

NEW WEIGHTED HERMITE–HADAMARD TYPE INEQUALITIES FOR DIFFERENTIABLE STRONGLY CONVEX AND STRONGLY QUASI–CONVEX MAPPINGS

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Abstract. In this paper, new weighted Hermite–Hadamard type inequalities for differentiable strongly convex and strongly quasi-convex mappings are proved. These results strengthen many results proved in earlier works for these classes of functions. Applications of some of our results to statistics are provided.

Mathematics subject classification (2020): 26D15, 26D20, 26D07.

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REFERENCES

- [1] M. ALOMARI, M. DARUS, U. S. KIRMACI, *Refinements of Hadamard-type inequalities for quasi-convex functions with applications to trapezoidal formula and special means*, Comput. Math. Appl., 59 (2010) 225–232.
- [2] M. U. AWAN, *On strongly generalized convex functions*, Filomat 31 (18) (2017), 5783–5790.
- [3] M. ADAMEK, *On a problem connected with strongly convex functions*, Math. Inequ. Appl., 19 (2016), 1287–1293.
- [4] G. D. ANDERSON, M. K. VAMANAMURTHY, M. VUORINEN, *Generalized convexity and inequalities*, J. Math. Anal. Appl., 335 (2007), 1294–1308.
- [5] H. ANGULO, J. GIMENEZ, A. M. MOROS, K. NIKODEM, *On strongly h -convex functions*, Ann. Funct. Anal., 2 (2011), 85–91.
- [6] A. AZCAR, J. GIMNEZ, K. NIKODEM, J. L. SNCHEZ, *On strongly midconvex functions*, Opuscula Math., 31 (2011), 15–26.
- [7] A. AZÓCAR, K. NIKODEM, G. ROA, *Fejér type inequalities for strongly convex functions*, Annal. Math. Siles., 26 (2012), 43–54.
- [8] M. BESSENYEI AND Z. PÁLES, *Hermite–Hadamard inequalities for generalized convex functions*, Aequ. Math., 69 (1) (2005), 32–40.
- [9] G. CRISTESCU, L. LUPSA, *Non-connected Convexities and Applications*, Kluwer Academic Publisher, Dordrecht, (2002).
- [10] L. FEJÉR, *Über die Fourierreihen, II*, Math. Naturwiss. Anz. Ungar. Wiss., 24 (1906), 369–390, (in Hungarian).
- [11] B. GAVREA, *A Hermite–Hadamard type inequality with applications to the estimation of moments of continuous random variables*, Appl. Math. Comp., 254 (2015) 92–98.
- [12] R. GEN AND K. NIKODEM, *Strongly convex functions of higher order*, Nonlinear Anal., 74 (2011), 661–665.
- [13] J. HADAMARD, *Étude sur les Propriétés des Fonctions Entières en Particulier d’une Fonction Considérée par Riemann*, Journal de Mathématiques Pures et Appliquées, 58, 171–215.
- [14] D.-Y. HWANG, *Some inequalities for differentiable convex mapping with application to weighted trapezoidal formula and higher moments of random variables*, Appl. Math. Comp., 217 (23) (2011) 9598–9605.

