Kim, Seongyoon (김성윤)

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I am deeply committed to implementing practical applications for industries, conducting research for the future, and making a positive impact in the world. My research at present is centered on the development of digital twins using AI/ML and computational models, aimed at diagnosing and optimizing energy systems. My current interests include:

- Physics-guided machine learning,
- Uncertainty quantification (Bayesian inference) and numerical optimization,
- Pattern recognition based on context learning in large language model (LLM), and
- Graph-based causality analysis.

I am pursuing my PhD at Yonsei University, under the guidance of Professor Jung-Il Choi in the Multi-Physics Modeling and Computation (MPMC) Lab.

Education

Ph.D. Candidate in School of Mathematics and Computing (Computational Science and Engineering) – Yonsei University, Republic of Korea 03 2018 — 02 2024

· Thesis title: Multi-modal diagnosis and prognosis of lithium-ion batteries
· Supervisor: Prof. Jung-Il Choi (jic@yonsei.ac.kr)
· This thesis aims to develop and propose a diagnosis and prognosis method using different modes of observable data from batteries, and finally develop a robust diagnosis algorithm by integrating multi-modal data.

B.S. in Department of Applied Statistics – Yonsei University, Republic of Korea 03 2013 — 02 2017

B.S. in Department of Atmospheric Sciences – Yonsei University, Republic of Korea 03 2013 — 02 2017

Positions

[2] Research Consultant — WorldQuant 09 2018 — 10 2019

· Developed machine learning, deep learning, and Kalman filter-based quantitative investment algorithms.
· Developed adaptive feature extraction and forecasting models from financial time series data.

[1] Research Associate — National Cancer Center 09 2017 — 02 2018

· Cancer patient survival rate prediction using statistical methods, machine learning, and deep learning
· Developed change-point detection algorithms for time series trends using genetic algorithms.
· Developed a hybrid deep survival network combining survival analysis and recurrent neural networks.

Project

[5] Development of Pre-diagnosis Algorithm for Internal Defects in EV Batteries

· Institution: Yonsei University, Hyundai Motor Company
· Period: 04 2023 — 04 2024
· Role: Project Manager (PM)
· Developed a lightweight algorithm for short-term detection of failure factors in battery time series data.

[4] Development of Physics-based Degradation Model for SiOx Anode Lithium-ion Batteries

· Institution: Yonsei University, LG Energy Solution
· Period: 04 2023 — 03 2024
· Role: Project Manager (PM)
· Developed optimization methods for parameter identification of electrochemical models.

[3] Development of Cloud Data-based Machine Learning Algorithm for Battery State Diagnosis

· Institution: Yonsei University, Hyundai Motor Company
· Period: 03 2023 — 12 2023
· Role: Project Manager (PM)
· Developed optimization methods for parameter identification of electrochemical models.

[2] Development of Waste Battery RUL Prediction Algorithm

· Institution: Yonsei University, Hyundai Motor Company
· Period: 01 2021 — 06 2022

· Role: Project Manager (PM)
· Developed recurrent neural network and attention-based prediction of remaining useful life changes when usage patterns change in battery time series data.

[1] Development of Lifetime Prediction Algorithm for Li-ion Batteries for Electric Vehicles for ESS Reuse

· Institution: Yonsei University, Hyundai Motor Company, Korea Electronics Technology Institute (KETI)
· Period: 06 2019 — 06 2021
· Role: Research Associate
· Developed recurrent neural network-based remaining useful life prediction through battery time series data.

Research Achievements

Honors and Awards

- [7] **Seongyoon Kim**, Departmental Best Paper Award, *Graduate Innovation Award for the first semester of 2022*, July, 2022.
  - Seongyoon Kim, Yun Young Choi, and Jung-Il Choi* (2022). Impedance-based Capacity Estimation for Lithium-Ion Batteries using Generative Adversarial Network. *Applied Energy*, 308, 118317.
  - Developed unsupervised deep learning methods based on generative adversarial networks to improve the accuracy and robustness of battery characterization and diagnostic techniques.
- [6] **Seongyoon Kim**, Sanghyun Kim, Yoon-young Choi, Jeong-il Choi, Outstanding Paper Presentation Award, *2022 KOBS Spring Conference*, June, 2022.
- [5] **Seongyoon Kim**, Award of Excellence (1st prize), *2021 Fall Semester CSE & MATH Poster Exhibition*, November, 2021.
- [4] Joohwan Ko, Minho Lee, Younghun Lee, **Seongyoon Kim**, Inbae Kang, Award of excellence (5th place), *National IT Industry Promotion Agency (NIPA) AI Competition*, December, 2020.
- [3] **Seongyoon Kim**, Award of Excellence (2nd prize), *2020 Fall Semester CSE & MATH Poster Exhibition*, November, 2020.
- [2] **Seongyoon Kim**, SG Poster Paper Award Encouragement Prize, *2018 KSS Autumn Conference*, November, 2018.
- [1] **Seongyoon Kim**, 2nd place in Korea (Stage 2), *WorldQuant International Quant Championship*, July, 2018.

