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INTEGRATING DATA AND MODELS IN CARDIOVASCULAR BIOMECHANICS

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ABSTRACT

Cardiovascular biomechanics increasingly relies on the integration of mechanistic models with heterogeneous sources of experimental, imaging, and clinical data. This interplay is crucial to better characterize cardiovascular tissues, identify subject-specific properties, improve model predictions, and ultimately bridge fundamental biomechanical understanding with clinically relevant applications.

Advances in data-driven methodologies, machine learning, inverse methods, and reduced-order modeling are providing new ways to extract information from data and incorporate it into biomechanical models. Rather than replacing physics-based descriptions, these approaches can complement established modeling frameworks by supporting parameter identification, constitutive characterization, model personalization, uncertainty quantification, and efficient prediction. At the same time, their integration raises important methodological questions concerning physical consistency, interpretability, generalization, and the effective combination of data with prior mechanical knowledge.

This Invited Session aims to bring together researchers working at the interface between cardiovascular biomechanics, data integration, and hybrid modeling methodologies. The session will provide a forum to discuss recent developments and emerging approaches for combining data and models across different cardiovascular applications and spatial and temporal scales.

Topics of interest include data-informed and machine-learning-enhanced biomechanical modeling, integration of experimental, imaging, and clinical data, inverse problems and parameter identification, constitutive modeling and tissue characterization, patient-specific modeling, surrogate and reduced-order models, uncertainty quantification, multiphysics approaches, and predictive modeling of cardiovascular function, adaptation, and disease.

The session seeks to foster interactions between established biomechanical modeling approaches and emerging data-centered methodologies, highlighting their current capabilities as well as the challenges toward more reliable, interpretable, and predictive models in cardiovascular biomechanics.