curriculum vitæ of
Jacob Scott Laurel

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Research Summary

My mission as a programming languages researcher is to build automated and mathematically principled program analyses for continuous computations. My efforts focus on two popular paradigms that expose continuous computations: differentiable and probabilistic programming languages. While a programming languages viewpoint anchors my research, my work spans the full computing stack: from applying formal methods to prove properties about differentiable programs all the way down to building compilers to generate fast inference code on embedded systems.

Education

Aug. 2017 – Dec. 2024 **Ph.D.** in Computer Science — University of Illinois at Urbana-Champaign
Advisor: Sasa Misailovic
Research areas: Differentiable and Probabilistic Programming Languages, Abstract Interpretation, Program Analysis, Formal Methods, Compilers, Embedded Systems

Aug. 2012 – May 2017 **B.S.E.E** in Electrical Engineering Summa Cum Laude — University of Alabama at Birmingham
B.S. in Mathematics (Applied Mathematics and Scientific Computation Track) Summa Cum Laude
GPA: 3.95/4.0

Work Experience

Jan. 2025 – present Assistant Professor of Computer Science — Georgia Institute of Technology

Sep. 2024 – Dec. 2024 Ph.D. Research Intern — Argonne National Laboratory
Manager: Jan Hückelheim

July 2018 – Present Research Assistant — University of Illinois Urbana-Champaign
Advisor: Sasa Misailovic

May 2019 – Aug. 2019 Ph.D. Research Intern — NASA Langley Research Center
Mentors: Cesar Muñoz and Aaron Dutle
Applied program analysis to quantify floating point error in probabilistic programs.

May 2016 – Aug. 2016 Undergraduate Research Intern — University of Central Florida
Helped develop a novel video summarization technique using LSTM Deep Neural Networks. Work published in CVPR 2017.

Publications

Peer-Reviewed Conference and Journal Publications

1. **Jacob Laurel**, Siyuan Brant Qian, Gagandeep Singh, Sasa Misailovic. Synthesizing Precise Static Analyzers for Automatic Differentiation. In *Object-Oriented Programming, Systems, Languages, and Applications* (**OOPSLA 2023**). Acceptance rate: 36%.

2. Rem Yang, **Jacob Laurel**, Sasa Misailovic, Gagandeep Singh. Provable Defense Against Geometric Transformations. In *11th International Conference on Learning Representations* (**ICLR 2023**). Acceptance rate: 31%. Designated **notable, top 25% of papers**.

3. Vimuth Fernando, Keyur Joshi, **Jacob Laurel**, Sasa Misailovic. Dynamic Monitoring of Uncertainty for Distributed Asynchronous Programs with Diamont. In *International Journal on Software Tools for Technology Transfer* (**STTT 2023**).

4. Ashitabh Misra, **Jacob Laurel**, Sasa Misailovic. ViX: Analysis-driven Compiler for Efficient Low-Precision Differentiable Inference. In *Design Automation and Test in Europe* **(DATE 2023)**. Full Paper Acceptance rate: 25%.

5. **Jacob Laurel**, Rem Yang, Shubham Ugare, Robert Nagel, Gagandeep Singh, Sasa Misailovic. A General Construction for Abstract Interpretation of Higher-Order Automatic Differentiation. In *Object-Oriented Programming, Systems, Languages, and Applications* **(OOPSLA 2022)**. Acceptance rate: 31%.

6. **Jacob Laurel**, Rem Yang, Gagandeep Singh, Sasa Misailovic. A Dual Number Abstraction for Static Analysis of Clarke Jacobians. In *Symposium on Principles of Programming Languages* **(POPL 2022)**. Acceptance rate: 23%.

7. Vimuth Fernando, Keyur Joshi, **Jacob Laurel**, Sasa Misailovic. Diamont: Dynamic Monitoring of Uncertainty for Distributed Asynchronous Programs. In *21st International Conference on Runtime Verification* **(RV 2021)**. Acceptance rate: 38%.

8. **Jacob Laurel**, Rem Yang, Atharva Sehgal, Shubham Ugare, Sasa Misailovic. Statheros: A Compiler for Efficient Low-Precision Probabilistic Programming. In *58th Design Automation Conference* **(DAC 2021)**. Acceptance rate: 23%.

9. **Jacob Laurel**, Sasa Misailovic. Continualization of Probabilistic Programs with Correction. In *29th European Symposium on Programming* **(ESOP 2020)**. Acceptance rate: 31%.

10. Aidean Sharghi, **Jacob Laurel**, Boqing Gong. Query-Focused Video Summarization: Dataset, Evaluation, and A Memory Network Based Approach. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition* **(CVPR 2017)**. Acceptance rate: 29%.

Preprints

11. Zixin Huang, **Jacob Laurel**, Saikat Dutta, Sasa Misailovic. Precise Abstract Interpretation of Probabilistic Programs with Interval Data Uncertainty. Under Submission

Posters and Workshop Papers

12. **Jacob Laurel**, Siyuan Brant Qian, Gagandeep Singh, Sasa Misailovic. Abstract Interpretation for Automatic Differentiation. In *Languages for Inference Workshop* **(LAFI 2024).**

13. **Jacob Laurel**. Exact Quantification of Continuity Correction Error in Probabilistic Programs. Poster presented at *1st International Conference on Probabilistic Programming* **(PROBPROG 2018)**.

