Juncai He: Curriculum Vitae

Applied Mathematics and Computational Sciences
The King Abdullah University of Science and Technology
Thuwal 23955-6900, Saudi Arabia

Phone: +966 56-376-8805
Email: juncai.he@kaust.edu.sa
Homepage: https://juncaihe.github.io/

Research Interest

- Machine Learning, Deep Learning, Stochastic Optimization.
- Numerical Analysis, Finite Element Methods, Multigrid Methods.

Academic Experience

- **Research Scientist** July 2022 - present
  Applied Mathematics and Computational Sciences, KAUST, Saudi Arabia
- **R.H. Bing Instructor Fellow** August 2020 - July 2022
  Department of Mathematics, The University of Texas at Austin, Austin, TX, USA
- **Postdoctoral Scholar** August 2019 - July 2020
  Department of Mathematics, The Pennsylvania State University, University Park, PA, USA

Education

- **Ph.D.**, Computational Mathematics, Peking University, 2014-2019
  Advisors: Prof. Jinchao Xu and Prof. Jun Hu
  Thesis: Finite Element Methods and Deep Neural Networks
- **Visiting Ph.D. Research Scholar**, Center for Computational Mathematics and Application, Department of Mathematics, The Pennsylvania State University, Feb. 2016 - Jul. 2016, Oct. 2017 - Mar. 2018 and Mar. 2019 - May 2019
- **B.S.**, Mathematics and Applied Mathematics, Sichuan University, 2010-2014

Honor and awards

- 2020-2022, R. H. Bing Fellowship, UT Austin.
- 2016-2019, The Elite Program of Computational and Applied Mathematics for PHD Candidates of Peking University
- 2017-2019, Ph.D. President Scholarship, Peking University
- 2015, Graduate academic scholarship, Peking University
- 2014, First Prize, Outstanding undergraduate thesis, Sichuan University
- 2011-2014, Excellent undergraduate student scholarship, Sichuan University

The Workshops/ Minisymposium Organized

- KAUST Research Conference on Scientific Computing and Machine Learning (Organizing Committee), November 14-18, 2022, KAUST, KSA.
- Minisymposium on "Multigrid and Multilayer Methods" (Co-organizer with Prof. Jinchao Xu and Dr. Xinliang Liu) in International Multigrid Conference , August 22-26, 2022, Lugano, Switzerland
- Workshop on Mathematical Machine Learning and Application (Organizing Committee), December 14-16, 2020, Penn State University, USA
- Minisymposium on "Multigrid and Machine Learning" (Co-organizer with Prof. Zuowei Shen and Prof. Jinchao Xu) in International Multigrid Conference , August 11-16, 2019, Kunming, China
- 4th PKU Workshop on Numerical Methods for PDEs (Organizing Committee), October 30-31, 2018, Peking University, China
- The First PKU Elite PHD Candidates Workshop on Computational Mathematics and 4th Beijing Graduate Students Workshop on Computational Mathematics (Chair of the Organizing Committee), September 9-12, 2018, Peking University, China

Presentations

- CMAI: Artificial Intelligence Colloquium Series, August 4th, The Chinese Hong Kong University, 2023.
- SIAM Conference on Computational Science and Engineering (CSE23), February 26 - March 23, Amsterdam, Netherlands, 2023.
- KAUST Research Conference on Scientific Computing and Machine Learning, November 14-18, KAUST, KSA, 2022.
- International Multigrid Conference (IMG2022), August 22-26, University of Lugano, Lugano, Switzerland, 2022.
- Applied and Computational Mathematics Seminar, UC Irvine, Irvine (Online), USA, Jan. 2022.
- The Finite Element Circus Fall 2021, Penn State University, University Park, USA, Nov. 2021.
- IMA Workshop on Mathematical Foundation and Applications of Deep Learning, Purdue University, West Lafayette (Online), USA, Aug. 2021.
- The First Young Scholar Forum, Peking University Chongqing Research Institute of Big Data, Chongqing (Online, invited talk), China, Jul. 2021.
- Workshop on Mathematical Machine Learning and Application, Penn State University, University Park (Online, invited talk), USA, Dec. 2020.
- Workshop on Computation and Applications of PDEs Based on Machine Learning, Jilin University, Changchun (Online, invited talk), China, Jul. 2020.
- Data Science Seminar, Shanghai Jiao Tong University, Shanghai (Online), China, Mar. 2020.
- "Advances in Multilevel Methods: from PDEs to Data Intensive Studies" and "Multigrid and Machine Learning", Minisymposiums in International Multigrid Conference, Kunming, China, Aug. 2019.

