

# Zhenyu Liao

## Curriculum Vitae

March 2025

🏠 <https://zhenyu-liao.github.io>  
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📄 Male, Chinese, born in 28/08/1992.

### Education

- 2019 **Ph.D.** Mathematics and Informatics [L2S, CentraleSupélec, University of Paris-Saclay](#), France.
- 2016 **M.Sc.** Signal and Image Processing [University of Paris-Saclay](#), France.
- 2014 **B.E.** Optical & Electronic Information [Huazhong university of Science and Technology](#), China.

### Professional Experiences

- 2021-now: **Associate Professor** at [School of Electronic Information and Communications, Huazhong University of Science and Technology \(HUST\)](#).
- June-July, 2024: **ANR-LabEx-CIMI Visiting Professor**, [Centre International de Mathématiques et Informatique de Toulouse \(CIMI\)](#), Toulouse, France.
- 2020-2021: **Postdoctoral Scholar** at [ICSI](#) and [Department of Statistics, University of California, Berkeley](#), hosted by [Michael Mahoney](#).

### Honors and Awards

- 2025: Recipient of the [MATRIX-Simons Travel Grant](#), MATRIX, Creswick, Australia.
- 2023: Recipient of Talent Program of Hubei Province, Hubei, China.
- 2021: Recipient of the Wuhan Youth Talent, Wuhan, China.
- 2021: Recipient of East Lake Youth Talent Program Fellowship of HUST, Wuhan, China.
- 2019: 2nd prize of [ED STIC Doctoral Prize](#), University Paris-Saclay, France.
- 2016: Recipient of the Supélec Foundation Ph.D. Fellowship, France.

## Publications

I've co-authored a book and ~ 30 papers published on conferences and journals on machine learning, signal processing, and statistics, with ~ 1000 citations and h-index = 15 according to [Google Scholar](#) (March 2025).

### Books

1. Romain Couillet and **Zhenyu Liao**. *Random Matrix Methods for Machine Learning*. Cambridge University Press, 2022. doi: [10.1017/9781009128490](#).

### Papers in conference proceedings

1. Xiaoyi Mai and **Zhenyu Liao**. The Breakdown of Gaussian Universality in Classification of High-dimensional Mixtures. In: *International Conference on Learning Representations (ICLR)*. 2025. <https://openreview.net/forum?id=UrKbn51HjA>.
2. Jiuqi Wei, Xiaodong Lee, **Zhenyu Liao**, Themis Palpanas, and Botao Peng. Subspace Collision: An Efficient and Accurate Framework for High-dimensional Approximate Nearest Neighbor Search. *Proc. ACM Manag. Data (SIGMOD)* 3(1) (Feb. 2025). doi: [10.1145/3709729](#).
3. Wei Yang, Zhengyu Wang, Xiaoyi Mai, Zenan Ling, Robert Caiming Qiu, and **Zhenyu Liao**. Inconsistency of ESPRIT DoA Estimation for Large Arrays and a Correction via RMT. In: *2024 32nd European Signal Processing Conference (EUSIPCO)*. Aug. 2024, pp.2722–2726. doi: [10.23919/EUSIPCO63174.2024.10715081](#).
4. Zenan Ling, Longbo Li, Zhanbo Feng, Yixuan Zhang, Feng Zhou, Robert C. Qiu, and **Zhenyu Liao**. Deep Equilibrium Models Are Almost Equivalent to Not-so-deep Explicit Models for High-dimensional Gaussian Mixtures. In: *Proceedings of the 41st International Conference on Machine Learning (ICML)*. Vol. 235. PMLR, 2024, pp.30585–30609. <https://proceedings.mlr.press/v235/ling24a.html>.
5. Yi Song, Kai Wan, **Zhenyu Liao**, Hao Xu, Giuseppe Caire, and Shlomo Shamai. An Achievable and Analytic Solution to Information Bottleneck for Gaussian Mixtures. In: *2024 IEEE International Symposium on Information Theory (ISIT)*. July 2024, pp.2460–2465. doi: [10.1109/ISIT57864.2024.10619077](#).
6. Yuanjie Wang, Zhanbo Feng, and **Zhenyu Liao**. FedRF-Adapt: Robust and Communication-Efficient Federated Domain Adaptation via Random Features. In: *2024 IEEE International Conference on Acoustics, Speech, and Signal Processing Workshops (ICASSPW)*. Apr. 2024, pp.615–619. doi: [10.1109/ICASSPW62465.2024.10626024](#).

