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Neurophysiology: The Guidelines for Future Application

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Abstract

In study on neurophysiology, complex data is frequently visualised. With an emphasis on time-frequency decompositions in electrophysiology as an instructive example, we address specific perceptual concerns associated with the continuous usage of versions of the rainbow colour scheme in this article. In this article, we examine the dangers of skewed interpretation of neurophysiological data and offer recommendations for better colour map visualisation of complicated, multidimensional data in neurophysiology research.

Introduction

In cognitive and clinical neurosciences, electroencephalography is the most commonly used method. EEG researchers can quickly produce data transformations to highlight various properties of neural activity in a time-resolved manner with the increasing recording capacity of acquisition systems, computational power, and proliferation of analysis toolboxes. These considerations also apply to humans' magneto encephalography, intracranial recordings, and a variety of EEG-related preparations. Time-frequency decompositions of electrophysiological time series are one prominent group of methods. The number of EEG studies utilizing such frequency-based analyses has increased by more than 4500% over the past two decades. In a nutshell, time-frequency analyses use a variety of Fourier or wavelet transforms to estimate the frequency contents of neurophysiological data. Using visual representations like time-frequency maps, frequency estimates are made across time windows so that changes in frequency properties like signal power can be evaluated and interpreted over time [1, 2].

Time-recurrence maps comprise of three dimensional plots projected onto two aspects. Time is typically represented by the abscissa and frequency by the ordinate map. The relief of the plot is a relevant dependent variable associated with that time-frequency coordinate. The relief feature is typically depicted using a color scale to indicate its magnitude. We contend that the selection of such colormaps may be perceptually erroneous, resulting in erroneous detections and interpretations of reported neurophysiological effects. We want to bring issues to light around these inquiries, which are not intended for time-recurrence planning or electrophysiology research yet influence the perception of logical information at large, and give best-practice proposals to moderate these issues and energize fair detailing of observational discoveries [3].

Throughout the course of recent many years, ~74% of distributed time-recurrence experimental impacts in electrophysiology was accounted for utilizing subsidiaries of the rainbow variety range. From cooler blue and green hues to warmer yellow and red hues, rainbow color palettes map data values to a linear path through RGB space. The resulting color scheme is vibrant and pleasing to the eye. Rainbow plots, on the other hand, are inaccessible to viewers who lack color vision and cause visible and quantifiable visual errors, such as anomalies in images caused by high contrast regions and "flat" perceptual bands that give the impression of limited color bands. To alleviate the drawbacks of the rainbow color scheme, a number of scientific fields, including oceanography and cartography, have developed and adopted alternate color schemes [4].

We suggest that the neurophysiology research community adopts a similar proactive approach and encourages its scientists to use effective visualization techniques as well. In this section, we discuss the scope and significance of color misappropriation in the field and offer helpful guidelines for resolving these well-known issues. Jet is an illustration of a MATLAB-implemented rainbow color palette. Because MATLAB is frequently utilized in electrophysiological research, we will use jet as a typical illustration of a rainbow color scheme to illustrate our points in the following sections. However, the issues that arise are applicable to all rainbow palettes, as we note [5].

Jet-like rainbow colormaps lack natural perceptual order. Take a look at a greyscale palette: sequential color scales are the natural order in which darker and lighter gray shades are perceived due to their brightness. Rainbow color palettes, on the other hand, use hue order rather than brightness to distinguish between sections of the colormap, despite their sequential nature. The viewer's familiarity with the color scheme is necessary for an accurate and effective reading of time-frequency maps plotted with rainbow colouring. However, behavioural data demonstrate that even those who self-identify as being familiar with rainbow color schemes perform worse when reading data plotted with rainbow scales as opposed to naturally ordered scales. The absence of perceptual requesting is clear when plotted against variety ranges with requesting. It is easy to understand shifts from light to dark in greyscale or from darker to lighter hues. Also providing interpretable perceptual order are multi-hued color scales that diverge from a common baseline color. Rainbow colourmap don't give these perceptual properties [6, 7].

Effective perceptual differentiation between red, yellow, and green hues is necessary for reading rainbow plots. Sadly, rainbow colormaps represent red and green colors at the same brightness level, making it difficult for viewers with color vision impairments to perceive large swatches of the color spectrum. CVDs influence the view of varieties in various habits, contingent upon the idea of the shortfall influencing retinal cone cells. However, rainbow variety ranges require the watcher's capacity to separate between shades as opposed to tint powers. As a result, they pose a constant challenge to viewers of CVD. Therefore,

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colormaps that challenge CVD perceptual discriminability should be avoided in order to encourage inclusivity and accessibility in scientific publications [8].

We urge neurophysiologists to guarantee they report their information with colourmaps that 1) have regular perceptual request, 2) are perceptually uniform and 3) are CVD-open. Even-mindedly, we distinguished the default variety planning choices of famous time-recurrence examination tool stash in neurophysiology, as default choices are in many cases the reason for variety range reception. We likewise give programming proposals to writers to change variety ranges in a manner that is reasonable for their information and perusers [9].

A significant number of these colourmap defaults might be fitting for time-recurrence maps. A list of accessible, open-source color palettes is provided below. Keep in mind that the specific steps needed to change color palettes may vary depending on the software used. However, before calling the colormap function, users can quickly load one of the following packages for MATLAB-visualized data [10].

Conclusion

In conclusion, we draw attention to the major drawbacks of using a rainbow color scheme to visualize neurophysiological data. We do not intend to prescribe a specific alternative color scheme because the most suitable palette should be determined by each individual's circumstances. However, we do call for a concerted effort on the part of researchers, software developers, and journals/editors to discourage the use of rainbow color maps in neurophysiology so that data can be presented in a way that is understandable, precise, and easy to understand.

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