Michela Paganini

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Education

Yale University
Ph.D., Physics, 2019
M.Phil., Physics, 2016
M.S., Physics, 2014 - student marshal

University of California, Berkeley
B.A., Astrophysics, 2013
B.A., Physics, 2013

University of Cambridge
Pembroke-King's Programme, 2012

Dissertation

Machine Learning Solutions for High Energy Physics: Applications to Electromagnetic Shower Generation, Flavor Tagging, and the Search for di-Higgs Production
[arXiv:1903.05082]

Research

FAIR (Facebook Artificial Intelligence Research)
Postdoctoral Researcher
October 2018 - present

- Investigating learning dynamics, initializations, "Lottery Tickets", and scientific approaches to deep learning phenomenology in the over-parametrized and under-parametrized regimes, with focus on reproducibility and fairness.
- Contributed centralized methods for neural network pruning in PyTorch ().
- Cross-functional collaboration with product teams to investigate pruning for memory and computational footprint reduction, and with engineering teams on quantization and interpretability.
- Supervised summer intern projects.

NERSC (National Energy Research Scientific Computing Center)
Research Affiliate
May 2017 - present

- Researched, developed, and deployed customized Generative Adversarial Networks to accelerate computationally intensive Physics simulation of particles interacting with matter in heterogeneously segmented 3D detectors.
- Explored and benchmarking deep neural networks training and evaluation in HPC environment on Cori (#6 TOP500) with TensorFlow optimizations for modern Intel architectures.
- Applied Computer Vision solutions for the identification of new Physics events from data in multi-channel, high-resolution sparse image format, using the search for R-parity violating supersymmetry as a case study.

CERN (European Organization for Nuclear Research)
Ph.D. Student, ATLAS Experiment
2013 - 2018

- Designed and implemented location-aware auxiliary-classifier GANs for fast detector-level physics simulation. Joined task force to deploy in ATLAS simulation production code.
- Developed multi-stream LSTMs for event-level classification for the $hh \to \gamma\gamma b\bar{b}$ analysis. Coordinated a team of students on this project.
- Designed Recurrent Neural Networks for impact parameter based flavor tagging. Led effort to integrate into live analysis deployment by contributing to LWTNN code development.
- Using Dark Knowledge to replace the Matrix Element Method (MEM) — a Physics driven, computationally intensive routine — in order to streamline the ttH with $H \to b\bar{b}$ analysis pipeline.
- Refined boosted top-tagging technique using Deep Learning discrimination versus QCD background. Performed in-depth studies of pile-up and p_T dependence. Compared to efficiency of substructure taggers.
- Contribution to code testing, maintainability, and documentation.

Cambridge Institute of Astronomy
Summer Exchange Student
July-August 2012

- Simulated galactic dynamics, mass-velocity profiles, and anisotropy variation to test modified gravity models.

Università degli Studi di Milano
Summer Research Assistant
June 2012

- Analytical predictions of positronium formation for anti-hydrogen production at the AEgIS experiment at CERN.

SETI Institute, University of California, Berkeley
Undergraduate Research Assistant
2011

- Remote observing for Optical SETI.

Space Sciences Lab, University of California, Berkeley
Undergraduate Research Assistant
2010-2011

- Data collection and analysis for MAVEN, STEREO and VEX missions.
- Catalogs of coronal mass ejections, live monitoring of solar activity.

Teaching

Department of Physics, Yale University
Teaching Fellow, Physics 440 (Quantum Mechanics and Natural Phenomena I), Spring 2015
Teaching Fellow, Physics 180 (University Physics - Mechanics), Fall 2014
Teaching Fellow, Physics 166L (General Physics Laboratory - E&M), Spring 2014
Teaching Fellow, Physics 165L (General Physics Laboratory - Mechanics), Fall 2013

College of Letters and Science, University of California, Berkeley
Undergraduate Student Instructor (UGSI), Sense and Sensibility and Science, 2012-2013
Reader, Physics H7A (Physics for Scientists and Engineers), 2012

Publications

Author of over 300 papers with the ATLAS Collaboration. Profiles:
Selected publications with substantial personal contribution:

Artificial Intelligence applied to Particle Physics, International Journal of Modern Physics A, in preparation (book).

M. Paganini, *Prune Responsibly*, under review.

M. Paganini, J. Forde, *Bespoke vs. Prêt-à-Porter Lottery Tickets: Exploiting Mask Similarity for Trainable Sub-Network Finding*, under review [arXiv:2007.04091].

M. Paganini, J. Forde, *dagger: A Python Framework for Reproducible Machine Learning Experiment Orchestration*, [arXiv:2006.07484].

M. Paganini, J. Forde, *Streamlining Tensor and Network Pruning in PyTorch*, ICLR 2020 workshop [arXiv:2004.13770].

M. Paganini, J. Forde, *On Iterative Neural Network Pruning, Reinitialization, and the Similarity of Masks*, ICLR 2020 workshop [arXiv:2001.05050].