7. Lingyu Gu, Yongqi Du, Yuan Zhang, Di Xie, Shiliang Pu, Robert Qiu, and **Zhenyu Liao**. "Lossless" Compression of Deep Neural Networks: A High-dimensional Neural Tangent Kernel Approach. In: *Advances in Neural Information Processing Systems (NeurIPS)*. Vol. 35. Curran Associates, Inc., 2022, pp.3774–3787. [https://proceedings.neurips.cc/paper\\_files/paper/2022/hash/185087ea328b4f03ea8fd0c8aa96f747-Abstract-Conference.html](https://proceedings.neurips.cc/paper_files/paper/2022/hash/185087ea328b4f03ea8fd0c8aa96f747-Abstract-Conference.html).
8. Hafiz Tiomoko Ali, **Zhenyu Liao**, and Romain Couillet. Random matrices in service of ML footprint: ternary random features with no performance loss. In: *International Conference on Learning Representations (ICLR)*. 2022. <https://openreview.net/forum?id=qwULHx9z1d>.
9. **Zhenyu Liao** and Michael W Mahoney. Hessian Eigenspectra of More Realistic Nonlinear Models. In: *Advances in Neural Information Processing Systems (NeurIPS)*. Vol. 34. Curran Associates, Inc., 2021, pp.20104–20117. <https://papers.nips.cc/paper/2021/hash/a7d8ae4569120b5bec12e7b6e9648b86-Abstract.html>.
10. Michal Dereziński, **Zhenyu Liao**, Edgar Dobriban, and Michael Mahoney. Sparse sketches with small inversion bias. In: *Proceedings of Thirty Fourth Conference on Learning Theory (COLT)*. Vol. 134. PMLR, 2021, pp.1467–1510. <https://proceedings.mlr.press/v134/derezinski21a.html>.
11. **Zhenyu Liao**, Romain Couillet, and Michael W. Mahoney. Sparse Quantized Spectral Clustering. In: *International Conference on Learning Representations (ICLR)*. 2021. <https://openreview.net/forum?id=pBqLS-7KYAF>.
12. Fanghui Liu, **Zhenyu Liao**, and Johan Suykens. Kernel Regression in High Dimension: Refined Analysis beyond Double Descent. In: *Proceedings of The 24th International Conference on Artificial Intelligence and Statistics (AISTATS)*. Vol. 130. PMLR, 2021, pp.649–657. <http://proceedings.mlr.press/v130/liu21b.html>.
13. **Zhenyu Liao**, Romain Couillet, and Michael W. Mahoney. A Random Matrix Analysis of Random Fourier Features: Beyond the Gaussian Kernel, A Precise Phase Transition, and the Corresponding Double Descent. In: *Advances in Neural Information Processing Systems (NeurIPS)*. Vol. 33. Curran Associates, Inc., 2020, pp.13939–13950. <https://papers.nips.cc/paper/2020/hash/a03fa30821986dff10fc66647c84c9c3-Abstract.html>.
14. Michal Dereziński, Feynman T Liang, **Zhenyu Liao**, and Michael W. Mahoney. Precise expressions for random projections: Low-rank approximation and randomized Newton. In: *Advances in Neural Information Processing Systems (NeurIPS)*. Vol. 33. Curran Associates, Inc., 2020, pp.18272–18283. <https://papers.nips.cc/paper/2020/hash/d40d35b3063c11244fbf38e9b55074be-Abstract.html>.
15. **Zhenyu Liao** and Romain Couillet. On Inner-Product Kernels of High Dimensional Data. In: *2019 IEEE 8th International Workshop on Computational Advances in Multi-Sensor Adaptive Processing (CAMSAP)*. IEEE. 2019, pp.579–583. doi: [10.1109/CAMSAP45676.2019.9022455](https://doi.org/10.1109/CAMSAP45676.2019.9022455).
16. Xiaoyi Mai, **Zhenyu Liao**, and Romain Couillet. A Large Scale Analysis of Logistic Regression: Asymptotic Performance and New Insights. In: *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. IEEE. 2019, pp.3357–3361. doi: [10.1109/ICASSP.2019.8683376](https://doi.org/10.1109/ICASSP.2019.8683376).
17. Romain Couillet, **Zhenyu Liao**, and Xiaoyi Mai. Classification Asymptotics in the Random Matrix Regime. In: *The 26th European Signal Processing Conference (EUSIPCO)*. IEEE. 2018, pp.1875–1879. doi: [10.23919/EUSIPCO.2018.8553034](https://doi.org/10.23919/EUSIPCO.2018.8553034).
18. **Zhenyu Liao** and Romain Couillet. The Dynamics of Learning: A Random Matrix Approach. In: *Proceedings of the 35th International Conference on Machine Learning (ICML)*. Vol. 80. PMLR, 2018, pp.3072–3081. <http://proceedings.mlr.press/v80/liao18b.html>.
19. **Zhenyu Liao** and Romain Couillet. On the Spectrum of Random Features Maps of High Dimensional Data. In: *Proceedings of the 35th International Conference on Machine Learning (ICML)*. Vol. 80. PMLR, 2018, pp.3063–3071. <http://proceedings.mlr.press/v80/liao18a.html>.
20. **Zhenyu Liao** and Romain Couillet. Random Matrices Meet Machine Learning: A Large Dimensional Analysis of LS-SVM. In: *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*. IEEE. 2017, pp.2397–2401. doi: [10.1109/ICASSP.2017.7952586](https://doi.org/10.1109/ICASSP.2017.7952586).

