The Role of Warping Window Size in case of EEG Classification

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Introduction

- Time series classification: common theoretical background of various recognition tasks, including recognition tasks related to EEG, such as
  - recognition of stimulus, or
  - recognition of the symphoms of a disease.
- DTW-based methods are popular for time series classification (in the computer science literature)

Dynamic Time Warping (DTW)

- Dissimilarity measure for time series that allows for shifts and elongations

- The maximum allowed warping is controlled by the warping window size (WWS)

- According to (Dau et al., 2018), appropriate setting of WWS is essential


Euclidean distance

DTW

WWS
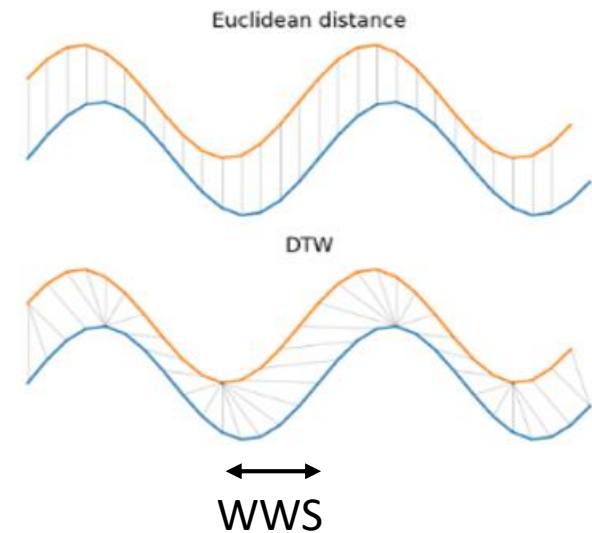
Sakoe, H. and Chiba, S: Dynamic programming algorithm optimization for spoken word recognition, IEEE Transactions on Acoustics, Speech, and Signal processing, 26 (1):43–49, 1978.

K. Buza: Time Series Classification and its Applications. 8th International Conference on Web Intelligence, Mining and Semantics, 2018.

