

Oz Amram

Postdoc at Fermilab

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Research Interests

Experimental Particle Physics.

Model-agnostic searches for new physics, jet substructure, precision standard model measurements, calorimeter simulations, silicon pixel trackers

Machine Learning.

Anomaly detection, weakly supervised learning, generative modeling, diffusion, semi-supervised learning, unsupervised learning

Education

2016-2022 **Johns Hopkins University, M.A., Ph.D.**

Thesis : Searching for Anomalies in Proton-Proton Collisions at the Large Hadron Collider Advisors: Morris Swartz and Petar Maksimovic

2012-2016 **Carnegie Mellon University, B.S. Physics.**

Projects

Current

CMS Dijet Anomaly Search.

Lead analyzer in search for dijet resonances with anomalous jet substructure. Search utilizes multiple novel ML anomaly detection methods to reject QCD and enhance anomalies. First CMS search using advanced anomaly detection techniques. Limits will be set on models producing jets with anywhere from 2 to 6 prongs.

Diffusion Models for Calorimeter Simulations.

Employing a new class of ML models to learn to accurately, fast, approximate to GEANT simulations of calorimeter showers. Developed several novel methods for making use of cylindrical geometries and irregular shapes of calorimeter showers. Achieved state of the art performance on community benchmark datasets.

High-Prong Jet Substructure Correction.

Developed a new method for correcting data-simulation differences in the modeling of boosted fat jets. The method is based on a per-prong correction and can be applied to jets of high numbers of prongs for which there is no SM equivalent. Calibrating these jets enables a new class of searches for high-prong signals which was not possible with previous methods.

Past

Measurement of the Drell-Yan Forward-Backward Asymmetry at High Dilepton Masses.

Main analyzer for CMS Run-II measurement. Employed a novel template fitting technique that improves sensitivity. Measurement used to set limits on the existence of a new heavy Z' that are complementary to direct searches.

Tag N' Train.

Developed a novel technique for training machine learning classifiers on collider data that combines unsupervised and weakly supervised approaches. Demonstrated its applicability in a dijet anomaly search. Successfully able to find the hidden signal in the LHC Olympics anomaly detection challenge.

CMS Pixel Detector Calibration and Software.

Co-convened CMS group responsible for the pixel detector reconstruction and calibration from 2021-2022. Projects included developing novel reconstruction techniques suitable for high levels of radiation damage, producing calibrations to account for radiation damage, testing candidate designs for the Phase-2 upgrade, and overseeing the first calibrations and performance studies of Run3 data.

Positions

- 2019- Regular Writer for Particle Bites, "The high energy physics reader's digest"
- 2021-2022 Co-Convener of the CMS pixel offline software and reconstruction subgroup (L3)
- 2020-2021 JHU Physics and Astronomy Graduate Student Diversity & Inclusion Co-Chair

Selected Publications

Primary Author

Oz Amram and Kevin Pedro. Denoising diffusion models with geometry adaptation for high fidelity calorimeter simulation. *Phys. Rev. D*, 108(7):072014, 2023.

Oz Amram and Cristina Mantilla Suarez. Tag N' Train: a technique to train improved classifiers on unlabeled data. *JHEP*, 01:153, 2021. arXiv:2002.12376.

CMS Collaboration. Measurement of the Drell-Yan forward-backward asymmetry at high dilepton masses in proton-proton collisions at $\sqrt{s} = 13$ TeV. *JHEP*, 2022(08):063, 2022.

Contributor

Gregor Kasieczka et al. The LHC Olympics 2020: A Community Challenge for Anomaly Detection in High Energy Physics, January 2021. arXiv:2101.08320.

Erini Lambrides et al. Merger or Not: Accounting for Human Biases in Identifying Galactic Merger Signatures, June 2021. arXiv:2106.15618.

Awards and Honors

- 2016 Richard E. Cutcosky Award, Carnegie Mellon
- 2016 Phi Beta Kappa, Carnegie Mellon
- 2015 Phi Kappa Phi, Carnegie Mellon

Presentations

- Nov. 2023 "Boosted Jet Tagging and Calibration in CMS". ML4Jets. Hamburg, Germany
- Aug. 2023 "Boosted Jet Tagging and Calibration in CMS 13 TeV Data". BOOST. Berkeley, CA
- May 2023 "Fast & Accurate Calorimeter Simulation with Diffusion Models". CaloChallenge Workshop. Rome, Italy. Virtual
- May 2023 "Fast & Accurate Calorimeter Simulation with Diffusion Models". Computing in High Energy Physics (CHEP). Norfolk, VA
- Mar. 2023 "Standard Model W, Z(+Jets) at CMS and ATLAS". Rencontres de Moriond : QCD & High Energy Interactions. La Thuile, Italy
- Nov. 2022 "Recent ML-usage in searches with boosted objects in CMS". ML4Jets. Rutgers, NJ
- Apr. 2022 "Recent Z boson Results from the LHC". Standard Model at LHC Workshop
- Sep. 2021 "Machine Learning Based Anomaly Detection at the LHC". UChicago Rising Stars in Experimental Particle Physics Symposia. Virtual
- Jul. 2020 "Anomaly Searches with Tag N' Train". Anomaly Detection Workshop, LHC Summer Olympics 2020. Virtual
- Jan. 2020 "Tag N' Train : Combining Autoencoders and CWoLa for Better Unsupervised Searches". ML4Jets. New York, NY
- April 2018 "Measurement of the forward-backward asymmetry of high mass Drell-Yan lepton pairs at 13 TeV" APS April Meeting. Columbus, OH

Mentoring & Teaching

- 2023- Mentoring group of UChicago undergraduate students on a project related to ML for calorimeter simulation as part of year-long data science course
- 2019-2022 Mentored younger graduate students at JHU on projects related to CMS pixel detector and data analysis
- 2020-2022 Mentored a younger graduate student at Ohio State through USCMS mentoring program
- 2017-2021 Head Teaching Assistant, General Physics I at JHU
- 2016-2017 Teaching Assistant, General Physics Lab JHU