Christopher V. **Rackauckas**

Mathematician · Software Engineer · Theoretical Biologist

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Research focus: How do biological organisms control/use noise (randomness), and how can scientists/clinicians utilize the information in noise?

Summary

Applied Mathematician	Experience with computational mathematics, stochastic processes, dynamical systems, and statistics.
Scientist	Experimental and theoretical research in physics, biology, climatology, economics, and chemistry.
Software Engineer	Over eight years of experience with individual and team software engineering in academia and industry.
Programming Polyglot	Adept at transferring knowledge to quickly learn new mathematics, software, tools, and programming languages.
Project Manager	Experience managing a large open-source software development community (JuliaDiffEq).

Research Interests

Mathematics	Stochastic (Partial) Differential Equations, Computational Differential Equations, Stochastic Analysis
Computation	High-Performance Parallel Computing, Machine Learning, "Big Data", Julia, Package Development
Biology	Systems, Developmental, Zebrafish, Craniofacial, Hindbrain, Cell Lineages, Breast Cancer

Education

University of California, Irvine — *Irvine, California*

Ph.D. in Mathematics — *Expected 2019*

- Certificate in Data Science

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%)

Current Research Projects

High-Order Adaptive Methods for Stiff Stochastic ODEs — *Numerical SODEs*

PI: Prof. Q. Nie, University of California, Irvine — *2014-Present*

- Utilizing high-order Stochastic Runge-Kutta methods for SODEs to develop adaptive stiff SODE methods.
- Implementing the solutions as high-performance open source packages.

Machine Learning for the Optimization of Numerical Methods for Stochastic ODEs — *Numerical SODEs*

PI: Prof. Q. Nie, University of California, Irvine — *2017-Present*

- Analyzing the mathematical problem from an experimental viewpoint and applying scientific methods.
- Implementing machine learning methods to optimize the numerical methods for various properties.
- Identifying computationally-efficient high-order implicit methods.

Mechanisms for Controlling Variability in Biological Organisms — *Mathematical Biology*

PI: Prof. Q. Nie, University of California, Irvine — *2013-Present*

- Developed phenomenological (S)PDE models of retinoic acid signaling pathways of zebrafish.
- Identified network motifs which are used to attenuate the noise in the response signal.

Work Experience

Project Manager, Baidu, Inc. — *Hong Kong, China*

Research in Industrial Projects for Students (RIPS-HK) — *Summer 2013*

- Lead an international team of researchers on a mathematical/computational research project for Baidu, Inc.
- Developed new algorithms in R, Python, and C for movie recommendation utilizing machine learning techniques.

Research Assistant — *Oberlin, Ohio*

Oberlin College Department of Chemistry and Biochemistry — *2012-2013*

- Modeled incommensurate crystal structures using x-ray diffraction data from crystallography experiments.
- Solved for the modulated structure for low temperature crystals of "H-Acid", a commodity dye intermediate.

Web Developer — *Oberlin, Ohio*

Oberlin College Residential Education — *2009 - 2013*

- Created and maintained secure web forms and programs in PHP and Perl.
- Developed the associated MYSQL relational databases for the housing data.
- Wrote scripts to convert housing data into interactive Excel sheets for use by non-programmers.

Web Developer — *Oberlin, Ohio*

Freelance — *2009 - 2013*

- Created and maintained websites for professors and businesses.
- Scripted interfaces to ensure that information could be updated by individuals without programming experience.
- Examples: Fernando Gomez Herrero's personal page (fernandogomezherrero.com), Acoustik Musik LTD. (acoustikmusik.com), and my personal page (chrisrackauckas.com).

Publications

DifferentialEquations.jl - A Performant and Feature-Rich Ecosystem for Solving Differential Equations in Julia — *Journal of Open Research Software*

Rackauckas C, Nie Q — *May 25, 2017*

Adaptive Methods for Stochastic Differential Equations via Natural Embeddings and Rejection Sampling with Memory — *Discrete and Continuous Dynamical Systems Series B*

Rackauckas C, Nie Q — *September 1, 2017*

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

Sosnik J, Zheng L, Rackauckas C, Digman M, Gratton E, Nie Q, Schilling T — *April 12, 2016*

On The Budyko-Sellers Energy Balance Climate Model with Ice Line Coupling — *Discrete and Continuous Dynamical Systems – Series B*

Walsh J, Rackauckas C — *September 2015*

Assessment of Statistical Methods for Water Quality Monitoring in Maryland's Tidal Waterways — *SIAM Undergraduate Research Online*

Le R, Rackauckas C, Ross A, Ulloa N. — *April 17, 2013*

Technical Reports

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

DifferentialEquations.jl — *Github Repository*

Rackauckas C — *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.