Dau et al.: Optimizing dynamic time warping's window width for time series data mining applications. Data Mining and Knowledge Discovery, 1-47, 2018.
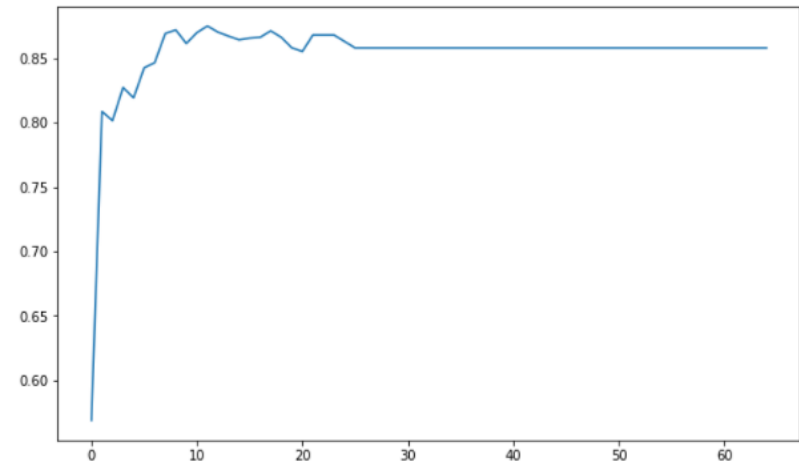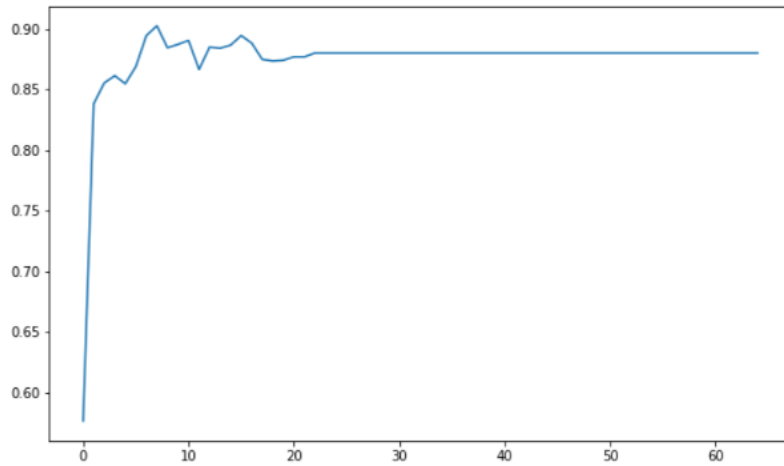
Is the WWS Essential in case of EEG?
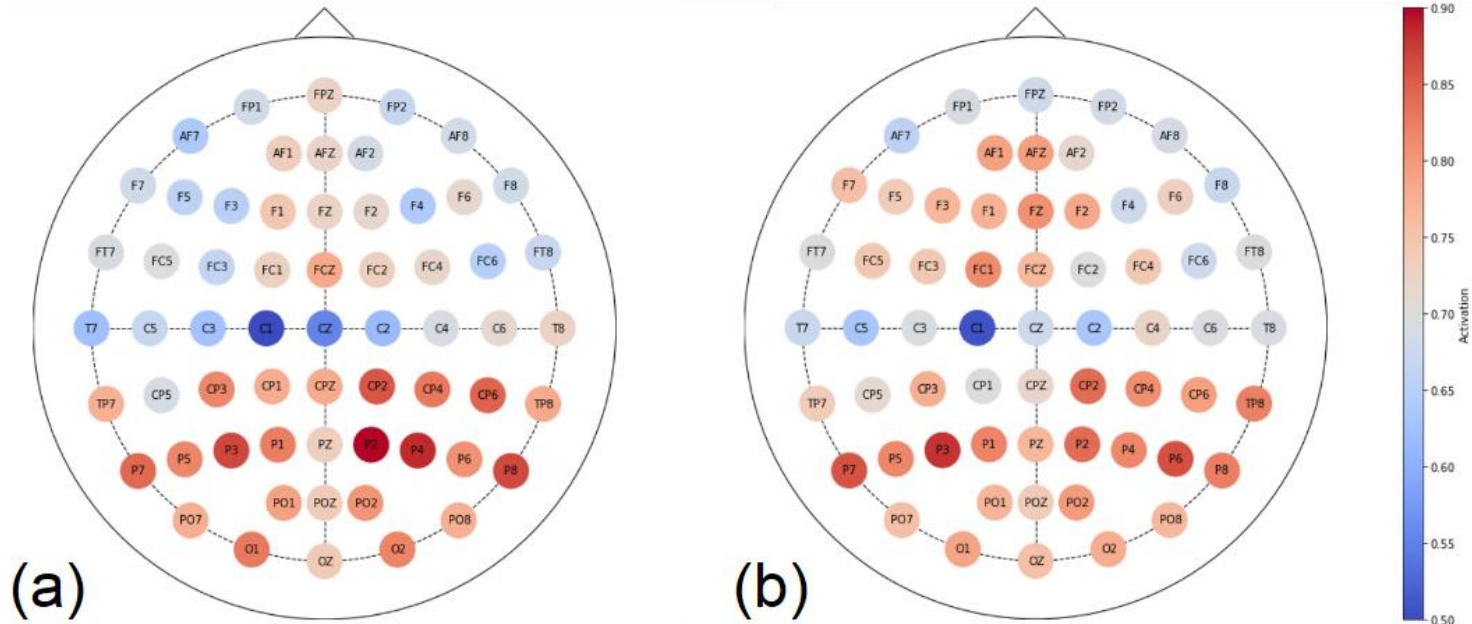
AUC of 1-nearest neighbor for various channels
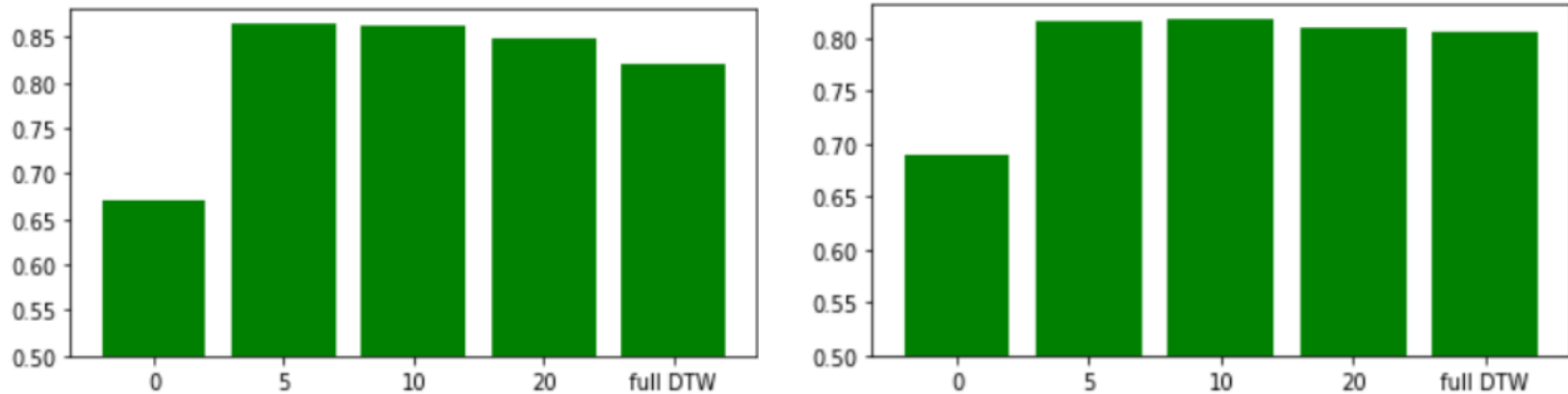(a) with warping window size of 5 time slots (≈78 ms), and
(b) in case of arbitrary warping (no explicit limit on the allowed
    shifts and elongations)

