Curriculum Vitae
Henry Kvinge

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Date of CV: April 2022

Education/Employment

2021 –	**Affiliate Assistant Professor**, Mathematics Department, University of Washington
2019 –	**Senior Data Scientist**, Pacific Northwest National Laboratory
2017-2019	**Postdoctoral Fellow**, Pattern Analysis Lab, Mathematics Department, Colorado State University
2011-2017	**Ph.D. in Mathematics,** University of California, Davis. Advisor: Monica Vazirani. Thesis: *A Categorification of the Crystal Isomorphism* $B^{1,1} \otimes B(\Lambda_i) \cong B(\Lambda_{\sigma(i)})$ *and a Graphical Calculus for the Shifted Symmetric Functions*
2004-2010	**B.S. in Mathematics, B.A. in Biochemistry,** University of Washington, *Magna Cum Laude*

Languages and other tools: Python: PyTorch, NumPy, SciPy; C++, CUDA, Matlab, Git

Research interests: Representation learning, robustness of deep learning models, applications of topology, abstract algebra, and geometry to deep learning, few-shot learning, computer vision, machine learning for materials science.

Book chapters

- Sofya Chepushtanova, Elin Farnell, Eric Kehoe, Michael Kirby, and Henry Kvinge, "Dimensionality reduction" in *Data Science for Mathematicians*, CRC Press, (2020).

Publications, submissions, and preprints

Machine learning and data science:

- Tegan Emerson, Lara Kassab, Scott Howland, Henry Kvinge, Keerti Sahithi Kappagantula, *TopTemp: Parsing Precipitate Structure from Temper Topology*.

  Note: Work will be presented at the 2022 ICLR Workshop on Geometric and Topological Representation Learning.
- Tegan Emerson, Grayson Jorgenson, Henry Kvinge, Colin Olson, *Random Filters for Enriching the Discriminatory Power of Topological Representations*.

  Note: Work will be presented at the 2022 ICLR Workshop on Geometric and Topological Representation Learning.
- Elizabeth Coda, Nico Courts, Colby Wight, Loc Truong, WoongJo Choi, Charles Godfrey, Tegan Emerson, Keerti Kappagantula, Henry Kvinge, *Fiber Bundle Morphisms as a Framework for Modeling Many-to-Many Maps*, arXiv:2203.08189v1.

  Note: Work will be presented at the 2022 ICLR Workshop on Geometric and Topological Representation Learning.
- Scott Mahan, Tim Doster, Henry Kvinge, *DNA: Dynamic Network Augmentation*, arXiv:2112.09277.
- Loc Truong, WoongJo Choi, Colby Wight, Lizzy Coda, Tegan Emerson, Keerti Kappagantula, Henry Kvinge, *Differential Property Prediction: A Machine Learning Approach to Experimental Design in Advanced Manufacturing*, arXiv:2112.01687.

  Note: This work was presented at the AAAI workshop AI-Based Design and Manufacturing (ADAM).

- Davis Brown, Henry Kvinge, *Brittle interpretations: The Vulnerability of TCAV and Other Concept-based Explainability Tools to Adversarial Attack*, arXiv:2110.07120.
- Nico Courts, Henry Kvinge, *Bundle Networks: Fiber Bundles, Local Trivializations, and a Generative Approach to Exploring Many-to-one Maps*, to appear at the Tenth International Conference on Learning Representations, arXiv:2110.06983.
- Henry Kvinge, Colby Wight, Sarah Akers, Scott Howland, Woongjo Choi, Xiaolong Ma, Luke Gosink, Elizabeth Jurrus, Keerti Kappagantula, Tegan H Emerson, *A Topological-Framework to Improve Analysis of Machine Learning Model Performance*, arXiv:2107.04714.

