

Charlie Godfrey

[godfrey-cw.github.io](https://github.com/godfrey-cw) | godfrey.cw@gmail.com | www.linkedin.com/in/godfrey-cw

Skills

Research: empirical science of foundation models, interpretable and explainable artificial intelligence, evaluating and understanding trustworthiness of machine learning systems

Data modalities: natural language processing, computer vision, reinforcement learning

Tools: ML frameworks (PyTorch, HuggingFace, DeepSpeed, lightgbm, scikit-learn), core data science libraries (NumPy, SciPy, Pandas, Matplotlib, Seaborn, Jupyter Notebooks), search and information retrieval (ElasticSearch, dense retrieval/vector search with approximate nearest neighbor algorithms), DevOps/MLOps (Git, Bash, Linux, Tensorboard, MLFlow), cloud environments (AWS EC2, S3, SageMaker, OpenSearch)

Experience

Applied Machine Learning Scientist, Thomson Reuters Labs

October 2023 - Present

- Conducted experiments to measure and improve quality of an AI assistant for a tax research product
 - Ran human evaluation experiments to assess quality of a search result summarization retrieval-augmented generation (RAG) pipeline, working with product and content editors to make rubrics for subject matter expert grading, running the RAG system on an evaluation set, uploading output to an annotation platform and analyzing results
 - Upgraded RAG pipeline by replacing full documents with (re-ranked) chunks, resulting in increased relevance of LLM input and better control of LLM context window usage
 - Engineered prompts, incorporating role-setting and guidelines in a system prompt, refining few-shot examples, “putting words in the LLM’s mouth” to ensure a correct beginning of the answer, and adding a stop sequence to avoid any excess generation
 - Wrote code integrated in a complex distributed system consisting of multiple search engines, models trained on proprietary data and an LLM-as-a-service, working with a cross-functional team including product managers, tax experts, software engineers and scientists with a tight beta-release deadline
- Trained and evaluated a re-ranking model for passages of editorial content to be displayed in search results (most used new feature of a legal research product as measured by user interaction data)
 - Designed efficient queries of an OpenSearch index to retrieve passages to be ranked
 - Worked closely with product team to align on success metrics for model selection, and with engineering team to ensure compatibility of model API with surrounding application
 - Improved rate at which best available snippet is selected by over 5%, while ensuring robustness to changes in the upstream search engine
 - Resulting model is being deployed to production as a SageMaker endpoint

Research Associate, Machine Learning, Pacific Northwest National Laboratory
National Security Directorate, Mathematics of Data Science Team

October 2021 - October 2023

- Adapted high-efficiency MosaicBERT language model training to internal cluster computer environment, obtaining 50% improvement in throughput (tokens/second) and dramatically reducing cost of training; in situations where compute budget was fixed, this resulted in increased model accuracy
- Improved performance of segmentation models for multispectral satellite images (5 % relative increase in Intersection-over-Union) by implementing multi-GPU distributed training, which facilitated learning for more epochs

- Accelerated training of neural image compressors (from 3 minutes to 6 seconds per epoch) with a modernized data loading and preprocessing pipeline. This allowed for more rapid hyperparameter sweeps to optimize performance
- Investigated safety and security of machine learning systems; constructed datasets to measure out-of-distribution performance of computer vision models
- Presented results to senior leadership and project sponsors in the form of slide decks and technical reports — comfortable conveying research findings at appropriate level of technical detail

Program Associate, [Mathematical Sciences Research Institute](#)

March-May 2019

- Participated in the Birational Geometry and Moduli Spaces semester program
- Presented research on logarithmic Chow-to-Hodge cycle maps at the institute's graduate student seminar

Education

PhD in Mathematics, The University of Washington-Seattle

June 2021

- Thesis: *Higher Direct Images of Ideal Sheaves, Correspondences in Log Hodge Cohomology and Globally F-Full Varieties*
- Completed the [eScience Institute's Advanced Graduate Data Science Option](#) (PhD-level courses in machine learning, data visualization and statistical inference, implemented machine learning methods like LASSO, kernel regression and k-means clustering in raw NumPy and SciPy)
- Department of Mathematics Graduate Fellowship (2018-2019)

Student, [MSRI Mathematics of Machine Learning Summer Graduate School](#)

July 29-August 9 2019

- Attended mini-courses and problem sessions on statistical learning, convex optimization, deep learning and reinforcement learning
- Presented an expository account of recent work on linear stochastic bandits

Master's of Science in Mathematics, The University of Washington-Seattle

June 2018

Bachelor's of Science in Mathematics and Physics, The University of Wisconsin-Madison

May 2014

Mentoring

Industry Mentor, [Math-to-Industry Boot Camp](#)

