Cunxi Yu

CONTACT INFORMATION	**Address:** 2126 MEB, 50 S Central Campus Dr, Salt Lake City, UT 84112 **Cell:** +1 413 992 9756 (U.S.) **Email:** cunxi.yu@utah.edu **Personal Website**

RESEARCH INTERESTS

Novel algorithms, hardware, and co-design infrastructures for computing and security

Keywords: Applied ML/RL in Design Automation, Co-design for Computing, Sustainable Computing, Optical AI System, Cryptography on Edge

RESEARCH APPOINTMENTS

University of Utah, Salt Lake City, UT, USA
Assistant Professor   **09.2019 - present**

Cornell University, Ithaca, NY, USA
Postdoc   **2018 - 2019**
Advisor: Prof. Zhiru Zhang

EPFL, Lausanne, Switzerland
Postdoc   **2017 - 2018**
Advisor: Prof. Giovanni De Micheli

University of Massachusetts Amherst, Amherst, MA, USA
Research Assistant   **2014 - 2017**
Advisor: Prof. Maciej Ciesielski

IBM Thomas J. Watson Research Center, Yorktown Heights, NY, USA
Research Intern, Design Automation Research   **2015, 2016**

EDUCATION

University of Massachusetts Amherst, Massachusetts, USA

 Ph.D. Computer System Engineering   **2017**
- Dissertation: "Formal Analysis of Arithmetic Circuits using Computer Algebra - Verification, Abstraction, and Reverse Engineering."

Zhejiang University City College, Hangzhou, China

 B.S. Electrical Engineering   **2013**

AWARDS

- American Physics Society - Division of Laser Science Poster Award (2022)
- NSF CAREER Award (2021)
- IEEE ASP-DAC Best Paper Nomination (2017)
- ACM Doctoral Dissertation Award Nomination (by UMass Amherst)
- DAC Hack@DAC Security Contest - 1st Place (2017)
- 2017 IWLS IBM Student Grant
- 2016 IEEE TVLSI Travel Grant
- IEEE TCAD Best Paper Nomination (2016)

PUBLICATIONS   Author keys: * Equal contributions; __ Students advised; † Communication author.

2023

- Yingjie Li, Ruiyang Chen, Minhan Lou, Berardi Sensale-Rodriguez, Weilu Gao, **Cunxi Yu**. *LightRidge: An End-to-end Agile Design Framework for Diffractive Optical Neural Networks.* ACM International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS'24).

- Yingjie Li, Weilu Gao, **Cunxi Yu**. *RubikONNs: Multi-task Learning with Rubik's Diffractive Optical Neural Networks.* 32nd International Joint Conference on Artificial Intelligence (IJCAI'23) (15%)

- Debjit Pal, Chenhui Deng, Ecenur Ustun, **Cunxi Yu**, Zhiru Zhang. *Book chapter: Machine Learning for Agile FPGA Design.* Springer.

- Minhan Lou, Yingjie Li, **Cunxi Yu**, Berardi Sensale-Rodriguez, Weilu Gao*. *Effects of Interlayer Reflection and Interpixel Interaction in Diffractive Optical Neural Networks.* Optics Letter. Jan 2023.

- Ecenur Ustun, **Cunxi Yu**, and Zhiru Zhang. *Invited: Equality Saturation for Datapath Synthesis: A Pathway to Pareto Optimality.* Design Automation Conference (DAC'23). (23%)

- Yingjie Li*, Shanglin Zhou*, Minhan Lou, Weilu Gao, **Cunxi Yu**, Caiwen Ding. *Physics-aware Roughness Optimization for Diffractive Optical Neural Networks.* Design Automation Conference (DAC'23). (23%)

- Jiaqi Yin, Yingjie Li, Daniel Gleen Robinson, and **Cunxi Yu**. *Reinforcement Learning based Edge Scheduling on Pipelined Coral Edge TPUs.* Design Automation Conference (DAC'23).(23%) **GitHub**

- Nan Wu, Yingjie Li, Steve Dai, Cong Hao, **Cunxi Yu**, Yuan Xie *Gamora: Graph Learning based Symbolic Reasoning for Large-Scale Boolean Networks.* Design Automation Conference (DAC'23). (23%) **GitHub**

2022

- Jiaqi Yin, Zhiru Zhang, **Cunxi Yu**. *IMpress: Large Integer Multiplication Expression Rewriting for FPGA HLS* ACM/IEEE International Symposium on Edge Computing (SEC'22). Dec, 2022.

