Fanghui Liu

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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 (co-founded the first fine-tuning workshop at NeurIPS'24)

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 Department of Mathematics (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
  - PhD Thesis: *Data-adaptive kernel learning and its application*

- **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*.

Accpeted 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. (Oral presentation)

   [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 ϵ-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.]

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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** Annals of Statistics (AoS), Mathematics of Computation, 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 Pevidor (Incoming PhD student) (Sept. 2025 - present)
  Alumni:
  Yichen Wang (visiting student, now PhD@UW-Madison) (Sept. 2024 - Dec. 2024)
  Alex John Caldarone (summer intern, now Master@EPFL) (Jun. 2024 - Aug. 2024)

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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)