

Zhenyu Liao

Curriculum Vitae

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📄 Male, Chinese, born in 28/08/1992.

Education

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

Professional Experiences

- 2021-now: (**Research**) Associate Professor at [School of Electronic Information and Communications, Huazhong University of Science and Technology \(HUST\)](#).
- 2020-2021: **Postdoctoral Scholar** at [ICSI](#) and [Department of Statistics, University of California, Berkeley](#), hosted by [Michael Mahoney](#).

Honors and Awards

- 2025: CRM-Simons Scholar, [Centre de recherches mathématiques \(CRM\)](#), Université de Montréal, as a part of the thematic program "[Mathematical Foundations of Data Science](#)."
- 2024: ANR-LabEx-CIMI Visiting professor, [Centre International de Mathématiques et Informatique de Toulouse \(CIMI\)](#), Toulouse, France, as a part of the thematic trimester "[Beyond classical regimes in statistical inference and machine learning](#)."
- 2023: Recipient of the 100 Talents 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.

Teaching Experiences

- 2017-2018: Signal and System 1 Practical Sessions (**undergraduate level**, 54 hours), with [Laurent Le Brusquet, CentraleSupélec](#), France.
- since 2021: Deep Learning and Computer Vision (**undergraduate level**, 16 hours per year), with [Xinggang Wang, EIC](#), HUST, China.
- since 2021: Probability and Stochastic Process (**graduate level**, 32 hours per year), with [Kai Wan, EIC](#), HUST, China.

Publications

I've co-authored a book and > 20 papers published on conferences and journals on machine learning, signal processing, and statistics, with > 850 citations and h-index = 15 according to [Google Scholar](#) (April 2024).

Books

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

Papers in conference proceedings

1. 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.
2. 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>.
3. **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>.

4. 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/dereziński21a.html>.
5. **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>.
6. 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>.
7. **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>.
8. 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>.
9. **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).
10. 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).
11. 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).
12. **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>.
13. **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>.
14. **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. 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](https://doi.org/10.1103/PhysRevA.108.022408).
2. 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](https://doi.org/10.3934/mcrf.2022021).
3. **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](https://doi.org/10.1088/1742-5468/ac3a77).
4. **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](https://doi.org/10.1109/TSP.2018.2889954).
5. 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](https://doi.org/10.1214/17-AAP1328).

Research Grants

- 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 Zenan Ling and Jeff Yao.
- 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.
- 2023-2025: **PI**, Research Fund from HUAWEI, “Random Matrix Driven Theory and Algorithm for Wireless Communication” (TC20231122043), ¥590K.
- 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.
- 2021-2022: **PI**, CCF-Hikvision Open Fund, Random Matrix Theory and Information Bottleneck for Neural Network Compression (20210008), ¥280K.
- 2021-2023: **PI**, Fundamental Research Funds for the Central Universities of China, Large Dimensional Random Matrix Methods in Machine Learning: Theory and Practice (No. 2021XXJS110), ¥500K, with Kai Wan.
- 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.
- 2018-2021: **contributor**, NSF Research Grant, Combining Stochastics and Numerics for Improved Scalable Matrix Computations (NSF-1815054), \$500K, PI: Michael W. Mahoney.
- 2018-2021: **contributor**, Programme d’Investissements d’avenir, GSTATS IDEX DataScience Chair, University of Grenoble-Alpes, €300K, PI: Romain Couillet.
- 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

- **General co-chair** of 10th EAI International Conference on IoT as a Service (EAI IoTaaS 2024), Wuhan, China, 2024.
- First workshop on High-dimensional Learning Dynamics (HiLD) at ICML 2023, Honolulu, USA, with Sanjeev Arora, SueYeon Chung, Murat Erdogdu, Surya Ganguli, and Andrea Montanari as plenary speakers.
- 2022 Joint workshop on “Math for Data Science” between HUST and University of Paris-Saclay, with more than 40 000 online attendees, see [playback](#).

Peer Reviewing

- 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: NeurIPS, ICML, ICLR, AISTATS, AAAI, ECAI, CAMSAP.
- Journals: Journal of Machine Learning Research (JMLR), IEEE Trans. on Pattern Analysis and Machine Intelligence (IEEE-TPAMI), IEEE Trans. on Signal Processing (IEEE-TSP), IEEE Trans. on Neural Networks and Learning Systems (IEEE-TNNLS), Transactions on Machine Learning Research (TMLR), Springer Statistics and Computing (STCO), SIAM Journal on Scientific Computing (SISC), Pattern Recognition (PR), Random Matrices: Theory and Applications (RMTA), Latin American Journal of Probability and Mathematical Statistics (ALEA), Foundations of Computational Mathematics (FoCM), Neural Processing Letters (NPL), PLOS ONE.

Tutorials and Invited Talks

- 5 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.
- 3 H mini-course on “Random Matrix Theory in Deep Learning: An Introduction”, Northeast Normal University, Changchun, Nov, 2023.
- 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.
- 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.
- Invited talk on “On the inversion bias of randomized sketching”, Shenzhen Conference on Random Matrix Theory and Applications (RMTA 2023), CUHK-Shenzhen, June, 2023.

- 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.
- Invited talk on “Random Matrix Methods for Machine Learning: with Applications to “Lossless” Compression and Training of DNNs”, Wuhan University, Wuhan, June, 2023.
- Invited talk on “Random Matrix Methods for Machine Learning: “Lossless” Compression of Large and Deep Neural Networks”, [NCIIP 2023](#), Changchun, Jinlin, May, 2023.
- 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.
- 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.
- 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.
- 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.
- Invited talk on “[Random Matrix Methods for Machine Learning](#)”, [Gaoling School of Artificial Intelligence](#), Renmin University of China, March, 2022.
- 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.
- Invited talk on “A Random Matrix Approach to Large Dimensional Machine Learning”, [AI+Math Colloquia](#), Institute of Natural Sciences, Shanghai Jiao Tong University, 2021.
- 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.
- 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.
- 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](#).
- 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.
- 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.
- Invited talk on “Performance-complexity Trade-off in Large Dimensional Spectral Clustering”, [STA 290 Seminar](#), Department of Statistics, University of California, Davis, 2021.
- 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 [video](#).
- 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.
- 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 [video](#).
- 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 [video](#).
- Invited talk on “Dynamical Aspects of Deep Learning” (with Y. Chitour), *Séminaire d'Automatique du plateau de Saclay of iCODE institute*, Paris, France, 2019.
- Invited talk on “Recent Advances in Random Matrix for Neural Networks”, *Workshop on deep learning theory*, Shanghai JiaoTong University, China, 2018.
- **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

- **Prof. 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

➤ Prof. Yacine Chitour

- Full Professor at Pairs-Sud, University Paris-Saclay, France.
- Director of the H-CODE institute, University Paris-Saclay, France.
- ✉ yacine.chitour@l2s.centralesupelec.fr

➤ Prof. 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