

Eric Qu

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Durham, North Carolina 27701, USA

EDUCATION

Duke Kunshan University / Duke University dual degree UG program	<i>Sep 2019 - May 2023</i>
<i>B.S. in Data Science (by Duke Kunshan)</i>	Kunshan, China / Durham, USA
<i>B.S. in Interdisciplinary Studies (Subplan: Data Science; by Duke)</i>	GPA 3.88/4 Major GPA 3.98/4

RESEARCH INTEREST

My research interest mainly falls on **Geometric Deep Learning** and **AI for Science**. I also have experience in sequence modeling, graph neural networks, reinforcement learning, and (3D) computer vision. In general, I am interested in combining ideas from mathematics (especially geometry) with machine learning, and using machine learning to solve interdisciplinary problems.

PUBLICATIONS & MANUSCRIPTS

Qu, Eric, Luo, Xufang, Li, Dongsheng. “Data Continuity Matters: Improving Sequence Modeling with Lipschitz Regularizer” *International Conference on Learning Representations (ICLR)* **Spotlight** (Notable Top 25%) (2023).

Qu, Eric, Zou, Dongmian. “Hyperbolic Convolution via Kernel Point Aggregation” [Preprint](#) (Submitted to ICML 2023).

Qu, Eric, Zou, Dongmian. “Autoencoding Hyperbolic Representation for Adversarial Generation” *arXiv:2201.12825* (Submitted to ICML 2023).

Qu, Eric, Zou, Dongmian. “Lorentz Direct Concatenation for Stable Training in Hyperbolic Neural Networks” *NeurIPS Symmetry and Geometry in Neural Representations Workshop* **Poster** (2022).

Qu, Eric, Jimenez, Andrew, Kumar, Sanat K., Zhang, Kai. “Quantifying Nanoparticle Assembly States in a Polymer Matrix through Deep Learning.” *Macromolecules* 54, no. 7 (2021): 3034-3040.

Bornani, K., Mendez, N. F., Altorbac, A. S., Müller, A. J., Lin, Y., **Qu, Eric**, Zhang, K., Kumar, S. K., Schadler, L. S. (2022). “*In Situ* Atomic Force Microscopy Tracking of Nanoparticle Migration in Semicrystalline Polymers.” *ACS Macro Letters*, 2022, 11, 6, 818–824.

EXPERIENCES

Research Assistant - Duke Kunshan University	<i>Mar 2021 - Present</i>
Adviser: Dongmian Zou	<i>Jiangsu, China</i>

- Autoencoding Hyperbolic Representation for Adversarial Generation *Submitted to ICML 2023*

- We propose a generative model (HAEGAN) in hyperbolic space that is capable of generating complex data.
- HAEGAN contains three parts: (1) a hyperbolic autoencoder (AE) that produces hyperbolic embedding; (2) a novel hyperbolic GAN that is trained to generate the hyperbolic embedding of AE from simple noise; (3) a generator that inherits the generator from the GAN and the decoder from the AE.
- Many specific operations and layers were proposed to ensure numerical stability.
- HAEGAN achieves SOTA in the molecular generation experiment with a hyperbolic version of JTVAE as the AE.

- Lorentz Direct Concatenation for Stable Training in Hyperbolic Neural Networks *NeurIPS Workshop Poster*

- We discussed an operation proposed in the HAEGAN paper, the Lorentz Direct Concatenation. Compared with concatenating in the tangent space, our method is more stable and better at preserving the hyperbolic distance.

- Hyperbolic Convolution via Kernel Point Aggregation *Submitted to ICML 2023*

- We constructed a novel hyperbolic convolution operation (HKConv), which first correlates trainable local hyperbolic features with fixed hyperbolic kernel points, then aggregates the output features within a local neighborhood.
- HKConv enjoys equivariance to permutation of input and invariance to parallel transport of a local neighborhood.
- Based on HKConv, we designed HKNet and it could outperformed the SOTA in graph related and NLP tasks.

