Vahidullah Tac

Data-driven computational mechanics

Mechanics & Mechanobiology Lab, Purdue University

765 532 2780
tacvahid@gmail.com
www.tajtac.com
github.com/tajtac
linkedin.com/in/tajtac

Summary: Senior PhD student working on data-driven modeling of soft materials. I specialize in combining physics and machine learning, imposing hard constraints on machine learning methods, uncertainty quantification with Bayesian Neural Networks and developing strategies for training neural networks with reduced data.

Education

PhD — 2021 - now
Purdue University, West Lafayette, IN
Mechanical Engineering
Dissertation title: Data-driven modeling of biological materials

MSc — 2016 - 2019
Middle East Technical University, Ankara, Turkey
Aerospace Engineering
Thesis title: Micromechanical modeling of carbon nanotube – polymer composites

BSc — 2012 - 2016
Middle East Technical University, Ankara, Turkey
Aerospace Engineering

Experience

Purdue University — 2021 - now
Research Assistant

- Developed a model of hyperelastic material behavior based on feed-forward neural networks in Python/TensorFlow.
- Used special properties of Neural ODEs to develop a model of hyperelasticity where physics-based constraints are satisfied a priori using Python/JAX. Using this approach, I was able to circumvent a large number of unnecessary floating-point operations performed for evaluating a complicated loss function otherwise.
- Developed the first physics-informed data-driven model of viscoelasticity in the world. The project uses Neural ODEs to model viscoelasticity in such a way that the relevant physical laws are satisfied automatically.
- Currently working on a hierarchical Bayesian model of hyperelasticity using Bayesian Neural Networks (BNNs) in Python/Numpyro. The model can characterize the uncertainty in training data and transfer knowledge from the population data to an unknown individual.

Turkish Aerospace — 2018 - 2021
Structural Design Engineer

- Designed various spacecraft parts such as structural panels, inserts and brackets. Spearheaded the development of the first structural panel with embedded active cooling in TAI.

TUBITAK Space Technologies Research Institute — 2017 - 2018
Research Engineer

- Developed two engineering software packages for 1) conceptual aircraft design and 2) prediction of failure modes of composite materials using Visual Basic

and MATLAB. The packages received praise for being user friendly and responsive.

Publications

[6] **V. Tac**, M. K. Rausch, F. S. Costabal and A. B. Tepole, "*Data-driven anisotropic finite viscoelasticity using neural ordinary differential equations*," in review at *Computer Methods in Applied Mechanics and Engineering*, 2023.

[5] **V. Tac**, K. Linka, F. S. Costabal, E. Kuhl and A. B. Tepole, "*Benchmarks for physics-informed data-driven hyperelasticity,"* in review at *Computational Mechanics*, 2023.

[4] **V. Tac**, F. S. Costabal, and A. B. Tepole, "*Data-driven tissue mechanics with polyconvex neural ordinary differential equations*," *Computer Methods in Applied Mechanics and Engineering*, 2022.

[3] **V. Tac**, V. D. Sree, M. K. Rausch, and A. B. Tepole, "*Data-driven modeling of the mechanical behavior of anisotropic soft biological tissue*," *Engineering with Computers*, 2022.

[2] Y. Leng, **V. Tac**, S. Calve, and A. B. Tepole, "*Predicting the mechanical properties of biopolymer gels using neural networks trained on discrete fiber network data*," *Computer Methods in Applied Mechanics and Engineering*, 2021.

[1] **V. Tac**, and E. Gürses, "*Micromechanical modelling of carbon nanotube reinforced composite materials with a functionally graded interphase*," *Journal of Composite Materials*, 2019.

Awards & Honours

- **Robert J. Melosh Medal** for best student paper in computational solid mechanics and a $500 honorarium, Duke University, 2022
- **Ward A. Lambert Graduate Fellowship**, $27,000, Purdue University, 2022
- **TUBITAK Publication Award**, 900 Turkish Liras (~$150), 2020
- **Ben M. Hillberry Graduate Scholarship**, $3600, Purdue University, 2022
- **3rd Place,** Individual Aircraft Design Competition 2015-16, $300, American Institute of Aeronautics and Astronautics (AIAA).
- **1st Place,** METU Engineering Day 2016 Poster Competition
- **Full scholarship** from the Ministry of Higher Education of Afghanistan for undergraduate studies in Turkey, covering all expenses.

Skills

- **Python** (Proficient in **Jax** and familiar with **TensorFlow** and **PyTorch)**
- **Machine learning** (Extensive experience with **Neural ODEs**)
- **FORTRAN**
- **Finite Element Method**
- Familiarity with a variety of tools and languages such as **Julia, Visual Basic, MATLAB, C, HTML, Javascript, PHP,** **LaTeX** and others.