Garrett Merz
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Github Page: https://github.com/GarrettMerz
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EDUCATION:

University of Michigan, Ann Arbor MI: Ph.D. Physics 2021; M.Sc. Physics, 2017. GPA: 3.744
The Ohio State University, Columbus, OH: B.S. Physics, Mathematics with Honors Research Distinction, 2016. GPA: 3.811

NOTABLE RESEARCH EXPERIENCE:

Intelinair, Inc.
Machine Learning Scientist: November 2021- February 2023
- Lead development of a Hierarchical Pretrained Vision Transformer model based on state-of-the-art work from computational histopathology (proprietary, but based on https://github.com/mahmoodlab/HIPT). Hierarchically pretrained a series of DeiT models on unlabeled agricultural data using DINO and fine-tuned on annotated field state data; adapted to multitask learning and multi-sensor data fusion.
- Designed, built and deployed a ResNet50 classifier with temporal Viterbi-decoder postprocessor for modeling the growth state of corn and soybean fields with 1m Airbus satellite imagery. Trained on synthetic data, generated using transfer functions applied to 10cm fixed-wing RGBN hyperspectral imagery. Dockerized, trained on AWS batch.
- CVPR 2022 Agriculture-Vision Workshop: Discussion panel host, paper reviewer.
- Application task (code at: https://github.com/GarrettMerz/IntelinAirChallenge): built a small U-Net based model for nutrient deficiency segmentation based on (https://arxiv.org/abs/2012.09654)

ATLAS High Energy Experimental Physics Group at University of Michigan
PhD Candidate; Advisor Dr. Thomas Schwarz

Measurements of Higgs Boson Properties in the Diphoton Decay Channel at $\sqrt{s}$ = 13 TeV with the ATLAS Detector: May 2018-April 2021
(https://cds.cern.ch/record/2628771 and https://cds.cern.ch/record/2668103**)**
- First-ever observation of rare top-associated Higgs production process (ttH)
  - (Press Release: https://atlas.cern/updates/briefing/observation-tth-production)
- Generated template signatures for key observable in background classes, perform signal shape parameterization, measure major systematic uncertainties related to signal mismodelling
  - Processed real and synthetic data samples on the Worldwide LHC Computing Grid using HTCondor and CERN Grid cloud-computing architectures
- Developed, implemented and tested a novel Gaussian Process Regression (GPR) Bayesian analysis tool to model shape of underlying continuum background process
  - Validated GPR efficacy using statistical tests across multiple regimes
- As HGAM group DAOD data manager, produced and validated DAOD/xAOD data/Monte Carlo samples
  - Maintained data sample production codebase

CP Properties of Higgs Boson Interactions with Top Quarks in the ttH and tH Processes Using H→γγ with the ATLAS Detector: October 2018-March 2020 (https://arxiv.org/abs/2004.04545)

- Implemented and compared novel "semantically high-level" physics object detection methods using "semantically low-level" features extracted from images of proton-proton collisions taken using CERN's ATLAS Detector. Methods explored include a Gradient Boosted Decision Tree (BDT) in XGBoost and a Maximum Likelihood Estimation based method
- Used synthetic data to train two complementary BDT classifiers to sort observed collision events into null-hypothesis signal, alternative-hypothesis signal, and background categories using a mixture of high-level and low-level engineered features.
- Parameterized expected statistical distributions of major observables for null-signal, alternate-signal, and background events in many regions of differing classifier confidence; perform simultaneous Maximum Likelihood Estimation across these regions in order to measure total contribution of signal process to observed event counts and whether it does or does not conform to null hypothesis
- Supervised undergraduate students in introductory data analysis tasks
- Lead paper editor responsible for writing and maintaining internal analysis documentation
- Presented analysis summary at 2019 USATLAS Collaboration Meeting in Amherst, Massachusetts

Construction and Testing of Prototype Small Monitored Drift Tube Chamber: May 2018-May 2019

- ATLAS authorship qualification task. Traveled to Max Planck Institute in Munich, Germany, to build and test 500 small monitored drift tubes for use in a protoype muon test chamber; assisted in the construction of said muon chamber at Michigan.
- Collected cosmic-ray data using prototype chamber; using this, measured spatial resolution of new chamber
    o Calibrated timing offset for each tube by fitting cosmic-ray tracks

Search for Pair Production of Scalar Leptoquarks Decaying to bτbτ with the ATLAS Detector
June 2017-June 2018 (https://arxiv.org/abs/1902.08103)

- Topic of PhD Candidacy Exam. Validated Monte Carlo pseudodata samples for suppressed "off-diagonal" leptoquark decays (cτcτ/jτjτ); trained Gradient Boosted Decision Tree in XGBoost to discriminate between signal and background events in the monoleptonic tau-lepton decay channel.
- Generated exclusion contour plots for use in setting final statistical limits.

