BYEONGTAK LEE

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SUMMARY

- Machine learning (ML) researcher with seven years of industrial research experience in the biomedicine domain.
- Experienced in developing AI solutions for healthcare applications and automated ML systems.
- Investigated ML challenges encountered during model deployment and the utilization of real-world biomedicine data, focusing on domain generalization and noisy labels.

RESEARCH & PROFESSIONAL EXPERIENCE

Medical AI Co. Ltd.   Seoul, South Korea
Senior Research Scientist   Apr. 2021 – Present
Research on Domain Generalization and Noisy Labels
- Developed a temporal adversarial data augmentation to address distribution shifts in real-world time series data, achieving up to 40% performance improvement on a specific external dataset.
- Investigated the structural inductive bias of neural networks to mitigate performance drop caused by distribution shifts in unseen data. Developed a method to adjust the inductive bias between convolution and self-attention using a tunable coefficient.
- Led a project of development of a personalized blood pressure estimation model using ECG and PPG, incorporating test-time training and noisy label filtering, achieving up to 30% improvement in regression performance.
- Studied self-supervised learning methods for electrocardiograms and proposed an effective learning strategy.

Development and Research on Automated Machine Learning Systems
- Led the development of an automated ML experimentation system built on large-scale distributed parallel framework (Ray), enabling medical professionals without ML expertise to conduct diverse experiments with medical data.
- Conducted research on network scalability and data augmentation in ECG classification to enhance the efficiency of hyperparameters optimization in the Automated ML system.

Development of AI Solutions for Cardiovascular Disease Diagnosis Screening
- Developed cardiovascular diseases screening model (AITIA-Series), including left ventricular systolic dysfunction (LVSD), myocardial infarction (MI), and aortic stenosis (AS). AITIA-LVSD and AITIA-MI were conferred as innovative medical device by the Korea FDA, and AITIA-LVSD won UNIST-UCLA Digital Healthcare Challenge 2023.

VUNO Inc.   Seoul, South Korea
Research Scientist   Aug. 2017 – Apr. 2021
Research on Generalization in Medical Data
- Developed a data augmentation technique utilizing graph structures of multi-channel ECG data, mitigating distribution shifts caused by variations of the heart position and angle, resulting in 3% performance improvement.
- Developed a regularization method for transformers by applying temporal correlation inductive bias into the self-attention, achieving up to an 8% improvement in AUPRC.
- Developed a self-supervised learning method for ECG using clinical knowledge-based pretext tasks, outperforming contrastive-based self-supervised learning approaches (e.g., SimCLR and BYOL) in ECG data.

Development and Evaluation of AI Model for Clinical Practice
- Led projects of development and evaluation of neural network model for diagnosing cardiovascular disease, including heart failure with reduced ejection fraction and myocardial infarction.
- Proposed an effective neural network training strategies for sepsis prediction and developed a missing value imputation method leveraging the graphical relationship between clinical variables in electronic hospital records.

Medical Biomechanics & Design Lab   Seoul, South Korea
Graduate Student Researcher   Sep. 2015 – Aug. 2017
- Developed a left ventricular **segmentation model** for echocardiography and a left ventricular volume estimation algorithm using two-dimensional images.
- Built physiological signal analysis systems, including stroke volume estimation based on pulse pressure variation.
- Contributed to the development of physiological signal sensors, including SvO2 sensors for a low-cost ECMO system.

EDUCATION

Seoul National University   Seoul, South Korea
M.S., Bioengineering   Sep. 2015 – Aug. 2017
- Thesis: Real-time Estimation of Left Ventricular Volume from Echocardiogram during Cardiopulmonary Resuscitation.
- Advisor: Jung Chan Lee

Pusan National University   Busan, South Korea
B.S., Mechanical Engineering (Magna Cum Laude)   Mar. 2011 – Aug. 2015
- Minor: Electrical Engineering

PUBLICATIONS   (*equal contributions)

PEER-REVIEWED PAPERS
- YY. Jo*, **BT. Lee***, BJ. Kim, JH. Hong, HS. Lee, J. Kwon. New Test-Time Paradigm for Real-World Biosignal: Concept and Its Approach. 2024. Machine Learning for Health (ML4H) Symposium (Finding Tracks)
- KG. Kim*, **BT. Lee***. Graph Structure Based Data Augmentation Method. 2024. Biomedical Engineering Letters.