July 2023-August 2023

- Mentored a team of math PhD students evaluating the usefulness of GPT-type large language models for scientific knowledge retrieval and the robustness of Segment Anything for person (e.g. pedestrian) detection
- To facilitate this capstone project, implemented a Segment Anything inference endpoint using TorchServe and provided a notebook demonstrating inference using the HuggingFace API

Graduate Mentor, [Washington Experimental Math Laboratory](#)

January 2019-December 2020

- Mentored undergraduate research projects on foundations of quantum mechanics and mathematical epidemiology

Publications

Main Track

1. Davis Brown, **Charles Godfrey**, Nicholas Konz, Jonathan Tu and Henry Kvinge. [Understanding the Inner Workings of Language Models Through Representation Dissimilarity](#). In *EMNLP 2023*.
2. Kelsey Lieberman, James Diffenderfer, **Charles Godfrey** and Bhavya Kailkhura. [Neural Image Compression: Generalization, Robustness, and Spectral Biases](#). In *NeurIPS 2023* (was also selected for an oral presentation at the *ICML 2023 Workshop Neural Compression: From Information Theory to Applications*).

3. **Charles Godfrey**, Davis Brown (equal contribution), Tegan Emerson and Henry Kvinge. [On the Symmetries of Deep Learning Models and their Internal Representations](#). In *NeurIPS 2022*. **Code available at github.com/pnnl/modelsym**.

Workshop

1. Nicholas Konz, **Charles Godfrey**, Madelyn Shapiro, Jonathan Tu, Henry Kvinge and Davis Brown. [Attributing Learned Concepts in Neural Networks to Training Data](#). In *The 1st Workshop on Attributing Model Behavior at Scale at NeurIPS 2023*, **selected for oral presentation**.
2. **Charles Godfrey**, Henry Kvinge, Elise Bishoff, Myles McKay, Davis Brown, Tim Doster and Eleanor Byler. [How many dimensions are required to find an adversarial example?](#). In *The 3rd Workshop of Adversarial Machine Learning on Computer Vision at CVPR 2023*, **selected for oral presentation**.
3. **Charles Godfrey**, Michael Rawson, Henry Kvinge and Davis Brown. [Fast computation of permutation equivariant layers with the partition algebra](#). In *ICLR 2023 Workshop on Physics for Machine Learning*.
4. Davis Brown, **Charles Godfrey** (equal contribution), Cody Nizinski, Jonathan Tu, Henry Kvinge. [Robustness of edited neural networks](#). In *ICLR 2023 Workshop on Mathematical and Empirical Understanding of Foundation Models*.
5. Henry Kvinge, Davis Brown and **Charles Godfrey**. [Exploring the Representation Manifolds of Stable Diffusion Through the Lens of Intrinsic Dimension](#). In *ICLR 2023 Workshop on Mathematical and Empirical Understanding of Foundation Models*, **featured in The Gradient**.
6. **Charles Godfrey**, Elise Bishoff, Myles McKay and Eleanor Byler. [Impact of architecture on robustness and interpretability of multispectral deep neural networks](#). In *SPIE Defense + Commercial Sensing 2023*.
7. Elizabeth Coda, Nico Courts, Colby Wight, Loc Truong, WoongJo Choi, **Charles Godfrey**, Tegan Emerson, Keerti Kappagantula and Henry Kvinge. [Fiber bundle morphisms as a framework for modeling many-to-many maps](#). In *ICLR 2022 Workshop on Geometrical and Topological Representation Learning*.

Preprints

1. [Correspondences in log Hodge cohomology](#) (2023).
2. Henry Kvinge, Grayson Jorgenson, Davis Brown, **Charles Godfrey** and Tegan Emerson. [Neural frames: A Tool for Studying the Tangent Bundles Underlying Image Datasets and How Deep Learning Models Process Them](#) (2022).
3. **Charles Godfrey**, Elise Bishoff, Myles McKay, Davis Brown, Grayson Jorgenson, Henry Kvinge and Eleanor Byler. [Testing predictions of representation cost theory with CNNs](#) (2022). Code available at https://github.com/pnnl/frequency_sensitivity.
4. Takumi Murayama and **Charles Godfrey**. [Pure subrings of Du Bois singularities are Du Bois singularities](#) (2022).
5. [Higher direct images of ideal sheaves](#) (2022).

Invited Talks

1. June 2023 [ICERM Mathematical and Scientific Machine Learning Workshop](#).
2. February 2023 [Boston College Math and Machine Learning Seminar](#).
3. January 2023 [Joint Mathematics Meetings](#) (Boston, MA).
4. November 2022 [Purdue Algebraic Geometry Seminar](#).
5. October 2020 AMS Fall Eastern Sectional Special Session on Algebraic Singularities in Arbitrary Characteristic.