OpenMDAO

An open-source, high-performance computing platform for systems analysis and multidisciplinary optimization

OpenMDAO, an open-source framework developed in the Python programming language, was developed at NASA's Glenn Research Center to solve large-scale design optimizations for the study of unconventional aerospace concepts. OpenMDAO dramatically simplifies and accelerates the algorithms and techniques used in multidisciplinary analysis and optimization (MDAO) tools, providing accurate and reliable results. OpenMDAO has been designed to handle variable problem formulations, encourage reconfiguration, and promote model reuse by supporting the exchange of information between multiple analysis codes at multiple levels of fidelity to create models of complex systems. The code supports the application of state-of-the-art MDAO algorithms designed to solve highly coupled problems that arise when multiple analysis tools are combined. This includes support for analytical derivatives, which is key for facilitating efficient numerical optimization.

BENEFITS

- Library of Built-in Solvers and Optimizers
- Tools for Meta-Modeling
- Data Recording Capabilities
- Support for Analytic Derivatives
- Support for High-Performance Compute Clusters and Distributed Computing
- Extensible Plugin Library
THE TECHNOLOGY

OpenMDAO is released under the Apache V. 2.0 license, a very permissive license that places few restrictions on use of OpenMDAO. This license allows proprietary software to be integrated without needing to be open source itself. OpenMDAO provides access to more than 15 different kinds of solvers and optimizers. In addition, it provides a set of tools for working with design of experiments (DOE) tools. OpenMDAO provides a custom class that allows users to integrate the training and execution of meta-models for arbitrary analysis components directly into their processes. MDAO can produce a tremendous amount of data through many hundreds or even thousands of analysis executions over the course of an optimization. OpenMDAO can record those data in a number of different formats, including SQLite database, flat file (a.k.a., comma-separated values), or human-readable text stream. The software provides direct support for components to declare their derivatives and the framework will automatically make use of them. If they are not available, OpenMDAO will revert to using a finite-differencing method. The transition between the two methods is seamless and invisible to the user. OpenMDAO supports distributed computing by automatically submitting compute jobs to remote clusters using message passing interface (MPI). The MPI-based implementation runs in parallel on a multi-core processor and high performance computing (HPC) environments.

APPLICATIONS

The technology has several potential applications:

- Cubesat design and mission planning
- Wind turbine design and wind farm layout
- Hybrid electric propulsion conceptual analysis
- Boundary layer ingestion modeling
- Optimization of aircraft trajectories

PUBLICATIONS

This software is available via Open Source release at:

https://software.nasa.gov/software/LEW-18550-1

For more information on this and other NASA Glenn software, please contact the Glenn Software Release Team at:
grc-sra-team@mail.nasa.gov