- 16th Annual Meeting of the China Society for Industrial and Applied Mathematics, Chengdu, China, Sept. 2018.
- The First PKU Elite PHD Candidates Workshop on Computational Mathematics and 4th Beijing Graduate Students Workshop on Computational Mathematics, Peking University, Beijing, China, Sept. 2018.
- Workshop on Numerical Methods for PDEs, Peking University, Beijing, China, Jul. 2017.

Skills

- **Languages**: Chinese, English
- **Programming**: Latex, C, Matlab, MPI, Python, Pytorch

Teaching Experience

- Instructor, M 408N Differential Calculus, UT Austin, Jan. 18 - May. 6 2022.
- Instructor, M 408K Differential Calculus, UT Austin, Aug. 25 - Dec. 10 2021.
- Instructor, M 408N Differential Calculus, UT Austin, Jan. 19 - May 7 2021.
- Instructor, M 408K Differential Calculus, UT Austin, Aug. 26 - Dec. 18 2020.
- Teaching Assistant, Deep Learning Algorithms and Analysis, Penn State University, May - Jun., 2020.
- Teaching Assistant, An Introduction to Deep Learning, Penn State Education Abroad Summer Course, Jul. 6-27, 2019.
- Teaching Assistant, An Introduction for Applied Mathematics, Peking University, Feb. - Jun. 2017.
- Senior Teaching Assistant, Advanced Linear Algebra I, Peking University, Sept. 2016 - Jan. 2017.
- Senior Teaching Assistant, Calculus, Peking University, Sept. 2015 - Jan. 2016.

Publications

1. J. Zhu, H. Huang, Z. Lin, J. Liang, Z. Tang, K. Almubarak, M. Alharthi, B. An, **J. He**, X. Wu, F. Yu, J. Chen, Z. Ma, Y. Du, Y. Hu, H. Zhang, E. Alghamdi, L. Zhang, R. Sun, H. Li, J. Xu, B. Wang. Second Language (Arabic) Acquisition of LLMs via Progressive Vocabulary Expansion. Submitted Conference On Language Modeling (COLM) 2024.
2. **J. He** L. Liu and R. Tsai. Data-induced Multiscale Losses and Efficient Multirate Gradient Descent Schemes. ArXiv:2402.03021, 2024.
3. **J. He**, T. Mao and J. Xu. Expressivity and Approximation Properties of Deep Neural Networks with ReLU^k Activation. ArXiv:2312.16483, 2023.
4. **J. He** and J. Xu. Deep Neural Networks and Finite Elements of Any Order on Arbitrary Dimensions. ArXiv:2312.14276, 2023.
5. **J. He**. On the Optimal Expressive Power of ReLU DNNs and Its Application in Approximation with Kolmogorov Superposition Theorem. ArXiv:2308.05509, 2023.

6. Y. Yang and **J. He**: Deeper or Wider: A Perspective from Optimal Generalization Error with Sobolev Loss. Accepted for ICML 2024, ArXiv:2402.00152 , 2024.

7. H. Huang, F. Yu, J. Zhu, X. Sun, H. Cheng, D. Song, Z. Chen, M. Alharthi, B. An, **J. He**, Z. Liu, Z. Zhang, J. Chen, J. Li, B. Wang, L. Zhang, R. Sun, X. Wan, H. Li, J. Xu. AceGPT, Localizing Large Language Models in Arabic. Accepted for *NAACL 2024*. ArXiv:2309.12053 , 2024.

