Kai van Brunt

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EDUCATION

Massachusetts Institute of Technology Cambridge, MA | Class of 2025

B.Sc. in Physics GPA: 4.8/5.0

Coursework: Experimental Physics, Atomic and Optical Physics, Classical Mechanics III, Quantum Physics II, Physics of Solids, Circuits and Electronics, Theory of Computation, Nonlinear Dynamics and Chaos, Functional Analysis, Abstract Algebra, Real Analysis, Differential Equations

Teaching: TA for 8.02 (Physics II) in Spring 2023 · Physics Mentor for 8.01/8.012 (Physics I) in Fall 2022, 2023

RESEARCH

MIT CLIMATE AND SUSTAINABILITY CENTER

Automated Counting of Migrating Salmon Sep 2023 - Present

- Training, evaluating, and fine-tuning computer vision object detection and tracking methods for accurate fish counting using PyTorch, in order to build systems that can generalize to new rivers with minimal additional human labeling.
- Developing hybrid CNN-transformer object detection architecture with capability for backpropagation through time.

MIT LABORATORY FOR NUCLEAR SECURITY AND POLICY

Maneuverability of Atmospheric Reentry Vehicles Jan 2024 - Feb 2024

- Analyzed effects of reentry vehicle geometry on their maneuverability and accuracy using Python.
- Wrote FORTRAN code that performs Monte Carlo integration to determine aerodynamic coefficients of reentry vehicles in hypersonic flow.

LOS ALAMOS NATIONAL LABORATORY

Simulating Turbulence in Rotating Magnetic Stars Jun 2023 - Aug 2023

- Ran simulations, analyzed data to assess the impact of rotation, magnetism on supernova core-collapse mechanisms.
- Evolved stars using 1D stellar evolution code MESA and 3D hydrodynamics code FLASH.

MIT PLASMA SCIENCE AND FUSION CENTER

Energy Dissipation in Sheared Magnetic Fields Sep 2021 - Dec 2022

- Investigated effect of shear magnetic field on turbulence and electron heating in kinetic plasmas through simulations using the spectral code Viriato.
- Presented at the undergraduate poster session at APS-DPP 2022.

PROJECTS

TESTING THE LIMITS OF MANEUVERABLE REENTRY VEHICLES Jan 2025

- Paper in preparation for submission to *Science & Global Security*, analyzing the feasibility of maneuverable reentry vehicles in conventional counterforce scenarios.

COUNTING FISH WITH TEMPORAL REPRESENTATIONS OF SONAR VIDEO Aug 2024

- Presented at ECCV 2024 in the Computer Vision for Ecology workshop.
- Developed lightweight computer vision method for automated salmon counting using temporal representations of sonar video.
- Designed domain-specific image augmentations and weakly-supervised training protocol that improved counting accuracy by 20-30% across test scenarios.

NUCLEAR POWER FOR CARBON-FREE HYDROGEN PRODUCTION Nov 2023

- Economic analysis of nuclear-powered hydrogen production via high-temperature steam electrolysis, developing historically-grounded cost estimates using actual commercial reactor data rather than hypothetical designs.
- Created financial model integrating nuclear plant construction/operation costs, electrolysis plant parameters, and varying electricity source scenarios to determine optimal configuration for hydrogen production.

SKILLS

Programming Languages: Python (numpy, scipy, pandas, matplotlib, pytorch, yt, jupyter), FORTRAN, C++, Julia, Java, Mathematica

Technology: Altium, SolidWorks, Linux, Git, bash, Slurm, emacs, LaTeX, Microsoft Office, Adobe Suite