

# Fanghui Liu

[fanghui.liu@warwick.ac.uk](mailto:fanghui.liu@warwick.ac.uk) | Homepage: [www.lfhgre.org](http://www.lfhgre.org)

Centre for Discrete Mathematics and its Applications (DIMAP)

Department of Computer Science, University of Warwick, Coventry, CV4 7AL, UK

## Research Interest (foundations of modern machine learning, efficient algorithm design)

---

My research is always contributing to how to **handle nonlinearity at a theoretical level and how to efficiently approximate nonlinearity at a practical level** under theoretical guidelines, which is a longstanding question over science, technology and engineering.

- **Mathematical foundations of ML:** Generalization, Statistical/computational efficiency, Over-parameterized models, RKHS/Barron spaces
- **Scaling and efficient ML:** Large-scale approximation, Fine-tuning (lead founder of the first **fine-tuning workshop** at NeurIPS'24)
- **Trustworthy ML:** Fundamental limits of robustness, Efficient adversarial algorithm design

## Professional Experience

---

- **University of Warwick** Oct. 2023 - present  
*Assistant Professor at Department of Computer Science* Coventry, UK
    - Faculty member of [Centre for Discrete Mathematics and its Applications \(DIMAP\)](#)
    - Affiliated member of [Theory and Foundations Group \(FoCS\)](#)
  - **EPFL** Oct. 2021 - Sept. 2023  
*Postdoc Researcher at LIONS Lab* Lausanne, Switzerland
    - Hosted by [Prof. Volkan Cevher](#)
  - **KU Leuven** Oct. 2019 - Sept. 2021  
*Postdoc Researcher at EAST-STADIUS* Leuven, Belgium
    - Hosted by [Prof. Johan A.K. Suykens](#)
- 

- **University of Stuttgart** Jun. 2025 - Sept. 2025  
*Visiting researcher at Institute for Stochastics and Applications (supported by DAAD)* Stuttgart, Germany
  - Hosted by [Prof. Ingo Steinwart](#)

## Education

---

- **Shanghai Jiao Tong University** Sept. 2014 - Jun. 2019  
*PhD in Pattern Recognition and Intelligence Systems* Shanghai, China
- **Harbin Institute of Technology** Sept. 2010 - Jun. 2014  
*Bachelor in Control Science and Engineering* Harbin, China

## Awards

---

- 2024 **AAAI New Faculty Award**
- 2024 **Warwick Staff Higher Performance Award** (for exceptional performance and contribution)
- 2024 **IEEE Senior Member**
- 2024 **DAAD AI-NeT Fellowship** on Safety and Security in AI
- 2023 **Rising Stars in AI Symposium** at KAUST
- 2023 **ELLIS Member**
- 2023 **ICLR 2023 Notable Reviewer** (62/5322)
- 2019 **Outstanding Doctoral Dissertation Award** by *China Society of Image and Graphics (CSIG)* (only ten graduates in China)
- 2016, 2017, 2018 **National Scholarship for Doctoral Students** (top ~0.2%) by *Ministry of Education, China*

## Research Grants

- **2025** Germany DAAD: **Short-term scholarship program of AI-NeT**
- **2024** Royal Society: **Kan Tong Po Visiting Fellowships award** (KTP R1 24101)  
"Orthogonal fine-tuning of large models in linear complexity"
- **2023** Alan Turing Institute: **UK-IT Trustworthy AI Exchange Programme**