8. **J. He**, X. Liu and J. Xu. MgNO: Efficient Parameterization of Linear Operators via Multigrid. Accepted for *ICLR 2024*, ArXiv:2310.19809, ResearchGate, 2024.

9. L. Liu, **J. He** and R. Tsai. Linear Regression on Manifold Structured Data: The Impact of Extrinsic Geometry on Solutions. *Topological, Algebraic and Geometric Learning Workshops at ICML2023*. PMLR 221:557-576, [Published PDF] 2023. [ArXiv:2307.02478].

10. J. Zhu, **J. He** and Q. Huang. An Enhanced V-cycle MgNet Model for Operator Learning in Numerical Partial Differential Equations. *Computational Geosciences* 2023. https://doi.org/10.1007/s10596-023-10211-8 [ArXiv:2302.00938].

11. J. Zhu, **J. He**, L. Zhang and J. Xu. FV-MgNet: Fully Connected V-cycle MgNet for Interpretable Time Series Forecasting. *Journal of Computational Science*. 69: 102005, 2023. https:doi.org10.1016j.jocs.2023.102005 [ArXiv:2302.00962].

12. **J. He**, J. Xu, L. Zhang and J. Zhu. An Interpretive Constrained Linear Model for ResNet and MgNet. *Neural Networks*. 162: 384-392, 2023. https://doi.org/10.1016/j.neunet.2023.03.011 [ArXiv:2112.07441]

13. **J. He**, R. Tsai and R. Ward. Side Effects of Learning from Low-dimensional Data Embedded in a Euclidean Space. *Research in the Mathematical Sciences*. 10(13), 2023. https:doi.org10.1007s40687-023-00378-y. [ArXiv:2203.00614]

14. **J. He**, L. Li and J. Xu. ReLU Deep Neural Networks from the Perspective of Hierarchical Basis. *Computers & Mathematics with Applications*. 120: 105-114, 2022. https:doi.org10.1016j.camwa.2022.06.006 [ArXiv:2105.04156].

15. **J. He**, L. Li and J. Xu. Approximation Properties of Deep ReLU CNNs. *Research in the Mathematical Sciences.* 9(38), 2022. https:doi.org10.1007s40687-022-00336-0. [ArXiv:2109.00190].

16. Q. Chen, W. Hao and **J. He**. Power Series Expansion Neural Network. *Journal of Computational Science*. 59, 2022. https:doi.org10.1016j.jocs.2021.101552. [ArXiv:2102.13221].

17. Q. Chen, W. Hao and **J. He**. A Weight Initialization Based on the Linear Product Structure for Neural Networks. *Applied Mathematics and Computation*. 415, 2022. https://doi.org/10.1016/j.amc.2021.126722 [ArXiv: 2109.00125].

18. **J. He**, X. Jia, J. Xu, L. Zhang and L. Zhao. Make ℓ_1 Regularization Effective in Training Sparse CNN. *Computational Optimization and Applications*. 77: 163–182, 2020. https://doi.org/10.1007/s10589-020-00202-1

19. **J. He**, L. Li, J. Xu, and C. Zheng. ReLU Deep Neural Networks and Linear Finite Elements. *Journal of Computational Mathematics*. 38(3): 502–527, 2020. doi:10.4208/jcm.1810-m2018-0096. [**ESI Highly Cited Paper in Mathematics (November/December 2022)**],[**Google Scholar Citation: 300+**].

20. **J. He**, K. Hu and J. Xu. Generalized Gaffney Inequality and Discrete Compactness for Discrete Differential Forms. *Numerische Mathematik*. 143, 781–795, 2019 . https://doi.org/10.1007/s00211-019-01076-0.

21. **J. He** and J. Xu. MgNet: A Unified Framework of Multigrid and Convolutional Neural Network. *Science China Mathematics*. 62(7): 1331–1354, 2019. https://doi.org/10.1007/s11425-019-9547-2. [**Google Scholar Citation: 120+**].

In Preparation

1. **J. He**, X. Liu and J. Xu. MgNet2.0: A New Convolution Mechanism for Learning Preconditioner for Elliptic PDEs. 2024.

Last updated: May 12, 2024