- Yingheng Tang, Princess Tara Zamani, Ruiyang Chen, Jianzhu Ma, Minghao Qi, **Cunxi Yu**†, Weilu Gao†. *Device-system Co-design of Photonic Neuromorphic Processor using Reinforcement Learning.* Laser & Photonics Reviews. Vol 16, July 2022 (IF:13.14). **Media**

- Walter Lau Neto, Yingjie Li, Pierre-Emmanuel Gaillardon, **Cunxi Yu**. *FlowTune: End-to-end Automatic Logic Optimization Exploration via Domain-specific Multi-armed Bandi.* IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD). 2022. **GitHub**

- Yingjie Li, Ruiyang Chen, Weilu Gao, **Cunxi Yu**. *Physics-aware Complex-valued Adversarial Machine Learning in Reconfigurable Diffractive All-optical Neural Network.* IEEE/ACM International Conference On Computer Aided Design (ICCAD). Nov, 2022.

- Ruiyang Chen*, Yingjie Li*, Minhan Lou, Jichao Fan, Yingheng Tang, Berardi Sensale Rodriguez, Weilu Gao†, **Cunxi Yu**†. *Physics-aware Complex-valued Adversarial Machine Learning in Reconfigurable Diffractive All-optical Neural Network.* Laser & Photonics Reviews. Vol 16, July 2022 (IF:13.14). **Media**

- Yingjie Li, Minhan Lou, Ruiyang Chen, Jichao Fan, Berardi Sensale Rodriguez, Weilu Gao, **Cunxi Yu**. *An Open-source End-to-end Compiler Framework for Diffractive Optical Neural Networks.* Workshop on Open-Source Computer Architecture Research (OSCAR) at International Symposium on Computer Architecture (ISCA'22). June, 2022.

- Ecenur Ustun, Ismail San, Jiaqi Yin, **Cunxi Yu**, and Zhiru Zhang. *Exact Memory- and Communication-Aware Scheduling of DNNs on Pipelined Edge TPUs.* IEEE International Symposium on Field-Programmable Custom Computing Machines (FCCM'22). May, 2022.

- Yingheng Tang, Jichao Fan, Xinwei Li, Jianzhu Ma, Minghao Qi, **Cunxi Yu†**, Weilu Gao†. *Physics-Guided and Physics-Explainable Recurrent Neural Network for Time Dynamics in Optical Resonances.* Nature Computational Science. 2.3 (2022): 169-178. **Media**

- Jiaqi Yin, Qiwei Yuan, Yingjie Li, **Cunxi Yu**. *Combinatorial Reinforcement Learning Based Scheduling for DNN Execution on Edge.* TinyML Research Symposium 2022 (TinyML'22). Jan, 2022.

2021

- Yingjie Li, Minhan Lou, Ruiyang Chen, Jichao Fan, Berardi Sensale Rodriguez, Weilu Gao, **Cunxi Yu**. *LightRidge: End-to-end Photonic Compiler Framework for Diffractive Optical Neural Networks.* ROAD4NN Workshop at ACM/IEEE Design Automation Conference (DAC). July, 2021.

- Yingjie Li, **Cunxi Yu**. *Physical Adversarial Attacks of Diffractive Deep Neural Networks.* ACM/IEEE Design Automation Conference (DAC). July, 2021.

- Walter Lau Neto, Matheus Trevisan Moreira, Yingjie Li, Luca Amaru, **Cunxi Yu**, and Pierre-Emmanuel Gaillardon *SLAP: A Supervised Learning Approach for Priority Cuts Technology Mapping.* ACM/IEEE Design Automation Conference (DAC). July, 2021.

