

# Hsin-Yuan Huang (Robert)

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## EDUCATION

**Ph.D., California Institute of Technology**

Oct. 2018 - Now

*Advised by John Preskill (Physics) and Thomas Vidick (CS).*

**B.S., National Taiwan University**

Sep. 2014 - Jun. 2018

*Studied in Computer Science (major) and Physics (minor). GPA: 4.30/4.30, Rank: 1/120.*

*Member of the Machine Learning and Data Mining Group; Advisor: Chih-Jen Lin*

## RESEARCH EXPERIENCE

Research Assistant, Institute for Quantum Information and Matter, Caltech

Oct. 2018 - Now

Research Intern, AWS Center for Quantum Computing, Mentor: Steven T. Flammia

Jun. 2021 - Sep. 2021

Research Intern, Google AI Quantum, Mentor: Jarrod R. McClean

Jun. 2020 - Oct. 2020

Visitor, Centre for Quantum Technologies, Host: Patrick Rebentrost

Jul. 2019 - Aug. 2019

Research Intern, Allen Institute for Artificial Intelligence, Mentor: Wen-tau Yih

Jun. 2018 - Sep. 2018

Research Intern, Microsoft Research, Redmond, USA, Mentor: Chenguang Zhu

Jun. 2017 - Sep. 2017

Research Assistant, Dept. of Computer Science, NTU, PI: Chih-Jen Lin

Sep. 2014 - Jun. 2018

Research Assistant, Dept. of Life Science, NTU, PI: Hsueh-Fen Juan

May 2013 - Aug. 2014

Research Assistant, Institute of Earth Sciences, Academia Sinica, PI: Fong Chao

Mar. 2012 - Mar. 2013

## ACADEMIC PAPERS

- [1] **H.-Y. Huang**, R. Kueng, G. Torlai, V. V. Albert, J. Preskill. Provably efficient machine learning for quantum many-body problems. *Science*, 2022. In *25th Annual Conference on Quantum Information Processing (QIP-22)*, 2022. (Plenary talk)
- [2] M. Cerezo, G. Verdon, **H.Y. Huang**, L. Cincio, P. Coles. Challenges and opportunities in quantum machine learning. *Nature Computational Science*, 2022.
- [3] M. C. Caro, **H.-Y. Huang**, M. Cerezo, K. Sharma, A. Sornborger, L. Cincio, P. J. Coles. Generalization in quantum machine learning from few training data. *Nature Communications*, 2022.
- [4] **H.-Y. Huang**, M. Broughton, J. Cotler, S. Chen, J. Li, M. Mohseni, H. Neven, R. Babbush, R. Kueng, J. Preskill, J. R. McClean. Quantum advantage in learning from experiments. *Science*, 2022.
- [5] **H.-Y. Huang**, S. Flammia, J. Preskill. Foundations for learning from noisy quantum experiments. arXiv preprint, arXiv:2204.13691, 2022. In *25th Annual Conference on Quantum Information Processing (QIP-22)*, 2022. (Contributed talk)
- [6] M. C. Caro<sup>†</sup>, **H.-Y. Huang<sup>†</sup> (co-first author)**, N. Ezzell, J. Gibbs, A. T. Sornborger, L. Cincio, P. J. Coles, Z. Holmes. Out-of-distribution generalization for learning quantum dynamics. arXiv preprint, arXiv:2204.10268, 2022.
- [7] J. Gibbs, Z. Holmes, M. C. Caro, N. Ezzell, **H.-Y. Huang**, L. Cincio, A. T. Sornborger, P. J. Coles. Dynamical simulation via quantum machine learning with provable generalization. arXiv preprint, arXiv:2204.10269, 2022.

