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 data-driven ML methods to reject QCD and enhance anomalies. First CMS search using advanced anomaly detection techniques. Limits 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 accurate, fast, approximates 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.

Selected Publications

Primary Author

[1] CMS Collaboration. "Model-agnostic search for dijet resonances with anomalous jet substructure in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: *CMS-PAS* (2024). Link.

[2] Oz Amram and Kevin Pedro. "Denoising diffusion models with geometry adaptation for high fidelity calorimeter simulation". In: *Phys. Rev. D* 108.7 (2023). DOI: 10.1103/PhysRevD.108.072014. arXiv: 2308.03876.

[3] CMS Collaboration. "Measurement of the Drell-Yan forward-backward asymmetry at high dilepton masses in proton-proton collisions at $\sqrt{s} = 13$ TeV". In: *JHEP* 2022.08 (2022). DOI: 10.1007/JHEP08(2022)063. arXiv: 2202.12327.

[4] Oz Amram and Cristina Mantilla Suarez. "Tag N' Train: a technique to train improved classifiers on unlabeled data". In: *JHEP* 01 (2021). DOI: 10.1007/JHEP01(2021)153. arXiv: 2002.12376.

Contributor

[5] Gregor Kasieczka et al. "The LHC Olympics 2020 a community challenge for anomaly detection in high energy physics". In: *Rept. Prog. Phys.* 84.12 (2021). DOI: 10.1088/1361-6633/ac36b9. arXiv: 2101.08320.

[6] Erini Lambrides et al. "Merger or Not: Accounting for Human Biases in Identifying Galactic Merger Signatures". In: *The Astrophysical Journal* 919 (Sept. 2021). DOI: 10.3847/1538-4357/ac0fdf. arXiv: 2106.15618.

Conference Presentations

Dec. 2024	"Techniques for ML-based Model Agnostic Searches in CMS". Lightning Talk, Award Winner. US LHC Users Association Meeting. Fermilab, IL
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

Awards and Honors

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

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

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 though USCMS mentoring program
2017-2021	Head Teaching Assistant, General Physics I at JHU
2016-2017	Teaching Assistant, General Physics Lab JHU