

EDUCATION

NOTRE DAME, IN JUL 2018 – PRESENT	University of Notre Dame <i>Doctor of Philosophy Computer Science and Engineering</i> Doctoral Advisor Dr Siddharth Joshi
LONDON, UK SEP 2016 – AUG 2017	University College London <i>Master of Science Computational Finance</i> Graduated with Distinction
INGOLSTADT, DE OCT 2013 – AUG 2016	Catholic University of Eichstätt-Ingolstadt <i>Bachelor of Science Business Administration with a Specialisation in Economics</i> Graduated ranked 2 nd

RESEARCH INTERESTS

Neural Network Model Quantization · Bio-inspired and Neuromorphic Computing
Hardware Acceleration of Machine Learning Algorithms · Spiking Neural Networks (SNNs)

EXPERIENCE

NOTRE DAME, IN JUN 2019 – PRESENT	University of Notre Dame <i>Graduate Research Assistant, Department of Computer Science and Engineering</i> <ul style="list-style-type: none">• Researching and developing low-power event-based machine learning algorithms, amongst other for computer vision and object recognition, by advancing machine learning algorithms with findings from neuroscience (such as neural dynamics) and making them biologically plausible.• Investigating the tradeoff between energy and accuracy of efficient quantized spiking neural networks which can be implemented in digital accelerators with different weight storage methods, resulting in an ISCAS conference paper.• Analyzing quantization for convolutional spiking neural networks trained with local learning, demonstrating $\approx 73\%$ memory savings at the cost of $\approx 1\%$ accuracy, results subsequently published and presented at ICONS.• Collaborating with researchers from the department of electrical engineering and simulating spiking neural networks with neurons based on properties from FerroFET devices, culminating in a joint journal paper.
MOUNTAIN VIEW, CA MAY 2022 – AUG 2022	Google LLC <i>Research Intern, ML Performance Team</i> <ul style="list-style-type: none">• Researching automated heterogeneous quantization without training data.• Combining model data extraction with hessian computation to estimate layer sensitivities for bit allocations.• Proof of concept on vision and language models.
VIRTUAL JUN 2021 – SEP 2021	Google LLC <i>Research Intern, QKeras and Application-Specific Machine Learning Team</i> <ul style="list-style-type: none">• Researching automated heterogeneous quantization and extending company internal quantization efforts by gradient based bit-width adaptation.• Exploring various forms of surrogate gradients to train quantized neural networks.
AUG 2020 – SEP 2020	Telluride Neuromorphic Cognition Engineering Workshop , Participant <ul style="list-style-type: none">• Working on the meta-learning challenge (learning with limited data) by applying few-shot learning principals to convolutional spiking neural networks.• Developed proof-of-concept for spiking few-shot learning with self-supervision to learn semantically meaningful features.
JUL 2020	Design Automation Conference (DAC) , Summer School

NOTRE DAME, IN
SEP 2018 – MAY 2019

University of Notre Dame

Graduate Teaching Assistant, Department of Computer Science and Engineering

- Additional training (HLS course) and networking opportunities, as well as a chance to present my current research to the community.
- Winning the DAC Young Fellows Research Video Award.
- Fall semester for “Introduction to Computing C/C++ Programming” and in the spring semester for “Elements of Computing 2”.
- Coordinating undergrad TAs, grading assignments, projects and exams on time, holding office hours to counsel students and lecturing when the instructor was absent.

FRANKFURT, DE
MAR 2018 – JUL 2018

Ernst & Young GmbH

Quant Team/Data Scientist, Financial Accounting Advisory Services

- Performing benchmark analysis for various financial instruments (e.g. equities, bonds, foreign exchange instruments and futures). Investigating price deviations and anomalies along with visualizing the deviations on a portfolio level and communicating the results with international teams.
- Developing a tool to aid the data handling for equity, bond and forward pricing using technologies such as Python3, Flask and SQLite.
- Carrying out large scale bond price deviation analysis to characterize deviations. Training various machine learning models such as ridge regression, support vector regression and regression trees using python-based libraries, e.g. scikit-learn, NumPy, pandas, matplotlib.

