**Bayesian Neural Power Spectrum Estimation for Robust Neural Feature Extraction**

**Summary**

There is a significant push for using parametric description of Neural Power Spectrum. In particular, parametrizing neural power spectra into periodic and aperiodic components [1], has been introduced recently and it gained significant attention in the field. This algorithm suggested a parametric model to estimate Power Spectrum density of neural brain activities. This algorithm defines two periodic and aperiodic components, in which both of them carry information of physiological activities of the brain signals. However, this parametric algorithm provides an interesting framework to assess frequency domain time-series data; it suffers from numerous of shortages. This parametric neural power spectrum model is not able to provide a robust frequency estimation, fails to control variability of parameters, and cannot include the notion of continuity of neural signals through time. In this research, we are introducing a Bayesian neural power spectrum model which addresses multiple issues of the previous model including time continuity over time, much more flexibility in controlling specific frequency bands, and also rather than providing a point estimate for each free parameter, the proposed model will provide a posterior estimation of each parameter of the model. We also develop a toolbox which can be used for a wide range of different kinds of time series data, including EEG, iEEG, and LFP, without having the expertise of the field. This model would be a significant endeavor in the computational neuroscience field to provide a parametric model of the Power Spectrum Density, which is very important notion in Neuroscience data analysis.

**Additional Details**

Neural power spectrum has been conflated of two main components: aperiodic and periodic parts. The aperiodic component which has a like distribution, plays a major role in physiological interpretation of the brain activity. The periodic component, which reflects the narrow-band frequency oscillations with a center frequency, carries information of a wide range of neural activities including cognitive tasks, behavioral tasks, and disease dysfunctions [1]. These two main components of neural power spectrum can be modelled in a parametric model as [1]:

|  |  |
| --- | --- |
|  | (1.a) |
|  | (1.b) |
|  | (1.c) |

where models the aperiodic component in which is the broad-band offset, is the knee, is a vector of frequency values [1]. The periodic activities are modeled by , in which indicates number of periodic activities, is amplitude, is center frequency, and is the variance of the the periodic activity. comprises power spectrum of aperiodic and periodic activities [1] and it provides the parametric power spectrum. We assume is providing an estimation of the observed , which is Multitaper power spectrum of time series data, with the residual error . follows a multivariate normal distribution with dimension , which is the length of .

|  |  |
| --- | --- |
|  | (2.a) |
|  | (2.b) |
|  | (2.c) |

where is a zero vector with length .

* observarion and likelihood
* Defiing of Ken relation transition
* Real Data result
* Talks about Bayesian advantages

**References**

[1] T. Donoghue *et al.*, “Parameterizing neural power spectra into periodic and aperiodic components,” *Nature Neuroscience 2020 23:12*, vol. 23, no. 12, pp. 1655–1665, Nov. 2020, doi: 10.1038/s41593-020-00744-x.