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# Hyperelastics.jl: A Julia package for hyperelastic material modelling

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## Summary

The modelling of hyperelastic materials is of paramount importance for research areas including: soft robotics, cancer screening, and automobile tire modelling. The challenge in hyperelastic material modelling arises from the variety of material models available for predicting the stress-stretch behavior of the material. Commonly, the strain energy density (SED) function (SEDF) is used to predict the energy stored in the material. Derivatives of the SEDF provide measures for the stress-stretch relationship. The further challenge arises as the derivatives are often hand-derived and implemented in a finite element method software. The problem of hyperelastic material moodelling requires a high-performance set of SEDFs and the tools required to calibrate the models to material tests. `Hyperelastics.jl` is a Julia (Bezanson et al., 2017) package containing 70+ analytical SEDF along with 3 data-driven methods for predicting the force-deformation behavior.

## Statement of need

`Hyperelastics.jl` is part of the Multi-Scale Material Modelling ($M^3$) Suite being developed in the Translational Robotics and Controls Engineering Research (TRACER) Lab at Liberty University. A pure Julia implementation allows for the use of automatic differentiation (AD) packages to calculate the partial derivatives of the SEDF. `Hyperelastics.jl` is designed to leverage multiple-dispatch to define a common set of functions for calculating the SED, Second Piola Kirchoff Stress Tensor, and the Cauchy Stress Tensor. The package provides: 1) a material model library that is AD compatible and 2) a set of extensible methods for easily defining and testing new material models.

## Functionality

The most basic definition in `Hyperelastics.jl` is the SEDF. The material +

## Mathematics

Single dollars ($) are required for inline mathematics e.g. $f(x) = e^{\pi/x}$

Double dollars make self-standing equations:

$$\Theta(x) = \begin{cases} 0 \text{ if } x < 0 \\ 1 \text{ else} \end{cases}$$

You can also use plain LaTeXfor equations

$$\hat{f}(\omega) = \int_{-\infty}^{\infty} f(x) e^{i\omega x} dx \tag{1}$$

and refer to Equation 1 from text.

## Citations

Citations to entries in paper.bib should be in rMarkdown format.

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## Acknowledgements

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## References

Example paper.bib file:

Bezanson, J., Edelman, A., Karpinski, S., & Shah, V. B. (2017). Julia: A fresh approach to numerical computing. *SIAM Review*, *59*(1), 65–98. https://doi.org/10.1137/141000671