Christopher V. **Rackauckas**

MATHEMATICIAN · SOFTWARE ENGINEER · PHARMACOLOGIST

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Research focus: How can the randomness from scientific data be used to uncover the underlying mechanistic structure?

Summary

Applied Mathematician	6 top paper awards earned in areas ranging from stochastic differential equations to automated GPU acceleration
Pharmacologist	Awardee of the ISoP Emerging Scientist Award 2020, the top award for early career pharmacometrics
Well-Funded	Awarded >20 grants in areas ranging from numerical space weather prediction to power grid simulation
High Real-World Impact	Lead developer of the widely used SciML Organization, DifferentialEquations.jl, JuliaSim, and Pumas
Interdisciplinary	Publications in high impact journals and conferences ranging from machine learning to pharmacology
Renowned Lecturer	Known for many online talks with over 20k views, created the MIT SciML graduate course with >100 students
Influential Writer	Author of many blogs such as StochasticLifestyle.com repeatedly featured on top tech websites

Research Interests

Mathematics	Stochastic (Partial) Differential Equations, Computational Differential Equations, Stochastic Analysis
Computation	High-Performance Parallel Computing, Scientific Machine Learning, "Big Data", Julia, Package Development
Biomedical	Systems Biology, Clinical Pharmacology, Quantiative Systems Pharmacology (QsP), Developmental Biology

Current Positions and Positions Held

VP of Modeling and Simulation   *Cambridge, Massachusetts*
JULIAHUB   *2018-Present*

Director of Scientific Research   *Baltimore, Maryland*
PUMAS-AI   *2020-Present*

Research Affiliate (Co-PI of the Julia Lab)   *Boston, Massachusetts*
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, COMPUTER SCIENCE AND AI LABORATORY (CSAIL)   *2021-Present*

Applied Mathematics Instructor   *Boston, Massachusetts*
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, DEPARTMENT OF MATHEMATICS   *2019-2021*

Senior Research Scientist   *Baltimore, Maryland*
UNIVERSITY OF MARYLAND, BALTIMORE, SCHOOL OF PHARMACY   *2018-2020*

Assistant Specialist   *Irvine, California*
UNIVERSITY OF CALIFORNIA, IRVINE, DEPARTMENT OF MATHEMATICS   *2018*

Education

University of California, Irvine   *Irvine, California*
PH.D. IN MATHEMATICS   *2018*
- Thesis: Simulation and Control of Biological Stochasticity
- Awarded Kovalevsky Outstanding Ph.D. Thesis Award

University of California, Irvine   *Irvine, California*

M.S. in Mathematics   *2015*

- Certificate in Mathematical, Computational, and Systems Biology

Oberlin College   *Oberlin, Ohio*

B.A. with Honors in Mathematics with Minors in Computer Science, Physics, and Economics   *2013*

- GPA: 3.8/4.0, GRE: V166 (96%), Q169 (98%), W5.5 (96%)

Grants

Rigorous Optimal Uncertainty Quantification   *AFOSR*

Lead PI: Adam Gerlach. Co-PIs: Alexander Von Moll, John Schierman, Chris Rackauckas   *December 2023*

$450K

Collaborative Research: Discovery and Collaboration of Stochastic Chemical Reaction Network Models   *NSF*

Lead PI: Samuel Isaacson. Co-PI: Chris Rackauckas   *September 2023*

$375K

ProteusSim: A Composable Integrated Approach for Automatic Simulator Construction   *DARPA ASKEM*

Lead PIs: Keno Fischer, Chris Rackauckas   *August 2022*

HR001122S0005 **$7.2M**

Bringing computation to the climate challenge   *MIT Climate Grand Challenge*

Lead PIs: Raffaele Ferrari and Noelle Selin. Significant Contributors: Tamara Broderick, Alan Edelman, Arlene Fiore, Glenn Flierl, Christopher Knittel, John Marshall, Youssef Marzouk, Elsa Olivetti, Bethany Patten, Chris Rackauckas, Daniela Rus, Adam Schlosser, Andre Souza, Gregory Wagner   *May 2022*

Amount Undisclosed.

Enhancing the open source SciML stack for clinical trial simulations   *Chan Zuckerberg Initiative*

PIs: Samuel Issacson and Christopher Rackauckas   *August 2021*

EOSS4-0000000437 **$290K**

Accelerating Drug Discovery with Symbolic-Numerics in SciML   *Wellcome Trust*

PIs: Samuel Issacson and Christopher Rackauckas   *August 2021*

Technology Development Grant **$140K**

Interpretable machine learning for high-speed, high-fidelity GEOS-Chem model simulations with uncertainty quantification   *NASA Space Technology Research, Development, Demonstration, and Infusion-2021*

PI: Christopher Tessum (UIUC). Collaborators: Daven Henze, Christopher Rackauckas, Nicole Riemer   *June 2021*

SpaceTech-REDDI-2021 **$600K**

Convergence of Bayesian inverse methods and scientific machine learning in Earth system models through universal differentiable programming   *National Science Foundation*

Lead PI: Patrick Heimbach (UT Austin). Co-PIs: Karen Wilcox (UT Austin), Alan Edelman (MIT), Chris Rackauckas (MIT), Chris Hill (MIT), Loose (CU Boulder), Morlighem (UC Irvine), Narayanan (U Chicago), Schanen (U Chicago)   *June 2021*

NSF CSSI **$4M**

Neuroblox: a Data-Driven Platform for Computational Psychiatry   *Private Funding*

PIs: LR Mujica-Parodi (SUNYSB/Harvard), A Edelman (MIT), C Rackauckas (MIT), E Miller (MIT) R Granger (Dartmouth), H Strey (SUNYSB)   *June 2021*

NeuralSPICE: Accelerated Simulation and Design of Electrical Circuits   *DARPA*

Lead PI: Viral Shah (Julia Computing). Co-PIs: Chris Rackacukas (JC), Keno Fisher (JC), Alan Edelman (JC)   *November 2020*

DARPA AIE DITTO **$1M**

Optimization Under Uncertainty: A Generalized Koopman Expectation Framework   *Airforce Research Laboratory (AFRL)*

Task Manager: Adam Gerlach (AFRL). Key Personnel: John Schierman (AFRL), Andrew Lenard, Chris Rackauckas (MIT)   *September 2020*

AFRL AFOSR Program in Optimization & Discrete Math. **$450K**

Scientific Machine Learning for Simulation and Control in Large Scale Power Systems

National Renewable Energy Laboratory (NREL)

PIs: Duncan Callaway (LBL and UC Berkeley), Bri-Mathias Hodge (NREL), Chris Rackauckas (MIT)

September 2020

NREL internal funding. **$1.3M**

Model Form Epistemic Uncertainty Quantification for Modeling with Differential Equations

Sandia National Laboratory

Erin Acquesta, Teresa Portone, and Ahmad Rushdi in collaboration with Chris Rackauckas (MIT)

August 2020

Sandia National Laboratory internal funding. **$180K**

SWIFT: Adaptive RFI Cancellation for Radio Science Observatories

National Science Foundation

PI: Frank D. Lind, CoPI : J. Swoboda, CoPI : A. Edelman, C. Rackauckas

August 2020

NSF 20-537, Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT). **$1.3M**

Composable Next Generation Software Framework for Space Weather Data Assimilation and Uncertainty Quantification

National Science Foundation

PIs: Youssef Marzouk (MIT), Alan Edelman (MIT), Boris Karmer (UCSD), Aaron Ridley (UMich), Chris Rackauckas (MIT), Philip Erickson (MIT), David Gondelach (MIT), Jaime Peraire (MIT), Jei Freeman (MIT) Ngoc Nguyen (MIT)

July 2020

NSF 20-529, Next Generation Software for Data-driven Models of Space Weather with Quantified Uncertainties (SWQU). **$3.1M**

Building an open platform for pandemic modeling

Microsoft Pandemic Response

Microsoft PI: Simon Frost, Academic Co-PIs: Sebastian Vollmer, and Chris Rackauckas, Deirdre Hollingsworth, Ronojoy Adhikari, Michael Gravenor, Biagio Lucin

June 2020

Dr. Sebastian Vollmer (The Alan Turing Institute, UK); Dr. Chris Rackauckas (CSAIL, MIT); Prof. Deirdre Hollingsworth (Big Data Institute, Univ. Oxford); Dr. Ronojoy Adhikari (Mathematics, Univ. Cambridge); Prof. Michael Gravenor (Biomedical Sciences, Swansea University); Prof. Biagio Lucini (Mathematics, Swansea University). **$180K**, with 80K budgeted to MIT

Neural Component Architecture to Accelerate Modeling & Simulation

National Science Foundation

PIs: Keno Fischer, Viral Shah, and Chris Rackauckas

March 2020

SBIR Phase I. **$220K**

Neural Surrogates for Augmenting Models of Complex Dynamical Systems

MIT-Ford Alliance

PIs: Alan Edelman and Chris Rackauckas (MIT)

