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DJAHOU NORBERT TOGNON

Born 06.06.1995, in Dangbo (Bénin).

Education

07.2025–	Post-doctoral position - Applied mathematics. Machine learning and numerical methods for PDEs for the modeling of irrigation channels. under the supervision of Magali Ribot and Bruno Galerne. *Université d'Orléans, Institut Dénis Pooisson (IDP), Orléans, France*.
04.2022– 06.2025	Ph.D. Thesis - Applied mathematics. "Time parallelization and machine learning for optimal control and inverse problems". under the supervision of Julien Salomon. *INRIA Paris (EPI ANGE) and Sorbonne Université (Laboratoire Jacques-Louis Lions), Paris, France*.
01.2021–03.2022	Internship. - Applied mathematics, "ParaOpt algorithm for unstable systems". under the supervision of Julien Salomon. *Institut de Mathématiques et Sciences Physiques (IMSP) Dangbo, Bénin, and INRIA Paris, Paris, France,*.
2018–2020	Master D. - Applied mathematics, "Numerical analysis". under the supervision of Sidi Kaber *Institut de Mathématiques et Sciences Physiques (IMSP) Dangbo, Bénin*.
2017–2018	High school teaching durty - Mathematics. *Cours du soutien scolaire, Cotonou, Bénin*.
2017	Bach. D. - Mathematics and Computing. *Faculté des sciences et techinques, Université d'Abomey-Calavi, Abomey-Calavi, Bénin*.x

Peer reviewed articles

[1] "Convergence of ParaOpt for general Runge-Kutta time discretizations ",
F. Kwok, J. Salomon, D. N. Tognon, **under reviewing in SIAM.**

[2] " ParaOpt for unstable system ",
D. N. Tognon, **under reviewing in ESIAM.**

Workshop proceedings

[1] "A Dynamical Neural Galerkin Scheme for Filtering Problems ",
J. Aghili, J. Atokple, M. Billaud-Friess, G. Garnier, O. Mula, D. Tognon
ESAIM : Proceedings and Surveys,pp. 2-15 June (2025).

[2] "Quantum Approach for Electrical System Maintenance Scheduling problem ",
Q. Zhou, D. Tognon, N. Henka, S. Tazi, F. Hafid, S. Chalal, C. Titouan
preprint (2025).

Conference peer reviewed Proceedings

[1] " A Parallel in Time Algorithm Based on ParaExp for Optimal Control Problems ",
F.. Kwok, D. Tognon,
2024 IEEE 63rd Conference on Decision and Control (CDC), pp. 6685-6690, Milano, Dec 2024.

Thesis

"Time parallelization and machine learning for optimal control and inverse problems",
PhD of Sorbonne Université defended June 30, 2025.

Summary Time-parallel algorithms (PinT) such as Parareal, ParaExp, etc., are well known in the literature for their ability to exploit the parallel architecture of today's computers to solve initial value porblem. Recently, ParaOpt, an algorithm based on the principles of the Parareal algorithm, has made it possible to parallelize the solution of optimality systems. A first analysis of the convergence of this algorithm was presented in [M.J. Gander, F. Kwok and J. Salomon, SIAM J. Sci. Comput.,42 (2020), A2773-A2802] in the restricted case of the implicit Euler method for linear quadratic optimal control problems (LQOCP) involving dissipative systems. In this thesis, we first present a convergence analysis when the system under study is unstable. Secondly, we focus on the influence of the solver used for time resolution on convergence, considering the more general case of LQOCP discretization by Runge-Kutta methods. We show that the convergence rate of ParaOpt has the same order as the Runge-Kutta time integration method used, provided that the Runge-Kutta method satisfies some additional order conditions. We then consider a preconditioning problem, for which we introduce a new PinT algorithm, this time based on the ParaExp algorithm, for LQOCP solving. Our approach is based on an overlapping time-interval decomposition in which we combine the solution of homogeneous subproblems of optimality systems using exponential propagation with local solutions of inhomogeneous subproblems. The formulation leads to a linear system whose matrix-vector product can be fully computed in parallel. We then propose two preconditioners to accelerate the convergence of GMRES in the special cases of heat and wave equations. In a final independent chapter, we analyze a learning-based model correction method. The approach studied follows the principles of Aphynity [Yuan Yin et al J. Stat. Mech. (2021) 124012], a method consisting of introducing a corrective term in the form of a neural network into the PDE under consideration. Learning is then performed in the outer loop of the solver used, so that training takes place indirectly through a time scheme. We study the influence of the solver on the resulting network, and show in particular that the order of approximation of the corrected model is equal to the order of the scheme used. Finally, we show how a Richardson-type acceleration strategy can speed up convergence by considering two smaller, independently trained networks with different time steps.

