Data-driven material modeling for soft biological tissues

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Abstract: The traditional approach to describing the deformation of a material body involves creating constitutive equations that relate strains and stresses. However, it can be challenging to develop appropriate functional relationships and identify material parameters. In this talk, we will discuss Constitutive Artificial Neural Networks (CANNs), a machine learning approach to data-driven constitutive modeling. CANNs combine the benefits of both theory- and data-driven approaches and do not require significant prior assumptions about the constitutive law. They can learn the constitutive law of a material from relatively small amounts of stress-strain data and predict that of new materials by incorporating non-mechanical data. CANNs are ideal for computational biomechanics, such as predicting the nonlinear macroscopic mechanical properties of arterial and brain tissue. Additionally, our machine learning architecture enables automatic, unbiased quantification of the importance of different microstructural features for macroscopic mechanical properties.