Cognitive Analysis of Working Memory Load from EEG, by a Deep Recurrent Neural Network

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Setting: To find a robust representations from EEG multi-channel time bound series by using a deep recurrent neural network (RNN) and predict the levels of cognitive load from EEG recordings.

Goal: Accuracy and efficiency.

Data Recording and Preprocessing
- 25 subjects (ten female) of age 16-28 perform the standard working memory (WM) experiment.
- An array of English character in SET is shown for 0.5 seconds. After 4 seconds the TEST characters are shown.
- In each trial the number of characters are chosen from the set (4, 6, 8, 10) and repeat experiment for 300 times.
- Each of the task condition containing 4, 6, 8, 10 characters is labeled with cognitive loads 1-4 respectively.
- Brain activity recorded during 4.5 sec trials and recognized as mental workload.
- Three different combination of LSTM and CNN+LSTM models are explored for experiment.

Experiments
- Classification Algorithm:
  - RNN Model
    - CNN handles space and frequency variations, and learns 2D representations.
    - CNN output feature vectors are fed into recurrent LSTMs to learn temporal variations.
    - LSTM frames propagated to FC layer and prediction is made by Softmax classifiers.
    - Bidirectional LSTM process the EEG data in both forward and backward directions.
- Classification results of different architectures
  - Improvement on classification efficiency.

Results
- Significant gains in efficiency.
- Find better classification accuracy i.e. up to 92.5% during the memory task execution.
- Reduce classification error to 7.61% in comparison to other state-of-art techniques.