March 2020

$300K

Digital Wells for Optimal Production and Drainage (DigiWell)

Norwegian Research Council

Project Manager: Bernt Lie (USN). Research Partners: Martin Giese (UiO), Stein Krogstad (SINTEF), Ann Muggeridge (ICL), Chris Rackauckas (MIT)

February 2020

Multi-University Grant. Key Partner: Equinor, **32M KOK** $\sim$ **$3.7M**

Robust Neural Differential Models for Navigation and Beyond

MIT-Air Force AI Innovation Accelerator

PI: Prof. Edelman. Co-PIs: Dr. Rackauckas, Dr. O'Keeffe, Dr. Belarge, P. Morales , N. Dalton

November 2019

Airforce stakeholders: Lieutenant Colonel Bradley Reuter (AMC/A8XC), Captain Alexander Hutcheson (AMC), Captain Kyle Baldwin (USAF Weapons School/26th Weapons Squadron), Captain Danae Peoples (USAF Weapons School/26th Weapons Squadron), Captain David Pagano (USAF Weapons School/26th Weapons Squadron) **$2.4M**

Accelerating Coupled HVAC-Building Simulation with a Neural Component Architecture

ARPA-E

PI: Viral Shah. Co-PI: Chris Rackauckas

November 2019

DIFFERENTIATE, DE-FOA-0002107, Assigned Control No: 2107-1656. **$1.1M**

MIT-Imperial-AIMS Scientific Machine Learning Workshop Series

MISTI GSF

PIs: Alan Edelman, Chris Rackauckas, Sheehan Olver, Simukai Utete

November 2019

Funding for an international three workshop series on scientific machine learning with dedicated funding for underrepresented and students of diverse backgrounds. **$30K**

A Fresh Approach to General, Performant, and Scalable Productivity

DARPA

PI: Alan Edelman. Co-PIs: Chris Rackauckas, Steven Johnson

November 2019

PAPPA, DARPA-PA-19-04-02- FP-020, **$1M**

High-fidelity Accelerated Design of High-performance Electrochemical Systems

ARPA-E

PI: Venkat Viswanathan. Co-PIs: Alan Edelman, Chris Rackauckas

November 2019

DIFFERENTIATE, DE-FOA-0002107, Assigned Control No: 2107-1548. **$600K**

Supervised Thesis

On Efficient Training & Inference of Neural Differential Equations   *Masters*
Avik Pal   *June 1, 2023*
https://dspace.mit.edu/handle/1721.1/151379

Higher-Order Automatic Differentiation and Its Applications   *Masters*
Songchen Tan   *June 1, 2023*
https://dspace.mit.edu/handle/1721.1/151501

Approximation of Large Stiff Acausal Models   *PhD*
Ranjan Anantharaman   *February 1, 2023*
https://dspace.mit.edu/handle/1721.1/150242

A new way to do epidemic modeling   *PhD*
Raj Abhijit Dandekar   *September 1, 2022*
https://dspace.mit.edu/handle/1721.1/147364

TCAD-Informed Surrogate Models of Semiconductor Devices   *Masters*
Samuel B. Chinnery   *May 1, 2022*
https://dspace.mit.edu/handle/1721.1/144946

SmartPitch: Applied Machine Learning for Professional Baseball Pitching Strategy   *Masters*
Stephen Eugene Otremba Jr.   *May 1, 2022*
https://dspace.mit.edu/handle/1721.1/145144

Quasi-potential analysis of multi-variate stochastic differential equations *Masters*
Bola Malek   *June 1, 2021*
https://dspace.mit.edu/handle/1721.1/142704

Current Research Mentees

Postdoctural Scholars

2021-P	**Frank Schaefer**	*MIT*
2022-P	**Torkel Loman**	*MIT*
2022-P	**Wiktor Phillips**	*MIT*

PhD Students

2021-P	**Emily Helen Nieves**	*MIT*
2021-P	**Avik Pal**	*MIT*
2021-P	**Flemming Holtorf**	*MIT*
2021-P	**Nicholas Klugman**	*MIT*
2021-P	**Shashi Gowda**	*MIT*

Masters Students

| 2021-P | **Vaibhav Dixit** | *MIT* |
| 2021-P | **Yonatan Delegan** | *MIT* |

Undergraduate Students

| 2021-P | **Gaurav Arya** | *MIT* |

Patents

Methods and systems for accelerating quantitative systems pharmacology (qsp) models   *US18/136,654*
Christopher Rackauckas, Viral B Shah, Sebastian Miclua-Câmpeanu   *April 19, 2023*

Systems and methods of component-based modeling using training surrogates   *PCT/US2021/050916*
Christopher Rackauckas, Viral B Shah, MA Yingbo   *September 17, 2021*

Method and apparatus for individualized administration of medicaments for enhanced safe delivery within a therapeutic range

CHRIS RACKAUCKAS, VIJAY IVATURI

WO2021041469A1 WPO (PCT)

March 4th, 2021

Provisional Patents

Transforming a model in a first language to a surrogate in a second language for simulation

CHRIS RACKAUCKAS

1027/4 PROV

September 25, 2021

Improving automated surrogate training performance by incorporating simulator information

CHRIS RACKAUCKAS, ANAS ABDELREHIM, RANJAN ANANTHARAMAN

1027/5 PROV

September 25, 2021

Solver for scientific computing that detects and handles discontinuities or irregularities in a simulation

CHRIS RACKAUCKAS, YINGBO MA

1027/6 PROV

September 25, 2021

Neural-Embedded Nonlinear Mixed Effects (NENLME) Models

CHRIS RACKAUCKAS, VIJAY IVATURI

63/136,719 PROV

January 13, 2021

Honors & Awards

CAREER AWARDS

2021	**United States Department of the Air Force Artificial Intelligence Accelerator Scientific Excellence Award**	*USAF*
2020	**ISoP Emerging Scientist Award**, The top early career award in pharmacometrics	*ISoP*

FELLOWSHIPS AND SCHOLARSHIPS

2016	**Data Science Initiative Summer Fellowship**, UC Irvine Data Science Initiative	*DSI*
2016	**Allocation DMS160004**, XSEDE	*XSEDE*
2014	**National Science Foundation Graduate Research Fellowship** , National Science Foundation	*NSF*
2014	**Ford Predoctoral Fellowship**, National Academies of Science	*Ford Foundation*
2013	**T32 Predoctoral Training Grant**, National Institute of Biomedical Imaging and Bioengineering	*UC Irvine*
2013	**Graduate Dean's Recruitment Fellowship**, University of California, Irvine	*UC Irvine*
2013	**Mathematical and Computational Biology (MCB) Fellowship**, University of California, Irvine	*UC Irvine*
2010	**S-STEM Scholarship**, National Science Foundation	*Oberlin College*
2009	**John F. Oberlin Scholarship**, Oberlin College	*Oberlin College*

MONETARY AWARDS

2022	**Best Poster Award**, NeurIPS Differentiable Programming Workshop	*NeurIPS*
2018	**Inaugural Julia Community Award**, JuliaCon 2018	*UCI*
2018	**PLOS ONE Early Career Travel Award in the Physical Sciences**, Computer Science & Engineering Category	*PLOS One*
2018	**Kovalevsky Outstanding Ph.D. Thesis Award**, UCI Department of Mathematics	*UCI*
2015	**Opportunity Award**, Center for Complex Biological Systems	*CCBS*
2013	**Margaret C. Etter Student Lecturer Award**, American Crystallographic Association, Service Crystallography SIG	*ACA*
2012	**Best Poster Presentation for Statistics**, Shenandoah Undergraduate Mathematics Conference	*JMU*

PAPER AND PRESENTATION AWARDS

2023	**Outstanding Paper Award**, IEEE-HPEC 2023	*IEEE*
2021	**Mathematical and Computational Sciences Special Interest Group Award**, for DeepNLME	*ACOP*
2020	**Outstanding Paper Award**, IEEE-HPEC 2020	*IEEE*
2020	**Quality Award**, One out of three awarded by the International Society of Pharmacology	*ACOP*
2019	**Mathematical and Computational Sciences Special Interest Group Award**, for UQ in Pumas	*ACOP*
2018	**DSWeb 2018 Software Contest Runner Up**, SIAM SIG on Dynamical Systems	*SIAM*
2017	**Best Speaker Award**, Tsukuba Global Science Week	*TGSW*
2014	**Outstanding Presentation Award**, Mathematical Association of America	*MAA*

STUDENT'S AWARDS

2023	**Best Oral Presentation Award for Emily Nieves**, ISoP QSP Student Symposium	*ISoP*
2023	**Outstanding Masters Research Award for Songchen Tan**, MIT Center for CS&E MathWorks Prize	*MIT*
2022	**MIT Portugal Program Poster Award for Vinicius Santana**, MIT Portrugal Program	*University of Porto*

Peer Reviewed Publications

Automated translation and accelerated solving of differential equations on multiple GPU platforms