- [8] **(alphabetical order)** A. Elben, S. Flammia, **H.-Y. Huang**, R. Kueng, J. Preskill, B. Vermersch, P. Zoller. The randomized measurement toolbox. arXiv preprint, arXiv:2203.11374, 2022.
- [9] **H.-Y. Huang**, Learning quantum states from their classical shadows. *Nature Review Physics*, 2022.
- [10] **(alphabetical order)** J. Cotler, **H.-Y. Huang**, J. R. McClean. Revisiting dequantization and quantum advantage in learning tasks. Technical manuscript, arxiv:2111:05874, 2021.
- [11] **(alphabetical order)** S. Chen, J. Cotler, **H.-Y. Huang**, J. Li. Exponential separation between learning with and without quantum memory. arXiv preprint, arxiv:2111:05881, 2021. In *62nd Annual IEEE Symposium on Foundations of Computer Science (FOCS-21)*, 2021. Invited to SIAM Journal of Computing Special Issue.
- [12] **(alphabetical order)** S. Chen, J. Cotler, **H.-Y. Huang**, J. Li. A hierarchy for replica quantum advantage. arXiv preprint, arxiv:2111:05874, 2021.
- [13] J. R. McClean, N. C. Rubin, J. Lee, M. P. Harrigan, T. E. O’Brien, R. Babbush, W. J. Huggins, **H.-Y. Huang**. What the foundations of quantum computer science teach us about chemistry. *Journal of Chemical Physics*, 2021.
- [14] **H.-Y. Huang**, R. Kueng, J. Preskill. Efficient estimation of Pauli observables by derandomization. *Physical Review Letters*, 2021.
- [15] J. Cotler<sup>†</sup>, D. Mark<sup>†</sup>, **H.-Y. Huang<sup>†</sup> (co-first author)**, F. Hernandez, J. Choi, A. L. Shaw, M. Endres, S. Choi. Emergent quantum state designs from individual many-body wavefunctions. arXiv preprint, arxiv:2103.03536, 2021.
- [16] J. Choi, A. Shaw, I. Madjarov, X. Xie, J. Covey, J. Cotler, D. Mark, **H.-Y. Huang**, A. Kale, H. Pichler, F. Brandao, S. Choi, M. Endres. Emergent Randomness and Benchmarking from Many-Body Quantum Chaos. arXiv preprint, arxiv:2103.03535, 2021.
- [17] **H.-Y. Huang**, R. Kueng, J. Preskill. Information-theoretic bounds on quantum advantage in machine learning. *Physical Review Letters (Editor’s Suggestion)*, 2021. In *24th Annual Conference on Quantum Information Processing (QIP-21)*, 2021 (Talk title: Fundamental aspects of solving quantum problems with machine learning).
- [18] Y. Su, **H.-Y. Huang**, E. Campbell. Nearly-tight Trotterization of interacting electrons. *Quantum*, 2021. In *24th Annual Conference on Quantum Information Processing (QIP-21)*, 2021.
- [19] **H.-Y. Huang**, M. Broughton, M. Mohseni, R. Babbush, S. Boixo, H. Neven, J. R. McClean. Power of data in quantum machine learning. *Nature Communications*, 2021. In *24th Annual Conference on Quantum Information Processing (QIP-21)*, 2021 (Talk title: Fundamental aspects of solving quantum problems with machine learning).
- [20] C.-F. Chen<sup>†</sup>, **H.-Y. Huang<sup>†</sup> (co-first author)**, R. Kueng, J. Tropp. Concentration for random product formulas. *PRX Quantum*, 2021.
- [21] **H.-Y. Huang**, K. Bharti, P. Rebentrost. Near-term quantum algorithms for linear systems of equations. *New Journal of Physics*, 2021.
- [22] M. Broughton, G. Verdon, T. McCourt, A. J. Martinez, J. H. Yoo, S. V. Isakov, P. Massey, R. Halavati, M. Y. Niu, A. Zlokapa, E. Peters, O. Lockwood, A. Skolik, S. Jerbi, V. Dunjko, M. Leib, M. Streif, D. V. Dollen, H. Chen, S. Cao, R. Wiersema, **H.-Y. Huang**, J. R. McClean, R. Babbush, S. Boixo, D. Bacon, A. K. Ho, H. Neven, M. Mohseni. TensorFlow Quantum: A Software Framework for Quantum Machine Learning. Technical manuscript, arXiv:2003.02989, 2020.

- [23] A. Elben, R. Kueng, **H.-Y. Huang**, R. van Bijnen, C. Kokail, M. Dalmonte, P. Calabrese, B. Kraus, J. Preskill, P. Zoller, B. Vermersch. Mixed-state entanglement from local randomized measurements. *Physical Review Letters*, 2020.
- [24] **H.-Y. Huang**, R. Kueng, J. Preskill. Predicting many properties in a quantum system from very few measurements. *Nature Physics*, 2020. In *23rd Annual Conference on Quantum Information Processing (QIP-20)*, 2020. (Single-track talk)
- [25] **H.-Y. Huang**, E. Choi, W. Yih. FlowQA: grasping flow in history for conversational machine comprehension. In *7th International Conference on Learning Representations (ICLR-19)*, 2019.
- [26] **H.-Y. Huang**, C. Zhu, Y. Shen, W. Chen. FusionNet: Fusing via Fully-aware attention with application to machine comprehension. In *6th International Conference on Learning Representations (ICLR-18)*, 2018. (top 3% in review score)
- [27] H.-F. Yu, **H.-Y. Huang**, I. S. Dhillon, C.-J. Lin. A unified algorithm for one-class structured matrix factorization with side information. In *31st AAAI Conference on Artificial Intelligence (AAAI-17)*, 2017. (acceptance rate: 24.6%)
- [28] **H.-Y. Huang**, C.-J. Lin. Linear and kernel classification: When to use which? In *SIAM International Conference on Data Mining (SDM-16)*, 2016. (acceptance rate: 25.8%)
- [29] C.-Y. Chen, A. Ho, **H.-Y. Huang**, H.-F. Juan and H.-C. Huang. Dissecting the human protein-protein interaction network via phylogenetic decomposition. In *Scientific Reports*, 4, 7153 (2014).

