Sa.i.zure
AI-Based Seizure Detection

Capstone Project Stakeholder Presentation
SPICED Academy Bootcamp
Ana, Silvan, Tassilo, Samet

Who are we?

Ana
Ph.D. Neuroscience

Data Science | ML
Health Science

Samet
M.Sc. Biotechnology

Data Science | ML
Biotech | Food Science

Tassilo
Social-turned-Data-Scientist

Silvan
Dipl. Engineer

Data Science | ML
Physics | Software

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01.

What is epilepsy?

50 M

People suffer from epilepsy in the world

70%

of people living with epilepsy could live seizure-free if properly diagnosed and treated

5 minutes

Seizures requiring emergency treatment

3x more

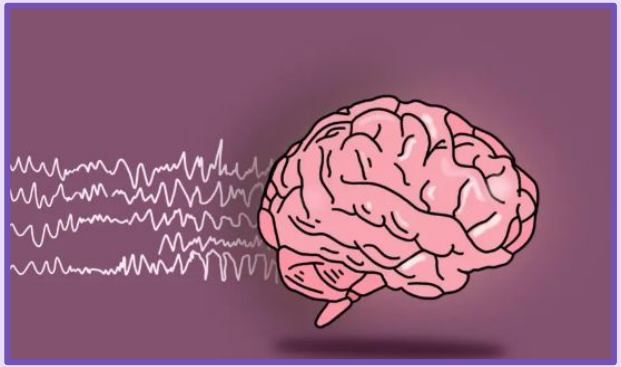
Risk of premature death in people with epilepsy

Source: World Health Organization (WHO)

Disorder of the brain that leads to recurrent seizures

What are epileptic seizures?

Sudden alteration of behavior



Change in the electrical functioning of the brain

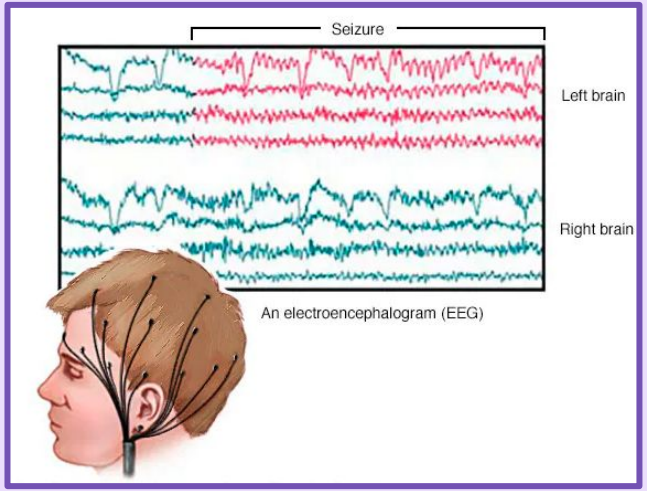
Risk of injury and psychosocial disability

Risk of injury and psychosocial disability, affecting the patient's quality of life

30% of patients are refractory to antiepileptic drugs

Specific alterations in brain activity can be observed before epileptic attacks

Traditionally, seizures are detected visualizing different patterns of activity on the electroencephalogram (EEG)



Alterations in brain activity can be observed before epileptic attacks

Data inspected by medical doctors

Machine learning algorithms can achieve remarkable performance in seizure prediction

Sina Shafiezadeh et al, Appl. Sci. 2023,

Project goal

Can we detect seizures on EEG data?

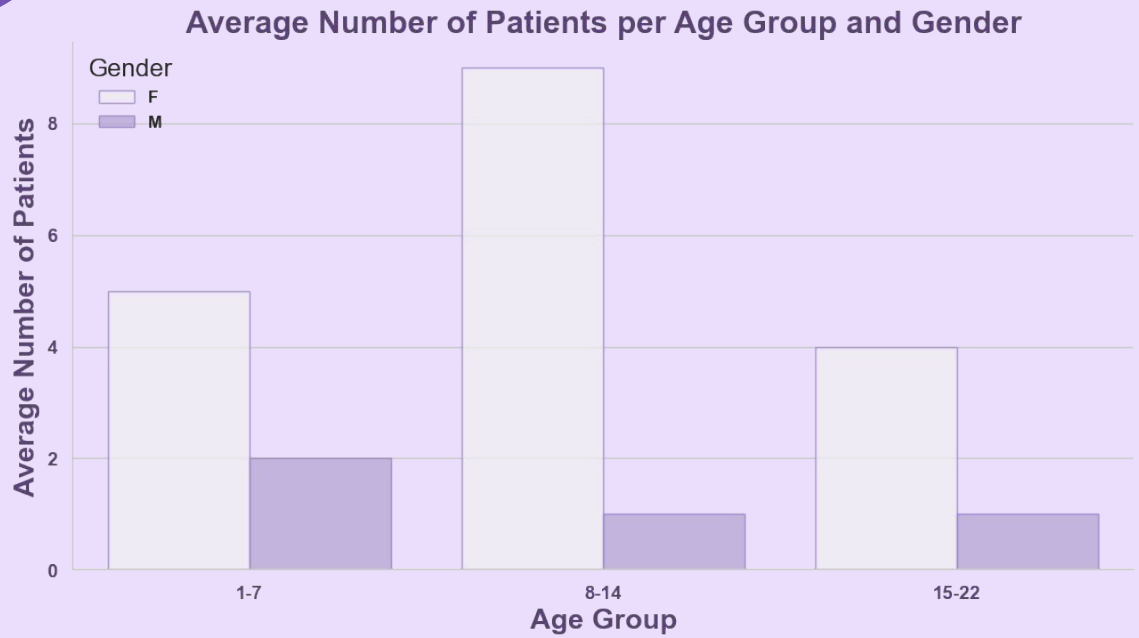
Can we predict incoming seizures?

