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 from the perspective of logic. I'm especially interested in issues at the intersection of neural network learning, belief revision, dynamic epistemic logic, and descriptive complexity.

My current (thesis) work is on the theory of neuro-symbolic AI, where I use insights from logic to better understand and control the behavior of neural networks as they learn over time. My long-term goal is to bring these ideas to bear on two of the most critical issues in artifical intelligence: neural network verification and the possibility of AI alignment.

Education

2018 – Present **PhD Candidate**, Indiana University, Bloomington, USA
PhD in Computer Science (in progress), minor in Logic. Current GPA: 3.75/4.0
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

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

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

SERVICE

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

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

HONORS AND AWARDS

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
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)

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 CS 401 - Theory of Computing
SUMMER 2019	CS 241 - Discrete Structures

University of South Carolina (Undergraduate Teaching Assistant)

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)

SKILLS

FORMAL LOGIC:	Epistemic logic, dynamic logics, model building, formal verification, functional programming, logic programming
AI AND COGSCI:	Neuro-symbolic AI, machine learning, deep learning, cognitive modeling
PROGRAMMING:	Python, Lean, Agda, Lisp (Racket); Tensorflow (Keras), Scikit-Learn; Git, LaTeX
SOFT SKILLS:	Academic writing, presentations (talks, posters), teaching, lesson planning