Tengfei Xu

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A researcher with a solid computational physics background, strong research interests, and a broad research perspective. Seeking full-time internship opportunities and doctoral positions in fields of AI4science.

EDUCATION

MS in Computational Mechanics,
State Key Laboratory of Structural Analysis, Optimization and CAE Software for Industrial Equipment, Dalian University of Technology (DLUT) (Expected Graduation: 06/2025)   09/2022-Current

BS in Engineering Mechanics (Qian Lingxi Excellence in Education Program),
Dalian University of Technology   Average Score: 87.8/100   09/2018-06/2022

Core Courses: Linear Algebra | Tensor Analysis | Functional Analysis | Mathematical physics | Mechanical Behavior of Materials | Elasticity | Elastoplasticity | Vibrations and Waves | Fluid Mechanics | Numerical Methods for Partial Differential Equations | Finite element methods | Structural Topology Optimization |

PUBLICATIONS & PATENTS

- **Tengfei Xu**, Dachuan Liu, Peng Hao, Bo Wang. "Variational Operator Learning: A Unified Paradigm Marrying Training Neural Operators and Solving Partial Differential Equations." Accepted by Journal of the Mechanics and Physics of Solids (Top Journal in Solid Mechanics).

- **Tengfei Xu**, Peng Hao, Dachuan Liu. " 基于变分原理的面向神经算子训练与偏微分方程组求解的统一方法、介质及产品" [Unified Method for Neural Operator Training and Partial Differential Equation Set Solving Based on Variational Principle, Medium and Product]. Chinese Patent Application No. CN 116468104 A, China National Intellectual Property Administration, filed on 2023.03.30.

- Dachuan Liu, Peng Hao, **Tengfei Xu**, Yingjie Zhu, Xuanxiu Liu, Bo Wang, Gang Li. "Intelligent Optimization of Stiffener Unit Cell via Variational Autoencoder-Based Feature Extraction." Published on Structural and Multidisciplinary Optimization (Top Journal in Structural Optimization, JCR-Q1 Journal).

RESEARCH EXPERIENCE

A Domain Knowledge Embedding Framework of Operator Learning and Brain-Inspired Computing
Supervised by Prof. Peng Hao of Department of Engineering Mechanics of DLUT   07/2022-Current

- Proposed variational operator learning (VOL), a unified paradigm for learning neural operators and solving partial differential equations; introduced Ritz and Galerkin approaches specifically tailored for the VOL framework, achieving the approximation of energy functional and calculation of residual in a matrix-free manner, with linear time complexity and constant ($O(1)$) space complexity

- Introduced direct minimization and iterative update as two optimization strategies into the framework of VOL to minimize the residual norm; integrated the steepest decent method (SD) and conjugate gradient method (CG) into VOL with an efficient restart-update manner for iterative update strategy

- Investigated VOL with various experimental results; conducted scaling experiments, resolution experiments, comparative experiments verifying generalization benefits of VOL, comparative experiments for different optimization strategies, and comparative experiments between VOL and existing physics-informed operator learning approaches in literature

- Current Undertaking: Design brain-inspired algorithms to handle PDE problems, especially PDEs of complex geometries and dynamic systems; To achieve this, I'm designing novel graph neural networks to adopt neural ansatz on unstructured mesh, following early work on graph-based simulation by deepmind etc.

Variational Autoencoder Design and Implementation for Image-Driven Intelligent Structural Design
Supervised by Prof. Peng Hao of Department of Engineering Mechanics of DLUT   06/2021-06/2022

- Conducted literature search and implement various variations VAEs, including vanilla VAEs, VAE with convolution architectures, VAE with ResNet shortcuts, etc.; trained them on the stiffener unit cell database, and record related numerical experimental results

- Implemented the idea of VAE-GAN, using an additional discriminator loss to improve the quality of stiffener unit cell designs generated by neural networks; organized numerical results and plot illustrations of neural architectures

- My VAE-GAN implementation was adopted in an intelligent optimization framework for grid-stiffened structures. In three typical numerical examples, compared with conventional stiffener unit cell designs, the obtained optimal designs were improved by 25.61%, 25.88%, and 10.66%, respectively

- Coauthored in the related published paper "Intelligent optimization of stiffener unit cell via variational autoencoder-based feature extraction" (See "Publications" section)

"Master of Structural Computation" APP Design

Supervised by Prof. Jun Yan of Department of Engineering Mechanics of DLUT $\qquad$ 01/2021-07/2021

