

GalaxAI: Machine Learning for Spacecraft Operations

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Mars Express (MEX) is a spacecraft operated by the European Space Agency (ESA) and orbiting Mars since the beginning of 2004. It has provided a wealth of scientific data such as evidence of the presence of water on and below the surface of the planet, three-dimensional renders of the surface, as well as data about the chemical composition of the Martian atmosphere. The instruments and on-board equipment are kept within their operating temperature ranges by an autonomous thermal control system composed of 33 heater lines. The thermal system consumes a significant amount of the total available electric power, leaving only a fraction to be used for science operations.

Within the project GalaxAI, we use state-of-the-art explainable machine learning methods for structured output prediction to address the challenge of optimal use of the available energy. We construct accurate models of the MEX's thermal power consumption under a variety of operating conditions, such as gyro-less flying and limited data availability. Besides good predictive performance, these methods also facilitate explainability and understanding of the provided estimates. The predictions and the explanations are visualized through a specialized dashboard, facilitating the user interaction with the learned models, and allowing for planning further operations of the spacecraft by the mission planning and operations team.