1. Introduction

It is generally understood that the human brain encodes and stores information. However, debate is ongoing about how this information is programmed into the individual components of the brain. A large number of Neuroscientists subscribe to the concept of temporal coding, which argues information is inherent in the patterns of spike trains, how often spikes occur and when spike occur relative to each other. Hence, the principle of synchronisation of neural activity [1] [2] is one of basic principles that underlie information processing in the brain.

Currently, large quantities of simultaneously recorded multidimensional spike train data sets are available. However, software tools to support the analysis of this data are incomplete. The quantity of data recorded is also due to significantly increase as hardware limitations are surmounted. As hardware constraints are reduced, it is essential to explore new approaches for the analysis of these vast data sets.

One of the common techniques used to analyse the synchrony between two simultaneously recorded spike trains, is the Cross-correlogram. This is a simple, yet very effective, technique where output is usually presented as a 2-dimensional histogram. Inevitably, as the quantity of data increases, this forms of analysis becomes infeasible. Hence, the requirement for improved software support is established and it is clear that new methods need to be defined to support the analysis of these increasing data sets. At the Multiple Unit Laboratory [3], support for the analysis of this data has been addressed for some time and several analysis tools have been developed. One of their most significant tools is the “Gravity Transformation” [4] [5]. The gravity transformation is credited as a significant contribution to the analysis of this type of data. However, the standard output facility, known as a distance graph, is not suitable for large numbers of particles.

2. Parallel Coordinates

In 1990, Inselberg [6] [7] was largely responsible for the regeneration of parallel coordinates, particularly in the field of Information Visualisation. Since this time, parallel coordinates have been used in a variety of ways to visualise dense, multivariate data sets.

The novelty of parallel coordinates lies in the fact that axes are adjacent to each other, as opposed to orthogonal axes traditional in Cartesian coordinates. Data points are denoted as vertical axis coordinate values distributed along the horizontal axis. Hence, a specific point in n-dimensional Euclidean space is represented by n vertical axis values distributed along the horizontal axis.

Since 1990, researchers in the area of information visualization have experimented with a variety of derivations of parallel coordinates such as the concept of hierarchical parallel coordinates [9]. In this paper, the use of another derivation, animated parallel coordinates, is proposed and evaluated for data exploration.

3. Software support for data exploration

It is widely accepted that parallel coordinates may be used to identify and reveal the relationships in multivariate data sets. This technique of representing data is useful as a means of presentation and exploration of data sets. The use of parallel coordinates in the animation of large complex data sets is demonstrated.

For the data produced by the gravity transform algorithm, each parallel coordinate displayed represents the position of a particle in n-dimensional space, where n is the number of adjacent axes in the display. See Figure 1 where n=10. Note the ten vertical axes used to represent data points in 10-dimensional space. Recall, each individual (10-dimensional) coordinate is represented by a line that intersects each of the vertical axes.

The animation of the parallel coordinate display, that represents the position of all the particles at time t, has provided a greater understanding of the inherent synchrony of the particles over time. As a result of this, parallel coordinate displays have been used for relatively larger values of n than the standard output display of the gravity transformation [8]. It is also useful in depicting the aggregation of particles that occurs as the gravity transform algorithm collapses.
This animation technique is part of a software system called VISA, Visualisation of Inter-Spike Associations, which supports the analysis of multidimensional spike train data. Additionally, the system supports the display of any subset of data for closer inspection, effectively zooming in upon selected data. VISA, also supports the representation of data in a static mode.

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References