Somdatta Goswami

Latrobe Hall,
Department of Civil and Systems Engineering,
Johns Hopkins University, Baltimore,
MD 21210, U.S.A.
✉ *somdatta_goswami@brown.edu*

Experience

2024, Jan – Present **Assistant Professor**, *Department of Civil and Systems Engineering, Johns Hopkins University, U.S.A.*

2022, Aug – 2023, Dec **Assistant Professor (Research)**, *Division of Applied Mathematics, Brown University, U.S.A.*

2021, Jan – 2022, July **Postdoctoral Research Associate**, *Division of Applied Mathematics, Brown University, U.S.A.*
Advisor: Dr. George Em Karniadakis
Field of research: Deep learning, Physics driven machine learning for mechanics.

2013 – 2017 **Assistant Manager**, *Tata Consulting Engineers Limited.*

Education

2017–2020 **Ph.D. in Civil Engineering**, *Bauhaus University-Weimar*, Germany.
Dissertation : Phase field modeling of fracture with isogeometric analysis and machine learning methods.
Advisor: Dr. Timon Rabczuk
Grade : Magna cum laude

2011–2013 **Master of Engineering, Structural Engineering**, *Indian Institute of Engineering Science & Technology*, Shibpur.
Thesis : Efficient Response Surface method in structural reliability analysis.
Advisor: Dr. Subrata Chakraborty
Score : 87.89%

2007–2011 **Bachelor of Engineering, Civil Engineering**, *Birla Institute of Technology*, Ranchi, India.
Thesis : Neural Model to determine the Pollution Level of Birla Institute of Technology.
Advisor: Dr. Bindhu Lal
CGPA : 8.32/10

Publications

List : **Google Scholar**.
ORCiD – 0000-0002-8255-9080.
Codes : All the codes are available on Github.
***** Contributed equally.

Communicated Journal Articles

2023 Katarzyna Michałowska, **Somdatta Goswami**, George Em Karniadakis, and Signe Riemer-Sørensen. Neural Operator Learning for Long-Time Integration in Dynamical Systems with Recurrent Neural Networks. *Preprint: arXiv:2303.02243*, 2023.

2023 Katarzyna Michałowska, **Somdatta Goswami**, George Em Karniadakis, and Signe Riemer-Sørensen. DON-LSTM: Multi-Resolution Learning with DeepONets and Long Short-Term Memory Neural Networks. *arXiv preprint arXiv:2310.02491*, 2023.

2023 Katiana Kontolati, **Somdatta Goswami**, George Em Karniadakis, and Michael D. Shields. Learning in latent spaces improves the predictive accuracy of deep neural operators. *Preprint: arXiv:2304.07599*, 2023.

2023 Qianying Cao, **Somdatta Goswami**, and George Em Karniadakis. LNO: Laplace Neural Operator for Solving Differential Equations. *Preprint: arXiv:2303.10528*, 2023.

2023 Nikolas Borrel-Jensen, **Somdatta Goswami**, Allan P Engsig-Karup, George Em Karniadakis, and Cheol-Ho Jeong. Sound propagation in realistic interactive 3d scenes with parameterized sources using deep neural operators. *arXiv preprint arXiv:2308.05141*, 2023.

2022 Ayan Chakraborty, Cosmin Anitescu, **Somdatta Goswami**, Xiaoying Zhuang, and Timon Rabczuk. Variational energy based XPINNs for phase field analysis in brittle fracture. *Preprint: arXiv:2207.02307*, 2022.

Book Chapter

2023 **Somdatta Goswami**, Aniruddha Bora, Yue Yu, and George Em Karniadakis. Physics-Informed Deep Neural Operator Networks. In Timon Rabczuk and Klaus-Jürgen Bathe, editors, *Machine Learning in Modeling and Simulation. Computational Methods in Engineering & the Sciences*. Springer International Publishing, 2023.

Journal Articles

2024 **Somdatta Goswami***, Ameya D Jagtap*, Hessam Babaee, Bryan T Susi, and George Em Karniadakis. Learning stiff chemical kinetics using extended deep neural operators. *Computer Methods in Applied Mechanics and Engineering*, volume 419, page 116674. Elsevier, 2024.

2024 Qianying Cao, **Somdatta Goswami**, Tapas Tripura, Souvik Chakraborty, and George Em Karniadakis. Deep neural operators can predict the real-time response of floating offshore structures under irregular waves. *Computers & Structures*, volume 291, page 107228. Elsevier, 2024.

2023 Maria Luisa Taccari, He Wang, **Somdatta Goswami**, Mario De Florio, Jonathan Nuttall, Xiaohui Chen, and Peter K Jimack. Developing a cost-effective emulator for groundwater flow modeling using deep neural operators. *Journal of Hydrology*, page 130551. Elsevier, 2023.

