**Classification of EEG signals into sleep stages: A Deep Learning Approach**

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1. **Deep Learning Architectures**

Two main deep learning techniques were chosen for the present work, namely Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs). The main rationale for this was the nature of the data: time-series information from EEG signals which were then converted to spectrograms. With the aim of classifying such signals into the correct sleep stages, we chose to experiment with these types of networks given their ability to deal with and process sequential inputs. Although RNNs are usually the best choice for time-series data, two-dimensional CNNs may be applied in simpler ways and may have the advantage of avoiding the exploding or vanishing gradients.

1. **Experiments**

When implementing either CNNs or RNNs, it is important to correctly set and tweak the hyperparameters of such models in order to leverage their power. With regards to this, we decided to build a genetic algorithm (GA) that iterates over several possible values for each of the hyperparameters and selects the most accurate ones. First, we started experimenting with a CNN architecture. Here, using Keras and TensorFlow, we implemented a sequential model which can be seen in diagram 1. Both for the convolutional layers and for the dense, fully connected layers we set the relevant hyperparameters and the number of layers according to the genetic algorithm recommendations. Secondly, we experimented with an RNN architecture. We tried to implement a sequential model using the built-in layers from Keras, such as SimpleRNN layers, Long-Short Term Memory layers and Gated Recurrent Units layers. On the final set of models, we applied interpolation, once again using the GA. Each model was given its own weight, which was added to the predicted sleep stage. The class label that was given the highest sum of weights is chosen as the final prediction.

1. **Results**

As can be seen in table 1, the RNN implementation did not yield any better results. Because of this, we decided to focus on the CNN model given its performance.

1. **Discussion**

For the present task of classifying EEG signals into sleep stages we decided to first implement a Convolutional Neural Network and to set the relevant hyperparameters for each layer in the network based on the outputs from a genetic algorithm devised for this specific task. Moreover, we tried to apply a Recurrent Neural Network for classification modelling. However, considering the positive and rather promising results coming from the CNN approach, we did not use the genetic algorithm to accurately tweak the hyperparameters of the RNN. This is perhaps the reason why the latter model did not yield such positive results on the test set. Future approaches should focus on carefully setting the hyperparameters according to the values chosen by the genetic algorithm.

1. **Codalab Submission details**