Benjamin P. Russo

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Employment History

Research Scientist Current

Riverside Research - Applied Mathematics and Physics Solutions Group

–Group focus on computational physics problems.

–Development of new algorithms and codebase improvements.

Postdoctoral Research Associate July 2021 - April 2024

Oak Ridge National Laboratory - Data Analysis and Machine Learning

–Developed machine learning algorithm for model predictive control of the boundary plasma state in a tokamak.

–Developed streaming compression algorithms for scientific data based on learning the underlying dynamics.

–Research on systems identification, compression, dimension reduction, and applications.

–Writing and publishing research articles.

–Writing grant proposals.

Assistant Professor September 2018 - July 2021

Farmingdale State College SUNY

–Teaching college level courses ranging from algebra to real analysis.

–Organized seminars for students and faculty.

–Development of mathematics courses.

–Writing and publishing research articles.

Visiting Assistant Professor August 2016 - August 2018

University of Connecticut

–Teaching college level courses ranging from algebra to real analysis.

–Managing teams of teaching assistants.

Education

Ph.D in Mathematics May 2016

University of Florida, Advisor: Scott McCullough

M.S. in Mathematics May 2012

University of Florida

B.S. in Mathematics and Physics May 2010

University of Florida

Programming Languages and computing

Python – Fluent, **MATLAB** – Intermediate, **FORTRAN** – Intermediate, **LaTeX** – Fluent.

Experience: Extensive experience in machine learning and computational packages such as Numpy, SciPy. Experienced in ML technology such as PyTorch and version control software Git. Some experience in HPC: completed HPC crash course at ORNL.

Research Interests

machine learning, kernel methods, data compression, data analysis, system identification, surrogate modeling, dynamical systems, functional analysis, operator theory, matrix analysis, applied functional analysis, reproducing kernel Hilbert spaces, quantum information theory.

Publications

Machine learning / computational mathematics

STOKEDMD: Streaming Occupation Kernel Dynamic Mode Decomposition, *Applied Mathematics for Modern Challenges*, Volume 2, Issue 4: 433-464, 2024, with Efrain H. Gonzalez, M. Paul Laiu, and Richard Archibald.

Weighted Composition Operators for Learning Nonlinear Dynamics, *IFAC-Papers Online*, Volume 58, Issue 17, 97-102, 2024, with Daniel A. Messenger, David Bortz, Joel A. Rosenfeld.

Kernelized approaches to streaming compression of scientific data, *Applied Mathematics for Modern Challenges*, Volume 2, Issue 3, 322-347, 2024, with Richard Archibald.

Convergence of weak-SINDy Surrogate Models, *SIAM Journal on Applied Dynamical Systems*, Volume 23, Issue 2, 1017-1051, 2024, with M. Paul Laiu.

The Occupation Kernel Method for Nonlinear System Identification, *SIAM Journal on Control and Optimization*, Volume 62, Issue 3, 1643-1668, 2024, with Joel Rosenfeld, Rushikesh Kamalapurkar, and Taylor T Johnson.

Time-dependent SOLPS-ITER simulations of the tokamak plasma boundary for model predictive control using SINDy, *Nuclear Fusion*, Volume 63, Number 4, 2023, with J.D. Lore, S. De Pascuale, P. Laiu, J.-S. Park, J.M. Park, S.L. Brunton, J.N. Kutz, and A.A. Kaptanoglu.

Fault Detection via Occupation Kernel Principal Component Analysis, *IEEE Control Systems Letters*, Vol 7. 2023, with Zachary Morrison, Yingzhao Lian, Rushikesh Kamalapurkar.

Occupation Kernels and Densely Defined Liouville Operators for System Identification, *2019 IEEE Conference on Decision and Control Proceedings*, with Joel Rosenfeld, Rushikesh Kamalapurkar, and Taylor T Johnson.

Motion Tomography via Occupation Kernels, *Journal of Computational Dynamics,* Volume 9, Issue 1, 27–45, 2021, with Rushikesh Kamalapurkar, Dongsik Chang, and Joel Rosenfeld.

Streaming Compression of Scientific Data via weak-SINDy, with M. Paul Laiu, and Richard Archibald (*accepted*)

Theoretical Foundations for Higher Order Dynamic Mode Decomposition, with Joel Rosenfeld and Rushikesh Kamalapurkar (*in submission*)

Occupation Kernel Hilbert Spaces for Fractional Order Liouville Operators and Dynamic Mode Decomposition, with Joel Rosenfeld and Xiuying Li (*in submission*)

Operator theory/complex analysis

Spectra for Toeplitz Operators Associated with a Constrained Subalgebra, *Integral Equations and Operator Theory*, Volume 94, Issue 2, 2022, with Christopher Felder and Douglas Pfeffer.

The 3-isometric Lifting Theorem, *Integral Equations and Operator Theory*, Volume 84, no. 1, 69–87, 2016, with Scott McCullough

Lifting Commuting 3-Isometric Tuples, *Operators and Matrices*, Volume 11, no. 2, 397–433, 2017.

The Mittag Leffler Reproducing Kernel Hilbert Spaces of Entire and Analytic Functions, *Journal of Mathematical Analysis and Applications*, Volume 463, Issue 2, 576–592, 2018, with Joel Rosenfeld and Warren Dixon

Liouville operators over the Hardy space, *Journal of Mathematical Analysis and Applications*, Volume 508, Issue 2, 2021, with Joel Rosenfeld.

