Isaac D. Gerg, Ph.D.
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Google Scholar, LinkedIn, ResearchGate

Professional Experience

Applied AI Scientist, Climate.Ai 2025–Present

- Led comprehensive research on weather-integrated consumer spending prediction, taking the idea from first principles to an authored paper accepted to the Journal of Retailing and Consumer Services (a top-tier journal for quantitative behavioral modeling) within six months of joining; validated the model across 1.2M training runs, improving forecast accuracy by 11.5% on average and exceeding 60% in some locations.
- Developed calibrated worldwide probabilistic forecasting methodology achieving 20+% CRPSS improvement over NBM, GEFS, and, operational ECMWF systems, validated against hundreds of locations spanning diverse climatologies; leveraged GEFS, CFSv2, SEAS5, CHELSA, NBM, ERA5, and teleconnection indices to enhance product reliability for agricultural and disaster planning customers.
- Built a verification toolkit enabling rapid retrieval of weather data (2000–present) and computation of forecast skill metrics (BSS, CRPSS, twCRPSS, CSI, MSE, bias) for arbitrary locations at lead times out to six months.
- Designed and deployed a nightly global QA dashboard tracking forecast skill at daily, weekly, and monthly timescales across key variables (t2mmin, t2mmax, t2m, precipitation, wind speed), catching underperformance and bad ingested data for our custom AI produced forecast and enabling rapid assessment of deliverable forecast quality for prospective clients.
- Created a cost/loss ratio analysis tool quantifying customer savings versus incumbent forecast systems, translating forecast skill directly into business value for sales and customer success conversations.
- Instituted an AI-agent-forward development methodology with rigorous verification of agent outputs, saving months of engineering effort while improving forecast skill and training/inference speed.
- Provided deep learning architectural guidance for watershed flood prediction models, advising on neural network design and training strategies to improve hydrological forecasting for climate risk assessment.
- Advised Customer Success team on technical requirements and use cases for Department of Defense customers, translating complex weather prediction capabilities into actionable solutions for military operational planning and logistics.
- Selected as Session Chair for the Maritime/Air Object Recognition session at IEEE IGARSS 2026; previously served as Session Chair for the Classification and Pattern Recognition session at IEEE OCEANS, moderating technical presentations on machine learning applications in oceanographic research.

Creator, ApertureLab — Synthetic Aperture Sonar Simulator (Gerg Ltd) 2026–Present

- Designed and built an end-to-end synthetic aperture sonar (SAS) simulation and beamforming workbench that generates physics-accurate, automatically labeled sonar imagery at scale, addressing the core data bottleneck blocking foundation models and modern AI for underwater perception.
- Implemented the complete signal chain in one tool: GPU ray-trace acoustic scattering, 36-channel complex IQ time-series synthesis, and integrated TDBP and ω-k beamforming producing georeferenced SLC and DRC imagery, with output in industry-interchange formats (POSSM-compatible HDF5, XTF, MSHDF) for drop-in use with real sonar pipelines.
- Built a visual scene editor and node-graph procedural seafloor system (calibrated ripple/roughness spectra, parametric bathymetry, backscatter, and rock placement), enabling one seeded recipe to regenerate thousands of statistically distinct seafloors for domain-randomized sim-to-real training.
- Enabled overnight generation of million-image labeled datasets on a single workstation, with per-image ground truth (object class, position, orientation, burial depth, seafloor type, shadow masks) that would require decades of ship time to collect at sea.
- Demonstrated cross-modality capability by rendering both real-aperture side-scan and SAS imagery from a single physics engine and scene file, supporting cross-modality transfer studies.
- Grounded the engine in peer-reviewed sonar science spanning GPU-accelerated TDBP reconstruction, micronavigation interpolation kernels, and validated sub-bottom acoustic simulation; supports a research arc culminating in zero-shot VLM classification of SAS imagery at 0.946 AUC (IEEE IGARSS 2026).

Staff Computer Vision Researcher, Kitware, Inc. 2023–2025

- DARPA Acoustic Foundation Models: Led development of acoustic foundation models for diverse SWaP hardware, enabling few-shot learning and semantic similarity on 1TB+ undersea dataset. Enhanced ML scientists' effectiveness through mentorship on acoustic phenomenology, advanced signal processing, and deployment realities including live sea trial support.
- Navy Few-Shot Learning for SAS Sonar Imagery: Developed few-shot learning techniques for sonar imagery, effectively leveraging abundant unlabeled public data to achieve state-of-the-art results on real-world datasets and reduce labeled training data requirements by 90%.
- ONR Interpretability & Synthetic Data: Used mechanistic interpretability to evaluate how synthetic data fidelity impacts real-world neural network performance.
- HPC & ML Infrastructure Leadership: Improved team research velocity by implementing HPC best practices, developing scalable ML infrastructure (PyTorch), and contributing to CI/CD frameworks, saving an estimated 2,000+ man-hours for teams of 2-5 researchers.
- Advanced ML Methods & Experimentation: Developed and evaluated ML methods (CNNs, MLPs, YOLO-X, Transformers) for varied sensor data (MWIR, SAR, SAS, Acoustics). Orchestrated thousands of large-scale experiments on HPC systems and advised team on interpreting results using NN theory.
- Research Portfolio Expansion: Identified novel ML/AI applications for complex sensor data, spearheading proposal efforts that secured $2M+ in DARPA and Navy SBIR funding within the first 9 months.
- Research Dissemination: Expanded research visibility by presenting findings at DoD NAML (invited speaker), DoD ATRWG, IEEE IGARSS, and Acoustical Society of America (invited speaker) conferences.

