Yixuan's research was motivated by modeling, analyzing, and simulating challenging problems with multiscale and singularity governed by physical equations. In his first year, they developed for the first time a state-of-the-art multiscale framework ExpMsFEM with theoretical guarantee of exponential scaling laws of accuracy for heterogenous elliptic and Helmholtz equations. Yixuan's later research was motivated by the Clay prize problem, singularity of Navier-Stokes equations in fluids. They studied a 1D modified model to understand the singularity phenomena. To mathematically establish singularity, they generalized the dynamic rescaling technique and established singularity of nonlinear heat and complex Ginzburg-Landau equations for the first time without spectral information, opening up the possibility of studying singularities beyond the self-similar assumption with computer-assisted proofs. One can first numerically search for a plausible candidate and upgrade the approximate profile to a rigorous proof via computer-assisted estimates. In the future they will study both challenging problems using this framework with computer-assisted proofs, and tackle open questions with more sophisticated type of singularities.

To model and simulate singularity, one could also resort to machine learning tools besides traditional numerical methods. With collaborators, Yixuan built upon the neural operator framework and constructed Fourier neural operators that can tackle non-periodic problems using Fourier continuation, and with symmetries encoded to boost the performance. Very recently, they proposed the KAN architecture for machine learning. Leveraging the Kolmogorov-Arnold representation theorem using a composition of sum of 1D functions to represent higher dimensional functions and generalizing into the perspective of modern machine learning, they proposed KANs with learnable activation functions between each neural pairs parameterized by splines. Compared with the prevalent multilayer perceptrons (MLPs), KANs are demonstrated to have much better scaling laws and interpretability via a much smaller network in many scientific problems, including function regression and PDE solving tasks. KANs also have nice theoretical properties like being universal approximators and suffer less from the spectral bias phenomenon. KANs have generated great interest and reached more than 200 citations within 5 months of arxiv release. They will continue to explore the applicability of KANs to larger scale problems, many of which have already been established by peers and domain experts, and further understanding of the mathematical properties of KANs.

# Yixuan Wang (Roy)

roywang@caltech.edu | (1) 6264609554
Applied and Comput. Math., Caltech, Pasadena, CA 91125


## EDUCATION BACKGROUND

**Peking University**
B.S., School of Mathematics, Peking University, Beijing, China 2016—2020
Elite Undergraduate Training Program in Applied Math and in Pure Math, Excellent Graduate
Overall GPA: **3.84**/4, Rank: **7**/200, Major GPA: **3.91**/4, GRE (**166+170+4.5**), TOEFL (**112**)
Graduation Date: 2020.07 **Summa Cum Laude** in Beijing

Summer Intern at **Caltech** on multiscale problems, supervised by Prof. Thomas Hou 2019

**California Institute of Technology**
Graduate Student, Applied + Computational Mathematics, supervised by Prof. Thomas Hou 2020—
Department of Computing + Mathematical Sciences, Caltech, Pasadena, California