- Yingjie Li, Ruiyang Chen, Berardi Sensale Rodriguez, Weilu Gao, **Cunxi Yu**. *Multi-Task Learning in Diffractive Deep Neural Networks via Hardware-Software Co-design.* Nature Scientific Reports. 2021.

- Weilu Gao, **Cunxi Yu**, Ruiyang Chen. *Artificial Intelligence Accelerators based on Graphene Optoelectronic Devices.* Advanced Photonics Research.

- Walter Lau Neto, Matheus Trevisan Moreira, Luca Amaru, **Cunxi Yu**, and Pierre-Emmanuel Gaillardon. *Read your Circuit: Leveraging Word Embedding to Guide Logic Optimization.* Asia and South Pacific Design Automation Conference (ASP-DAC). Jan, 2021.

2020

- **Cunxi Yu**. *FlowTune: Practical Multi-Arm Bandits in Boolean Optimization.* IEEE/ACM International Conference On Computer Aided Design (ICCAD). Nov, 2020.

- **Cunxi Yu**, Wang Zhou. *Decision Making in Synthesis cross Technologies using LSTMs and Transfer Learning.* ACM/IEEE Workshop on Machine Learning for CAD (MLCAD). Sep, 2020.

- Walter Lau Neto, Matheus Trevisan Moreira, Luca Amaru, **Cunxi Yu**, and Pierre-Emmanuel Gaillardon. *EaSyOpt: Predicting Post Place and Route Critical Paths for Early Synthesis Optimization.* International Workshop on Logic & Synthesis (IWLS). July, 2020.

2019

- **Cunxi Yu**, Zhiru Zhang. *Painting on Placement: Forecasting Routing Congestion using Conditional Generative Adversarial Nets.* ACM/IEEE Design Automation Conference (DAC). June, 2019.

- **Cunxi Yu**, Atif Yasin, Tiankai Su, and Maciej Ciesielski. *Spectral Approach to Verifying Nonlinear Arithmetic Circuits.* Asia and South Pacific Design Automation Conference (ASP-DAC). Jan, 2019.

- Maciej Ciesielski, Atif Yasin, Tiankai Su, **Cunxi Yu**. *Understanding Algebraic Rewriting for Arithmetic Circuit Verification: a Bit-Flow Model.* IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD). 2019

- <u>Ecenur Ustun</u>, <u>Shaojie Xiang</u>, Jinny Gui, **Cunxi Yu**, Zhiru Zhang. *LAMDA: Learning-Assisted Multi-stage Design Autotuning.* IEEE International Symposium on Field-Programmable Custom Computing Machines (FCCM). May, 2019.

2018

- **Cunxi Yu**, Atif Yasin, Tiankai Su, Alan Mishchenko and Maciej Ciesielski. *Rewriting Environment for Arithmetic Circuit Verification.* International Conference on Logic for Programming Artificial Intelligence and Reasoning (LPAR-22), Nov 2018.

- **Cunxi Yu**, Houping Xiao, Giovanni De Micheli. *Developing Synthesis Flows without Human Knowledge.* ACM/IEEE Design Automation Conference (DAC). June, 2018.

- **Cunxi Yu**, Maciej Ciesielski and Alan Mishchenko. *Fast Computer Algebra Rewriting based on And-Inv-Graphs.* IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD). 2018

- **Cunxi Yu** and Maciej Ciesielski. *Formal Analysis of Galois Field Arithmetic -Verification and Reverse Engineering in Parallel.* IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD). 2018

- **Cunxi Yu**, Heinz Riener, Francesca Stradolini, Giovanni De Micheli. *Generating Safety Guidance for Medical Injection with Three-Compartment Pharmacokinetics Model.* (ISVLSI'18)

- **Cunxi Yu**, Gi-Joon Nam, Mihir Choudhury, Victor Kravets, Andrew Sullivan and Maciej Ciesielski, Giovanni De Micheli. *End-to-End Industrial Study of Retiming.* (ISVLSI'18).

