

Bridging the Visualization Gap in Time Series Analysis through Spatialization

Kambiz Borna¹ and Tony Moore²

¹ Unitec Institute of Technology; ² University of Otago Te Whare Wānanga o Otāgo

Abstract:

This paper introduces a new method based on spatialization to bridge the visualization gap for time-oriented data. We first develop a 2D time-based framework using linear, cyclic, and branching concepts of time, which allows all time elements to be directly utilized for data visualization and analysis. This framework is then used to integrate attribute data, such as exchange rates, adding a third dimension to create a 3D map. We use the AUDNZD exchange rate for testing, and our results highlight the potential of the proposed method to enhance both the visualization and analysis of time-oriented data.

1. Introduction

Time is an important data dimension that plays a key role in modelling changes in objects and events. Despite its importance in data modelling, time has fewer tools and less flexibility for independent perception and visualization compared to spatial and attribute data dimensions. This limits common modelling techniques to using the spatial and attribute dimensions of time-oriented data for visualizing time, rather than directly utilizing the time dimension itself.

To address these limitations, this paper introduces a new method based on spatialization, creating graphically meaningful and cognitively effective representations of non-spatial phenomena (Fabrikant and Skupin, 2005). We first construct a 2D time-based framework incorporating concepts of linear, cyclic, and branching time. Within this framework, the x-axis represents linear time, the y-axis addresses the cyclic dimension of time, and branching time is utilized to maintain connectivity between time steps. This allows time to be visualized directly in a way that parallels human perception of spatial objects. We then apply this framework to embed time-oriented data and generate a 3D map.

2. Results

To test the model, we utilized AUD/NZD exchange rates with a 12-minute frequency. Initially, we used the temporal elements of this data to construct our 2D time-based framework. We then used the temporal coordinates to place the exchange rates within a 3D space. In the final step, we interpolated this data in spatial space and used the resulting interpolated surface to extract profiles at each time step (Figure 1).

Figure 1 displays two profiles: a black profile representing the open price and a blue profile for the close price, both at 9:36 AM NZST. These profiles are derived from the interpolated surface, which allows for a range of prices at each time step for both the open and close prices,

linked geometrically through our interpolated surface. This method provides additional geometric data useful for visualizing and analysing trends. For instance, as observed in the figure, at the corners of the profiles, there is evidence of a bull market where the close price is higher than the open price, similar to the green candle shown in Figure 1(b).

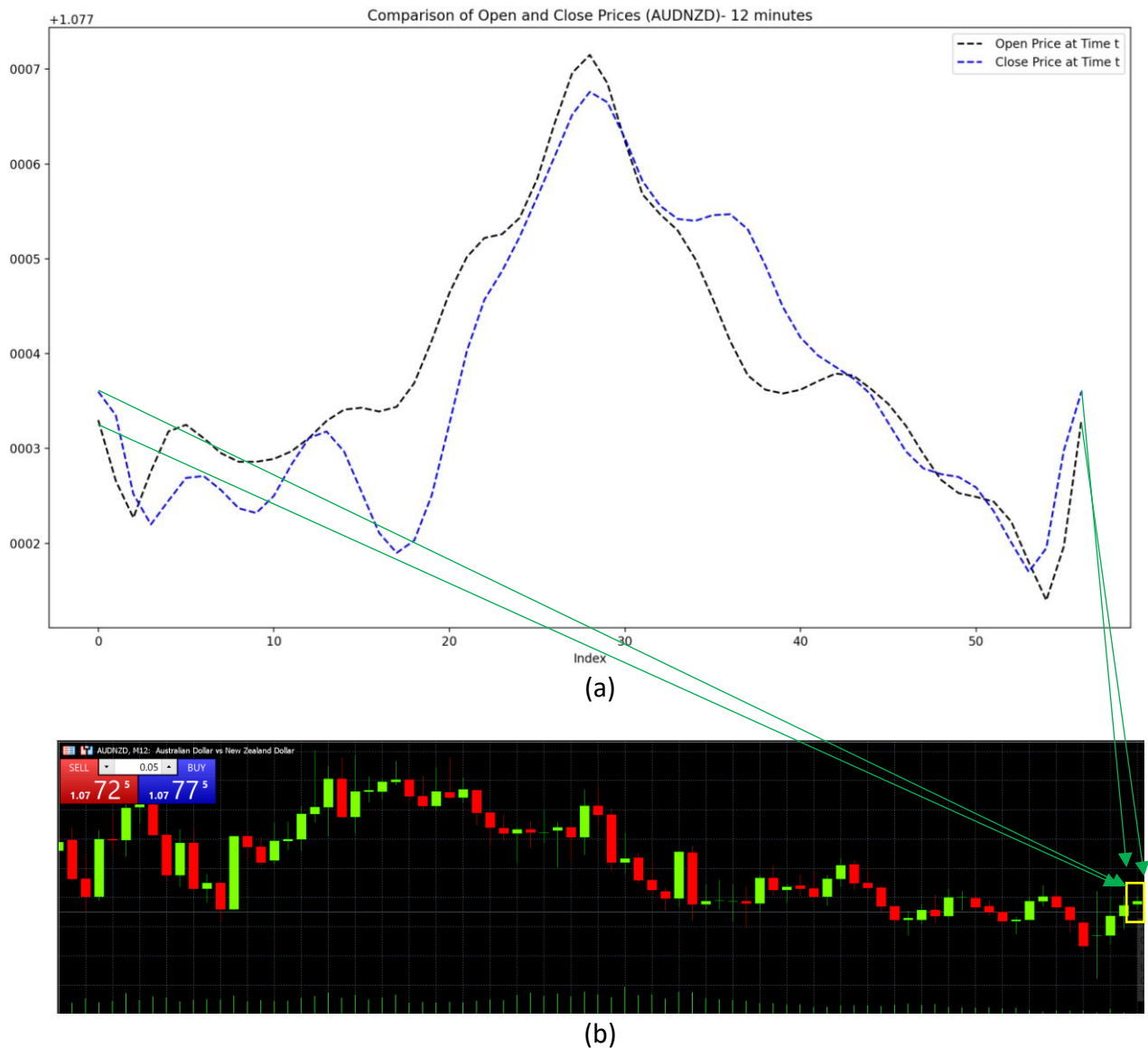


Figure 1. (a) Extracted profiles of open and close exchange rates at 9:36 AM on June 17, 2024; (b) Candle-based view of the AUDNZD exchange rate for the same date and time.

3. References

Fabrikant, S., A. Skupin. 2005. Cognitively Plausible Information Visualisation. In Exploring Geovisualisation, edited by Dykes, J, MacEachren, A and M.-J. Kraak. Amsterdam: Elsevier.