02.

Data-Set & EDA

What does the data look like?

Data set and story line



Boston Children's Hospital
Until every child is well™

EEG recordings from pediatric subjects with intractable seizures

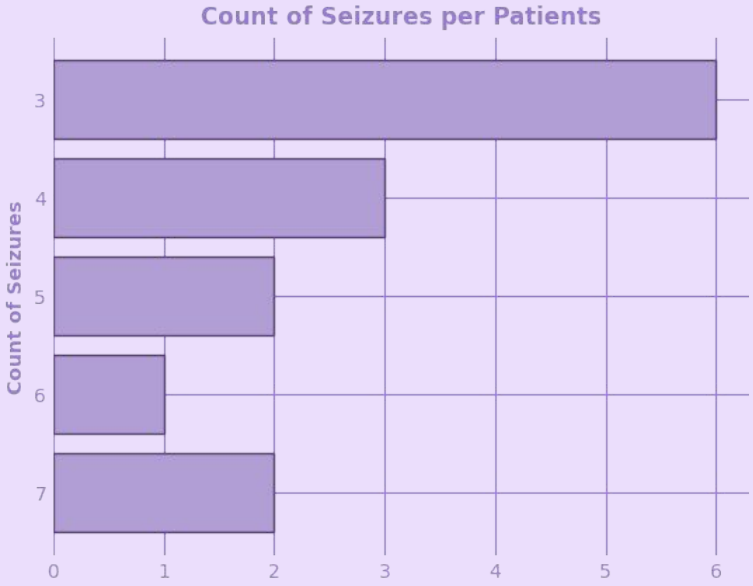
23 patients around 20 hours EEG data at 256 Hz frequency