2023 Varun Kumar, **Somdatta Goswami**, Daniel Smith, and George Em Karniadakis. Real-time prediction of gas flow dynamics in diesel engines using a deep neural operator framework. *Applied Intelligence*, pages 1–21. Springer, 2023.

2023 Katiana Kontolati*, **Somdatta Goswami***, Michael D. Shields, and George Em Karniadakis. On the influence of over-parameterization in manifold based surrogates and deep neural operators. *Journal of Computational Physics*, page 112008, 2023.

2023 Adar Kahana, Enrui Zhang, **Somdatta Goswami**, George Karniadakis, Rishikesh Ranade, and Jay Pathak. On the geometry transferability of the hybrid iterative numerical solver for differential equations. *Computational Mechanics*, pages 1–14. Springer, 2023.

2022 **Somdatta Goswami**, Minglang Yin, Yue Yu, and George Em Karniadakis. A physics-informed variational DeepONet for predicting crack path in quasi-brittle materials. *Computer Methods in Applied Mechanics and Engineering*, volume 391, page 114587. Elsevier, 2022.

2022 **Somdatta Goswami***, David S Li*, Bruno V Rego, Marcos Latorre, Jay D Humphrey, and George Em Karniadakis. Neural operator learning of heterogeneous mechanobiological insults contributing to aortic aneurysms. *Journal of The Royal Society Interface*, volume 19, page 20220410, 2022.

2022 **Somdatta Goswami***, Katiana Kontolati*, Michael D Shields, and George Em Karniadakis. Deep transfer operator learning for partial differential equations under conditional shift. *Nature Machine Intelligence*, pages 1–10. Nature Publishing Group, 2022.

2022 Vivek Oommen, Khemraj Shukla, **Somdatta Goswami**, Remi Dingreville, and George Em Karniadakis. Learning two-phase microstructure evolution using neural operators and autoencoder architectures. *npj Computational Materials*, volume 8, 2022.

2022 Lu Lu, Xuhui Meng, Shengze Cai, Zhiping Mao, **Somdatta Goswami**, Zhongqiang Zhang, and George Em Karniadakis. A comprehensive and fair comparison of two neural operators (with practical extensions) based on FAIR data. *Computer Methods in Applied Mechanics and Engineering*, volume 393, page 114778. Elsevier, 2022.

2022 Ritukesh Bharali, **Somdatta Goswami**, Cosmin Anitescu, and Timon Rabczuk. A robust monolithic solver for phase-field fracture integrated with fracture energy based arc-length method and under-relaxation. *Computer Methods in Applied Mechanics and Engineering*, volume 394, page 114587. Elsevier, 2022.

2021 Tanmoy Chatterjee, Souvik Chakraborty, **Somdatta Goswami**, Sondipon Adhikari, and Michael I Friswell. Robust topological designs for extreme metamaterial micro-structures. *Scientific Reports*, volume 11, pages 1–14. Nature Publishing Group, 2021.

2020 **Somdatta Goswami**, Cosmin Anitescu, and Timon Rabczuk. Adaptive fourth-order phase field analysis using deep energy minimization. *Theoretical and Applied Fracture Mechanics*, page 102527. Elsevier, 2020.

2020 **Somdatta Goswami**, Cosmin Anitescu, and Timon Rabczuk. Adaptive fourth-order phase field analysis for brittle fracture. *Computer Methods in Applied Mechanics and Engineering*, volume 361, page 112808. Elsevier, 2020.

2020 **Somdatta Goswami**, Cosmin Anitescu, Souvik Chakraborty, and Timon Rabczuk. Transfer learning enhanced physics informed neural network for phase-field modeling of fracture. *Theoretical and Applied Fracture Mechanics*, volume 106, page 102447. Elsevier, 2020.

2020 E Samaniego, C Anitescu, **Somdatta Goswami**, VM Nguyen-Thanh, H Guo, K Hamdia, X Zhuang, and T Rabczuk. An energy approach to the solution of partial differential equations in computational mechanics via machine learning: Concepts, implementation and applications. *Computer Methods in Applied Mechanics and Engineering*, volume 362, page 112790. Elsevier, 2020.

2019 **Somdatta Goswami***, Souvik Chakraborty*, Rajib Chowdhury, and Timon Rabczuk. Threshold shift method for reliability-based design optimization. *Structural and Multidisciplinary Optimization*, volume 60, pages 2053–2072. Springer, 2019.

2019 **Somdatta Goswami**, Cosmin Anitescu, and Timon Rabczuk. Adaptive phase field analysis with dual hierarchical meshes for brittle fracture. *Engineering Fracture Mechanics*, volume 218, page 106608. Elsevier, 2019.

