

# Daniel Quigley

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## Education

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### University of Wisconsin-Milwaukee

Milwaukee, WI | 2025

*PhD: Linguistics | Mathematics | Computer Science*

- Interdisciplinary PhD research across linguistics, mathematics, philosophy, and logic
- **Advisors:** Nicholas Fleisher, Hamid Ouali (linguistics) | Jeb Willenbring (mathematics) | Matthew Knachel (philosophy and logic)

### University of Wisconsin-Milwaukee

Milwaukee, WI | 2023

*MA: Linguistics*

- Interdisciplinary MA research across linguistics, computer science, logic, and mathematics
- **Advisors:** Nicholas Fleisher, Hamid Ouali (linguistics) | Susan McRoy (computer science)

### Universiteit Utrecht

Utrecht, The Netherlands | 2019

*MSc Certificate: Theoretical Physics*

- Interdisciplinary Graduate Honors recipient
- Completed Master's coursework in Theoretical Physics and Mathematics

### University of Wisconsin-Madison

Madison, WI | 2018

*BSc: Anthropology | Astronomy | Linguistics | Mathematics | Physics*

- Record holder for number of majors
- **Advisors:** Stefan Westerhoff (physics, astronomy, mathematics) | Monica Macaulay (linguistics) | J. Mark Kenoyer (anthropology)

## PhD Research

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### University of Wisconsin-Milwaukee

Milwaukee, WI | Aug 2020 – Current

*Theoretical Linguistics | Mathematics | Artificial Intelligence | Natural Language Processing*

- Conducting research in interpretable neuro-symbolic artificial intelligence and natural language processing on problems in natural language understanding, knowledge representations, and semantic representations.
- Developing mathematical models for computably tractable neuro-symbolic architectures for formal semantics and vector space semantics for logical reasoning tasks.
- Proving morphisms between intensional semantics and vector space semantics using model-theoretic, group-theoretic, and category-theoretic frameworks.
- Developing first- and second-order logic representations for intensional semantics in the context of category theory.
- Designing algorithms and computing their space and time complexities to facilitate interpretable language processing for logical reasoning tasks.
- Exploring theoretical foundations in the context of graph and group theory to explain model architectures for deep neural networks.

## MA Research

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### University of Wisconsin-Milwaukee

Milwaukee, WI | Aug 2020 – May 2023

*Theoretical Linguistics | Mathematics | Artificial Intelligence | Natural Language Processing*

- Designed and proved PSPACE-hard algorithms for language processing based on extensional and intensional semantics.
- Proved homomorphism between discrete intensional semantics models and vector space semantics.
- Derived tensor forms for semantic representations of various linguistic phrasal types and constructions in hyperbolic spaces.

## MSc Research

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### Universiteit Utrecht

Utrecht, The Netherlands | Aug 2018 – Jul 2019

*Theoretical Physics: Graduate Interdisciplinary Honors*

- Completed coursework in Theoretical Physics, with a focus on high energy physics, cosmology, and gravitational physics.
- Completed coursework in Mathematics, with a focus on differential geometry, geometric partial differential equations, and geometric flows.
- Applied scientific expertise to interdisciplinary applications across multiple departments, including presenting independent research on geography and climate science to colleagues in the honors seminar.

## BSc Research

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### University of Wisconsin-Madison

Madison, WI | Oct 2015 – May 2018

#### Indus Valley Civilization Undergraduate Researcher

- Reconstructed broken strings of written data from the Indus Valley Script using  $n$ -gram Markov chains and conditional entropy, and applied statistical analysis techniques to analyze the data using Python.
- Collaborated with international colleagues to analyze the Indus Valley Script data, resulting in the creation of sign frequency scores that showed the context in which different symbols were used.
- Presented results at an international academic conference.

### University of Wisconsin-Madison

Madison, WI | Oct 2014 – May 2018

#### Wisconsin Baldwin Idea Grant Project Assistant

- Coordinated with team of students and academic advisors to work with Menominee elders with Menominee language data elicitation and transcription.
- Recorded and documented language data for preservation and revitalization, and prepared teaching materials for language preservation and revitalization efforts.
- Results of work integrated into Menominee reference grammar (to be published).