Competitions

- [3] AI-based Meeting Minutes Summarization Competition (Ranked 22nd out of 430 teams), *DACON*, October, 2021.
  - Developed the fine-tuned Pre-trained BART (Bidirectional Auto-Regressive Transformer) model.
- [2] 2020 Space Radio Disaster Prediction AI Competition (5th place), *National IT Industry Promotion Agency (NIPA) AI Competition*, December, 2020.
  - Developed Vision Transformer (ViT)-based model for solar flare occurrences prediction through sunspot image data.
- [1] 2018 International Quant Championship (2nd place in Korea (Stage 2)), *WorldQuant*, July, 2018.
  - Developed a hybrid adaptive method based on Kalman filter and recurrent neural network for financial time series data.

Research Papers

- [14] **Seongyoon Kim** and Jung-Il Choi* (2023). Bayesian Impedance Deconvolution Using Timescale Distribution for Lithium-Ion Battery State Estimation, *In preparation*.
  - Proposed a Bayesian estimation method for extracting physical parameters of impedance and utilized the estimated timescale distribution as an input for Gaussian process and Transformer networks, confirming that stronger physical significance in input variables leads to more robust estimations.
- [13] Jinho Ha, **Seongyoon Kim**, Youngkwon Kim, and Jung-Il Choi* (2023). Capacity Fade-Aware Parameter Identification of Zero-Dimensional Model for Vanadium Redox Flow Batteries, *Submitted*.
  - Proposed a optimization method for identifying model parameters for different types of data on voltage and capacity.

- [12] Minho Lee, **Seongyoon Kim**, Sanghyun Kim, and Jung-Il Choi* (2023). Bilevel-Optimized Continual Learning for Predicting Capacity Degradation of Lithium-Ion Batteries, *Submitted*.
  - Presented a continual learning-based method for learning predictive models for lithium-ion battery degradation patterns in environments where diverse types of batteries are continuously introduced.
- [11] Dahhay Lee, **Seongyoon Kim**, Sanghee Lee, Hak Jin Kim, Myong Cheol Lim, and Hyunsoon Cho* (2023). Predicting the risk of venous thromboembolism among ovarian cancer patients: A dynamic survival neural network in electronic health record-based real-world settings, *in Revision*.
  - Developed a hybrid deep survival network combining survival analysis and recurrent neural networks for predicting the risk of ovarian cancer metastasis in cardiovascular disease patients.
- [10] Mingyu Yang, **Seongyoon Kim**, Xiang Sun, Sanghyun Kim, Jiyong Choi, Tae Seon Park, and Jung-Il Choi* (2023). Deep-learning-based reduced-order modeling to optimize recuperative burner operating conditions, *Applied Thermal Engineering*, 121669.
  - Developed a dimension reduction model for simplifying high-dimensional output combustion models and a Transformer-based deep learning model for optimizing recuperative burner operating conditions.
- [9] **Seongyoon Kim**, Sanghyun Kim, Yun Young Choi, and Jung-Il Choi* (2023). Bayesian Parameter Identification in Electrochemical Model for Lithium-Ion Batteries, *Journal of Energy Storage*, 108129.
  - Developed a Bayesian inference-based method for accurate parameter identification in lithium-ion battery electrochemical models, incorporating global sensitivity analysis to assess parameter identifiability under varying discharge rates.
- [8] **Seongyoon Kim**, Hangsoon Jung, Minho Lee, Yun Young Choi, and Jung-Il Choi* (2023). Model-Free Reconstruction of Capacity Degradation Trajectory of Lithium Ion Batteries Using Early Cycle Data, *eTransportation*, 100243.
  - Developed a convolutional neural network (CNN)-based reconstruction model-free deep learning approach incorporating Bayesian optimization for predicting lithium-ion battery degradation patterns using early cycle data.
- [7] Xiang Sun, **Seongyoon Kim**, and Jung-Il Choi* (2022). Recurrent Neural Network-Induced Gaussian Process. *Neurocomputing*, 509, 75-84.
  - Developed the recurrent neural network-induced Gaussian process (RNNGP) for sequential data modeling, proposing a methodology that kernelizes RNNs to estimate uncertainties without the need for training, demonstrating improved predictive performance and quantifiable uncertainty over traditional RNNs and GPs.
- [6] **Seongyoon Kim**, Yun Young Choi, and Jung-Il Choi* (2022). Impedance-based Capacity Estimation for Lithium-Ion Batteries using Generative Adversarial Network. *Applied Energy*, 308, 118317.
  - Developed an unsupervised learning approach using an information maximizing generative adversarial network (InfoGAN) to extract meaningful latent variables from unstable impedance data for robust capacity estimation of lithium-ion batteries.
  - Deploying the proposed model on a web-based cloud environment using AWS Lambda.
- [5] Yun Young Choi, **Seongyoon Kim**, Kyunghyun Kim, Sanghyun Kim, and Jung-Il Choi* (2022). Parameter Identification and Identifiability Analysis of Lithium-Ion Batteries. *Energy Science & Engineering*, 10(2), 488-506.
  - Developed a cost-effective parameter identification method for lithium-ion battery electrochemical models, with a Fisher information matrix-based analysis for parameter identifiability, depending on observed data and the model, enabling the selection of highly identifiable parameters to strengthen model robustness.
  - Deploying the proposed model on a web-based cloud environment using AWS Lambda.
- [4] Jaeho Shin, Seongmin Jeong, Jinmo Kim, Yun Young Choi, Joonhwa Choi, Jae Gun Lee, **Seongyoon Kim**, Munju Kim, Yoonsoo Rho, Sukjoon Hong, Jung-Il Choi, Costas P. Grigoropoulos, and Seung Hwan Ko* (2021). Dynamic Pore Modulation of Stretchable Electrospun Nanofiber Filter for Adaptive Machine Learned Respiratory Protection. *ACS Nano*, 15(10), 15730-15740.
  - Developed a recurrent neural network model for predicting mask dynamics based on user's breathing, enabling personalized, AI-optimized respiratory protection through a smart mask.

