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# Using neural networks to detect coastal hydrodynamic phenomena in high-resolution tide gauge data

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Tide gauges are exposed to various kinds of influences that are able to affect water level measurements significantly and lead to time series containing different phenomena and artefacts. These influences can be natural or anthropogenic, while both lead to actual changes of the water level. Opposed to that, technical malfunction of measuring devices as another kind of influence causes non-physical water level data. Both actual and non-physical data need to be detected and classified consistently, and possibly corrected to enable the supply of adequate water level information. However, there is no automatically working detection algorithm yet. Only obvious or frequent technical malfunctions like gaps can be detected automatically but have to be corrected manually by trained staff. Consequently, there is no consistently defined data pre-processing before, for example, statistical analyses are performed or water level information for navigation is passed on.

In the research project DePArT*, we focus on detecting natural phenomena like standing waves, meteotsunamis, or inland flood events as well as anthropogenic artefacts like operating storm surge barriers and sluices in water level time series containing data every minute. Therefore, we train artificial neural networks (ANNs) using water level sequences of phenomena and artefacts as well as redundant data to recognize them in other data sets. We use convolutional neural networks (CNNs) as they already have been successfully conducted in, for example, object detection or speech and language processing (Gu et al., 2018). However, CNNs need to be trained with high numbers of sample sequences. Hence, as a next step the idea is to synthesize rarely observed phenomena and artefacts to gain enough training data. The trained CNNs can then be used to detect unnoticed phenomena and artefacts in past and recent time series. Depending on sequence characteristics and the results of synthesizing, we will possibly be able to detect certain events as they occur and therefore provide pre-checked water level information in real time.

In a later stage of this study, we will implement the developed algorithms in an operational test mode while cooperating closely with the officials to benefit from the mutual feedback. In this way, the study contributes to a future consistent pre-processing and helps to increase the quality of water level data. Moreover, the results are able to reduce uncertainties from the measuring process and improve further calculations based on these data.

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Gu, Wang, Kuen, Ma, Shahroudy, Shuai, Liu, Wang, Wang, Cai, Chen (2018): Recent advances in convolutional neural networks. In: Pattern Recognition, Vol. 77, Pages 354–377. https://doi.org/10.1016/j.patcog.2017.10.013