All-Hadronic Search for Vector-Like Quarks in ATLAS at 13 TeV: June 2016-January 2017
(https://arxiv.org/abs/1808.01771)

- Performed trigger efficiency studies to determine optimal ATLAS data acquisition conditions. Developed jet-tagging algorithm to classify variable-radius reclustered hadronic jets.

CMS/CDF Computational Physics Lab at The Ohio State University
Undergraduate Researcher; Advisor Dr. Richard Hughes

Using Convolutional Neural Networks to Identify ttH Events at the LHC: August 2014-June 2016

- Built a simple VGG/AlexNet style Deep Convolutional Neural Network model in Lua/Torch7 to distinguish between signal process (*ttH*) and background (*ttbb*) using raw physics detector signals rather than high-level engineered features. Employed then-novel regularization techniques such as Dropout and BatchNorm to improve performance.
- Compared CNN against MLP-based methods for classification of synthetic event images generated from a simulated high-energy physics detector using the Monte Carlo method
- Poster presented by collaborators at TOP2012 5th International Workshop on Top Quark Physics

Georg-August Universität Göttingen, Second Institute of Physics: June 2014- August 2014
DAAD RISE Intern. Group Leader: Prof. Dr. Arnulf Quadt; Project Advisor: Philipp Stolte

- Assisted in the development of the Kinematic Likelihood Fitter (KLFitter) Framework for kinematic reconstruction of top quark pair production events in the ATLAS detector
- Attended Hadron Collider Summer School (HASCO) program

NOTABLE SCHOLARSHIPS AND LEADERSHIP ROLES:

2018 National Science Foundation Graduate Research Fellowship
2018 UM Science Communication Fellowship Program
2017 Norman Barnett Award
2016 Denman Research Forum, First Prize
2016 National Science Foundation Graduate Research Fellowship, Honorable Mention
2015 Staninovski Mathematics Scholarship
2013 Hellen Cowan Book Award
2012 Valentino Physics Scholarship
2012 Honors Medalist Scholarship
Society of Physics Students, OSU Chapter: *Vice President* 2013-2015

ADDITIONAL MACHINE LEARNING EXPERIENCE:

TOOLS AND PACKAGES:

Proficiency with: C++, UNIX/Linux, git, bash/csh, TensorFlow/Keras, Pytorch/Pytorch-Lightning, Python (scikit-learn, pandas, numpy/scipy, matplotlib/seaborn, rasterio, PIL, beautifulsoup, networkX, nltk, etc.), postgresSQL, AWS, Docker, various ML lifecycle tools such as ClearML and Tensorboard, various agile workflow tools such as JIRA/Confluence, ROOT, pyROOT
Familiarity With: MatLab, Lua, Torch7

- EECS 545: Machine Learning at University of Michigan
  - Covered topics such as Linear/Logistic Regression, Kernels, K-Nearest Neighbors, Support Vector Machines, Decision Trees, Neural Networks
  - Final project: predict political party affiliation from text of political speeches
  - Class projects and assignments on my github page!

- PHYS 510: Statistical Mechanics at University of Michigan
  - Final Project- Second-Order Phase Transitions in Hopfield Neural Networks

- Additional portfolio projects on my github:
  - A Deep Graph Autoencoder-Based Recommender System for Roller Derby Team Lineups
  - Predicting Tweet Sentiment with DistilBERT
  - Semantic Segmentation of Self-Driving Car Images with U-Net
  - Identifying Butterflies with ResNet
  - Using Boosted Decision Trees to Identify Mushroom Edibility

- Attended 2017 Yandex Machine Learning in High Energy Physics summer school in Reading, UK
  - Weeklong course consisting of lectures, hands-on coding sessions, and a Kaggle challenge. Covered topics such as Convolutional/Recurrent Neural Networks, Gaussian Process Regression, GANs, etc.

TEACHING AND SCIENCE COMMUNICATION:

"Saturday Morning Physics: Update on Physics from the LHC": **March 2019**
   •   Assisted in delivery of televised lecture on top-associated Higgs production at ATLAS; performed and discussed various demonstrations.

UM Science Communication Fellowship Program: Spring 2019

• Construct tabletop cosmic-ray detector demonstration; present at UMich Museum of Natural History open houses and public events.

ComSciCon 2019
- Attended seminars on science journalism, data visualization, podcast development. Produced and workshop a piece of science communication writing

UMATLAS Virtual and Augmented Reality Outreach Program: June 2016-April 2021
- Presented ATLASRift virtual reality software (showcasing the ATLAS detector in virtual reality using HTC Vive and Oculus Rift software) to the general public at museums and showcases
- Developed novel pedagogical experiences integrating virtual and augmented reality demonstrations into introductory physics laboratory classes through UMich Center for Academic Innovation XR grant

University of Michigan Dept. of Physics. Graduate Student Instructor: September 2016-December 2017
- Instructor for a total of seven sections of introductory physics lab work
- Designed and administered weekly quizzes and facilitated the completion of weekly lab reports
  - Participated in general physics tutoring through the Physics Help Room