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Advantages of DTW windowing function in automated correlation of stratigraphic time series

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The Dynamical Time Warping (DTW) technique has been originally developed for speech recognition in the late 1960s and early 1970s and has more recently been applied in geoscientific studies. One of the key objectives of dtw is to stretch or compress two complementary series locally in order for one series to resemble the other as much as possible. In our project, we aim to correlate industrial and scientific downhole wireline logs from offshore Australia, with the ultimate goal to obtain a regional paleoclimate reconstruction at high spatial resolution ("All around Australia"). Here, we propose a novel way to constrain the alignment of two sedimentary sequences based on a-priori stratigraphic information. Therewith, we provide a means to make dtw calculations less computationally expensive, while still evaluating all possible stratigraphic correlations, even for long time-series.

The "All around Australia" project focuses on the automated correlation of thousands of scientific and industrial time-series. Hence, it is important to speed up the calculations and reduce the computational costs. The global constraint on dtw, also known as the window function, speeds up the calculations by limiting the 2-dimensional space of possible alignments between two time-series. As a case study, IODP Site U1463 (Northwest Shelf of Australia) serves as the reference to which two industrial sites (Finucane-1 and Angel-2) are correlated. Biostratigraphic datums of Site U1463 have few meters of depth uncertainty. Their corresponding depths at the industrial sites are manually determined, albeit with a depth uncertainty that is one order of magnitude higher (so-called "slack"). These manually determined correlation points are then utilized to create custom-made windows, reflecting a priori knowledge of the large-scale stratigraphy of the studied basin. In this case, the comparison of the computational time and the goodness-of-fit for 'no-window' and 'windowed' dtw calculations reveals that the quality of the correlation improves and computational time is reduced by 15-20%. Hence, the novel window function is primarily useful for stratigraphers to guide the dtw algorithm in creating warping paths that are stratigraphically more plausible.