A multiscale model of material failure and its applications to soft tissue tearing

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Abstract:
Modelling material failure is an open problem in continuum mechanics, with many modelling techniques filling the panorama of damage mechanics. Our research has focused on creating a model that can account for how microscopic changes effect the macroscopic process of material failure. To that end, we have developed a novel multiscale model of the damage phase field method. This was achieved via new analytical methods introduced for the upscaling of the damage phase field. We also introduced new numerical methods for solving a damage phase field model. As a result, we have a rigorous multiscale model of material damage, which can be employed to study a myriad of physical phenomenon. Including processes such as plasticity, cyclic damaging or sudden material failure. This work of course has many applications in the realm of material science, but we are more interested in clinical applications.

Our long-term goal is to apply our modelling methods to biological phenomena of soft tissue tearing. Namely, diseases such as aortic dissections and ACL ruptures. By applying a multiscale model of these diseases, we may potentially understand what microscopic changes in the body are making people more susceptible to these diseases. The clinical applications of these models would include predicting the occurrence of soft tissue tearing and preventing it, or a better understanding of the long-term effects of treatment. This would allow clinicians to make more informed decisions, leading to better patient outcomes.