## SELECTED AWARDS AND HONORS

### Google Ph.D. Fellowship

#### Awards for Academic Excellence:

*First Place Scholarship, Ministry of Education (awarded to Olympiad medalists ranking top 1)*

2015, 2016, 2017, 2018

*Presidential Award, National Taiwan University (awarded to students ranking top 5%)*

Fall / Spring 2015, 2016, 2017, 2018

#### Awards for Competition in Algorithm and Informatics:

*25th International Olympiad in Informatics, Bronze Medal*

Jul. 2013

*2013 Asia-Pacific Informatics Olympiad, Silver Medal*

May 2013

*National Informatics Olympiad in Taiwan, First Place*

Dec. 2012

## TALKS

- [1] "Quantum advantage in learning from experiments". Invited Talk at Hybrid Quantum Classical Computation workshop hosted by Andris Ambainis, Sep. 14th, 2022.
- [2] "Quantum advantage in learning from experiments". Invited Talk at the Joint Colloquium, National Taiwan University, Sep. 13th, 2022.
- [3] "Quantum advantage in learning from experiments". Invited Talk at 17th Conference on the Theory of Quantum Computation, Communication and Cryptography (TQC-22), Jul. 11th, 2022.
- [4] "Quantum advantage in learning from experiments". Invited Lecture at Los Alamos Quantum Computing Summer School, Jul. 7th, 2022.
- [5] "Quantum advantage in learning from experiments". Invited Talk at MediaTek, Jul. 3rd, 2022.
- [6] "Quantum advantage in learning from experiments". Invited Talk at IBM Qiskit Quantum Seminar, Jun. 24th, 2022.

- [7] "Learning from quantum experiments". Invited talk, Quantum and Lattices Joint Reunion Workshop at Simons Institute, Jun. 14th, 2022.
- [8] "Foundations for learning from noisy quantum experiments". Invited talk, Quantum Research Seminars Toronto, May. 31st, 2022.
- [9] "Quantum advantage in learning and making predictions". Invited Banquet Talk at QSC Quantum Algorithms Workshop, May. 19th, 2022.
- [10] "Quantum advantage in learning from experiments". Contributed Talk at Caltech Balleroy Meeting, May. 13th, 2022.
- [11] "Quantum advantage in learning from experiments". Invited Talk at CIFAR QIS program meeting, Apr. 22nd, 2022.
- [12] "Quantum advantage in learning from experiments". Invited Talk at Quantum Science Center Hot Topics Talk, Apr. 14th, 2022.
- [13] "Quantum advantage in learning from experiments". Invited Talk at QuICS, University of Maryland, Apr. 8th, 2022.
- [14] "Predicting many properties of a quantum system from very few measurements". Invited Talk at Lawrence Berkeley National Laboratory, Mar. 31st, 2022.
- [15] "Power of data in quantum machine learning". Invited Talk at QuEra, Mar. 31st, 2022.
- [16] "Quantum advantage in learning from experiments". Invited Talk at Harvard Quantum Initiative Special Seminar, Mar. 25th, 2022.
- [17] "Provably efficient machine learning for quantum many-body problems". Invited Talk at Math Picture Language Seminar, Mar. 22nd, 2022.
- [18] "Making predictions in a quantum world". Invited Talk at APS March Meeting, Mar. 18th, 2022.
- [19] "Foundations for learning from noisy quantum experiments". Contributed talk, 25th Annual Conference on Quantum Information Processing (QIP-22), Mar. 7th, 2022.
- [20] "Provably efficient machine learning for quantum many-body problems". Plenary talk, 25th Annual Conference on Quantum Information Processing (QIP-22), Mar. 7th, 2022.
- [21] "Information-theoretic bounds on quantum advantage in machine learning". Invited talk at PsiQuantum, Mar. 1st, 2022.
- [22] "Predicting many properties of quantum systems from very few measurements". Invited Talk at Graeme Smith's group at CU Boulder / JILA. Feb. 22th, 2022.
- [23] "Making predictions in a quantum world". Invited Talk at CTQM Seminar, CU Boulder / JILA. Feb. 18th, 2022.
- [24] "Quantum advantage in learning from experiments". Invited Talk at Los Alamos National Laboratory, Jan. 20th, 2022.
- [25] "Making predictions in a quantum world". Invited Talk at Quantum Colloquium, Simons Institute for the Theory of Computing. Nov. 30th, 2021.
- [26] "Provably efficient machine learning for quantum many-body problems". Invited Talk at Shivaji Sondhi's group at Oxford University. Nov. 19th, 2021.
- [27] "Information-theoretic bounds on quantum advantage in machine learning". Invited talk at the International Conference on Quantum Techniques in Machine Learning (QTML), Nov. 9th, 2021.

