

KAREEM HEGAZY

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EDUCATION

Stanford University: Physics Ph.D Candidate (GPA: 3.91) Sep 2014 - Dec 2022

- Research: Applying statistical and machine learning techniques to ultrafast molecular dynamics measurements
- Machine Learning Classes: CS229/ML, CS221/AI, CS231n/CNN, CS224n/NLP

University of Michigan: B.Sc in Physics and Math with Highest Honors Sep 2009 - Jun 2014

- Research: Improved mass and spin measurement used in discovery of the Higgs Boson particle
- Awards: 2014 William L. William award for best undergraduate thesis, 2012-2014 Angell Scholar for consecutive straight A grades, 2011 Otho Lyle & Mary Lois Tiffany Fellowship for promising undergraduate physicists

EXPERIENCE

SLAC National Lab (Researcher): Visualizing Quantum Molecular Dynamics June 2014 - Present

- **Molecular Movies:** Rigorously derived a novel statistical analysis that upends 50 years of imaging quantum molecular dynamics (“molecular movies”) from time-dependent diffraction data.
 - Improved resolution by 100X and transformed this measurement to surpass theory, making it discovery-oriented
 - Solely derived the Bayesian Inferencing statistical approach and primarily derived the physics theory
 - Worked independently with little oversight, and now lead a multi-group effort to expand my method
 - Combining disparate datasets across experimental paradigms into a single measurement with induced dynamics
 - Developed and improved methods to analyze unprocessed data to retrieve small signals of roughly 3% variation

Google X (AI Residency): Investigating Fundamentals of Neural Networks Jun 2019 - Dec 2019

- **Adversarial Example Transferability:** Probed fundamental neural network structures using transferability
 - Primary researcher who built and analyzed a large dataset of adversarial examples and calculated transferability
 - Measured feature representation similarities across disparate architectures as a function of training

Stanford University (Graduate Student): Projects Jun 2014 - Present

- **Generalizing Word Vectors in a Multimodal Approach:** Designed a novel stacking based neural network to experiment with contextualization by generalizing various methods. (SQuAD: F1=70.9, EM=60.27)
- **Image Sentiment Classification:** Compared architectures and classified Reddit images into sub-reddits with multitask learning on ResNet, GoogleNet, and AlexNet (achieved 94.5% ResNet accuracy)
- **Comparative Automated Bitcoin Trading Strategies:** Built and compared five machine learning models. Identified the optimal model to consistently outperform the market over 250 days (55.7% profitable decisions)
- **ImageTrust (Ethereum dApp):** Created alternative to existing secure software management and validation systems with licensing capabilities: a decentralized “app store” on the Ethereum blockchain

Ople.ai (Intern): AI Model Development Jan 2018 - Mar 2018

- Constructed hot swappable version of stacked AI models to learn random data sets

CERN (Researcher): High Energy Physics Researcher Sep 2010 - Sep 2014

- **Higgs Boson Particle Measurement:** Performed key measurements used in discovering the Higgs Boson.
 - Created a new Higgs mass error estimation required for the spin measurement
 - Primary contributor to Higgs’ spin measurement: required to validate the Standard Model of particle physics.

SKILLS AND INTERESTS

Programming Languages

C/C++, Python, TensorFlow/Keras, JAX, Node, javascript, Solidity, Bash, SQL, LaTeX, ROOT

Extracurricular

Crypto-currency (algorithmic and manual) trading, blockchain (runner-up award at Ethereum Hackathon), tutoring, volunteering, scuba (PADI rescue diver), skiing, backpacking

PUBLICATIONS

Primary Researcher

1. Kareem Hegazy, Varun Makhija, Phil Bucksbaum, Jeff Corbett, James Cryan, Nick Hartmann, Markus Ilchen, Keith Jobe, Li Renkai, Igor Makasyuk, Xiaozhe Shen, Xijie Wang, Stephen Weathersby, Jie Yang, and Ryan Coffee. Bayesian inferencing and deterministic anisotropy for molecular geometry retrieval in gas phase diffraction experiments. Accepted (in principal) to Nature Communications Physics, July 2023
2. Kareem Hegazy, Li Renkai, Ming-Fu Lin, Brian Moore, Xiaozhe Nunes, Pedro Shen, Xijie Wang, Stephen Weathersby, Jie Yang, and Thomas Wolf. Investigating dissociation pathways in photoinduced no abstraction from nitrobenzene via electron diffraction. To be submitted for publication in Physical Review A, August 2023
3. Rex Brown, Tiesheng Dai, Kareem Hegazy, Bing Li, Lulu Liu, Jianbei Liu, Bing Zhou, and Junjie Zhu. Commissioning of the end-cap extension in the atlas muon spectrometer. *ATLAS Internal Note*, 2011

