Using surrogate models to speed up the creation of aerodynamic databases in CEASIOMpy

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July 23, 2020

Abstract

Aircraft design is a long process which requires a lot of knowledge and computational tools in many different disciplines. Machine learning techniques are increasingly used in the field of aircraft design to speed up the design process. Surrogate modeling is one of the most commonly used methods, being particularly useful to interpolate data which have never been calculated before. In aircraft design, the creation of aerodynamic databases is generally the most computationally expensive discipline and various techniques including surrogate modeling are developed to reduce these costs [1].

With the help of the OpenMDAO [2] and SMT [3] libraries, we have integrated surrogate modeling in CEASIOMpy. First, a few high fidelity Euler calculation are performed for different flight state parameters (angle of attack, Mach number and altitudes), the results are then used to train a surrogate model, which can then be used to generate a more complete aerodynamics database or replace costly aerodynamic calculations in an optimisation workflow.

CEASIOMpy [4] is an open source conceptual aircraft design software written in Python and using the CPACS [5] standard, an XML data definition for aircraft. CEASIOMpy includes modules which cover several of the main aircraft design disciplines. These modules can be connected and executed in an order defined by the user depending on his needs. CEASIOMpy includes aircraft geometry CAD [6], Weight & Balance estimation, aerodynamics (Vortex Lattice Methods [7] and SU2 [8]) and stability analysis modules. The aerodynamic modules of CEASIOMpy are being used and further developed in the framework of the H2020 project AGILE4.0 [9] in collaboration with other European partners in order to run Multidisciplinary Design Analysis and Optimization (MDAO) on aircraft design cases.

In this paper we will describe the different parameters that are used to create and employ surrogate models efficiently in CEASIOMpy. Accuracy testing will be performed on different test cases. We will also evaluate the possibility to add geometric parameters (such as wing span, fuselage length, etc.) in a surrogate model to make it suitable for a real optimisation workflow.

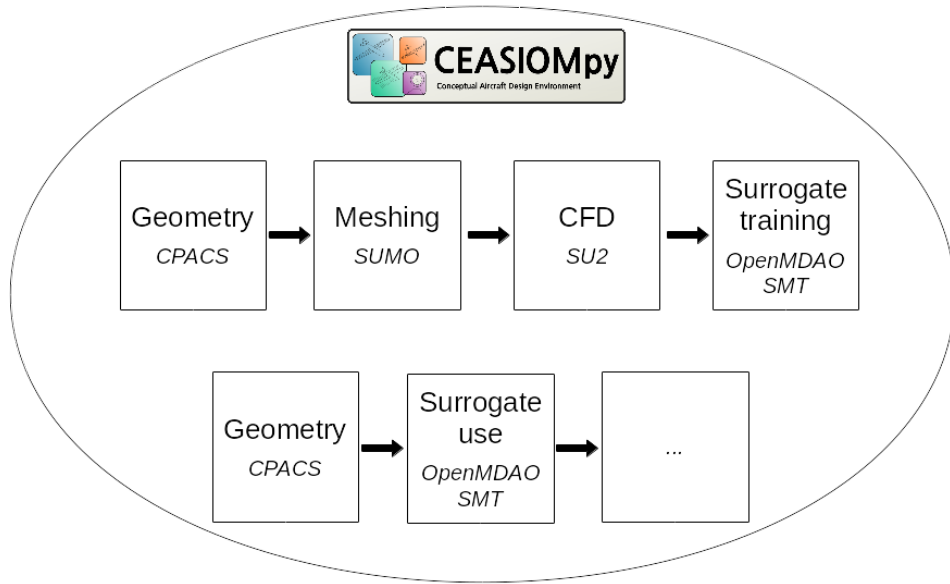***Keywords:*** aircraft design, aerodynamics, surrogate model

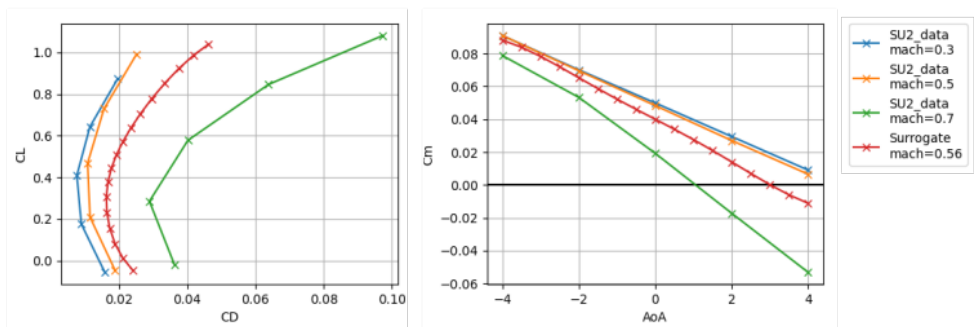Figure 1: CEASIOMpy workflow to create and use surrogate models

Figure 2: Example of usage of surrogate model with aerodynamic coefficients

Acknowledgement

References

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