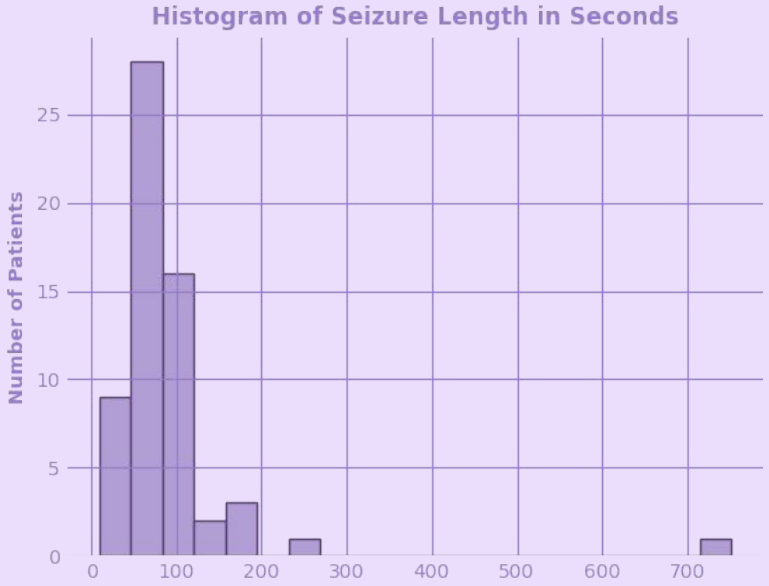
21 channels at standardized locations

Data Source: CHB-MIT
physionet.org/content/chbmit/1.0.0/

13 Patients without clustered seizures were selected for modeling

Exploratory data analysis

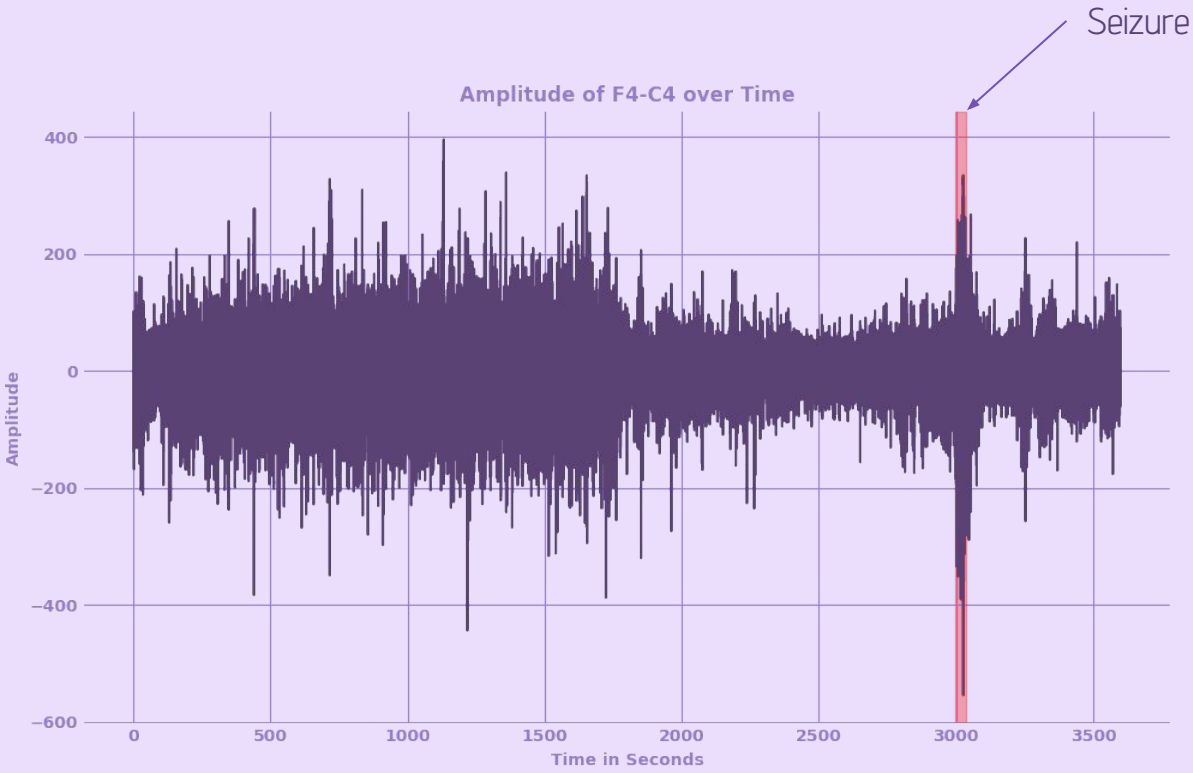


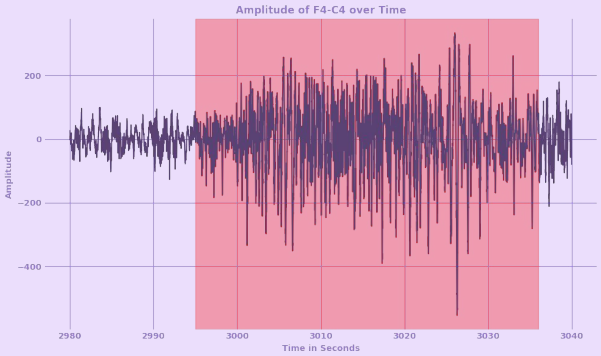


Average count of seizures per patient: 4,3

Average length of seizure: 92 seconds

Exploratory data analysis



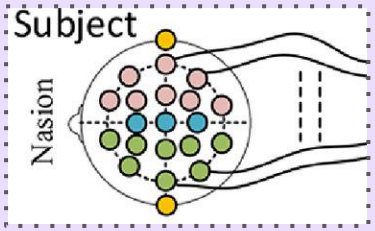


03.

