

Machine learning: Satellite retrievals

Satellite observations are today essential for weather forecasting, air quality monitoring and climate studies. The satellites generate huge datasets, that must be treated in a efficient manner. The complexity of the analysis varies, but is in general a highly demanding task. The step of extracting geophysical data from a satellite observation is denoted as the retrieval. Traditional retrieval approaches have several limitations. They lead to a high computationally burden and statistical approximations are frequently required. In some cases, the physical mechanisms involved are too complex to simulate and the retrieval must be based on empirical data. Anyhow, the full potential of the satellite observations is today not reached due to limitations in the retrievals and more efficient approaches are required.

Machine learning techniques are highly interesting alternatives. They can both replace traditional methods and better handle retrievals based on empirical data. A training step is required, but the actual retrieval can be performed with a very small computational burden. We have been considering neural net retrievals for almost 20 years, but it is first now with modern machine learning methods that the interesting problems can be attacked.

A disadvantage of machine learning retrievals can be error estimation. The standard situation is that either no error at all or only a general, mean error is given. We have recently introduced a machine learning approach that solves this issue (Pfreundschuh et al., 2018). In short, the neural net is used in a Bayesian framework and is trained to provide the posterior distribution. This effectively gives a full description of the retrieval uncertainty for each individual retrieval. The aim of this project is to apply this machine learning approach on some new retrieval problem. There are many possibilities. The exact problem to consider is decided after discussion with the student. It can be selected to fit a particular interest of the student.

The project will give you experience of modern machine learning methods and tools. The specific approach to apply is not restricted to satellite retrievals, it should be of high interest for all applications where knowledge of uncertainties is required.

Prerequisites: Some knowledge in neural nets/machine learning, basic programming experience; background in physics or Earth science is beneficial

Contact: Patrick Eriksson, patrick.eriksson@chalmers.se

Reference: Pfreundschuh, Eriksson, Duncan, Rydberg, Håkansson and Thoss, A neural network approach to estimating a posteriori distributions of Bayesian retrieval problems, Atmospheric measurement techniques, 2018.