

# 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 ability: [Research Perspective]

- The latest paper: NAS-based AutoML system (submitted in ICASSP 2022)
- 1% ML journal (TNNLS) 1st author publication
- Physionet Challenge Hackton 5th ranked
- Total Citation: 209, h-index:5, i10-index: 4 (2021.11.14)

### Involvement in product development: [Practical Perspective]

- 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.

### Various experience using deep learning: [Broaden Perspective]

- 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 sequential 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)

### Highly motivated in other fields

- For discussing deep learning knowledge (annual deep learning seminars)
- For efficient training (distributed learning system, multi-processing, and so on)
- For convenient training (docker environment, ..)
- Open-source contributor (<https://github.com/PatternRecognition/OpenBMI>)

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## Project Experiences

March. 2021– **Automated Learning system project: Build biosignal AutoML system.**

- Current Build AutoML system based on reinforcement learning for analysis of time-series biosignal data.
- Main role and Contribution (Team Lead)
    - Build an end-to-end AutoML system framework from preprocessing to architecture search
  - Major development
    - Construct entire AutoML system based on ENAS
    - Design a controller of AutoML system for biosignal field
  - Development issues
    - Implementation and training process (several training issues when I trained)
    - When search spaces increased, controller should be modified.
  - Implementation tools
    - Python & pytorch, multiprocessing, etc..
  - Major achievements
    - Improve performance compared to the backbone in use and confirm the possibility of using it as a baseline project.
    - ICASSP 2022 paper submission
    - Recently, hyperparameter optimization integration is ongoing.

April. 2020– **Deep Learning Project III.**

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

- Main role and Contribution (Part Lead)
  - Study design, data processing, architecture build and evaluation
- 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
  - Considering a number of preprocessing functions (filtering, centering, etc)
  - Long range signal (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))
  - Involve other developments before the product

July. 2018– **Deep Learning Project II.**

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

- Main role and Contribution (Part Member)
  - Study design, data processing, architecture build and evaluation
- Major development
  - LSTM & Transformer based architecture design for sequential data analysis
  - Data sampling & Feature tokenization
  - Missing data imputation by using graph-based Transformer
- Development issues
  - Raw data, preprocessing, the difficulty of data cleaning
  - Data imbalance & Feature Tokenization
  - Sequential architecture design (irregularly data missing and noisy data)
- Implementation tools
  - Python & TF1 implementation
- Major achievements
  - Four papers in clinical journals (Details in Publications, co-first three papers)
  - Physionet Challenge Hackton 5th ranked
  - Involve other developments before the product

July, 2016–July. **Deep Learning Project 1.**

- 2018 Brain signal classification model development
- Main role and Contribution (Part Member)
    - Study design, data processing, architecture build and evaluation
  - Major development
    - Participating open source development (One of main contributors)
    - Open dataset management and experiment
    - Frequency sampling based on mutual Information to obtain common features
    - CNN architecture design for achieving stable performance
  - Development issues
    - Open Source development & Data management
    - Common feature extraction and CNN architecture design
  - Implementation tools
    - Matlab & Python and TF1
  - Major achievements
    - ML 1% journal (TNNLS) 1st author publication
    - Public Dataset (2nd author paper publication)
    - Open source development (<https://github.com/PatternRecognition/OpenBMI>)

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## Education

- 2016.09 ~ **MS**, Brain and Cognitive Engineering, *Korea University*, Seoul, South Korea.
- 2018.08
- (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 Department.), Detection and Estimation I, Probability and Statistics for Brain and Cognitive Eng., Applied Mathematics I, II
- 2011.03 ~ **BSE**, Bio Medical Engineering, *Yonsei University*, Wonju, South Korea.
- 2015.08
- (Overall GPA:) 3.70/4.50
  - (Bachelor's degree dissertation) Brain emotion analysis; a degree of arousal from 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 Math. I. II, Biomedical Signals and Systems, Digital Signal Processing

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## Experience

- 2016.04 ~ 2016.07: **Research Intern**, *Seoul National University*, Korea
- 2015.09 ~ 2016.03: **Intern**, *Maureen Data System*, Manhattan, USA
- 2014.08 ~ 2015.08: **Research Intern**, *Yonsei University*, Korea
- 2013.08 ~ 2014.08 : **Exchange Student**, *Northern State University*, SD, USA

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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.)
1. 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.)
2. 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.
3. 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.
4. 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**”, (IF:7.447), *Critical Care Medicine* (IF:7.447), 2020.
5. 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.
6. 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
7. 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 EMR data
- **Sponsor and Rank:** Physionet Challenge at Hacker-ton Challenge in Singapore, Ranked 5th
- **Idea:** Using graph convolutional networks and Transformer
- **Reward:** Critical Care Medicine (Impact factor:7.442)