  Note: This work was presented at the ICML workshop on Uncertainty and Robustness in Deep Learning, 2021.
- Scott Mahan, Henry Kvinge, Tim Doster, *Rotating spiders and reflecting dogs: a class conditional approach to learning data augmentation distributions*, Submitted, arXiv:2106.04009.
- Henry Kvinge, Scott Howland, Nico Courts, Lauren A Phillips, John Buckheit, Zachary New, Elliott Skomski, Jung H Lee, Sandeep Tiwari, Jessica Hibler, Courtney D Corley, Nathan O Hodas, *One Representation to Rule Them All: Identifying Out-of-Support Examples in Few-shot Learning with Generic RepresentationsOne Representation to Rule Them All: Identifying Out-of-Support Examples in Few-shot Learning with Generic Representations*, Submitted, arXiv:2106.01423.
- Henry Kvinge and Mark Blumstein, *Multi-dimensional scaling on groups*, Proceedings of the IEEE/CVF International Conference on Computer Vision (2021). arXiv:1812.03362.
- Henry Kvinge, Brett Jefferson, Cliff Joslyn, Emilie Purvine, *Sheaves as a Framework for Understanding and Interpreting Model Fit*, Proceedings of the IEEE/CVF International Conference on Computer Vision (2021).Proceedings of the IEEE/CVF International Conference on Computer Vision (2021). arXiv:2105.10414.
- Henry Kvinge, Zachary New, Nico Courts, Jung H. Lee, Lauren A. Phillips, Courtney D. Corley, Aaron Tuor, Andrew Avila, and Nathan O. Hodas, *Fuzzy Simplicial Networks: A Topology-Inspired Model to Improve Task Generalization in Few-shot Learning*. In AAAI Workshop on Meta-Learning and MetaDL Challenge, pp. 77-89. PMLR, 2021.
- Elliott Skomski, Aaron Tuor, Andrew Avila, Lauren A. Phillips, Zachary New, Henry Kvinge, Courtney D. Corley, Nathan O. Hodas, *Prototypical Region Proposal Networks for Few-Shot Localization and Classification*, arXiv:2104.03496.

  Note: This work was presented at the NeurIPS 2020 Workshop on Meta-learning, (2020).
- Song Feng, Emily Heath, Brett Jefferson, Cliff Joslyn, Henry Kvinge, et. al, *Hypergraph Models of Biological Networks to Identify Genes Critical to Pathogenic Viral Response*, BMC Bioinformatics, 22(1), 1-21., arXiv:2010.03068 (2020).
- Lucius Bynum, Tim Doster, Tegan H. Emerson and Henry Kvinge, *Rotational Equivariance for Object Classification Using xView*, IGARSS 2020 - 2020 IEEE International Geoscience and Remote Sensing Symposium, Waikoloa, HI, USA, 2020, pp. 3684-3687.
- Julia R. Dupuis, John P. Dixon, Elizabeth Schundler, Chase S. Buchanan, JD Rameau, David Mansur, Henry Kvinge, Elin Farnell, Chris Peterson, Michael Kirby, *LWIR compressive sensing hyperspectral sensor for chemical plume imaging*, Proc. SPIE 11416, Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) Sensing XXI, 1141606 (2020).
- Henry Kvinge, Elin Farnell, Julia R. Dupuis, Michael Kirby, Chris Peterson, and Elizabeth C. Schundler *More chemical detection through less sampling: amplifying chemical signals in hyperspectral data cubes through compressive sensing*, Proc. SPIE 11392, Algorithms, Technologies, and Applications for Multispectral and Hyperspectral Imagery XXVI, 113920N (2020).

- Elin Farnell, Henry Kvinge, John P. Dixon, Julia R. Dupuis, Michael Kirby, Chris Peterson, Elizabeth C. Schundler, and Christian W. Smith *A data-driven approach to sampling matrix selection for compressive sensing*, Proc. SPIE 11396, Computational Imaging V, 1139603 (2020).
- Elin Farnell, Henry Kvinge, Julia R. Dupuis, Michael Kirby, Chris Peterson, and Elizabeth C. Schundler *Total variation vs L1 regularization: a comparison of compressive sensing optimization methods for chemical detection*, Proc. SPIE 11396, Computational Imaging V, 113960Q (2020).
- Manuchehr Aminian, Helene Andrews-Polymenis, Jyotsana Gupta, Michael Kirby, Henry Kvinge, Xiaofeng Ma, Patrick Rosse, Kristin Scoggin, and David Threadgill. *Mathematical methods for visualization and anomaly detection in telemetry datasets*. Interface Focus, 10(1), 20190086 (2019).
- Henry Kvinge, Michael Kirby, Chris Peterson, Chad Eitel, and Tod Clapp, *Walking through spectral bands: Using virtual reality to better visualize hyperspectral data*, to appear in the 13th International Workshop on Self-Organizing Maps and Learning Vector Quantization, Clustering and Data Visualization (2019).
- Henry Kvinge, Elin Farnell, Jingya Li, and Yujia Chen. *Rare geometries: revealing rare categories via dimension-driven statistics*. In 2019 18th IEEE International Conference On Machine Learning And Applications (ICMLA), pp. 276-281. IEEE, (2019).
- Henry Kvinge, Elin Farnell, Michael Kirby and Chris Peterson, *Monitoring the shape of weather, soundscapes, and dynamical systems: a new statistic for dimension-driven data analysis on large data sets*, 2018 IEEE International Conference on Big Data (Big Data), Seattle, WA, USA, pp. 1045-1051 (2018).
- Henry Kvinge, Elin Farnell, Michael Kirby, and Chris Peterson, *Too many secants: a hierarchical approach to secant-based dimensionality reduction on large data sets*, 2018 IEEE High Performances Extreme Computing Conference (HPEC), Waltham, MA, USA, pp. 1-7, (2018).
- Henry Kvinge, Elin Farnell, Michael Kirby and Chris Peterson, *A GPU-Oriented Algorithm Design for Secant-Based Dimensionality Reduction*, 2018 17th International Symposium on Parallel and Distributed Computing (ISPDC), Geneva, Switzerland, pp. 69-76 (2018).
- Elin Farnell, Henry Kvinge, Michael Kirby and Chris Peterson, *Endmember Extraction on the Grassmannian*, 2018 IEEE Data Science Workshop (DSW), Lausanne, Switzerland, pp. 71-75 (2018).

