# Caleb Schultz Kisby

## Personal Information


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## Research Interests

I am a computer scientist studying the foundations of artificial intelligence (AI) and cognition, using tools from logic and theoretical computer science. My research spans issues at the intersection of neuro-symbolic AI, machine learning, belief revision, dynamic epistemic logic, and descriptive complexity. I'm especially interested in questions such as:

- How should we best integrate symbolic and neural (sub-symbolic) systems?
- How can we extract, interpret, and verify the internal beliefs of neural networks?
- How powerful and reliable are different learning algorithms, when compared to one another?
- Is provably correct AI alignment possible?

## Education

2018 – Present **PhD Candidate**, Indiana University, Bloomington, USA
PhD in Computer Science (in progress), minor in Logic.
Jointly advised by Lawrence Moss and Saúl A. Blanco

2014 – 2018 **Bachelors**, University of South Carolina, Columbia, USA
BSCS in Computer Science, BS in Mathematics, *Summa Cum Laude*
Undergraduate research advised by George McNulty

## Peer-Reviewed Publications

1. **Caleb Schultz Kisby**, S. Blanco, and L. Moss. What Do Hebbian Learners Learn? Reduction Axioms for Iterated Hebbian Learning. AAAI, Feb. 2024.
2. **Caleb Kisby**, S. Blanco, and L. Moss. The Logic of Hebbian Learning. The International FLAIRS (Florida AI Research Society) Conference, May 2022. *Nominated for Best Student Paper.*
3. **Caleb Kisby**, S. Blanco, A. Kruckman, and L. Moss. Logics for Sizes with Union or Intersection. AAAI, Feb. 2020.
4. L. Gates, **Caleb Kisby**, and D. Leake. CBR Confidence as a Basis for Confidence in Black Box Systems. International Conference on Case-Based Reasoning, Sep. 2019.

## Talks and Presentations

Invited Talk Seminar on Logic and Interactive Rationality, University of Amsterdam, Online (Sep 2024)
*The Modeling Power of Neural Networks*

Poster PhD Visit Day, Indiana University (Feb 2024)
*Reduction Axioms for Iterated Hebbian Learning*

Talk & Poster AAAI (Feb 2024)
*Reduction Axioms for Iterated Hebbian Learning*

Invited Talk 1st GALAI (General Algebra, Logic & AI) Workshop, Chapman University (Jan 2024)
*Logical Dynamics of Neural Network Learning*

Poster Trusted AI DoD Grant Project Meeting, University of Notre Dame (Apr 2023)
*Neural Network Semantics*

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| POSTER | AI Center Open House, Indiana University (Mar 2023)<br>*Reasoning about Neural Network Learning* |
| TALK | Cognitive Lunch Seminar, Indiana University (Feb 2023)<br>*A Semantic Theory for Neuro-Symbolic AI* |
| TALK | The International FLAIRS (Florida AI Research Society) Conference (May 2022)<br>*The Logic of Hebbian Learning* |
| TALK | Logic Seminar, Indiana University (May 2022)<br>*The Logic of Hebbian Learning* |
| POSTER | Trusted AI DoD Grant Project Meeting, IUPUI (Apr 2022)<br>*Reasoning about Neural Network Learning* |
| TALK | Trusted AI DoD Grant Project Meeting, Indiana University (Mar 2022)<br>*From Logic to Hebbian-Learned Nets and Back* |
| TALK & POSTER | AAAI (Feb 2020)<br>*Logics for Sizes with Union or Intersection* |
| TALK | Logic Seminar, Indiana University (Sep 2019)<br>*Logics for Sizes with Union or Intersection* |
| TALK | International Conference on Case-Based Reasoning (Sep 2019)<br>*CBR Confidence as a Basis for Confidence in Black Box Systems* (joint talk with L. Gates) |
| TALK | PL Wonks Seminar, Indiana University (Sep 2019)<br>*Syllogistic Logic with Sizes of Sets and Noun Union* |
| POSTER | Discover UofSC, University of South Carolina (Apr 2017)<br>*Exploring Non-finitely Based Finite Algebras* |