Is the WWS Essential in case of EEG?

AUC of 1-nearest neighbor as function of the warping window size (in time slots) for channels P3 (left) and P7 (right)

Is the WWS Essential in case of EEG?

AUC for averaging 100 projection-based predictions, each one using 100 selected (reference) signals in case of channels P3 (left) and P7 (right)

Buza et al.: PROCESS: Projection-based classification of electroencephalograph signals. International Conference on Artificial Intelligence and Soft Computing, 91-100, 2015.
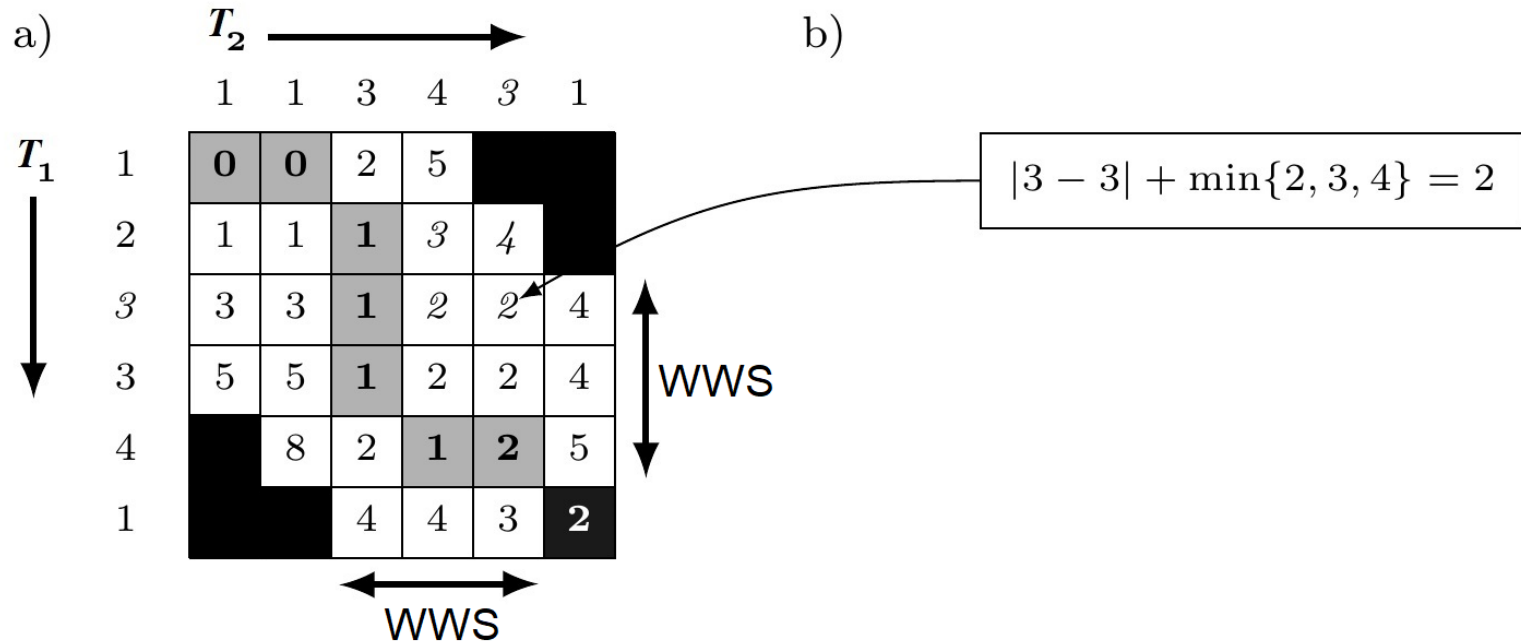
Is the WWS Essential in case of EEG?

