Md Rubel Ahmed

CONTACT INFORMATION

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MAJOR RESEARCH TOPICS

- System-on-Chip Design and Validation
- Energy efficient AI Accelerator Design
- High-Level Synthesis Optimization using Machine Learning
- Computer Architecture
- Neuro-Symbolic Reasoning

EDUCATION

University of South Florida, Tampa, FL Aug. 2018 - Nov. 2023
Ph.D. in Computer Science and Engineering
- *Dissertation Title: "Machine Learning for Electronic Design Automation: Specification Mining and High-Level Synthesis."*
- Thesis Supervisor: Dr. Hao Zheng
- 2023 Dissertation Completion Fellowship
M.S. in Computer Engineering

Khulna University of Engineering and Technology, Bangladesh Mar. 2013 - Apr. 2017
B.Sc. in Computer Science and Engineering

SKILLS

Programming Languages	C/C++, Python
EDA Tools	Vitis HLS, Xilinx ISE Webpack, Vivado HLx
Architectural Simulator	Simplescalar, and gem5
Miscellaneous	Reinforcement Learning, PyTorch, UPPAAL, VHDL, Z3 solver, Git, Docker, ROS2, AirSim, Optuna

EXPERIENCE

Postdoctoral Researcher Jan. 2024 - Current
AI and Emerging Computing Lab, U. of Central Florida, Orlando, FL
Supervisor: Dr. Rickard Ewetz (University of Florida)
- Developed hybrid neuro-symbolic algorithms for the ANSR program, ensuring robust perception for autonomous drones
- Contributed to machine learning projects and co-authored high-quality manuscripts for publication in leading AI conferences
- Facilitated brainstorming sessions and mentored undergrad and grad students in advancing their research projects

Research Intern Sept. 2022 - May 2023
Mitsubishi Electric Research Laboratories, Cambridge, MA
- Developed an ML model for novel applications with innovative techniques
- Improved the efficiency of ML model on FPGA implementation
- Analyzed performance and power trade-offs and achieved low power consumption and high throughput
- Developed a multi-objective optimization framework utilizing the capabilities of both Open AI and Optuna APIs

Research Assistant Aug. 2019 - Aug. 2022
The SEES Lab, U. of South Florida, Tampa, FL
- Successfully instrumented and generated traces from SoCs modeled in VHDL, gem5, and Rocket Chip Generators
- Developed an innovative algorithm for automatic specification mining using advanced Data Mining and NLP models
- Mentored and trained Research Experience for Undergrad (REU) students, providing guidance and support for their research and helping to foster the next generation of experts

Instructor May 2019 - July 2022
University of South Florida, Tampa, FL
• Taught the course Computer Architecture (CDA 4205) in the summer of 2022 and 2019, providing students with a strong foundation in modern computing architecture and ISAs
• Developed labs, and class activities and implemented a backward course design approach to help students understand micro-architecture using gem5
• Designed and administered both summative and formative assessments, held weekly discussion sessions and office hours
• Successfully managed and facilitated the smooth running of three lab sections for the course. Held weekly meetings with lab TAs and provided timely feedback.

Teaching Assistant Aug. 2018 - July 2022
University of South Florida, Tampa, FL
• FPGA Design (Spring 2020)
• System Integration and Architecture (Spring 2020)
• Computer Architecture (Fall 2019)
• Cloud Computing for IT (Fall 2018)
• Software Engineering (Fall 2018)

Software Engineer Nov. 2017 - July 2018
Synchronous ICT, Dhaka, Bangladesh
• Leveraged FFMPEG technology to process multimedia data in mobile applications effectively
• Innovatively designed and implemented a cutting-edge data-driven cross-platform mobile application using React JS

MAJOR PROJECT HIGHLIGHTS

Assured Neuro Symbolic Learning and Reasoning (ANSR) Jan. 2024 - Current
The ANSR project, part of DARPA's initiative, focuses on developing hybrid AI algorithms that combine neuro-symbolic reasoning with data-driven learning to create trustworthy autonomous systems. My work centers on enhancing the perception capabilities of autonomous drones in tightly resource-constrained situations. It also includes integration with the maneuver component, using ROS2 and Docker multi-container setups. As a postdoctoral researcher, I developed neuro-symbolic perception algorithms, mentored students, and co-authored papers for top AI conferences. [C11, U3]

Specification Mining 2018 - 2022
This project aims to study and explore various approaches to mine sequential patterns from SoC traces. It overcomes the challenges associated with traditional pattern mining for SoC traces. This work incorporates an assertion mining approach to find highly correlated patterns. In addition, a trace-to-Finite State Models (FSMs) conversion approach is also proposed. The FSM models can be used for analysis and improvement of flow specifications. [J1, J3, C3, C6, C5, C7, C8]

HLS Accelerator Design 2022 - 2023
Design parameter space in HLS creates a multi-objective optimization problem. A Quantum Neural Network (QNN) based early failure prediction method is proposed that solves three issues with the existing methods. The QNN model has a relatively small set of weights and is less computationally expensive, making it a greener pathway for HLS acceleration. [C9, C10]

