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An introduction to JRA4 - Machine Learning in Europlanet-2024

Tarek Al-Ubaidi (1), Roman Kern (2), Michael Granitzer (3), Maxim Khodachenko (1), Jörn Helbert (9), Nick Cox (4), Jan Soucek (5), Sergio Fonte (6), Apostolos Christou (7) and Igor Alexeev (8)

(1) IWF-OeAW, Physik des Erdnahen Weltraums, Graz, Austria (tarek.al-ubaidi@oeaw.ac.at), (2) KNOW Center Graz, Austria (rkern@tugraz.at), (3) The University of Passau, Germany (michael.granitzer@uni-passau.de), (4) ACRI-ST, France (nick.cox@acri-st.fr), (5) Institute of Atmospheric Physics, Academy of Sciences of the Czech Republic, Prague (soucek@ufa.cas.cz), (6) The National Institute for Astrophysics, Rome, Italy (sergio.fonte@inaf.it), (7) Armagh Observatory and Planetarium, Ireland, (Apostolos.Christou@Armagh.ac.uk), (8) M.V. Lomonosov Moscow State University, Russia, Moscow (alexeev@dec1.sinp.msu.ru), (9) Deutsches Zentrum Für Luft - Und Raumfahrt EV (Joern.Helbert@dlr.de)

Abstract

The use of Artificial Intelligence (AI) and Machine Learning (ML) in particular to analyze and classify planetary datasets derived from space missions, observation campaigns and theoretical studies has been driven by major breakthroughs over the past decade in Machine Learning (ML) and Deep Learning (DL) in particular. Initially applied very successfully in tasks such as speech or text recognition, the potential applications of ML in general have exploded in recent years, however, the development of tools specifically designed for the field of planetary science is still in its early stages. The EPN-2024-RI ML JRA4 will develop a number of ML tools based on science cases submitted by the planetary science community that will form the basis for further developments.

1. Introduction

JRA4 will develop ML powered data analysis and exploitation tools for planetary science and provide expert knowledge with regard to ML to the community. The focus will be laid on time-based signal analysis and general classification systems, related to particular ML technologies. Dedicated tasks (Figure 1) will be targeting a set of representative scientific use cases i.e. science cases in order to define requirements and validate the developed tools, assuring their practical relevance and generality. About a dozen of proposals for specific applications of ML in planetary science were submitted by the scientific user community in the course of proposal preparation, of which a representative subset was selected. These science cases can be grouped under the following scientific topics: *magnetospheres, plasma environments and space weather*; *planetary and solar radio emissions*; *planetary surfaces / compositions / interiors*; *small bodies, asteroids & comets* and *Exoplanets* (analogous to topics addressed in *VESPA*). A review of all submitted proposals showed that all applications share three basic types of data: **time series** (i.e. records of physical quantities varying over time, see Figure 2), **images** (e.g. dynamical power spectra, geologic interior maps, surface images etc.) and **video data**. These data will be analysed by the ML tools, developed in accordance with respective research questions and goals addressed within these scientific use cases. Data processing and ML tools and solutions will be elaborated in the course of tasks dedicated to the software development effort. An API for integration will be available, depending on requirements and feasibility. Software developed in the course of JRA4 will be open source (*Apache License 2.0*), thoroughly documented and available via a *GIT* repository, hence all project results can be used freely, further developed and extended by the community.

2. Figures

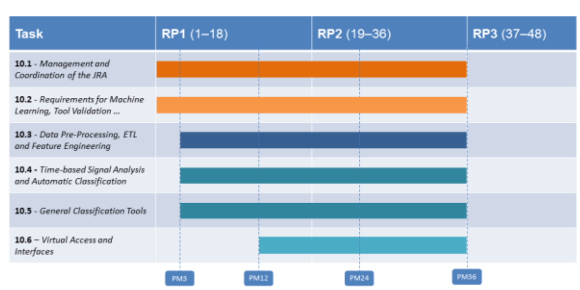

Figure 1: Overview of tasks planned for JRA4

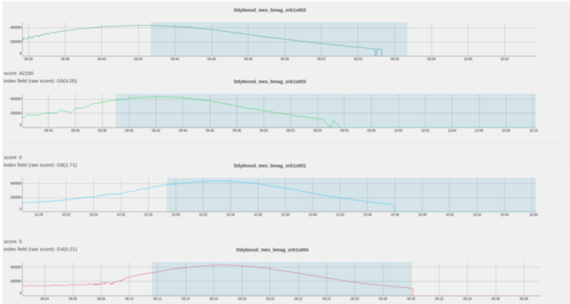

Figure 2: A screen shoot of a prototype of the planned tool for the content based search and automatic classification of time series data in planetary science.

3. Summary and Conclusions

Machine Learning is rapidly becoming a vital tool for data analysis and hence has great potential for applications in the course of scientific investigations in planetary science. A dedicated JRA will address a number of scientific challenges in planetary science that are expected to benefit significantly by the application of ML technologies with the aim of implementing a generic tool set, able to tackle a wide range of scientific problems with minimal customization effort. This presentation will give an overview of planned activities of EPN-2024-RI ML JRA4, its tasks and science cases and outline the main goals and envisioned ML tool development of the JRA.

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