Mathematics:

- Ian Holmes Kesser, Henry Kvinge, and James Wilson, *A Frobenius-Schreier-Sims Algorithm to tensor decompose algebras*, arXiv:1812.03346 (2018).
- Henry Kvinge, *Coherent systems of probability measures on graphs for representations of free Frobenius algebras*, arXiv:1810.11555 (2018)
- Henry Kvinge, Can Ozan Oguz, and Michael Reeks. *The center of the twisted Heisenberg category, factorial Schur Q-functions, and transition functions on the Schur graph*. Journal of Algebraic Combinatorics, 1-36, (2019).

  Extended abstract in Proceedings of the 30th International Conference on Formal Power Series and Algebraic Combinatorics, Séminaire Lotharingien de Combinatoire, 80B.76 (2018) 12pp.
- Henry Kvinge, Anthony Licata, and Stuart Mitchell *Khovanov's Heisenberg category, moments in free probability, and shifted symmetric functions*, Algebraic Combinatorics 2.1 (2019): 49-74. arXiv:1610.04571.

  Extended abstract in Proceedings of the 29th International Conference on Formal Power Series and Algebraic Combinatorics, Séminaire Lotharingien de Combinatoire, 78B.63 (2017), 12 pp.

- Henry Kvinge and Monica Vazirani, *A combinatorial categorification of the tensor product of the Kirillov-Reshetikhin crystal $B^{1,1}$ and a fundamental crystal*, Algebr. Represent. Theory 21 (2018), no. 6, 1277-1331.

  Extended abstract in Proceedings of the 28th International Conference on Formal Power Series and Algebraic Combinatorics, Discrete Math. Theor. Comput. Sci. Proc. (2016), pp. 719-730.

Selected talks and poster presentations

2021 July, Applied Category Theory 2021
Sheaves as a Framework for Understanding and Interpreting Model Fit

2021 July, ICML 2021 Workshop on Uncertainty & Robustness in Deep Learning
Dataset to Dataspace: A Topological-Framework to Improve Analysis of Machine Learning Model Performance

2021 February, AAAI 2021 Workshop on Meta-Learning
Fuzzy Simplicial Networks: A Topology-Inspired Model to Improve Task Generalization in Few-shot Learning

2019 November, UC Davis Algebra Seminar
Using diagrammatics to motivate coherent systems on towers of Frobenius algebras

2019 June, Conference on Geometric Data Analysis *Representation theory and multidimensional scaling*

2019 June, Tensors: Algebra-Computation-Applications,
Letting symmetry guide reduction: representation theory and dimensionality reduction

2018 December, IEEE International Conference on Big Data,
Monitoring the shape of weather, soundscapes, and dynamical systems: a new statistic for dimension-driven data analysis on large data sets

2018 November, University of Colorado Lie Theory Seminar,
Coherent systems of probability measures on graphs for representations of free Frobenius towers

2018 October, Workshop on Representation Theory, Combinatorics, and Geometry
Heisenberg categories, towers of algebras, and up/down-transition functions