Multi-Objective Optimization in Health-Care Planning 2020 - 2021
This project proposes a healthcare facility expansion plan using Reinforcement Learning (RL). The objective is to use an RL model to simulate the demand-supply scenario of various natural and man-made situations in order to suggest an optimal hospital facility expansion plan. This is a multi-objective optimization problem. [J2, C4, C2]

FUNDING PROPOSAL DEVELOPMENT

Under development

PUBLISHED/ACCEPTED JOURNAL PUBLICATIONS

[J3] [$\mathbf{TCAD'24}$] **Md Rubel Ahmed**, Bardia Nadimi, Hao Zheng, "AutoModel: Automatic Synthesis of Models from Communication Traces of SoC Designs", IEEE Transactions on Computer-Aided Design of Integrated Circuits & Systems.

[J2] [$\mathbf{JBHI'22}$] Shuvo, Salman Sadiq; Symum, Hasan; **Ahmed, Md Rubel**; Yilmaz, Yasin; Zayas-Castro, Jose L, "Multi-Objective Reinforcement Learning Based Healthcare Expansion Planning Considering Pandemic Events", IEEE Journal of Biomedical and Health Informatics.

[J1] [**TCAD'21**] **Md Rubel Ahmed**, Hao Zheng, Parijat Mukherjee, Mahesh C. Ketkar, Jin Yang, "Mining Patterns From Concurrent Execution Traces", IEEE Transactions on Computer-Aided Design of Integrated Circuits & Systems.

PUBLISHED CONFERENCE PROCEEDINGS (REFEREED)

[C12] [**ICCAD'24**] Thijssen, S., Rashed, M. R. H., **Ahmed, M. R.**, Singireddy, S. S., Jha, S. K., & Ewetz, R. "Equivalence Checking for Flow-Based Computing using Iterative SAT Solving." International Conference on Computer Aided Design. (accepted)

[C11] [**AAAI Workshop'23**] M Shifat Hossain, **Md Rubel Ahmed***, Laura Pullum, Sumit Jha, Rickard Ewetz, "Neuro-Symbolic Representations of 3D Scenes using Universal Scene Description Language", Neuro-Symbolic Learning and Reasoning in the era of Large Language Models. (*equal contribution as the first author.)

[C10] [**MWSCAS'23**] **Md Rubel Ahmed**, Toshiaki Koike-Akino, Kieran Parsons, Ye Wang, "Joint Software-Hardware Design for Green AI", 66^{th} International Midwest Symposium on Circuits and Systems.

[C9] [**MWSCAS'23**] **Md Rubel Ahmed**, Toshiaki Koike-Akino, Kieran Parsons, Ye Wang, "AutoHLS: Learning to Accelerate Design Space Exploration for HLS Designs", 66^{th} International Midwest Symposium on Circuits and Systems.

[C8] [**MWSCAS'23**]**Md Rubel Ahmed**, Bardia Nadimi, Hao Zheng, "System-on-Chip Message Flow Mining with Masked-Language Models", 66^{th} International Midwest Symposium on Circuits and Systems. (Student Best Paper Contest Finalist)

[C7] [**SRF@ASP – DAC'23**] **Md Rubel Ahmed**, "Mining Message Flows from System-on-Chip Execution Traces", ACM SIGDA Student Research Forum at ASP-DAC.

[C6] [**ICCD'21**] Hao Zheng, **Md Rubel Ahmed**, Parijat Mukherjee, Mahesh C. Ketkar, Jin Yang, "Model Synthesis for Communication Traces of System Designs", The 39^{th} IEEE International Conference on Computer Design.

[C5] [**ISVLSI'21**] **Md Rubel Ahmed**, Hao Zheng, Parijat Mukherjee, Mahesh C. Ketkar, Jin Yang, "A Comparative Study of Specification Mining Methods for SoC Communication Traces."

[C4] [**IJCNN'21**] Salman Sadiq Shuvo , **Md Rubel Ahmed**, Hasan Symum, Yasin Yilmaz, "Deep Reinforcement Learning Based Cost-Benefit Analysis for Hospital Capacity Planning", International Joint Conference on Neural Networks.

[C3] [**ISQED'21**] **Md Rubel Ahmed**, Hao Zheng, Parijat Mukherjee, Mahesh C. Ketkar, Jin Yang, "Mining Message Flows from System-on-Chip Execution Traces", The 22^{nd} International Symposium on Quality Electronic Design.

[C2] [**NSysS'20**] Salman Sadiq Shuvo, **Md Rubel Ahmed**, Sadia Binta Kabir, Shaila Akter Shetu, "Application of Machine Learning Based Hospital Up-gradation Policy for Bangladesh", 7^{th} Int'l Conf. on Networking, Systems and Security.