- [28] "Provably efficient machine learning for quantum many-body problems". Invited Talk at Perimeter Institute. Oct. 20th, 2021.
- [29] "Provably efficient machine learning for quantum many-body problems". Quantum Creators Prize Symposium. Sep. 29th, 2021.
- [30] "Provably efficient machine learning for quantum many-body problems". Invited Talk at QuSoft. Sep. 17th, 2021.
- [31] "Provably efficient machine learning for quantum many-body problems". Invited Talk at MIT/Harvard QML Journal Club. Sep. 2nd, 2021.
- [32] "Power of data in quantum machine learning". Invited Talk at QML Meetup. Aug. 26th, 2021.
- [33] "Provably efficient machine learning for quantum many-body problems". Invited Talk at Technical University of Munich. Jul. 26th, 2021.
- [34] "Experimental advantage in learning with noisy quantum memory". Invited Talk at Google Quantum Summer Symposium. Jul. 22nd, 2021.
- [35] "Provably efficient machine learning for quantum many-body problems". Invited Talk at Simons Institute for the Theory of Computing. Jul. 15th, 2021.
- [36] "How can we estimate properties of many-body quantum states in a Rydberg-atom system?". Theory Talk at Quantum Systems Accelerator meetings. Jul. 14th, 2021.
- [37] "Experimental advantage in learning with noisy quantum memory". Invited Talk at Google Quantum AI Theory Meeting. Jul. 13th, 2021.
- [38] "Provably efficient machine learning for quantum many-body problems". Invited Talk at Max Planck Institute of Quantum Optics. Jul. 13th, 2021.
- [39] "Predicting many properties of quantum systems from very few measurements". Invited Talk at Cornell University. May 20th, 2021.
- [40] "Recent advances on predicting properties of quantum many-body systems". Invited Talk at Peking University. May 12th, 2021.
- [41] "Information-theoretic bounds on quantum advantage in machine learning". Invited talk at IBM Research, May 5th, 2021.
- [42] "Information-theoretic bounds on quantum advantage in machine learning". Invited talk at Microsoft Research, Apr. 26th, 2021.
- [43] "Making predictions in the quantum world". Invited talk at Quantum Information Processing Seminar, Massachusetts Institute of Technology, Apr. 23rd, 2021.
- [44] "Information-theoretic bounds on quantum advantage in machine learning". Invited talk at Duke University, Apr. 16th, 2021.
- [45] "Characterizing quantum advantage in machine learning". Invited Talk at Scientific Machine Learning Series, Carnegie Mellon University. Apr. 15th, 2021.
- [46] "Power of data in quantum machine learning". Invited Talk at Rigetti Computing. Apr. 14th, 2021.
- [47] "Recent advances on predicting properties of quantum many-body systems". Invited Talk at the 6th International Conference for Young Quantum Information Scientists. Apr. 12th, 2021.
- [48] "Fundamental aspects of solving quantum problems with machine learning". Los Alamos National Laboratory, Mar. 25th, 2021.

