Zhenyu Liao

Curriculum Vitae

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Male, Chinese, born in 28/08/1992.

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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

- 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 Ph.D. Student Award of University Paris-Saclay, France.
- 2016: Recipient of the Supélec Foundation Ph.D. Fellowship, France.

Publications

I've co-authored a book and $\sim$ 30 papers published on conferences and journals on machine learning, signal processing, and statistics, with $\sim$ 1000 citations and h-index = 15 according to Google Scholar (January 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) (June 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.
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=qwULHx9zld.
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 Derezinski, **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 Derezinski, 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.
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.
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.
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.

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* (2024), 1–14. DOI: 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 Provence, *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 playback.

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).
- **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 Pro-

cessing (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
- **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
- **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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