Surrogate models for space trajectory problems

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ASTRIUM Space Transportation is involved in the FDMU (Functional digital mockup) development project which is an innovative and revolutionary concept that aims at introducing multidiscipline collaboration in engineering processes, with improved engineering loops during preliminary project phases, and with support of Dassault Systems (ISIGHT software technologies).
The global objectives of FDMU project are to fixe and size architectures of future launchers, and for a fix architecture, build fast surrogate models for different physics and disciplines launchers : trajectory, propulsion first, then structures and CFD. The different displines for a given set of launcher concepts are explored by the discipline expert using their own tools encapsulated in a workflow manager. Then using these results a surrogate model of each discipline is built. The Final goal is to use these fast surrogate models to find a global optimal concept in these studied configuration set using the quick prediction capabilities of the surrogate models with all disciplines interacting.
The topic of this paper is to present some results obtained in the framework of this project using surrogate models in dynamic trajectory problems.
The results to be reported have been obtained with the software tool box MACROS developed by DATADVANCE, LLC. The tool box includes Approximation package providing various tools for construction, evaluation and analysis of approximations and interpolations. These tools feature a wide range of well-known approximation methods (Splines, Linear Regression, Kriging, etc.), original methods developed by DATADVANCE (e.g., HDA - Higher Dimensional Approximation), and many algorithmic and conceptual innovations making work with approximations efficient and convenient: automatic choice of the approximation type based on data properties, flexible support for accelerated training, smoothing, efficient handling of large datasets and large numbers of response components, etc.
The particular test case analyzed with MACROS was a dynamic trajectory problem involving multiple parameters of a trajectory depending on time and several independent variables. The initial dataset included tens of thousands of measurements of hundreds of response variables performed at hundreds of irregularly placed time instances.
Using MACROS, several surrogate models have been successfully constructed for the whole set of response parameters, integrating all the available, highly anisotropic data. The models have been analyzed and compared with each other. In particular, the accuracy of the models of the type that was automatically chosen using built-in heuristics were shown to be quite good for continuous response components.