

Δ-CONVERGENCE OF CONVEX COMBINATIONS OF TWO MAPS ON p -UNIFORMLY CONVEX METRIC SPACES

BYOUNG JIN CHOI

Department of Mathematics Education, Jeju National University,
Jeju 63243, Korea
E-mail: choibj@jejunu.ac.kr

Abstract. In this paper, we first study some properties of the convex combination metric and the convex combination of two maps on a p -uniformly convex metric space. Also, we study the Δ -convergence of an iterative sequence for a convex combination of two maps on p -uniformly convex metric spaces.

Key Words and Phrases: Convex feasibility problem, p -uniformly convex metric spaces, convex combination of two maps, weighted average projection method, Δ -convergence, fixed point.

2020 Mathematics Subject Classification: 41A65, 47H09, 47J25, 47N10, 47H10.

ACKNOWLEDGMENT.

This work was supported by the research grant of Jeju National University in 2021.

REFERENCES

- [1] D. Ariza-Ruiz, G. López-Acedo, A. Nicolae, *The asymptotic behavior of the composition of firmly nonexpansive mappings*, J. Optim. Theory Appl., **167**(2015), 409-429.
- [2] A. Auslender, *Méthodes Numériques pour la Résolution des Problèmes d'Optimisation avec Contraintes*, Thèse, Faculté des Sciences, Grenoble, 1969.
- [3] M. Bačák, *Convex Analysis and Optimization in Hadamard Spaces*, De Gruyter Series in Nonlinear Analysis and Applications, **22** De Gruyter, Berlin, 2014.
- [4] M. Bačák, S. Reich, *The asymptotic behavior of a class of nonlinear semigroups in Hadamard spaces*, J. Fixed Point Theory Appl., **16**(2014), 189-202.
- [5] M. Bačák, I. Seaton, B. Sims, *Alternating projections in CAT(0) spaces*, J. Math. Anal. Appl., **385**(2012), 599-607.
- [6] H.H. Bauschke, J.M. Borwein, *On projection algorithms for solving convex feasibility problems*, SIAM Rev., **38**(1996), 367-426.
- [7] H.H. Bauschke, E. Matoušková, S. Reich, *Projection and proximal point methods: convergence results and counterexamples*, Nonlinear Anal. **56**(2004), 715-738.
- [8] L.M. Brègman, *Finding the common point of convex sets by the method of successive projection*, Dokl. Akad. Nauk SSSR, **162**(1965), 487-490 (in Russian); English Transl. in Sov. Math. Dokl., **6**(1965), 688-692.
- [9] M.R. Bridson, A. Haefliger, *Metric Spaces of Non-positive Curvature*, Grundlehren der Mathematischen Wissenschaften, **319**, Springer-Verlag, Berlin, 1999.

- [10] B.J. Choi, Δ -convergences of weighted average projections in $CAT(\kappa)$ spaces, *J. Aust. Math. Soc.*, **110**(2021), 289–301.
- [11] B.J. Choi, Δ -convergence of product of operators in p -uniformly convex metric spaces, *Mathematics*, **8**(2020), 741.
- [12] B.J. Choi, U.C. Ji, Y. Lim, Convergences of alternating projections in $CAT(\kappa)$ spaces, *Constr. Approx.*, **47**(2018), 391-405.
- [13] B.J. Choi, U.C. Ji, Y. Lim, Convex feasibility problems on uniformly convex metric spaces, *Optim. Methods Softw.*, **35**(2020), 21-36.
- [14] J.A. Clarkson, Uniformly convex spaces, *Trans. Amer. Math. Soc.*, **40**(1936), 396-414.
- [15] P.L. Combettes, Hilbertian convex feasibility problem: convergence of projection methods, *Appl. Math. Optim.*, **35**(1997), 311-330.
- [16] R. Espínola, A. Fernández-León, $CAT(\kappa)$ -spaces, weak convergence and fixed points, *J. Math. Anal. Appl.*, **353**(2009), 410-427.
- [17] J.S. He, D.H. Fang, G. López, C. Li, Mann's algorithm for nonexpansive mappings in $CAT(\kappa)$ spaces, *Nonlinear Anal.*, **75**(2012), 445-452.
- [18] H.S. Hundal, An alternating projection that does not converge in norm, *Nonlinear Anal.*, **57**(2004), 35-61.
- [19] Y. Kimura, K. Satô, Halpern iteration for strongly quasinonexpansive mappings on a geodesic space with curvature bounded above by one, *Fixed Point Theory Appl.*, **7**(2013), 14 pp.
- [20] W.A. Kirk, B. Panyanak, A concept of convergence in geodesic spaces, *Nonlinear Anal.*, **68**(2008), 3689-3696.
- [21] K. Kuwae, Jensen's inequality on convex spaces, *Calc. Var. Partial Differential Equations*, **49**(2014), 1359-1378.
- [22] T.C. Lim, Remarks on some fixed point theorems, *Proc. Amer. Math. Soc.*, **60**(1976), 179-182.
- [23] A. Naor, L. Silberman, Poincaré inequalities, embeddings, and wild groups, *Compos. Math.*, **147**(2011), 1546-1572.
- [24] S. Ohta, Convexities of metric spaces, *Geom. Dedicata*, **125**(2007), 225-250.
- [25] B. Prus, R. Smarzewski, Strongly unique best approximations and centers in uniformly convex spaces, *J. Math. Anal. Appl.*, **121**(1987), 10-21.
- [26] S. Reich, Z. Salinas, Weak convergence of infinite products of operators in Hadamard spaces, *Rend. Circ. Mat. Palermo*, **65**(2016), 55-71.
- [27] A. Sipoş, The asymptotic behaviour of convex combinations of firmly nonexpansive mappings, *J. Convex Anal.*, **26**(2019), 911-924.
- [28] K.-T. Sturm, Probability measures on metric spaces of nonpositive curvature, *Heat Kernels and Analysis on Manifolds, Graphs, and Metric Spaces*, Contemp. Math., **338**, 357-390, Amer. Math. Soc., Providence, RI, 2003.
- [29] J. von Neumann, *Functional Operators II: The Geometry of Orthogonal Spaces*, Annals of Mathematics Studies **22**, Princeton University Press, Princeton, NJ, 1950 (This is a reprint of mimeographed lecture notes first distributed in 1933).

Received: March 27, 2020; Accepted: March 6, 2021.

