Raghav **Kansal**

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Education

UC San Diego/CERN   *La Jolla, USA and Geneva, Switzerland*
PHD IN PHYSICS, **GPA: 3.97/4.00**   *2019 -*
Topic: Machine Learning and Particle Physics   Advisor: Javier Duarte

UC San Diego   *La Jolla, USA*
BS IN PHYSICS & COMPUTER ENGINEERING, **GPA: 3.98/4.00**, *summa cum laude*   *2015 - 2019*
Divisional and Departmental Highest Honors

Publications

[1]   Raghav Kansal et al. "Graph Generative Adversarial Networks for Sparse Data Generation in High Energy Physics". In: *3rd Machine Learning and the Physical Sciences Workshop at the 34th Annual Conference on Neural Information Processing Systems*. Dec. 2020. arXiv: 2012.00173.

[2]   Raghav Kansal et al. *Particle Cloud Generation with Message Passing Generative Adversarial Networks*. June 2021. arXiv: 2106.11535.

Honors and Awards

Aug 2019   **CERN Openlab Summer Students Lightning Talks Award Runner-Up**   *CERN*
           For the talk 'Deep Graph Neural Networks for Fast HGCAL Simulation'

Jun 2019   **2019 IRIS-HEP Fellowship**   *IRIS-HEP*
           For the project 'HGCAL Fast Simulation with Graph Networks'

Jun 2019   **2019 John Holmes Malmberg Prize**   *UCSD Department*
                                                                                                           of Physics
           Sole recipient of this prize, which is 'presented annually at commencement to a graduating physics student who is recognized for potential for a career in physics and a measure of experimental inquisitiveness.'

May 2019   **2018-2019 Physical Sciences Dean's Undergraduate Award for Excellence**   *UCSD Division of*
                                                                                                          Physical Sciences
           One of 33 students from the departments of Mathematics, Physics and Chemistry 'recognized for excellence in academics and fundamental research'.

Jul 2018   **2018 William A. Lee Undergraduate Research Award**   *UCSD Division of*
                                                                                                          Physical Sciences
           For the project 'Arbitrary ultra-cold atomic lattices using holographic optical tweezers'

Selected Talks and Posters

See raghavkansal.com/event for a complete list, as well as links, slides, posters, and videos.

Jun 2021   **Mainz Institute for Theoretical Physics Machine Learning for Particle Physics Workshop**   *Virtual (Talk)*
           Particle Cloud Generation with Message Passing GANs

May 2021   **CMS ML Forum (Topic: ML4Sim)**   *Virtual (Talk)*
           Sparse Data Generation

Mar 2021   **James Madison University Artificial Intelligence and Machine Learning Seminar**   *Virtual (Talk)*
           Graph Generative Adversarial Networks for High Energy Physics Data Generation

Mar 2021   **Berkeley Institute for Data Science Deep Generative Models for Fundamental Physics Meeting**   *Virtual (Talk)*
           Graph Generative Adversarial Networks for High Energy Physics Data Generation

Feb 2021   **Imperial College London DataLearning Working Group Meeting**   *Virtual (Talk)*
           Graph Generative Adversarial Networks for High Energy Physics Data Generation

Dec 2020	**NeurIPS 2020, Machine Learning and the Physical Sciences Workshop**	*Virtual (Poster)*
	Graph Generative Adversarial Networks for Sparse Data Generation in High Energy Physics	
Nov 2020	**Inter-Experimental LHC Machine Learning Working Group Meeting**	*Virtual (Talk)*
	Sparse Data Generation with Graph GANs	
Feb 2020	**Princeton IRIS-HEP Review Meeting**	*Princeton (Poster)*
	Deep Graph Neural Networks for Fast HGCAL Simulation	
Aug 2019	**CMS Machine Learning Forum**	*CERN (Talk)*
	Deep Graph Neural Networks for Fast HGCAL Simulation	
Aug 2019	**CMS Computing Group Meeting**	*CERN (Talk)*
	Deep Graph Neural Networks for Fast HGCAL Simulation	
Aug 2019	**CERN Openlab Lightning Talks**	*CERN (Talk)*
	Deep Graph Neural Networks for Fast HGCAL Simulation	
Oct 2018	**UCSD Dean of Physical Sciences' Leadership Council Poster Presentations**	*UCSD (Poster)*
	Arbitrary Positioning and Manipulation of Ultra-Cold Atoms with Optical Tweezers	
Aug 2018	**William A. Lee Undergraduate Research Award Poster Presentations**	*UCSD (Poster)*
	Arbitrary Positioning and Manipulation of Ultra-Cold Atoms with Optical Tweezers	
May 2018	**Undergraduate Research Conference**	*UCSD (Talk)*
	Arbitrary Ultra-Cold Atomic Lattices Using Holographic Optical Tweezers	

