

Sunwoo Lee

Assistant Professor
Department of Computer Engineering
Inha University, South Korea

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Research Interest

- Large-Scale Distributed Machine Learning and Deep Learning
- Federated Learning on Heterogeneous Systems
- Applied Machine Learning (E.g., Physics + ML)

Education

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|---|------------------|
| Northwestern University | Evanston, IL USA |
| Ph.D. in Computer Engineering | 2020 |
| Advisors: Prof. Alok Choudhary and Prof. Wei-keng Liao | |
| Thesis: Scalable Parallelization Strategy for Large-Scale Deep Learning | |

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| Hanyang University | Seoul, South Korea |
| B.S. and M.S. in Computer Engineering | 2009 |
| Advisor: Prof. Minsoo Ryu | |

Employment

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| Inha University | Incheon, South Korea |
| Assistant Professor of Computer Engineering | 2022 – now |

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| University of Southern California | Los Angeles, CA USA |
| Postdoctoral Researcher | 2020 – 2022 |
| Advisor: Prof. Salman Avestimehr | |

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|---|-----------------------|
| Samsung Electronics, Memory Solutions Lab. | Hwaseong, South Korea |
| System Software Researcher | 2013 – 2015 |

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| Humax | Bundang, South Korea |
| Software Engineer (Alternative Military Service) | 2009 – 2013 |

Research Internship

Lawrence Berkeley National Laboratory
Research Intern

Berkeley, CA USA
Jun 2020 – Aug 2020

Fermi National Accelerator Laboratory
Research Intern

Batavia, IL USA
Jul 2019 – Sep 2019

Argonne National Laboratory
Research Intern

Lemont, IL USA
Jun 2018 – Aug 2018

Teaching Experience

Inha University

- CSE4315: Machine Learning Spring 2023, 2024
- CSE1103: Objected Oriented Programming 2 Spring 2023, 2024
- CSE3209: System Programming Fall 2022, 2023
- CSE3313: Linux Programming Fall 2022, 2023

University of Southern California

- AEOP Scholarship Program in Data Science Summer 2021

Northwestern University

- CE501: Social Media Mining Spring 2020
- CE303: Advanced Digital Design Fall 2019

Honors & Awards

FL-AAAI Workshop Best Paper Award 2022

- SSFL: Tackling Label Deficiency in Federated Learning via Personalized Self-Supervision

IEEE HiPC Best Paper Finalist 2017

- Parallel Deep Convolutional Neural Network Training by Exploiting the Overlapping of Computation and Communication

Invited Talks

- Department of Physics at Ajou University, South Korea: System-Aware Large-Scale Neural Network Training and its Applications, 3/20/2024
- Department of Computer Engineering at Gachon University, South Korea: Scalable Federated Learning Strategies on Real-world Edge Computing Environments, 11/18/2022

- Department of Electrical Engineering at Hanyang University, South Korea: Partial Model Training Strategies in Federated Learning, 10/04/2022
- U.S. Department of Energy, SciDAC, RAPIDS Institute, Tech Talk: Asynchronous I/O Strategy for Large-Scale Deep Learning Applications, 12/01/2021
- HDF5 User Group Meeting: A Case Study on Parallel HDF5 Dataset Concatenation for Scientific Data Analysis, 10/21/2021
- U.S. Department of Energy, SciDAC, RAPIDS Institute, Tech Talk: Communication-Efficient Local SGD for Scalable Deep Learning, 7/7/2021

Service

- Program Committee of Association for the Artificial Intelligence (AAAI) 2021, 2022, 2023, 2024
- Program Committee of NeurIPS 2023, 2024
- Program Committee of KDD 2024
- Reviewer in IEEE Transactions on Parallel and Distributed Computing 2023
- Reviewer in IEEE Transactions on Mobile Computing 2023
- Program Committee of Federated Learning for Natural Language Processing (FL4NLP) workshop held in conjunction with Association for Computational Linguistics (ACL) 2022
- Program Committee of International Conference on Learning Representations (ICLR) 2021, 2022
- Program Committee of International Conference on Machine Learning (ICML) 2021, 2022, 2023
- Program Committee of International Conference on Artificial Intelligence and Statistics (AISTATS) 2021, 2022