## SERVICE

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| OCT 2024 | Local Organizer for the KOI Combinatorics Conference |
| FEB 2024 | Volunteer for AAAI, as well as for the AAAI Workshop on Neuro-Symbolic Learning and Reasoning in the era of Large Language Models |
| NOV 2023 | Reviewer for the AAAI Workshop on Neuro-Symbolic Learning and Reasoning in the era of Large Language Models (2 reviews) |
| JUN 2023 | Local Organizer for CALCO (Algebra and Coalgebra in Computer Science), & jointly-held MFPS (Mathematical Foundations of Programming Semantics) |
| SEP 2019 | Reviewer for the Journal of Logic, Language, and Information (1 review) |

## OTHER CONFERENCE ACTIVITY

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| JUL 2023 | Participated in NeSy (Workshop on Neural-Symbolic Learning and Reasoning) |
| JAN 2023 | Participated in the IBM Neuro-Symbolic AI Workshop |
| MAR 2017 | Participated in the Special Session on Algebras, Lattices, and Varieties at the AMS Spring Southeastern Sectional Meeting |

## HONORS AND AWARDS

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| MAR 2024 | Recipient of the SCALE Ambassador Award for excellence in leadership and research, US Department of Defense |
| MAY 2022 | "The Logic of Hebbian Learning" nominated for Best Student Paper at FLAIRS 2022 |
| AUG 2019 | Recipient of the Paul Purdom Fellowship, Indiana University |

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| APR 2018 | Outstanding Senior in Computer Science, USC Columbia |
| APR 2018 | Recipient of the Jeong S. Yang Award for Excellence in Undergraduate Mathematics, USC Columbia |
| APR 2017 | Recipient of the Thomas Markham Mathematics Scholarship, USC Columbia |
| JAN 2017 | Recipient of the Magellan Scholar Undergraduate Research Grant, USC Columbia |

## SELECTED PUBLIC SOFTWARE

**Argyle:** A suite of neural network properties that are formally verified in Lean

**à-la-Mode:** Neural network model checker & model builder

**Notakto Player** [pdf]**:** A convolutional neural network that uses reinforcement learning to learn winning strategies for Thane Plambeck's Notakto.

**Sense-Able** [pdf]**:** A proof-of-concept LIDAR obstacle sensor for the visually impaired. This was my senior team project at USC, in collaboration with our client P. B. Mumola, Ph.D., LLC.

## TEACHING

**Indiana University (Teaching Assistant)**

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| FALL 2024 | CS 231 - Intro to the Mathematics of Cybersecurity (Head TA) |
| SPRING 2021 | CS 200 - Introduction to Programming (Head TA) |
| FALL 2021 | CS 200 - Introduction to Programming (Head TA) |
| SUMMER 2021 | CS 241 - Discrete Structures |
| SPRING 2021 | CS 200 - Introduction to Programming |
| FALL 2020 | CS 200 - Introduction to Programming |
| SPRING 2020 | CS 241 - Discrete Structures |
| FALL 2019 | CS 501 - Graduate Theory of Computing<br>CS 401 - Theory of Computing |
| SUMMER 2019 | CS 241 - Discrete Structures |

**University of South Carolina (Undergraduate Teaching Assistant)**

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| FALL 2016 | Math 374 - Discrete Structures |
| SPRING 2016 | Math 174 - Discrete Structures for Informatics |
| FALL 2015 | Math 141 - Calculus I |
| SPRING 2015 | Math 142 - Calculus II |

## SELECTED COURSEWORK

**Logic and Formal Languages**

Model Theory (IU, 2021)

Programming Language Foundations (IU, 2020)

Programming Language Principles (IU, 2019)

Seminar on Proof Theory and Constructive Mathematics (IU, 2018)

Theory of Computing (IU, 2018)

Seminar on Equational Logic (Audited, UofSC, 2017)

Theory of Computation (UofSC, 2017)

Intro to Mathematical Logic (UofSC, 2016)

Introduction to Mathematical Philosophy (Coursera, organized by LMU, 2015)

**AI and Cognitive Science**

Computer Models of Symbolic Learning (IU, 2021)

Knowledge-Based Artificial Intelligence (IU, 2021)

Seminar on Natural Language Inference (IU, 2020)

Philosophical Foundations of Cognitive Science (IU, 2020)

Elements of Artificial Intelligence (IU, 2019)

Semantics (Linguistics) (IU, 2019)

## REFERENCES


**Larry Moss**

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**Nina Gierasimczuk**

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