Research Intern - Microsoft Research Aisa, [Shanghai AI/ML Group](#)

May 2022 - Sept 2022

Adviser: [Dongsheng Li](#), Xufang Luo

Shanghai, China

- Building a more efficient and accurate model for Gene Expression Prediction*In Progress*

- We developed a new architecture for Gene Expression Prediction (GEP) that has a mutation-accommodated encoder, and a modified S4 model as backbone for better long-range dependency and efficient space complexity.
- A more comprehensive dataset for GEP is also constructed that has doubled sample size than the current dataset.

- Data Continuity Matters: Improving Sequence Modeling with Lipschitz Regularizer*ICLR 2023 Spotlight*

- During the exploration of the GEP project, we discovered a way to increase the performance of the S4 model, and it could be generalized to most of the sequence models.
- We empirically discovered and theoretically proved that many sequence models have different assumptions about the continuity of the input sequence, e.g. Transformer prefers discrete input, S4 prefers continuous input.
- To utilize this property, we designed a regularizer that could alter the continuity of the input sequence and showed its effectiveness in various sequence models, e.g. Transformers for Time series, Audio, Vision; S4 for Text.

Research Assistant - Duke Kunshan University

Nov 2019 - Present

Adviser: [Kai Zhang](#)

Jiangsu, China

- Quantifying Nanoparticle Assembly States in a Polymer Matrix through Deep Learning*Published in Macromolecules*

- We develop and apply a deep-learning based image analysis method to quantify the distribution of spherical NPs in a polymer matrix directly from their real-space TEM images.

- Solving Sticky Hard Sphere Packing Problem through Deep Learning*In Progress*

- Sticky hard sphere packing is a challenging problem in physics. In our method, we first map the packing state into a graph and use a modified Graph Isomorphism Network (GIN) to identify the valid packing with high accuracy. Then, a Mento Carlo Search Tree is trained to generate new packings with the reward based on the GIN.

- Finding Optimal Order Parameter for Monodisperse Systems*In Progress*

- Order parameter of a particle system describes whether it is more crystal-like or glass-like. The packing state could be represented by 3D point cloud. We proposed a novel Kernel Point Autoencoder model using KPConv as encoder and our Kernel Point Generator as decoder. Then, the bottleneck activation is extracted to be the order parameter.

Teaching Assistant - Duke Kunshan University

Jan 2022 - May 2022

Course: STATS 303 Statistical Machine Learning & STATS 403 Deep Learning

Jiangsu, China

- Weekly recitations to teach practice problems.
- Serve as the Student Assistant in Textbook Preparation for STATS 403 Deep Learning.

[Lecture Notes](#)

SELECTED COURSEWORK

Machine Learning: Duke K_STATS 302 Principles of Machine Learning (A+); Duke K_STATS 403 Deep Learning (A); Duke K_STATS 303 Statistical Machine Learning (A+); DKU STATS 402 Interdisciplinary Data Analysis (A).

Mathematics: DKU MATH 305 Advanced Linear Algebra (A); DKU MATH 303 ODE and Dynamic Systems (A-); DKU MATH 304 Numerical Analysis and Optimization (A); DKU MATH 408 Differential Geometry (A) [My Notes](#); Duke MATH 412 Topological Data Analysis (A); DKU MATH 307 Complex Analysis; DKU MATH 308 Real Analysis.

HONORS & AWARDS

Conference Travel Grant (NeurIPS 2022) - Duke Kunshan University

Dec 2022

Summer Research Scholar - Duke Kunshan University

Jun 2020, Jun 2022

Dean's List with Distinction - Duke Kunshan University

Fall 2019, Spring 2022

Dean's List - Duke Kunshan University

Fall 2020, Spring 2021, Fall 2021

SKILLS**Programming:** Proficient in Python, C++, C for CUDA, R, MATLAB, Mathematica, L^AT_EX**Frame:** Pytorch, TensorFlow, Keras, Gym for RL**English:** GRE 324 (V 156, Q 168), TOEFL 108