- [49] "Power of data in quantum machine learning". APS March Meeting, Mar. 18th, 2021.
- [50] "Information-theoretic bounds on quantum advantage in machine learning". Invited talk at IST seminar series on Mathematics, Physics & Machine Learning, Mar. 17th, 2021.
- [51] "Power of data in quantum machine learning". Invited talk at SIAM Conference on Computational Science and Engineering, Mar. 3rd, 2021.
- [52] "Fundamental aspects of solving quantum problems with machine learning". Caltech Institute for Quantum Information and Matter (IQIM) Seminar, Feb. 26th, 2021.
- [53] "Fundamental aspects of solving quantum problems with machine learning". QuICS Seminar, University of Maryland, Feb. 17th, 2021.
- [54] "Fundamental aspects of solving quantum problems with machine learning". Contributed talk, 24rd Annual Conference on Quantum Information Processing (QIP-21), Jan. 30-31, 2021.
- [55] "Information-theoretic bounds on quantum advantage in machine learning". Invited talk at National Tsing Hua University, Jan. 12th, 2021.
- [56] "Information-theoretic bounds on quantum advantage in machine learning". Invited talk at Academia Sinica, Jan. 8th, 2021.
- [57] "Predicting Many Properties of a Quantum System from Very Few Measurements", National Taiwan University, Center for Quantum Science and Engineering, Dec. 18th, 2020.
- [58] "Predicting Many Properties of a Quantum System from Very Few Measurements", University College London, Quantum Information Seminar, Nov. 27th, 2020.
- [59] "Power of data in quantum machine learning", Centre for Quantum Technologies, Quantum Machine Learning Seminar, Nov. 26th, 2020.
- [60] "Predicting Many Properties of a Quantum System from Very Few Measurements", Caltech Institute for Quantum Information and Matter (IQIM) Seminar, Apr. 17th, 2020.
- [61] "Predicting Features of Quantum Systems using Classical Shadows", Single-track talk, 23rd Annual Conference on Quantum Information Processing (QIP-20), Jan. 6-10, 2020.
- [62] "Understanding Machine Reading Comprehension", Invited Talk, Academia Sinica, Oct 16, 2017.
- [63] "A Unified Algorithm for One-class Structured Matrix Factorization with Side Information", 31st AAAI Conference on Artificial Intelligence (AAAI-17), Feb. 4-9, 2017.
- [64] "Linear and Kernel Classification: When to Use Which?", SIAM International Conference on Data Mining (SDM16), May 5-8, 2016.
- [65] "Linear and Kernel Classifier: When to Use Which?", Spotlight presentation (acceptance rate: 11%), Machine Learning Summer School (MLSS'15), Kyoto University, August 23-September 4, 2015.
- [66] "Brief Introduction to Automatic Machine Learning", Science Exploration Forum, National Taiwan University, August 11, 2015.
- [67] "Dissecting Human Protein-Protein Interaction Network via Phylogenetic Decomposition." 14th International Conference on Systems Biology (ICSB2013), August 30-September 3, 2013.

## TEACHING EXPERIENCE

Guest lecture on "Predicting properties in quantum systems" at Harvard University (2022).

Guest lecture on "Learning quantum states" at Caltech (2021).

Lecture on "Online learning" at Caltech (2020).

Teaching Assistant: Introduction to the Theory of Computation (2017).

## SYNERGISTIC ACTIVITY

Conference review: NeurIPS, QIP, ICML, STOC, SODA, Asia Pacific Bioinformatics Conference.

Journal review: Nature, Physical Review Letters, npj Quantum Information, npj Quantum Materials, Quantum, Physical Review A, Quantum Machine Intelligence, Data Mining and Knowledge Discovery.

Conference volunteer: QIP 2022, AAAI 2017.

## OTHER AWARDS AND HONORS

<i>MediaTek Research Young Scholarship</i>	<i>Dec. 2021</i>
<i>Quantum Creators Prize</i>	<i>Sep. 2021</i>
<i>J. Yang Scholarship</i>	<i>Oct. 2020</i>
<i>Kortschak Scholarship</i>	<i>Oct. 2018</i>
<i>Taiwan Government Scholarship to Study Abroad</i>	<i>Sep. 2019</i>
<i>The Phi Tau Phi Scholastic Honor Society of the Republic of China</i>	<i>Jun. 2018</i>
<i>Undergraduate Research Project Exhibition, First Place</i>	<i>Jun. 2017</i>
<i>Appier Scholarship</i>	<i>Apr. 2016, Feb. 2017</i>
<i>AAAI Conference on Artificial Intelligence 2017 Scholarship</i>	<i>Feb. 2017</i>
<i>Shih-Liang Chien Memorial Award</i>	<i>May. 2016</i>
<i>SIAM International Conference on Data Mining 2016 Travel Award</i>	<i>Apr. 2016</i>
<i>Machine Learning Summer School 2015 Travel Award</i>	<i>Oct. 2015</i>
<i>Wang Da Gang Natural Science Scholarship</i>	<i>May 2013</i>
<i>Taiwan International Science Fair, Third Prize</i>	<i>Nov. 2012</i>
<i>Science Research Grant for High School Student, First Prize</i>	<i>Nov. 2012</i>
<i>Taipei High School Informatics Competition, First Place</i>	<i>Oct. 2012</i>
<i>Taipei High School Informatics Competition, Third Place</i>	<i>Oct. 2011</i>