Hetero-EUCLID: Simultaneously segmenting and discovering hyperelastic constitutive models of all components of a heterogeneous hyperelastic material using EUCLID.

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Abstract

In this work we build upon the Bayesian-EUCLID* framework to simultaneously segment, and characterize the full hyperelastic behavior of all constituents of a heterogeneous material. To achieve this, we make use of experimentally observable 3D surface displacements and boundary force data obtained from the finite element simulation of the biaxial tension test on the heterogenous sample. We make use of the derivatives of the strain-invariant field, as opposed to the invariants themselves, to segment the material with high-fidelity. The segmented material is then analyzed by an improved form of the EUCLID framework to simultaneously discover the material models of all constituent materials. We are able to achieve the segmentation and characterization of the material with data from a single experiment, thereby highlighting the ability of the hetero-EUCLID framework to be deployed in high-throughput characterization of heterogeneous elastic/hyperelastic materials. These settings include rapid characterization of composites and rapid characterization of selective tissue stiffening in medical conditions such as fibroatheroma/atherosclerosis or cancer. *Bayesian-EUCLID: Discovering hyperelastic material laws with uncertainties (https://doi.org/10.1016/j.cma.2022.115225)

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