Keywords Time parallelization, optimal control, Preconditioning, Unstable systems, Runge-Kutta methods, Machine learning, Aphynity.

Funding

2022-2026, A.N.R DEEP-NUM	Deep Learning et Modélisation Numérique, (P.I.).
09-12. 2023 Mitacs IT34057	Time Parallel Algorithms for Optimal Control with PDE constraints.

International conferences

Prague, 25-29.07.22	”ParaOpt algorithm for solving unstable syste.”, *27-th International Conference on Domain Decomposition Methods, Prague, Czech Republic.*
C.Mountain, 16-20.04.23	”Paraopt algorithm and Runge-Kutta methods”, *21-st Copper Mountain Conference On Multigrid Methods, Copper Mountain, Colorado, USA*
Milan, 16-19.12.24	”A parallel in time algorithm based on ParaExp for optimal control problems”, *2024 IEEE 63rd Conference on Decision and Control (CDC 2024), Dec 2024, Milan , Italy.*
Milan, 23-27.06.25	”A Parallel in Time Algorithm Based on ParaExp for optimality systems.”, *29-th International Conference on Domain Decomposition Methods, Milan, Italy*

National conferences

Canum, 13-17.06.2022	”45 em Congrès National d’Analyse Numérique ” *EVian-les-bains, France .*
Canum, 27-31.05.2024.	” 46 em Congrès National d’Analyse Numérique” *Le Bois-plage-en-Ré Île-de-Ré, France.*

Seminars

Grenoble, 18.12.25	” Time parallelization and machine learning for optimal control and inverse problems”. *Laboratoire Jean Kuntzmann, Université Grenoble Alpes, France.*
Nantes, 16.12.25	” Time parallelization and machine learning for optimal control and inverse problems”. *Laboratoire Jean Leray, Nantes Université, France .*
Marseille 22.08.2025	”Quantum approach for electrical system maintenance scheduling problem”. *CEMRACS seminar, CIRM.*
Orléans 22.04.2025	”Data-driven Reconstruction of Dynamic Systems via Machine Learning.”. *GdT Machine Learning, Institut Dénis Poisson, Université Orléans, France.*
Hamburg 08.01.2024	”A scalar inverse problem with Neural Galerkin Scheme (NGS)”. *Seminar Parallel in time Team, Hamburg University of Technology, Germany.*
Québec 10.11.2023	”Two time Parallel algorithms for solving optimality systems”. *Seminar of CIMMUL at Université Laval, Canada.*
Paris 06.12.2022	”Parallel-in-time methods and Paraopt for unstable system ”. *Rencontres des jeunes chercheurs africains en France Cinquième Édition, Institut Henry Poincaré, France.*

Workshops, summer schools and research stay

Marseille, 07-08.2025	CEMRACS 2025, *Quantum computing for scientific computing and cryptography.*
Québec , 09-12.2023	Mitacs Globalink and INRIA research stay, *Parallel in time algorithm for optimal control problem constrained by hyperbolic equation.*
Marseille, 07-08.2023	CEMRACS 2023, *Scientific Machine Learning.*
Marseille, 05-09.09.2022	Domain Decomposition for Optimal Control Problems.
Nantes, 16-20.05.2022	Approximation en grande dimension et apprentissage profond.

Teaching activities (french)

Bachelor 3	Travaux dirigés — Cours d'équation différentiel (36H), *2024-2025, Sorbonne Université, Paris France*
Bachelor 2	Travaux pratiques — Cours de python pour les mathématiques (32H) , *2023-2024, Sorbonne Université, Paris France*
Bachelor 2	Travaux dirigés — Cours de probabilité (10H), *2023-2024, Polytechnique Sorbonne, Paris France*
High school	Cours de mathématiques — Première C (196H), *2018 Cours du soutien scolaire, Cotonou, Bénin* — Première B (84H), *2017, Cours du soutien scolaire, Cotonou, Bénin*
Secondary School	Cours de mathématiques — Troisième (168H), *2018, Collège d'enseignement général de Yagbé, Cotonou, Bénin* — Quatrième (140H), *2017, Cours du soutien scolaire, Cotonou, Bénin*