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Application of a deep neural network for Cp prediction on multiple wing geometries in a transonic regime

Authors

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Abstract

Data driven methods for shape optimization in the aerospace industry has become a widely field for the possibility to reduce cost in the process. This optimization typically involves treating huge amount of data that comes from a space based on different flight conditions or geometrical configurations made from computational fluid dynamics (CFDs) simulations. Given the amount of variability of parameters employed, more parameters means different pressure distributions, which difficult the optimization process. For that, machine learning in combination with reduced-order modes (ROMs) can help such procedure [1].
Surrogate-based modeling approaches have been applied to aerodynamic data recently. Among all of them, artificial neural networks have emerged as an alternative to model data and extract the nonlinear features of it, using a multi-layer perceptron architecture (MLP) [2] to predict aerodynamics coefficients or a conditional variational autoencoder (CVAE) [3] to improve the shape optimization process. Regarding reduced-order models in aerodynamic data, if applied to high-fidelity flow physics [4], the proper orthogonal decomposition (POD) can be use, however, in cases where nonlinearity arises, other methods as Isomap [5], grants the possibility to find the intrinsic features of the data.
This paper describes an incremental prediction assessment, using a ROM+DNN architecture, on geometrical configurations and flight conditions. Through this process, we will analyze the prediction error after adding for each iteration, new predictors while exploring the optimal solution. This is perform using a CFD database of the XRF1 3D model in the transonic regime, that contains the flight condition parameters Mach number and the angle of attack, and the geometrical parameters delta sweep, span ratio, thickness ratio, aileron deflection and outer/inner aileron position. The work presented here has been performed in the frame of the GARTEUR AD/AG60 European research project [6].

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