Ronak Tali

1940 Long Rd, Unit F.
Ames, IA 50010

253.867.7315
r.tali@live.com

Education

Iowa State University, Ames, IA
Ph.D. Electrical Engineering *expected* August 2026.

Utah State University, Logan, UT
M.S. in Statistics, August 2020.

Georgia Institute of Technology, Atlanta, GA
M.S. in Industrial Engineering, December 2012.

Veer Surendra Sai University of Technology, Odisha, India
B.S. in Mechanical Engineering, June 2007.

Research Interests

Geospatial Analytics, Scientific Machine Learning, and Big Data Generation, management and governance.

Papers

"A multi-electrode electrical clamp for rapid, non-destructive estimation of internal stalk cavity volume", Smart Agricultural Technology, *In-Review*

We evaluate an electrical sensing strategy for estimating internal cavity volume using a flexible multi-electrode clamp. Applying small voltages across electrode pairs and measuring the resulting pairwise resistances yields a characteristic resistance pattern that reflects how current is diverted around low-conductivity, air-filled voids. Because cavity volume is mechanistically linked to structural weakening, it provides a biologically meaningful target for screening stalk strength. Using a three-dimensional finite-element model of a stalk containing an ellipsoidal cavity, we simulate current flow for thousands of virtual geometries and compute pairwise electrode resistances in the low-frequency limit of impedance. Regression models trained on this library, with gradient boosting performing best, accurately predict cavity volume for previously unseen geometries ($R^2 \approx 0.99$). Once trained, inference is performed at the millisecond scale, supporting rapid screening workflows.

"Flowbench: A large-scale benchmark for flow simulation over complex geometries", Journal of Data-centric Machine Learning Research**,** Apr 2025.

We introduce FlowBench, a dataset for neural simulators with over 10K samples, which is currently larger than any publicly available flow physics dataset. FlowBench contains flow simulation data across complex geometries (parametric vs. non-parametric), spanning a range of flow conditions (Reynolds number and Grashoff number), capturing a diverse array of flow phenomena (steady vs. transient; forced vs. free convection), and for both 2D and 3D. FlowBench contains over 10K data samples, with each sample the outcome of a fully resolved, direct numerical simulation using a well-validated simulator framework designed for modeling transport phenomena in complex geometries. We enumerate several evaluation metrics to help rank order the performance of current (and future) neural PDE solvers. We benchmark the performance of several methods, including Fourier Neural Operators (FNO), Convolutional Neural Operators (CNO), DeepONets, and recent foundational models.

“SEARS: a lightweight FAIR platform for multi-lab materials experiments and closed-loop optimization”, Royal Society of Chemistry – Digital Discovery, Sep 2025

The Shared Experiment Aggregation and Retrieval System (SEARS) is an open-source, lightweight, cloud-native platform that captures, versions, and exposes materials-experiment data and metadata via FAIR, programmatic interfaces. Designed for distributed, multi-lab workflows, SEARS provides configurable, ontology-driven data-entry screens backed by a public definitions registry (terms, units, provenance, versioning); automatic measurement capture and immutable audit trails; storage of arbitrary file types with JSON sidecars; real-time visualization for tabular data; and a documented REST API and Python SDK for closed-loop analysis (e.g., adaptive design of experiments) and model building (e.g., QSPR). We illustrate SEARS on doping studies of the high mobility conjugated polymer, pBTTT, with the dopant, F4TCNQ, where experimental and data-science teams iterated across sites using the API to propose and execute new processing conditions, enabling efficient exploration of ternary co-solvent composition and annealing temperature effects on sheet resistance of doped pBTTT films. By making data findable, accessible, interoperable, and reusable across teams, SEARS lowers the barrier to collaborative materials research and accelerates the path from experiment to insight.

“MPFBench: A Large-Scale Dataset for SciML of Multi-Phase-Flows: Droplet and Bubble Dynamics”, Journal of Data-centric Machine Learning Research**,** Apr 2025.

Multiphase fluid dynamics, such as falling droplets and rising bubbles, are critical to many industrial applications. However, simulating these phenomena efficiently is challenging due to the complexity of instabilities, wave patterns, and bubble breakup. This paper investigates the potential of scientific machine learning (SciML) to model these dynamics using neural operators and foundation models. We apply sequence-to-sequence techniques on a comprehensive dataset generated from 11,000 simulations, comprising one million time snapshots, produced with a well-validated Lattice Boltzmann method (LBM) framework. The results demonstrate the ability of machine learning models to capture transient dynamics and intricate fluid interactions, paving the way for more accurate and computationally efficient SciML-based solvers for multiphase applications.

“Byzantine Resilient Federated REINFORCE (GM-FedREINFORCE)”, 2023 International Conference for Machine Learning Applications**,** December 2023.