## Journal papers

1. Zhanbo Feng, Yuanjie Wang, Jie Li, Fan Yang, Jiong Lou, Tiebin Mi, Robert. C. Qiu, and **Zhenyu Liao**. Robust and Communication-Efficient Federated Domain Adaptation via Random Features. *IEEE Transactions on Knowledge and Data Engineering* **37**(3) (2025), 1411–1424. doi: [10.1109/TKDE.2024.3510296](https://doi.org/10.1109/TKDE.2024.3510296).

2. Jingcheng Wang, Shaoliang Zhang, Jianming Cai, **Zhenyu Liao**, Christian Arenz, and Ralf Betzholz. Robustness of random-control quantum-state tomography. *Phys. Rev. A* **108** (2 2023), 022408. doi: [10.1103/PhysRevA.108.022408](#).
3. Yacine Chitour, **Zhenyu Liao**, and Romain Couillet. A geometric approach of gradient descent algorithms in linear neural networks. *Mathematical Control and Related Fields* **13**(3) (2023), 918–945. doi: [10.3934/mcrf.2022021](#).
4. **Zhenyu Liao**, Romain Couillet, and Michael W Mahoney. A random matrix analysis of random Fourier features: beyond the Gaussian kernel, a precise phase transition, and the corresponding double descent. *Journal of Statistical Mechanics: Theory and Experiment* **2021**(12) (2021), 124006. doi: [10.1088/1742-5468/ac3a77](#).
5. **Zhenyu Liao** and Romain Couillet. A Large Dimensional Analysis of Least Squares Support Vector Machines. *IEEE Transactions on Signal Processing* **67**(4) (2019), 1065–1074. doi: [10.1109/TSP.2018.2889954](#).
6. Cosme Louart, **Zhenyu Liao**, and Romain Couillet. A Random Matrix Approach to Neural Networks. *The Annals of Applied Probability* **28**(2) (2018), 1190–1248. doi: [10.1214/17-AAP1328](#).

