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Idea Submission

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Emotion Recognition from EEG (electroencephalogram) using Deep Learning

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TEAM DETAILS

Team Name	
Member 1 Name	Abhishek Verma
Member 2 Name	N.A.
Member 3 Name	N.A.
Member 4 Name	N.A.

THEME SELECTED

Smart Lifestyle

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ONE LINE PITCH OF YOUR IDEA

Implementing State of the Art algorithms for Emotion Recognition from Multi-Channel EEG brain signals which can help in determining the thoughts and emotions of an individual.

PROBLEM STATEMENT, YOU ARE SOLVING

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Most EEGs are done to diagnose and monitor seizure disorders. EEGs also can identify causes of other problems, such as sleep disorders and changes in behaviour. They're used to evaluate brain activity after a severe head injury or before/after a heart or liver transplant. Emotions like arousal (heightened senses like anger and fear) and valence (intrinsic attractiveness/"good"-ness or averseness/"bad"-ness) can be classified using the EEG signals. These will help us greatly in healthcare sector for paralysed patients, babies, children as well as in entertainment and gaming industry to track emotions experienced by the viewers/gamers. Human emotions can be detected by facial expressions, speech, eye blinking and physiological signals and these approaches are susceptible to be deliberately disguised. Physiological signals like electroencephalograms (EEG), electrooculography (EOG), blood volume pressure (BVP) are produced spontaneously by human body.

Consequently, the physiological signals are more objective and reliable in capturing real emotional states. Of all of these physiological signals, the EEG signal comes directly from human brain, which means changes in EEG signals can directly reflect changes in human emotional states. This technology thus can surely be used for lie detection (people can fool the polygraph systems which work on heart beats). Being non-invasive BCI’s (Brain Computer Interface) they hold an advantage over invasive BCI’s and even MRI’s as EEG sensor caps are portable, cost-effective, and without any health hazards (no magnetic rays). They can have further applications in home automation (setting lighting, fragrances in rooms as a consequence of the emotions user in going through). This can also be applied to Mood Changing Technology as shown in Mercedes Benz S Class advertisement to automate it. Facebook is currently investing a lot in BCI program outlining their goal to build a non-invasive, wearable device that lets people type by simply imagining themselves talking.

SOLUTION PROVIDED

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- As a challenging pattern recognition task, automatic real-time emotion recognition based on multi-channel EEG signals is becoming an important computer-aided method for emotion disorder diagnose in neurology and psychiatry.
- Traditional machine learning approaches require to design and extract various features from single or multiple channels based on comprehensive domain knowledge.
- Consequently, these approaches may be an obstacle for non-domain experts. On the contrast, deep learning approaches have been used successfully in many recent literatures to learn features and classify different types of data.
- A hybrid neural network which combines 'Convolutional Neural Network (CNN)' and 'Recurrent Neural Network (RNN)' has been applied to classify human emotion states by effectively learning compositional spatial-temporal representation of raw EEG streams. The CNN module is used to mine the inter channel correlation among physically adjacent EEG signals by converting the chain-like EEG sequence into 2D frame sequence. The LSTM module is adopted to mine contextual information.
- Experiments are carried out in a segment-level emotion identification task, on the DEAP benchmarking dataset.

- State of the Art literatures have quoted up to 90 % accuracy in recognising these emotions.

- A minimum viable product (a model classifier here) can be created using current SOTA neural net architectures in recent literatures depending in the compute power provided. Considering Google Colab and the number of epochs we run for an MVP can take up to 3 days (considering 8 hrs/day). And novelty introduction to the product requires intensive R&D which can take substantial amount of time.

- The amount of an EEG sensor band can be around 10,000 INR and considering the classifier model is hosted on a cloud service (heroku) which can be free, the headset can be linked via Bluetooth to any device. But my focus would be on achieving the best accuracies which could later be deployed after being financed.