Publications

1. **Sunwoo Lee**, Tuo Zhang, Saurav Prakash, Yue Niu, and Salman Avestimehr, 2024
Embracing Federated Learning: Enabling Weak Client Participation via Partial Model Training, *IEEE Transactions on Mobile Computing*
2. **Sunwoo Lee**, Anit Sahu, Chaoyang He, and Salman Avestimehr, Partial Model 2023
Averaging in Federated Learning: Performance Guarantees and Benefits, *Neurocomputing*
3. Yue Niu, Saurav Prakash, Souvik Kundu, **Sunwoo Lee**, and Salman Avestimehr, 2023
Overcoming Resource Constraints in Federated Learning: Large Models Can Be Trained with only Weak Clients, *Transactions on Machine Learning Research*
4. Yue Niu, Zalan Fabian, **Sunwoo Lee**, Mahdi Soltanolkotabi, and Salman Avestimehr, 2023
mL-BFGS: A Momentum-based L-BFGS for Distributed Large-Scale Neural Network Optimization, *Transactions on Machine Learning Research*
5. **Sunwoo Lee**, Tuo Zhang, and Salman Avestimehr, Layer-wise Adaptive Model 2023
Aggregation for Scalable Federated Learning, *AAAI Conference on Artificial Intelligence (AAAI)*, **oral presentation** (19.7%)
6. Tuo Zhang, TianTian Feng, Samiul Alam, **Sunwoo Lee**, Mi Zhang, Shrikanth S. 2023
Narayanan, and Salman Avestimehr, FedAudio: A Federated Learning Benchmark for Audio Tasks, *IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP)*
7. **Sunwoo Lee**, Chaoyang He, and Salman Avestimehr, Achieving Small-Batch 2023
Accuracy with Large-Batch Scalability via Hessian-Aware Learning Rate Adjustment. *Elsevier Neural Networks*, **158**, 1-14
8. **Sunwoo Lee**, Jaeyong Jeon, and Hyungwoo Lee, Probing Oxygen Vacancy 2022
Distribution in Oxide Heterostructures by Deep Learning-based Spectral Analysis of Current Noise. *Applied Surface Science*, p154599
9. **Sunwoo Lee**, Jaeyoung Jeon, Kitae Eom, Chaehwa Jeong, Yongsoo Yang, Ji-Yong 2022
Park, Chang Beom Eom, and Hyungwoo Lee, Variance-aware Weight Quantization of Multi-level Resistive Switching Devices based on Pt/LaAlO₃/SrTiO₃ Heterostructures. *Scientific Reports*, **12**, 1-10
10. Kewei Wang, **Sunwoo Lee**, Jan Balewski, Alex Sim, Peter Nugent, Ankit Agrawal, 2022
Alok Choudhary, Kesheng Wu, and Wei-keng Liao, Using Multi-resolution Data to Accelerate Neural Network Training in Scientific Applications. *International Symposium on Cluster, Cloud and Internet Computing (CCGrid)*
11. **Sunwoo Lee**, Qiao Kang, Reda Al-Bahrani, Ankit Agrawal, Alok Choudhary, and Wei- 2022
keng Liao, Improving Scalability of Parallel CNN Training by Adaptively Adjusting

Parameter Update Frequency. *Journal of Distributed and Parallel Computing*, **159**, 10-23