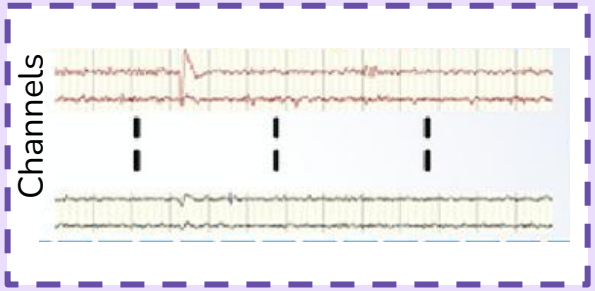
Classification

Seizure detection within EEG data

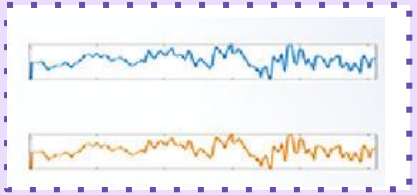
Workflow



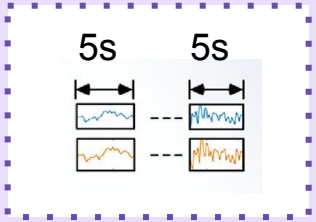
Raw EEG data



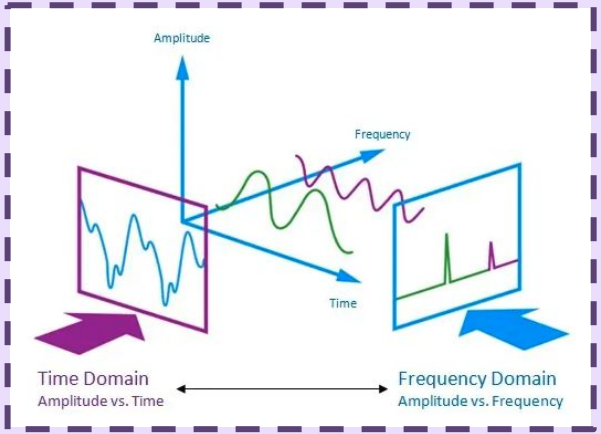
Channel selection



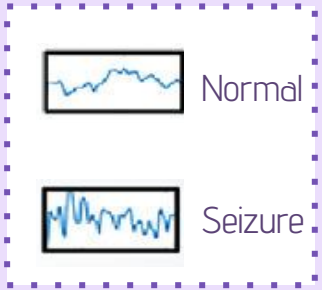
Data segmentation



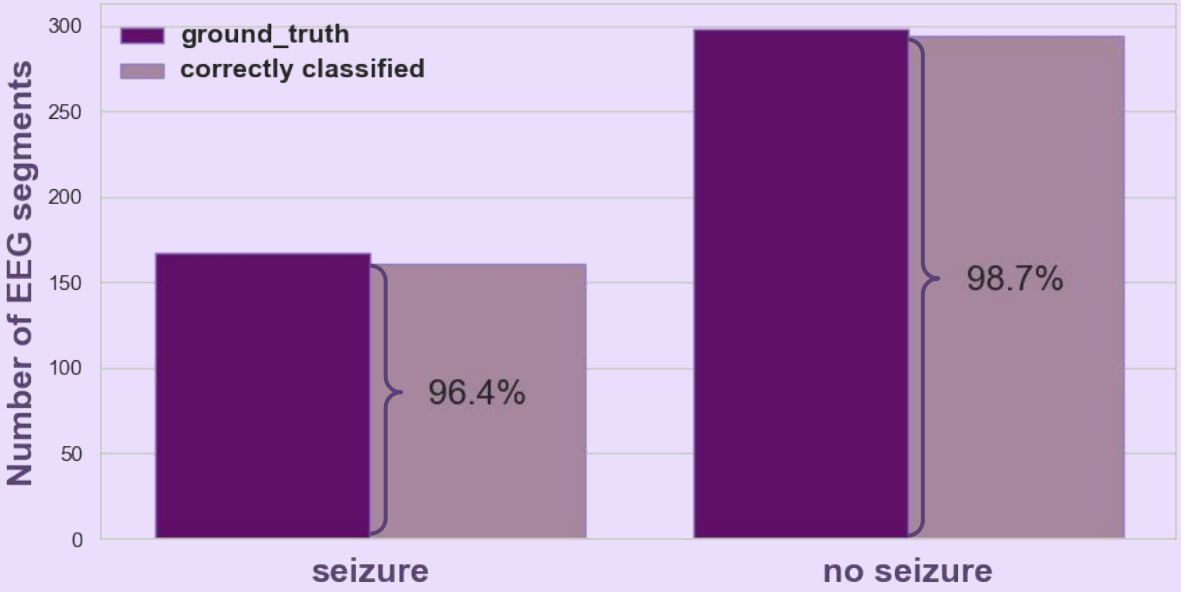
Feature extraction



Classification



Classification models



Metrics with using XGBoost classifier:

Accuracy	0.98
Precision	0.98
Recall	0.99
f1-Score	0.98

Achieved classification is comparable to state of the art !

04.

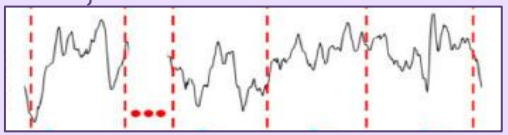
Prediction

Is there an immediate seizure risk?