- Shahrzad Keshavarz, **Cunxi Yu**, Samaneh Ghandali, Xiaolin Xu, Daniel Holcomb. *Survey on applications of formal methods in reverse engineering and intellectual property protection.* (**Invited**) Journal of Hardware and Systems Security - Springer.

- Tiankai Su, **Cunxi Yu**, Atif Yasin, Maciej Ciesielski. *Computer Algebraic Approach for Galois Field Multipliers Verification and Debugging.* IEEE International Symposium on Circuits and Systems (ISCAS). May, 2018.

2017

- **Cunxi Yu**, Mihir Choudhury, Andrew Sullivan and Maciej Ciesielski. *Advanced Datapath Synthesis using Graph Isomorphism.* IEEE/ACM International Conference On Computer Aided Design (ICCAD). Nov, 2017.

- **Cunxi Yu** , Daniel Holcomb and Maciej Ciesielski. *Reverse Engineering Irreducible Polynomial of GF(2^m) Arithmetic.* Design Automation and Test in Europe (DATE'17). March, 2017. Lausanne, Switzerland.

- **Cunxi Yu** and Maciej Ciesielski. *Efficient Parallel Verification of Galois Field Multipliers.* Asia and South Pacific Design Automation Conference (ASP-DAC). Jan, 2017. (**Best Paper Award Nomination**).

- **Cunxi Yu**, Xiangyu Zhang, Duo Liu, Maciej Ciesielski, Daniel Holcomb. *Incremental SAT-based Reverse Engineering of Camouflaged Logic Circuits.* IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD). 2017

- Tiankai Su, **Cunxi Yu**, Atif Yasin, Maciej Ciesielski. *Formal Verification of Truncated Multipliers using Algebraic Approach and Re-synthesis.* IEEE Computer Society Annual Symposium on VLSI (ISVLSI), July 2017.

2016

- **Cunxi Yu**, Walter Brown, Duo Liu, Andre Rossi and Maciej Ciesielski. *Formal Verification of Arithmetic Circuits by Function Extraction.* IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD). 2016. (**Best Paper Nomination**)

- **Cunxi Yu** and Maciej Ciesielski. *Formal Verification using Don't-care and Vanishing Polynomials.* 2016 IEEE Computer Society Annual Symposium on VLSI (ISVLSI), July 2016.

- **Cunxi Yu** and Maciej Ciesielski. *Analyzing Imprecise Adders using BDDs - A Case Study.* 2016 IEEE Computer Society Annual Symposium on VLSI (ISVLSI) , July 2016.

- **Cunxi Yu**, Mihir Choudhury, Andrew Sullivan and Maciej Ciesielski. *DAG-Aware Logic synthesis of Datapaths.* ACM/IEEE Design Automation Conference (DAC). June, 2016.

- **Cunxi Yu**, Maciej Ciesielski. *Automatic Word-level Abstraction on Datapaths.* IEEE International Symposium on Circuits and System (ISCAS), May 2016.

- Duo Liu, **Cunxi Yu**, Xiangyu Zhang, Daniel Holcomb. *Oracle-Guided Incremental SAT Solving to Reverse Engineer Camouflaged Logic Circuits.* Design, Automation and Test in Europe (DATE'16) March 2016, Dresden, Germany.

2015

- **Cunxi Yu**, Duo Liu, Walter Brown, Samaneh Ghandali, Maciej Ciesielski. Verification of Sequential Arithmetic Circuit. ACM/IEEE Design Automation Conference (DAC). June, 2015.

- Maciej Ciesielski, **Cunxi Yu**, Walter Brown, Duo Liu, Andre Rossi. *Verification of Gate-level Arithmetic Circuits by Function Extraction.* ACM/IEEE Design Automation Conference (DAC). June, 2015.

- Samaneh Ghandali, **Cunxi Yu**, Duo Liu, Maciej Ciesielski. Diagnosis and Debugging of Arithmetic Circuits. ACM/IEEE Design Automation Conference (DAC). June, 2015.

