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Letter to the editor

Reply to paper 'Ecological momentary assessment (EMA) combined with unsupervised machine learning shows sensitivity to identify individuals in potential need for psychiatric assessment'

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Acknowledgement

We would like to thank Prof. Eamonn Keogh (University of California – Riverside) who provided helpful comments and constructive feedback for this letter to the editor.

This letter to the editor serves to further elaborate on the methodological issues we have encountered in our paper ‘Ecological momentary assessment (EMA) combined with unsupervised machine learning shows sensitivity to identify individuals in potential need for psychiatric assessment’ [1] and which we have corrected in an erratum. We hope that this will be helpful for future investigations that combine dynamic time warping (DTW) and ecological momentary assessment (EMA) data.

The aim of our paper was to examine longitudinal trajectories of psychotic(-like) experiences in EMA between groups on the continuum of familial risk towards psychotic illness. We used DTW in combination with unsupervised machine learning to identify individuals who might particularly profit from direct engagement with professional services based on their dynamic rating patterns in EMA.

As outlined in the paper, DTW calculates the distances between two time series through “stretching” and “compression” in a way that the Euclidean distance between values of each time series is minimized. Using DTW we accounted for the fact that rating dynamics, i.e. symptom variability between study participants might follow the same overall pattern but shifted in time. This method has mainly been applied in speech recognition [2] and only recently has been adopted to assess temporal similarities in symptom clusters of depressive patients [3] or has been used in context of other clinical investigations [4]. Despite its previously reported usefulness to identify dynamic symptom clusters [3], it shows intricacies that are important to consider combining it with time series data based on EMA.

DTW is a metric to measure similarities in dynamics (‘shape’) of two time series which is sensitive to any mean differences between these two time series. This implies that even small differences in the scale or offset will ‘outweigh’ any similarity information encoded in the dynamic or shape of this trajectory [5]. Figure 1 illustrates the artificial data of four rating trajectories over time. It is obvious from Figure 1b that the blue and red trajectory (as well as green and black trajectories) are characterized by the same shape of ratings. However, due to the differences in offsets of ratings (average of ratings) DTW will identify the black and blue trajectories (as well as green and red trajectories) as similar to each other (Fig 1c). In order to avoid the mean differences determining the (dis-)similarities between trajectories, it is inevitable to remove mean differences between trajectories, e.g. through z-normalization, prior to application of the DTW algorithm as illustrated in figure 1b [5].

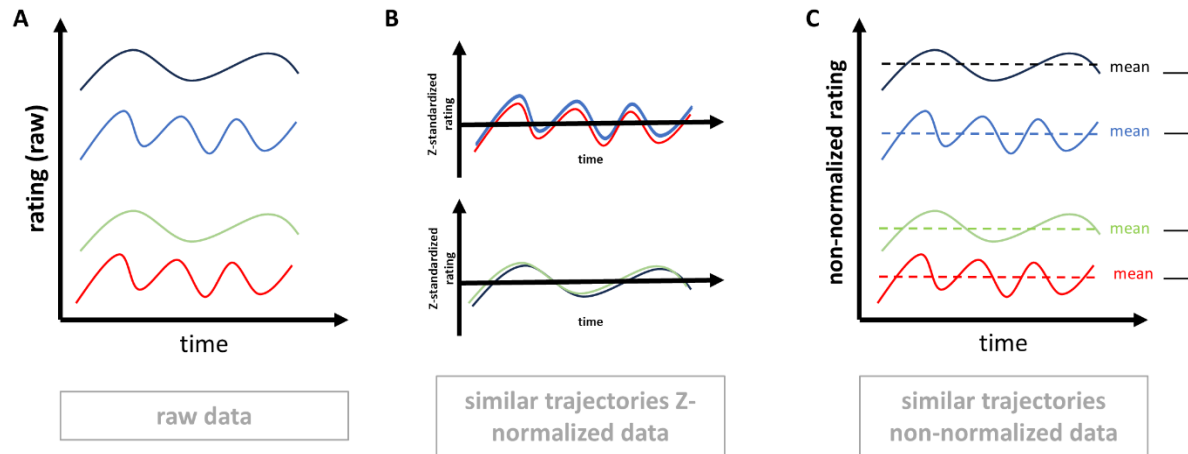


Fig. 1 Four times series with different mean ratings. (B) Using z-normalized values for DTW the black and green as well as the blue and red trajectory will show high similarity. (C) Using non-normalized values for DTW the black and blue as well as the green and red trajectory will show high similarity as similarities in the offsets for each trajectory will outweigh similarities in the shape of each trajectory

As suggested to us by an expert in the field of dynamic time warping (DTW), we implemented z-normalization as a preprocessing step in the erratum of the above referenced manuscript. However, despite z-normalization of individual trajectories, i.e. removing differences in mean ratings/offsets between trajectories, the resulting cluster solution was still characterized by significant differences in mean ratings, i.e. when comparing the individual rating trajectories based on their non-normalized mean EMA ratings.

A reason for that might be the finite nature (defined maximum and minimum value) of the 7-point EMA rating scale that is different to ‘physiological’ measures which have theoretically no minimum/maximum value or a much wider range, e.g. the audio-physical signal in speech recognition. An individual who on average scores more to the middle range of the EMA scale can vary in positive and negative direction. In contrast, individuals who on average score lower can vary only in positive direction and in negative direction are limited by the lower limit of the scale (floor effect). This is also applicable to individuals who on average score higher and who are limited by the higher limit of the scale in positive direction (ceiling effect). Therefore, mean rating and rating variance (shape) in finite measures are often not completely independent. Consequently, in finite scales in some cases the resulting DTW similarity estimate might to some extent represent the average rating of an individual rather than its actual rating dynamics/variance.

For future studies combining DTW and any finite measure it might be important to carefully consider the choice of distance measure and to check for the effect of differences in mean ratings on the distance measure.

Literature

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Statements and Declarations

Conflicts of interest

Joseph Kambeitz is currently honorary speaker for Otsuka/Lundbeck. Lana Kambeitz-Ilankovic has served on the advisory board of Boehringer-Ingelheim.

Ethics approval

All authors confirm that procedures related to the current work comply with ethical standards of the relevant institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

The studies this letter to the editor refers to have received ethical approval from the medical research ethics committee of the Medical Center of the VU University Amsterdam [NL56511.068.16] and the London-Harrow Research Ethics Committee [14/LO/0710], respectively.