UTKARSH UTKARSH, VALENTIN CHURAVY, YINGBO MA, TIM BESARD, PRAKITR SRISUMA, TIM GYMNICH, ADAM R GERLACH, ALAN EDELMAN, GEORGE BARBASTATHIS, RICHARD D BRAATZ, CHRISTOPHER RACKAUCKAS

https://www.sciencedirect.com/science/article/abs/pii/S0045782523007156

Computer Methods in Applied Mechanics and Engineering

February 1, 2024

Performance Bounds for Quantum Control

FLEMMING HOLTORF, FRANK SCHÄFER, JULIAN ARNOLD, CHRISTOPHER RACKAUCKAS, ALAN EDELMAN

https://ieeexplore.ieee.org/abstract/document/10313626

2023 IEEE International Conference on Quantum Computing and Engineering (QCE)

September 9, 2023

Physics-enhanced deep surrogates for partial differential equations

RAPHAËL PESTOURIE, YOUSSEF MROUEH, CHRIS RACKAUCKAS, PAYEL DAS, STEVEN G JOHNSON

https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1011530

Nature Machine Intelligence

December 4, 2023

Catalyst: fast biochemical modeling with Julia

TORKEL E LOMAN, YINGBO MA, VASILY ILIN, SHASHI GOWDA, NIKLAS KORSBO, NIKHIL YEWALE, CHRIS RACKAUCKAS, SAMUEL A ISAACSON

https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1011530

PLoS Computational Biology

October 18, 2023

Efficient hybrid modeling and sorption model discovery for non-linear advection-diffusion-sorption systems: A systematic scientific machine learning approach

VINICIUS V SANTANA, ERBET COSTA, CARINE M REBELLO, ANA MAFALDA RIBEIRO, CHRISTOPHER RACKAUCKAS, IDELFONSO BR NOGUEIRA

https://www.sciencedirect.com/science/article/abs/pii/S0009250923007790

Chemical Engineering Science

December 5th, 2023

Continuous Deep Equilibrium Models: Training Neural ODEs Faster by Integrating Them to Infinity

AVIK PAL, ALAN EDELMAN, CHRISTOPHER RACKAUCKAS

Best Student Paper Award, https://arxiv.org/abs/2201.12240 (to be updated)

HPEC 2023

September 25th, 2023

Differentiable modelling to unify machine learning and physical models for geosciences

CHAOPENG SHEN, ALISON P APPLING, PIERRE GENTINE, TOSHIYUKI BANDAI, HOSHIN GUPTA, ALEXANDRE TARTAKOVSKY, MARCO BAITY-JESI, FABRIZIO FENICIA, DANIEL KIFER, LI LI, XIAOFENG LIU, WEI REN, YI ZHENG, CIARAN J HARMAN, MARTYN CLARK, MATTHEW FARTHING, DAPENG FENG, PRAVEEN KUMAR, DOAA ABOELYAZEED, FARSHID RAHMANI, YALAN SONG, HYLKE E BECK, TADD BINDAS, DIPANKAR DWIVEDI, KUAI FANG, MARVIN HÖGE, CHRIS RACKAUCKAS, BINAYAK MOHANTY, TIRTHANKAR ROY, CHONGGANG XU, KATHRYN LAWSON

https://www.nature.com/articles/s43017-023-00450-9

Nature Reviews Earth & Environment

July 11th, 2023

A differentiable, physics-informed ecosystem modeling and learning framework for large-scale inverse problems: demonstration with photosynthesis simulations

Biogeosciences

Doaa Aboelyazeed, Chonggang Xu, Forrest M Hoffman, Jiangtao Liu, Alex W Jones, Chris Rackauckas, Kathryn Lawson, Chaopeng Shen

July 6th, 2023

https://arxiv.org/abs/2207.08135

Forecasting virus outbreaks with social media data via neural ordinary differential equations

Nature Scientific Reports

Matías Núñez, Nadia L Barreiro, Rafael A Barrio, Christopher Rackauckas

July 5th, 2023

https://www.nature.com/articles/s41598-023-37118-9

Locally regularized neural differential equations: some black boxes were meant to remain closed!

ICML

Avik Pal, Alan Edelman, Christopher Vincent Rackauckas

July 3rd, 2023

https://proceedings.mlr.press/v202/pal23a.html

Differentiating Metropolis-Hastings to Optimize Intractable Densities

ICML Workshop

Gaurav Arya, Ruben Seyer, Frank Schäfer, Alex Lew, Mathieu Huot, Vikash K Mansinghka, Chris Rackauckas, Kartik Chandra, Moritz Schauer

July 3rd, 2023

https://arxiv.org/abs/2306.0796, https://differentiable.xyz/

Julia for biologists

Nature Methods

Elisabeth Roesch, Joe G Greener, Adam L MacLean, Huda Nassar, Christopher Rackauckas, Timothy E Holy, Michael PH Stumpf

April 6th, 2023

https://www.nature.com/articles/s41592-023-01832-z

AutoMat: Automated materials discovery for electrochemical systems

MRS Bulletin

Emil Annevelink, Rachel Kurchin, Eric Muckley, Lance Kavalsky, Vinay I Hegde, Valentin Sulzer, Shang Zhu, Jiankun Pu, David Farina, Matthew Johnson, Dhairya Gandhi, Adarsh Dave, Hongyi Lin, Alan Edelman, Bharath Ramsundar, James Saal, Christopher Rackauckas, Viral Shah, Bryce Meredig, Venkatasubramanian Viswanathan

December 22nd, 2022

https://link.springer.com/article/10.1557/s43577-022-00424-0

Automatic differentiation of programs with discrete randomness

NeurIPS

Gaurav Arya, Moritz Schauer, Frank Schäfer, Christopher Rackauckas

December 6th, 2022

https://proceedings.neurips.cc/paper_files/paper/2022/hash/43d8e5fc816c692f342493331d5e98fc-Abstract-Conference.html

Symbolic-numeric integration of univariate expressions based on sparse regression

ACM Communications in Computer Algebra

Shahriar Iravanian, Carl Julius Martensen, Alessandro Cheli, Shashi Gowda, Anand Jain, Yingbo Ma, Chris Rackauckas

November 23rd, 2022

https://dl.acm.org/doi/abs/10.1145/3572867.3572882

Continuous-time echo state networks for predicting power system dynamics

Electric Power Systems Research

Ciaran Roberts, José Daniel Lara, Rodrigo Henriquez-Auba, Matthew Bossart, Ranjan Anantharaman, Chris Rackauckas, Bri-Mathias Hodge, Duncan S Callaway

November 1st, 2022

https://www.sciencedirect.com/science/article/pii/S0378779622006587

Validation and parameterization of a novel physics-constrained neural dynamics model applied to turbulent fluid flow

Physics of Fluids

Varun Shankar, Gavin D Portwood, Arvind T Mohan, Peetak P Mitra, Dilip Krishnamurthy, Christopher Rackauckas, Lucas A Wilson, David P Schmidt, Venkatasubramanian Viswanathan

November 1st, 2022

https://pubs.aip.org/aip/pof/article-abstract/34/11/115110/2847650/Validation-and-parameterization-of-a-novel-physics

GlobalSensitivity.jl: Performant and Parallel Global Sensitivity Analysis with Julia

Journal of Open Source Software

Vaibhav Dixit, Chris Rackauckas

August 17th, 2022

https://joss.theoj.org/papers/10.21105/joss.04561.pdf

Parallelizing Explicit and Implicit Extrapolation Methods for Ordinary Differential Equations

HPEC 2022

Utkarsh, Chris Elrod, Yingbo Ma, Christopher Rackauckas

September 19, 2022

https://arxiv.org/abs/2207.08135

Continuous-time echo state networks for predicting power system dynamics

Electric Power Systems Research

Ciaran Roberts, José Daniel Lara, Rodrigo Henriquez-Auba, Matthew Bossart, Ranjan Anantharaman, Chris Rackauckas, Bri-Mathias Hodge, Duncan S Callaway

November 1, 2022

Differential methods for assessing sensitivity in biological models

PLoS Computational Biology

Rachel Mester, Alfonso Landeros, Chris Rackauckas, Kenneth Lange

June 13, 2022

Constrained Smoothers for State Estimation of Vapor Compression Cycles

2022 American Control Conference

Vedang Deshpande, Christopher R Laughman, Yingbo Ma, Chris Rackauckas

June 8, 2022

Two heads are better than one: current landscape of integrating QSP and machine learning

Journal of Pharmacokinetics and Pharmacodynamics

Tongli Zhang, Ioannis P Androulakis, Peter Bonate, Limei Cheng, Tomáš Helikar, Jaimit Parikh, Christopher Rackauckas, Kalyanasundaram Subramanian, Carolyn R Cho

February 1, 2022

Symbolic-Numeric Integration of Univariate Expressions based on Sparse Regression

ACM Communications in Computer Algebra

Shahriar Iravanian, Julius Martensen, Alessandro Cheli, Shashi Gowda, Anand Jain, Yingbo Ma, Chris Rackauckas

January 27, 2022

ReservoirComputing.jl: an efficient and modular library for reservoir computing models