### Wisconsin IceCube Particle Astrophysics Center

Madison, WI | Oct 2014 – May 2018

#### High Energy Astroparticle Physics Research Assistant

- Designed and implemented simulations, data acquisition systems, and visualizations for HAWC (High-Altitude Water Cherenkov) gamma-ray detector.
- Resolved discrepancies in gamma-ray results across four international experiments; wrote GPS data system using ZeroMQ in C++.
- Communicated results of simulations and technical developments with international teams, demonstrating strong collaboration and communication skills.

## Internship Experience

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### IPAM (Institute for Pure and Applied Mathematics)

Los Angeles, CA | Sept 2024 – Present

#### Visiting Researcher

- Collaborating on a fall-semester program with UCLA Institute for Pure and Applied Mathematics (IPAM).
- Interdisciplinary program across cognitive science, artificial intelligence, and mathematics for cross-field collaboration on problems in the mathematical foundations of intelligences.
- Exploring mathematical approaches such as: dynamical systems, statistical physics, theoretical machine learning, probability and (Bayesian) statistics, information theory, high-dimensional geometry, functional analysis, the theory of programming languages, game theory, and category theory to drive breakthroughs in intelligence research.

### Fujitsu Limited

Sendai, Japan | Jun 2024 – Aug 2024

#### Visiting Scientist

- Collaborated on an 8-week project with Graduate-level Research in Industrial Projects for Students (G-RIPS), UCLA Institute for Pure and Applied Mathematics (IPAM) and Fujitsu Limited, focusing on explanatory and interpretable AI in causal modeling.
- Reverse-engineered underlying mathematics of Fujitsu's "Wide Learning" classification machine learning model for causal AI.
- Developed a logical framework for feature relationships in Pearlean causal models.
- Developed a classifier model for causal graph structures using graph-theoretic hierarchical metrics.
- Designed an interactive, accessible interface for causal graph representation, incorporating language, vision-based, and machine-readable features for explanatory and interpretable AI in causal modeling.

### Apple

Cupertino, CA | Jul 2023 – Nov 2023

#### Career Experience: Production Engineer

- Tested and deployed demo content to channel stores across iOS, tvOS, watchOS, and macOS platforms from development to production.
- Developed, maintained, and documented sophisticated automation frameworks, using Python scripting to enhance operational efficiency.
- Resolved failing Wi-Fi connectivity across demo devices by investigating plist data structures for discrepancies; resolved publishing content issues for by region and device.
- Validated content in twenty-one languages across twenty-five locales sensitive to local content and language requirements while crafting comprehensive test plans and technical documentation for new features and internal tools.

## Presentations and Publications

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### Presentations

- Forde, John and Mendez, Gaspar and Okubo, Akane and **Quigley, Daniel** and Sakamoto, Renji (2024). *Fujitsu Causal Discovery: a novel interactive platform for conditional causal discovery*. Fujitsu Limited.
- **Quigley, Daniel** (2024). *Be Reasonable! Relating Logical Models and Vector Spaces for NLP Interpretability*. Workshop in General Linguistics.
- **Quigley, Daniel** (2024). *Getting Started with  $\LaTeX$* . Workshop in General Linguistics.
- **Quigley, Daniel** (2024). *Merge: Syntax-Semantics as a Hopf Algebra*. Algebraic Structures Seminar.
- **Quigley, Daniel** (2024). *Natural Language Understanding as Tensor Product Models*. Algebraic Structures Seminar.
- **Quigley, Daniel** (2024). *A Primer on the Mathematics of Artificial Neural Networks*. Graduate Student Colloquium.
- **Quigley, Daniel** (2023). *Tensor Space and Category-Theoretic Semantics for Resolving Long-Distance Linguistic Expressions in Natural Language Processing*. PhD preliminary paper and presentation.
- **Quigley, Daniel** (2023). *Decoding Authorial Style, Tone, and Mood in Poetic Translations through Natural Language Processing: An Analysis of Beowulf*. Workshop in General Linguistics.
- **Quigley, Daniel** (2023).  *$\LaTeX$  for Linguists*. Summer Workshop.