## Invited Talks and Seminars (with slides)

- **Be aware of model capacity when talking about generalization**  
2025.06 INRIA, Paris. (Host: Prof. Francis Bach)  
2025.06 LSE Statistics and Data Science Seminar. (Host: Prof. Zoltán Szabó)  
2025.05 Oxford Statistics Seminar. (Host: Prof. Patrick Rebeschini)  
2025.03 Seminar on data science and applied mathematics, HKUST Math. (Host: Prof. Yuan Yao)  
2025.02 ITA'25 Workshop
- **Bridging theory and practice: One-step full gradient can suffice for low-rank fine-tuning in LLMs**  
2025.05 Deepmind. (Host: Dr. Ilja Kuzborskij)  
2025.04 CS Colloquium, City University of Hong Kong. (Host: Prof. Chen Liu)  
2025.04 CS department seminar, HKUST. (Host: Prof. James Kwok)  
2025.02 CS department seminar, UCLA. (Host: Prof. Quanquan Gu)
- **Learning with norm-based neural networks: function spaces and computational-statistical gaps**  
2024.12 University of Wisconsin-Madison, CS department. (Host: Prof. Yudong Chen)  
2024.12 Northwestern University, IE&MS Department. (Host: Prof. Yiping Lu)  
2024.11 RTPU (formerly 'TU Kaiserslautern'), ML group. (Host: Prof. Marius Kloft)  
2024.11 University of Stuttgart, Math Department. (Host: Prof. Ingo Steinwart)  
2024.11 Ludwig-Maximilians-Universität München. (Host: Prof. Gitta Kutyniok)  
2024.09 INRIA Paris. (Host: Prof. Francis Bach)
- **Over-parameterization in neural networks: double descent, function spaces, curse of dimensionality**  
2024.05 External seminar series, Gatsby Unit, UCL. (Host: Prof. Arthur Gretton)  
2024.02 MaLGa Seminar, University of Genoa. (Host: Prof. Lorenzo Rosasco)
- **On the convergence of encoder-only shallow Transformers**  
2024.02 MILD Seminar, UBC. (Host: Prof. Christos Thrampoulidis)

## Publications and Preprints (Google Scholar) xxx\* indicates equal contribution; xxx indicates corresponding author(s)

### Preprints and submitted papers

1. Yichen Wang, Yudong Chen, Lorenzo Rosasco, **Fanghui Liu**. *The shape of generalization through the lens of norm-based capacity control*.
2. Zhongjie Shi, **Fanghui Liu**, Yuan Cao, Johan A.K. Suykens. *Can overfitted deep neural networks in adversarial training generalize? – An approximation viewpoint*.
3. Honam Wong, Wendao Wu, **Fanghui Liu**, Yiping Lu. *Benign overfitting in fixed dimension via physics-informed learning with smooth inductive bias*.

### Accepted papers (with the following five representative publications at first)

1. Yuanhe Zhang, **Fanghui Liu**, Yudong Chen. *LoRA-One: One-step full gradient could suffice for fine-tuning large language models, provably and efficiently*. International Conference on Machine Learning (ICML), 2025. (Spotlight)  
[TLDR: We show how theory on subspace alignment improves algorithm design for fine-tuning LLMs.]
2. **Fanghui Liu**, Leello Dadi, Volkan Cevher. *Learning with norm constrained, over-parameterized, two-layer neural networks*, Journal of Machine Learning Research (JMLR), 2024.  
[TLDR: We (optimally) trade-off sample complexity and dimension dependence in high-dimensional ML.]
3. **Fanghui Liu**, Johan A.K. Suykens, Volkan Cevher. *On the double descent of random features models trained with SGD*, Advances in Neural Information Processing Systems (NeurIPS), 2022.  
[TLDR: Study the role of SGD in double descent, interplay with data-parameter-compute (scaling law).]

4. **Fanghui Liu**, Luca Viano, Volkan Cevher. *Understanding deep neural function approximation in reinforcement learning via  $\epsilon$ -greedy exploration*, Advances in Neural Information Processing Systems (NeurIPS), 2022.

[TLDR: The first theoretical framework for (non-lazy) deep neural function approximation in online RL.]

5. **Fanghui Liu**, Xiaolin Huang, Yudong Chen, Johan A.K. Suykens. *Random features for kernel approximation: A survey on algorithms, theory, and beyond*, IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), 2021.

[TLDR: The first comprehensive survey on random features with huge potential on linear attention, fine-tuning.]

---

6. Zhenyu Zhu, **Fanghui Liu**, Volkan Cevher. *How gradient balances features: A dynamical analysis for two-layer neural networks*. International Conference on Learning Representations (ICLR), 2025.

7. Yihang Chen, **Fanghui Liu**, Taiji Suzuki, Volkan Cevher. *High-dimensional kernel methods under covariate shift: data-dependent implicit regularization*, International Conference on Machine Learning (ICML), 2024.

