

# Oyeon Kwon

## Research Interests

My research interests lie within practical areas of machine learning, which enables our lives to make better. Previously, I have developed machine learning tools for its applications to health care, which range from intermittent area to real-time area. Recently, I am very interested in building an automated learning system that can broaden an audience without requiring neither expertise nor computational environments in the field of deep learning. The research goal is to develop technology that can be widely and conveniently used in our lives by grafting engineering technology.

## Career Summary

### Research Capabilities

- The latest paper: NAS-based AutoML system (submitted in ICASSP 2022, 1st author)
- Top-tier (1% journal) ML paper publication (TNNLS, 1st author)
- 5th ranked in 2019 Physionet Challenge Hackerton
- Total citations in 5 yrs: 212, h-index:5, i10-index: 4 (2021.11.29)

### Practical Perspective (Involvement in product development)

- DeepECG at VUNO Inc. (Main role: Part Lead)
  - Heart disease early prediction/classification model development
- DeepCARS at VUNO Inc. (Main role: Part Member)
  - Deteriorating patient early prediction/classification model development

### Variety of Experience

- Product-related technology development
  - Spatial & temporal (1D, 2D, 1D & 2D CNN) model development & Ensemble strategy
  - Long-range signal (48 hours) classification (CNN & Transformer)
  - LSTM & Transformer based architecture design for irregular and noisy data analysis
  - Data sampling & feature tokenization
  - Missing data imputation using GCN and Transformer
- Automation system technology development
  - Network architecture search (based on REINFORCE concept)
  - Hyperparameter optimization (Bayesian optimization, etc)

### Self-Development

- Participation in deep learning seminars
- The interest of efficient systems (distributed learning system, multi-processing, docker, ..)
- Open-source contributor (<https://github.com/PatternRecognition/OpenBMI>)

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## Experience

- 2018.08 ~ Present: **AI Researcher**, *VUNO Inc.*, Seoul, Korea
- 2016.07 ~ 2018.08: **Graduate School**, *Korea University*, Seoul, Korea
- 2016.04 ~ 2016.07: **Research Intern**, *Seoul National University*, Seoul, Korea
- 2015.09 ~ 2016.03: **Intern**, *Maureen Data System*, Manhattan, NY, USA
- 2011.03 ~ 2015.08: **Undergraduate School**, *Yonsei University*, Wonju, Korea
  - 2014.08 ~ 2015.08: **Research Intern**, *Yonsei University*, Wonju, Korea
  - 2013.08 ~ 2014.08: **Exchange Student**, *Northern State University*, SD, USA

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## Education

- 2016.07 ~ 2018.08    **MS**, Brain and Cognitive Engineering, *Korea University*, Seoul, South Korea.
- (Overall GPA): 4.44/4.50
  - (Field of Research): Deep Learning, Machine Learning
  - (Thesis): Subject to Subject Transfer Learning for Zero-Training Brain-Computer Interfaces
  - (Advisor): Prof. Seong-Whan Lee
  - Graduate Coursework
    - Introduction to Machine Learning, Pattern Recognition, Linear Algebra (Auditing in Math Depart.), Detection and Estimation I, Probability and Statistics for Brain and Cognitive Eng., Applied Mathematics I, II
- 2011.03 ~ 2015.08    **BSE**, Bio Medical Engineering, *Yonsei University*, Wonju, South Korea.
- (Overall GPA): 3.70/4.50
  - (Bachelor's degree dissertation): Brain emotion analysis; a degree of arousal from a human brain while watching movies
  - (Advisor): Prof. Kyung-Hwan Kim for a dissertation
  - Undergraduate Coursework
    - Microcomputer Application, Visual Programming, Design of Biomedical Devices and Systems, Engineering Maths. I. II, Biomedical Signals and Systems, Digital Signal Processing

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## Project Experiences

- March. 2021– Present    **Automated Learning System Project**, *VUNO Inc.*, Korea.
- Building AutoML system based on reinforcement learning for analysis of time-series biosignal data.
- Main role and Contribution (Team Lead)
    - Create an end-to-end AutoML framework from preprocessing to architecture
  - Major development
    - Construct an entire AutoML system based on an efficient NAS framework
    - Define proper search spaces for our framework
    - Design our controller for AutoML system in biosignal field
  - Development issues
    - Implementation and training issues
    - The design of search spaces to consider time-series characteristics
    - The requirement of a modified controller according to search spaces expansion
  - Implementation tools
    - Python & PyTorch, multiprocessing, etc..
  - Major achievements
    - Confirm robust performance and the possibility of using it as a baseline project
    - ICASSP 2022 paper submission
    - Recently, hyperparameter optimization (HPO) integration is ongoing

April. 2020– **DeepECG Project**, VUNO Inc., Korea.

March. 2021 Heart disease early prediction/classification model development.

- Main role and Contribution (Part Lead)
  - Study design, data processing, architecture design, and evaluation in ECG data domain
- Major development
  - Spatial & temporal (1D, 2D, 1D & 2D CNN) model development & Ensemble strategy
  - Long-range signal (48 hours) classification (CNN & Transformer)
- Development issues
  - Data imbalance
  - Preprocessing design (filtering, centering, etc)
  - Long-range signal training (48 hours data)
- Implementation tools
  - Python & TF2, CNN & Transformer implementation
  - Mixed precision training, multi-processing, distributed training, etc...
- Major achievements
  - 4th Int. Conf. of the ESC Council on Stroke: Stroke patient prediction (co-first)
  - Create a prototype to start B2C service

July. 2018– **DeepCARS Project**, VUNO Inc., Korea.