- KG. Kim*, **BT. Lee***. Self Attention with Temporal Prior: Can We Learn More from Arrow of Time?. 2024. Frontiers in Artificial Intelligence.
- **BT. Lee***, J. Kwon*, J. Cho, W. Bae, H. Park, WW. Seo, I. Cho, Y. Lee, J. Park, B. Oh, K. Jeon. Usefulness of Deep Learning Algorithm for Detecting Acute Myocardial Infarction Using Electrocardiogram Alone in Patients With Chest Pain at Emergency Department: DAMI-ECG Study. 2023. Journal of Cardiovascular Intervention.
- **BT. Lee***, YY Jo*, SY. Lim, Y. Song, J. Kwon. Efficient Data Augmentation Policy for Electrocardiograms. 2022. Proceedings of the 31st ACM International Conference on Information & Knowledge Management.
- **BT. Lee**, YY. Jo, J. Kwon. On the Inductive Bias Transfer with Knowledge Distillation for Real World Data. 2022. Workshop on Applied Machine Learning Methods for Time Series forecasting.
- C. Han, Y. Song, HS. Lim, Y. Tae, JH. Jang, **BT. Lee**, Y. Lee, W. Bae, D. Yoon. Automated Detection of Acute Myocardial Infarction Using Asynchronous Electrocardiogram Signals—Preview of Implementing Artificial Intelligence With Multichannel Electrocardiographs Obtained from Smartwatches: Retrospective Study. 2021. Journal of Medical Internet Research.
- J. Cho*, **BT. Lee***, J. Kwon, Y. Lee, H. Park, B. Oh, K. Jeon, J. Park, K. Kim. Artificial intelligence algorithm for screening heart failure with reduced ejection fraction using electrocardiography. 2021. ASAIO Journal.
- **BT. Lee***, ST. Kong*, Y. Song, Y. Lee. Self-Supervised Learning with Electrocardiogram Delineation for Arrhythmia Detection. 2021. Annual International Conference of the IEEE Engineering in Medicine & Biology Society.
- **BT. Lee***, OY. Kwon*, H. Park, KJ. Cho, J. Kwon, Y. Lee. Graph Convolutional Networks-Based Noisy Data Imputation in Electronic Health Record. 2020. Critical Care Medicine.
- YS. Jung*, WS. Cho*, GJ Suh, JC. Lee, WY. Kwon, KS. Kim, SM. Shin, MW. Kang, MS. Lee, **BT. Lee**. Pulse Oximeter Plethysmograph Variation During Hemorrhage in Beta Blocker–Treated Swine. 2020. Journal of Surgical Research.
- **BT. Lee**, KJ. Cho, OY. Kwon, Y. Lee. Improving the Performance of a Neural Network for Early Prediction of Sepsis. 2019. Computing in Cardiology.

MANUSCRIPTS UNDER REVIEW & IN PREPARATION
- **BT. Lee***, YY. Jo*, J. Kwon. Revisiting Neural Network Scale for ECG Classification. (under review)
- **BT. Lee**, J. Kwon, YY. Jo. TADA: Temporal Adversarial Data Augmentation for Time Series Data. (under review)
- J. Song, JH. Jang, **BT. Lee**, D. Hong, J. Kwon, YY. Jo. Foundation Models for Electrocardiograms. (under review)
- **BT. Lee**, J. Kwon, YY. Jo. Optimizing Inductive Bias with a Generalized Self-Attention Layer. (in preparation)

PATENTS
- **BT. Lee**, Y. Song, W. Bae, O. Kwon. Deep neural network pre-training method for classifying electrocardiogram (ecg) data. US20220084679A1, KR102390326B1
- **BT. Lee**, W. Bae, O. Kwon. Disease judgment method. US20220076835A1, KR1020200113261
- GJ. Suh, WY. Kwon, KS. Kim, SH Na, J. Park, JC. Lee, YS. J, KM. Y, MJ. P, TG. K, J. Ko, JS. K, J. Jung, SH. Kim, BW. Yoo, **BT. Lee**, WS. Cho, JW. Choi. Automatic cardiopulmonary resuscitation device and control method therefor. US11071686B2, KR101956776B1

AWRADS & SCHOLARSHIPS
- Seoul National University Merit-based Scholarship (2015) — ₩385,500 (~$300)
- Pusan National University Merit-based Scholarship (2011-2014, 8 times) — ₩6,316,000 (~$5000)

TECHNICAL SKILLS
- Programming Languages: Python, C/C++, MATLAB
- Frameworks: Pytorch, TensorFlow, Ray
- Tools & Platforms: Linux, Git, Docker, PostgreSQL

RELEVANT COURSES
- ML & Mathematics: Pattern recognition, Estimation theory, System modeling and control, Complex analysis, Differential equation, Discrete mathematics, Linear algebra, Statistics, Calculus, etc.
- Biology and Medicine: Molecular Biology, Protein engineering, Cell biology, Human Biology, Biomedical system simulation, PK/PD Modeling, Biomedical engineering, Bioelectromagnetics, etc.

EXTRACURRICULAR ACTIVITIES
Member of a multidisciplinary academic club addressing everyday problems.	Sep. 2016 – Aug. 2017
Taught Korean to foreigners in Busan (9 students for 3 semesters).	Mar. 2014 – Jun. 2015
Tutored mathematics to an underprivileged high school student.	Mar. 2014 – Aug. 2014
Organized and led science class for elementary school students in underprivileged area.	Nov. 2011 – Feb. 2012
Volunteered at a club supporting local welfare centers and children's care centers.	Mar. 2011 – Feb. 2012

REFERENCES
- Dr. Yong-Yeon Jo, AI Lead & Research Director at Medical AI Co Ltd, Supervisor (yy.jo@medicalai.com)
- Dr. Mineok Chang, Director of Medical Science at AIMS USA Inc, Former Advisor (mineok.chang@aimsbiosci.com)
- Dr. Yongjae Song, Chief Executive Officer at Bambit Co Ltd, Former Advisor (yjsong@sj-labs.or)
- Dr. Jung Chan Lee, Professor at Seoul National University, Graduate Research Advisor (ljch@snu.ac.kr)