

Documents

Mukhamedov, F.M.^a, Pah, C.H.^b, Rosli, A.^c

Bijjective Class of Replicator Equations

(2024) *Mathematical Notes*, 116 (5), pp. 1072-1079.

DOI: 10.1134/S0001434624110191

^a Department of Mathematical Sciences, United Arab Emirates University, Abu Dhabi, Al Ain, 15551, United Arab Emirates

^b Department of Computational and Theoretical Sciences, International Islamic University Malaysia, Pahang, Kuantan, 25710, Malaysia

^c Department of Mathematical Sciences, Universiti Teknologi Malaysia, Johor, Johor Bahru, 81310, Malaysia

Abstract

Abstract: The Rock–Paper–Scissors game serves as a crucial toy model in understanding evolutionary dynamics, leading to the formulation of a replicator equation. This paper introduces a comprehensive and enduring category of replicator equations derived from expanding functions. It is established that such equations are bijections of the 2D simplex. The current investigation allows further exploration of inverse dynamical behavior of the replicator equations. © Pleiades Publishing, Ltd. 2024.

Author Keywords

bijection; evolutionary game; Lotka–Volterra operator; stochastic

Funding details

G00003447

Ministry of Higher Education, Malaysia MOHEFRGS/1/2021/STG06/UIAM/02/5

Funding details

The first author (F. M. Mukhamedov) thanks the UAEU UPAR grant no. G00003447 for support. Moreover, the authors would like to thank Ministry of Higher Education (MOHE) Fundamental Research Grant Scheme (FRGS) under the grant FRGS/1/2021/STG06/UIAM/02/5.

References

- Hofbauer, J., Sigmund, K.
(1998) *Evolutionary Games and Population Dynamics*, Cambridge, Cambridge University Press, 0914.90287
- Sandholm, W.H.
(2010) *Population Games and Evolutionary Dynamics*, Cambridge, MIT Press, 1208.91003
- Ganikhodjaev, N.N., Ganikhodjaev, R.N., Jamilov, U.U.
Quadratic stochastic operators and zero-sum game dynamics
(2015) *Ergodic Theory Dyn. Syst.*, 35 (5), pp. 1443-1473.
3365730, 1352.37026
- Jamilov, U., Mukhamedov, F.
A class of Lotka–Volterra operators with historical behavior
(2022) *Results Math*, 77 (4), pp. 1-15.
4447332, 1502.37009
- Mukhamedov, F., Embong, A.F., Rosli, A.
Orthogonal-preserving and surjective cubic stochastic operators
(2017) *Ann. Funct. Anal*, 8 (4), pp. 490-501.
3717171, 1489.47085
- Saburov, M.
The discrete-time Kolmogorov systems with historic behavior

- (2021) *Math. Methods Appl. Sci*, 44 (1), pp. 813-819.
4185284, 1470.92260
- Saburov, M.
Historic behavior in rock–paper–scissor dynamics
(2023) *Qualit. Theory Dyn. Syst*, 22 (3), pp. 1-20.
4603405, 1537.91039
 - Alishah, H.N., Duarte, P., Peixe, T.
Conservative and dissipative polymatrix replicators
(2015) *J. Dyn. Games*, 2 (2), pp. 157-185.
3436357, 1360.91028
 - Edelstein-Keshet, L.
(2005) *Mathematical Models in Biology*, 46.
Philadelphia, SIAM, 1100.92001
 - Hofbauer, J., Hutson, V., Jansen, W.
Coexistence for systems governed by difference equations of Lotka–Volterra type
(1987) *J. Math. Biol*, 25, pp. 553-570.
915090, 0638.92019
 - Jamilov, U.U., Scheutzow, M., Vorkastner, I.
A prey-predator model with three interacting species
(2023) *Dyn. Syst*, 38 (4), pp. 493-509.
4653856, 1530.37108
 - Lotka, A.J.
Undamped oscillations derived from the law of mass action
(1920) *J. Am. Chem. Soc*, 42 (8), pp. 1595-1599.
47.0706.04
 - Murray, J.D.
(2002) *Mathematical Biology. Vol. 1: An Introduction*, 17.
New York, Springer, 1006.92001
 - Basson, M., Fogarty, M.J.
Harvesting in discrete-time predator-prey systems
(1997) *Math. Biosci*, 141 (1), pp. 41-74.
0880.92034
 - Dohtani, A.
Occurrence of chaos in higher-dimensional discrete-time systems
(1992) *SIAM J. Appl. Math*, 52 (6), pp. 1707-1721.
1191358, 0774.93049
 - Fisher, M.E., Goh, B.S.
Stability in a class of discrete time models of interacting populations
(1977) *J. Math. Biol*, 4, pp. 265-274.
475985, 0381.92019
 - Goel, N.S., Maitra, S.C., Montroll, E.W.
On the volterra and other nonlinear models of interacting populations
(1971) *Rev. Mod. Phys*, 43, pp. 231-276.
484546, 1023.94539
 - Lu, Z., Wang, W.
Permanence and global attractivity for Lotka–Volterra difference systems
(1999) *J. Math. Biol*, 39 (3), p. 269.
1716315, 0945.92022