## PROFESSIONAL EXPERIENCE

**Janestreet**
Quant Trader Intern, Hong Kong 2020.6—2020.9

## PUBLICATIONS

- R. Li, Y. Wang and **Y. Wang**. Approximation to Singular Quadratic Collision Model in Fokker-Planck-Landau Equation, SIAM Journal on Scientific Computing, 42(3), 2020, pp. B792-B815.
- Y. Chen, T.Y. Hou and **Y. Wang**. Exponential Convergence for Multiscale Linear Elliptic PDEs via Adaptive Edge Basis Functions, Multiscale Modeling and Simulation, 19(2), 2021, pp. 980–1010.
- Z. Liu, S. Qian, **Y. Wang,** Y. Yan and T Yang. Schrödinger Principal-component Analysis: On the Duality between Principal-component Analysis and the Schrödinger Equation, Physics Review E, 104(2), 2021, 025307.
- Y. Chen, T.Y. Hou and **Y. Wang**. Exponentially Convergent Multiscale Methods for 2D High Frequency Heterogeneous Helmholtz Equations, Multiscale Modeling and Simulation, 21(3), 2023, pp. 849–883.
- Z. Liu, A. Stuart and **Y. Wang**. (2022) Second Order Ensemble Langevin Method for Sampling and Inverse Problems.
- H. Maust, Z. Li, **Y. Wang**, D. Leibovici, O. Bruno, T.Y. Hou and A. Anandkumar. Fourier Continuation for Exact Derivative Computation in Physics-Informed Neural Operators, NeurIPS 2022, 3rd AI for Science workshop.
- Y. Chen, T.Y. Hou and **Y. Wang**. Exponentially Convergent Multiscale Finite Element Method, Communications on Applied Mathematics and Computation, 6(2), 2024, 862-878.
- T.Y. Hou and **Y. Wang**. Blowup Analysis for a Quasi-exact 1D Model of 3D Euler and Navier-Stokes, Nonlinearity, 37(3), 2024, 035001.
- T.Y. Hou, V.T. Nguyen and **Y. Wang**. (2024) L^2-based Stability of Blowup with Log Correction for Semilinear Heat Equation.
- Z. Liu, **Y. Wang**, S. Vaidya, F. Ruehle, J. Halverson, M. Soljacic, T.Y. Hou and M. Tegmark. (2024) KAN: Kolmogorov-Arnold Networks.
- J. Chen, T.Y. Hou, V.T. Nguyen and **Y. Wang.** (2024) On the stability of blowup solutions to the complex Ginzburg-Landau equation in R^d.
- Z. Liu, P. Ma, **Y. Wang**, W. Matusik and M. Tegmark. (2024) KAN 2.0: Kolmogorov-Arnold Networks Meet Science.
- **Y. Wang,** J.W. Siegel, Z. Liu and T.Y. Hou. (2024) On the expressiveness and spectral bias of KANs.

## SELECTED INVITED TALKS

- Ensemble Hamiltonian Monte Carlo, EnKF workshop, Balestrand, Norway, May. 2022
- ExpMsFEM, Numerical Analysis seminar, University of Hong Kong, Sep. 2022
- Blowup for a quasi-exact 1D model of 3D Euler, Workshop on Fluids, Duke University, May. 2023
- ExpMsFEM, Minisymposium on rough PDEs, ICIAM at Waseda University, Tokyo, Japan, Aug. 2023
- ExpMsFEM, Siam Chapter, Ohio State University, Nov. 2023

- KAN, Math seminar, National University of Singapore, Aug. 2024
- Stable type-I blowup by local normalization conditions: NLH and CGL, Math seminar, NUS, Aug. 2024
- KAN, Machine learning seminar, Peking University, Sep. 2024
- Stable type-I blowup by local normalization conditions: NLH and CGL, Math seminar, PKU, Sep. 2024
- KAN, Math seminar, Shanghai Jiaotong University, Sep. 2024
- KAN, Applied Math seminar, UCLA, Sep. 2024
- KAN, Mathematics, Information and Computation (MIC) seminar, Courant Institute, NYU, Nov. 2024
- Stable type-I blowup by local normalization conditions: NLH and CGL, Math seminar, Duke, Nov. 2024
- KAN, Applied Math seminar, University of Hong Kong, Nov. 2024

## MATHEMATICAL ENGAGEMENT

- Founding President of the SIAM Student Chapter at Caltech 2021-2023
- Member of DEI committee at Caltech

## TEACHING EXPERIENCE

- ACM 106a (Numerical linear algebra) 22/23/24 Fall
- ACM 106b (Numerical analysis) 23/24 Winter
- ACM 107a (Linear analysis) 21 Fall
- ACM 107b (Real and functional analysis) 22 Winter
- ACM 127 (Calculus of variations) 22 Spring
- ACM 180a (Multiscale modeling) 23 Spring
- ACM 270 (Machine learning for inverse problems and data assimilation) 24 Spring

## AWARDS AND HONORS

- Silver Award at 56th International Mathematical Olympiad, 2016
- All Three 2nd Places in Analysis, Applied Math, and Overall Individual Competitions, S.-T. Yau College Mathematics Contests, 2019
- 1st Place in Team Competition, S.-T. Yau College Mathematics Contests, 2019
- 1st Prize in National University Math Competition, 2017
- 1st Prize in National University Math Modeling Competition, 2017
- 1st Place in Citadel Datathon, China, 2018
- National Scholarship, 2018, 2019
- Representative of PKU for National Scholarship, 2019
- PKU Person of the Year, 2019
- PKU May 4th-Award, 2020