Quantum information theory/ quantum probability theory

A non-commutative Bayes' Theorem, *Linear Algebra and its Applications*, Volume 644, 28–94, 2022, with Arthur Parzygnat.

Non-commutative disintegrations: existence and uniqueness in finite dimensions, *Journal of Noncommutative Geometry,* Vol. 17, No. 3, pp. 899–955, 2023, with Arthur Parzygnat.

Bayesian inversion and the Tomita–Takesaki modular group, *The Quarterly Journal of Mathematics,*Volume 74, Issue 3, 2023, with Luca Giorgetti, Arthur J. Parzygnat, Alessio Ranallo

Talks/Presentations

Invited

AMS Special Session on Operators, Function Spaces, and Models January 2016
Sub-Jordan Operator Tuples

IWOTA Special Session on Multivariable Operator Theory July 2016
Sub-Jordan Operator Tuples

Graduate Mathematics Association, University of Florida February 2016
Dilations and Completely Positive Maps

SIGMA Seminar, University of Connecticut October 2016
Dilations and Completely Positive Maps

AMS Sectional Meeting Special Session, Indiana University April 2017
A Generalization of the Fock Space

AMS Special Session on Operators on Function Spaces – JMM January 2018
A Generalization of the Fock Space

AMS Special Session, University of Delaware September 2018
C-algebras and the Category of Stochastic Maps*

WINRS Special Session, University of Virginia September 2018
Fractional Derivatives and the Segal Bargmann Space

AMS Special Session on Multivariable Operator Theory – JMM January 2019
C-algebras and the Category of Stochastic Maps*

IWOTA Special Session on Free-Analysis and Free Probability July 2019
C-algebras and the Category of Stochastic Maps*

AMS Special Session on Recent Progress in Operator Theory November 2019
Occupation Kernels and Liouville Operators

American Control Conference Workshop June 2020
Motion Tomography via Occupation Kernels

Mathematics in Computation Seminar, ORNL June 2021
Embedding Non-Linear Systems Data into a Reproducing Kernel Hilbert space

Marquette University Mathematics Colloquium April 2022
System Identification Techniques

JMM Special Session on the Interplay of Matrix Analysis and Operator Theory April 2022
Applications of Reproducing Kernels to Dynamical Systems in the Sciences

University of Tennessee - Analysis Seminar May 2022
Spectra for Toeplitz Operators Associated with a Constrained Subalgebra

University of South Florida Mathematics Colloquium May 2022
System Identification Techniques

International Symposium on Mathematical Theory of Networks and Systems September 2022
Kernelized Active Subspaces

SIAM Conference on the Mathematics of Data Science September 2022
Data Driven System Identification and Surrogate Modeling

SIAM Conference on Imaging Science May 2024
Streaming Compression of Scientific Data Through Surrogate Modeling

Contributed

Southeastern Analysis Meeting, University of Georgia March 2015
The Equivalence of Lifting and Factorization for 3-Isometric Tuples

Great Plains Operator Theory Symposium, Purdue University May 2016
The Equivalence of Lifting and Factorization for 3-Isometric Tuples

Southeastern Analysis Meeting, University of South Florida March 2016
Multivariate Lifting Theorems with an Application

Southeastern Analysis Meeting, University of Tennessee March 2017
A Generalization of the Fock Space

Hilbert Function Spaces, Gargnano, Italy May 2017
A Generalization of the Fock Space

UConn Math Club, University of Connecticut October 2017
The Game of Hex

Northeastern Analysis Meeting, University of Albany October 2017
A Generalization of the Fock Space

Southeastern Analysis Meeting, University of Alabama March 2019
C^*-algebras and the Category of Stochastic Maps

Mathematics in Computation Seminar, ORNL July 2021
Analysis of the use of System Identification Techniques to Generate Surrogate Models

Oak Ridge Postdoctoral Associate Research Symposium, ORNL May 2023
System Identification and Surrogate Modeling

AI Expo Poster Session, ORNL Sept 2023
Convergence of weak-SINDy Surrogate Models

Mathematics in Computation Seminar, ORNL Sept 2023
An Overview of Reproducing Kernel Hilbert Spaces

CCSD Seminar, ORNL Sept 2023
Reproducing Kernel Hilbert Spaces in Machine Learning

Referee Activity

Operators and Matrices

Annales de l'institut Fourier

Banach Journal of Mathematical Analysis

Czechoslovak Mathematical Journal

Journal of Mathematical Analysis and Applications

23rd Asian Quantum Information Science Conference (AQIS)

Automatica

SIAM Journal on Applied Dynamics (SIADS)

Computational Methods and Function Theory (CMFT)

Autonomous Robots

Complex Analysis and Operator Theory (CAOT)

Mentoring

Periodic Cycles on the Riemann Sphere under Möbius Transformations
with Farmingdale undergraduate Anthony Ercolano

StOKeDMD: Streaming Occupation Kernel Dynamic Mode Decomposition
Efrain Gonzalez – USF Graduate Student and GEM Fellow

Dissertation Committee
Himanshu Singh – USF Mathematics

Dissertation Committee
John Kyei – USF Mathematics