Journal of Machine Learning Research

Francesco Martinuzzi, Chris Rackauckas, Anas Abdelrehim, Miguel D Mahecha, Karin Mora

January 1, 2022

Composable and Reusable Neural Surrogates to Predict System Response of Causal Model Components

AAAI 2022 Workshop on AI for Design and Manufacturing (ADAM)

Ranjan Anantharaman, Anas Abdelrehim, Francesco Martinuzzi, Sharan Yalburgi, Elliot Saba, Keno Fischer, Glen Hertz, Pepijn de Vos, Chris Laughman, Yingbo Ma, Viral Shah, Alan Edelman, Chris Rackauckas

November 10, 2021

AbstractDifferentiation.jl: Backend-Agnostic Differentiable Programming in Julia

NeurIPS Differentiable Programming Workshop

Frank Schäfer, Mohamed Tarek, Lyndon White, Chris Rackauckas

December 13, 2021

The implications of delayed reopening in controlling the COVID-19 surge in the Southern and West-Central USA

Health Data Science

Dandekar R, Wang E, Barbastathis G, Rackauckas C

August 31, 2021

Stiff Neural Ordinary Differential Equations

Chaos

S Kim, W Ji, S Deng, C Rackauckas

August 31, 2021

A Comparison of Automatic Differentiation and Continuous Sensitivity Analysis for Derivatives of Differential Equation Solutions

IEEE-HPEC

Yingbo Ma, Vaibhav Dixit, Xingjian Guo, Mike Innes, Christopher Rackauckas

August 1, 2021

Composing Modeling and Simulation with Machine Learning in Julia

14th International Modelica Conference

C Rackauckas, R Anantharaman, A Edelman, S Gowda, M Gwozdz, A Jain, C Laughman, Y Ma, F Martinuzzi, A Pal, U Rajput, E Saba, V Shah

September 2021

High-performance symbolic-numerics via multiple dispatch

S Gowda, Y Ma, A Cheli, M Gwozdz, V Shah, A Edelman, C Rackauckas

Opening the Blackbox: Accelerating Neural Differential Equations by Regularizing Internal Solver Heuristics

A Pal, Y Ma, V Shah, C Rackauckas

Collocation based Training of Neural Ordinary Differential Equations

E Roesch, C Rackauckas, M Stumpf

Bayesian Neural Ordinary Differential Equations

R Dandekar, V Dixit, M Tarek, A Garcia-Valadez, C Rackauckas

LAFI 2021

Accelerating Simulation of Stiff Nonlinear Systems using Continuous-Time Echo State Networks

Anantharaman R, Ma Y, Gowda S, Laughman C, Shah V, Edelman A, Rackauckas C

Safe Blues: The case for virtual safe virus spread in the long-term fight against epidemics

R Dandekar, SG Henderson, HM Jansen, J McDonald, S Moka, Y Nazarathy, C Rackauckas, PG Taylor, A Vuorinen

Hybrid Mechanistic + Neural Model of Laboratory Helicopter

C Rackauckas, R Sharma, B Lie

A Machine Learning-Aided Global Diagnostic and Comparative Tool to Assess Effect of Quarantine Control in COVID-19 Spread

Dandekar R, Rackauckas C, Barbastathis G

ACED: Accelerated Computational Electrochemical systems Discovery

Kurchin R, Kavalsky L, Sun X, Viswanathan V, Muckley E, Hegde V, Saal J, Meredig B, Gandhi D, Shah V, Johnson M, Edelman A, Rackauckas C

Learning non-linear spatio-temporal dynamics with convolutional Neural ODEs

Shankar V, Portwood G, Mohan A, Mitra P, Rackauckas C, Wilson L, Schmidt D, Viswanathan V

Signal Enhancement for Magnetic Navigation Challenge Problem

Albert R. Gnadt, Joseph Belarge, Aaron Canciani, Lauren Conger, Joseph Curro, Alan Edelman, Peter Morales, Michael F. O'Keeffe, Jonathan Taylor, Christopher Rackauckas

Beyond Deterministic Models in Drug Discovery and Development

Irurzun-Arana I, Rackauckas C. McDonald T, Trocóniz I

Stability-Optimized High Order Methods and Stiffness Detection for Pathwise Stiff Stochastic Differential Equations

Rackauckas C, Nie Q

IEEE Outstanding Paper Award

Generalized Physics-Informed Learning Through Language-Wide Differentiable Programming

Rackauckas C, Edelman A, Fischer K, Innes M, Saba E, Shah V, Tebbutt W

StochasticDelayDiffEq.jl - An Integrator Interface for Stochastic Delay Differential Equations in Julia

Sykora H, Rackauckas C, Widmann D, Bachrathy D

Sparsity Programming: Automated Sparsity-Aware Optimizations in Differentiable Programming

Gowda S, Ma Y, Churavy V, Edelman A, Rackauckas C

Confederated Modular Differential Equation APIs for Accelerated Algorithm Development and Benchmarking

Rackauckas C, Nie Q

Interdisciplinary Case Study:How Mathematicians and Biologists Found Order in Cellular Noise

Rackauckas C, Nie Q

Mean-Independent Noise Control of Cell Fates via Intermediate States

Rackauckas C, Nie Q

Featured as a cover article for iScience.

DifferentialEquations.jl - A Performant and Feature-Rich Ecosystem for Solving Differential Equations in Julia

Rackauckas C, Nie Q

Awarded DSWeb 2018 Runner-Up by SIAM Dynamical Systems Interest Group

Adaptive Methods for Stochastic Differential Equations via Natural Embeddings and Rejection Sampling with Memory

Rackauckas C, Nie Q

Noise modulation in retinoic acid signaling sharpens segmental boundaries of gene expression in the embryonic zebrafish hindbrain

Sosnik J, Zheng L, Rackauckas C, Digman M, Gratton E, Nie Q, Schilling T

On The Budyko-Sellers Energy Balance Climate Model with Ice Line Coupling

Walsh J, Rackauckas C

Assessment of Statistical Methods for Water Quality Monitoring in Maryland's Tidal Waterways

Le R, Rackauckas C, Ross A, Ulloa N.

Preprints and Technical Reports

Leveraging Julia's automated differentiation and symbolic computation to increase spectral DCM flexibility and speed

David Hofmann, Anthony G Chesebro, Chris Rackauckas, Lilianne Rivka Mujica-Parodi, Karl Friston, Alan Edelman, Helmut H Strey

https://www.biorxiv.org/content/10.1101/2023.10.27.564407v1.abstract

Advancing Odor Classification Models Enhanced by Scientific Machine Learning and Mechanistic Model: Probabilistic Weight Assignment for Odor Intensity Prediction and Uncertainty Analysis for Robust Fragrance Classification

ChemRxiv

VINICIUS SANTANA, ERBET COSTA, CARINE REBELLO, ANA MAFALDA RIBEIRO, CHRIS RACKAUCKAS, IDELFONSO NOGUEIRA

November 30, 2023

https://chemrxiv.org/engage/chemrxiv/article-details/656703395bc9fcb5c9a3a476

Uncertainty quantified discovery of chemical reaction systems via Bayesian scientific machine learning

Bioarxiv

EMILY NIEVES, RAJ DANDEKAR, CHRIS RACKAUCKAS

October 2, 2023

https://www.biorxiv.org/content/10.1101/2023.09.11.557164v2.abstract

Extending JumpProcess.jl for fast point process simulation with time-varying intensities

Arxiv

GUILHERME AUGUSTO ZAGATTI, SAMUEL A ISAACSON, CHRISTOPHER RACKAUCKAS, VASILY ILIN, SEE-KIONG NG, STÉPHANE BRESSAN

June 12, 2023

https://arxiv.org/abs/2306.06992

A Practitioner's Guide to Bayesian Inference in Pharmacometrics using Pumas

Arxiv

MOHAMED TAREK, JOSE STOROPOLI, CASEY DAVIS, CHRIS ELROD, JULIUS KRUMBIEGEL, CHRIS RACKAUCKAS, VIJAY IVATURI

March 31, 2023

https://arxiv.org/abs/2304.04752

Robust Parameter Estimation for Rational Ordinary Differential Equations

ArXiv

OREN BASSIK, YOSEF BERMAN, SOO GO, HOON HONG, ILIA ILMER, ALEXEY OVCHINNIKOV, CHRIS RACKAUCKAS, PEDRO SOTO, CHEE YAP

March 2, 2023

https://arxiv.org/abs/2303.02159

Stochastic Optimal Control via Local Occupation Measures

Arxiv

FLEMMING HOLTORF, CHRISTOPHER RACKAUCKAS

November 28, 2022

https://arxiv.org/abs/2211.15652

Model-Form Epistemic Uncertainty Quantification for Modeling with Differential Equations: Application to Epidemiology.

