Martian signal automatic clustering and event's detection using SEIS data in continuous records with an unsupervised deep scattering network

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Abstract

InSight (Interior Exploration using Seismic Investigations, Geodesy, and Heat Transport) lander had successfully deployed onto Mars' surface the SEIS (Seismic Experiment for Internal Structure) instrument; a six-axes seismometer equipped with both a long-period three-axes, very Broad Band (VBB) instrument and a three-axes short-period (SP) instrument. These six sensors will cover a broad range of the seismic bandwidth, from 0.01 Hz to 50 Hz, with possible extension to longer periods. It's the first broad-band instrument monitoring Mars's seismic noise and activity in order to estimate the interior structure of Mars.

However, planetary seismology is still far from providing models with high precision due to the high sensitivity of the seismological features used in the inversion process. In fact, SEIS is a very sensitive instrument ; noise in an octave bandwidth around 1 Hz is expected to be in the range of 2–3 10^{-9} $\mathrm{m}/s^2/\ Hz^{\frac{1}{2}}$, thus, they may nevertheless be hidden into noise, or may escape from analysis due to the limitations imposed by the current methodologies.

Therefore, the aim of this study is to overcome this problem by well extracting, recognizing and classifying the SEIS signals using Deep Learning and Machine Learning strategies . In fact, this tool has recently proved to be powerful in signal processing, data automatic feature extraction and may even be helpful to detect new types of signals. Those new signals can reveal unknown processes and lead to new discoveries about Mars physical processes. The method used in this study is a new adapted version of the unsupervised representation learning approach for clustering and detection of seismic signals in earth continuous seismic records [2] It's inspired from the deep scattering network [1]. This technic is divided into two steps. The first one, to make an automatic feature extraction using the scattering transfrom network. The second step is to cluster them using the Gaussian Mixture Model. This technique was tested on the blind test data provided by the Marsquake Service (MQS) and by the Mars Structure Service (MSS). It is also used to analyze the first data recorded data by the co-located broadband and short period seismometers and has shown to be able to detect so many events that can be classified into an instrumental events (noise, glitch,...) and Nature events (Dust devils, seismic noise, seismic events,...)that is going to be discussed in detailed in this paper.

References

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