2019 Souvik Chakraborty*, **Somdatta Goswami***, and Timon Rabczuk. A surrogate assisted adaptive framework for robust topology optimization. *Computer Methods in Applied Mechanics and Engineering*, volume 346, pages 63–84. Elsevier, 2019.

2016 **Somdatta Goswami**, Shyamal Ghosh, and Subrata Chakraborty. Reliability analysis of structures by iterative improved response surface method. *Structural Safety*, volume 60, pages 56–66. Elsevier, 2016.

In Conference Proceedings

2019 Ranjan Mukherjee, Sushant Kumar Meinia, **Somdatta Goswami**, and Gita Negi. Objective evaluation of poor veins using image processing technique: An outcome analysis. In *Scientific Session – Finding Solutions for Donor Problems. The 30th regional congress of the International Society of Blood Transfusion*, pages 10–11. 2019.

2014 **Somdatta Goswami** and Subrata Chakraborty. Adaptive response surface method based efficient monte carlo simulation. In *Vulnerability, Uncertainty, and Risk: Quantification, Mitigation, and Management*, pages 2043–2052. 2014.

2013 **Somdatta Goswami**, Subrata Chakraborty, and S Ghosh. Adaptive response surface method in structural response approximation under uncertainty. In *International Conference on Structural Engineering and Mechanics*, pages 194–202. 2013.

Talks and Presentations

Invited talks

August 2023 ***Argonne Training Program on Extreme-Scale Computing (ATPESC)***.
Title: Transfer and Multi-Task Learning in Physics-Based Applications with Deep Neural Operators.

July 2023 ***SAMVAAD, Bosch Global Software Technologies Private Limited***.
Title: Employing machine learning approaches to solve PDEs in "Mechanics" within big-data regime.

May 2023 ***One World Seminar Series on the Mathematics of Machine Learning***.
Title: Transfer Learning in Physics-Based Applications with Deep Neural Operators (**Link**).

Mar 2023 ***USACM Technical Thrust Area***, *Seminar on UQ and Probabilistic Modeling*.
Title: Integration of Numerical Modeling and Machine Learning in Mechanics (**Link**).

Dec 2022 ***Penn State University-Purdue University-University of Maryland***, *Joint Seminar on Mathematical Data Science*.
Title: Transfer Learning in Deep Neural Operators.

Nov 2022 ***Vanderbilt University***, *Emerging Scholars Seminar*.
Title: Scientific machine learning: Research at the Intersection of Mathematics, Computing, and Data.

Oct 2022 ***The University of Texas at El Paso***, *Advanced Modeling and Simulations Seminar Series*.
Title: At the crossroads of Numerical Modeling & Machine Learning for Mechanics.

Aug 2022 ***Los Alamos National Laboratory***.
Title: Scientific machine learning: Bridging physical models and observational data.

Dec 2021 ***NASA Langley Research Center***.
Title: Physics informed deep learning methods for brittle fracture.

Nov 2021 ***George Washington University***.
Title: Physics informed deep learning methods: a solution to bridge data gap in computational mechanics.

May 2020 ***Brown University***.
Title: Phase field modeling of fracture with isogeometric analysis and machine learning methods.

Conference Presentations

October 2023 ***Advances in Computational Mechanics***.
Title: Efficient Emulation of Stiff Chemical Kinetics: A Cost-Effective Approach.

July 2023 ***17th U. S. National Congress on Computational Mechanics (USNCCM17)***.
Title: An Operator Learning Approach for Brittle Fracture Analysis.

June 2023 ***Platform for Advanced Scientific Computing (PASC)***.
Title: Neural operators for detecting aortic aneurysm contributors.

June 2023 ***Mathematical and Scientific Machine Learning***, ***ICERM***.
Title: Transfer learning in deep operator networks (Link).

Apr 2023 ***Copper Mountain Conference on Iterative and Multigrid Methods***.
Title: On the Geometry Transferability of the Hybrid Iterative Numerical Solver for Differential Equations.

Apr 2023 ***USACM Workshop***, *Establishing Benchmarks for Data-Driven Modeling of Physical Systems*.
Title: Solving Partial Differential Equations with Machine Learning.

March 2023 ***Brown American Physician Scientist Association Research Conference***.
Title: Deep learning based automatic vein selection to improve phlebotomy outcomes in blood donors. Featured in Brown Daily Newspaper (Link).

Apr 2022 ***Society for Industrial and Applied Mathematics – UQ22***.
Title: An Efficient Multiscale Surrogate for Brittle Fracture Analysis.

Dec 2018 ***Structural Engineering Convention 2018***.
Title: An efficient framework for fracture analysis of brittle materials.

