Project Proposals

Deep Learning

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Project Proposals

Below, there are several project proposals. We are still looking for the optimal project to work on, also depending on the related datasets that we hope we will be able to find. In general, it would be interesting for us to work on the application of deep learning techniques on longitudinal data/time series, and we thought that a project related to the diagnosis of some disease could be a good fit for us.

Deep Learning Framework for Early Alzheimer's Detection

Alzheimer's Disease (AD) is a progressive neurodegenerative disorder that requires early detection for effective intervention. This project aims to develop an advanced deep learning framework to enhance early AD diagnosis using multivariate time-series data. Building on the deep stacking approach proposed by Saleh et al., we will integrate optimized Long Short-Term Memory (LSTM) networks and advanced feature selection techniques. The model will be trained and validated using datasets such as the NACC database, focusing on biomarkers, cognitive assessments, and neuroimaging data. Our goal is to improve predictive accuracy, precision and sensitivity (studying also ROC curve), optimize model generalizability, and contribute to early AD diagnosis. Regarding qualitative evaluation, we expected to see graphs showing trends in biomarkers, cognitive assessments, or neuroimaging data over time for AD vs. non-AD patients, confusion matrix, plots of bar chart or SHAP to visualize which biomarkers contribute most to the predictions, and also heatmaps to highlight key brain regions that influence predictions.

Link: https://www.nature.com/articles/s41598-023-42796-6#Sec2

Deep Learning for Early Parkinson's Detection Using Speech Analysis

Parkinson's Disease (PD) is a neurodegenerative disorder that affects motor and speech functions. Early detection is crucial for improving patient outcomes and optimizing treatment plans. This project aims to develop a deep learning model for early PD detection using voice recordings. The approach will leverage Convolutional Neural Networks (CNNs) applied to spectrograms and Long Short-Term Memory (LSTM) networks for sequential feature extraction. The dataset will be sourced from large-scale speech repositories, such as the Parkinson's Voice Initiative or PhysioNet, containing thousands of recordings from individuals with and without PD. The model will be optimized for high sensitivity and specificity in a quantitative insight, contributing to non-invasive and accessible diagnostic tools for clinical applications. Regarding qualitative evaluation, we expected to see spectrogram visualization, confusion matrix and SHAP or Grad-CAM to highlight which time-frequency patterns in spectrograms contribute most to predictions.

Link: https://www.parkinsonsvoice.org/index.php

Facial Fatigue Detection Using Deep Learning

Fatigue detection is essential in high-risk environments such as healthcare, transportation, and industrial workspaces. This project proposes a deep learning-based system to detect fatigue levels through facial image analysis. The model will utilize Convolutional Neural Networks (CNNs) to identify key facial markers associated with fatigue, such as eye closure, drooping eyelids, and facial muscle relaxation. Datasets such as the NTHU-DDD (Driver Drowsiness Dataset) will be used for training and validation. The goal is to develop an accurate and real-time fatigue detection system that can be integrated into workplace safety protocols, healthcare monitoring, and driver assistance systems. Regarding qualitative evaluation, we expected to see sample prediction outputs, that classify fatigue vs. non-fatigue, Grad-CAM that will highlight the regions of the face (e.g., eyes, eyelids, facial muscles) that influence predictions and confusion matrix. Regarding quantitative evaluation, we will be expected to study the accuracy, sensitivity and specificity, and study the ROC curve.

Link: http://cv.cs.nthu.edu.tw/php/callforpaper/datasets/DDD/