Accelerating the Rate of Technology Development in Neural Engineering Through a Common Evaluation Paradigm

I. Obeid and J. Picone

The past two decades have seen an explosion in Neural Engineering research. However, despite significant advancements, overall progress in the field does not appear to have been commensurate with the scope of investment (over $200M in the last decade from NIH and NSF alone). Potential contributing factors include limited data, a lack of common evaluation metrics, and a diffuse focus on key challenges. For example, many topics of interest, such as automatic interpretation of EEGs, often suffer from data sets of 100 or fewer EEG studies, thus precluding the use of state of the art machine learning algorithms [1][2]. Such small studies simply do not produce statistically significant outcomes and therefore prevent generalization of the findings. This problem is exacerbated when correlates such as drug treatments, patient medical histories, or patient demographics are factored in. In contrast, data-driven approaches have made enormous advances in recent years in other fields in terms of their ability to predict events through supervised training on big data resources. Equally important, however, is the fact that many of these techniques have the ability to discover underlying structure of the data using latent variables and unsupervised training techniques. The only impediment in recent years to applying these techniques has been the lack of a suitable amount of data to support comprehensive experimentation.

The Neural Engineering Data Consortium (NEDC) is being launched to develop and curate massive data sets to be used in addressing the next generation of data-driven research challenges for the neural engineering community. NEDC's primary mission will be to focus the attention of the research community on a progression of neural engineering research questions and to generate data to support those investigations. Competition-based evaluations on common data will also drive progress by focusing the community's attention on key signal processing problems. While limited attempts at public competitions have been made in the past, most notably the Berlin BCI Competition, these efforts have not operated at a scale or progression that would have allowed researchers to address neural engineering research challenges systematically.

A community-wide assessment, funded by a planning grant from the National Science Foundation, is being conducted to define and prioritize the resources required by researchers to fuel innovation. NEDC will broaden participation by making data available to research groups who have significant signal processing expertise but who lack capacity for data generation. This effort is modeled in part after similar successful endeavors, particularly in the human language technology field where the Linguistic Data Consortium (LDC) has led to systematic research and technology advances over a 20-year span[3][4].

In this paper, we also present NEDC's first corpus – clinical electroencephalogram (EEG) recordings conducted at Temple University Hospital from 2002 to 2013. The Temple University Hospital EEG Corpus (TUH-EEG) will be the world's largest publicly available database of clinical EEG data. Although information disclosing a patient's identity, such as name and corresponding video are being redacted, other demographic information such as gender, age, ethnicity, relevant medical history, and medications will be retained. The data includes time-aligned annotations provided by physicians, a physician's EEG Report that contains a summary of the patient's clinical history and medications, and auxiliary encodings of the findings in terms of ICD-9 codes. This corpus will support the development of technology to automatically interpret EEGs in addition to advancing the basic science of what aspects of a patient's medical record correlate with various pathologies that can be diagnosed from EEG studies. The complete corpus is expected to be freely available by the end of 2013.

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