-valued, share almost all properties with univariate quantile functions and are indeed generalizations of the latter: this can be shown by set optimization techniques.
Applications are given to classification of multidimensional data points.

The talk is based on

- Hamel, Kostner, Cone distribution functions and quantiles for multivariate random variables, J. Multivariate Analysis 2018,
- Ararat, Hamel, Lower cone distribution functions and set-valued quantiles form Galois connections, Theory of Probability and Its Applications 2020,
- Hamel, Kostner, Computation of quantile sets for bi variate ordered data, Comp. Stat. & Data Analysis 2022.

Applications of Proximal Point Algorithms to Characterize The Existence Convergence of Zero Point Problems

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Abstract. In this paper, we introduce two types of proximal point problems $(ZPP1)$ (resp. $(ZPP2)$) and two regularization methods of proximal point algorithms (1.1) (resp (1.2) for $(ZPP1)$ (resp. $(ZPP2)$).

The sufficient conditions for the boundness and the asymptotic behavior of the sequence $\{x_n\}$ generated by the regularization methods of proximal point algorithms (1.1) and (1.2) were investigated. Our result provided sufficient conditions for the case that the set of all solutions for problems $(ZPP1)$ and $(ZPP2)$ are nonempty. Finally, we proposed an equivalent condition of the existence of solutions for two types of problems $(ZPP1)$(also $(ZPP2)$).

Key words: proximal point algorithm, zero point problem, bounded sequences, coercive maximal operator, weak cluster point, reflexive , strictly convex and smooth Banach space, duality mapping, metric resolvent mapping, Hilbert space

2020 Mathematics Subject Classification: 47J25, 47J20, 47H26

Second-ordered Wolfe type and Mond-Weir type duality models for the complex multi-objective fractional programming

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Abstract. We consider a complex multi-objective fractional programming problem(CMFP). Duality problem is an important role on optimization theory. The goal of this paper is to formulate some second-ordered free type dual problems. We aim to establish the second-ordered Wolfe type and second-ordered Mond-Weir type duality problems of (CMFP), and then prove that the duality theorems: the weak, strong and strictly converse duality theorem.

Key words: multi-objective fractional programming, generalized convexity, duality theorems

MSC 2010: 49K35, 90C29, 26A51, 90C46

Fixed point theorem for weighted generalized pseudocontractions in metric spaces

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Abstract. Let (X, d) be a metric space. A mapping T from X into itself is said to be widely more generalized hybrid if there exist real numbers $\alpha, \beta, \gamma, \delta, \epsilon$ and ζ such that

$$\alpha d(Tx, Ty)^2 + \beta d(x, Ty)^2 + \gamma d(Tx, y)^2 + \delta d(x, y)^2 + \epsilon d(x, Tx)^2 + \zeta d(y, Ty)^2 \leq 0$$

for any $x, y \in X$. Such a mapping is called an $(\alpha, \beta, \gamma, \delta, \epsilon, \zeta)$-widely more generalized hybrid mapping.

Furthermore, we proved

Theorem 1. *Let X be a complete metric space and let T be an $(\alpha, \beta, \gamma, \delta, \epsilon, \zeta)$-widely more generalized hybrid mapping from X into itself. Suppose that there exists $\lambda \in [0, 1]$ such that*

(1) $\alpha + (1 - \lambda)\varepsilon + \lambda\zeta + 2\min\{\lambda\beta + (1 - \lambda)\gamma, 0\} \geq 0$;

(2) $\alpha + \delta + \varepsilon + \zeta + 4\min\{\lambda\beta + (1 - \lambda)\gamma, 0\} > 0$;

(3) $\alpha + (1 - \lambda)(\beta + \zeta) + \lambda(\gamma + \varepsilon) > 0$.

Then T has a fixed point u, where $u = \lim_{n\to\infty} T^n x$ for any $x \in X$. Additionally, if $\alpha + \beta + \gamma + \delta > 0$, then T has a unique fixed point.