## Research Grants

1. 2024-2026: **PI**, Guangdong Key Lab of Mathematical Foundations for Artificial Intelligence Open Fund “Generalization Theory for Transformer-based Models via Random Matrix Methods” (OFA00003), ¥100K, with Jeff Yao as co-PI.
2. 2023-2025: **PI**, National Natural Science Foundation of China, youth program “Fundamental Limits of Pruning Deep Neural Network Models via Random Matrix Methods” (NSFC-62206101), ¥300K.
3. 2022-2024: **contributor**, National Natural Science Foundation of China, grants for “Mathematical Foundations for Future Communications (Information Theory)” (NSFC-12141107), ¥3M. PI: Robert C. Qiu.
4. 2021-2022: **PI**, CCF-Hikvision Open Fund, *Random Matrix Theory and Information Bottleneck for Neural Network Compression* (20210008), ¥280K, with Kai Wan as co-PI.
5. 2021-2023: **contributor**, Key Research and Development Program of Hubei Province, *Research on Key Technologies of Next-generation Industrial Internet Network* (2021BAA037), ¥1 000K., PI: Daiming Qu.
6. 2018-2021: **contributor**, NSF Research Grant, *Combining Stochastics and Numerics for Improved Scalable Matrix Computations* (NSF-1815054), \$500K, PI: Michael W. Mahoney.
7. 2018-2021: **contributor**, Programme d’Investissements d’avenir, *GSTATS IDEX DataScience Chair*, University of Grenoble-Alpes, €300K, PI: Romain Couillet.
8. 2014-2017, **contributor**, French National Research Agency, *Random Matrix Theory for Large Dimensional Graphs* (ANR-14-CE28-0006), €300K, PI: Romain Couillet.

## Professional Services

### Organization of Scientific Activities

- **Area Chair** of [ICLR 2025](#), [ICML 2025](#), [IJCNN 2025](#).
- **Associate Editor** of Springer [Statistics and Computing](#) (since 2025).
- **General Co-chair** of [10th EAI International Conference on IoT as a Service \(EAI IoTaaS 2024\)](#), 2024.
- Co-organizer of 2025 Random Matrix Theory and Application (RMTA 2025) Conference, Jan 2025, Changchun, China, with more than 150 attendees.
- Co-organizer of the 1st High-dimensional Learning Dynamics ([HiLD](#)) workshop at [ICML 2023](#), together with Mihai Nica, Courtney Paquette, Elliot Paquette, Andrew Saxe, and René Vidal.
- Co-organizer of the 2022 Joint workshop on “[Math for Data Science](#)” between [HUST](#) and [University of Paris-Saclay](#), together with Yacine Chitour. The workshop had more than 40 000 online attendees, see [play-back](#).

### Peer Reviewing

- **Research grants:**
  - Referee of [European Research Council \(ERC\)](#).
  - External reviewer of [Natural Sciences and Engineering Research Council of Canada \(NSERC\)](#).
  - Referee of [National Natural Science Foundation of China \(NSFC\)](#).
  - Reviewer of [Israel Science Foundation \(ISF\)](#).
- **Conferences:** [ICLR](#), [ICML](#), [NeurIPS](#), [SODA](#), [AISTATS](#), [AAAI](#), [ECAI](#), [IEEE-ICASSP](#), [IEEE-CAMSAP](#).
- **Journals:**

- Applied mathematics, statistical physics, statistics, and data science: [SIAM Review \(SIREV\)](#), [Foundations of Computational Mathematics \(FoCM\)](#), [Physical Review X \(PRX\)](#), [IEEE Trans. on Signal Processing \(IEEE-TSP\)](#), [Springer Statistics and Computing \(STCO\)](#), [SIAM Journal on Scientific Computing \(SISC\)](#), [Random Matrices: Theory and Applications \(RMTA\)](#), [Latin American Journal of Probability and Mathematical Statistics \(ALEA\)](#), [Electronic Journal of Statistics \(EJS\)](#).
- ML and AI: [Journal of Machine Learning Research \(JMLR\)](#), [IEEE Trans. on Pattern Analysis and Machine Intelligence \(IEEE-TPAMI\)](#), [IEEE Trans. on Neural Networks and Learning Systems \(IEEE-TNNLS\)](#), [Transactions on Machine Learning Research \(TMLR\)](#), [Pattern Recognition \(PR\)](#), [Neural Processing Letters \(NPL\)](#).