Contributing Researcher

1. Jie Yang, Xiaolei Zhu, Thomas J. A. Wolf, Zheng Li, J. Pedro F. Nunes, Ryan Coffee, James P. Cryan, Markus Gühr, Kareem Hegazy, Tony F. Heinz, Keith Jobe, Renkai Li, Xiaozhe Shen, Theodore Vecchione, Stephen Weathersby, Kyle J. Wilkin, Charles Yoneda, Qiang Zheng, Todd J. Martinez, Martin Centurion, and Xijie Wang. Imaging cf3i conical intersection and photodissociation dynamics with ultrafast electron diffraction. *Science*, 361(6397):64–67, 2018
2. E. G. Champenois, D. M. Sanchez, J. Yang, J. P. Figueira Nunes, A. Attar, M. Centurion, R. Forbes, M. Ghr, K. Hegazy, F. Ji, S. K. Saha, Y. Liu, M.-F. Lin, D. Luo, B. Moore, X. Shen, M. R. Ware, X. J. Wang, T. J. Martinez, and T. J. A. Wolf. Conformer-specific photochemistry imaged in real space and time. *Science*, 374(6564):178–182, 2021
3. T. J. A. Wolf, D. M. Sanchez, J. Yang, R. M. Parrish, J. P. F. Nunes, M. Centurion, R. Coffee, J. P. Cryan, M. Gühr, K. Hegazy, A. Kirrander, R. K. Li, J. Ruddock, X. Shen, T. Vecchione, S. P. Weathersby, P. M. Weber, K. Wilkin, H. Yong, Q. Zheng, X. J. Wang, M. P. Minitti, and T. J. Martínez. The photochemical ring-opening of 1,3-cyclohexadiene imaged by ultrafast electron diffraction. *Nature Chemistry*, 11(6):504–509, Jun 2019
4. Jie Yang, Markus Guehr, Xiaozhe Shen, Renkai Li, Theodore Vecchione, Ryan Coffee, Jeff Corbett, Alan Fry, Nick Hartmann, Carsten Hast, Kareem Hegazy, Keith Jobe, Igor Makasyuk, Joseph Robinson, Matthew S. Robinson, Sharon Vetter, Stephen Weathersby, Charles Yoneda, Xijie Wang, and Martin Centurion. Diffractive imaging of coherent nuclear motion in isolated molecules. *Phys. Rev. Lett.*, 117:153002, Oct 2016
5. Yusong Liu, Spencer L. Horton, Jie Yang, J. Pedro F. Nunes, Xiaozhe Shen, Thomas J. A. Wolf, Ruaridh Forbes, Chuan Cheng, Bryan Moore, Martin Centurion, Kareem Hegazy, Renkai Li, Ming-Fu Lin, Albert Stolow, Paul Hockett, Tamás Rozgonyi, Philipp Marquetand, Xijie Wang, and Thomas Weinacht. Spectroscopic and structural probing of excited-state molecular dynamics with time-resolved photoelectron spectroscopy and ultrafast electron diffraction. *Phys. Rev. X*, 10:021016, Apr 2020
6. Siqi Li, Zhaoheng Guo, Ryan N. Coffee, Kareem Hegazy, Zhirong Huang, Adi Natan, Timur Osipov, Dipanwita Ray, Agostino Marinelli, and James P. Cryan. Characterizing isolated attosecond pulses with angular streaking. *Opt. Express*, 26(4):4531–4547, Feb 2018
7. S. Li, E. G. Champenois, R. Coffee, Z. Guo, K. Hegazy, A. Kamalov, A. Natan, J. O'Neal, T. Osipov, M. Owens, D. Ray, D. Rich, P. Walter, A. Marinelli, and J. P. Cryan. A co-axial velocity map imaging spectrometer for electrons. *AIP Advances*, 8(11):115308, 2018

Projects

1. Kareem Hegazy. Generalizing word vectors in a multi model approach. *CS224n project*, 2018
2. Tyler Chase, Rolland He, and Kareem Hegazy. Deep visual learning of reddit images. *CS231n project*, 2017
3. Kareem Hegazy and Samuel Mumford. Comparative automated bitcoin trading strategies. *CS229 project*, 2016