Research Faculty & Senior Scientist, Penn State Applied Research Lab 2009–2023

- Developed the ASASIN real-time synthetic aperture sonar (SAS) image formation software (CUDA/C++/Jax) to address critical undersea drone bottlenecks, achieving a 100x speed increase and 10x power reduction, earning the lab's highest award and remaining in use today. Implemented full CI/CD pipeline with automated regression testing and version control.
- Advanced underwater remote sensing by pioneering novel non-image ML representations and computer vision algorithms for SAS, achieving state-of-the-art performance published in multiple IEEE journals (TGRS, JOE, JSTARS). Developed novel ML methods across diverse tasks including classification, segmentation, anomaly detection, and representation learning.
- Spearheaded rapid prototyping of diverse signal processing algorithms by implementing complex mathematical frameworks for critical detection challenges. Delivered working solutions across domains including active seismic detection, signal separation, 3D reconstruction, and aerial/satellite hyperspectral unmixing.
- Identified critical Navy ML capability gaps, proposing innovative technical solutions that secured 10 consecutive years of ONR funding and established lasting international research collaborations.
- Maintained 100% soft-money funding through research excellence while completing PhD in 4 years. Established collaborations with Univ. of Bath, Penn State, NATO CMRE, Hershey Medical, & IPEG.

Invited Research Scientist, NATO Centre for Maritime Research and Experimentation 2018

- Selected for competitive NATO visiting scientist position in Italy; developed novel Fourier domain analysis techniques for synthetic aperture sonar imagery, achieving state-of-the-art ML results. This work produced enduring source code, led to publication, and earned highest performance review.

Software Engineer → Senior Systems Engineer, Raytheon 2004–2009

- Promoted from Software Engineer to Systems Engineer based on demonstrated algorithmic and DSP expertise. Developed C++ DSP software packages (Hilbert transform, demodulation, frequency hop processing) for large-scale distributed signal processing system (Top 50 supercomputer).
- Led two successful IRAD initiatives: pioneered low-SWaP processing by integrating software-defined radio with early CUDA acceleration, and developed simulated annealing optimization for temporal network visualization.
- Transformed academic research (MS thesis) into funded IRAD prototype, delivering new capability in high-speed hyperspectral unmixing.

Education

Ph.D., Electrical Engineering, Advisor Prof. Vishal Monga, Thesis: Domain-enriched deep learning for synthetic aperture sonar (SAS) 2022
Pennsylvania State University

M.S., Electrical Engineering, Thesis: Hyperspectral unmixing using constrained optimization 2008
Pennsylvania State University

B.S., Computer Engineering, Schreyer Honors College, Thesis: Realtime gesture recognition on COTS hardware. 2004
Pennsylvania State University — Lion Ambassador

Selected Technical Skills with 10+ Years Experience

Algorithms & Mathematics: Adaptive filtering, Classical machine learning, Deep learning theory, Design of experiments, Global optimization, Linear algebra, Machine learning theory, Nonlinear least squares, PDEs, Physical modeling, Statistical testing

Machine Learning: Adversarial example mitigation, Classification, Detection, Domain transfer, Enhancement, Few-shot learning, Generative AI, LLMs, Open-set recognition, Out-of-distribution detection, Segmentation, Self-supervised learning

Phenomenologies: Active sonar acoustics, Air acoustics, Communications (HF/VHF/UHF), Hyperspectral, MWIR, NIR, Passive underwater acoustics, Radar, Remote sensing for Meteorology, SAR/SAS, SWIR, Tabular data, Text, Video

Programming: C++, CUDA, Cython, Git, HPC (SLURM, PBS), Jax, Julia, Keras, Lightning, MATLAB, NumPy/SciPy, Python, PyTorch, TensorFlow

Signal & Image Processing: Acoustic/RF processing, Beamforming, Demodulation, Filter design, Geolocation, Image compression, K-space processing, Photogrammetry, SLAM, 3D reconstruction, Visual odometry, Wave propagation physics

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Selected Awards & Recognition

- 2nd Place, IEEE OCEANS Poster Competition (2021)
- 3rd Place (of 239), IEEE IGARSS Student Paper Competition (2021)
- Penn State ARL Engineering Award of Excellence (2016) for ASASIN software, out of 1000+ engineers and scientists

Publications & Software

A full list is available on ResearchGate and Google Scholar.Software projects available on GergLtd.