6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Symbolic Regression of Algebraic Stress-Strain Relation for RANS Turbulence Closure

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Keywords: *Turbulence Modelling, RANS, Explicit Algebraic Reynolds-stress Models, Deterministic Symbolic Regression, Regularised Least-Square Regression, Machine Learning*

The workhorse in industry to solve the closure problem of the Reynolds-averaged Navier-Stokes (RANS) equations is still the linear eddy-viscosity (LEV) hypothesis and corresponding transport models. The lower computational costs compared to high-fidelity approaches, e.g. large-eddy simulation, come at the price of low predictive performance for flows with separation, adverse pressure gradients or high streamline curvature. Explicit Algebraic Reynolds-Stress Models (EARSM) were introduced to lift the predictive fidelity of RANS at similar costs as LEV. Commonly, EARSM are derived by projecting a Reynolds-stress model (RSM) onto a polynomial tensor basis with the intention that the resulting model inherits a part of the predictive fidelity of the underlying RSM. Recently, an approach has been proposed to use genetic-programming based symbolic regression to derive algebraic models directly from data to reduce the effect of modelling assumptions [1]. In this work we present recent advancements in utilising deterministic symbolic regression to infer algebraic models with sparsity-promoting regression techniques. The goal is to build a functional expression from a set of candidate functions in order to represent the target data most accurately [2]. Targets are the coefficients of the polynomial tensor basis, which are identified from high-fidelity data using regularised least-square regression. A model will be inferred for the flow over periodic hills at $Re = 10595$ and its predictive performance will be assessed.

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