- Smith, J.M., Slatkin, M.
The stability of predator-prey systems
(1973) *Ecology*, 54 (2), pp. 384-391.
1302.92081
- Venkateswaran, V.R., Gokhale, C.S.
Evolutionary dynamics of complex multiple games
(2019) *Proc. R. Soc. B*, 286.
0931.41017
- Wen, T., Gao, Q., Kalmár-Nagy, T., Deng, Y., Cheon, K.H.
A review of predator-prey systems with dormancy of predators
(2022) *Nonlinear Dynamics*, 107, pp. 3271-3289.
1471.35234
- Takens, F.
Orbits with historic behavior, or nonexistence of averages
(2008) *Nonlinearity*, 21 (3), pp. 33-36.
2396607, 1147.37013
- Jamilov, U., Mukhamedov, F.
Takens' the last problem and Stein–Ulam spiral type maps
(2024) *Jour. Math. Anal. Appl*, 531.
Article ID 127813, 4653345, 1546.37093
- Mukhamedov, F., Pah, C.H., Rosli, A.
A class of bijective Lotka–Volterra operators and its application
(2023) *Math. Methods Appl. Sci*, 46 (8), pp. 9834-9845.
4589897, 1533.37176
- Mukhamedov, F., Saburov, M.
Stability and monotonicity of Lotka–Volterra type operators
(2017) *Qual. Theory Dyn. Syst*, 16 (2), pp. 249-267.
3671724, 1383.92072
- Mukhamedov, F., Khakimov, O., Embong, A.F.
Solvability of nonlinear integral equations and surjectivity of non-linear Markov operators
(2020) *Math. Methods Appl. Sci*, 43 (9), pp. 9102-9118.
4151394, 1452.45004
- Jamilov, U., Mukhamedov, F.
Historical behavior for a class of Lotka–Volterra systems
(2022) *Math. Methods Appl. Sci*, 45 (17), pp. 11380-11389.
4509882, 1534.37006
- Ruelle, D.
Historical behaviour in smooth dynamical systems
(2001) *Global Analysis of Dynamical Systems*, pp. 63-66.
Bristol, Institute of Physics Publishing, 1067.37501
- Labouriau, I.S., Rodrigues, A.A.P.
On Takens' last problem: tangencies and time averages near heteroclinic networks
(2017) *Nonlinearity*, 30 (5), pp. 1876-1910.
3639293, 1370.34073

Correspondence Address

Mukhamedov F.M.; Department of Mathematical Sciences, Abu Dhabi, United Arab Emirates; email: farrukh.m@uaeu.ac.ae

Publisher: Pleiades Publishing

ISSN: 00014346

Language of Original Document: English

Abbreviated Source Title: Math. Notes
2-s2.0-85218197486
Document Type: Article
Publication Stage: Final
Source: Scopus

ELSEVIER

Copyright © 2025 Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.

 **RELX Group™**