

Shijun ZHANG

Assistant Professor

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| ORCID: URL | Google Scholar: URL |
| Articles on arXiv: URL | Address: Department of Applied Mathematics The Hong Kong Polytechnic University |

Appointments

Assistant Professor (Tenure-Track),
The Hong Kong Polytechnic University (PolyU), Hong Kong SAR, China Jul 2024 ~ Present

Phillip Griffiths Assistant Research Professor,
Duke University, United States Aug 2022 ~ Jun 2024
Mentors: **Jianfeng Lu** and **Hongkai Zhao**

Research Fellow, National University of Singapore, Singapore Jan 2021 ~ Jul 2022
Mentor: **Zuowei Shen**

Education

Ph.D. in Mathematics, National University of Singapore, Singapore Aug 2016 ~ Jan 2021
Thesis: *Deep neural network approximation via function compositions* [URL]
Supervisors: **Zuowei Shen** and **Haizhao Yang**

B.S. in Mathematics, Wuhan University, China Sep 2012 ~ Jun 2016
Thesis supervisor: **Xiliang Lv**

Teaching

Mathematical Numerical Analysis (Math 361S), Duke University
Instructor, Syllabus Spring 2024

Matrices and Vectors (Math 218D-2), Duke University
Teaching assistant Fall 2023

Awards

Scholar Award, NeurIPS 2022 Financial Assistance Program, URL.
The EASIAM (East Asia section of SIAM) Student Paper Prize, 2020 ~ 2021, first prize, URL.

Publications

[number] (Position & Institution, Date of first submission) Author(s). *Paper title*. Journal or conference reference. [Links]

* Corresponding author † Equal contribution

RF = Research Fellow NUS = National University of Singapore ARP = Assistant Research Professor Duke = Duke University
AP = Assistant Professor (Tenure-Track) PolyU = The Hong Kong Polytechnic University

Preprint(s)

- [14] (AP at PolyU, 12 Jul 2024) Qianchao Wang[†], **Shijun Zhang[†]**, Dong Zeng, Zhaoheng Xie, Hengtao Guo, Feng-Lei Fan, Tiejong Zeng. *Don't Fear Peculiar Activation Functions: EUAF and Beyond*. Submitted. [arXiv]
- [13] (ARP at Duke, 30 Jun 2024) **Shijun Zhang^{*}**, Hongkai Zhao, Yimin Zhong, Haomin Zhou. *Structured and Balanced Multi-component and Multi-layer Neural Networks*. Submitted. [arXiv]
- [12] (ARP at Duke, 29 Jun 2023) **Shijun Zhang^{*}**, Hongkai Zhao, Yimin Zhong, Haomin Zhou. *Why shallow networks struggle with approximating and learning high frequency: A numerical study*. Submitted. [arXiv]

Published (Accepted)

- [11] (ARP at Duke, 13 Jul 2023) **Shijun Zhang^{*}**, Jianfeng Lu, Hongkai Zhao. *Deep network approximation: Beyond ReLU to diverse activation functions*. **Journal of Machine Learning Research**, 25(35):1–39, 2024. [arXiv, Journal]
- [10] (ARP at Duke, 29 Jan 2023) **Shijun Zhang^{*}**, Jianfeng Lu, Hongkai Zhao. *On enhancing expressive power via compositions of single fixed-size ReLU network*. Proceedings of the 40th International Conference on Machine Learning (**ICML 2023**), PMLR 202:41452–41487, 2023. [arXiv, Poster, Conference]
- [9] (RF at NUS, 19 May 2022) Zuowei Shen, Haizhao Yang, **Shijun Zhang^{*}**. *Neural network architecture beyond width and depth*. Advances in Neural Information Processing Systems (**NeurIPS 2022**), 35:5669–5681, 2022. [arXiv, Poster, Conference]
- [8] (RF at NUS, 15 Nov 2021) Zuowei Shen, Haizhao Yang, **Shijun Zhang^{*}**. *Deep network approximation in terms of intrinsic parameters*. Proceedings of the 39th International Conference on Machine Learning (**ICML 2022**), PMLR 162:19909–19934, 2022. [arXiv, Spotlight, Conference]
- [7] (RF at NUS, 6 Jul 2021) Zuowei Shen, Haizhao Yang, **Shijun Zhang^{*}**. *Deep network approximation: achieving arbitrary accuracy with fixed number of neurons*. **Journal of Machine Learning Research**, Volume 23, Issue 276, September 2022, Pages 1–60. [arXiv, Journal]
- [6] (RF at NUS, 28 Feb 2021) Zuowei Shen, Haizhao Yang, **Shijun Zhang^{*}**. *Optimal approximation rate of ReLU networks in terms of width and depth*. **Journal de Mathématiques Pures et Appliquées**, Volume 157, January 2022, Pages 101–135. [arXiv, Journal]
- [5] (PhD at NUS, 25 Oct 2020) Zuowei Shen, Haizhao Yang, **Shijun Zhang**. *Neural network approximation: Three hidden layers are enough*. **Neural Networks**, Volume 141, September 2021, Pages 160–173. [arXiv, Journal]
- [4] (PhD at NUS, 22 Jun 2020) Zuowei Shen, Haizhao Yang, **Shijun Zhang**. *Deep network with approximation error being reciprocal of width to power of square root of depth*. **Neural Computation**, Volume 33, Issue 4, April 2021, Pages 1005–1036. [arXiv, Journal]