- [15] D.-Y. HWANG, *Some inequalities for differentiable convex mapping with application to weighted midpoint formula and higher moments of random variables*, Appl. Math. Comp., 232 (2014) 68–75.
- [16] M. JOVANOVIĆ, *On strong quasiconvex functions and boundedness of level sets*, Optimization, 20 (2) (1989), 163–165.
- [17] M. V. JOVANOVIĆ, *A note on strongly convex and strongly quasiconvex functions*, Math. Notes, 60 (1996), 778–779.
- [18] T. LARA, N. MERENTES, K. NIKODEM, *Strong h -convexity and separation theorems*, Int. J. Anal., 2016 (2016), 5 pages.
- [19] U. S. KIRMACI, *Inequalities for differentiable mappings and applications to special means of real numbers and to midpoint formula*, Appl. Math. Comput., 147 (2004), 137–146.
- [20] U. S. KIRMACI, M. E. ÖZDEMİR, *On some inequalities for differentiable mappings and applications to special means of real numbers and to midpoint formula*, Appl. Math. Comput., 153 (2004) 361–368.
- [21] B. BIN-MOHSINA, M. A. NOOR, K. I. NOORB, S. IFTIKHAR, *Relative strongly harmonic convex functions and their characterizations*, J. Nonlinear Sci. Appl., 11 (2018), 1070–1076.
- [22] N. MERENTES AND K. NIKODEM, *Remarks on strongly convex functions*, Aequat. Math., 80 (2010), 193–199.
- [23] M. A. NOOR, K. I. NOOR, S. IFTIKHAR AND M. U. AWAN, *Strongly generalized harmonic convex functions and integral inequalities*, J. Math. Anal., 7 (3) (2016), 66–71.
- [24] M. A. NOOR, G. CRISTESCU, M. U. AWAN, *Bounds having Riemann type quantum integrals via strongly convex functions*, Studia Sci. Math. Hungar., 54 (2017), 221–240.
- [25] M. A. NOOR, K. I. NOOR, S. IFTIKHAR, *Hermite-Hadamard inequalities for strongly harmonic convex functions*, J. Inequal. Spec. Funct., 7 (2016), 99–113.
- [26] M. A. NOOR, K. I. NOOR, S. IFTIKHAR, *Inequalities via strongly p -harmonic log-convex functions*, J. Nonl. Funct. Anal., 2017 (2017), 14 pages.
- [27] M. A. NOOR, K. I. NOOR, S. IFTIKHAR, *Integral inequalities for differentiable relative harmonic preinvex functions (survey)*, TWMS J. Pure Appl. Math., 7 (2016), 3–19.
- [28] M. A. NOOR, K. I. NOOR, S. IFTIKHAR, M. U. AWAN, *Strongly generalized harmonic convex functions and integral inequalities*, J. Math. Anal., 7 (2016), 66–77.
- [29] K. NIKODEM, *Strongly convex functions and related classes of functions*, Handbook of functional equations, 2014 (2014), 365–405.
- [30] K. NIKODEM, Z. PALES, *Characterizations of inner product spaces by strongly convex functions*, Banach J. Math. Anal., 5 (2011), 83–87.
- [31] C. E. M. PEARCE, J. PECARIC, *Inequalities for differentiable mappings with applications to quadrature formulae*, Appl. Math. Lett., 13 (2000), 51–55.
- [32] J. E. PECARIC, F. PROSCHAN, Y. L. TONG, *Convex Functions, Partial Ordering and Statistical Applications*, Academic Press, New York, 1991.
- [33] B. T. POLYAK, *Existence theorems and convergence of minimizing sequences in extremum problems with restrictions*, Soviet mathematics, Doklady, 166 (2) (1966), 72–75.
- [34] T. M. RASSIAS, *Handbook of Functional Equations: Functional Inequalities*, Springer New York Heidelberg Dordrecht London (2014).
- [35] A. W. ROBERTS, D. E. VARBERG, *Convex Functions*, Academic Press, New York (1973).
- [36] Y.-X. SUN, J.-Y. WANG AND B.-N. GUO, *Some integral inequalities of the Hermite-Hadamard type for strongly quasi-convex functions*, Turkish Journal of Analysis and Number Theory, 4 (5) (2016), 132–134.
- [37] M. TUNÇ, *On new inequalities for h -convex functions via Riemann-Liouville fractional integration*, Filomat, 27 (4) (2013), 559–565; available online at <https://doi.org/10.2298/FIL1304559T>.
- [38] G.-S. YANG, D.-Y. HWANG, K.-L. TSENG, *Some inequalities for differentiable convex and concave mappings*, Comput. Math. Appl., 47 (2004) 207–216.
- [39] T. ZHAO, M. S. SALEEM, W. NAZEER, I. BASHIR AND I. HUSSAIN, *On generalized strongly modified h -convex functions*, Journal of Inequalities and Applications, (2020) 2020:11, 12 pages.