OSTI

ERIN ACQUESTA, TERESA PORTONE, RAJ DANDEKAR, CHRIS RACKAUCKAS, RILEIGH BANDY, JOSE HUERTA

September 1st, 2022

Technical Report, https://www.osti.gov/biblio/1888443

DelayDiffEq: Generating delay differential equation solvers via recursive embedding of ordinary differential equation solvers

Arxiv

DAVID WIDMANN, CHRIS RACKAUCKAS

August 26th, 2022

https://arxiv.org/abs/2208.12879

Plots.jl-a user extendable plotting API for the julia programming language

Arxiv

SIMON CHRIST, DANIEL SCHWABENEDER, CHRISTOPHER RACKAUCKAS, MICHAEL KRABBE BORREGAARD, THOMAS BRELOFF

April 19, 2022

https://arxiv.org/abs/2204.08775

ReservoirComputing.jl: An Efficient and Modular Library for Reservoir Computing Models

Arxiv

FRANCESCO MARTINUZZI, CHRIS RACKAUCKAS, ANAS ABDELREHIM, MIGUEL D MAHECHA, KARIN MORA

April 8, 2022

https://arxiv.org/abs/2204.05117

Mixing Implicit and Explicit Deep Learning with Skip DEQs and Infinite Time Neural ODEs (Continuous DEQs)

Arxiv

AVIK PAL, ALAN EDELMAN, CHRISTOPHER RACKAUCKAS

January 28, 2022

https://arxiv.org/abs/2201.12240

Differentiable State Space Models and Hamiltonian Monte Carlo Estimation

DAVID CHILDERS, JES US FERNÁNDEZ-VILLAVERDE, JESSE PERLA, CAMERON PFIFFER, CHRISTOPHER RACKAUCKAS, PEIFAN WU

December 9, 2021

Platooning for Improved Safety and Efficiency of Semi-Trucks (PISES – III)

TRID

VENKATASUBRAMANIAN VISWANATHAN, VARUN SHANKAR, GAVIN D PORTWOOD, ARVIND T MOHAN, PEETAK P MITRA, DILIP KRISHNAMURTHY, CHRISTOPHER RACKAUCKAS, LUCAS A WILSON, DAVID P SCHMIDT

November 15, 2021

Validation and parameterization of a novel physics-constrained neural dynamics model applied to turbulent fluid flow

Shankar V, Portwood GD, Mohan AT, Mitra PP, Krishnamurthy D, Rackauckas C, Wilson LA, Schmidt DP, Viswanathan V.

Julia for Biologists

Roesch, E., Greener, J. G., MacLean, A. L., Nassar, H., Rackauckas, C., Holy, T. E., & Stumpf, M. P.

NeuralPDE: Automating Physics-Informed Neural Networks (PINNs) with Error Approximations

Zubov, K., McCarthy, Z., Ma, Y., Calisto, F., Pagliarino, V., Azeglio, S., Bottero, L., Luján, E., Sulzer, V., Bharambe, A. and Vinchhi, N.

ModelingToolkit: A Composable Graph Transformation System For Equation-Based Modeling

Y Ma, S Gowda, R Anantharaman, C Laughman, V Shah, C Rackauckas

Forecasting virus outbreaks with social media data via neural ordinary differential equations

M Núñez, N Barreiro, R Barrio, C Rackauckas

Efficient Precision Dosing Under Estimated Uncertainties via Koopman Expectations of Bayesian Posteriors with Pumas

CV Rackauckas, V Dixit, AR Gerlach, V Ivaturi

Accelerated Predictive Healthcare Analytics with Pumas, A High Performance Pharmaceutical Modeling and Simulation Platform

Chris Rackauckas, Andreas Noack, Vaibhav Dixit, Yingbo Ma, Patrick Kofod Mogensen, Shubham Maddhashiya, Simon Byrne, Joga Gobburu, Joakim Nyberg, Vijay Ivaturi

Capturing missing physics in climate model parameterizations using neural differential equations

Ramadhan A, Marshall J, Souza A, Wagner G, Ponnapati M, Rackauckas C

The Koopman Expectation: An Operator Theoretic Method for Efficient Analysis and Optimization of Uncertain Hybrid Dynamical Systems

Gerlach A, Leonard A, Rogers J, Rackauckas C

Safe Blues: A Method for Estimation and Control in the Fight Against COVID-19

Raj Abhijit Dandekar, Shane G. Henderson, Marijn Jansen, Sarat Moka, Yoni Nazarathy, Christopher Rackauckas, Peter G. Taylor, Aapeli Vuorinen

Universal Differential Equations for Scientific Machine Learning

Christopher Rackauckas, Yingbo Ma, Julius Martensen, Collin Warner, Kirill Zubov, Rohit Supekar, Dominic Skinner, Ali Ramadhan

A Differentiable Programming System to Bridge Machine Learning and Scientific Computing

Mike Innes, Alan Edelman, Keno Fischer, Chris Rackauckas, Elliot Saba, Viral B Shah, Will Tebbutt

DiffEqFlux.jl - A Julia Library for Neural Differential Equations

Chris Rackauckas, Mike Innes, Yingbo Ma, Jesse Bettencourt, Lyndon White, Vaibhav Dixit

Doubly Ensemble Movie Prediction with Social Media Data Using TBEEF   *MLOSS Repository*

RACKAUCKAS C, CAI W, JARVIS C, XU C, CHING A   *August 10, 2013*

The Jormungand Climate Model   *OhioLINK Electronic Theses and*
                                                                           Dissertation Center

RACKAUCKAS C   *July 11, 2013*

Water Quality Monitoring of Maryland's Tidal Waterways, HPCF-2012-12   *UMBC HPCF*

LE R, **Rackauckas C**, ROSS A, ULLOA N. ADVISORS: POPURI S, NEERCHAL N, SMITH B   *October 2012*

Notable Software

JuliaSim   *Julia Computing*

CREATOR AND LEAD DEVELOPER   *November 2019 - Present*

- Julia platform for ML-accelerated modeling and simulation
- Automates the acceleration of causal and acausal modeling with neural surrogates

Pumas   *Pumas-AI*

CREATOR AND LEAD DEVELOPER   *July 23, 2017 - Present*

- Julia platform for integrated pharmacometrics
- Integrates nonlinear mixed effects modeling and fitting for Pk/Pd, PBPK, QSP that mixes with NCA and more
- High efficiency mixed with automated parallelism and cloud scaling

DifferentialEquations.jl   *SciML Organization*

CREATOR AND LEAD DEVELOPER   *May 11, 2016 - Present*

- Julia package for solving various forms of differential equations
- Supports stochastic (partial) differential equations (S(P)DEs) via recent research algorithms
- Utilizes multi-node parallelization and GPU/Xeon Phi acceleration for HPC applications
- Implements finite element and finite difference solvers for various important nonlinear (S)PDEs

Invited Presentations

Scientific Machine Learning as a Future for AI in Pharmacometrics   *Virtual*

AI IN PHARMACOMETRICS WORKSHOP BY NOVARTIS   *December 13th, 2023*

Invited Seminar

Generalizing Scientific Machine Learning and Differentiable Simulation Beyond Continuous Models   *Virtual*

NORTHWESTERN SEMINAR SERIES   *December 6th, 2023*

Invited Seminar

Bringing Symbolic-Numeric Computing to Industrial Scientists and Engineers with Julia's SciML and ModelingToolkit.jl   *Virtual*

JOINT CUNY/COURANT/NCSU SEMINAR IN SYMBOLIC-NUMERIC COMPUTING   *December 4th, 2023*

Invited Seminar, https://sites.google.com/view/symbolic-numeric-seminar/

Generalizing Scientific Machine Learning and Differentiable Simulation Beyond Continuous Models   *Seattle*

UNIVERSITY OF WASHINGTON AEROASTRO SEMINAR   *November 28th, 2023*

Invited Seminar

Generalizing Scientific Machine Learning and Differentiable Simulation Beyond Continuous Models   *Virtual*

UIUC MACHINE LEARNING READING GROUP   *November 17th, 2023*

Invited Seminar

JuliaSim: Scientific Machine Learning and Digital Twins for System-Level Modeling   *Dresden*

UNIVERSITY OF DRESDEN SEMINAR   *November 14th, 2023*

Invited Seminar

Automatic Differentiation and SciML: what can go wrong, and what to do about it

Erlangen

Julia High Energy Physics (JuliaHEP) Workshop

November 13th, 2023

Invited Workshop, https://indico.cern.ch/event/1292759/

Maintaining Large Scale Julia Ecosystems

Erlangen

Julia High Energy Physics (JuliaHEP) Workshop

November 11th, 2023

Invited Workshop, https://indico.cern.ch/event/1292759/

Generalizing Scientific Machine Learning and Differentiable Simulation Beyond Continuous Models

Virtual

Alan Turing Institute Phi-ML meets Engineering Seminar Series

October 26th, 2023

Invited Seminar, https://www.turing.ac.uk/events/phi-ml-meets-engineering-generalizing-scientific-machine-learning-and-differentiable

Generalizing Scientific Machine Learning and Differentiable Simulation Beyond Continuous models

Virtual

LLNL Data-driven Physical Simulations (DDPS) Seminar Series

October 20th, 2023

Invited Seminar, https://www.youtube.com/watch?v=16jtJDiJIuU

Differentiable Simulation, Neural ODEs, and Universal ODEs: The Real Bits

Amsterdam

CWI Autumn School - Scientific Machine Learning and Dynamical Systems

October 15th, 2023

Invited Workshop,
https://www.cwi.nl/nl/events/cwi-research-semester-programs/autumn-school-scientific-machine-learning-semester-programme/

Improved Parallelism and Memory Performance Differentiating Stiff Differential Equations

Virtual

ICIAM 2023

August 29th, 2023

Invited Talk, https://www.youtube.com/watch?v=5jat8moluUM

Improving Model Discovery with Imposed Structure through Scientific Machine Learning

Heidelburg

Carl Zeiss Stiftung Summer School 2023

August 17th, 2023

Invited Talk, https://www.youtube.com/watch?v=5jat8moluUM

Large Language Models (LLMs) for Pharmacology: Where are they Useful?