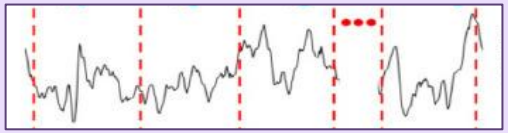
Prediction model

EEG SEQUENCE

30 segments of 2 seconds



176 Pre-ictal sequences



515 Inter-ictal sequences

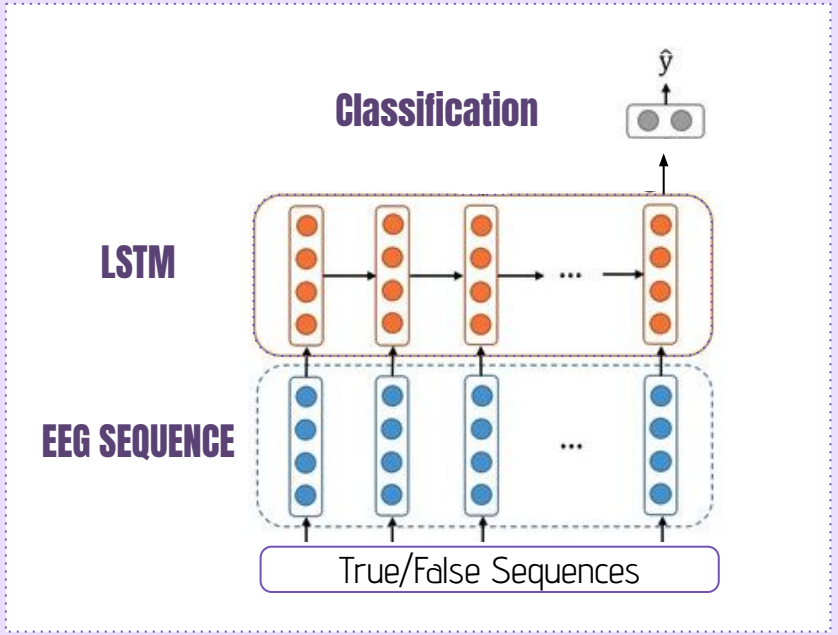
n sequences

Seizure is going to Happen within 60s

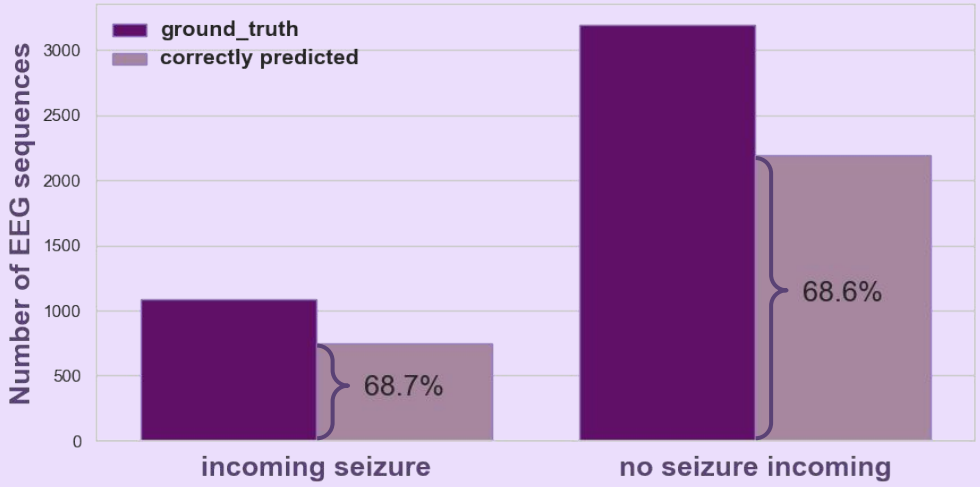
True 25.5%

False 74.5%

Feature Extraction segment-wise



Prediction Model - Results

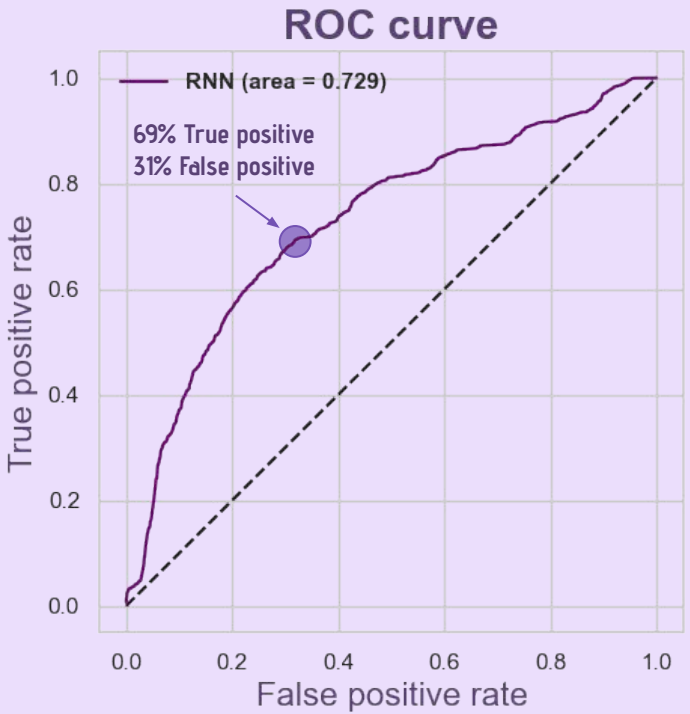


Prediction of seizures up to 60 seconds before happening

Recall	0.69
Precision	0.43

Achieved prediction of 69% of all seizures
Almost half the predictions made are correct

Prediction Model - Results



Trade-Off concerning catching more seizures and minimizing false warnings.

