

# Shijun ZHANG

Phillip Griffiths Assistant Research Professor

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## Work Experience

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**Phillip Griffiths Assistant Research Professor,**

Duke University, United States

Aug 2022 ~ Present

Mentors: Jianfeng Lu and Hongkai Zhao

**Research Fellow,** National University of Singapore, Singapore

Jan 2021 ~ Jul 2022

Mentor: Zuowei Shen

## Education

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**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 ~ Jul 2016

Thesis supervisor: Xiliang Lv

## Awards

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Scholar Award, NeurIPS 2022 Financial Assistance Program, URL.

The EASIAM (East Asia section of SIAM) Student Paper Prize, 2020 ~ 2021, first prize, URL.

## Publications

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

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\* Corresponding author

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RF = Research Fellow    NUS = National University of Singapore    ARP = Assistant Research Professor    Duke = Duke University

## Preprints

- [12] (ARP at Duke) Shijun Zhang\*, Jianfeng Lu, Hongkai Zhao. *Deep network approximation: Beyond ReLU to diverse activation functions*. Submitted. [ arXiv ]
- [11] (ARP at Duke) 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)

- [10] (ARP at Duke) 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) 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) 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 ]
- [7] (RF at NUS) 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 ]
- [6] (RF at NUS) 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) 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 ]
- [4] (PhD at NUS) 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 ]
- [3] (PhD at NUS) 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 ]
- [2] (PhD at NUS) 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) Zuowei Shen, Haizhao Yang, Shijun Zhang. *Nonlinear approximation via compositions*. Neural Networks, Volume 119, November 2019, Pages 74–84. [ arXiv, Journal ]