April. 2020 Deteriorating patient early prediction/classification model development.

- Main role and Contribution (Part Member)
  - Study design, data processing, architecture design, and evaluation in tabular data domain
- Major development
  - Architecture design (LSTM & Transformer) for sequential data analysis
  - Data sampling & feature tokenization
  - Missing data imputation by using graph-based CNN and Transformer
- Development issues
  - Raw data preprocessing, the difficulty of data cleansing
  - Data imbalance & feature engineering
  - Sequential architecture design (irregularly data missing and noisy data)
- Implementation tools
  - Python & TF1 implementation
- Major achievements
  - Create a prototype to provide Korean hospitals
  - Four papers in clinical journals (Details in Publications, co-first three papers)
  - 2019 Physionet Challenge Hackerton 5th ranked

July. 2016–July. 2018 **Machine Learning & Deep Learning Project**, Korea University, Korea.

Brain signal classification model development

- Main role and Contribution (Part Member)
  - Develop open-source & dataset and solve subject-independent BCI issue
- Major development
  - Numerous functions development and large dataset construction
  - Subject-independent brain-computer interfaces framework development
- Development issues
  - Code & data management
  - Design proper algorithm (extract common features from the large dataset)
- Implementation tools
  - Matlab & Python and TF1
- Major achievements
  - ML 1% journal (TNNLS) 1st author publication
  - Construct and release public datasets (2nd author paper publication)
  - Release open source (<https://github.com/PatternRecognition/OpenBMI>)

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## Publications

★ First or Co-First Author

1. **O.-Y. Kwon**★, M.-H. Lee, C. Guan, and S.-W. Lee, “**Subject-Independent Brain-Computer Interfaces Based on Deep Convolutional Neural Networks**”, *IEEE Trans. on Neural Networks and Learning Systems*, 2019 (IF:11.683; 0.97% (2019 years: 1 of 104, Computer Science, Theory and Methods).)
2. M.-H. Lee, **O.-Y. Kwon**, Y.-J. Kim, H.-K. Kim, Y.-E. Lee, J. Williamson, S. Fazli, and S.-W. Lee, “**EEG Dataset and OpenBMI Toolbox for Three BCI Paradigms: An Investigation into BCI Illiteracy**”, *GigaScience*, Vol. 8, No. 5, 2019, pp. 1-16. (IF: 7.267, 10% Journal, 2019.)
3. B.-T. Lee, K.-J. Cho, **O.-Y. Kwon**, and Y.-H. Lee, “**Improving the performance of a neural network for early prediction of sepsis**”, *2019 Computing in Cardiology (CinC)*. 2019.
4. K.-J. Cho\*, **O.-Y. Kwon**★, J.-M. Kwon, Y.-H. Lee, H.-H. Park, K.-H. Jeon, K.-H. Kim, J.-S. Park, and B.-H. Oh, “**Detecting patient deterioration using artificial intelligence in a rapid response system**”, *Critical Care Medicine* (IF:7.447), 2020.
5. B.-T. Lee\*, **O.-Y. Kwon**★, H Park, KJ Cho, JM Kwon, and Y.-H. Lee, “**Graph Convolutional Networks-Based Noisy Data Imputation in Electronic Health Record**”, *Critical Care Medicine* (IF:7.447), 2020.
6. D.-Y. Kang\*, K.-J. Cho\*, **O.-Y. Kwon**★, J.-M. Kwon, K.-H. Jeon, H.-H. Park, Y.-H. Lee, J.-S. Park, B.-H. Oh, “**Artificial intelligence algorithm to predict the need for critical care in prehospital emergency medical services**”, *Scandinavian journal of trauma, resuscitation and emergency medicine*, 2020.
7. SJ Park\*, KJ Cho\*, **O.-Y. Kwon**, H Park, Y Lee, WH Shim, CR Park, WK Jhang “**Development and validation of a deep-learning-based pediatric early warning system: a single-center study**”, *Biomedical Journal*, 2021
8. Yeon Joo Lee, Kyung-Jae Cho, **O.-Y. Kwon**, Hyunho Park, Yeha Lee, Joon-Myoung Kwon, Jinsik Park, Jung Soo Kim, Man-Jong Lee, Ah Jin Kim, Ryoung-Eun Ko, Kyeongman Jeon, You Hwan Jo, “**A Multicenter Validation Study of the Deep Learning-based Early Warning Score for Predicting in-hospital Cardiac Arrest in Patients Admitted to General Wards**”, *Resuscitation*, 2021

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## Preprints (Under Revision & Review)

★ First or Co-First Author

### Ongoing Papers

1. **O.-Y. Kwon**★ and Yeha Lee, “**An End-to-End Automated Machine Learning Framework for Multi-Label ECG Classification**”, *submitted in ICASSP 2022*

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## Competition

Physionet Challenge 2019

- **Objective:** Risk prediction using tabular data
- **Sponsor and Rank:** Physionet Challenge at Hackerton Challenge in Singapore, Ranked 5th
- **Idea:** Using graph convolutional networks and Transformer
- **Reward:** Critical Care Medicine (Impact factor:7.442)