- **Cunxi Yu**, Walter. Brown, Maciej. Ciesielski. *Verification of Arithmetic Datapath Designs using Word-level Approach.* IEEE International Symposium on Circuits and System (ISCAS), May 2015.

- Samaneh Ghandali, **Cunxi Yu**, Duo Liu, Maciej Ciesielski. *Logic Debugging of Arithmetic Circuits.* IEEE Computer Society Annual Symposium on VLSI (ISVLSI), July 2015.

GRANTS

- *NSF: SWIFT: Decentralized Intelligent Spectrum Sharing in UAV Networks via Hardware-software Co-design.* 10.2022 - 09.2025. Amount: $750,000.
  PI: Mingyue Ji (25%), **co-PI: Cunxi Yu** (25%), Rong-rong Chen (25%), University of Utah; co-PI Zhangyu Guan University of Buffalo (25%)

- *NSF: REU: Compiler Optimizations with Quality Guarantees for Efficient DNN Model Execution.* 07.2022 - 06.2024. Amount: $16,000.
  PI: Cunxi Yu, University of Utah.

- *NSF: CAREER: CAREER: OneSense: One-Rule-for-All Combinatorial Boolean Synthesis via Reinforcement Learning.* NSF-#2008144, 09.01.2021 - 08.31.2026. Amount: $478,526.00
  PI: Cunxi Yu, University of Utah.

- *NSF: SHF: Small: Boosting Boolean Reasoning with Inductive Attributed Graph Learning.* NSF-#2008144, 09.01.2020 - 08.31.2023. Amount: $381,707.00.
  PI: Cunxi Yu, University of Utah.

- *NSF: FMiTF: Collaborative: DeepSmith: Scheduling with Quality Guarantees for Efficient DNN Model Execution.* NSF-#2019336, 09.01.2020 - 08.31.2024. Amount: $743,000.00.
  PI: Cunxi Yu (50%), University of Utah; co-PI: Zhiru Zhang (50%), Cornell University.

- *NSF: I-Corps: Heterogeneous HPC Compiler Framework for Hardware-Software Optical AI Accelerator Co-Design.* 2021. Amount: $6,000.
  PI: Weilu Gao (50%), **co-PI: Cunxi Yu** (50%). University of Utah.

- *Industrial support.* NVIDIA, Amphere Computing, AMD Xilinx. Total: $30,000
  Under-review

- *NSF: FET: LightRidge.* Amount: $600,000.
  PI: Cunxi Yu (50%), co-PI: Weilu Gao (50%). University of Utah.
- *NSF: IIS:SHF: Reinforcement Learning in Chip Design Automation.* Amount: $1,2000,000.
  Pan Li, GaTech (PI); **co-PI: Cunxi Yu** (33%), Ruqi Zhang, Purdue

OPEN-SOURCE TOOLS	**LightRidge: Open-source Physics-aware Design Framework for Diffractive Optical Neural Networks** [Laser & Photonics Reviews 22, ICCAD'22, Nature Scientific Reports '21] `https://lightridge.github.io/lightridge/`

DeepLight: Device-to-System Optical GEMM Framework [Advanced Photonics Research'21, Nature Computational Science'22, Laser & Photonics Reviews'22]
`https://deeplight.github.io/deeplight/`

Intelligent Hardware Synthesis Systems [TCAD'22, ICCAD'20, DAC'18]
FlowTune:`https://github.com/Yu-Utah/FlowTune`
FlowGen: `https://github.com/ycunxi/FLowGen-CNNs-DAC18`

ACEC: **A**rithmetic **C**ombinational **E**quivalence **C**hecking [Ph.D. Thesis][DAC'15] [TCAD'17,'19]
ABC integration: `https://github.com/berkeley-abc/abc/tree/master/src/proof/acec`
Galois Field Verification: `https://github.com/ycunxi/Parallel_Formal_Analysis_GaloisField`