- Studied the basics of structural mechanics, including displacement methods of bar system structures, stiffness matrix methods of bar system structures, direct stiffness methods, etc.
- Led "Master of Structural Computation" APP project. "Master of Structural Computation" can handle displacement calculation of bars and beams, and visualize nodal displacements on Android mobile devices
- "Master of Structural Computation" APP has been granted a computer software copyright registration certificate

The Seventh National Youth Science Popularization Innovation Experiment and Work Competition

Supervised by Prof. Dixiong Yang of Department of Engineering Mechanics of DLUT $\qquad$ 01/2021-05/2021

- Led the design and implementation of the "YiFen" APP, an Android-based solution for the real-time garbage image classification
- Utilized transfer learning techniques, employing the VGG backbone pre-trained on ImageNet; fine-tuned the fully-connected layers with garbage classification datasets to enhance model performance; deployed the trained deep learning model on mobile devices
- The fine-tuned model achieves 96.7% accuracy on garbage classification datasets
- Won the 1st Prize of Creative Work Unit - Intelligent Control Proposition (University Group)

2020 Liaoning Provincial Undergraduate Mathematical Modeling Competition

Supervised by Prof. Qiuhui Pan of School of Innovation and Entrepreneurship of DLUT $\qquad$ 11/2020-12/2020

- Developed a metacellular automata model to analyze the impact of the proportion of self-driving vehicles on traffic efficiency in single-lane, two-lane, and two-way four-lane traffic network models under different maximum road speed limits
- Established a NaSch model dividing the studied road into one-dimensional cells and related evolution rules to update the speeds and positions of the vehicles; Introduced stochastic slowing to represent the difference between automatic and non-automatic driving, the rule of lane-changing to stipulate the probability of lane-changing under specific circumstances
- Simulated specific highways with Python to obtain the spatio-temporal map, traffic density map and traffic efficiency-autonomous driving ratio map under the given parameters; concluded that the proportion of automated driving has a significant impact on the traffic efficiency under different maximum speeds and the two have a positive linear correlation
- Won the 1st Prize of 2020 Liaoning Provincial Undergraduate Mathematical Modeling Competition

2020 National Undergraduate Mathematical Modeling Competition

Supervised by Prof. Qiuhui Pan of School of Innovation and Entrepreneurship of DLUT $\qquad$ 06/2020-09/2020

- Established a multi-objective control model for solder reflow oven temperature profile based on genetic algorithm
- Analyzed the mathematical relationship between the temperature of the circuit board and the set temperature as well as the process speed of the solder reflow oven; established the circuit board temperature change model and the mechanism model of reasonable process speed; utilized the genetic algorithm to minimize the integral of the furnace temperature profile with respect to time above the hazardous temperature; developed a multi-objective planning model to achieve the optimal temperature profile
- Won the 2nd Prize of 2020 National Undergraduate Mathematical Modeling Competition (Liaoning Region)

BLOGS AND CHANNELS

My Bilibili Channel: https://space.bilibili.com/86610525/ $\qquad$ 01/2022-Current

- Shared some basic domain knowledge in my major, such as robotics, mechanics of composite materials and shells.
- Shared popular algorithms, such as PINNs, FNOs, DeepONets
- Shared my opinions on Arts and Artists in the era of AI.
- More to come...
- By the time this CV was penned, the total views of my channel has exceeded 40k, with over 400 likes and 350 fans.

My CSDN Blog: https://xutengfei.blog.csdn.net/ $\qquad$ 12/2018-Current

- Shared my technical notes and debugging experiences here, and also some paper reading notes.
- By the time this CV was penned, the total views of my blog has exceeded 570k, with over 550 fans, 250 likes and 580 collections.

SKILLS

- Programming: C/C++ (proficient), Fortran (proficient), Python (proficient), CUDA (functional), CMake (functional), Matlab (proficient), Git (proficient), Bash (functional), LaTeX (proficient), Java (functional)
- Deep learning Software: PyTorch (proficient), Jax (proficient), Flax (proficient), Tensorflow (proficient), Docker (functional), OpenCV (proficient), DeepXDE (proficient)
- Computational Physics Software: ABAQUS (professional), COMSOL (professional), Rhinoceros 3D (professional) Solidworks (professional), Fenics (professional), G+Smo (beginner)

Scholarships and Awards

The First-Class Graduate Scholarship,
Dalian University of Technology Education Development Foundation
2022-2025

Chiang Chen Scholarship (The First-Class Scholarship),
Chiang Chen Industrial Charity Foundation
2022

Qian Lingxi Mechanics Scholarship,
Dalian University of Technology Education Development Foundation
2019