### Publications

- Forde, John and Mendez, Gaspar and Okubo, Akane and **Quigley, Daniel** and Sakamoto, Renji (2024). *Fujitsu Causal Discovery: a novel interactive platform for conditional causal discovery*. Fujitsu Limited.
- **Quigley, Daniel** (2024). *Categorical Framework for Typed Extensional and Intensional Models in Formal Semantics*. Manuscript submitted for review. arXiv.
- **Quigley, Daniel** (2024). *Be Reasonable! Relating Logical Models and Vector Spaces for NLP Interpretability*. In Proceedings: Workshop in General Linguistics.
- **Quigley, Daniel** (2023). *Exploring Category-Theoretic Morphisms for Model-Theoretic Semantics*. Manuscript submitted for review.
- **Quigley, Daniel** (2023). *Decoding Authorial Style, Tone, and Mood in Poetic Translations through Natural Language Processing: An Analysis of Beowulf*. In Proceedings: Workshop in General Linguistics.

## Project Experience

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### University of Wisconsin-Milwaukee

Milwaukee, WI | Aug 2020 – Present

#### $\LaTeX$ Developer

- Designed  $\LaTeX$  document templates, accepted by university as official resources for graduate school.
- Created document tagging and readability methods to improve designs of accessible PDF documents.
- Developing intelligent UIs for improved accessibility of PDF documents, improving usability for users with accessibility needs and machine readability.

### University of Wisconsin-Madison

Milwaukee, WI | May 2021

#### Data Visualization and Sentiment Analysis of Movie Reviews across Four Neural Network Models

- Conducted a comprehensive comparison of performance metrics for polarity sentiment analysis of movie reviews using deep learning techniques, including the design of four different machine learning architectures (CNN, RNN, RCNN, LSTM).
- Compared the performance of the different model architectures across ten epochs, with a cutoff for validation loss, and achieved an accuracy rate of greater than 83% for each model.
- Demonstrated expertise in the application of deep learning techniques to natural language processing tasks through the successful execution and analysis of this research project.

### University of Wisconsin-Madison

Milwaukee, WI | May 2021

#### ML Optimization: No Free Lunch

- Optimized, evaluated, and compared performance scores for classification machine learning tasks: Decision Tree Classifier; K-Nearest Neighbor; Multinomial Naive Bayes; Logistic Regression; SVC; Dummy Classifier; Neural Network.
- Optimized, evaluated, and compared performance scores for regression machine learning tasks: Decision Tree Regressor; Linear Regression; SVR; Dummy Regressor; Neural Network.
- Evaluated CNN architectures of image classification task using the Fashion-MNIST dataset.

### University of Wisconsin-Madison

Milwaukee, WI | Jul 2020

#### Linux from Scratch

- Completed *Linux from Scratch* project, building a fully functional Linux distribution from scratch using source code and following project documentation, demonstrating strong problem-solving and troubleshooting skills to resolve issues during build process.
- Developed deep understanding of Linux operating system, including kernel, system libraries, and userland utilities, and improved skills in working with source code and building software from ground up.
- Created a customized Linux distribution that met specific needs and preferences, showcasing ability to tailor a system to meet unique requirements.

## Work Experience

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### University of Wisconsin-Milwaukee

Milwaukee, WI | Aug 2024 – Present

#### Research Assistant

- Designing AI causal models for battery health and failure in collaboration with Clarios.
- Developing algorithms for data explanation and interpretability of causal relationships for battery health and failure, using LiNGAM models and classification machine learning.
- Developing visual representations for data, causality, and explainability for battery health and failure.

### Eruditis

Milwaukee, WI | Jun 2024 – Present

#### Contract: Machine Learning Scientist

- Developing mathematical models for AI-enhanced algorithmic trading systems intended for non-institutional investors.
- Derived mathematical model and representation for financial metrics adaptable to investor profile parameters.
- Wrote documentation and instruction for Python code and underlying mathematics for internal app development.

### Apple

Glendale, WI | Oct 2021 – March 2024

#### Genius Technician

- Demonstrated leadership while also mentoring Technical Specialists and Technical Experts | developed and implemented new processes to improve efficiency and effectiveness of Genius Bar team.
- Exceeded expectations for customer satisfaction: attained performance review scores of 88 TMS and 74 NPS, excelling in metrics for technical expertise (89) and empathy (80).
- Certified for iPhone and Mac repair, maintaining 95% repair rate on devices.

### University of Wisconsin-Milwaukee

Milwaukee, WI | Aug 2020 – Present

#### Instructor of Record

- Responsible for class sizes of 20-30 students per semester, providing comprehensive support and guidance.
- Designed course content to include topics in natural language processing, such as introductory concepts and artificial intelligence ethics.
- Providing effective feedback and communication to improve performance, demonstrating commitment to student success and learning.