RELEVANT PUBLICATIONS

- **Clemens JS Schaefer**, Siddharth Joshi, Shan Li, Raul Blazquez, “Edge Inference with Fully Differentiable Quantized Mixed Precision Neural Networks”, arXiv:2206.07741v1, 2022
- Weier Wan, Rajkumar Kubendran, **Clemens JS Schaefer**, S. Burc Eryilmaz, Wenqiang Zhang, Dabin Wu, Stephen Deiss, Priyanka Raina, He Qian, Bin Gao, Siddharth Joshi, “A compute-in-memory chip based on resistive random-access memory”, Nature volume 608, pages504–512 (2022)
- **Clemens JS Schaefer**, Mark Horeni, Pooria Taheri, Siddharth Joshi, “LSTMs for Keyword Spotting with ReRAM-based Compute-In-Memory Architectures”, IEEE International Symposium on Circuits and Systems (ISCAS), 2021
- **Clemens JS Schaefer**, Siddharth Joshi, “Quantizing Spiking Neural Networks with Integers”, International Conference on Neuromorphic Systems (ICONS), 2020
- **Clemens JS Schaefer**, Patrick Faley, Emre Neftci, Siddharth Joshi, “Memory Organization for Energy Efficient Learning and Inference in Digital Neuromorphic Accelerators”, IEEE International Symposium on Circuits and Systems (ISCAS), 2020
- Sourav Dutta, **Clemens JS Schaefer**, Jorge Tomas Gomez, Siddharth Joshi, Suman Datta, “Supervised Learning in All FeFET-Based Spiking Neural Network: Opportunities and Challenges”, Frontiers in Neuroscience, 2020
- **Clemens JS Schaefer**, Siddharth Joshi, “Memory Organization and Structures for On-Chip Learning in Spiking Neural Networks”, IEEE 63rd International Midwest Symposium on Circuits and Systems (MWSCAS), 2020

INVITED TALKS AND CONFERENCE PRESENTATIONS

- “LSTMs for Keyword Spotting with ReRAM-based Compute-In-Memory Architectures”, **Clemens JS Schaefer**, Mark Horeni, Pooria Taheri, Siddharth Joshi, IEEE International Symposium on Circuits and Systems (ISCAS), May 22-28, 2021
- “Quantizing Spiking Neural Networks with Integers” **Clemens JS Schaefer**, SynSense AG, Zurich Switzerland (virtual), Apr. 2021
- “Quantizing Spiking Neural Networks with Integers” **Clemens JS Schaefer**, Google LLC, Mountainview CA (virtual), Mar. 2021
- “Memory Organization for Energy Efficient Learning and Inference in Digital Neuromorphic Accelerators”, **Clemens JS Schaefer**, Patrick Faley, Emre Neftci, Siddharth Joshi, IEEE International Symposium on Circuits and Systems (ISCAS), Oct. 10-21, 2020
- “Quantizing Spiking Neural Networks with Integers” **Clemens JS Schaefer**, Siddharth Joshi, International Conference on Neuromorphic Systems (ICONS), Jul. 28–30,2020.

- “Memory Organization and Structures for On-Chip Learning in Spiking Neural Networks” **Clemens JS Schaefer**, Siddharth Joshi, IEEE 63rd International Midwest Symposium on Circuits Systems, Aug. 9–12, 2020.

RELEVANT COURSE WORK

Hardware Platforms for Deep Learning and Optimization · Advanced Computer Architecture
Machine Learning · Complexity and Algorithms · Operating Systems · VLSI Circuit Design

SKILLS

Programming Languages: Python (proficient), JAX (proficient), PyTorch (proficient), TensorFlow (proficient), C++ (basic)

Tools: Matlab (intermediate), Cadence Virtuoso (basic), L^AT_EX(intermediate)

Languages: German (native), English (proficient, TOEFL iBT 112), Spanish (conversational)

FELLOWSHIP

JUL 2020 | **Design Automation Conference (DAC)**, Young Student Fellow

OCT 2013 – AUG 2017 | **Friedrich-Naumann-Foundation for Liberty**, Fellowship Holder

NOV 2014 – APR 2015 | **German Academic Exchange Service**, Fellowship Holder