J. Rae Chipera

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Research Interests

Nonlinear dynamics and irregular activation functions in reservoir computing (echo state networks); fractal and chaotic systems as models for real-world data; applied machine learning for scientific classification tasks. Broader interests include explainable AI, computational learning theory, and AI for disaster response.

Education

National University – PhD Candidate, Data Science **2022 – Present**

Dissertation: Beyond Smooth Activations: Irregular Functions for Modeling Chaotic Data Patterns in Neural Networks

Committee: Dr. Jenny Du (Chair), Dr. Irene Tsapara (Department Head & Academic Reader), Dr. Khaldoon Dhou (Subject Matter Expert)

National University – MBA, Quantitative Finance **2015 – 2016**

National University – BBA **2013 – 2015**

Carnegie Mellon University – Deep Learning Bootcamp **2022**

Massachusetts Institute of Technology – Machine Learning Bootcamp **2022**

Defense Language Institute – Modern Standard Arabic **2006 – 2008**

Publications

Chipera, R., Du, J., & Tsapara, I (2025). Beyond Lipschitz Continuity and Monotonicity: Fractal and Chaotic Activation Functions in Echo State Networks. arXiv: 2512.14675.

Thesis

Chipera, J.R. (2016). A Notional $1.1 Trillion Collar Trade Over the Financial Crisis: Would It Have Saved Us? National University.

Teaching Experience

Private Mathematics Instructor **2024 – Present**

Rio Rancho, New Mexico

- Provided individualized instruction in Geometry, Algebra II, AP Calculus, AP Statistics, and college statistics
- Prepared students for undergraduate-level coursework and standardized examinations

Technical Instructor, Signals Intelligence Operations **2008 – 2011**

- Provided technical instruction to adult learners in signals intelligence operations
- Delivered training in high-stakes, operational environments

Research Experience

Doctoral Researcher – National University **2022 – Present**

- Developed the Degenerate Echo State Property (d-ESP) framework for fractal and chaotic activation functions in reservoir computing
- Applied novel architectures to Galaxy Zoo 2, Gravity Spy, and a control dataset
- Co-authored publication (in review) indexed on arXiv and NASA ADS

Industry Experience

Jaxorik AI Research Group – Founder & Principal Investigator **2022 – Present**

Rio Rancho, New Mexico

- SDVOSB/WOSB eligible LLC focused on explainable AI for disaster response and defense applications
- SAM.gov and Disaster Response registered; pursuing government contracting opportunities with DOE, FEMA and national laboratories
- Developing air-gapped and light-compute AI tools for defense and emergency management use cases

Professional Memberships

- Association for Computing Machinery (ACM)
- Society of Women Engineers (SWE)

Additional Qualifications

- Arabic language proficiency: Modern Standard Arabic, Iraqi and Egyptian dialects (Defense Language institute trained)
- U.S. Marine Corps veteran: Iraq deployment OIF 2008 – 2009
- TS/SCI security clearance (lapsed)