Discovering New Constitutive Models for Soft Materials by Symbolic Regression

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Abstract

Soft materials can undergo large deformations, demonstrate not only elastic but also inelastic and often anisotropic response, which makes their constitutive modeling very challenging. Traditionally, it was mostly driven by expert knowledge whereas attention was focused in particular to elastomers, soft biological tissues and fabrics. Symbolic regression represents an interesting method of machine learning which allows an unbiased automatized generation of constitutive models for such materials. In comparison to other data-driven methods symbolic regression reproduces a mathematical expression of a strain energy, damage or other desired function which can be analyzed, interpreted und easily implemented into a finite element code. In this contribution, we present some applications of symbolic regression demonstrating how effective it can be for example in modeling elastic and inelastic response of elastomers. The proposed procedure also grants new insights into many established and well-known material models.

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