[C1] [**EICT'17**] Amit Sutradhar, Md. Samiul Haque Sunny, Manash Mandal, **Rubel Ahmed**, "Design and construction of an automatic electric wheelchair: An economic approach for Bangladesh", 2017 3^{rd} International Conference on Electrical Information and Communication Technology.

POSTERS/PRESENTATION

[P8] [**MERL'23**] Md Rubel Ahmed, Toshiaki Koike-Akino, Ye Wang, Kieran Parsons, "Learning to Accelerate High-Level Synthesis", MERL Intern Exit Presentation, March 2023.

[P7] [**DAC'21**] Md Rubel Ahmed, Hao Zheng, "Model Synthesis for Communication Traces of Systems Designs", WIP paper at 58^{th} Design and Automation Conference.

[P6] [**USF'21**] Md Rubel Ahmed, Hao Zheng, "Model Synthesis for Communication Traces of System-on-Chip Designs", USF Annual Graduate Research Symposium. Sept. 2021.

[P5] [**DAC'20**] Md Rubel Ahmed, Hao Zheng, "Mining Message Flows from SoC Execution Traces", 57^{th} Design and Automation Conference.

[P4] [**DAC'19**] Md Rubel Ahmed, Yuting Cao, Hao Zheng, "Specification Mining for SoC Validation using Data Mining Techniques", 56^{th} Design and Automation Conference.

[P3] [**UF'19**] Md Rubel Ahmed, Yuting Cao, Hao Zheng, "Message Flow Mining for SoC Validation for Safe and Secure IoT Edge Node Design", Warren B. Nelms Annual IoT Conference.

[P2] [$\mathbf{IFIP-IoT'19}$] Md Rubel Ahmed, Yuting Cao, Hao Zheng, "Execution Trace Mining for SoC Validation for Safe and Secure IoT Edge Node Design", IFIP International Internet of Things Conference.

[P1] [$\mathbf{FICS'19}$] Md Rubel Ahmed, Yuting Cao, Hao Zheng, "Specification Mining from Message Flows for SoC Validation", 2019 FICS Research Conference on Cybersecurity, Mar 2019. doi: 10.1109/MDAT.2015.2499272

PREPRINTS/UNDER REVIEW

[U5] Data Augmentation for Image Classification using Generative AI (under review)

[U4] Context-Aware Local Explanations for High Dimensional Tabular Data (under review)

[U3] A Neuro-Symbolic Natural Language Navigational Planner (under review)

[U2] [$\mathbf{ARXIV}$] Ahmed, Md Rubel and Zheng, Hao, "Deep Bidirectional Transformers for SoC Flow Specification Mining", publisher: arXiv, 2022, doi:10.48550/ARXIV.2203.13182

[U1] [$\mathbf{ARXIV}$] Ahmed, Md Rubel and Nadimi, Bardia and Zheng, Hao, "Mining SoC Message Flows with Attention Model", publisher: arXiv, 2022, doi:10.48550/ARXIV.2209.07929

REVIEW ACTIVITY

- Transactions on Computer-Aided Design of Integrated Circuits & Systems (1 manuscript)
- International Conference on Computer Design (4 manuscripts)
- Joint Conference on Neural Networks (10 manuscripts)

PROFESSIONAL ACTIVITIES

- Treasurer for IEEE-CS USF Student Chapter 2020 - 2022
- Judge: USF Undergraduate Research Conference 2021
- Registered volunteer for Meals on Wheels of Tampa 2019 - 2022
- Volunteer of ISVLSI Conference 2021
- Volunteer of IFIP IoT Annual Conference 2019

AWARDS

- Dissertation Completion Fellowship (worths $9K) from the Office of Graduate Studies at USF 2023
- Student Research Forum at ASP-DAC (SRF@ASP-DAC) 2023
- USF Engineering Alumni Society Scholarship 2022
- NSF travel grant for ISVLSI 2021
- USF Student Govt. travel grant for ISQED 2021
- Young Fellow DAC 2021
- A. Richard Newton Young Student Fellowship award: 56^{th}(2019) and 57^{th}(2020) Design Automation Conference
- Technical Education Scholarship, Bangladesh Govt. 2015 - 2016
- Secondary School Scholarship, Bangladesh Govt. 2010

PROFESSIONAL TRAINING

- Information Security Awareness Training, (UCF) 2024
- Responsible Conduct of Research for Engineers- Stage 2, (CITI) 2024
- Authorship, Credit and Collaborative Scholarship, (UCF) 2024
- Doing the Right Thing: Know About Research Misconduct, (UCF) 2024
- Preparing for College Teaching, (USF) 2021
- At-Risk Friends in College, (USF) 2021
- Graduate Writing Workshop, (USF) 2020
- USF Grant Writing Workshop, (USF) 2020
- ATLE Teaching Assistant Training, (USF) 2018

TALKS

- AI and Emerging Computing Lab Research talk
- Student Research Forum at ASP-DAC 2023
- "Interrupt and Pseudo Multi-threading in Arduino", Arduino Day at FabLab, IUB 2017
- SEES Lab quarterly research summary presentation 2020 - 2023