Brandon Pries

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Education

Michigan State University (MSU) Expected Spring 2022

Bachelor of Science, Astrophysics, College of Natural Science
- Exoplanets, telescopes, stars, galaxies
- Classical/quantum/statistical mechanics, electromagnetism

Minor in Mathematics
- Calculus, linear/abstract algebra, number theory, analysis, partial differential equations (PDEs)

Minor in Computational Mathematics, Science, and Engineering (CMSE)
- Computational modeling, parallelization, Python, C++, Bash, Linux, SLURM, Git

Minor in Data Science
- Probability/statistics, hypothesis testing, sampling, R, SQL

Honors College

GPA 3.9545/4.0

Research Experience

Undergraduate Researcher, IceCube Collaboration, MSU September 2018 – Present

Advisors/Mentors: Claudio Kopper (Faculty)[1,2,3,4,7], Jessie Micallef (Graduate Student)[1,2,3,4,7], Brian Clark (Postdoc)[3,4,7], Mehr Un Nisa (Postdoc)[5,6,7]

1. Optimized structure of Convolutional Neural Networks (CNNs) using grid-search algorithm
2. Explored effects of loss functions on CNN regression problems using 5 different loss functions
3. Reconstructing neutrino events using Recurrent Neural Networks (RNNs) for orders-of-magnitude increase in reconstruction speed
4. Gathering and processing roughly 2 million neutrino events as data for use in RNN research
5. Processing IceCube data to use with neutrino spectra from dark matter annihilation
6. Generating custom probability distribution functions (PDFs) to calculate IceCube sensitivities to annihilation spectra
7. Providing periodic presentations for updates on research progress

Publications and Presentations

Pries, B. *Detecting Neutrinos from WIMPs (Oral)*
MSU Society of Physics Students, October 2021
- WIMPs in dwarf galaxies may be a potential source for IceCube neutrinos
- Flux of neutrinos as IceCube can be used to set limits on WIMP annihilation rates
- Outreach presentation; results from Summer 2021-early Fall 2021 research

Pries, B. and Willey, Nathan. *Recurrent Neural Networks as a Tool for IceCube-Upgrade Reconstructions (Oral)*
Brown University Student Machine Learning Initiative, October 2021
- RNNs are a viable tool for reconstructing low-energy IceCube neutrino events and show comparable results to current reconstructions
- IceCube-Upgrade improves low-energy event resolution beyond limits of current detector geometry

- Eliminating events with high predicted uncertainties improves sample quality and reconstructions
- Results from Summer 2020-Summer 2021 research

Pries, B. *Searching for Dark Matter in Dwarf Galaxies Through Neutrino Production (Poster)*
Mid-Michigan Symposium for Undergraduate Research Experiences (Mid-SURE), July 2021
- Dark matter particles may annihilate into neutrinos that can be detected at Earth
- Detected flux of neutrinos can be used to place limits on dark matter annihilation rates
- Results from early Summer 2021 research

Pries, B. *IceCube-Upgrade Reconstructions using Recurrent Neural Networks (Oral)*
2021 American Physical Society Division of Particles and Fields Meeting, July 2021
- RNNs are capable of reconstructing the energy and direction for low-energy neutrino events
- Could potentially use uncertainty estimates to remove lower-quality events from data sample
- Results from Spring 2021 research

Pries, B. *Recurrent Neural Networks for IceCube-Upgrade Reconstructions (Poster)*
University Undergraduate Research and Arts Forum (UURAF), April 2021
- Energy reconstruction RMS comparable to RetroReco (IceCube low-energy, likelihood-based reconstruction software)
- Directional reconstruction RMS lower than RetroReco RMS at most energies
- Results from Spring 2021 research

Pries, B. *Update on RNN IceCube-Upgrade Reconstructions (Oral)*
Spring 2021 IceCube Collaboration Meeting, March 2021
- Larger dataset led to improved directional and low-energy reconstructions
- Reconstructions are comparable to results from RetroReco (IceCube low-energy, likelihood-based reconstruction software), even on lower-quality data
- Results from Fall 2020-Spring 2021 research

Pries, B. *Recurrent Neural Networks for Low-Energy Neutrino Interaction Reconstruction (Oral)*
MSU Society of Physics Students, October 2020
- Neutrinos are important to study because they are extremely abundant particles and they provide information about the universe
- RNNs can be used to reconstruct neutrino events from the IceCube detector with good accuracy
- Outreach presentation; results from early Summer 2020 research

Pries, B. *Recurrent Neural Networks for IceCube-Upgrade Reconstruction (Oral)*
Fall 2020 IceCube Collaboration Meeting, September 2020
- Preliminary results for RNN reconstructions using Upgrade-geometry data were promising
- Cutting for higher-quality neutrino events greatly improved directional reconstructions
- Results from Summer 2020 research

Pries, B. *Applications of Recurrent Neural Networks to the IceCube-Upgrade (Poster)*
Mid-Michigan Symposium for Undergraduate Research Experiences (Mid-SURE), August 2020
- RNNs are a viable reconstruction method for reconstructing data from upgraded detector
- RNNs are capable of reconstructions orders-of-magnitude faster than current methods
- Results from early Summer 2020 research

Teaching Experience

Undergraduate Learning Assistant (ULA), MSU Spring 2020, Fall 2021 (Present)

AST 207 – The Science of Astronomy, Dr. Gerard "Mark" Voit Fall 2021 (Present)
- Grading homework assignments and providing constructive criticism to approximately 60 students

- Holding office hours to assist students with coursework by answering questions and working through problems
- Assisting in in-class instruction by answering questions and guiding problem solving for approximately 60 students

AST 208 – Planets and Telescopes, Dr. Joseph "Joey" Rodriguez Spring 2020
- Graded homework assignments and provided constructive criticism to approximately 30 students
- Held office hours to assist students with coursework by answering questions and working through problems
- Assisted in astronomy lab instruction by answering questions and guiding problem solving for approximately 30 students

Service and On-Campus Involvement

Vice President, Astronomy Club Fall 2021 (Present)
- Reaching out to Astronomy Department faculty members as potential speakers for club meetings
- Planning joint Astronomy Club/Society of Physics Students field trip to Fermilab for approximately 20 students (expected)
- Working with MSU Observatory Interim Director to plan Astronomy Club tour of the observatory facilities for approximately 10 students (expected)
- Coordinating with President on running meetings with approximately 20 attendees
- Assisting with Presidential duties

Member, Astronomy Club Fall 2018 – Fall 2021 (Present)

Member, Society of Physics Students (SPS) Fall 2018 – Fall 2021 (Present)

Member, MSU Running Club Fall 2018

Member, MSU March of Dimes Chapter Spring 2019

Honors and Awards

Honors College, MSU
Dean's List, Fall 2018 – Spring 2021 (ongoing)
Professorial Assistantship (research scholarship), Fall 2018 – Spring 2020
Outstanding ULA Award (Upper-Level Physics/Astronomy Course), Spring 2021
IceCube Collaboration author list
National Society of Collegiate Scholars (NSCS) member
Phi Sigma Theta (ΦΣΘ) National Honor Society member
Sigma Pi Sigma (ΣΠΣ) National Honor Society member