Categorization of Meteorological Data by Contrastive Clustering

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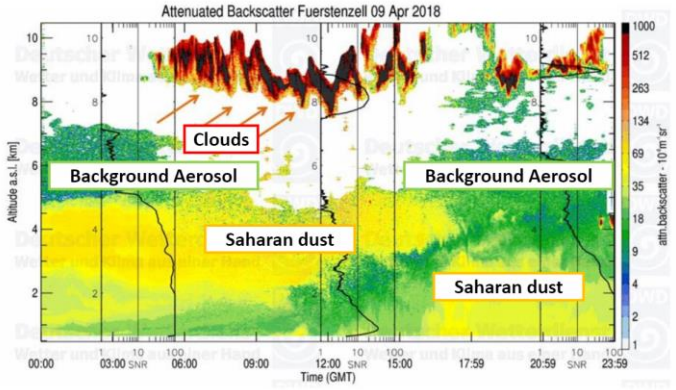
HAW HAMBURG

Deutscher Wetterdienst
Wetter und Klima aus einer Hand

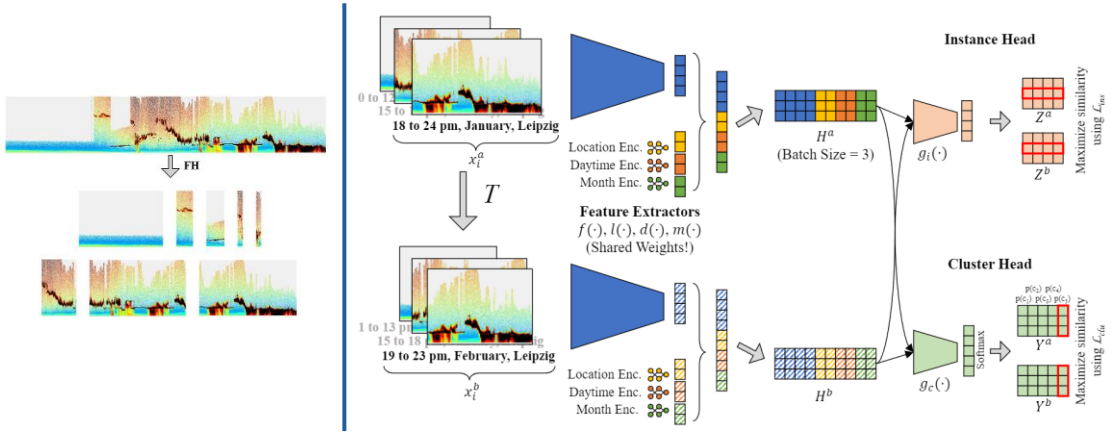
ICLR
Tackling Climate Change with Machine Learning

The Problem



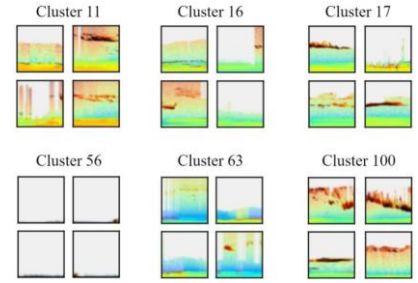
- The German Weather Service (DWD) maintains a large ceilometer network.
- Ceilometers are LIDAR systems (quasi-) continuously measuring atmospheric backscattering data (an example shown above).
- A range of meteorological phenomena can be identified in these measurements.
- However, the data is unlabeled and each profile has to be manually annotated by an expert.
- This work: apply ML to automatically annotate measurements

The Approach

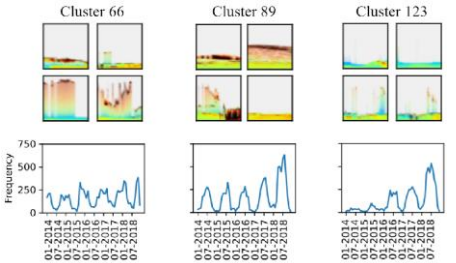


- First, we segment the profiles using the Felzenszwalb Huttenlocher algorithm. The segments are used to slice the original profiles (left).
- Then, we jointly learn representations and cluster assignments for these slices by applying the Contrastive Clustering framework by Li et al. to our use case.
- In addition to the image data, we also incorporate information about the location of the slice (ceilometer station) and when the slice took place (month and daytime)
- We introduce an augmentation regime adapted to the ceilometer use case to construct positive and negative pairs. Put simply, we use small perturbations of the daytime, month and location encoding (like deleting or adding one hour/month or slightly changing longitude/latitude)

The Results



Clusters specialize on certain phenomena
E.g.: 56: fog, 63: clear sky, 100: clouds



Clusters change frequency over time.
Detection of, e.g., heat wave patterns.
→ Climatic insights

Outlook:
Use clusters as labels for supervised model
Label correction GUI for meteor. experts

Literature:

- Michael Dammann, Ina Mattis, Michael Neitzke, and Ralf Möller. Towards the automatic analysis of ceilometer backscattering profiles using unsupervised learning. In NeurIPS 2022 Tackling Climate Change with Machine Learning, 2022.
- Werner Thomas, Harald Flentje, Ina Mattis, and Gerhard Müller. How ceilometers detect saharan dust events, May 2018. URL https://www.dwd.de/DWD/forschung/projekte/ceilomap/files/Saharan_dust_example_en.pdf.
- Yunfan Li, Peng Hu, Zitao Liu, Dezhong Peng, Joey Tianyi Zhou, and Xi Peng. Contrastive clustering. AAAI 2021.

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Full paper: