United States Department of the Interior

GEOLOGICAL SURVEY

U.S. GEOLOGICAL SURVEY
ASTROGEOLOGY SCIENCE CENTER
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To Whom it May Concern,

We are writing to certify that Christian Houmann, Ivik Hostrup, and Patrick Østergaard have made several meaningful contributions to the Python Hyperspectral Analysis Tool (PyHAT).

Their team met with us virtually, along with their advisor Dr. Jens Frydenvang, to discuss their results in duplicating state-of-the-art machine learning models that we have personally developed. Even without all of the workflows and scripts available to them, their team was able to achieve remarkable success. During this meeting, the students discussed many improvements on published methods that they personally developed or explored during their project. These contributions stand to make a sizeable impact on the field of chemometrics as applied to the ChemCam and SuperCam emission spectroscopy instruments on two active missions as part of NASA's Mars Exploration Program.

First, the team suggested the use of a Stacking Regressor to combine the results of several models into a final "meta model". This is an alternative to the relatively crude and labor-intensive "submodel blending" approach that was used for the current ChemCam calibration. The team also suggested the use of a power transform as a preprocessing step. Both suggestions have been implemented and are showing promising results.

They also directly contributed to the PyHAT repository in the form of commits and merge requests found at the link below. These important contributions include parallelizing and improving the ChemCam data reading functionality, developing an automated approach to a previously tedious manual outlier identification method, and adding a function that helps to interpret loadings from Independent Component Analysis.

See Merge Requests 8, 9, 10, and 11:
https://code.usgs.gov/astrogeology/pyhat/-/merge_requests

We thank Christian, Ivik, and Patrick for their valuable contributions. Please do not hesitate to contact us with any questions.

Sincerely,

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