- [3] (PhD at NUS, 9 Jan 2020) Jianfeng Lu, Zuowei Shen, Haizhao Yang, **Shijun Zhang**. *Deep network approximation for smooth functions*. **SIAM Journal on Mathematical Analysis**, Volume 53, Issue 5, September 2021, Pages 5465–5506. [arXiv, Journal]
- [2] (PhD at NUS, 13 Jun 2019) Zuowei Shen, Haizhao Yang, **Shijun Zhang**. *Deep network approximation characterized by number of neurons*. **Communications in Computational Physics**, Volume 28, Issue 5, November 2020, Pages 1768–1811. [arXiv, Journal]
- [1] (PhD at NUS, 26 Feb 2019) Zuowei Shen, Haizhao Yang, **Shijun Zhang**. *Nonlinear approximation via compositions*. **Neural Networks**, Volume 119, November 2019, Pages 74–84. [arXiv, Journal]



Shijun Zhang 张仕俊

Assistant Professor, PolyU

Approximation theory

Neural networks

| | All | Since 2019 |
|-----------|-----|------------|
| Citations | 919 | 916 |
| h-index | 10 | 10 |
| i10-index | 10 | 10 |

0 articles

8 articles

not available

available

Based on funding mandates

| TITLE | CITED BY | YEAR |
|---|----------|------|
| Deep network approximation for smooth functions J Lu, Z Shen, H Yang, S Zhang SIAM Journal on Mathematical Analysis 53 (5), 5465–5506 | 264 | 2020 |
| Deep network approximation characterized by number of neurons Z Shen, H Yang, S Zhang Communications in Computational Physics 28 (5), 1768-1811 | 196 | 2020 |
| Neural network approximation: Three hidden layers are enough Z Shen, H Yang, S Zhang Neural Networks 141, 160-173 | 107 | 2021 |
| Optimal approximation rate of ReLU networks in terms of width and depth Z Shen, H Yang, S Zhang Journal de Mathématiques Pures et Appliquées 157, 101-135 | 104 | 2022 |
| Nonlinear approximation via compositions Z Shen, H Yang, S Zhang Neural Networks 119, 74-84 | 96 | 2019 |
| Deep network with approximation error being reciprocal of width to power of square root of depth Z Shen, H Yang, S Zhang Neural Computation 33 (4), 1005-1036 | 61 | 2021 |
| Deep network approximation: Achieving arbitrary accuracy with fixed number of neurons Z Shen, H Yang, S Zhang The Journal of Machine Learning Research 23 (276), 1-60 | 30 | 2022 |
| Deep network approximation for smooth functions. arXiv e-prints J Lu, Z Shen, H Yang, S Zhang arXiv preprint arXiv:2001.03040 | 19 | 2020 |
| Neural network architecture beyond width and depth S Zhang, Z Shen, H Yang Advances in Neural Information Processing Systems 35, 5669-5681 | 13 | 2022 |
| Deep neural network approximation via function compositions S Zhang PhD thesis, National University of Singapore | 11 | 2020 |

| TITLE | CITED BY | YEAR |
|---|----------|------|
| <p>Deep network approximation: Beyond relu to diverse activation functions S Zhang, J Lu, H Zhao Journal of Machine Learning Research 25 (35), 1-39</p> | 8 | 2024 |
| <p>Deep network approximation in terms of intrinsic parameters Z Shen, H Yang, S Zhang International Conference on Machine Learning 162, 19909-19934</p> | 6 | 2022 |
| <p>On enhancing expressive power via compositions of single fixed-size relu network S Zhang, J Lu, H Zhao International Conference on Machine Learning, 41452-41487</p> | 2 | 2023 |
| <p>Why shallow networks struggle with approximating and learning high frequency: A numerical study S Zhang, H Zhao, Y Zhong, H Zhou arXiv preprint arXiv:2306.17301</p> | 2 | 2023 |
| <p>Don't Fear Peculiar Activation Functions: EUAF and Beyond Q Wang, S Zhang, D Zeng, Z Xie, H Guo, FL Fan, T Zeng arXiv preprint arXiv:2407.09580</p> | | 2024 |
| <p>Structured and Balanced Multi-component and Multi-layer Neural Networks S Zhang, H Zhao, Y Zhong, H Zhou arXiv preprint arXiv:2407.00765</p> | | 2024 |