Dong-Kyum **Kim**

Postdoctoral Researcher

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Summary

I am a physicist passionate about AI and did my PhD in physics at KAIST, Korea. Under professor Hawoong Jeong's supervision, I worked on applications of ML in complex systems and statistical physics. My current research focus is understanding highly complex nonequilibrium systems, such as biological systems, active matter, and others in nature, through stochastic thermodynamics with ML-based approaches.

Education

Korea Advanced Institute of Science and Technology (KAIST) — Daejeon, Korea

Doctor of Philosophy (PhD) in Physics, Advisor: Prof. Hawoong Jeong — Mar. 2016 - Feb. 2022

- Dissertation: Nonequilibrium Statistical Physics Study using Deep Learning

Seoul National University (SNU) — Seoul, Korea

Bachelor of Science (BS) in Physics with a Minor in Computer Science & Engineering — 2011 - 2015

Experience

Institute for Basic Science (IBS) — Daejeon, Korea

Senior Researcher — Mar. 2022 - present

- Hosted by prof. Meeyoung Cha (Chief Investigator).
- Data Science Group, Center for Mathematical and Computational Sciences.

Samsung Electronics — Hwaseong, Korea

Machine Learning Intern — Sep. 2017 - Dec. 2017

- Collaborated with Daniel Kim, PhD (Senior Data Scientist).
- Improved anomaly image classification tasks via distributed multi-GPU training methods of Keras & Spark.
- Implemented a distributed image searching framework to detect similar patterns in images through Elasticsearch.

Publication

Transformer as a hippocampal memory consolidation model based on NMDAR-inspired nonlinearity — 2023

D.-K. Kim, J. Kwon, M. Cha, & C. J. Lee, *Conference on Neural Information Processing Systems (NeurIPS)*

Spontaneous emergence of music detectors in a deep neural network — 2023

G. Kim, **D.-K. Kim** & H. Jeong, *bioRxiv* 2021.10.27.466049, *kgspiano/Music* (accepted in Nature Communications; in press)

SUBTLE: An unsupervised platform with temporal link embedding that maps animal behavior — 2023

J. Kwon, S. Kim, **D.-K. Kim**, J. Joo, S. H. Kim, M. Cha, & C. J. Lee, *bioRxiv* 2023.04.12.536531 (Under Review)

Multidimensional entropic bound: Estimator of entropy production for Langevin dynamics with an arbitrary time-dependent protocol — 2023

S. Lee, **D.-K. Kim**, J. M. Park, W. K. Kim, H. Park & J. S. Lee, *Phys. Rev. Research* **5**, 013194

Neural Classification of Terrestrial Biomes — 2023

V. Shen, **D.-K, Kim**, E. Zeller, M. Cha, *IEEE International Conference on Big Data and Smart Computing (BigComp)*

Transformer needs NMDA receptor nonlinearity for long-term memory — 2022

D.-K, Kim, J. Kwon, M. Cha, C. J. Lee, *NeurIPS-W 2022 (Memory in Artificial and Real Intelligence)*

Inferring dissipation maps from videos using convolutional neural networks — 2022

Y. Bae, **D.-K. Kim** & H. Jeong, *Phys. Rev. Research* **4**, 033094, *qodudrud/CNEEP*

Estimating entropy production with odd-parity state variables via machine learning — 2022

D.-K. Kim, S. Lee & H. Jeong, *Phys. Rev. Research* **4**, 023051, *kdkyum/odd_neep*

Deep reinforcement learning for feedback control in a collective flashing ratchet
D.-K. Kim & H. Jeong, *Phys. Rev. Research* **3**, L022002, *kdkyum/RatchetDRL* 2021

Learning Entropy Production via Neural Networks
D.-K. Kim, Y. Bae, S. Lee & H. Jeong, *Phys. Rev. Lett.* **125**, 140604, *kdkyum/neep* 2020

Multi-Label Classification of Historical Documents by Using Hierarchical Attention Networks
D.-K. Kim, B. Lee, D. Kim & H. Jeong, *J. Korean Phys. Soc.* **76**, 368 2020

Skills

Programming Languages Python*, R, JAVA, Scheme, C, C++ (* skills daily used)
ML Frameworks JAX*, PyTorch*, Keras, TensorFlow
Distributed Computing Slurm*, Spark, Elasticsearch

Award

2021.8.30 Pre-doctoral Fellow of Physics at KAIST Daejeon, Korea

Presentation

Working and reference memory in transformers on a navigation task Sono Belle, Jeju, Korea
2022 KIAS CAINS Summer Workshop (Invited talk) Sep. 2, 2022

Deep reinforcement learning for optimal mechanism in active Brownian particles KIAS, Seoul, Korea
2022 Nonequilibrium Statistical Physics of Complex Systems (Conference, Poster) Jul. 25, 2022

Exploring optimal mechanisms in active Brownian particles via deep reinforcement learning Jeju, Korea
APCTP Workshop for Physics and Machine Learning (Invited talk) Nov. 26, 2021

Methods of estimating entropy production (Online) Korea
Seoul National University Statistical Physics Seminar (Invited talk) Feb. 1, 2021

Deep reinforcement learning for feedback-controlled flashing ratchets (Online) Korea
Korean Physical Society Fall Meeting (Conference, Oral) Nov. 6, 2020

Discovering wiring patterns of neural networks via backboning (Online) Rome, Italy
NetSci2020 (Conference, Oral) Sep. 22, 2020

Neural estimator for entropy production (Online) Korea
Korean Physical Society Spring Meeting (Conference, Oral) Jul. 13, 2020

Quantifying Individual Reputation in Large-scale Historical Documents Burlington, Vermont, USA
Quantifying Success satellite at NetSci2019 (Conference, Oral) May. 27, 2019

Teaching Experience

Computational Physics KAIST, Korea
Invited talk Apr. 24 & May. 1, 2023

Physics and AI Winter School (Online) Korea
Invited talk Feb. 24, 2022

General Physics II KAIST, Korea
Teaching Assistant 2016 (Fall), 2017 (Spring)

References

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