## Tutorials and Invited Talks

1. Invited talk at “[Log-gases in Caeli Australi](#)” research program, [MATRIX](#) institute of Creswick, Australia, August, 2025.
2. Invited talk on “Examples and Counterexamples of Gaussian Universality in Large-dimensional Machine Learning” at [RMTA 2024 Conference](#), Changchun, China, Jan, 2025.
3. Invited talk on “Random Matrix Methods for Explicit and Implicit Neural Networks” at [The 4th China Big Data Statistics Forum](#), Xuzhou, China, October, 2024.
4. **6 H mini-course** on “Random Matrix Theory for Machine Learning”, thematic trimester on “[beyond classical regimes in statistical inference and machine learning](#),” Centre International de Mathématiques et Informatique de Toulouse ([CIMI](#)), Toulouse, France, 2024.
5. Invited talk on “Recent Advances in Random Matrix Methods for Deep Learning Theory” at [CSML 2024](#), Shanghai, China, August, 2024.
6. Invited talk on “A Random Matrix Approach to Explicit and Implicit Deep Neural Networks” at Institut de Mathématiques de Toulouse ([IMT](#)), Toulouse, France, July, 2024.
7. **12 H mini-course** on “Random Matrix Theory for Modern Machine Learning: New Intuitions, Improved Methods, and Beyond” at Institut de Recherche en Informatique de Toulouse ([IRIT](#)), Toulouse, France, July, 2024.
8. **5 H short course** on “Random Matrix Theory and Its Applications in ML” at Jiangsu Normal University, China, 2024. Links to recordings: [part 1](#) on RMT and [part 2](#) on its application to deep learning.
9. **3 H mini-course** on “[Random Matrix Theory in Deep Learning: An Introduction](#)”, [Northeast Normal University](#), Changchun, Nov, 2023.
10. Invited talk on “Neural Tangent Kernel in High Dimensions: From Theory to Practice,” [Beijing Jiaotong University School of Computer and Information Technology](#), Beijing, Oct, 2023.
11. Invited talk on “Random Matrix Methods for Machine Learning: with Applications to “Lossless” Compression and Training of DNNs”, [International Chinese Statistical Association \(ICSA\) China Conference](#), Chengdu, July, 2023.
12. Invited talk on “On the inversion bias of randomized sketching”, [Shenzhen Conference on Random Matrix Theory and Applications \(RMTA 2023\)](#), CUHK-Shenzhen, June, 2023.
13. Invited talk on “Random Matrix Methods for Machine Learning: with Applications to “Lossless” Compression and Training of DNNs”, [Guangzhou Institute of International Finance](#), Guangzhou, June, 2023.
14. Invited talk on “Random Matrix Methods for Machine Learning: with Applications to “Lossless” Compression and Training of DNNs”, Wuhan University, Wuhan, June, 2023.
15. Invited talk on “Random Matrix Methods for Machine Learning: “Lossless” Compression of Large and Deep Neural Networks”, [NCIIP 2023](#), Changchun, Jinlin, May, 2023.
16. Invited talk on “[Random Matrix Methods for Machine Learning: “Lossless” Compression of Large and Deep Neural Networks](#)”, SPMS MAS Seminar Series, School of Physical and Mathematical Sciences, Nanyang Technological University, Jan, 2023.
17. Invited talk on “[Random Matrix Methods for Machine Learning: An Application to “Lossless” Compression of Large and Deep Neural Networks](#)”, SDS Workshop on “Topics in Random Matrix Theory”, CUHK-Shenzhen, October, 2022.
18. Invited talk on “[Random Matrix Methods for Machine Learning: “Lossless” Compression of Large Neural Networks](#)”, Institute for Interdisciplinary Information Sciences (IIIS), Tsinghua University, August, 2022.
19. Invited talk on “Random Matrix Methods for Machine Learning: “Lossless” Compression of Large Neural Networks”, [China conference on Scientific Machine Learning \(CSML 2022\)](#), August, 2022.
20. Invited talk on “[Random Matrix Methods for Machine Learning](#)”, [Gaoling School of Artificial Intelligence](#), Renmin University of China, March, 2022.
21. Invited talk on “Performance-complexity Trade-off in Large Dimensional Spectral Clustering”, [HUST Vision and Learning Salon 2021](#), Huazhong University of Science and Technology, December, 2021.



