Delfim Fernando Marado Torres (Delfim F. M. Torres)

Subjects: Mathematics

Contributor: Delfim F. M. Torres

Portuguese Scientist | Mathematician | Biography

Basic Information

Name: Delfim Fernando Marado Torres (Delfim F. M. Torres) (Aug 1971–)

Birth Location:	Nampula, Mozambique
Titles:	Professor Mathematician Director of CIDMA Portuguese Scientist African Scientist
Affiliations:	American Mathematical Society University of Aveiro
Honors:	Web of Science Highly Cited Researcher (2015, 2016, 2017 and 2019) Lifetime Member of The American Mathematical Society Grunvald-Letnikov Award 325 Years of Fractional Calculus Award Yang-Hui Award

1. Brief Introduction

Professor Dr. Delfim F. M. Torres, D.Sc. (Habilitation) in Mathematics, Ph.D. in Mathematics, Web of Science Highly Cited Researcher (2015, 2016, 2017 and 2019). Full Professor of Mathematics (Professor Catedrático), Department of Mathematics, University of Aveiro, 3810-193 Aveiro, Portugal. Director of the R&D unit CIDMA (http://cidma.ua.pt). Coordinator of the Systems and Control Group (http://systems.cidma.ua.pt). Director of the Doctoral/PhD Programme in Applied Mathematics (MAP-PDMA). Lifetime Member of The American Mathematical Society.

2. Research Interests

Delfim F. M. Torres is a Full Professor of Mathematics at the Department of Mathematics of University of Aveiro (UA), Portugal, Director of the Center for Research and Development in Mathematics and Applications (R&D Unit CIDMA, http://cidma.ua.pt, with a Base Funding for 2020-2023 of 1185 KEuro plus a Programmatic Funding of 654 KEuro), Coordinator of its Systems and Control Group till 2022.

He obtained a B.Sc. in Computer Science Engineering from the University of Coimbra in 1994, a M.Sc. in Optimization and Control Theory from University of Aveiro (UA) in 1998, a Ph.D. in Mathematics from UA in 2002, and Habilitation in Mathematics, UA, in 2011. His main research area is calculus of variations and optimal control; optimization (MSC 49-XX), with emphasis on the regularity of solutions and necessary optimality conditions, fractional derivatives and integrals (MSC 26A33), dynamic equations on time scales or measure chains (MSC 34N05), and Mathematical Biology (MSC 92D30).

Delfim F. M. Torres has written more than 500 scientific and pedagogical publications, including research papers in first class international journals, refereed conference proceedings, chapters in books, and books (as an author and also as an editor). In particular, he has co-authored two books about the Fractional Calculus of Variations with Imperial College Press, 2012 and 2015, and 3 books with Springer on Quantum Variational Calculus, Advanced Methods in the Fractional Calculus of Variations, and on Variable-Order Fractional Calculus of Variations, respectively in 2014, 2015 and 2019, and more than 100 papers in international journals ranked in the 1st quartile by ISI Web of Science and Scopus.

He has a strong experience in graduate and post-graduate student supervision and teaching in mathematics, both in Portugal and abroad.

Moreover, he has been team leader and member in several national and international R&D projects, including EU projects and networks. He was (2011-2014) a Key Scientist of the European Marie Curie Project SADCO (Sensitivity Analysis for Deterministic Controller Design), Network for Initial Training, under the 7th Framework Programme FP7-PEOPLE-2010-ITN, grant agreement number 264735-SADCO.

3. Notable Contributions

Torres is a *Highly Cited Researcher*, having been awarded the title in 2015, 2016, 2017, and 2019 (https://recognition.webofsciencegroup.com/awards/highly-cited/2019/).

Professor Torres is, since 2013, the Director of the FCT Doctoral Programme Consortium in Mathematics and Applications (MAP-PDMA) of Universities of Minho, Aveiro, Porto.

Twenty six (26) Ph.D. students in Mathematics (https://genealogy.math.ndsu.nodak.edu/id.php?id=63039) and thirteen (13) post-docs have successfully finished under his supervision.

4. Personal Life

Delfim F. M. Torres has been married since 2003, and has 1 daughter and 2 sons.

5. Principal Work

Scientific and professional profile and career

Delfim F. M. Torres, a Portuguese Mathematician born in Mozambique in 1971, graduated with top honors in Computer Science from Univ. of Coimbra (UC) in 1994. During 93/94, he held a JNICT fellowship as a Junior Researcher at UC's Institute of Biomedical Research on Light and Image, collaborating with doctors from the Hospital of UC and a team of Engineers on retinal structures and lesions.

Torres secured a competitive Teaching Assistant position in Mathematics at Univ. of Aveiro (UA) in 1994 and completed his Master's in Optimization and Control Theory from UA's Dep. of Mathematics (DMat) in 1998. He was then promoted to Assistant Lecturer.

In 1999, Torres was awarded a PRODEP fellowship to pursue his PhD under Prof. A. Sarychev's guidance. He defended his PhD thesis in 2002, titled 'Regularity of Minimizers in the Calculus of Variations and Optimal Control', before being appointed Assistant Professor.