8. Elias Abad Rocamora, Yongtao Wu, **Fanghui Liu**, Grigorios Chrysos, Volkan Cevher. *Revisiting character-level adversarial attacks for language models*, International Conference on Machine Learning (ICML), 2024.

9. Yihang Chen, **Fanghui Liu**, Yiping Lu, Grigorios Chrysos, Volkan Cevher. *Generalization of deep ResNets in the mean-field regime*, International Conference on Learning Representations (ICLR), 2024. (spotlight)

10. Yongtao Wu, **Fanghui Liu**, Carl-Johann Simon-Gabriel, Grigorios Chrysos, Volkan Cevher. *Robust NAS under adversarial training: benchmark, theory, and beyond*, International Conference on Learning Representations (ICLR), 2024.

11. Elias Abad Rocamora, **Fanghui Liu**, Grigorios Chrysos, Pablo M. Olmos, Volkan Cevher. *Efficient local linearity regularization to overcome catastrophic overfitting*, International Conference on Learning Representations (ICLR), 2024.

12. Tao Li, Weisen Jiang, **Fanghui Liu**, Xiaolin Huang, James Kwok. *Scalable learned model soup on a single GPU: An efficient subspace training strategy*, European Conference on Computer Vision (ECCV), 2024.

13. Yongtao Wu, **Fanghui Liu**, Grigorios Chrysos, Volkan Cevher. *On the convergence of shallow Transformers*, Advances in Neural Information Processing Systems (NeurIPS), 2023.

14. Jiayuan Ye, Zhenyu Zhu, **Fanghui Liu**, Reza Shokri, Volkan Cevher. *Initialization matters: Privacy-utility analysis of over-parameterized neural networks*, Advances in Neural Information Processing Systems (NeurIPS), 2023.

15. **Fanghui Liu**, Luca Viano, Volkan Cevher. *What can online reinforcement learning benefit from general coverage conditions?* International Conference on Machine Learning (ICML), 2023.

16. Zhenyu Zhu, **Fanghui Liu**, Grigorios Chrysos, Francesco Locatello, Volkan Cevher. *Benign overfitting in deep neural networks under lazy training*, International Conference on Machine Learning (ICML), 2023.

17. Zhenyu Zhu, **Fanghui Liu**, Grigorios Chrysos, Volkan Cevher. *Generalization properties of NAS under activation and skip connection search*, Advances in Neural Information Processing Systems (NeurIPS), 2022.

18. Zhenyu Zhu, **Fanghui Liu**, Grigorios Chrysos, Volkan Cevher. *Robustness in deep learning: The good (width), the bad (depth), and the ugly (initialization)*, Advances in Neural Information Processing Systems (NeurIPS), 2022.

19. Yongtao Wu, Zhenyu Zhu, **Fanghui Liu**, Grigorios Chrysos, Volkan Cevher. *Extrapolation and spectral bias of neural nets with Hadamard product: a polynomial net study*, Advances in Neural Information Processing Systems (NeurIPS), 2022.

20. Elias Abad Rocamora, Mehmet Fatih Sahin, **Fanghui Liu**, Grigorios Chrysos, Volkan Cevher. *Sound and complete verification of polynomial networks*, Advances in Neural Information Processing Systems (NeurIPS), 2022.

21. Fanghui Liu\*, Lei Shi\*, Xiaolin Huang, Jie Yang, Johan A.K. Suykens. *Generalization properties of hyper-RKHS and its applications*, Journal of Machine Learning Research (JMLR), 2021.
22. Fanghui Liu\*, Lei Shi\*, Xiaolin Huang, Jie Yang, Johan A.K. Suykens. *Analysis of regularized least squares in reproducing kernel Kreĭn spaces*, Machine Learning, 2021.
23. Fanghui Liu, Xiaolin Huang, Yudong Chen, Johan A.K. Suykens. *Towards a unified quadrature framework for large scale kernel methods*, IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), 2021.
24. Fanghui Liu, Zhenyu Liao, Johan A.K. Suykens. *Kernel regression in high dimensions: Refined analysis beyond double descent*, International Conference on Artificial Intelligence and Statistics (AISTATS), 2021.
25. Fanghui Liu, Xiaolin Huang, Yingyi Chen, Johan A.K. Suykens. *Fast learning in reproducing kernel Kreĭn spaces via generalized measures*, International Conference on Artificial Intelligence and Statistics (AISTATS), 2021.
26. Fanghui Liu, Xiaolin Huang, Chen Gong, Jie Yang, Li Li. *Learning data-adaptive nonparametric kernels*, Journal of Machine Learning Research (JMLR), 2020.
27. Fanghui Liu, Chen Gong, Xiaolin Huang, Tao Zhou, Jie Yang, Dacheng Tao. *Robust visual tracking revisited: From correlation filter to template matching*, IEEE Transactions on Image Processing (TIP), 2018.

