REVERSE EXPO

Developing Machine Learning solutions with a sheer focus on Medical applications

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TechAid

INTRODUCTION

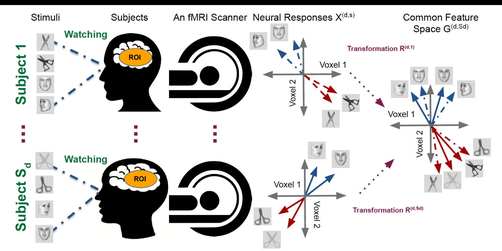
I am a Postdoctoral Fellow working with the Department of Computing Science and the Department of Psychiatry at the University of Alberta under the supervision of Prof. Russell Greiner and Prof. Andrew Greenshaw since March 2019. I completed my Ph.D. in the Department of Computer Science and Technology at Nanjing University of Aeronautics and Astronautics (NUAA) with a full scholarship from China Scholarship Council (CSC) in 2018.

My primary research interests lie in developing machine/deep learning for solving real-world big and complex problems. Specifically, I am now working on the intersection of machine learning and computational neuroscience, where I am translating various machine-learning techniques/concepts for medical professions in Canada, China, Australia, and the U.S.

I have published several theoretical machine learning papers in prestigious venues such as NeurIPS, AAAI, SIAM SDM, ICDM, and IEEE TCBY, where I developed novel algorithms to address real-world problems. In addition, I collaborate in various applied machine learning studies to analyze ***(medical) images, texts, and audio*** that are published in journals such as Nature Scientific Report, Neuroinformatics, Journal of Affective Disorders, Frontiers in Psychiatry, etc.

The following are some of these research studies.

FMRI ANALYSIS USING MULTI-VIEW LEARNING



MOTIVATION

- Extracting shared features from multi-subject fMRI datasets
- Enhancing prediction rates for classification analysis by finding a better feature representation or latent space

METHODS

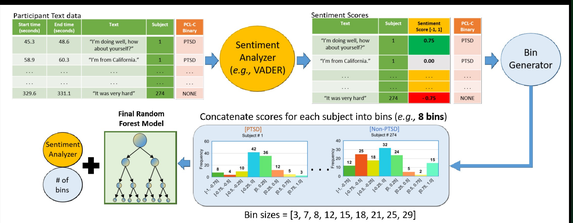
- We have several approaches to analyzing noisy, high-dimensional, large neuroimages using deep kernels (NIPS 2017) and infusing supervised information (AAAI 2017, IEEE TCDS 2020).

RESULTS

- Our models are **more accurate** than state-of-the-art techniques
- Our models are **faster** than other modern approaches
- Our models can be **scaled** for datasets with a large number of subjects

NIPS 2017 | AAAI 2017 | IEEE TCDS 2020

PREDICTING PTSD USING SENTIMENT ANALYSIS



MOTIVATION

- Sentiment analysis (SA) extracts emotional content from **text information**
- Train an ML model to identify individuals with PTSD using SA from online semi-structured interviews
- Inexpensive and time-effective use of ML in a virtual environment

METHODS

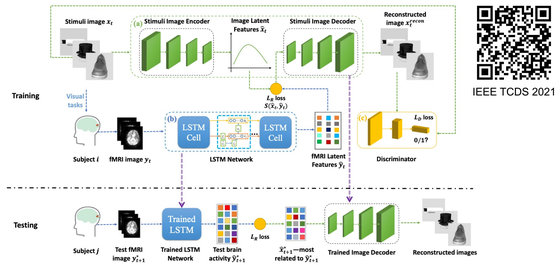
3 types of partitioning x 3 types of sentiment analyzers (VADER, Blob, Flair) x 4 different models = 36 combinations within our pipeline

RESULTS

- **80.4%** prediction accuracy
- Text alone can predict the presence of PTSD

Frontiers 2022

HUMAN BRAIN MAPPING AND DECODING



IEEE TCDS 2021

MOTIVATION

- Understanding how the brain processes different cognitive states
- Reconstructing actual photos watched during functional brain imaging
- Developing causal models between neural responses and visual stimuli

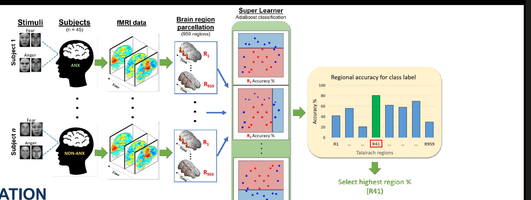
METHODS

- We use custom-designed GAN autoencoders to extract features from images and LSTMs to model neural pathways.

RESULTS

Here, we compare the original photos watched during the scan versus the images that are reconstructed using neural responses from human brains:

PREDICTING PEDIATRIC ANXIETY



MOTIVATION

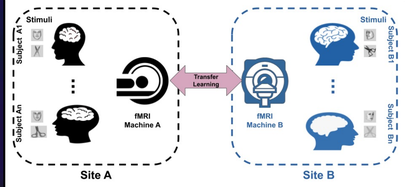
- A behavioral aspect of anxiety is dysregulation of the emotional interpretation of facial expressions
- fMRI responses were analyzed as children viewed images of fearful and angry faces
- Searching for biomarkers and predicting pediatric anxiety

RESULTS

- Our model selected the right Temporal Pole
- **81%** accuracy for this region

Scientific Report 2021 >

ANALYZING BATCH EFFECTS ON MULTI-SITE DATA



RESULTS

- Up to **97%** prediction rate
- **10 times** faster than other alternatives
- Easily **scalable** for a large number of sites

MOTIVATION

- Training a robust, generalized predictive model using multi-site neuroimage datasets
- Learning predictive models using publicly available neuroimage datasets

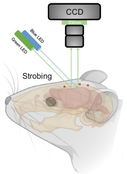
NeurIPS 2020

SOME OF OUR RECENT RESEARCH PROJECTS

Predicting Mental Diseases Using Audio and Text

We are working on an extended version of our NLP studies, where we will use audio (**speech**) data to improve the prediction rate of our model.

Animal Studies



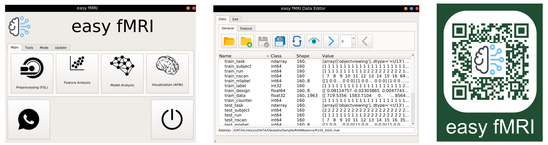
We are now collaborating on several research studies to model different cognitive states in mice brains.

These studies aim to develop **causal models** based on neural responses to understand consciousness and various mental diseases.

More Publications

OUR OPEN-SOURCE TOOLS

easy fMRI



We have developed the easy fMRI project, which allows research scientists, experts, and medical doctors to apply different machine learning approaches (including those presented here) in the form of a **user-friendly GUI-based toolbox** to analyze neuroimage data to diagnose anxiety, PTSD, Alzheimer's disease, autism spectrum disorders, etc.

easyX

We have developed easyX as a simple Python library based on Hierarchical Data Format 5 (HDF5) for saving **big and complex data structures**, such as medical images, text, audio, etc. easyX is available via PyPi:

```
pip install easyx
```

Other related projects

We also have several related open-source projects available via our GitHub repositories.

Scan here to see them >

SOFTWARE AND LIBRARIES

I use the following software libraries/platforms for my research studies:

Machine Learning Library: Scikit-learn, Tensorflow (+Probability, GPflux), JAX, PyTorch, PyWhy, Z3 API, Stable-Baselines3.

Programming Languages: Python, C/C++, Rust, Javascript, Bash.

Database: Oracle Database, Microsoft SQL, PostgreSQL, MySQL.

Operating System: Linux, macOS, Windows.

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