A. S. Morcos, H. Yu, M. Paganini, Y. Tian, *One Ticket to Win Them All: Generalizing Lottery Ticket Initializations across Datasets and Optimizers*, NeurIPS 2019 [arXiv:1906.02773].

J. Forde, M. Paganini, *The Scientific Method in the Science of Machine Learning*, ICLR 2019 workshop [arXiv:1904.10922].

L. de Oliveira, B. Nachman, M. Paganini, *Electromagnetic Showers Beyond Shower Shapes*, NIMA 951, 162879 (2019), [arXiv:1806.05667].

HEP Software Foundation, *HEP Software Foundation Community White Paper Working Group - Detector Simulation*, [arXiv:1803.04165].

HEP Software Foundation, *A Roadmap for HEP Software and Computing R&D for the 2020s*, [arXiv:1712.06982].

M. Paganini, L. de Oliveira, B. Nachman, *Controlling Physical Attributes in GAN-Accelerated Simulation of Electromagnetic Calorimeters*, in Proceedings of ACAT 2017, J. Phys. Conf. Ser. 1085 (2018) no.4, 042017, [arXiv:1711.08813].

W. Bhimji, S. Farrell, T. Kurth, M. Paganini, Prabhat, E. Racah, *Neural Networks for Physics Analysis on low-level whole-detector data at the LHC*, in Proceedings of ACAT 2017, J. Phys. Conf. Ser. 1085 (2018) no.4, 042034, [arXiv:1711.03573].

M. Paganini, *Machine Learning Algorithms for b-jet tagging at the ATLAS experiment*, in Proceedings of ACAT 2017, J. Phys. Conf. Ser. 1085 (2018) no.4, 042031, [ATL-PHYS-PROC-2017-211].

M. Paganini, L. de Oliveira, B. Nachman, *Accelerating Science with Generative Adversarial Networks: An Application to 3D Particle Showers in Multi-Layer Calorimeters*, Phys. Rev. Lett. 120, 042003 (2018), [arXiv:1705.02355].

M. Paganini, L. de Oliveira, B. Nachman, *CaloGAN: Simulating 3D High Energy Particle Showers in Multi-Layer Electromagnetic Calorimeters with Generative Adversarial Networks* , Phys. Rev. D 97, 014021 (2018), [arXiv:1712.10321].

L. de Oliveira, M. Paganini, B. Nachman, *Learning Particle Physics by Example: Location-Aware Generative Adversarial Networks for Physics Synthesis*, Comput. Softw. Big Sci. (2017) 1: 4, [arXiv:1701.05927].

The ATLAS Collaboration, *Optimisation and Performance Studies of the ATLAS b-Tagging Algorithms for the 2017-18 LHC Run*, [ATL-PHYS-PUB-2017-013].

The ATLAS Collaboration, *Identification of Jets Containing b-Hadrons with Recurrent Neural Networks at the ATLAS Experiment*, [ATL-PHYS-PUB-2017-003].

The ATLAS Collaboration, *Search for Higgs boson pair production in the $bb\gamma\gamma$ final state using pp collision data at $\sqrt{s} = 13$ TeV with the ATLAS detector*, [ATLAS-CONF-2016-004].

Invited Talks, Posters, Panels, and Lectures

Mediterranean Machine Learning School, Jan 2021
UCI Symposium on Reproducibility in Machine Learning, Sep 2020
6th Machine Learning in High Energy Physics Summer School, Jul 2020
Machine Learning & Data Science Meetup, Rome, Jul 2020
Workshop on Machine Learning Retrospective, ICML, Jul 2020
Workshop on Practical ML for Developing Countries, ICLR, Apr 2020
RE·WORK Deep Learning Summit, San Francisco, Jan 2020
Applied Machine Learning Days, Lausanne, Jan 2020
Introduction to PyTorch Workshop, WiMLDS, NYC, Nov 2019
Workshop on Preregistration in Computer Vision, ICCV, Nov 2019
PyTorch DevCon, San Francisco, Oct 2019
Workshop on Debugging Machine Learning Models, ICLR, May 2019
3rd Inter-experimental Machine Learning workshop, CERN, Apr 2018
Workshop on Machine Learning for Phenomenology, Durham Univ., Apr 2018
NVIDIA GTC 2018, Silicon Valley, Mar 2018
Workshop on Machine Learning for Jet Physics, LBNL, Dec 2017
Women in Machine Learning (WiML) workshop, NIPS, Dec 2017
Workshop on Deep Learning for Physical Sciences, NIPS, Dec 2017
Mitchell Institute for Fundamental Physics and Astronomy, TAMU, Nov 2017
Rice University seminar series, Nov 2017
NASA Ames workshop on Radiation Characterization from Earth to Moon, Mars, and Beyond, Nov 2017
LUX Collaboration week, LBNL, Oct 2017
NERSC Data Day, LBNL, Sep 2017
18th Int'l Workshop on Advanced Computing and Analysis Techniques in Physics Research (ACAT 2017), University of Washington, Aug 2017
Women in Computer Vision (WiCV) workshop, CVPR, Jul 2017
Workshop on Machine Learning and b-Tagging in ATLAS, SLAC, May 2017
Fermilab machine learning group kick-off, FNAL, May 2017
Data Science @ HEP workshop, FNAL, May 2017
Berkeley Institute for Data Science faire, UC Berkeley, May 2017
AI at SLAC seminar, SLAC, March 2017
2nd Inter-experimental Machine Learning workshop, CERN, Mar 2017
2nd Developers@CERN forum, CERN, May 2016
3rd HEP Software Foundation workshop, LAL Orsay, May 2016

