Facilitating the Annotation of Seizure Events Through an Extensible Visualization Tool[1]

J. Smith[1], S. Jones[2], M. Smith[1], J. Doe[3], B. Smith[1] and J. Jones[1]

1. Neural Engineering Data Consortium, Temple University, Philadelphia, Pennsylvania, USA
2. Center for Corporate Research, Acme Corporation, Los Angeles, California, USA
3. Advanced Technology Laboratory, XYZ Research, New York, New York, USA

{jsmith, bsmithjjones}@temple.edu, sjones@acme.com, jdoe@xyzr.co

An electroencephalogram (EEG) is a multi-channel signal which describes the electrical activity in the brain via voltages measured in a variety of locations on the scalp. EEG recordings can be interpreted using montages, which redefine channels as the difference of channel voltages. EEG recordings are most commonly stored as raw signals in the European Data Format (EDF). Existing EEG visualization tools, such as EDF Browser [1] and EEGLab [2], do not allow users to annotate directly over their signal displays. Furthermore, it is not possible to easily add new visualizations to these tools. Our tool displays annotations in a time-aligned format, and allows the direct creation and manipulation of these annotations. We provide an extensible framework that allows for the creation of new visualizations or analytics based on user needs. In addition to the conventional multi-waveform viewing capability to which neurologists are accustomed, we provide a spectrogram and/or energy visualizations. These visualizations are becoming increasingly popular with clinicians as an efficient way to review continuous EEGs [3] (cEEG). In this presentation, we will introduce a software tool that facilitates annotation of EEG signals.

The user can create, select, and operate on sets of annotations via an interface which pairs click and drag interaction with context menus for selection of annotation type or preferred action. The annotations themselves will “snap to boundary” in a manner similar to digital audio workstations such as Audacity – boundaries are adjustable but overlap is prevented. This interface facilitates the annotation process through simplicity and efficiency, while ensuring the accuracy and precision of the user’s actions.

Our viewer includes a configurable filter, allowing the user to view the EEG signal with various ranges of frequencies removed. A typical usage of this filter is to low-pass the signal and reject both DC offset and 60 Hz hum. The filter also includes several bandpass presets that reject all but a range of frequencies (i.e. the frequencies associated with theta or alpha waves).

Annotators also make use of a feature which allows for per-channel setting of gain. This kind of manual adjustment is useful when a channel, such as the Electrocardiogram (EKG) channel, has a gain disproportionate to that of the other channels. The signal can also be “played”, meaning that it automatically scrolls through the signal until a user finds a region of interest to annotate.

The viewer also integrates a search API for querying the TUH EEG Corpus [4]. The results returned by the API offer clinical reports, along with corresponding EEG data. We allow for the user to visualize this data with the same features as previously described. This search API is part of a new capability, called cohort retrieval [5] that allows users to do multimodal queries on EEG records. The system integrates knowledge extracted from the unstructured EEG reports with EEG signal events automatically extracted from the signal. The system returns a list of the top ranked reports and lets users easily reviews reports and EEG signals in the same framework that the display tool uses.

Many of the features described are customizable via an integrated preferences window. This allows the customization of virtually all aspects of the available analytics. These parameters can be saved to a file for

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later use. For example, the montage used to interpret EDF files can be adjusted from within the program. This is a critical capability because channel labels vary from site to site, and users must be able to adapt to each site's naming conventions to the preferred visualization (e.g., defining a TCP montage).

Since this viewer is written in Python, it is easy to integrate with other software. It is developed with PyQt, a set of Python wrappers to the Qt GUI framework, making it cross-platform software capable of running on almost any OS. We currently use it on OSX, Windows, and Linux.

References

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