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 Pespective]
- 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 Pespective]
- 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/classifiaction model development.

Various experience using deep learning: [Broaden Pespective]
- 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 architecutre search (based on REINFORCE concept)
  - Hyperparamter optimization (Baysian 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 traininig (docker environment, ..)
- Open-source contributor (https://github.com/PatternRecognition/OpenBMI)

Project Experiences

March. 2021–
Current

Automated Learning system project: Build biosignal AutoML system, VUNO, Korea.
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 archiecture search
- Major development
  - Consturct 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 acheivements
  - Improve performance compared to the backbone in use and confirm the possibility of using it as a baseline project.
  - ICASSP 2022 paper sumbission
  - Recently, hyperparmeter optimization integration is ongoing.

April. 2020–
March. 2021

Deep Learning Project III, VUNO, Korea.
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
  - Conisering a numer 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 acheivements
  - 4th Int. Conf. of the ESC Council on Stroke: Stroke patient prediction (co-first))
  - Involve other developments before the product

July. 2018–
April. 2020

Deep Learning Project II, VUNO, Korea.
Deteriorating patient early prediction/classifiaction 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 Tonknization
  - Sequential architecture design (irregularly data missing and noisy data)
- Implementation tools
  - Python & TF1 implementation
- Major acheivements
  - 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**, Korea University, Korea.
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 acheivements
    - ML 1% journal (TNNLS) 1st author publication
    - Public Dataset (2nd author paper publication)
    - Open source development (https://github.com/PatternRecognition/OpenBMI)

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 Mathmatics 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

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

Publications

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

Preprints (Under Revision & Review)

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*

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)