- [3] **Seongyoon Kim**, Yun Young Choi, Ki Jae Kim, and Jung-Il Choi* (2021). Forecasting State-of-Health of Lithium-Ion Batteries using Variational Long Short-Term Memory with Transfer Learning. *Journal of Energy Storage*, 41, 102893.
  - Developed a long short-term memory (LSTM)-based forecasting method with transfer learning and Monte Carlo dropout for predicting lithium-ion battery health, enhancing prediction accuracy across different battery types and reducing data collection efforts.
  - Deploying the proposed model on a web-based cloud environment using AWS Lambda.
- [2] **Seongyoon Kim**, Sanghee Lee, Jungi-Il Choi, and Hyunsoon Cho* (2021). Binary Genetic Algorithm for Optimal Joinpoint Detection: Application to Cancer Trend Analysis. *Statistics in Medicine*, 40(3), 799-822.
  - Developed an algorithm using a binary genetic algorithm for simultaneous optimization of change-point detection and trend regression in cancer incidence analysis, efficiently identifying multiple change-points with a clear separation of optimization and regression calculations.
- [1] Yun Young Choi, **Seongyoon Kim**, Soowhan Kim, and Jung-Il Choi* (2020). Multiple Parameter Identification Using Genetic Algorithm in Vanadium Redox Flow Batteries. *Journal of Power Sources*, 450, 227684.
  - Proposed a method for multiple parameter identification in vanadium redox flow batteries, evaluating identifiability using the Fisher information matrix and developing an optimal model parameter estimation method using genetic algorithms.

International Conference

- [5] Kyeongeun Cho, Sanghyun Kim, **Seongyoon Kim**, and Jung-Il Choi*, Electrochemical Model-Based State-Space Approach for Real-Time Parameter Estimation of Lithium-Ion Batteries, *244th Electrochemical Society (ECS) Meeting*, October 10, 2023, Gothenburg, Sweden.
- [4] Sanghyun Kim, **Seongyoon Kim**, Jinho Ha, and Jung-Il Choi*, Accelerated 3D Simulation for Analyzing Electrochemical and Thermal Distribution in Lithium-Ion Batteries, *244th Electrochemical Society (ECS) Meeting*, October 10, 2023, Gothenburg, Sweden.
- [3] **Seongyoon Kim** and Jung-Il Choi*, Bayesian Approach to Estimate Distribution of Relaxation Times for Lithium-Ion Batteries, *244th Electrochemical Society (ECS) Meeting*, October 8, 2023, Gothenburg, Sweden.
- [2] **Seongyoon Kim**, Yun Young Choi, and Jung-Il Choi*, State of Health Forecasting of Lithium-Ion Batteries Using Variational Long Short-Term Memory Trained with Transfer Learning, *72nd Annual Meeting of the International Society of Electrochemistry*, September 3, 2021, Korea.
- [1] Yun Young Choi, **Seongyoon Kim**, Mingyu Yang, Ki Jae Kim, and Jung-Il Choi*, An optimal flow frame design for the Fe/Cr flow battery, *The International Flow Battery Forum*, July 10-12, 2018, SwissTec Convention Centre, Lausanne, Switzerland.

Technical Skills

- **Python** (PyTorch, TensorFlow, sklearn, SciPy, etc.), **Matlab**, **R**
- **linux**, **AWS** (Lambda, EC2, S3, Cloud9)