Dong-Kyum Kim

Contact Information

Center for Mathematical and Computational Sciences (Data Science Group)
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Education

Korea Advanced Institute of Science and Technology (KAIST) *2016 – 2022*
Ph.D. in Physics
- Advisor : Prof. Hawoong Jeong
- Dissertation : Nonequilibrium Statistical Physics Study using Deep Learning

Seoul National University (SNU) *2011 – 2015*
Bachelor of Science (BS) in Physics with a minor in Computer Science & Engineering

Research Interest

Artificial Intelligence (AI), Deep Learning, Machine Learning, Interpretable AI, Mechanistic Interpretability, Large Language Models (LLMs), Data Science, AI for Physics, Statistical Physics, Nonequilibrium Physics, Neuroscience, Brain-Inspired AI, Learning & Memory

Employment History

Institute for Basice Science (IBS) *Mar. 2022 – Present*
Senior Researcher
- Hosted by prof. Meeyoung Cha (Chief Investigator).
- Data Science Group, Center for Mathmatical and Computational Science

Samsung Electronics *Sep. 2017 – Dec. 2017*
Data Science Intern
- 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.

Publications

† : equal contribution.

Jea Kwon, Sunpil Kim, **Dong-Kyum Kim**, Jinhyeong Joo, SoHyung Kim, Meeyoung Cha, and C. Justin Lee. "SUBTLE : An unsupervised platform with temporal link embedding that maps animal behavior". *Under review.* bioRxiv:10.1101/2023.04.12.536531.

Gwangsu Kim, **Dong-Kyum Kim**, and Hawoong Jeong. "Spontaneous emergence of rudimentary music detectors in deep neural networks". In : *Nature Communications* **15**, 148 (2024).

Dong-Kyum Kim†, Jea Kwon†, Meeyoung Cha, and C. Justin Lee. "Transformer as a hippocampal memory consolidation model based on NMDAR-inspired nonlinearity". In : *Advances in Neural Information Processing Systems* (2023).

Sangyun Lee, **Dong-Kyum Kim**, Jong-Min Park, Won Kyu Kim, Hyunggyu Park, and Jae Sung Lee. "Multidimensional entropic bound : Estimator of entropy production for Langevin dynamics with an arbitrary time-dependent protocol". In : *Physical Review Research* **5**, 013194 (2023).

Vyacheslav Shen, **Dong-Kyum Kim**, Elke Zeller, and Meeyoung Cha. "Neural Classification of Terrestrial Biomes". In : *2023 IEEE International Conference on Big Data and Smart Computing (BigComp)*, pp. 163-166, (2023).

Youngkyoung Bae, **Dong-Kyum Kim**, and Hawoong Jeong. "Inferring dissipation maps from videos using convolutional neural networks". In : *Physical Review Research* **4**, 033094 (2022).

Dong-Kyum Kim†, Sangyun Lee†, and Hawoong Jeong. "Estimating entropy production with odd-parity state variables via machine learning". In : *Physical Review Research* **4**, 023051 (2022).

Dong-Kyum Kim and Hawoong Jeong. "Deep reinforcement learning for feedback control in a collective flashing ratchet". In : *Physical Review Research* **3**, L022002 (2021).

Dong-Kyum Kim†, Youngkyoung Bae†, Sangyun Lee, and Hawoong Jeong. "Learning Entropy Production via Neural Networks". In : *Physical Review Letters* **125**, 140604 (2020). arXiv : 2003.04166 [cond-mat.stat-mech].

Dong-Kyum Kim†, Byunghwee Lee†, Daniel Kim, and Hawoong Jeong. "Multi-label classification of historical documents by using hierarchical attention networks". In : *Journal of the Korean Physical Society* **76**, 368 (2020).

Awards

- **Pre-doctoral Fellow of Physics at KAIST** *Aug. 30, 2021*

Presentations

Invited talks and lectures

- Computational Physics Course in KAIST (Daejeon, Korea). *May. 1, 2023*
  "Deep learning applications : Nonequilibrium statistical physics study using AI"
- Computational Physics Course in KAIST (Daejeon, Korea). *Apr. 24, 2023*
  "Deep Learning Introduction"
- IBS Winter School on AI-Boosted Basic Science (Daejeon, Korea). *Dec. 13, 2022*
  "Resemblances between Transformer's Nonlinearity and NMDA Receptor Dynamics"
- KIAS CAINS Summer Workshop (Jeju, Korea). *Sep. 2, 2022*
  "Working and reference memory in transformers on a navigation task"
- KIAS Nonequilibrium Statistical Physics of Complex Systems (Seoul, Korea). *Jul. 25, 2022*
  "Deep reinforcement learning for optimal mechanism in active Brownian particles"
- SNU Physics and AI Winter School (Seoul, Korea). *Feb. 24, 2022*
  "Exploring Irreversibility via Machine Learning"
- APCTP Workshop for Physics and Machine Learning (Jeju, Korea). *Nov. 26, 2021*
  "Exploring optimal mechanisms in active Brownian particles via deep reinforcement learning"
- Seoul National University Statistical Physics Seminar ((Online) Korea). *Feb. 1, 2021*
  "Methods of estimating entropy production"
- Korean Physical Society Fall Meeting ((Online) Korea). *Nov. 6, 2020*
  "Deep reinforcement learning for feedback-controlled flashing ratchets"
- NetSci2020 ((Online) Rome, Italy). *Sep. 22, 2020*
  "Discovering wiring patterns of neural networks via backboning"
- Korean Physical Society Spring Meeting ((Online) Korea). *Jul. 13, 2020*
  "Neural estimator for entropy production"
- Quantifying Success satellite at NetSci2019 (Burlington, Vermont, USA). *May. 27, 2019*
  "Quantifying Individual Reputation in Large-scale Historical Documents"

In the press

Selected list of media coverages

- "Transformer as a hippocampal memory consolidation model based on NMDAR-inspired nonlinearit" (*NeurIPS* 2023)
  - IBS Research News (2023/11/28) ; Korean version.
  - Donga Science (2023/11/30).
  - YTN Science (2023/11/30).
- "Learning Entropy Production via Neural Networks" (*Phys. Rev. Lett.* **125**, 140604, 2020)
  - Physics and High Technology (2020/12/17).

References

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