## Professional services

---

- **Area Chair** NeurIPS'25, ICLR'25, AISTATS'25, AAMAS'25
- **Workshop organizer** Co-founded NeurIPS'24 workshop: *Fine-Tuning in Modern Machine Learning: Principles and Scalability* with Grigorios Chrysos (UW-Madison), Beidi Chen (CMU), Rebekka Burkholz (CISPA), Saleh Soltan (Amazon), Angeliki Giannou (UW-Madison), Masashi Sugiyama (RIKEN/UTokyo), Volkan Cevher (EPFL)
- **Seminar organizer** Co-founded *Warwick Foundation of AI seminar*
- **Tutorials**
  - ◊ 2024 *"Scaling and reliability foundations in machine learning"*  
at IEEE International Symposium on Information Theory (ISIT'24)  
with Volkan Cevher, Grigorios Chrysos, and Leena Chennuru Vankadara
  - ◊ 2023 *"Deep learning theory for computer vision researchers"*  
at IEEE/CVF Computer Vision and Pattern Recognition Conference (CVPR'23)  
with Volkan Cevher and Grigorios Chrysos
  - ◊ 2023 *"Neural networks: the good, the bad, and the ugly"*  
at IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP'23)  
with Johan Suykens and Volkan Cevher
- **Journal reviewers** Mathematics of Computation, Annals of Statistics (AoS), Journal of Machine Learning Research (JMLR) etc.
- **Funding Reviewers** EPSRC, British Council

## Teaching Experience

---

- **University of Warwick (Instructor)**
  - CS147: Discrete Mathematics and its application 2 (Spring 2024, 2025)
  - CS416: Optimization methods (Spring 2025)
- **EPFL (Teaching assistant)**
  - EE-556 Mathematics of data: from theory to computation (Fall 2022)

## Students

---

- **University at Warwick**
  - Yuanhe Zhang (PhD student, co-supervised with Prof. Chenlei Leng) (Sept. 2024 - present)
  - Joao Felipe Lobo Pevitor (Incoming PhD student, 2025.09 - )
- **Alumni:**
  - Yichen Wang (visiting student from SJTU, now PhD@UW-Madison) (Sept. 2024 - Dec. 2024)
  - Alex John Caldarone (summer intern, now Master@EPFL) (Jun. 2024 - Aug. 2024)

—  
At Warwick, I have supervised 6 undergraduate thesis and 4 master thesis.

- **EPFL (daily supervisor of bachelor/master thesis, intern projects, and PhD projects)**
  - Elias Abad Rocamora (bachelor/master thesis, PhD project, now PhD@EPFL) (Jan. 2022 - Feb. 2024)
  - Yihang Chen (master thesis, intern project, now PhD@UCLA) (Feb. 2023 - Feb. 2024)
  - Zhenyu Zhu (master thesis, intern/PhD projects, now PhD@EPFL) (Oct. 2021 - Sept. 2024)
  - Yongtao Wu (intern project, PhD projects, now PhD@EPFL) (Jan. 2022 - Feb. 2024)
  - Edmund Hofflin (master thesis, now PhD@Oxford) (Jan. 2023 - Jun. 2023)
- **KU Leuven (daily supervisor of master thesis)**
  - Zachary Jones (master thesis, now PhD@CMAP, Paris) (Oct. 2018 - Jun. 2019)