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NAIF PDS4 Bundler: A Python package to generate SPICE PDS4 archives

Marc Costa Sitja[1]

1 Jet Propulsion Laboratory, California Institute of Technology, USA

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Software

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Summary

`naif-pds4-bundler` (NPB) is a Python package that enables SPICE kernels archive producers to get familiar with, design, and generate Planetary Data System (PDS) (Prockter et al., 2021) SPICE archives from end-to-end using the applicable PDS4 standards (NASA Planetary Data System, 2021).

A SPICE archive includes the complete set of SPICE data files (kernel files) for a given mission, which can be accessed using SPICE software. The SPICE data contain geometric and other ancillary information needed to recover the full value of science instrument data. In particular SPICE kernels provide spacecraft and planetary ephemerides, spacecraft and instrument orientation, instrument mounting alignments, data specifying target body size, shape and orientation, and data needed for relevant time conversions. Data in SPICE kernel files must be accessed using the software called the SPICE Toolkit produced and distributed by the Navigation and Ancillary Information Facility (NAIF) Node of the Planetary Data System (Acton, 1996; Acton et al., 2018).

NPB is an open source project led by the NAIF group at the Jet Propulsion Laboratory (JPL) with the support of the PDS Engineering Node (PDS-EN). NPB makes use of the SPICE Toolkit through the open source Python wrapper SpiceyPy (Annex et al., 2020). NPB is hosted at the NASA PDS GitHub repository and is easy to install since it is hosted in the Python Package Index and includes a number of ready-to-go examples that facilitate the task to set it up.

NPB also includes documentation that describes the process to prepare SPICE archives and describes the NAIF approach to using PDS4 standards in great detail. Adhering to this approach is critical to the current and future use of archived SPICE data, especially to achieve interoperability across national archives, and, to facilitate use of archived SPICE data in data search, retrieval and processing tools that are, or will be, part of archive systems.

The planetary data community and SPICE archive producers are encouraged to contribute to the project following the NASA PDS Code of Conduct. The expected forum to have discussions related to NPB is the OpenPlanetary community.

Statement of need

SPICE is widely used in the planetary data community and is the recommended ancillary data standard by the International Planetary Data Alliance (IPDA). Most planetary science space missions that generate a SPICE kernels archive; NPB is aimed to make things easier for those generating mission SPICE PDS4 archives.

NPB is used in the day-to-day archiving activities of NAIF and is used to generate all the PDS4 archives: LADEE (Costa-Sitja & Semenov, 2021), MAVEN (Semenov & Costa-Sitja, 2021b),

InSight (Semenov & Costa-Sitja, 2021a), OSIRIS-REx (Semenov & Costa-Sitja, 2021c), and Mars 2020 (Costa-Sitja, Semenov, et al., 2021).

Both the European Space Agency (ESA) SPICE Service (ESS) and the Japanese Space Exploration Agency (JAXA) Data Archives and Transmission System (DARTS) have started using it for their PDS4 SPICE Archives: ExoMars2016 (Costa-Sitja, Escalante, et al., 2021), BepiColombo (Escalante et al., 2021), Venus Climate Orbiter Akatsuki, and Hayabusa2.

In the future, in addition to supporting NASA's, ESA's and JAXA's SPICE PDS4 archives, NPB could also help the rising community of science small satellites and commercial science payloads that could greatly benefit from such a package to reduce the effort spent on generating SPICE PDS4 archives.

State of the field

Understanding and generating the PDS4 artifacts required by PDS4 archives is a challenging endeavor. Because of this PDS is making an effort to generate and gather training material and to provide a number of tools to assist archive producers. NPB is part of this effort and benefits from NAIF's terse usage of the PDS4 standards and enables archive producers to generate a PDS archive from end-to-end with minimal effort.

Different nodes of the PDS offer a number of tools adequate for the data archived in their holdings. PDS-EN provides the Metadata Injector for PDS Labels (NASA Planetary Data System, 2010); a command-line interface for generating PDS4 Labels using a user provided PDS4 XML template and input (source) data products. The PDS Geosciences Node provides MakeLabels a program that generates PDS4 labels using a label template and one or two Excel spreadsheets. The PDS Small Bodies Node (SBN) also provides a suite of tools to assist the label generation. In addition SBN provides an end-to-end web-based tool to generate PDS4 archives, but it only supports Images (FITS and 2-D arrays) and tables.

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