Awards and Fellowships

High Energy Physics Center for Computational Excellence Summer Fellowship, NERSC and Lawrence Berkeley National Laboratory, 2017
Leigh Paige Prize, Yale Physics Department, 2013
UC Summer Grant, UC Berkeley, 2012
University of California Undergraduate Grant, UC Berkeley, 2011-2012
UC Freshman Scholarship, UC Berkeley, 2010

Service to the Profession

Project reviewer, NASA Frontiers Development Lab 2020
Volunteer, Women in Machine Learning (WiML) virtual workshop, ICML 2020
Connection chair, WiML organizing committee, NeurIPS 2019
Organizer, Machine Learning & Physical Sciences workshop, NeurIPS 2019
Organizer, Machine Learning Retrospectives workshop, NeurIPS 2019
Reviewer, ICLR 2019 reproducibility challenge
Reviewer, CVPR 2019 workshop on Computer Vision for Global Challenges
Reviewer, ICML 2019 workshop on Theoretical Physics for Deep Learning
Scientific program committee member, DL4Sci 2019 summer school
Track convener & reviewer, SUSY 2019
Track convener & reviewer, CHEP 2018
Organizer, Generative Modeling in Physics workshop, PASC 2018
Associate Editor, Frontiers in Big Data and AI in High Energy Physics open access journal
Organizer, Deep Learning for Physical Sciences workshop, NeurIPS 2017
Reviewer, venues including: Comput. Softw. Big Sci., JINST, IEEE Access, ACAT, WiML

Students and Interns

Jessica Forde, Brown
Alizeh Maqbool, Yale, now at BCG
Ilana Kaufman, Yale, now at JPMorgan Chase
Nicholas Brown, Yale, now at Google
Aaron Effron, Yale, now at Waymo

Languages and Skills

Languages: Italian, English (bilingual), French (intermediate), Spanish (elementary)
Computing: Python, C, C++, Git
Libraries: PyTorch, Keras, sklearn, TensorFlow, NumPy, SciPy, Matplotlib, pandas, ROOT
Interpersonal Skills: project management, leadership, effective communication, knowledge sharing, mentoring, onboarding, event planning

Schools

Leadership in Science Policy Institute, Computing Community Consortium, 2019
Scaling to Petascale Institute, 2017
Thematic CERN School of Computing, 2017
SLAC Summer Institute, 2016

Outreach and Leadership

Facebook AI Research
AI Residency onboarding lecturer
Computer Vision for Global Challenges (CV4GC) CVPR workshop publicity ambassador, reviewer, and mentor
Facebook summer PhD interns mentor
Facebook Women in AI ambassador
Facebook AI mentorship participant
Italian Association for Machine Learning (IAML) volunteer
Letters to a Pre-Scientist STEM professional

Lawrence Berkeley National Laboratory
Deep Learning for Science 2019 summer school scientific committee member
US LUA delegate at annual meeting with Congress in Washington, DC
Exploratorium volunteer

CERN
S'Cool Lab tutor
Open Geneva hackathon, *Preventing Suicide with Social Media Data*
DiploHack, *Extracting Sensitive Human Rights Data from Inaccessible Countries*
TEDxCERN volunteer
THEPort CERN hackathon, *Integrating Humanitarian Data*
POP Science, Nuit des Chercheurs
CERN tour guide

Yale University
Graduate Student Assembly - Representative for Department of Physics
Graduate School of Arts and Science Executive Committee
Academics and Professional Development Committee secretary
McDougal Graduate Student Life Fellow
Yale Minority Advisory Council - graduate representative
Board member of Italian Society of Yale Students and Affiliates
Graduate affiliate at Pierson residential college

University of California, Berkeley
Society of Physics Students (SPS) officer
SWPS Physics undergraduate coordinator
Member of Order of Omega Leadership Honor Society
Academic tutor at Athletic Study Center
Founder of Italian Society at Berkeley
Team Manager - Div I Women's tennis team
Emerging Leaders Institute at Butler University