Dec 2018 ***Structural Engineering Convention 2018***.
Title: Topology optimization under uncertainty.

July 2014 ***Second International Conference on Vulnerability and Risk Analysis and Management (ICVRAM)***.
Title: Adaptive Response Surface Method based Efficient Monte Carlo Simulation.

Dec 2013 ***International Conference on Structural Engineering and Mechanics (ICSEM-2013)***.
Title: Adaptive Response Surface Method in Structural Response Approximation under Uncertainty.

Achievements & Recognitions

Grants

2023-2027 **U.S. Department of Energy Office of Science**,
Awarded as a co-PI. Amount = $\$4.8$M.
Title: Physics and Uncertainty Informed Latent Operator Learning.

2023-2024 **Small Business Innovation Research Fund from Defense Threat Reduction Agency, USA**,
Awarded as a co-PI. Amount = $\$1.1$M.
Title: Numerics-Informed Neural Networks (Phase II).

2023-2024 **Seed grant under Data Science Initiative, Brown University**,
Awarded as a PI. Amount = $\$18{,}850$.
Title: Advancing Nucleic Acid Electrophoretic Mobility Models through Scientific Machine Learning: Implications for Quality Control in RNA-Based Therapies

2023 **Brown University funding for Summer Projects for Research, Internships, and Teaching** ,
Awarded as a PI. Amount =$\$2{,}500$.
Title: Generalizing AI for Partial Differential Equations: A Path towards AGI

Computational Grants

2022–2023 **U.S. Department of Energy for ASCR Leadership Computing Challenge (ALCC) award**, Awarded 150,000 Node Hours.
Title: A Multiscale Surrogate Model for Fracture Evolution using DeepONet.

2022 **ALCF Director's Discretionary Startup Allocation Grant for developing and scaling multi-scale fracture codes**.
RITM0208173: Multi-scale fracture using DeepONet.

2021 - 2022 **XSEDE startup grant for developing multi-scale codes, Texas Advanced Computing Center (TACC)**.
CIS210111: Surrogate modeling for multiscale fracture analysis using DeepONets.

Awards

2022 Selected for the Argonne Training Program on Extreme-Scale Computing (**ATPESC 2022**).

2021 **INSPIRE Faculty Fellowship,** Department of Science and Technology, India.

2021 **Postdoctoral Research Associate Funding,** Division of Applied Mathematics, Brown University, USA.

2018 **Best Paper Award** in the Reliability and Optimization category at the Structural Engineering Convention 2018, Kolkata, India.

2017 **DAAD Fellowship** for pursuing Ph.D. at Bauhaus University Weimar, Germany.

2011 **MHRD scholarship** for pursuing Master's degree at Indian Institute of Engineering Sciences and Technology, Shibpur, India.

Students

Current

Ph.D. : Varun Kumar, ***School of Engineering, Brown University.***.

Postdocs : Qianying Cao, ***Division of Applied Mathematics, Brown University.***.

Visitors : Nikolas Borrel-Jensen, ***Ph.D. at Technical University of Denmark, Denmark***.

Katarzyna Michalowska, ***Ph.D. at University of Oslo, Norway***.

Past

Masters : Yuchen Xin, ***Thesis in the School of Engineering, Brown University.***.

UG : Anvita Bhagavathula, Maxim Beekenkamp, Philip LaDuca.
Final year project in School of Engineering (Computer Engineering), Brown University.

Professional Service

2022–2023 Mentoring **female doctoral candidates and postdocs (WISA+)** at Bauhaus University-Weimar.

Minisymposia organizer GACM Colloquium on Computational Mechanics (2022), SIAM Conference on Computational Science and Engineering (2023), U.S. National Congress Conference on Computational Mechanics (2023), MMDLE-CSET (2023).

Journal Reviewer Computer Methods in Applied Mechanics and Engineering, International Journal of Rock Mechanics and Mining Sciences, Engineering with Computers, Defence Technology, International Journal of Impact Engineering, Reliability Engineering and System Safety, International Journal of Computational Methods, Frontiers of Structural and Civil Engineering, Energies, Sadhana, Computer and Mathematics with Applications, Scientific Reports, Engineering Fracture Mechanics, ICML-AI4Science, MTI, Applied Sciences..

Referees

Dr. George Em Karniadakis
Professor
Applied Mathematics Department
Brown University, U.S.A.
george_karniadakis@brown.edu

Dr. Timon Rabczuk
Professor
Civil Engineering Department
Bauhaus University-Weimar,
Germany.
timon.rabczuk@uni-weimar.de

Dr. Jay D. Humphrey
Professor
Biomedical Engineering
Yale School of Engineering & Applied Science,
U.S.A.
jay.humphrey@yale.edu