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.
- Led a project of development of a personalized blood pressure estimation model using ECG and PPG. Designed algorithms for filtering noisy data and labels collected in in intensive care units settings and 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.
- 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, incorporating the findings into the Automated ML system to enhance efficiency.
- 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 of develop and evaluation of neural network model for diagnosing heart failure with reduced ejection fraction and myocardial infarction, where the proposed method demonstrated superiority 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