In this talk, we introduce weighted generalized pseudocontractions and show a fixxed point theorem.

Some algorithms for the inverse mixed variational inequality problems in Hilbert spaces

Chih-Sheng Chuang
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Abstract. The inverse mixed variational inequality problem comes from the classical variational inequality, and it has many applications. In this talk, we propose new algorithms to study the inverse mixed variational inequality problems in Hilbert spaces. Next, we establish convergence theorems under inverse strongly monotonicity conditions, and the conditions are different from the above convergence theorems.

Novel constructions for closed convex cones through inequalities and support functions

Jein-Shan Chen
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Abstract. Two novel ways to generate closed convex cones, the main ingredient of conic optimization, are presented in this talk. The first way is constructing closed convex cones via inequalities, whereas the second one is through support functions. The contribution of this article is twofold. One is opening up new ideas for looking into structures of closed convex cones. The other one is providing novel approaches and mediums for investigating conic optimization.

β-dimensional sharp maximal function and its applications

You-Wei Chen
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Abstract. In this talk, I will introduce a β-dimensional sharp maximal operator defined using Hausdorff content:

$$\mathcal{M}_\beta^\# f(x) := \sup_{Q \ni x} \frac{1}{\ell(Q)^\beta} \inf_{c \in \mathbb{R}} \int_Q |f - c| \, d\mathcal{H}_\infty^\beta,$$

where the supremum is over cubes with sides parallel to the axes. I will present a Fefferman–Stein inequality in this setting, which is obtained via a new good-λ estimate adapted to the nonlinear structure of the Choquet integral. Time permitting, I will also discuss a pointwise comparison between this operator and the fractional maximal function applied to Riesz potentials, which leads to new insights into the local behavior of functions with bounded β-dimensional mean oscillation.

Mean Inequalities associated with circular cones

Yu-Lin Chang
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Abstract. Mean inequalities on the second order cone have been studied as an extension of the SPD cone. In this talk, we turn our eyes on non-symmetric cones. In fact we investigate two types of decompositions associated with circular cones, and establish their own mean inequalities. These inequalities are ground bricks for further study regarding circular cone optimization. We also find under the condition $0 < \theta < \frac{\pi}{4}$ some inequalities cannot hold if we apply different decomposition, and correspondingly we raise a conjecture.

On fixed point theorem in rectangular b-metric menger space

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Abstract. Probabilistic metric spaces were introduced in 1942 by Menger [7]. Sehgal, in his Ph.D. Thesis [8], extended the notion of a contraction mapping to the setting of the Menger probabilistic metric spaces. The probabilistic version of the classical Banach Contraction Principle was first studied in 1972 by Sehgal and Bharucha-Reid [9]. After that many authors have obtained fixed point theorems for probabilistic φ-contractions under the assumption that φ is nondecreasing and such that $\sum_{n=1}^{\infty} \varphi^n(t) < \infty$ for any $t > 0$ (see, e.g., [2] and the references in [4]). Ćirić [1] consider Boyd and Wang condition and Jachymski [6] correctly defined the conditions. In [3] Fang by means of weakening conditions of the gauge function φ, a new fixed point theorem for probabilistic φ-contraction in Menger probabilistic metric spaces with a t-norm of H-type is established. This theorem improves and generalizes the recent results of Ćirić [1], Jachymski [6] and Xiao et al.[10]

In this talk, we consider the extsntion of φ-contraction in b-metric or rectangle Menger probabilistic metric spaces.

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On generalized Meir-Keeler type conditions: New existence results and applications

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Abstract. The primary aim of this talk is to provide new fixed point theorems for generalized Meir–Keeler type conditions and their applications to fixed point theory. Our new results simultaneously generalize and improve several known fixed point theorems available in the corresponding literature.

Key words: generalized Meir–Keeler type condition, Banach contraction principle, Kannan's fixed point theorem, Chatterjea's fixed point theorem, Meir–Keeler's fixed point theorem

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