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Master Thesis Announcement

TLE data assessment using machine learning for the investigation of the thermosphere

In the recent days, the world's most valuable resource is no longer oil, but data. Experts claim that only in the last decade, we have generated more data than in the entire recorded history and hundreds of terabytes are created on a daily basis. However, to leverage this data and to find the signal in the noise is not an easy task.

In cooperation with the company Astos Solution GmbH, the Institute of Space Systems (IRS) has accumulated an extensive collection of TLE data (approx. 14. million entries ranging from 2009 - 2013), which can be expanded and supplemented as needed. This set of data has already been structured and analyzed in a bachelor thesis. A two-line element set (TLE) is a data format encoding a list of orbital elements of an Earth-orbiting object for a given point in time, the so called *epoch*. Using suitable prediction formula, the state (position and velocity) at any point in the past or future can be estimated to some accuracy. At this point, the question arises whether and if so how this data can be exploited to answer scientific research questions.

The sheer amount of data along with the complexity of the nature of their variations renders them impractical to be assessed with traditional methods. Thus, in this master thesis we will take a machine learning approach to extract meaningful but hidden trends and patterns by identifying the underlying correlations within the data set, e.g., using kernel principal component analysis (kernel PCA). To reduce computational complexity of the ML method, previously-known (and reliable) process or observation models could be used for bootstrapping. We will also compare our approach with state-of-the-art tools like those provided by IBM Watson as a part of the IBM academic initiative program. The key focus of the thesis is the assessment whether the data serves to allow to draw conclusions on the temporal and spatial evolution of the thermospheric properties as well as their influencing parameters (e.g. solar activity) and thereby to increase the understanding of the solar-terrestrial physics.

Task description of the Master thesis work:

- Familiarization with two-line element sets and the available data base (including a possible extension)
- Familiarization with the machine learning methods such as (kernel) PCA, self-organizing maps (SOM), deep clustering, etc. as well as the Watson tool from IBM
- Performing in-depth analysis of the available data
- Critical assessment of the results
- Documentation

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