- Short answer: **no, it isn't**.

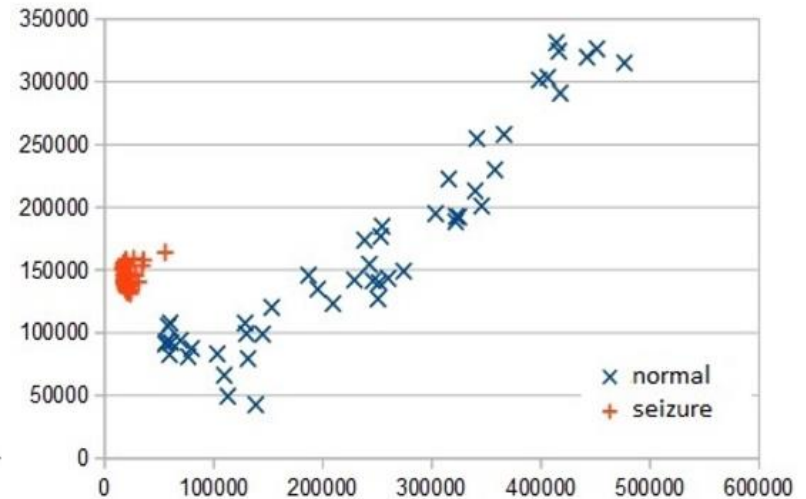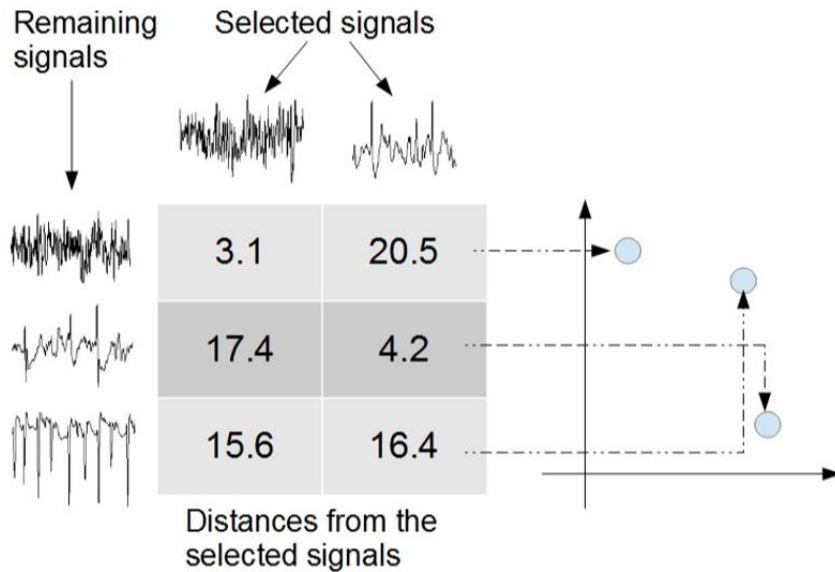- Answer in one sentence (conclusion):

  According to our observations, the warping window size is not crucial, as long as it is not set to an extremely low value, such as zero.

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Supplementary Slides

DTW Matrix

PROCESS

Buza et al.: PROCESS: Projection-based classification of electroencephalograph signals. International Conference on Artificial Intelligence and Soft Computing, 91-100, 2015.

Experimental Settings

- <u>Data:</u> EEG Database from UCI Machine Learning Repository, https://archive.ics.uci.edu/ml/datasets/eeg+database

- <u>Classifiers</u> (recognition methods):
    - nearest neighbor
    - PROCESS

- <u>Goal</u>: disease recognition

- <u>Protocol</u>: patient-based 10-fold cross-validation

- <u>Evaluation metric</u>: area under receiver operator characteristic curve (AUC)