

# Benjamin P. Russo

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## Employment History

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### 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 2023

*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

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### 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

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**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

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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

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### Machine learning / computational mathematics

**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*)

**STOKEDMD: Streaming Occupation Kernel Dynamic Mode Decomposition** with Efrain H. Gonzalez, M. Paul Laiu, and Richard Archibald. (*in submission*)

**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

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### 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*

<b>JMM Special Session on the Interplay of Matrix Analysis and Operator Theory</b> <i>Applications of Reproducing Kernels to Dynamical Systems in the Sciences</i>	April 2022
<b>University of Tennessee - Analysis Seminar</b> <i>Spectra for Toeplitz Operators Associated with a Constrained Subalgebra</i>	May 2022
<b>University of South Florida Mathematics Colloquium</b> <i>System Identification Techniques</i>	May 2022
<b>International Symposium on Mathematical Theory of Networks and Systems</b> <i>Kernelized Active Subspaces</i>	September 2022
<b>SIAM Conference on the Mathematics of Data Science</b> <i>Data Driven System Identification and Surrogate Modeling</i>	September 2022
<b>SIAM Conference on Imaging Science</b> <i>Streaming Compression of Scientific Data Through Surrogate Modeling</i>	May 2024
<b><u>Contributed</u></b>	
<b>Southeastern Analysis Meeting, University of Georgia</b> <i>The Equivalence of Lifting and Factorization for 3-Isometric Tuples</i>	March 2015
<b>Great Plains Operator Theory Symposium, Purdue University</b> <i>The Equivalence of Lifting and Factorization for 3-Isometric Tuples</i>	May 2016
<b>Southeastern Analysis Meeting, University of South Florida</b> <i>Multivariate Lifting Theorems with an Application</i>	March 2016
<b>Southeastern Analysis Meeting, University of Tennessee</b> <i>A Generalization of the Fock Space</i>	March 2017
<b>Hilbert Function Spaces, Gargnano, Italy</b> <i>A Generalization of the Fock Space</i>	May 2017
<b>UConn Math Club, University of Connecticut</b> <i>The Game of Hex</i>	October 2017
<b>Northeastern Analysis Meeting, University of Albany</b> <i>A Generalization of the Fock Space</i>	October 2017
<b>Southeastern Analysis Meeting, University of Alabama</b> <i>C*-algebras and the Category of Stochastic Maps</i>	March 2019
<b>Mathematics in Computation Seminar, ORNL</b> <i>Analysis of the use of System Identification Techniques to Generate Surrogate Models</i>	July 2021
<b>Oak Ridge Postdoctoral Associate Research Symposium, ORNL</b> <i>System Identification and Surrogate Modeling</i>	May 2023
<b>AI Expo Poster Session, ORNL</b> <i>Convergence of weak-SINDy Surrogate Models</i>	Sept 2023
<b>Mathematics in Computation Seminar, ORNL</b> <i>An Overview of Reproducing Kernel Hilbert Spaces</i>	Sept 2023
<b>CCSD Seminar, ORNL</b> <i>Reproducing Kernel Hilbert Spaces in Machine Learning</i>	Sept 2023

## Referee Activity

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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

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**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