

JENSEN AND HERMITE-HADAMARD INCLUSIONS FOR STRONGLY CONCAVE SET-VALUED MAPS

José Giménez, Lorena López, Luisa Sánchez and José L. Sánchez

Abstract

Counterparts of the classical integral and discrete Jensen inequalities and the Hermite-Hadamard theorem and its converse, for strongly concave set-valued maps, are presented.

Keywords and phrases: strongly convex function, strongly concave set-valued map, Jensen inequality, Hermite-Hadamard inequality.

Received December 13, 2015

References

- [1] A. Azócar, J. Giménez, K. Nikodem and J. L. Sánchez, On strongly midconvex functions, *Opuscula Math.* 31(1) (2011), 15-26.
- [2] M. Bessenyei and Zs. Páles, Characterization of convexity via Hadamards in-equality, *Math. Inequal. Appl.* 9(1) (2006), 53-62.
- [3] S. Dragomir and C. Pearce, *Selected Topics on Hermite-Hadamard Inequalities and Applications*, RGNIA Monographs Victoria University, 2002.
- [4] C. González, K. Nikodem, Z. Páles and G. Roa, Bernstein-Doetsch type theorems for set-valued maps of strongly and approximately convex and concave type, *Publ. Math. Debrecen* 84(1-2) (2014), 229-252.
- [5] S. Hu and N. Papageorgiou, *Handbook of Multivalued Analysis, Vol. I, Theory*, Kluwer Acad. Publ. Dordrecht, Boston, London, 1997.
- [6] H. Huang, Global error bounds with exponents for multifunctions with set constraints, *Comuni. Contempor. Math.* 12 (2010), 417-435.
- [7] H. Leiva, N. Merentes, K. Nikodem and J. L. Sánchez, Strongly convex set-valued maps, *J. Glob. Optim.* 57 (2013), 695-705.
- [8] J. Matkowski and K. Nikodem, An integral Jensen inequality for convex multifunctions, *Results Math.* 26 (1994), 348-353.
- [9] N. Merentes and K. Nikodem, Remark on strongly convex function, *Aequationes Math.* 80(1-2) (2010), 193-199.

- [10] C. Mitroi, K. Nikodem and Sz. Wasowicz, Hermite-Hadamard inequalities for convex set-valued functions, *Demonstratio Math.* 46 (2013), 655-662.
- [11] O. Mejás, N. Merentes and K. Nikodem, Strongly concave set-valued maps, *Math. Aeterna* 4(5) (2014), 477-487.
- [12] K. Nikodem, K -convex and K -concave set-valued functions, *Zeszyty Nauk. Politech. Ldz. Mat.* 559 (Rozprawy Nauk 114), Ldz, (1989), 1-75.
- [13] K. Nikodem, On midpoint convex set-valued functions, *Aequationes Math.* 33 (1987), 46-56.
- [14] K. Nikodem, On concave and midpoint concave set-valued functions, *Glasnik Mat.* 22 (1987), 69-76.
- [15] K. Nikodem, J. L. Sánchez and L. Sánchez, Jensen and Hermite-Hadamard inequalities for strongly convex set-valued maps, *Math. Aeterna* 4(8) (2014), 979-987.
- [16] B. Polyak, Existence theorems and convergence of minimizing sequences in extremum problems with restrictions, *Soviet Math. Dokl.* 7 (1966), 72-75.
- [17] E. Polovinkin, Strongly convex analysis, *Sb. Math.* 187(2) (1996), 259-286.
- [18] D. Popa, Semicontinuity of a class of generalized convex and a class of generalized concave set-valued maps, *Pure Math. Appl.* 11 (2000), 369-374.
- [19] H. Rådström, An embedding theorem for space of convex sets, *Proc. Amer. Math. Soc.* 3 (1952), 165-169.
- [20] S. Rolewicz, Functional Analysis and Control Theory, Linear Systems, PWN Polish Scientific Publisher and d...., 1987.
- [21] E. Sadowska, Hadamard inequality and a refinement of Jensen inequality for set-valued functions, *Results Math.* 32 (1997), 332-337.
- [22] E. Sadowska, A Sandwich with convexity for set-valued functions, *Math. Pannonica* 7(1) (1996), 163-169.
- [23] J. Vial, Strong convexity of sets and functions, *J. Math. Economy* 9 (1982), 187-205.