BYEONG TAK LEE

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SUMMARY

- Machine learning (ML) researcher passionate about using artificial intelligence (AI) to advance in biology and medicine.
- Experienced in developing AI solutions for real-world healthcare applications and automated ML systems.
- Investigated techniques to enhance ML models in medicine, with a focus on domain generalization and noisy label.

RESEARCH & PROFESSIONAL EXPERIENCE

Medical AI Co. Ltd., Seoul, Republic of Korea
Senior Research Scientist. Apr. 2021 – Present

- Developed a temporal **adversarial data augmentation** to address **distribution shifts** in the real-world time series data, achieving up to 40% performance improvement on a specific external dataset.
- Proposed a **personalized blood pressure (BP) estimation** model using ECG and PPG. Incorporated **test-time training** to mitigate **distribution shifts** among individual, resulting in up to a 30% improvement in regression performance.
- Investigated the **inductive bias** of neural networks to improve robustness against **distribution shift** in unseen data. Enhanced transformer performance by introducing inductive bias of convolution to self-attention.
- Developed algorithms for filtering **noisy data and labels** collected in in intensive care units settings.
- Studied **self-supervised learning** method for electrocardiograms and proposed an effective learning strategy.
- Led the development of an **automated ML** experiment 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, demonstrating that training neural networks for ECG requires distinct hyperparameters setups compared to other domains due to cyclic nature of ECG.
- Developed cardiovascular diseases screening model (AITIA-Series), including left ventricular systolic dysfunction, myocardial infactrion, and aeortic stenosis. One of the product (AITIA-LVSD) was conferred as an innovative medical device by the Korea FDA and won UNIST-UCLA Digital Healthcare Challenge 2023.

VUNO Inc. Seoul, Republic of Korea
Research Scientist. Aug. 2017 – Apr. 2021

- Developed a data augmentation technique that leverages the inherent **graph structures** of multi-channel ECG data, effectively addressing **distribution shifts** caused by variations of the heart position.
- Developed a regularization method for transformers by applying temporal correlation **inductive bias** into the self-attention.
- Developed a **self-supervised learning** method for ECG using clinical knowledge-based pretext tasks, achieving superior performance compared to contrastive-based self-supervised learning for ECG data.
- Led projects to develop neural network model for diagnosing heart failure with reduced ejection fraction and myocardial infarction, evaluating its performance against experienced cardiologists.
- Proposed a effective neural network training strategies for sepsis prediction and developed a **missing value imputation** method that leverage the **graphical relationship between clinical variables** in electronic hospital records.

EDUCATION

Seoul National University Seoul, Republic of Korea
M.S., Bioengineering Aug. 2015 – Aug. 2017

- Thesis: Real-time estimation of left ventricular volume from echocardiogram during cardiopulmonary resuscitation using convolutional neural network
- Advisor: Jung Chan Lee

Pusan National University Busan, Republic of Korea
B.S., Mechanical Engineering Mar. 2011 – Aug. 2015

- Minor: Electrical Engineering
- Magna Cum Laude

PUBLICATIONS

(*equal contributions)