Virtual

ISoP Virtual QSP Week, QSP+ML Panel

August 16th, 2023

Invited Talk / Panel Discussion

Generalizing Scientific Machine Learning and Differentiable Simulation Beyond Continuous Models

Virtual

Argonne ANL AI Applied Speaker Series

August 14th, 2023

Invited Seminar

Julia's SciML: Scientific Machine Learning through Symbolic Numerics

Virtual

Ecological Society of America (ESA)

August 9th, 2023

Invited Talk

The Details of Making Nonlinear Mixed Effects Modeling Fast

Toronto

Joint Statistical Meetings 2023

August 9th, 2023

Invited Talk, https://ww2.aievolution.com/JSMAnnual/index.cfm

The Special Math of Translating Theory to Software in Differential Equations

Cambridge

Synergistic Interactions between Theory and Computation (ASE60)

July 27th, 2023

Keynote, https://math.mit.edu/events/ase60celebration/program/, https://www.youtube.com/watch?v=s_t6dIKjUUc

Scientific Machine Learning through Symbolic Numerics

Cambridge

JuliaCon 2023

July 24th, 2023

Keynote, https://www.youtube.com/watch?v=tynmTkpdAME

Automating Mechanistic Modeling with Scientific Machine Learning

London

Conference on Deep Learning for Computational Physics (Maths4DL)

July 6th, 2023

Keynote

Automating Mechanistic Modeling with Scientific Machine Learning

Trondheim

Norwegian University of Science and Technology Julia Special Seminar

June 7th, 2023

Keynote

Julia for Differentiable Control

San Diego

AMERICAN CONTROL CONFERENCE

May 30th, 2023

Invited Talk, Workshop on Differentiable Programming for Modeling and Control of Dynamical Systems
https://d-biswa.github.io/Differentiable-SysCon/

Julia for Differentiable Control

San Diego

AMERICAN CONTROL CONFERENCE

May 30th, 2023

Invited Talk, Workshop on Differentiable Programming for Modeling and Control of Dynamical Systems
https://d-biswa.github.io/Differentiable-SysCon/

Differentiable Simulation and SciML: Fast Solving and Automated Model Construction

Las Angeles

USC QUANTITATIVE AND COMPUTATIONAL BIOLOGY SEMINAR SERIES

May 25th, 2023

Invited Seminar

Differentiable Simulation and SciML: Fast Solving and Automated Model Construction

Irvine

UCI APPLIED MATHEMATICS SEMINAR

May 24th, 2023

Invited Seminar

Extending Scientific Machine Learning and Automatic Differentiation to Stochastic Financial Models

New York

BLOOMBERG-COLUMBIA ML IN FINANCE 2023

May 19th, 2023

Invited Talk, https://cfe.columbia.edu/events/9th-annual-bloomberg-columbia-machine-learning-finance-workshop-2023

Differentiable Simulation and SciML: Fast Solving and Automated Model Construction

St. Louis

WASHINGTON ST. LOUIS APPLIED ENGINEERING SEMINAR

May 11th, 2023

Invited Seminar

Extending Scientific Machine Learning to Agent-Based Models

Virtual

ICLR

May 5th, 2023

Invited Talk in AI4ABM, https://iclr.cc/virtual/2023/workshop/12840, https://www.youtube.com/watch?v=fm277BM3Y8M

Differentiable Simulation and Scientific Machine Learning: Fast Solving and Automated Model Construction

Virtual

MODELING ALPHABET TALK SERIES

April 20th, 2023

Invited Seminar

Julia Scientific Machine Learning for Industrial Modeling and Simulation

Eindhoven

SIUOX TECHNOLOGIES SPECIAL EVENT

April 18th, 2023

Keynote

Differentiable Simulation and Scientific Machine Learning: Fast Solving and Automated Model Construction

Virtual

ARGONNE NATIONAL LABS LANS SEMINAR

April 12th, 2023

Invited Seminar, https://www.anl.gov/event/differentiable-simulation-and-scientific-machine-learning-fast-solving-and-automated-model

Scientific Machine Learning with Julia: ML-Assisted Model Development and Simulation Analysis

Virtual

FDA MODELING AND SIMULATION WORKING GROUP SEMINAR

February 16th, 2023

Invited Seminar

Machine Learning for Pharmacology: Is It Ready?

Montreal, Canada

SAFETY PHARMACOLOGY SOCIETY ANNUAL MEETING

September 12th, 2022

Keynote Debate Session

Scientific Machine Learning: Mixing Physics with Machine Learning for Speed and Accuracy

Virtual

MICROSOFT RESEARCH INTERNAL SEMINAR

August 23rd, 2022

Improving Forecasting by Merging Deep Learning with Mechanistic Modeling

Washington DC

SIGKDD 2022

August 15th, 2022

Keynote and Panelist, https://kdd-milets.github.io/milets2022/

SIGKDD 2022

Washington DC

FRAGILE EARTH 2022: AI FOR CLIMATE MITIGATION, ADAPTATION, AND ENVIRONMENTAL JUSTICE

August 15th, 2022

Panelist, https://ai4good.org/fragile-earth-2022/

Integrating equation solvers with probabilistic programming through differentiable programming *Virtual*

COMPUTATIONAL ABSTRACTIONS FOR PROBABILISTIC AND DIFFERENTIABLE PROGRAMMING WORKSHOP *July 29th, 2022*

https://mlg.eng.cam.ac.uk/capp-workshop/

Automating Predictive Modeling with Differentiable Simulation *Virtual*

NASA/ESA GN&C V&V SEMINAR SERIES *July 21st, 2022*

https://jarvis.nist.gov/events/aims2022

Accurate and Efficient Physics-Informed Learning Through Differentiable Simulation *Virtual*

AMERICAN STATISTICAL ASSOCIATION (ASA) SCIENTIFIC COMPUTING WEBINAR SERIES *April 20th, 2022*

https://www.youtube.com/watch?v=Xwh42RhB7O4

Accurate and Efficient Physics-Informed Learning Through Differentiable Simulation *Virtual*

NIST WORKSHOP: ARTIFICIAL INTELLIGENCE FOR MATERIALS SCIENCE (AIMS) *July 13th, 2022*

https://jarvis.nist.gov/events/aims2022

Lessons on Scientific Machine Learning *Virtual*

PSU SUMMER SCHOOL IN ASTROINFORMATICS II *June 15th, 2022*

Associated lab: https://github.com/Astroinformatics/ScientificMachineLearning

Ph.D. Course on Scientific Machine Learning *Virtual*

DTU COMPUTE GRADUATE SCHOOL (ITMAN) *June 13th, 2022*

Week long Ph.D Course http://www2.compute.dtu.dk/ apek/SCIML2022/

Scientific Machine Learning: Where We Are and Where We Need To Go *Virtual*

LINKÖPING UNIVERSITY SOFTWARE AND SYSTEMS RESEARCH SEMINAR SERIES *June 10th, 2022*

ELLIIT Distinguished lecture

Data-Efficient and Model Discovery with Scientific Machine Learning *Virtual*

PYTORCH INTERNAL SEMINAR *May 16th, 2022*

Data-Efficient and Model Discovery with Scientific Machine Learning *Virtual*

ELLIT FOCUS PERIOD, DATA-DRIVEN MODELLING AND LEARNING FOR CANCER IMMUNOTHERAPY, LUND *May 5th, 2022*

Accurate and Efficient Physics-Informed Learning Through Differentiable Simulation *Virtual*

UT AUSTIN ODEN INSTITUTE *April 26th, 2022*

Accurate and Efficient Physics-Informed Learning Through Differentiable Simulation *Virtual*

AMERICAN STATISTICAL ASSOCIATION (ASA) *April 19th, 2022*

Accurate and Efficient Physics-Informed Learning Through Differentiable Simulation *Virtual*

RAYTHEON BBN *January 27th, 2022*

Accurate and Efficient Physics-Informed Learning Through Differentiable Simulation *Virtual*

