

# Raghav Kansal

MHA 5525, UC San Diego, La Jolla, CA, 92092

✉ rkansal@ucsd.edu | ✉ rkansal@cern.ch | 🌐 www.raghavkansal.com | 📱 rkansal47

## Education

### UC San Diego/CERN

PHD IN PHYSICS, GPA: 3.97/4.00

Topic: Machine Learning and Particle Physics | Advisor: [Javier Duarte](#)

La Jolla, USA and Geneva, Switzerland

2019 -

### UC San Diego

DOUBLE BS IN PHYSICS & COMPUTER ENGINEERING, GPA: 3.98/4.00, *summa cum laude*

Divisional and Departmental Highest Honors

La Jolla, USA

2015 - 2019

## 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.

## Honors and Awards

Aug 2019 **CERN Openlab Summer Students Lightning Talks Award Runner-Up**

For the talk 'Deep Graph Neural Networks for Fast HGAL Simulation'

CERN

Jun 2019 **2019 IRIS-HEP Fellowship**

For the project 'HGAL Fast Simulation with Graph Networks'

IRIS-HEP

Jun 2019 **2019 John Holmes Malmberg Prize**

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.'

UCSD Department  
of Physics

May 2019 **2018-2019 Physical Sciences Dean's Undergraduate Award for Excellence**

One of 33 students from the departments of Mathematics, Physics and Chemistry 'recognized for excellence in academics and fundamental research'.

UCSD Division of  
Physical Sciences

Jul 2018 **2018 William A. Lee Undergraduate Research Award**

For the project 'Arbitrary ultra-cold atomic lattices using holographic optical tweezers'

UCSD Division of  
Physical Sciences

## Selected Talks and Posters

See [raghavkansal.com/event](http://raghavkansal.com/event) for a complete list, as well as slides, posters and videos.

Mar 2021 **James Madison University Artificial Intelligence and Machine Learning Seminar**

Graph Generative Adversarial Networks for High Energy Physics Data Generation

Virtual (Talk)

Mar 2021 **Berkeley Institute for Data Science Deep Generative Models for Fundamental Physics Meeting**

Graph Generative Adversarial Networks for High Energy Physics Data Generation

Virtual (Talk)

Feb 2021 **Imperial College London DataLearning Working Group Meeting**

Graph Generative Adversarial Networks for High Energy Physics Data Generation

Virtual (Talk)

Dec 2020 **NeurIPS 2020, Machine Learning and the Physical Sciences Workshop**

Graph Generative Adversarial Networks for Sparse Data Generation in High Energy Physics

Virtual (Poster)

Nov 2020 **Inter-Experimental LHC Machine Learning Working Group Meeting**

Sparse Data Generation with Graph GANs

Virtual (Talk)

Feb 2020 **Princeton IRIS-HEP Review Meeting**

Deep Graph Neural Networks for Fast HGAL Simulation

Princeton (Poster)

|          |  |               |
|----------|--|---------------|
| Aug 2019 | <b>CMS Machine Learning Forum</b><br>Deep Graph Neural Networks for Fast HGCAL Simulation  | CERN (Talk)   |
| Aug 2019 | <b>CMS Computing Group Meeting</b><br>Deep Graph Neural Networks for Fast HGCAL Simulation   | CERN (Talk)   |
| Aug 2019 | <b>CERN Openlab Lightning Talks</b><br>Deep Graph Neural Networks for Fast HGCAL Simulation  | CERN (Talk)   |
| Oct 2018 | <b>UCSD Dean of Physical Sciences' Leadership Council Poster Presentations</b><br>Arbitrary Positioning and Manipulation of Ultra-Cold Atoms with Optical Tweezers | UCSD (Poster) |
| Aug 2018 | <b>William A. Lee Undergraduate Research Award Poster Presentations</b><br>Arbitrary Positioning and Manipulation of Ultra-Cold Atoms with Optical Tweezers        | UCSD (Poster) |
| May 2018 | <b>Undergraduate Research Conference</b><br>Arbitrary Ultra-Cold Atomic Lattices Using Holographic Optical Tweezers  | UCSD (Talk)   |

## Experience

---

### Duarte Lab, UC San Diego

UCSD/CERN

#### MACHINE LEARNING AND PARTICLE PHYSICS RESEARCHER

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

#### CERN OPENLAB INTERN

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

UCSD

#### NEUROPHYSICS RESEARCHER

Sep 2018 - Jun 2019

- Used two-photon microscopy to measure pO<sub>2</sub> in the mouse somatosensory cortex
- Imaged the cortex to measure vasomotion relative to pO<sub>2</sub>

### Barreiro Lab, UC San Diego

UCSD

#### EXPERIMENTAL QUANTUM INFORMATION SCIENCE RESEARCHER

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

Mumbai, India

#### SOFTWARE INTERN

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](#)

Apr 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](#)

Mar 2018 - Mar 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