Information Theoretical Approach Towards the Reconstruction of Tempo from EEG Responses: Abstract Submission

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Here we propose an information theoretical model to analyze the reconstruction of the tempo of music stimuli from EEG responses. Neural encoding and decoding focus on the question of what the neuronal response can inform us about the stimulus. We focus on a related but different question of computationally quantifying the amount of information shared between the response of neuronal populations and the stimulus input they receive. We employ the information theory techniques to measure the mutual information, which we then use to establish bounds on tempo change for the reconstruction from EEG response data. We interpret the entire transmission chain consisting of the stimulus generation, brain processing by the human subject, and the EEG response measurements as a nonlinear, time-varying communication channel with memory. We use mutual information (MI) to access the information transferred from the music stimulus to the EEG response. We model the recorded EEG measurements as a multidimensional Gaussian mixture model (GMM). The input to our channel is the tempo value modelled as a uniform random variable, and the output is the recorded EEG potential modelled as a GMM. The MI between the output EEG data and the tempo value tells us the maximum rate of change of tempo, which we can afford in a music stimulus for perfect reconstruction of the tempo sequence. We use Stanford's Naturalistic Music EEG Dataset - Tempo (NMED-T) to perform our computations of MI. To ensure the tractability of the MI computations and effective mapping of activity across different brain regions, we group the 128 electrodes of the EEG system into nine specific regions of interest (ROI). The obtained MI value averaged over all the stimuli was 3.95. This implies that we can classify a maximum of 15 different stimuli given the recorded data. Also, the obtained value of mutual information limits the rate of tempo change within stimuli, provided a complete reconstruction of the tempo sequences is the objective. This preliminary research establishes that by using information, we can comment on the nature of input stimulus and establish bounds within which the reconstruction of the music stimulus is possible.

Note:

- Awarded the Best Paper Award at CogMIR 2019.

- The abstract submission was updated after fixing typos and additional updates.