Torres' academic journey continued as he earned an international competitive position of Associate Professor at DMat in 2006. He obtained tenure in 2010 and assumed leadership of the Systems and Control Group, leading a research team with more than 20 members. In 2011, he obtained his DSc (Agregação) in Mathematics and, in 2013, became the Director of the PhD Program in Applied Mathematics of Univ. of Minho, Aveiro, and Porto.

In 2015, Torres earned an international competitive position of Full Professor of Mathematics at UA and, from 2018 onwards, he has served as the Director of CIDMA - the largest Mathematics R&D Center in Portugal, with more than 200 researchers. His primary research interests include calculus of variations, optimal control, optimization, fractional operators, dynamic equations, and BioMath.

Torres has extensive supervision experience, with 26 PhD theses completed under his guidance. Since 2019, he has been a Member of the Advisory Board of Commun. Nonlinear Sci. Numer. Simulat. and, as of 2022, a Member of the Doctoral School Advisory Council of UA.

Contributions to science and society

Contributions to the generation of new ideas, tools, methodologies or knowledge

Torres' initial contributions in the Calculus of Variations (CV) and Optimal Control (OC) involved a novel approach to Lipschitz regularity of minimizing trajectories. He achieved this by generalizing the classical Noether's symmetry

theorem to OC problems, extending the concept of invariance. His findings establish a relationship between the quasi-symmetries of problems and the conservation laws for Pontryagin extremals. Using these conservation laws, Torres obtained the first results in the literature concerning the Lipschitz regularity of minimizing trajectories for OC problems with nonlinear dynamics. Even for problems with linear dynamics, such as those in the CV, his results were groundbreaking, see e.g [1][2][3].

Since 2006, Torres has been developing the theory of CV and OC with his students to better explain and predict the behavior of nature in 2 different directions: through fractional calculus (FC) and through time scales (TS).

In 1931, Bauer proved the impossibility of deriving a single linear dissipative equation of motion with constant coefficients using Variational Principles (VP). Bauer's theorem underscores the commonly held belief that there is no direct approach to applying VP to nonconservative systems, which involve friction or other dissipative processes. FC offers an elegant solution to this challenge. While Bauer's theorem is based on the assumption that all derivatives are of integer order, constructing a Lagrangian using fractional derivatives allows for nonconservative equations of motion. The first nonconservative Noether's theorems in the CV and OC via FC were obtained in Aveiro, see [4][5].

Existence of solutions to the Fractional CV (FCV) were also obtained by Torres and two other PhD students, by introducing suitable space of functions and general assumptions of regularity, coercivity, and convexity, see [6].

The four celebrated books on FCV were all written in Aveiro: see [7][8][9][10].

Torres' work is also the first to show that for any variational symmetry of the problem of the CV on TS, there exists a conserved quantity along the respective Euler-Lagrange extremals: see [11].

Both theories of fractional differential equations and dynamic equations on TS received intensive independent research. The question of integrating the two subjects was first raised by Torres. The pioneering work is that of [12] [13]. This work is part of Bastos' PhD thesis, defended in Aveiro in 2012. After the pioneer work of Torres and his two PhD students, the study of fractional calculus on TS developed in a popular research subject. It should be mentioned that the new theory is relevant on real applications, e.g. in the study of calcium ion channels that are retarded with injection of calcium-chelator Ethylene Glycol Tetraacetic Acid; in the investigation of nonlocal thermally sensitive resistors on arbitrary TS; or to obtain symmetries of Birkhoffian systems.

Torres has received several awards in recognition of his contributions to knowledge generation. We mention here the Grunvald-Letnikov Award, cf. [14], and the Yang-Hui Award attributed in 2023 by the Long Shan Mathematical Foundation, as international recognition for his outstanding works throughout his career in Mathematics, particularly for his seminal contributions to the mathematical modeling of COVID-19 and optimal control, see e.g. [15][16].

Contributions to the training and career development of researchers and/or research teams

From 2005 to 2006, Torres assumed responsibility for the projects "Impedance Change and the Calculus of Variations" and "Analytical Solutions to Magnetohydrodynamical Control Problems on a Flow of Conducting Fluid" as part of the Multi-partner Marie Curie Training Site known as the "Control Training Site". The two PhD students trained by Torres at UA under these projects are currently Assistant Professors at Riga Technical University.

From 2008 to 2010, Torres supervised Dr. Agnieszka Malinowska, who worked with him on the project "Multiobjective optimal control problems and related issues" funded by a Polish fellowship. Dr. Malinowska currently holds the position of Full Professor and Managing Director at Bialystok University of Technology.

From 2011 to 2014, Torres served as a Key Scientist in the European SADCO (Sensitivity Analysis for Deterministic Controller Design) Project, funded under the Marie Curie Action “Networks for Initial Training”.

From 2013 to 2017, Torres served as a member of the Program Committee and as an Associate Editor (Full Papers) for The SIAM Conference on Control and Its Applications held in San Diego, Paris, and Pittsburgh.

In 2019, Torres founded the BioMath Thematic Line, which currently comprises 20 members from four different Research Groups of CIDMA.