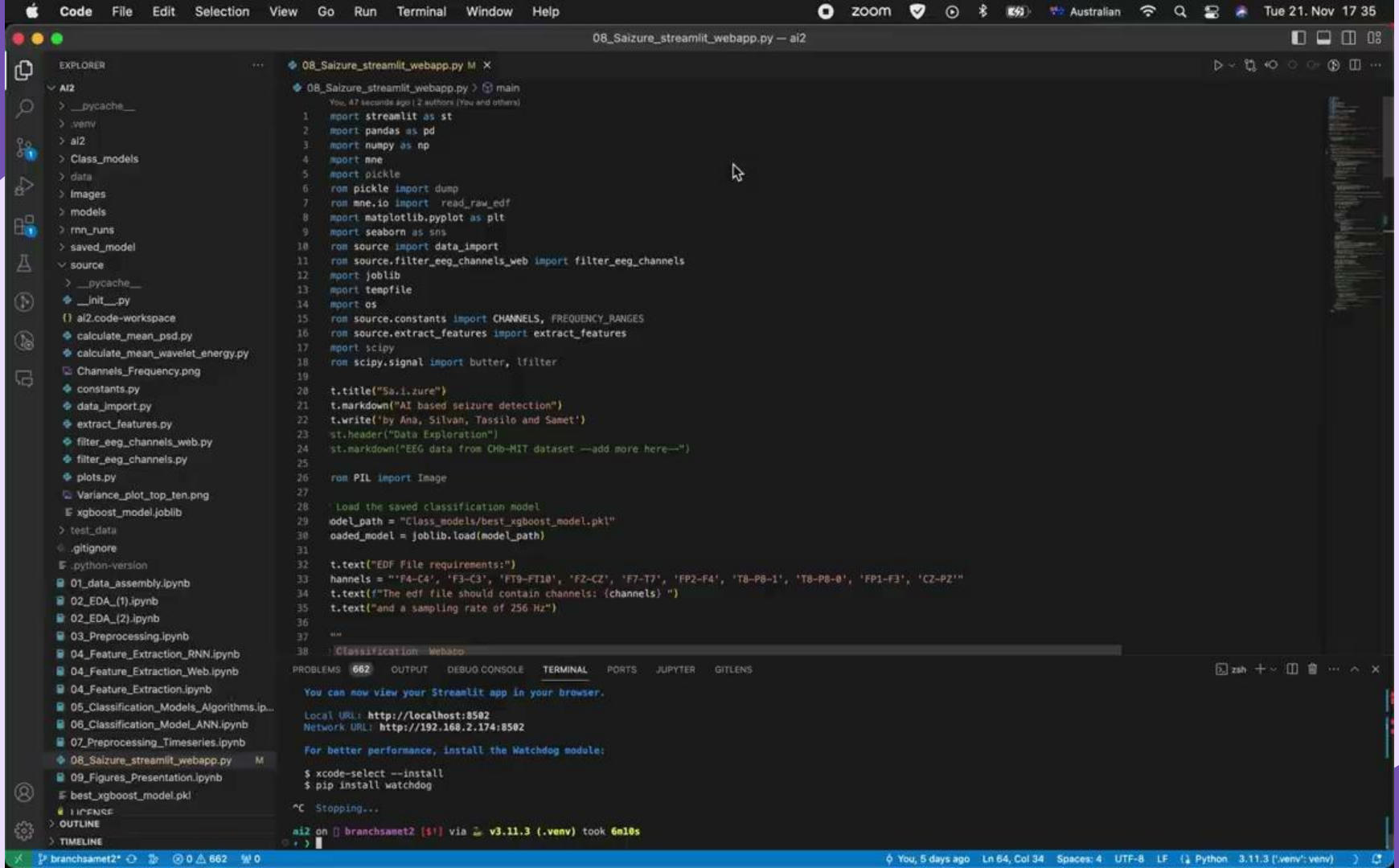
Area under the ROC curve (AUC) 0.73

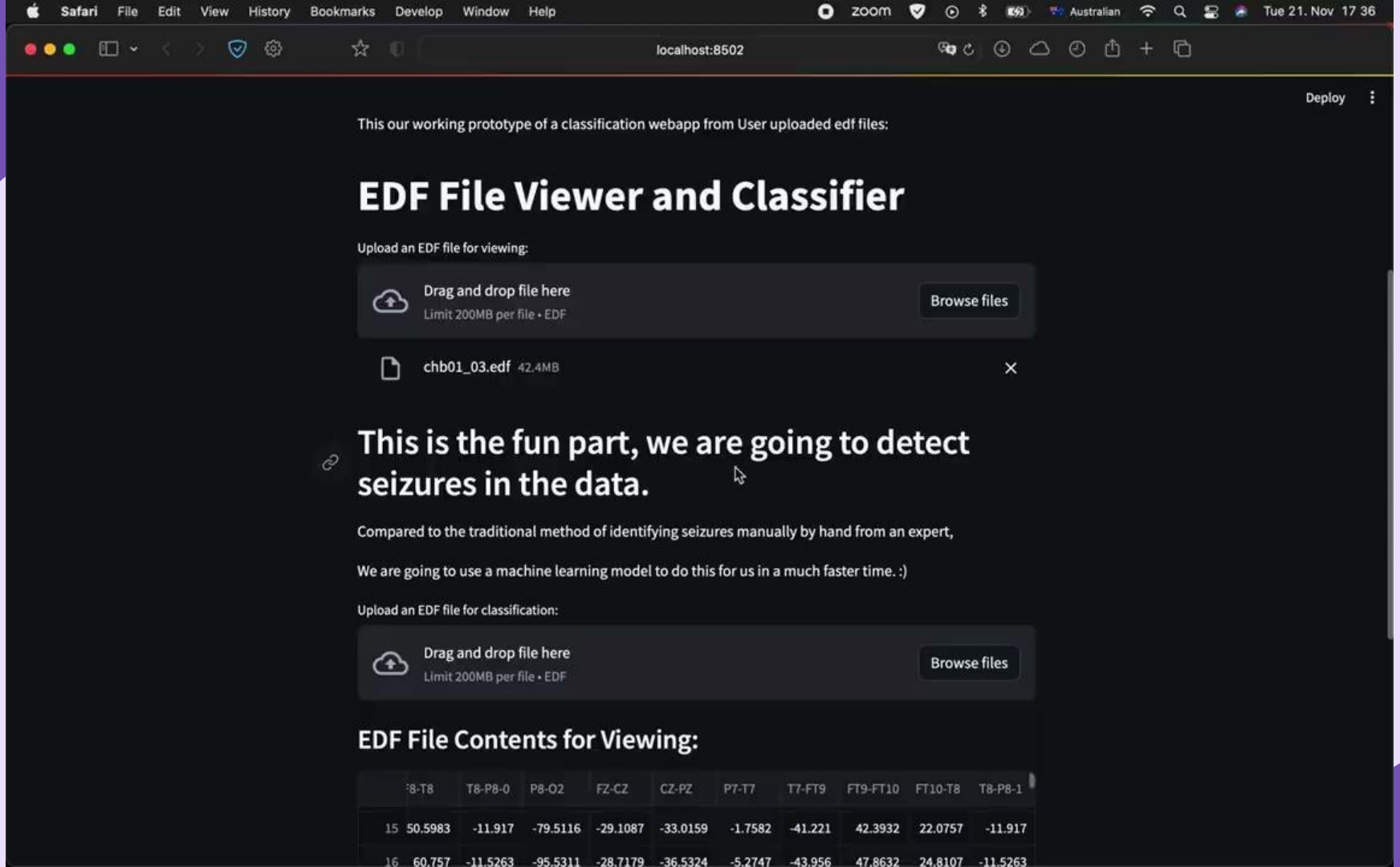
Direct comparison is difficult due variety of models, datasets and metrics. Results are on a par with current state of the art models.

05.

Web Application

Classify your own EEG data


Code File Edit Selection View Go Run Terminal Window Help
Tue 21. Nov 17 35
08_Saizure_streamlit_webapp.py — ai2
EXPLORER
08_Saizure_streamlit_webapp.py M
You, 47 seconds ago | 2 authors (You and others)
import streamlit as st
import pandas as pd
import numpy as np
import mne
import pickle
from pickle import dump
from mne.io import read_raw_edf
import matplotlib.pyplot as plt
import seaborn as sns
from source import data_import
from source.filter_eeg_channels_web import filter_eeg_channels
import joblib
import tempfile
import os
from source.constants import CHANNELS, FREQUENCY_RANGES
from source.extract_features import extract_features
import scipy
from scipy.signal import butter, lfilter
t.title("Sa.i.zure")
t.markdown("AI based seizure detection")