BROWN MACHINE LEARNING + X SEMINAR *December 3rd, 2021*

Accurate and Efficient Scientific machine learning (SciML) Through Differentiable Simulation *Virtual*

SINGAPORE-MIT ALLIANCE FOR RESEARCH AND TECHNOLOGY (SMART) CENTRE RAMP SEMINAR *December 2nd, 2021*

Data-Efficient and Interpretable AI with Scientific Machine Learning *Virtual*

RECENT ADVANCES IN AI FOR NATIONAL SECURITY (RAAINS) *November 18th, 2021*

Invited Vanguard Topics Talk

The Use and Practice of Scientific Machine Learning *Virtual*

FREIBURG YOUNG SCIENTIST AI NETWORK *November 12th, 2021*

Novel methodology, case studies and collaboration opportunities, career opportunities for young trainees

Cardiac Physiome 2021

Invited panelist

Virtual

October 5th, 2021

The Continuing Advances of Differentiable Simulation

AAAI Science-Guided AI Symposium

Keynote Presentation

Virtual

October 5th, 2021

The Continuing Advances of Differentiable Simulation

Oxford Mathematical Brain Modeling Group

Virtual

September 21st, 2021

New Horizons in Modeling and Simulation with Julia

The 14th International Modelica Conference

Keynote Presentation

Virtual

September 20th, 2021

Pharmacometrics-Informed Deep Learning with DeepNLME

42nd Conference of the International Society for Clinical Biostatistics (ISCB), Invited Session

https://www.youtube.com/watch?v=fU7ueuz6rjQ

Virtual

July 20th, 2021

Scientific Machine Learning and Stiffness

Argonne LANS Seminar

Virtual

April 21st, 2021

Julia Webinar: Differential Equations

Los Alamos National Laboratory

Virtual

April 7th, 2021

Scientific Machine Learning and Stiffness

NSF AI Institute for Artificial Intelligence and Fundamental Interactions (IAIFI) Seminar

https://youtu.be/FENK1SDvPiA

Virtual

March 25th, 2021

High Efficiency Differential Equation Solving and Scientific Machine Learning

KROME School

Virtual

February 26th, 2021

Scientific Machine Learning: Introduction

KROME School

Virtual

February 26th, 2021

Scientific Machine Learning: More Predictive ML with Less Data

Data Science Summit '21

https://youtu.be/VKx-Yky8rQQ

Virtual

February 26th, 2021

Scientific Machine Learning and Stiffness

MIT Mechanical Engineering Seminar

Virtual

February 9th, 2021

Stiffness in Scientific Machine Learning

Cornell SCAN Seminar

Virtual

December 7th, 2020

A Foundation for Automated High Performance Scientific Machine Learning

Lancaster Data Science of the Natural Environment Seminar

Virtual

November 26th, 2020

A Foundation for Automated High Performance Scientific Machine Learning

Oxford Computational Mathematics and Applications Seminar

Virtual

November 19th, 2020

A Primer on Universal Differential Equations

CMU SciML Webinar Course

Virtual

November 19th, 2020

A Foundation for Automated High Performance Scientific Machine Learning

Johns Hopkins Applied Physics Laboratory

Virtual

November 19th, 2020

A Foundation for Automated High Performance Scientific Machine Learning

University of Pennsylvania Applied Mathematics and Computational Science Seminar

Virtual

October 30th, 2020

Composable Abstractions for Scientific Machine Learning

Buzzconf

Keynote Presentation, https://youtu.be/3hM7wn7iJ70

Virtual

July 31st, 2020

Automated Discovery and Acceleration of Physical Equations with Julia's Scientific Machine Learning (SciML) Ecosystem

ARPA-E Physics-Informed and Scientific Machine Learning Seminar

Virtual

July 22nd, 2020

COVID-19 Epidemic Mitigation via Scientific Machine Learning (SciML)

CovZoom Panel

https://youtu.be/jMhPZFZ0yvE

Virtual

July 6th, 2020

Cheap But Effective: Instituting Effective Pandemic Policies Without Knowing Who's Infected

COVID-19 seminar, MIT-Air Force AI Accelerator

https://youtu.be/-_8MWoX5rvU

Virtual

June 26, 2020

Universal Differential Equations for Scientific Machine Learning

Mitsubishi Electronic Research Lab

Virtual

May 7th, 2020

Universal Differential Equations for Scientific Machine Learning

Modeling, Computation, Nonlinerarity, Randomness and Waves Seminar, University of Arizona

https://youtu.be/5zaB1B4hOnQ

Virtual

April 16th, 2020

Generalized Physics-Informed Learning Through Language-Wide Differentiable Programming

AAAI 2020 SPRING SYMPOSIUM SERIES

https://youtu.be/SEhMWkgcTOI

Virtual

March 24th, 2020

Universal Differential Equations for Scientific Machine Learning

Numerical Analysis and PDEs Seminar

University of Delaware

February 21th, 2020

Universal Differential Equations for Scientific Machine Learning

Scientific Computing Seminar

https://youtu.be/bBH8HVEr0-A

Florida State University

February 19th, 2020

Interpretable and Pharmacologically-Informed Machine Learning with Universal Differential Equations

Takeda Digitalks Seminar

Takeda

February 12th, 2020

Universal Differential Equations for Scientific Machine Learning

3rd Physics-Informed Learning Workshop

Santa Fe

January 15th, 2020

Neural Differential Equations as a Basis for Scientific Machine Learning

Applied Mathematics Seminar

Dartmouth

November 19th, 2019

Neural Differential Equations as a Basis for Scientific Machine Learning

Invited Seminar

UC Irvine

November 8th, 2019

Neural Differential Equations as a Basis for Scientific Machine Learning

Biomathematics Seminar

UCLA

November 7th, 2019

Neural Differential Equations as a Basis for Scientific Machine Learning

Weierstraß-Institut

Seminar Numerische Mathematik

November 4th, 2019

Modern Programming Languages for Science and Statistics: R and Julia

Oberwolfach Research Institute for Mathematics (MFO)

Leibniz MMS Summer School 2019

November, 2019

Week long workshop in Julia and R for scientific computing

The Mathematical and Computational Basis of Next Generation Pharmacometrics

University of Buffalo

Invited Seminar

October 10th, 2019

Recent Advancements in Differential Equation Solver Software

Lund University

Future Directions of System Modeling and Simulation Invited Talk

September 30th, 2019

https://www.youtube.com/watch?v=76gLISrSEro

Neural Differential Equations as a Basis for Scientific Machine Learning

Massachusetts Institute of Technology

MIT SIAM Distinguished Seminar Series

September 24th, 2019

The Mathematical and Computational Basis of Next Generation Pharmacometrics

Cambridge Innovation Center

ISoP Invited iPSP Talks

August 26th, 2019

Fast Optimization under Uncertainty for Precision Airdrop

Airforce Research Lab

CRDInAL TIM

July 16th, 2019

Model-Free Scientific Computing with Neural Differential Equations

National Institutes of Science and Technology (NIST)

ACMD Invited Seminar

July 10th, 2019

Merging Differential Equations with Machine Learning through Differentiable Programming

National Institutes of Health (NIH)

Invited Seminar

July 9th, 2019

Merging Differential Equations with Machine Learning through Differentiable Programming

Los Alamos National Lab

Invited Seminar

June 25th, 2019

Handling Multiscale Stochastic Differential Equations in Julia

Snowbird, Utah

SIAM Dynamical Systems

May 22nd, 2019

Merging Differential Equations with Machine Learning through Differentiable Programming

Flatiron Institute

New York Julia Meetup

May 17th, 2019

Modern Differential Equations Solver Software: Where We Are and Where We're Headed

Airforce Research Lab

Invited Seminar

February 14th, 2019

Julia and DifferentialEquations.jl

Alan Turing Institute

Epirecipes Workshop

September 30th, 2018

https://www.youtube.com/watch?v=_TK_s3uThWA

Efficient Integration of Stochastic Biological Models

UC Riverside

Partial Differential Equations & Applied Math Seminar, UC Riverside

April 11th, 2018

Efficient High Order Adaptive Time Stepping for Langevin and Brownian Dynamics

UC Irvine

Molecular Dynamics Seminar, UC Irvine Department of Chemistry

April 4th, 2018

Mixing Flexibility with Speed through DifferentialEquations.jl: From Stochastic Differential Equations to Zebrafish Hindbrain Development

Smart Grid Seminar, Los Alamos National Lab

Center for Nonlinear Studies

November 7th, 2017

The Hidden Noise in Biological Randomness

Tsukuba Global Science Week

Awarded Best Speaker Award

University of Tsukuba

September 26th, 2017

Superspace Refinement of the (3+1) Dimensional Incommensurately Modulated Phase of the Hydrated Sodium Salt of a Commodity Dye Intermediate

American Crystallography Association Annual Meeting

Award Margaret C. Etter Student Lectuer Award

Sheraton Waikiki Beach Hotel

July 22, 2013

Did a Jormungand state exist? An investigation using the Budyko-Widiasih model

Mathematics of Climate Research Network

Webinar

March 6th and 20th , 2013

Other Notable Presentations

NonlinearSolve.jl: Efficient rootfinding and solving of algebraic equations in Julia

JuliaCon Local Eindhoven

https://www.youtube.com/watch?v=O-2F8fBuRRg

Eindhoven

December 1st, 2023

Scientific Machine Learning for Industrial Modeling and Simulation

Detroit / Ann Arbor Julia Meetup

Virtual

October 16th, 2023

JuliaSim: Scientific Machine Learning and Digital Twins for System-Level Modeling

2023 International Modelica Conference

Aachen

October 9th, 2023

Scientific Computing + Machine Learning = SciML

Eindhoven Julia User's Meetup

Eindhoven

February 29th, 2023

The SciML Common Solver Interface

2023 SIAM Conference on Computational Science and Engineering

Amsterdam

February 29th, 2023

The Continuing Advances of Differentiable Simulation

2022 SIAM Conference on Mathematics of Data Science

Virtual

September 30th, 2022

Stably Accelerating Stiff Quantitative Systems Pharmacology Models: ContinuousTime Echo State Networks as Implicit Machine Learning

FOSBE 2022

Virtual

August 28th, 2022

How to debug Julia simulation codes (ODEs, optimization, etc.!)