## Graduate Teaching Experience

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**Linguistics 100:** Instructor of Record

Fall 2024

**Linguistics 100:** Instructor of Record

Spring 2024

**Linguistics 100:** Instructor of Record

Fall 2023

**Linguistics 210:** Instructor of Record

Spring 2023

**Linguistics 100:** Instructor of Record

Fall 2022

**Linguistics 210:** Instructor of Record

Spring 2022

**Linguistics 210:** Instructor of Record

Fall 2021

**Linguistics 210:** Teaching Assistant

Spring 2021

**Linguistics 210:** Teaching Assistant

Fall 2020

## Graduate Coursework

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**Linguistics:** Phonetics | Phonology | Morphology | Syntax | Semantics | 2nd Language Acquisition | Seminar: Ellipsis | Typology and Universals | Historical and Comparative Linguistics | Seminar: Research Methods | Seminar: Double Object Constructions | Advanced Phonetics | Advanced Phonology | Advanced Syntax | Advanced Semantics | Foundations of Formal Logic | Advanced Independent Study  
**Computer Science:** Machine Learning and Applications | Introduction to Natural Language Processing | Introduction to Artificial Intelligence | Artificial Intelligence in Business | Advanced Independent Study | Advanced Machine Learning | Algorithm Design and Analysis

**Physics:** Quantum Field Theory | Statistical Field Theory | General Relativity | String Theory | Field Theory in Particle Physics | Cosmology | Radiative Processes | High Energy Astrophysics

**Mathematics:** Differential Geometry | Geometric Partial Differential Equations | Mathematical Methods in Theoretical Physics | Algebraic Structures

## Professional Interests

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**Linguistics:** formal logic | mathematical models | model theory | ellipsis | double object constructions | transitivity mismatches | case stacking | construction grammar | scope | binding | degree and comparison | typology | language change

**Computer Science:** algorithm design | complexity | formal logic | mathematical models | model theory | machine learning methods for language processing | human language technologies | human-computer interaction

**Artificial Intelligence:** neural networks | natural language processing | explainable artificial intelligence | geometric neural networks | graph neural networks

**Physics:** gravitational physics | black hole physics | early universe physics | topological defects | quantum field theory in curved spacetime | inverse problem for Lagrangians

**Mathematics:** category theory | group theory | differential geometry | geometric PDEs | geometric flows | Ricci flow | operator theory | formal logic | model theory | inverse problems

**Anthropology:** writing | calendrical systems | power and social relations | gender | ethnoarchaeology | archaeoastronomy

## Professional Affiliations

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**American Mathematical Society (AMS)**  
**American Physical Society (APS)**  
**Association for Computational Linguistics (ACL)**  
**Association for the Advancement of Artificial Intelligence (AAAI)**  
**Language Creation Society (LCS)**  
**Linguistic Society of America (LSA)**

## Honors and Awards

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<b>University of Wisconsin-Milwaukee:</b> <i>Graduate Teaching Assistantship</i>	Aug 2020 – Current
<b>University of Wisconsin-Milwaukee:</b> <i>Chancellor's Graduate Student Award</i>	2020, 2023
<b>Universiteit Utrecht:</b> <i>Graduate Honors</i>	2019
<b>University of Wisconsin-Madison:</b> <i>Record - Number of Majors (5)</i>	2018

## Skills

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**Data skills:** Technical writing | Data collection, annotation, processing, visualization, statistical analysis, machine learning (Python: NumPy, Keras, Scikit-Learn, NLTK, Pandas, Matplotlib, TensorFlow, Mathematica, LiNGAM) | Technical documentation

**Project skills:** Written and oral presentation and communication | Qualitative and quantitative research methods | Problem solving | Experiment design | Language data collection and analysis | Team work and team leadership

**Technical skills:** Python |  $\LaTeX$  | Excel | Praat | R | SPSS | regex | SQL (basic) | HTML (basic) | Jekyll (basic)

**Operating Systems and Software:** Linux | Windows | MacOS | Conda | CUDA (GPU Programming) | MS Office Suite

## Languages

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**Native:** English

**Conversational:** German

**Elementary:** Dutch | Finnish | Japanese

**Some Study:** Menominee | Arabic (MSA) | Sanskrit | Georgian