t.write('by Ana, Silvan, Tassilo and Samet')
st.header("Data Exploration")
st.markdown("EEG data from CHb-MIT dataset ---add more here---")
from PIL import Image
Load the saved classification model
odel_path = "Class_models/best_xgboost_model.pkl"
oaded_model = joblib.load(model_path)
t.text("EDF File requirements:")
hannels = "'F4-C4', 'F3-C3', 'FT9-FT10', 'FZ-CZ', 'F7-T7', 'FP2-F4', 'T8-P8-1', 'T8-P8-0', 'FP1-F3', 'CZ-PZ'"
t.text(f"The edf file should contain channels: {channels} ")
t.text("and a sampling rate of 256 Hz")
"""
Classification Webapp
PROBLEMS 662 OUTPUT DEBUG CONSOLE TERMINAL PORTS JUPYTER GITLENS
You can now view your Streamlit app in your browser.
Local URL: http://localhost:8502
Network URL: http://192.168.2.174:8502
For better performance, install the Watchdog module:
$ xcode-select --install
$ pip install watchdog
^C Stopping...
ai2 on branchsamet2 [$!] via v3.11.3 (.venv) took 6m10s
OUTLINE
TIMELINE
branchsamet2* 0 662 0
You, 5 days ago Ln 64, Col 34 Spaces: 4 UTF-8 LF Python 3.11.3 ('.venv': venv)