12. **Sunwoo Lee**, Kai-yuan Hou, Kewei Wang, Saba Sehrish, Marc Paterno, James Kowalkowski, Quincey Koziol, Ross Robert, Ankit Agrawal, Alok Choudhary, and Wei-keng Liao, A Case Study on Parallel HDF5 Dataset Concatenation for High-Energy Physics Data Analysis. *Parallel Computing*, **110**, 102877 2022
13. Kai-yuan Hou, Qiao Kang, **Sunwoo Lee**, Ankit Agrawal, Alok Choudhary, and Wei-keng Liao, Supporting Data Compression in PnetCDF, *International Conference on BigData* (19.9%) 2021
14. **Sunwoo Lee**, Qiao Kang, Kewei Wang, Jan Balewski, Alex Sim, Kesheng Wu, Ankit Agrawal, Alok Choudhary, Peter Nugent, and Wei-keng Liao, Asynchronous I/O Strategy for Large-Scale Deep Learning Applications. *International Conference on High-Performance Computing, Data, and Analytics (HiPC)* (22.9%) 2021
15. Reda Al-bahrani, Dipendra Jha, Qiao Kang, **Sunwoo Lee**, Zijiang Yang, Wei-keng Liao, Ankit Agrawal, and Alok Choudhary, SIGRNN: Synthetic minority Instances Generation in imbalanced datasets using a Recurrent Neural Network. *International Conference on Pattern Recognition Applications and Methods* 2021
16. **Sunwoo Lee**, Qiao Kang, Ankit Agrawal, Alok Choudhary, and Wei-keng Liao, Communication-Efficient Local SGD for Scalable Deep Learning. *International Conference on Big Data* (15.7%) 2020
17. Sandeep Madireddy, Ji Hwan Park, **Sunwoo Lee**, Prasanna Balaprakash, Shinjae Yoo, Wei-keng Liao, Cory Hauck, M. Paul Laiu, and Richard Archibald, In Situ Compression Artifact Removal in Scientific Data Using Deep Transfer Learning and Experience Replay. *Machine Learning: Science and Technology*, **2**, 025010 2020
18. Qiao Kang, **Sunwoo Lee**, Ankit Agrawal, Alok Choudhary, and Wei-keng Liao, Improving All-to-many Personalized Communication in MPI I/O. *International Conference for High Performance Computing, Networking, Storage, and Analysis (SC)* 2020
19. Qiao Kang, **Sunwoo Lee**, Kai-yuan Hou, Robert Ross, Ankit Agrawal, Alok Choudhary, and Wei-keng Liao, Improving MPI Collective I/O for High Volume Non-contiguous Requests with Intra-node Aggregation. *IEEE Transactions on Parallel and Distributed Systems*, **31**, 11, 2682-2695 2020
20. Qiao Kang, Alex Sim, Peter Nugent, **Sunwoo Lee**, Wei-keng Liao, Ankit Agrawal, Alok Choudhary, and Kesheng Wu. Predicting Resource Requirement in Intermediate Palomar Transient Factory Workflow. *International Symposium on Cluster, Cloud and Internet Computing (CCGrid)*, 2020 2020
21. **Sunwoo Lee**, Qiao Kang, Sandeep Madireddy, Prasanna Balaprakash, Ankit Agrawal, Alok Choudhary, Richard Archibald, and Wei-keng Liao. Improving Scalability of Parallel CNN Training by Adjusting Mini-Batch Size at Run-Time. *International Conference on Big Data* (18.7%) 2019

22. **Sunwoo Lee**, Ankit Agrawal, Prasanna Balaprakash, Alok Choudhary, and Wei-keng Liao. Communication-Efficient Parallelization Strategy for Deep Convolutional Neural Network Training. *Machine Learning in High-Performance Computing Environments (MLHPC)* 2018
23. **Sunwoo Lee**, Dipendra Jha, Ankit Agrawal, Alok Choudhary, and Wei-keng Liao. Parallel Deep Convolutional Neural Network Training by Exploiting the Overlapping of Computation and Communication. *International Conference on High-Performance Computing, Data, and Analytics (HiPC)* (22.8%) 2017
24. **Sunwoo Lee**, Wei-keng Liao, Ankit Agrawal, Nikos Hardavellas, and Alok Choudhary. Evaluation of K-Means Data Clustering Algorithm on Intel Xeon Phi. *International Conference on Big Data* 2016
25. Diana Palsetia, William Hendrix, **Sunwoo Lee**, Ankit Agrawal, Wei-keng Liao, and Alok Choudhary. Parallel Community Detection Algorithm Using a Data Partitioning Strategy with Pairwise Subdomain Duplication. *International Conference on High Performance Computing (ISC)* 2016
26. **Sunwoo Lee**, Byung Kwan Jung, Minsoo Ryu, Seungwon Lee, Extending Component-based Approaches for Multi-threaded Design of Multiprocessor Embedded Software. *International Symposium on Object/Component/Service-Oriented Real-Time Distributed Computing* 2009

Pre-prints

1. Zhenheng Tang, Xiaowen Chu, Ryan Yide Ran, **Sunwoo Lee**, Shaohuai Shi, Yonggang Zhang, Yuxin Wang, Alex Qiaozhong Liang, Salman Avestimehr, Chaoyang He, FedML Parrot: A Scalable Federated Learning System via Heterogeneity-Aware Scheduling on Sequential and Hierarchical Training. *arXiv* 2023.
2. Yue Niu, Saurav Prakash, Souvik Kundu, **Sunwoo Lee**, Salman Avestimehr, Federated Learning of Large Models at the Edge via Principal Sub-Model Training. *FL-NeurIPS* 2022.
3. Chaoyang He, Zhengyu Yang, Erum Mushtaq, **Sunwoo Lee**, Mahdi Soltanolkotabi, Salman Avestimehr, SSFL: Tackling Label Deficiency in Federated Learning via Personalized Self-Supervision. *arXiv* 2021

Skills and Qualifications

Programming Language

C/C++, Python

Deep Learning Software Frameworks

TensorFlow, PyTorch, Caffe

Parallelization Libraries

MPI, OpenMP

I/O Libraries

MPI-I/O (ROMIO), HDF5, NetCDF