2018 September, Conference: 2018 IEEE High Performance Extreme Computing Conference
Too many secants: a hierarchical approach to secant-based dimensionality reduction on large data sets

2018 June, Conference: Interactions of quantum affine algebras with cluster algebras, current algebras and categorification
Heisenberg categories, towers of algebras, and symmetric functions

2018 May, University of Washington Combinatorics Seminar
Symmetric functions, towers of algebras, and Heisenberg categories

2018 May, University of Colorado Algebraic Lie Theory Seminar
Symmetric functions, towers of algebras, and centers of Heisenberg categories

2018 March, Pacific Northwest Combinatorics Day
Centers of Heisenberg categories, symmetric functions, and the combinatorics of induction/restriction functors

2017 December, Future Directions in Representation Theory, University of Sydney
The center of the twisted Heisenberg category, factorial Schur P-functions, and up/down transition functions on the Schur graph

2017 October, University of Colorado Algebraic Lie Theory Seminar
The Kirillov-Reshetikhin crystal $B^{1,1}$ and cyclotomic quiver Hecke algebras

2017 September, University of Virginia Algebra Seminar
Khovanov's Heisenberg category, the asymptotic representation theory of symmetric groups, and shifted symmetric functions

2017 September, Rocky Mountain Combinatorics Seminar - Colorado State University
Khovanovs Heisenberg category, moments in free probability, and shifted symmetric functions
2017 July, Formal Power Series and Algebraic Combinatorics Conference (FPSAC), London
Khovanov's Heisenberg category, moments in free probability, and shifted symmetric functions
2016 October, AMS Sectional - University of St. Thomas, Minneapolis (invited talk)
Special Session on Combinatorial Representation Theory
A surprising connection between Khovanov's Heisenberg category and the asymptotic representation theory of symmetric groups.
2016 September, Arizona State University Discrete Math Seminar
A graphical calculus for the shifted symmetric functions.
2016 July, Formal Power Series and Algebraic Combinatorics Conference (FPSAC), UBC
Categorifying the tensor product of the KR crystal $B^{1,1}$ and a fundamental crystal
2016 June, US-Mexico Conference on Representation Theory, Categorification, and Noncommutative Algebra, USC
Khovanov's Heisenberg category and the asymptotic representation theory of symmetric groups
2016 March, University of Oregon, Algebra Seminar
The influence of the Kirillov-Reshetikhin crystal $B^{1,1}$ on the structure of simple cyclotomic KLR modules.
2016 February, University of Washington, Algebra and Algebraic Geometry Seminar
The influence of the KR crystal $B^{1,1}$ on the structure of simple cyclotomic KLR modules.
2016 January, UC Berkeley (invited talk)
Berkeley/Davis Combinatorics Gathering
The influence of the KR crystal $B^{1,1}$ on the structure of simple cyclotomic KLR modules.
2015 October, AMS Sectional - Loyola University, Chicago (invited talk)
Special Session on Combinatorial and Geometric Representation Theory
The influence of the KR crystal $B^{1,1}$ on the structure of simple cyclotomic KLR modules.
2015 October, UC Davis Algebra and Discrete Math Seminar
The influence of the KR crystal $B^{1,1}$ on the structure of simple cyclotomic KLR modules.
2013 September, Arizona State University Discrete Math Seminar
The Okounkov-Vershik approach to the representation theory of the symmetric group

Workshops, and conferences organized

2022 October, Special Session: Geometry in the Mathematics of Data Science, Joint Math Meetings (Planned)
2021 October, ICCV Workshop on Topology, Algebra, and Geometry in Computer Vision (Planned)
2021 January, Special Session: Geometry in the Mathematics of Data Science, Joint Math Meetings
2021 January, Special Session: Mathematics to the Rescue-Addressing Deficiencies in the Analysis of Overhead Imagery Products, Joint Math Meetings

Seminars organized

2021 – present: Pacific Northwest Topology, Algebra, and Geometry in Data Science Seminar (Seattle)
2020 – 2021: Pure Math for Machine Learning (PMML) (Virtual)
2020 – present: Western Washington Data-Driven Discovery Seminar (Virtual)

Teaching activities

Courses taught at Colorado State

2019 Spring Linear Algebra (Math 369)
2018 Fall Advanced Calculus (Math 417)

Courses taught at UC Davis

2016 Summer Combinatorics (Math 145)
2015 Winter Calculus for Biology and Medicine (Math 17B)