

# 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 system.
- Investigated ML challenges encountered during model deployment and the utilization of real-world biomedicine data, focusing on domain generalization and noisy label.

## 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 method 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 an 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 in 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 a 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

#### AWARDS & 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)
- University Leadership Academy Debate Competition 1st Team Award (2012)

#### 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)