Recent advancements in federated learning have inspired the emergence of federated reinforcement learning, wherein multiple agents learn a policy in a federated manner without sharing trajectories. However, one of the key challenges in federated learning lies in dealing with adversarial attacks, such as Byzantine attacks. This work addresses this challenge by introducing the GM-FedREINFORCE algorithm, which extends the REINFORCE method-an established policy gradient technique-and provides robust theoretical guarantees on its convergence even in the face of adversarial attacks. We do this by replacing the mean step of GD by Geometric median. Remarkably, our algorithm remains effective when less than half of the agents are under attack, ensuring robust learning. To validate our theoretical claims, we conducted empirical experiments on benchmark RL environments with both discrete and continuous action spaces. Specifically, we employed the Cart-Pole environment to evaluate discrete action spaces and the Cart-Pole Swing-Up environment to assess continuous action spaces. Our experimental results confirm the effectiveness of our algorithm, showcasing its ability to successfully learn policies even under Byzantine attacks.

Research in Progress

"NURBS based sparse approximation of Digital Elevation Maps"
Working in collaboration with John Deere – Intelligent Services Group
We employ techniques from Solid Geometry to perform signal processing on USGS Digital Elevation Maps at 1m resolution to replace sharp features (high gradients/curavtures) with smooth basis spline curves with C^3 smoothness guarantees. These corrected maps are critical for downstream control systems approximations.

"Genetics, Environment and Management (G.E.M) segregated latent space approximation of crop lifecycle"
Work funded by AI Institute for Resilient Agriculture, Iowa State University.
We collect multi-modal data (satellite imagery, soil, weather, elevation) from Google Earth Engine over several years and merge them with on-field measurements and management practices to design a segregated latent space that learns the plant growth physics from the G.E.M perspective. This latent space will be used for a range of downstream tasks, such as, yield prediction, plant stress risk estimation, etc.

Teaching Assistant Experience

Undergraduate: Theoretical Foundations of Computer Engineering.
Master of Science: Deep Learning – Theory and Applications, Statistical Learning and Data Mining – II.

Tools And Techniques

QGIS, Google Earth Engine, Python - Native and Scientific computing, PyTorch, Computer Vision based techniques for data cleaning and preprocessing, Web-based Application development using React, Next.js

Professional Experience

REI, Kent, WA, 2014 – 2018
Data Scientist
At REI, I built high-impact analytics solutions across forecasting, marketing, and customer analytics. I developed demand forecasting models using the Prophet framework (GAM and STAN) that achieved up to 99% accuracy, a churn prediction model using GBMs with an AUC near 80%, and a fully in-house, behavior-based marketing attribution model that replaced an industry-leading vendor and provided a holistic, customer-level view of channel performance. I also designed a multi-level clustering framework that became the organization-wide customer segmentation standard and created innovative experimental designs that enabled zip-code-level testing despite platform limitations, reducing cost and risk

Fedex Corporation, Memphis, TN, 2013 - 2014
Senior Revenue Science Analyst
At FedEx, I developed customer profile vectors within verticals to identify future sales opportunities and measure market penetration and built a customer lifecycle and churn model for international customers that enabled early intervention and prevented losses of nearly 48,000 packages per day. I also created multivariate statistical models to optimize retail store location decisions, helping avoid estimated lifetime losses of over USD 1.2 million per store due to poor placement.

Systems Engineer, Redmond, WA and Pune India, 2007 – 2011
Systems Engineer
At TCS, I developed a server monitoring tool using Lean Six Sigma methodologies that generated over USD 100,000 in cost savings for a large-scale, ongoing project valued at more than USD 1 million. I also implemented extensive software test automation, reducing manual testing effort by over 80% on average and significantly improving delivery efficiency and quality.

References

Prof. Baskar Ganapathysubramanian (Advisor)
Joseph C. and Elizabeth A. Anderlik Professor in Engineering and Professor Mechanical Engineering
Director, AI Institute for Resilient Agriculture
ISU Plant Science Institute Fellow
Department of Electrical and Computer Engineering (by courtesy)
Iowa State University
2029 Union Dr, Ames, IA 50011
Phone (515) 294 – 7442
Email – baskarg@iastate.edu

Prof. Soumik Sarkar
Walter W. Wilson Faculty Fellow in Engineering and Professor Mechanical Engineering
Director, Translational AI Center (TrAC)
ISU Plant Science Institute Fellow
Department of Computer Science (by courtesy)
Iowa State University
2029 Union Dr, Ames, IA 50011
Phone (515) 294 – 5212
Email – soumiks@iastate.edu

Dr. Talukder (Zaki) Jubery
Research Scientist – III
Translational AI Center (TrAC)
Iowa State University
1111 Woi Rd, Ames, IA 50011
Phone (515) 294 – 1423
Email – znjubery@iastate.edu