Triple Bagged Ensemble Ensemble Framework (TBEEF) — *MLOSS Repository*

Rackauckas C, Cai W, Jarvis C, Xu C, Ching A — *August 10, 2013*

- Machine learning software in R, Python, and C for recommendation problems using double ensembles.
- Over 1,000 downloads as of May 11, 2016.

Teaching Experience

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-Present*

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

Systems Biology Short Course Workshop Tutor — *UC Irvine*

UC Irvine Center for Complex Biological Systems — *2014-Present*

- 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.

Calculus Tutor — *Oberlin, Ohio*

Oberlin College Mathematics Department — *2009-2010*

- Responsibilities included teaching Oberlin College students first and second semester calculus.

Extracurricular Activities

Pro Bono Web and Data Analysis Software Engineer — *Virtual*

Maryland Department of Natural Resources — *2012 - 2013*

- Developed statistical analysis software for analyzing the output of data from continuous monitoring stations.
- Analyses were made to run through a graphical user interface (GUI) so that researchers and educators could be able to run the sophisticated statistical analyses without prerequisite programming knowledge.
- Developed an animated water quality map to be displayed on the Department of Natural Resources "Eyes on the Bay" website that would show the changes in the environment over time to help educate the public on the changing environmental conditions.

Representative for the Biological Sciences — *UC Irvine*

UC Irvine Associated Graduate Students — *2014-2015*

- Held positions in the Social and the Funding Committees

Honors & Awards

Fellowships and Scholarships

2017	**Best Speaker Award**, Tsukuba Global Science Week	*TGSW*
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

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*

Miscellaneous

2014	**Outstanding Presentation Award**, Mathematical Association of America	*MAA*
2013	**Certificate of Appreciation**, Maryland Department of Natural Resources	*DNR*
2007	**Eagle Scout**, Boy Scouts of America	*BSA*

Presentations

The Hidden Noise in Biological Randomness — *University of Tsukuba*

Tsukuba Global Science Week — *September 26th, 2017*

Adaptive Methods for Stochastic Differential Equations via Natural Embeddings and Rejection Sampling with Memory — *CRM, Barcelona*

3rd BCN Workshop on Stochastic Analysis — *July 1st, 2016*

How do biological organisms interpret noisy signals? A peak into mathematical systems biology — *UC Irvine*

Associated Graduate Students Graduate Research Symposium — *April 22, 2016*

Superspace Refinement of the (3+1) Dimensional Incommensurately Modulated Phase of the Hydrated Sodium Salt of a Commodity Dye Intermediate — *Sheraton Waikiki Beach Hotel*

American Crystallography Association Annual Meeting — *July 22, 2013*

Was the Earth Entirely Covered by Glaciers? A Mathematical Investigation of "Snowball Earth" — *Oberlin College*

Honors Presentation — *May 9, 2013*

Did Glaciers Cover the Planet? An Inquiry Into "Snowball Earth" — *Oberlin College*

Senior Symposium — *April 26, 2013*

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

Mathematics of Climate Research Network *March 6th and 20th , 2013*

Water Quality Monitoring of Maryland's Tidal Waterways *James Madison University*

Shenandoah Undergraduate Mathematics Conference (SUMS) *September 29, 2012*

Skills

Mathematics	**Stochastic** (partial) differential equations, real/complex analysis, abstract algebra, computational algebra, differential geometry, dynamical systems, mathematical modeling, numerical analysis, scientific computing, optimization, probability, mathematical statistics, computational statistics, Bayesian statistics, information theory, machine learning, time series analysis, algorithmic analysis, and theory of computation.
Programming	**Julia**, MATLAB, Mathematica, C (MPI), C++, R, Python, Javascript, PHP, (MY)SQL, and HTML5/CSS3
Science	**Systems** biology, molecular biology, developmental biology, evolutionary biology, electrodynamics, classical/Lagrangian/Hamiltonian mechanics, quantum mechanics, statistical mechanics, general relativity, micro/macroeconomics, econometrics, biophysics, general chemistry, physical chemistry, and analytical chemistry.
Notable Software	**Linux** and Adobe Master Collection
Engineering	**Software** engineering, audio engineering, digital signal processing, and control theory.

Professional Affiliations

American Crystallographic Association, ACA
American Mathematical Society, AMS
Mathematical Association of America, MAA
Mathematics of Climate Research Network, MCRN
Society for Industrial and Applied Mathematics, SIAM
Society for the Advancement of Chicanos and Native Americans in Science, SACNAS
Sigma Xi