Honors and Awards

2023	One of 6 UIUC students selected to attend the Global Young Scientists Summit in Singapore (GYSS 2024)
2023-2024	UIUC Mavis Future Faculty Fellowship ($ 2000 Award)
2023	UIUC CS Department Outstanding Graduate Student Ambassador ($ 100 Award)
2023	UIUC ALERT Program Mentor Award ($ 1000 Award)
2017-Present	UIUC Sloan UCEM Scholarship ($ 40,000 Award)
2012-2017	UAB Presidential Honors List for 4.0 GPA during semester
2012-2016	UAB Presidential Scholarship as National Hispanic Recognition Program Scholar
2015	UAB School of Engineering Dupuis Scholarship
2015	UAB School of Engineering Undergraduate Research Award for Honors Research
2013	Inducted into Tau Beta Pi Engineering Honor Society

Research Talks and Presentations

Sep. 2024	"Abstract Interpretation for Automatic Differentiation " - 8th International Conference on Algorithmic Differentiation

Feb.-May 2024	Invited Talk: "Automated Analyses for Continuous Computations" - Tufts University, Yale University, University of Virginia, Pennsylvania State University, University of Wisconsin-Madison, Georgia Institute of Technology
Jan. 2024	Invited Talk: "Automated Analyses for Continuous Computations" - Columbia University Systems Seminar (host: Baishakhi Ray)
Dec. 2023	Invited Talk: "Abstractly Interpreting Differentiable Programming" - Purdue University PurPL Seminar (host: Ben Delaware)
Oct. 2023	Invited Talk: "Abstractly Interpreting Differentiable Programming" - University of Michigan Midwest Programming Languages Summit 2023
Oct. 2023	Invited Talk: "Abstractly Interpreting Differentiable Programming - A Trilogy" - Cornell University PLDG Seminar (host: Adrian Sampson)
Aug. 2023	Invited Talk: "Abstractly Interpreting Differentiable Programming" - Argonne National Laboratory CS Seminar (host: Jan Hückelheim)
June 2023	Invited Talk: "A General Construction for Abstract Interpretation of Higher-Order Automatic Differentiation" - UCF CRCV Seminar (host: Niels Da Vitoria Lobo)
July 2022	Invited Talk: "Abstract Interpretation for Differentiable Programming" - UC Berkeley Formal Methods Seminar (host: Sanjit Seshia)
June 2022	Invited Talk: "Abstract Interpretation for Differentiable Programming" - Stanford Software Seminar (host: Clark Barrett)

Research Mentoring

Mentored two graduate students and five undergraduate students:

Feb. 2020 - May 2023	Rem Yang (BS, UIUC) - Co-author on DAC21, POPL22, OOPSLA22, ICLR23
Mar. 2020 - May 2021	Atharva Sehgal (BS, UIUC) - Co-author on DAC21
May. 2021 - May 2023	Robert Nagel (BS, UIUC) - Co-author on OOPSLA22
Nov. 2020 - Aug. 2022	Shubham Ugare (PhD, UIUC) - Co-author on DAC21, OOPSLA22
May. 2022 - Feb. 2023	Ashitabh Misra (PhD, UIUC) - Co-author on DATE23
Jan. 2023 - present	Siyuan Brant Qian (BS, UIUC/ZJU) - Co-author on OOPSLA23, LAFI24
May 2023 - Aug. 2023	Jonah Black (BS UIUC) - Mentored through the UIUC ALERT Program

Teaching Experience

Spring 2023	UIUC CS 477 Formal Software Development Methods (Guest Lecture)
Fall 2019	UIUC CS 421 Programming Languages and Compilers (Teaching Assistant)
Spring 2019	UIUC CS 126 Software Design Studio (Teaching Assistant)
Fall 2018	UIUC CS 173 Discrete Structures (Teaching Assistant)
Spring 2018	UIUC CS 374 Algorithms and Models of Computation (Teaching Assistant)
Spring 2014	UAB ECE 312 Electrical Systems (Undergraduate Course Assistant)

Open-Source Software Contributions

I have led the development of the following open-source software libraries:

AbstractAD: AbstractAD is a parametric abstract interpretation of higher-order differentiable programs that allows for expressive abstract domains (like Zonotopes), published in OOPSLA22. It is available at `https://github.com/uiuc-arc/AbstractAD`

DeepJ: DeepJ is a sound abstract interpretation of Clarke Generalized Jacobians, published in POPL22. It is available at `https://github.com/uiuc-arc/DeepJ`

Statheros: Statheros is a compiler for fixed-point probabilistic programming, published in DAC21. It is available at `https://github.com/uiuc-arc/Statheros`

Pasado: Pasado is a tool for synthesizing static analyzers for Automatic Differentiation, published in OOPSLA23. It is available at `https://github.com/uiuc-arc/Pasado` as well as `https://doi.org/10.5281/zenodo.8332724`

Service

Fall 2023	Graduate Student Representative for UIUC Faculty Awards Committee
Summer 2023	Reviewer - WFVML 2023
Summer 2023	Mentor for UIUC Accelerated Learning and Engineering Research Training (ALERT) Program
Mar. 2023	Graduate Ambassador and Panelist for session on Diversity and Inclusivity for UIUC CS Visit Day
Fall 2022 - Spring 2023	Graduate Student Representative for UIUC's CS Graduate Study Committee
Summer 2022	Reviewer - ECCV 2022
Summer 2022	Artifact Evaluation Committee - SAS 2022
Fall 2021	Panelist for UIUC's Society of Hispanic Professional Engineers Graduate Student Panel
Summer 2021	Artifact Evaluation Committee - OOPSLA 2021
Mar. 2020	Graduate Ambassador for UIUC CS Visit Day
Jan. 2020	Graduate Volunteer for UIUC School of Engineering Undergraduate Research Expo
Fall 2019	Organizer - UIUC Brett Daniel Software Engineering Seminar