JuliaCon 2022

https://youtu.be/g-iOOhh2U6o

Virtual

June 29th, 2022

LinearSolve.jl: because A
b is not good enough

JuliaCon 2022

https://youtu.be/JWI34_w-yYw

Virtual

June 28th, 2022

Stably Accelerating Stiff Quantitative Systems Pharmacology Models: Continuous-Time Echo State Networks as Implicit Machine Learning

QSPC 2022

Chosen for a Flash Talk

Virtual

April 20th, 2022

State of SciML
Virtual

SciMLCon 2022

March 23rd, 2022

https://www.youtube.com/watch?v=eSeY4K4bITI

Peregrination of a raconteur through maths, computing, and life with Chris Rackauckas (MIT)
Virtual

Random Walks Podcast

December 24th, 2021

https://anchor.fm/random-walks/episodes/Peregrination-of-a-raconteur-through-maths--computing--and-life-with-Chris-Rackauckas-MIT-e1c4cla

A Comparison of Automatic Differentiation and Adjoints for Derivatives of Differential Equations
Virtual

IEEE HPEC 2021

September 23rd, 2021

https://www.youtube.com/watch?v=6hhF6Llv4sI

JuliaSim: Machine Learning Accelerated Modeling and Simulation
Virtual

JuliaCon 2021

July 30th, 2021

https://www.youtube.com/watch?v=lNbU5jNp67s

Simulating Big Models in Julia with ModelingToolkit
Virtual

JuliaCon 2021

July 24th, 2021

https://www.youtube.com/watch?v=HEVOgSLBzWA

Opening the Blackbox: Accelerating Neural Differential Equations
Virtual

Thirty-eighth International Conference on Machine Learning (ICML) 2021

July 21st, 2021

https://www.youtube.com/watch?v=rFzWuXu7wFA

Symbolics.jl - High performance symbolic numerics via multiple dispatch
Virtual

International Symposium on Symbolic and Algebraic Computation (ISSAC) 2021

July 21st, 2021

https://www.youtube.com/watch?v=rFzWuXu7wFA

JuliaSim: Accelerated Simulation of Stiff HVAC Systems with Continuous-Time Echo State Networks
Virtual

16th U.S. National Congress on Computational Mechanics

July 28th, 2021

https://www.youtube.com/watch?v=ZaYinbYWkYE

Accelerated Large-Eddy Simulation via Universal Partial Differential Equations
Virtual

SIAM Conference on Mathematical & Computational Issues in the Geosciences (GS21)

June 22nd, 2021

https://www.youtube.com/watch?v=MV9-RIN0uYw

Accelerating Quantitative Systems Pharmacology with Machine Learning
Virtual

Society of Mathematical Biology 2021

June 15th, 2021

https://www.youtube.com/watch?v=KLjJps268Wc

Accelerating Simulation of Stiff Nonlinear Systems using Continuous-Time Echo State Networks
Virtual

AAAI-MLPS 2021

March 22nd, 2021

https://youtu.be/3lM-Stc7z28

The Julia SciML Ecosystem: Scientific Machine Learning as a Software Problem
Virtual

SIAM Computational Science and Engineering

March 5th, 2021

https://youtu.be/XRJ-rtP2fVE

Chris Rackauckas - Physics-Informed Neural Networks (PINNs), Podcast #42
Virtual

The Engineered-Mind Podcast

March 5th, 2021

https://youtu.be/OmySUTFwh2g

The Stardust Podcast #7 - Christopher Rackauckas
Virtual

The Stardust Podcast

December 28th, 2020

https://youtu.be/uoz08EqSpmY

DeepNLME in Pumas
Virtual

Pumas-AI

November 9th, 2020

https://youtu.be/Z_-WxpaygB0

GPU Acceleration of Quantitative Systems Pharmacology (QSP) Workflows
APPLIED BIOMATH QSP SUMMIT
https://youtu.be/npXtqYAvcvU

Virtual
November 5th, 2020

Automated Discovery of Mechanistic Models via Universal Differential Equations
APPLIED BIOMATH QSP SUMMIT
https://youtu.be/AKwqJxhKkoA

Virtual
November 5th, 2020

Differential Equations in 2021
DIGIWELL TEAM MEETING
https://youtu.be/Xl-iHixmGgg

Virtual
October 21st, 2020

Stability-Optimized High Order Methods for Pathwise Stiffness in Stochastic Differential Equations
IEEE HPEC 2020
https://youtu.be/u5vbjmCKvIg, awarded Outstanding Paper Award

Virtual
September 25th, 2020

Auto-Optimization and Parallelism in DifferentialEquations.jl
JULIACON 2020
https://youtu.be/UNkXNZZ3hSw

Virtual
July 29th, 2020

Doing Scientific Machine Learning (SciML) with Julia
JULIACON 2020
https://youtu.be/QwVO0Xh2Hbg

Virtual
July 26th, 2020

Scientific AI: Domain Modeling with Integrated Machine Learning
JULIACON 2019
https://www.youtube.com/watch?v=FGfx8CQHdQA

University of Maryland, Baltimore
July 23rd, 2019

PuMaS.jl: Pharmasceutical Modeling and Simulation Engine
JULIACON 2018
https://www.youtube.com/watch?v=KQ4Vtsd9XNw

University College London
August 9th, 2018

Solving Partial Differential Equations in Julia
JULIACON 2018
https://www.youtube.com/watch?v=okGybBmihOE

University College London
August 7th, 2018

Simulation and Control of Biological Stochasticity
PHD DEFENSE
https://www.youtube.com/watch?v=_h5fVDvGp-8

UC Irvine
June 5th, 2018

The Unique Features and Performance of DifferentialEquations.jl
JULIACON 2017
https://www.youtube.com/watch?v=75SCMIRlNXM

UC Berkley
June 20, 2017

DifferentialEquations.jl: A performant and feature-rich ecosystem for solving differential equations
AGS SYMPOSIUM 2017
https://www.youtube.com/watch?v=Oojdf2oKHh4

UC Irvine
June 20, 2017

Water Quality Monitoring of Maryland's Tidal Waterways
SHENANDOAH UNDERGRADUATE MATHEMATICS CONFERENCE (SUMS)
Awarded Best Poster Presentation in Statistics

James Madison University
September 29, 2012

Teaching Experience

Applied Mathematics Instructor
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MIT
2019-Present

- Created and taught a course "Scientific Machine Learning and Parallel Computing", a graduate course which received over 100 students from across the Greater Boston area.
- Created a curriculum and taught a course "Linear Partial Differential Equations" on the mathematics and computation of PDEs

Google Summer of Code Administrator and Mentor

JuliaLang

GOOGLE SUMMER OF CODE

2017-Present

- Helped students prepare project plans and guided them through technical aspects.
- Reviewed student code and led them to developing new software packages.

Data Science Initiative Instructor

UC Irvine

UC IRVINE DATA SCIENCE INITIATIVE

2016-2018

- Developed and taught 5 workshops on advanced Julia programming.
- Mentored teams of students in machine learning for the Mobile Data Science Hackathon.

Systems Biology and Big Data Short Course Workshop Tutor

UC Irvine

UC IRVINE CENTER FOR COMPLEX BIOLOGICAL SYSTEMS

2014-2017

- Taught Mathematica and MATLAB to workshop participants

Teaching Assistant

UC Irvine

UC IRVINE DEPARTMENT OF MATHEMATICS

2014-2015

- Taught upper division courses: Mathematical Biology, Probability and Statistics II, Numerical Differential Equations, and Mathematical Finance.
- Lectured twice a week. Developed quizzes. Graded quizzes, homeworks, and exams.

Professional Affiliations

International Society of Pharmacometrics, ISoP

Society for Industrial and Applied Mathematics, SIAM