- Docker containers can be used to deploy the python files which extract data from EEG and compute it via the model classifier to predict the emotions. Can be deployed as a PC/smartphone app.

- Assumptions taken are that the hardware requirements (EEG machine which could cost up to 2 lacs) isn’t available. The dataset taken is a licensed dataset (DEAP dataset) and further inferences on predictions would be required for advanced applications.

ADDITIONAL DOCUMENTS FOR SOLUTION

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Dataset - https://www.eecs.qmul.ac.uk/mmv/datasets/deap/

Literatures -

- https://www.researchgate.net/publication/320580554_Multimodal_Emotion_Recognition_Using_Deep_Neural_Networks
- Theerawit Wilaiprasitporn, Apiwat Ditthapron, Karis Matchaparn, Tanaboon Tongbuasirilai, Nannapas Banluesombatkul and Ekapol Chuangsuwanich. “Affective EEG-Based Person Identification Using the Deep Learning Approach”.
- Li, Xiang, et al. "Emotion recognition from multi-channel EEG data through Convolutional Recurrent Neural Network." Bioinformatics and Biomedicine (BIBM), 2016 IEEE International Conference on. IEEE, 2016.
- Dan Nie, Xiao-Wei Wang, Li-Chen Shi, and Bao-Liang Lu “EEG-based Emotion Recognition during Watching Movies”.
- Ahmad Tauseef Sohaib, Shahnawaz Qureshi,, Olle Hilborn, and Petar”Evaluating Classifiers for Emotion Recognition Using EEG”.
- Yuan-Pin Lin , Chi-Hong Wang , Tien-Lin Wu , Shyh-Kang Jeng and Jyh-Horng Chen “EEG-BASED EMOTION RECOGNITION IN MUSIC LISTENING: A COMPARISON OF SCHEMES FOR MULTICLASS SUPPORT VECTOR MACHINE ”.
- Zhenqi Li, Xiang Tian, Lin Shu , Xiangmin Xu, and Bin Hu “Emotion Recognition from EEG Using RASM and LSTM”.

COMPETITORS

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- **Strengths** - EEG signal comes directly from human brain, which means changes in EEG signals can directly reflect changes in human emotional states. This technology thus can surely be used for lie detection (people can fool the polygraph systems which work on heart beats). Being non-invasive BCI's (Brain Computer Interface) they hold an advantage over invasive BCI's and even MRI's as EEG sensor caps are portable, cost-effective, and without any health hazards (no magnetic rays).

- **Weaknesses** – EEG has several limitations. Most important is its poor spatial resolution. EEG is most sensitive to a particular set of post-synaptic potentials: those generated in superficial layers of the cortex, on the crests of gyri directly abutting the skull and radial to the skull.

- **Opportunities** - They can have further applications in home automation (setting lighting, fragrances in rooms as a consequence of the emotions user in going through). This can also be applied to Mood Changing Technology as shown in Mercedes Benz S Class advertisement to automate it. Facebook is currently investing a lot in BCI program outlining their goal to build a non-invasive, wearable device that lets people type by simply imagining themselves talking.

- **Threats** - EEGs are very safe. If a child has a seizure disorder, the doctor might want to stimulate and record a seizure during the EEG. A seizure can be triggered by flashing lights or a change in breathing pattern. EEG is a safe test with no side effects. However, a person with epilepsy may experience a seizure, triggered by the various stimuli used in the procedure, including the flashing lights. (This is not seen as a 'complication' by medical staff, because a seizure during an **EEG** can greatly help in diagnosis.)

WHAT INNOVATION/CREATION ARE YOU BRINGING ?

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- Most literatures show that preprocessing can improve the accuracies of the model significantly. My focus would be to preprocess the baseline signals (produced for the initial amount of time as the subject puts on the EEG sensor cap).

- Further novelty would be fine - tuning the model to introduce early stopping of iteration, and experimenting with optimisers and activation functions.

- Introducing scope for further analysis on the predicted data.

- Working towards making the technology more deployable.