PEER-REVIEWED JOURNALS & PROCEEDINGS

- Kyung Geun Kim*, **Byeong Tak Lee***. Graph Structure Based Data Augmentation Method. 2024. Biomedical Engineering Letters.
- Kyung Geun Kim*, **Byeong Tak Lee***. Self Attention with Temporal Prior: Can We Learn More from Arrow of Time?. 2024. Frontiers in Artificial Intelligence.
- **Byeong Tak Lee***, Joom-myoung Kwon*, Jinwoo Cho, Woong Bae, Hyunho Park, Won-Woo Seo, Iksung Cho, Yeha Lee, Jinsik Park, Byung-Hee Oh, Ki-Hyun 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.
- **Byeong Tak Lee***, Yong-Yeon Jo*, Seon-Yu Lim, Youngjae Song, Joon-myoung Kwon. Efficient Data Augmentation Policy for Electrocardiograms. 2022. Proceedings of the 31st ACM International Conference on Information & Knowledge Management.
- **Byeong Tak Lee**, Yong-Yeon Jo, Joon-myoung Kwon. On the Inductive Bias Transfer with Knowledge Distillation for Real World Data. 2022. Workshop on Applied Machine Learning Methods for Time Series forecasting.
- Changho Han, Youngjae Song, Hong-Seok Lim, Yunwon Tae, Jong-Hwan Jang, **Byeong Tak Lee**, Yeha Lee, Woong Bae, Dukyong 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.
- Jinwoo Cho*, **Byeong Tak Lee***, Joon-myoung Kwon, Yeha Lee, Hyunho Park, Byung-Hee Oh, Ki-Hyun Jeon, Jinsik Park, Kyung-Hee Kim. Artificial intelligence algorithm for screening heart failure with reduced ejection fraction using electrocardiography. 2021. ASAIO Journal.
- **Byeong Tak Lee***, Seo Taek Kong*, Youngaje Song, Yeha Lee. Self-Supervised Learning with Electrocardiogram Delineation for Arrhythmia Detection. 2021. Annual International Conference of the IEEE Engineering in Medicine & Biology Society.
- **Byeong Tak Lee***, O-Yeon Kwon*, Hyungho Park, Kyung-Jae Cho, Joon-myoung Kwon, Yeha Lee. Graph Convolutional Networks-Based Noisy Data Imputation in Electronic Health Record. 2020. Critical Care Medicine.
- Yoon Sun Jung*, Woo Sang Cho*, Gil Joon Suh, Jung Chan Lee, Woon Yong Kwon, Kyung Su Kim, So Mi Shin, Min Woo Kang, Min Sung Lee, **Byeong Tak Lee**. Pulse Oximeter Plethysmograph Variation During Hemorrhage in Beta Blocker–Treated Swine. 2020. Journal of Surgical Research.
- **Byeong Tak Lee**, Kyung-Jae Cho, O-Yeon Kwon, Yeha Lee. Improving the Performance of a Neural Network for Early Prediction of Sepsis. 2019. Computing in Cardiology.

MANUSCRIPTS UNDER REVIEW, SUBMITTED & IN PREPARATION
- **Byeong Tak Lee**, Yong-Yeon Jo, Joon-myoung Kwon. Revisiting Neural Network Scale for ECG Classification. (under review)
- **Byeong Tak Lee**, Joon-myoung Kwon, Yong-Yeon Jo. TADA: Temporal Adversarial Data Augmentation for Time Series Data. (under review)
- Junho Song, Jong-Hwan Jang, **Byeong Tak Lee**, DongGyun Hong, Joon-myoung Kwon, Yong-Yeon Jo. Foundation Models for Electrocardiograms. (under review)
- Yong-Yeon Jo*, **Byeong Tak Lee***, Beom Joon Kim, Jeong-Ho Hong, Hak Seung Lee, Joon-myoung Kwon. New Test-Time Paradigm for Real-World Biosignal: Concept and Its Approach. (under review)
- **Byeong Tak Lee**, Joon-myoung Kwon, Yong-Yeon Jo. Optimizing Inductive Bias in Networks with a Generalized Self-Attention Layer. (in preparation)

PATENTS
- **Byeong Tak Lee**, Youngjae Song, Woong Bae, O-yeon Kwon. Deep neural network pre-training method for classifying electrocardiogram (ecg) data. US20220084679A1, KR102390326B1
- **Byeong Tak Lee**, Woong Bae, O-yeon Kwon. Disease judgment method. US20220076835A1, KR1020200113261
- Gil Joon Suh, Woon Yong Kwon, Kyung Su Kim, Sang Hoon Nam Jaeheung Park, Jung Chan Lee, Yoon Sun Jung, Kyoung Min You, Min Ji Park, TaeGyun Kim, Jung-In Ko, Jeeseop Kim, Jaesug Jung, Sanghyun Kim, Byeong Wook Yoo, **Byeong Tak Lee**, Woo Sang Cho, Jin Woo Choi. Automatic cardiopulmonary resuscitation device and control method therefor. US11071686B2, KR101956776B1

EXTRACURRICULAR ACTIVITIES
- An academic club on solving everyday problems from a multidisciplinary perspective. Sep. 2016 – Aug. 2017
- Teaching Korean to foreigners living in Busan (9 students for 3 semesters). Mar. 2014 – Jul. 2015
- Tutored mathematics to a local underprivileged high school student. Mar. 2014 – Aug. 2014
- An academic club for international business strategy research. Mar. 2012 – Feb. 2013
- A volunteer club that aid local welfare centers and children's care center. Mar. 2011 – Aug. 2011

SKILLS
- Programming: Python, C/C++, MATLAB
- Frameworks & Tools: Pytorch, TensorFlow, scikit-learn, Ray, Git