

Heuristic introduction to weakly Picard operator theory

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ABSTRACT.

In this paper we study the impact of weakly Picard operator theory, [see I. A. Rus, *Picard operators and applications*, Sc. Math. Japonicae, **58** (2003), No. 1, 191–219] on the following problem: what can we do in order to find conditions under which a given operator is a weakly Picard operator?

REFERENCES

- [1] Abel, U. and Ivan, M., *Over-iterates of Bernstein's operators: A short and elementary proof*, Amer. Math. Monthly, **116** (2009), No. 6, 535–538
- [2] Adell, J. A., Germán Badia, F. and Jesús de la Cal., *On the iterates of some Bernstein-type operators*, J. Math. Anal. Appl., **209** (1997), 529–541
- [3] Agratini, O. and Rus, I. A., *Iterates of a class of discrete linear operators via contraction principle*, Comment. Math. Univ. Carolin., **44** (2003), No. 3, 555–563
- [4] Agratini, O. and Rus, I. A., *Iterates of some bivariate approximation process via weakly Picard operators*, Nonlinear Anal. Forum, **8** (2003), No. 2, 159–168
- [5] Agratini, O., *Aproximare prin operatori liniari*, Presa Universitară Clujană, Cluj-Napoca, 2000
- [6] Altomare, F. and Campiti, M., *Korovkin-type approximation theory and its applications*, de Gruyter, Berlin, 1994
- [7] András, S. and Rus, I. A., *Iterates of Cesàro operators, via fixed point principle*, Fixed Point Theory, **11** (2010), No. 2, 171–178
- [8] Bauer, H., *Approximation and abstract boundaries*, Amer. Math. Monthly, **85** (1978), No. 8, 632–647
- [9] Berinde, V., *Iterative Approximation of Fixed Points*, Springer, 2007
- [10] Berinde, V., Păcurar, M. and Rus, I. A., *From a Dieudonné theorem concerning the Cauchy problem to an open problem in the theory of weakly Picard operators*, Carpathian J. Math., **30** (2014), No. 3, 283–292
- [11] Bohl, E., *Linear operator equations on a partially ordered vector space*, Aequat. Math., **4** (1970), 89–98
- [12] Boyd, D. W., *The spectral radius of averaging operators*, Pacific J. Math., **24** (1968) 19–28
- [13] Cătinaș, T. and Otrocol, D., *Iterates of Bernstein type operators on a square with one curved side via contraction principle*, Fixed Point Theory, **13** (2012), No. 1, 97–106
- [14] Cătinaș, T. and Otrocol, D., *Iterates of multivariate Cheney-Sharma operators*, J. Comput. Anal. Appl., **15** (2013), 1240–1246
- [15] Chiș-Novac, A., Precup, R. and Rus, I. A., *Data dependence of fixed points for non-self generalized contractions*, Fixed Point Theory, **10** (2009), No. 1, 73–87
- [16] Cristescu, R., *Spații liniare ordonate*, Editura Academiei R. P. R., București 1959
- [17] Cristescu, R., *Ordered vector spaces and linear operators*, Abacus Press, 1976
- [18] Engelking, R., *General Topology*, PWN, 1977
- [19] Gal, S. G., *Voronovskaja's theorem and iterations for complex Bernstein polynomials in compact disks*, Mediterr. J. Math., **5** (2008), 253–272
- [20] Gavrea, I. and Ivan, M., *On the iterates of positive linear operators*, J. Approx. Theory, **163** (2011), 1076–1079
- [21] Gavrea, I. and Ivan, M., *The iterates of positive linear operators preserving constants*, Appl. Math. Lett., **24** (2011), 2068–2071
- [22] Gonska, H., Kacsó, D. and Pițul, P., *The degree of convergence of over-iterated positive linear operators*, J. Appl. Funct. Anal., **1** (2006), 403–423
- [23] Gonska, H. and Pițul, P., *Remarks on an article of J. P. King*, Comment. Math. Univ. Carolin., **46** (2005), No. 4, 645–652
- [24] Gonska, H., Pițul, P. and Raşa, I., *Over-iterates of Bernstein-Stancu operators*, CALCOLO, **44** (2007), 117–125
- [25] Gonska, H. and Raşa, I., *The limiting semigroup of the Bernstein iterates: degree of convergence*, Acta Math. Hungar., **111** (2006), No. 1-2, 119–130