Experience

Duarte Lab, UC San Diego
MACHINE LEARNING AND PARTICLE PHYSICS RESEARCHER
UCSD/CERN
Sep 2019 -

- Developing new graph generative models for sparse and irregular data like that in particle physics
- Using new deep graph neural network classifiers to set the most stringent constraints to date on double-Higgs production, allowing insight into the metastability of the universe

Machine Learning for Particle Physics Group, CERN
CERN OPENLAB INTERN
CERN
Jun - Aug 2019

- Started our project on graph generative models for particle physics simulations, motivated primarily by the CMS experiment's new High Granularity Calorimeter (HGCAL)

Kleinfeld Lab, UC San Diego
NEUROPHYSICS RESEARCHER
UCSD
Sep 2018 – Jun 2019

- Used two-photon microscopy to measure pO2 in the mouse somatosensory cortex
- Imaged the cortex to measure vasomotion relative to pO2

Barreiro Lab, UC San Diego
EXPERIMENTAL QUANTUM INFORMATION SCIENCE RESEARCHER
UCSD
Jun 2017 – Jun 2019

- Designed and implemented a setup for a quantum gas microscope (QGM) to image with single-site resolution
- Generated 2D dynamic, arbitrarily arranged, sub-micron optical tweezers, integrated with the QGM, via two methods, using: 1) a Digital Micromirror Device (i.e. holography), and 2) an acousto-optic deflector
- Characterized a high (0.8) Numerical Aperture objective for the QGM using OSLO optical simulations and point-spread function image analysis in Python
- Using an FPGA device, outputted RF waveforms that modulate laser beams with parabolic spatial intensity in order to produce a Bose-Einstein Condensate
- Programmed FPGA and C electronic devices, and created and (3D) printed mechanical mounts and electronics circuits for experimental use

Focus Analytics
SOFTWARE INTERN
Mumbai, India
Jul 2016 – Sep 2016

- Interned at a software startup which has since been bought by Moka
- Developed and deployed a location prediction SparkJava server with Cassandra and Redis databases
- Implemented ML k-means clustering and SVM linear classification algorithms on location data
- Wrote NodeJS servers and pages for receiving users' predicted locations and displaying the live data on maps
- Designed Cassandra and MySQL databases storing user tracking data, and wrote server APIs for accessing/updating, along with web panels for easy viewing of the data (using said APIs)

Projects

Graph GAN   **paper   slides   github**   *Jun 2019 -*
- Leading the effort on developing a graph-based Generative Adversarial Network (GAN), which has proven effective at generating sparse data with irregular underlying geometry
- First results accepted as a poster at the Machine Learning for the Physical Sciences Workshop at NeurIPS 2020
- Now experimenting with a conditional GAN version and variable-sized graphs, as well as applications to other datasets such as CERN detector data

Machine Learning for Particle Flow   **github**   *May 2021 -*
- Developing graph neural networks to perform event reconstruction in the CMS experiment at CERN

Equivariant Neural Networks   **review**   *Dec 2020 -*
- Wrote a review of deep learning models that are equivariant to physics-relevant group transformations for Prof. John McGreevy's fantastic group theory course.
- Now looking into applications of Lorentz group equivariant models to generation

Sequential Modeling for Soccer Predictions   **github**   *Mar 2018 - Mar 2019*
- Fun project mostly to gain experience with RNNs and Attention
- I achieved a 71% testing accuracy in predicting the outcome of European soccer matches

Optical Tweezers and a Quantum Gas Microscope   **poster**   *Jun 2017 - Jun 2019*
- Created dynamic, sub-micron holographic optical tweezers and a Quantum Gas Microscope with sub-micron resolution in order to manipulate individual atoms (or qubits) for quantum computing and quantum information science experiments
- This work won a William A. Lee Research award, and will be published soon

GRAD: An interactive graph-based degree planning app   **github**   *Jan 2017 - Mar 2017*
- Created an app for visualizing course requirements with a user-friendly UI
- I was the Back-end and Algorithms Lead for a team of 10, and personally wrote the server, scraping and graphing algorithms for the app
- We were one of 8 finalists out of 60 projects in the UCSD 2018 software engineering course