Zhen Zhang

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Skills

- Machine learning: PyTorch, JAX, Tensorflow, Pandas, Scikit-learn, XGBoost.
- Programming: Python, SQL, MATLAB, Linux command, LaTeX.
- Math: Probability & statistics, Linear algebra, Optimization.

Education

- **Brown University** — Sep 2018 – Dec 2023 (Expected)
  Ph.D. in Applied Mathematics; Advisor: Prof. George Em Karniadakis — *GPA: 4.00/4.00*
- **City University of Hong Kong** — Sep 2014 – Jun 2018
  Major in Computing Mathematics; Advisor: Prof. Ding-Xuan Zhou; Minor in CS — *GPA: 4.08/4.30*

Scholarships and Awards

Fellowship for graduate students, Division of Applied Mathematics, Brown University — Sep 2018
HKSAR government scholarship (top 2% in university), HKSAR — Sep 2016, Sep 2017

Experiences

- **Quantitative research** — Citadel Securities
  Incoming internship — *Jun 2023 - Aug 2023*
  - Equities high frequency trading.
- **Graduate research work** — Brown University
  Supervisor: Dr. George Em Karniadakis — *Sep 2019 - now*
  - Conduct research on structure-preserving neural networks utilizing prior physical knowledges. Responsible for the idea formulation, proof of universal approximation theorems and simulations (using PyTorch). My researches are summarized in this page. Get 193 citations and an h-index of 6.
  - Develop symplectic neural networks (SympNets) for the prediction of time series which exhibit conservative properties. The prediction MSE is decreased by **90%** over the SOTA method Hamiltonian neural network on the three-body benchmark task. Apply SympNet to accelerate the process molecule dynamics simulation of water while conserving total energy / temperature. The running time per calculation step is reduced by **20%** compared to production-level MD software on large-scale simulations.
  - Apply SympNets to the simultaneous optimal path planning problem of **256** agents (continuous in space). Adapt the neighbor list algorithm to reduce the training time from **90** minutes to less than **10** minutes. Conduct uncertainty quantification analysis on the trajectories of drones assuming linear dynamics.
  - Develop Poisson neural networks as a generalization of SympNet, which allows training data to be written in arbitrary coordinates. Establish universal approximation theorems and propose the prediction of a nonlinear Schrödinger equation as a new benchmark.
  - Develop GENERIC formalism informed neural networks for the prediction of deterministic and stochastic time series which exhibit dissipative properties. Strictly encode the first and second law of thermodynamics and fluctuation-dissipation relationship into the architecture of neural network.
- **Research internship** — UTK/ORNL
  Supervisor: Dr. Kwai Wong, Dr. Cheng Liu, Dr. Lonnie Crosby — *May 2016 - Aug 2016*
  - Propose a parallel version of a dasymetric mapping algorithm in GIS and implemented it in MPI. The new method can incoporate multi-scale demographic datasets and improve running efficiency. The overall running speed is increased by **15** times when 16 processes are utilized.

Publications

* *indicates equal contribution or alphabetical order.*

Journals:

1. **Zhen Zhang**, Yeonjong Shin and George Em Karniadakis. GFINNs: GENERIC Formalism Informed Neural Networks for Deterministic and Stochastic Dynamical Systems. Philos. Trans. R. Soc. A, 2022.
2. Pengzhan Jin, **Zhen Zhang**, Yannis Kevrekidis and George Em Karniadakis. Learning Poisson systems and trajectories of autonomous systems via Poisson neural networks. *IEEE Transactions on Neural Networks and Learning Systems*, 2022.
3. Ehsan Kharazmi, Min Cai, Xiaoning Zheng, **Zhen Zhang**, Guang Lin and George Em Karniadakis. Identifiability and predictability of integer- and fractional-order epidemiological models using physics-informed neural networks. *Nature Computational Science*, 2021.
4. Sheng Zhang*, Joan Ponce*, **Zhen Zhang***, Guang Lin and George, Karniadakis. An integrated framework for building trustworthy data-driven epidemiological models: Application to the COVID-19 outbreak in New York City. *PLOS Comput Biol* 17(9), 2021.
5. Pengzhan Jin*, **Zhen Zhang***, Aiqing Zhu, Yifa Tang and George Em Karniadakis. SympNets: Intrinsic structure-preserving symplectic networks for identifying Hamiltonian systems. *Neural Networks* 132, p. 166-179, 2020.
6. Tingwei Meng*, **Zhen Zhang***, Jerome Darbon and George Em Karniadakis. SympOCnet: Solving optimal control problems with applications to high-dimensional multi-agent path planning problems. (Accepted by SIAM Journal on Scientific Computing.)

In preparation:

1. **Zhen Zhang**, Yeonjong Shin, George Em Karniadakis. Symplectic graph networks for particle simulations.
2. **Zhen Zhang**, Tingwei Meng, Zongren Zou, Jerome Darbon, George Em Karniadakis. Time dependent SympOCNet for optimal control problems with linear dynamics.

Book chapters:

1. Mitchell Daneker, **Zhen Zhang**, George Em Karniadakis, Lu Lu. Systems Biology: Identifiability analysis and parameter identification via systems-biology informed neural networks. (Under review, invited by book series *Methods in Molecular Biology.*)

Invited talks & conferences

- **AAAI Spring Symposium on Computational Approaches to Scientific Discovery** — San Francisco, USA
  Structure preserving neural networks and applications to optimal control problems — *Mar 2023*
- **SIAM Conference on Computational Science and Engineering (CSE23)** — Amsterdam, Netherlands
  Structure preserving neural networks for identifying and solving dynamical systems — *Feb 2023*
- **AMS Sectional Meeting** — Amherst, USA
  Structure preserving neural networks and their applications to optimal control problems — *Oct 2022*
- **SIAM Conference on Mathematics of Data Science (MDS22)** — San Diego, USA
  SympOCNet: Solving optimal control problems with applications to multi-agent path planning problems — *Sep 2022*
- **NUMDIFF-16** — Halle, Germany
  SympNet & PNN: structure-preserving networks for identifying Hamiltonian & Poisson systems. — *Sep 2021*

Other Services

- Reviewer: *JCP, CMAME, IEEE TNNLS, IEEE WCCI*
- Teaching assistant: APMA 1170, Brown University: Introduction to Computational Linear Algebra (Fall 2019)
  APMA 1660, Brown University: Statistical Inference II (Spring 2020)