

# Charlie Godfrey

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## Skills

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- **Research:** empirical science of foundation models, novel deep learning architecture components, interpretable and explainable AI, evaluating and understanding trustworthiness of machine learning systems.
- **Data modalities:** computer vision, reinforcement learning, natural language processing.
- **Tools:** Python (PyTorch, Huggingface, NumPy, SciPy and Pandas), Git, Bash, Linux, cluster computing (SLURM), AWS (EC2).

## Experience

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### Postdoctoral Research Associate, [Pacific Northwest National Laboratory](#)

October 2022 - Present

- Showed that recently introduced *model editing algorithms* (model updates with low data and compute requirements) *decrease distribution-shift robustness*, enabling ML practitioners to make better-informed decisions about deploying edited models.
- Found that symmetries of neural network architectures give rise to symmetries of hidden feature representations, *narrowing the scope of model debugging efforts*.
- Explained how convolutional neural networks develop sensitivity to Fourier frequencies, providing a case study of how training data, network architecture and optimization hyperparameters impact model robustness.
- Implement training/evaluation of large deep learning models (including transformers). Experience with distributed training, parallel hyperparameter sweeps, unsupervised training, fine-tuning of pretrained models and transfer learning.

## Select Publications

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1. Kelsey Lieberman, James Diffenderfer, **Charles Godfrey** and Bhavya Kailkhura. [Neural Image Compression: Generalization, Robustness, and Spectral Biases](#). In *ICML 2023 Workshop Neural Compression: From Information Theory to Applications*.
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*.
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*.
6. **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](https://github.com/pnnl/modelsym).
7. Higher Direct Images of Ideal Sheaves, Correspondences in Log Hodge Cohomology and Globally F-Full Varieties. PhD thesis, University of Washington 2021.

## Select Invited Talks

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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.

## Education

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**PhD in Mathematics**, The University of Washington-Seattle June 2021

- Extended results on singularities using inductive construction algorithms for semi-simplicial schemes. Built a new Fourier-type transform on differential forms with poles using duality theory. Defined generalizations of ordinary elliptic curves over finite fields and studied their deformations.
- 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)

**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