Safari File Edit View History Bookmarks Develop Window Help
zoom
Australian
Tue 21. Nov 17 36
localhost:8502
Deploy
This our working prototype of a classification webapp from User uploaded edf files:
EDF File Viewer and Classifier
Upload an EDF file for viewing:
Drag and drop file here
Limit 200MB per file • EDF
Browse files
chb01_03.edf 42.4MB
This is the fun part, we are going to detect seizures in the data.
Compared to the traditional method of identifying seizures manually by hand from an expert,
We are going to use a machine learning model to do this for us in a much faster time. :)
Upload an EDF file for classification:
Drag and drop file here
Limit 200MB per file • EDF
Browse files
EDF File Contents for Viewing:
T8-T8 T8-P8-0 P8-O2 FZ-CZ CZ-PZ P7-T7 T7-FT9 FT9-FT10 FT10-T8 T8-P8-1
15 50.5983 -11.917 -79.5116 -29.1087 -33.0159 -1.7582 -41.221 42.3932 22.0757 -11.917
16 60.757 -11.5263 -95.5311 -28.7179 -36.5324 -5.2747 -43.956 47.8632 24.8107 -11.5263

06_

Outlook

Online Prediction and Warnings

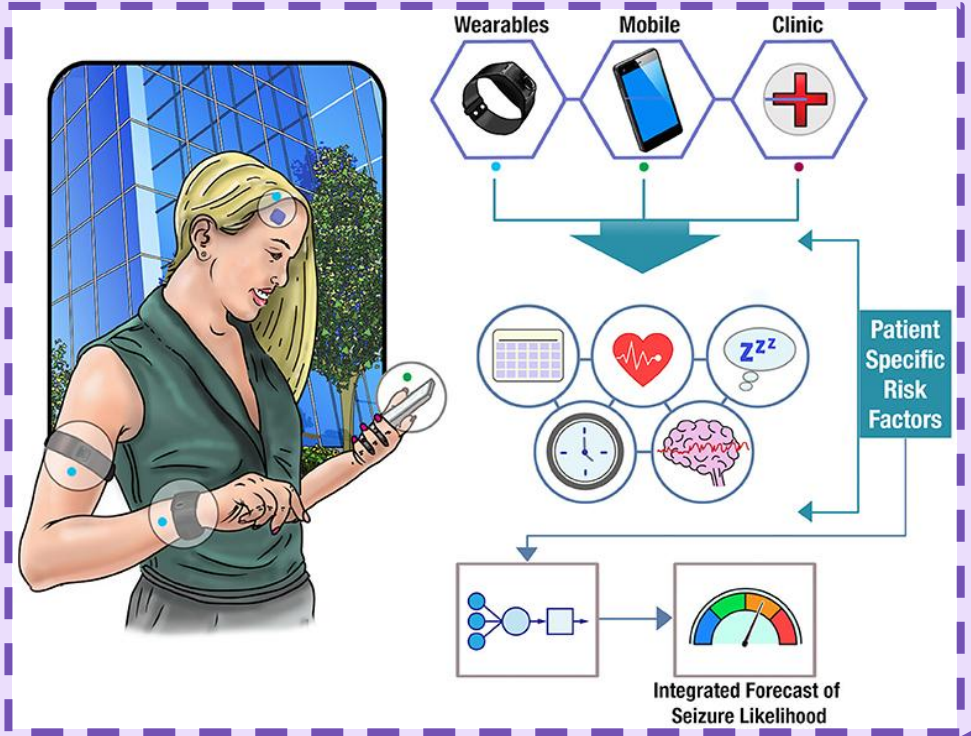
Outlook use case

Prediction model implemented into web service or proprietary software installed locally on equipment used by medical professionals

Warning systems implemented into smart watches with eeg capabilities

↓

Could save lives of epileptic people in emergencies!!



Thank you for your attention

Do you have any questions?