Hsin-Yuan Huang (Robert)

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RESEARCH STATEMENT

I am a Ph.D. student at Caltech. I am broadly interested in the interplay between quantum systems, information, and machine learning. On the fundamental science side, the study of quantum systems and information has led to a deeper understanding of exotic phases of matter, topological quantum matter, and quantum gravity. On the engineering side, I am interested in the synergy between machine learning and quantum architectures. On the pure learning side, I am captivated by generalization, especially those of combinatorial forms. I have previously worked on statistical machine learning, optimization, and deep learning applications in natural language understanding.

EDUCATION

Ph.D., California Institute of Technology Oct. 2018 - Now

Advised by John Preskill (Physics) and Thomas Vidick (CS, Math).
Participating in "Quantum Machine Learning for High Energy Physics" led by Maria Spiropulu (Caltech), Seth Lloyd (MIT) and Daniel Lidar (USC).

B.S., National Taiwan University Sep. 2014 - Jun. 2018

Studied in Computer Science and Physics. 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
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**. On the Existence of Exponential Quantum Advantage in Sample Complexity for Machine Learning. In preparation, 2019.

[2] **H.-Y. Huang**, K. Bharti, P. Rebentrost. Near-Term Quantum Algorithms for Linear Systems of Equations. arXiv preprint, arxiv:1909.07344, 2019.

[3] **H.-Y. Huang**, R. Kueng. Predicting Features of Quantum Systems using Classical Shadows. arXiv preprint, arxiv:1908.08909, 2019.

[4] **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.

[5] **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)

[6] 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%)

[7] **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%)

[8] 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

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*

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

SELECTED PROJECTS

Near-Term Quantum Algorithm for Linear Systems May 2019 – Now
Research Assistant at Institute for Quantum Information and Matter, Caltech
Visitor at Centre for Quantum Technologies

- Solving linear systems of equations is crucial and quantum computers promise large speedups.
- Analyze the optimization landscape in variational quantum algorithms and found significant problems.
- Develop an alternative approach for near-term quantum computers that circumvent this newly observed issues.
- Perform numerical simulation of the quantum algorithm to solve linear systems of size $2^{300} \times 2^{300}$.

Learning Efficient Classical Representation of Quantum Systems Feb 2019 – Now
Research Assistant at Institute for Quantum Information and Matter, Caltech

- Learning and characterizing quantum systems are important for the development of quantum technologies.
- Obtaining a complete description of a quantum systems require exponential resources.
- We develop an optimal learning procedure for learning an approximate classical description *(classical shadow)* of the quantum systems that can be used to provably predict large number of features.
- Due to the optimality, it outperforms existing machine learning approaches based on generative models.

Machine Reading Comprehension Jun. 2017 – Oct. 2018
Research Intern at Microsoft AI+Research, Redmond, USA
Research Intern at Allen Institute for Artificial Intelligence

- Teach machines to read and understand an arbitrary passage then answer any question on the passage.
- Achieve a new state-of-the-art on the competitive Stanford Question Answering Dataset (SQuAD).
- Follow-up work consider machine reading comprehension in a conversational setup.
- Performs significantly better (+4% to +7%) on various conversational QA datasets.

Human Protein-Protein Interaction Network May 2013 – Aug. 2014
Research Assistant supervised by Professor Hsueh-Fen Juan, National Taiwan University

- Data analysis on human protein-protein interaction network to reveal hidden properties.

- Simulate the evolution of human protein network using our proposed perturbation avoidance model.

ORAL AND POSTER PRESENTATIONS

[1] "Understanding Machine Reading Comprehension", Invited Talk, Academia Sinica, Oct 16, 2017.

[2] "A Unified Algorithm for One-class Structured Matrix Factorization with Side Information", 31st AAAI Conference on Artificial Intelligence (AAAI-17), Feb. 4-9, 2017.

[3] "Linear and Kernel Classification: When to Use Which?", SIAM International Conference on Data Mining (SDM16), May 5-8, 2016.

[4] "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.

[5] "Brief Introduction to Automatic Machine Learning", Science Exploration Forum, National Taiwan University, August 11, 2015.

[6] "Dissecting Human Protein-Protein Interaction Network via Phylogenetic Decomposition." 14th International Conference on Systems Biology (ICSB2013), August 30-September 3, 2013.

SYNERGISTIC ACTIVITY

Organizing a stand for LIBSVM at Future Tech Exhibition, Taipei World Trade Center (2017).

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

Conference volunteer: AAAI Conference on Artificial Intelligence (2017).

Conference review: Asia Pacific Bioinformatics Conference (2017).

Journal review: Data Mining and Knowledge Discovery (2016).

OTHER AWARDS AND HONORS

Kortschak Scholarship	*Oct. 2018*
The Phi Tau Phi Scholastic Honor Society of the Republic of China	*Jun. 2018*
Undergraduate Research Project Exhibition, First Place	*Jun. 2017*
Appier Scholarship	*Apr. 2016, Feb. 2017*
AAAI Conference on Artificial Intelligence 2017 Scholarship	*Feb. 2017*
Shih-Liang Chien Memorial Award	*May. 2016*
SIAM International Conference on Data Mining 2016 Travel Award	*Apr. 2016*
Machine Learning Summer School 2015 Travel Award	*Oct. 2015*
Wang Da Gang Natural Science Scholarship	*May 2013*
Taiwan International Science Fair, Third Prize	*Nov. 2012*
Science Research Grant for High School Student, First Prize	*Nov. 2012*
Taipei High School Informatics Competition, First Place	*Oct. 2012*
Taipei High School Informatics Competition, Third Place	*Oct. 2011*