- [26] Heikkilä, S. and Roach, G. F., *On equivalent norms and the contraction mapping principle*, Nonlinear Anal., **8** (1984), No. 10, 1241–1252
- [27] Holmess, R. B., *A formula for the spectral radius of an operator*, Amer. Math. Monthly, **75** (1968), 163–166
- [28] Jachymski, J., *Convergence of iterates of linear operators and the Kelisky-Rivlin type theorems*, Studia Math., **195** (2009), No. 2, 99–112
- [29] Jamison, G., *Ordered Linear Spaces*, Springer, 1970
- [30] Kantorović, L. V. and Akilov, G. P., *Analiză funcțională*, Editura Științifică și Enciclopedică, București, 1986
- [31] Kantorović, L. V., Vulikh, B. C. and Pinsker, A. G., *Functional Analysis in Partially Ordered Spaces*, (Russian), Moscow-Leningrad, 1950
- [32] Karlin, S. and Ziegler, Z., *Iteration of positive approximation operators*, J. Approximation Theory, **3** (1970), 310–339
- [33] King, J. P., *Positive linear operators which preserve x^2* , Acta Math. Hungar., **99** (2003), 203–208
- [34] Kuratowski, K., *Topology I*, Acad. Press, 1966
- [35] La Salle, J. P., *The stability of dynamical systems*, SIAM, 1976
- [36] Mahmudov, N. I., *Asymptotic properties of powers of linear positive operators which preserve e_2* , Comput. Math. Appl., **82** (2011), 4568–4575
- [37] Ortega, J. M. and Rheinboldt, W. C., *Iterative solution of nonlinear equations in several variables*, Acad. Press, 1970
- [38] Păcurar, M., *Fixed point theory for cyclic Berinde operators*, Fixed Point Theory, **12** (2011), No. 2, 419–428
- [39] Petrușel, A., Rus, I. A. and Șerban, M. A., *The role of equivalent metrics in fixed point theory*, Topol. Methods Nonlinear Anal., **41** (2013), No. 1, 85–112
- [40] Raşa, I., *Asymptotic behaviour of iterates of positive linear operators*, Jaen J. Approx., **1** (2009), No. 2, 195–204
- [41] Raşa, I., *Positive linear operator preserving linear functions*, Ann. T. Popovici Seminar of Funct. Eq. Approx. Conv., **7** (2009), 105–109
- [42] Rus, I. A., *Picard operators and applications*, Sc Math. Japonicae, **58** (2003), No. 1, 191–219
- [43] Rus, I. A., *Fixed Point Structure Theory*, Cluj University Press, Cluj-Napoca, 2006
- [44] Rus, I. A., *Iterates of Bernstein operators, via contraction principle*, J. Math. Anal. Appl., **292** (2004), 259–261
- [45] Rus, I. A., *Fixed point and interpolation point set of a positive linear operator on $C(\bar{D})$* , Studia Univ. Babeș-Bolyai, Math., **55** (2010), No. 4, 243–248

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- [46] Rus, I. A., *Iterates of Stancu operators (via fixed point principle) revisited*, Fixed Point Theory, **11** (2010), No. 2, 369–374
- [47] Rus, I. A., Petrușel, A. and Petrușel, G., *Fixed Point Theory*, Cluj University Press, 2008
- [48] Rus, I. A., *Five open problems in the fixed point theory in terms of fixed point structures (I): singled valued operators*, 39–60 in Proceed. of the 10th IC-FPTA, Cluj-Napoca, 2013
- [49] Rus, I. A., *An abstract point of view on iterative approximation of fixed points: impact on the theory of fixed point equations*, Fixed Point Theory, **13** (2012), No. 1, 179–192
- [50] Rus, I. A. *Some nonlinear functional and integral equations, via weakly Picard operator theory: a survey*, Carpathian J. Math., **26** (2010), No. 2, 230–258
- [51] Schaefer, H. H., *Banach lattice and positive operators*, Springer, 1974
- [52] Trotter, H. F., *Approximation of semi-groups of operators*, Pacific J. Math., **8** (1958), 887–919
- [53] Vulikh, B. Z., *Introduction to the theory of partially ordered spaces*, Wolters-Noordhoff, 1967

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