From 2020 to 2023, as Director and Scientific Leader of CIDMA, Torres managed a Base Funding of 1185 KEuro along with Programmatic Funding of 654 KEuro.

Over the years, Torres has successfully supervised 15 Master's students, 26 PhD students, and 13 Post-docs. His former PhD students now hold positions in various countries, including Gastão Frederico at UFC; Cristiana Silva at Iscte; Tatiana Odzijewicz at SGH Warsaw School of Economics; and Shakoor Pooseh at University of Freiburg. Additionally, Torres acted as the Host PhD Advisor for 14 PhD students who joined him at UA based on recommendations from their supervisors. These students received funding from their respective countries.

Contributions to the scientific community

Torres has served as an Editor and Guest Editor for several journals, including Commun. Nonlinear Sci. Numer. Simul., Discrete Contin. Dyn. Syst., and Eur. J. Control. He has also been an Editor for conferences such as the SIAM Conference on Control and Its Applications and Progress on Difference Equations. Furthermore, Torres has served as an Editor for books published by Springer, Academic Press, and Chapman & Hall.

Torres served as a reviewer for numerous MSc and PhD theses, both nationally and internationally, as well as for MathSciNet and zbMATH databases and research project proposals, e.g. in the Calculus of Variations at the University of Padova in 2012. In recognition of his contributions to peer review, Torres received a Sentinel of Science Award in 2016, placing him in the top 10% of researchers in Mathematics. He also received a Publons Peer Review Award in 2017, ranking him as the world's top peer reviewer, placing him in the top 1%. Additionally, from 2013 to 2014, Torres served as a Member of the FCT Evaluation Panel (Mathematics) for applications to PhD and post-doc fellowships.

Over the years, Torres has chaired and been a member of the organizing committee for over 30 conferences and workshops. He has also organized special/invited sessions, mini-courses, thematic sessions and contests.

Ten female mathematicians completed their PhD theses under Professor Torres' supervision. The IMAME'2024 conference in Morocco recognizes his significant contributions to Africa.[17]

Contributions to society

Torres has made significant societal contributions, enhancing public engagement and knowledge transfer across various sectors. Some highlights include:

- National radio interviews, such as on the CLICK Program of Antena 1, where his research on dengue was discussed.
- Coverage in national newspapers, including features in Jornal de Notícias and Expresso, where Torres presented his innovative mathematical models addressing societal issues like unemployment.
- Recognition in national magazines, with features on his work in combating infections like HIV/Tuberculosis.
- International exposure through news from foreign universities, e.g. showcasing Torres' contributions to mathematical modeling in addressing global health challenges, University of Vigo, Spain, regarding COVID-19.
- TV appearances, both nationally and internationally, e.g. Torres was featured on TVI 24 and interviewed multiple times on Cape Verde television, showcasing his dedication to promoting mathematics education and research.
- Invitations to give talks in secondary schools, both domestically and internationally, reflecting his commitment to education and public outreach.
- A European patent titled "Control method for trajectory tracking of a dynamic system and respective device" was deposited on January 5, 2024, with Torres' as one of the inventors.

Torres' impact extends beyond academia, as evidenced by his diverse engagements to address pressing societal issues through innovative research and public initiatives.

Scientific production and/or selected activities (2018-2023)

From 2018 to 2023, Torres co-authored 159 publications with 157 colleagues from 30 different countries across Asia, Africa, North America, South America, Europe, and Australia. His 5 main research areas during this period are:

1. Biology and other natural sciences (MSC 92), where main contributions lie in Epidemiology, Population dynamics, Pest management, and Medical applications.
2. Calculus of variations and optimal control; optimization (MSC 49), where Torres advanced knowledge on Optimality conditions, Existence theories, and various other miscellaneous topics.
3. Real functions (MSC 26), with important contributions on Inequalities, Fractional derivatives and integrals, Real analysis on time scales, and Integrals of Riemann, Stieltjes, and Lebesgue type.

4. Ordinary differential equations (MSC 34), where he had an impact on Stability theory, Fractional ODEs, Functional-differential equations, and their Qualitative theory.
5. Numerical analysis (MSC 65), with relevant results in Finite difference and finite volume methods for ODEs, and Numerical methods for integral equations and time-dependent initial/boundary value problems.

One article for each of these 5 areas is: [18], where Torres' main role was the idea on how to obtain the exact solution to a SIR model on arbitrary time scales; [19], where Torres' main role was the optimal impulse control of SIR epidemics; [20] (sole author); [21], where Torres' main role was the study of psi-Riemann-Liouville fractional integrals with respect to a function psi on time scales; [22], where Torres' main role was on the approximation errors.

Further Reading

https://arxiv.org/a/torres_d_1.html https://orcid.org/0000-0001-8641-2505 https://zbmath.org/authors/?q=ai:torres.delfim-f-m https://www.genealogy.math.ndsu.nodak.edu/id.php?id=63039 http://www.ams.org/mathscinet/MRAuthorID/657307 https://www.mdpi.com/journal/axioms/special_issues/delfim https://www.mdpi.com/books/book/7382 https://www.wikidata.org/wiki/Q56810031 https://africanscientists.africa/business-directory/torres/

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