22. Invited talk on “A Random Matrix Approach to Large Dimensional Machine Learning”, [AI+Math Colloquia](#), Institute of Natural Sciences, Shanghai Jiao Tong University, 2021.
23. Invited talk on “A Random Matrix Approach to Large Dimensional Machine Learning”, [STAT-DS Seminar](#), Department of Statistics and Data Science, Southern University of Science and Technology, 2021.
24. Invited talk on “A Random Matrix Approach to Large Dimensional Machine Learning”, [Optimization Seminar](#), [Academy of Mathematics and Systems Science](#), Chinese Academy of Science, 2021.
25. Invited talk on “A Data-dependent Theory of Overparameterization: Phase Transition, Double Descent, and Beyond” at [Workshop on the Theory of Over-parameterized Machine Learning \(TOPML\) 2021](#). April 20-21, 2021. Link to [video](#).
26. Invited talk on “Performance-complexity Trade-off in Large Dimensional Spectral Clustering”, [Statistics Seminar](#), Research School of Finance, Actuarial Studies and Statistics, Australian National University, Canberra, 2021.
27. Invited talk on “Performance-complexity Trade-off in Large Dimensional Spectral Clustering”, HUAWEI First Mini-workshop on Random Matrix Theory and Machine Learning, Paris, 2021.
28. Invited talk on “Performance-complexity Trade-off in Large Dimensional Spectral Clustering”, [STA 290 Seminar](#), Department of Statistics, University of California, Davis, 2021.
29. Invited talk on “Dynamical Aspects of Learning Linear Neural Networks”, The Fields Institute for Research in Mathematical Sciences, [Second Symposium on Machine Learning and Dynamical Systems](#), 2020. Link to [recording](#).
30. Invited talk on “Random Matrix Advances in Large Dimensional Machine Learning”, Shanghai University of Finance and Economics, [Random Matrices and Complex Data Analysis Workshop](#), Shanghai, 2019.
31. Invited talk on “Random Matrix Viewpoint of Learning with Gradient Descent”, [DIMACS](#), [Workshop on Randomized Numerical Linear Algebra, Statistics, and Optimization](#), Rutgers University, 2019. Link to [recording](#).
32. Invited talk on “Recent Advances in Random Matrix Theory for Machine Learning and Neural Nets”, workshop of the [Matrix](#) series on “*Random matrix theory faces information era*”, Kraków, Poland, 2019. Link to [recording](#).
33. Invited talk on “Dynamical Aspects of Deep Learning” (with Y. Chitour), *Séminaire d’Automatique du plateau de Saclay of iCODE institute*, Paris, France, 2019.
34. Invited talk on “Recent Advances in Random Matrix for Neural Networks”, *Workshop on deep learning theory*, Shanghai JiaoTong University, China, 2018.
35. **Tutorial** on “[Random Matrix Advances in Machine Learning and Neural Nets](#)” (with R. Couillet and X. Mai), *The 26th European Signal Processing Conference (EUSIPCO’18)*, Roma, Italy, 2018.

## References

### ► Michael W. Mahoney

- Associate Adjunct Professor at Department of Statistics, UC Berkeley, CA, USA.
- Director of the UC Berkeley FODA (Foundations of Data Analysis) Institute, Berkeley, CA, USA.
- ✉ [mmahoney@stat.berkeley.edu](mailto:mmahoney@stat.berkeley.edu)

### ► Romain Couillet

- Full Professor at University Grenoble-Alps, France
- Holder of the UGA MIAI LargeDATA Chair, University-Grenoble-Alps, France.
- ✉ [romain.couillet@gipsa-lab.grenoble-inp.fr](mailto:romain.couillet@gipsa-lab.grenoble-inp.fr)

### ► Yacine Chitour

- Full Professor at Pairs-Sud, University Paris-Saclay, France.
- Director of the H-CODE institute, University Paris-Saclay, France.
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