Capstone Project Proposal

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1 Time Series Classification

There are a lot of TimeSeries available for classification. I have chosen EEG signals for classification as I'm interested in the use of machine learning in the medical area.

1.1 EEG signal Based Eye State Classification

1.1.1 Domain Background

The electroencephalogram (EEG) is a bio-signal just like MRI, CT, f-MRI, ECG. It is the recording of the electrical activity of the brain from the scalp. Whenever we do some activities neurons are fired in the brain which generates some current, we use electrodes on the scalp and measure that very tiny current and then amplify it. In various researches, it is found that our brain generates different EEG time-series patterns for different activities like moving hands, legs, eyes opening and closing etc. So if we use machine learning to recognize those patterns then we can easily classify them.

1.1.2 Problem Statement

Given EEG pattern(Time - Series), we have to classify person's eyes are open or closed using supervised machine learning approach.

1.1.3 Datasets and Inputs

Dataset - EEG Eye State Data Set (http://archive.ics.uci.edu/ml/datasets/EEG+Eye+State).

Each row consist of 14 EEG values (means 14 time-series values) representing 14 electrodes (TF7, O2, F3, P8, T8, F4, FC6, AF3, FC5, T7, F8, P7, O1, and AF4) along with a value indicating the eye state.

'1' indicates eye-closed.
'0' indicates eye-open.

Input - 14 EEG vlaues.
Output - '1' or '0'.

1.1.4 Solution Statement

Three approaches -

- **Statistical Feature Extraction** - Extract statistical feature like - mean, standard-deviation, Kurt, Skewness, Band Power etc and train it classification algorithm - SVM, Logistic Regression. So when a new EEG signal comes, we will first extract statistical features and then send it to classification algorithm and predict the output.
- **Using Multilayer Perceptron** - Directly use those 14 values as feature vector and train it to the neural network.
- **Recurrent Neural Network** - Train LSTM(Long Short Term Memory) network on eeg signal and use last layer as sigmoid to predict a value of '0' and '1'.

1.1.5 Benchmark Model

I am not sure which model to be used for the benchmark as I am doing Time Series classification first time. Intuitively we can choose Statistical Feature Extraction and Training SVM and Logistic Regression for classification as Benchmark Model. We will compare Benchmark Model with other models using Evaluation Metrics given below.

1.1.6 Evaluation Metrics

- $Accuracy = \frac{TP+TN}{TP+FP+FN+TN}$
- $Precision = \frac{TP}{TP+FP}$
- $Recall = \frac{TP}{TP+FN}$
- $F1 - Score = 2.\frac{precision.recall}{precision+recall}$

Where,

- TP - True Positives.
- TN - True Negatives.
- FP - False Positives.
- FN - False Negatives.

1.1.7 Project Design

- Visulize both classes time series.
- Extract Statistical Features and train it on SVM and Logistic Regression.
- Create a Multilayer neural network and directly train it on time-series values.
- Create a LSTM and train it on time-series values.
- Compare all three models using evaluation Metrics.
- Conclude the results.

1.2 References

1. Rösler, Oliver, and David Suendermann. *A first step towards eye state prediction using eeg.* Proc. of the AIHLS (2013).
2. Neha Jain, Sandeep Bhargava, Savita Shivani, Dinesh Goyal. *Eye State prediction using eeg by supervised learning.* International Journal of Science, Engineering and Technology.