HAMLET How to Apply Machine Learning to Experimental & Theoretical PHYSICS

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ML in the Dating of Greenland Ice Cores: A GRU Method for Automated Annual Layer Identification

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Our understanding of past climate and the mechanisms that drive climate change can be improved through analysis of the excellent palaeoclimatic data available in the Greenland ice cores, but such insights depend on having an established chronology of the ice core. Therefore, the dating of ice cores is an essential part of palaeoclimatic science. However, this dating is often carried out by manual identification, which is both time-consuming and somewhat subjective.

A GRU Encoder-Decoder model for automatic annual layer identification is developed. The GRU provides a sigmoid output, which is then used to find annual layer positions with a peak detection algorithm. The method is applied to the ice cores NGRIP, GRIP and DYE-3 using the manually identified layer positions from GICC05 and GICC21 as targets in training. These annual layer positions, together with reference horizons from stratigraphic markers, are used for evaluating predictions from the model.

The developed GRU model is found to be able to match the GICC annual layer count for all three tested ice cores within a difference of 4.36%. Within the reference horizons used for GRIP and NGRIP, upwards of 78.9% of GRU counts either agree or are within a margin of ± 1 of the number of annual layers identified in GICC05. The proposed GRU model is useful for validating timescales, since dubious annual layers can be located by examining the difference between existing annual layer positions and the ones provided by the model.

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