Unsupervised Distribution Learning for Lunar Surface Technosignature Detection

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Abstract

In this work we show that modern data-driven machine learning techniques can be successfully applied on lunar surface remote sensing data to learn, in an unsupervised way, sufficiently good representations of the data distribution to enable lunar technosignature and anomaly detection. In particular we have trained an unsupervised distribution learning model to find the landing module of the Apollo 15 landing site in a testing dataset, with no specific model or hyperparameter tuning .

ML Assisted Search for Lunar Anomalies

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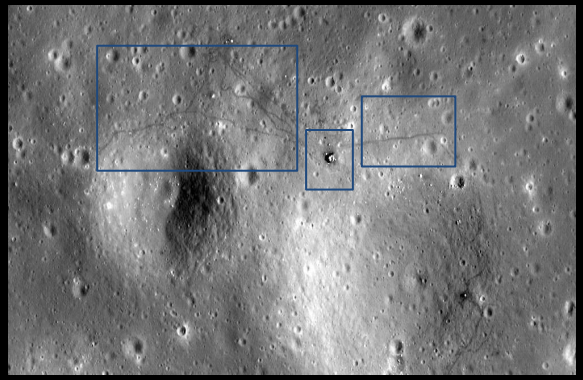
Idea:

train a **machine learning model on known technosignatures** on the Moon with the goal to search for other (non-) natural anomalies, using high-resolution imagery (LRO Narrow Angle Camera - NAC)



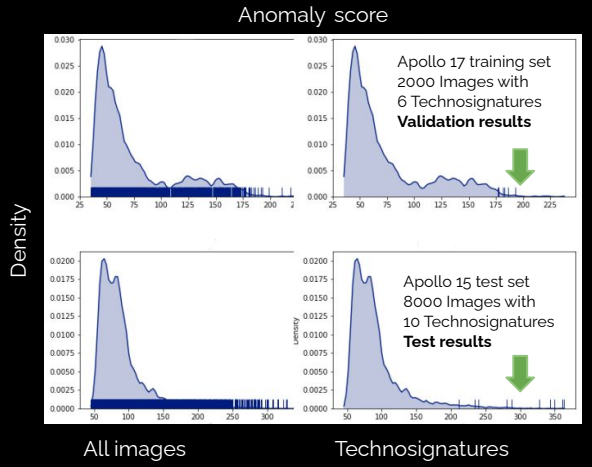
Apollo 12 Landing Site and Tracks **(NAC image)**

First results:

We trained a model on an Apollo 17 NAC data set, and then applied it to a Apollo 15 NAC test set.

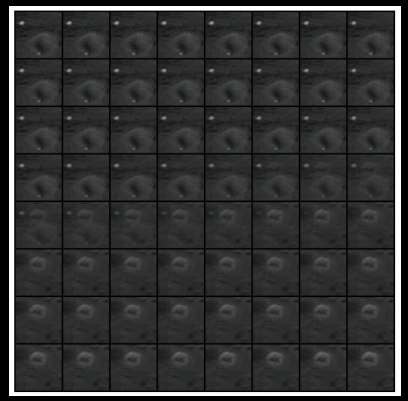
All technosignatures were identified with high anomaly scores.

Lesnikowski, Bickel & Angerhausen, NeurIPS, 2019



Methods:

besides providing **bulk data download APIs** for lunar data and **data augmentation methods** for this highly imbalanced dataset, we used *deep neural network* (DNN) and *variational autoencoder* (VAE) architectures



sample walk through the learned latent variable space

Conclusions and Next steps:

The prototype presented here scores in efficiency over manual vetting (EoMV) between 50 and 110, an **increase by orders of magnitude.** With the support of a *Google Cloud Platform Education Program Grant* our next steps will be:

(1) to **improve upon** the promising results of our early **prototype** and
(2) to extend our analysis to **the whole lunar surface** that has available NAC data