Incremental-SAT De-camouflaging for Encrypted Logic Circuits [DATE'16] [TCAD'16]
SAT Attack: `https://github.com/ycunxi/Incremental-SAT-DeCam`

TEACHING EXPERIENCE

UNIVERSITY OF UTAH

- Instructor. ECE/CS 3700 - Digital System Design (Undergraduate Core). University of Utah. Fall'20, Fall'21, Fall'22
- Instructor. ECE/CS 5740/6740 - CAD of Digital Circuits. University of Utah. Spring'21, Spring'23
- Instructor. ECE 5960/6960 - Deep Learning Systems. University of Utah. Spring'20, Spring'22

BEFORE JOINING UNIVERSITY OF UTAH

- Teaching Assistant. ECE 667 - Synthesis and Verification. UMass Amherst. Spring'16
- Teaching Assistant. ECE 221 - Introduction to Digital Systems. UMass Amherst. Fall'15
- Teaching Assistant. ECE 597/697 MB - Embedded Systems. Spring'15

SERVICES

General Chair: IWLS'23.

Organizing Committee: ASAP'19, IWLS'20, IWLS'21, IWLS'22, VLSI-SoC'20, ICCD'20, ICCD'21,

TPC Member: IWLS'17-20, DUHDe@DATE'19, ASPDAC'20, ICCAD'20, ASPDAC'21, ICCAD'21, DAC'22, ICCAD'22, DATE'23, DAC'23

Session Chairs: ICCAD'21, DAC'22, ICCAD'22

Reviewer: VTS'15, ICCAD'15, CHES'16, DAC'17, DATE'18, DAC'18, ASP-DAC'19, FPGA'19

Journal Editor:
Journal of Signal Processing Systems (Guest Editor)

Journal Reviewer:
Nature Scientific Report
Nature Light: Science & Applications
Nanophotonics
ACM Transactions on Design Automation of Electronic Systems
IEEE Design & Test of Computers
IEEE Transactions on Very Large Scale Integration Systems
IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems
IEEE Transactions on Computers
IEEE Transactions on Information Forensics and Security
IEEE Journal on Emerging and Selected Topics in Circuits and Systems
IEEE Transactions on Emerging Topics in Computing
IEEE Computer Architecture Letters
ACM Transactions on Reconfigurable Technology and Systems

MENTORING EXPERIENCE

UNIVERSITY OF UTAH

- Yingjie Li, Ph.D. student (Chair).
- Jiaqi Yin, Ph.D. student (Chair).
- Mingju Liu, Ph.D. student (Chair).
- Keqi Song, Ph.D. student (Chair).
- Tara Zamani, M.S. thesis (Chair).
- Walter Lau Neto, Ph.D. student (co-Chair) *Advanced Logic Synthesis System.*
- Aurelien Alacchi, Ph.D. student (Committee) *Smart FPGA Architecture for Reliability Improvement in Harsh Environments.*
- Max Austin, Ph.D. student (Committee) *Integration of Machine Learning in Logic Synthesis..*
- Venkata Sai MadhuKiran Harsha Nori, Ph.D. student (Committee) *Scalable Asynchronous Circuit Design.*
- Ziyi Chen, Ph.D. student (Committee) *Non-Convex Optimization Theories and Applications.*

CORNELL UNIVERSITY

- Shaojie Xiang, Ph.D. student. *EZTune: A Generic Auto-tuning Language and Framework.*
- Zhijing Li and Chenhui Deng, Ph.D. student. *HLS Performance Estimation using Graph Learning.*
- Ecenur Ustun (Ph.D.), Jinny Gui (B.S.). *Learning Assisted Design Closure System for FPGAs.*

UMASS AMHERST

- Tiankai Su,Ph.D. student. *Formal Verification of Approximate Arithmetic Circuits* [ISCAS'18, ASP-DAC'19]
- Atif Yasin, Ph.D. student. *Logic Diagnosis based on Gröbner basis.* [ISCAS'18, ASP-DAC'19]
- Walter Brown, *Honor* B.S project. *Logic Debugging using Machine Learning.*