Machine Learning Workshop

Report of Abstracts

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Utilizing self-learning capability of a deep neural network and continuous monitoring of geostationary satellite to understand clouds structure and organization.

Content

The resolution of geostationary satellites is continuously improving, enabling new insights into clouds' complex structure and organization. High-resolution spatio-temporal structures of clouds are major challenges for numerical weather prediction. An important question is whether high-resolution models can realistically produce reality.

Our work aims to understand the structure and organization of cloud systems by exploiting the self-learning capability of a deep neural network and using high-resolution cloud optical depth images. The neural network utilizes deep clustering and non-parametric instance-level discrimination for decision-making at any learning stage. The data augmentation in the data pipeline, multi-clustering of the dense vectors, and Multilayer perceptron projection at the end of CNN help the network learn a better representation of images.

Unlike most studies, our neural network is trained over the central European domain, characterized by strong land surface type and topography variations. The satellite data is post-processed and retrieved at a higher spatio-temporal resolution(2 km,5 min), equivalent to the future Meteosat Third Generation satellite.

We show how recent advances in deep learning networks are used to understand the cloud's physical properties in temporal and spatial scales. We avoid the noise and bias from human labeling in a purely data-driven approach. We demonstrate explainable artificial intelligence (XAI), which helps gain trust for the neural network's performance. We visualize the cloud organization's different regions that correspond to any decision of interest by the neural network. We use K-nearest neighbors to find similar cloud structures at different time scales.

A thorough quantified evaluation is done on two spatial domains and two-pixel configurations (128x128,64x64). We examine the uncertainty associated with distinct machine-detected cloud-pattern categories using an independent hierarchal-agglomerative algorithm. Therefore the work also explores the uncertainties related to the automatic machine-detected patterns and how they vary with different cloud classification types.

Topic

Machine learning for feature detection and user applications

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