

# Michela Paganini

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Facebook Inc.  
MPK 21.MZ9 MQ.9.39E  
✉ [mickypaganini@berkeley.edu](mailto:mickypaganini@berkeley.edu)  
☎ +1 (510) 423-2136

1 Hacker Way  
Menlo Park, CA 94025  
🔗 <https://mickypaganini.github.io/>  
👤 [mickypaganini](#)

## 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, initialization techniques, “Lottery Tickets”, and scientific approaches to deep learning phenomenology in the over-parametrized and under-parametrized regimes, with focus on reproducibility.
- 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, interpretability, and neuronal importance.
- Supervised summer intern projects.

### NERSC (National Energy Research Scientific Computing Center)

*High Energy Physics Center for Computational Excellence Graduate Student Intern*  
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  $hh \rightarrow \gamma\gamma b\bar{b}$  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  $t\bar{t}H$  with  $H \rightarrow b\bar{b}$  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     
Selected publications with substantial personal contribution:

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

M. Paganini, J. Forde, *On Iterative Neural Network Pruning, Reinitialization, and the Similarity of Masks*.

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 workshop on Debugging Machine Learning Models, [[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, *Measurements of Higgs Boson Properties in the Diphoton Decay Channel with  $36.1 \text{ fb}^{-1}$  pp Collision Data at the Center-of-Mass Energy of 13 TeV with the ATLAS Detector*, [[ATLAS-CONF-2017-045](#)].

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  $\sqrt{s} = 13 \text{ TeV}$  with the ATLAS detector*, [[ATLAS-CONF-2016-004](#)].

## Invited Talks, Posters, and Panels

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  
3<sup>rd</sup> 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  
18<sup>th</sup> 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  
2<sup>nd</sup> Inter-experimental Machine Learning workshop, CERN, Mar 2017  
2<sup>nd</sup> Developers@CERN forum, CERN, May 2016  
3<sup>rd</sup> 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

Workflow chair, AISTATS 2020 organizing committee  
Connection chair, WiML 2019 organizing committee  
Organizer, Machine Learning & Physical Sciences workshop, NeurIPS 2019  
Organizer, 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 at PASC 2018  
Associate Editor, Frontiers in Big Data and AI in High Energy Physics open access journal  
Reviewer, Comput. Softw. Big Sci.  
Reviewer, JINST  
Reviewer, IEEE Access  
Reviewer, ACAT 2017  
Organizer, Deep Learning for Physical Sciences workshop, NeurIPS 2017  
Reviewer, WiML 2017

## 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, active listening, 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 steering committee  
Facebook AI mentorship participant  
Italian Association for Machine Learning (IAML) volunteer

### **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

Last updated: January 14, 2020