# DIFFERENTIABLE PROGRAMMING OF DATAFLOW ARCHITECTURES

A Collection of B.Sc. / M.Sc. Thesis Topics at STCE*

1. Motivation. Differentiable programming (DP) based on algorithmic differentiation (AD) [1] has been gaining significant relevance over the past years due to raising popularity in, e.g., machine learning. Moreover, it is a functional requirement for all derivative-based numerical simulation and optimization solutions targeted by scientific computing [2]. As a modern alternative to the traditional von-Neumann computer, dataflow architectures promise to lend themselves nicely to augmentation of their programs with derivatives, including both tangents (directional derivatives) and adjoints (e.g., known from backpropagation for training deep neural networks).

Next Silicon Ltd. (`nextsilicon.com`) is at the forefront of the development of dataflow architectures. STCE (`www.stce.rwth-aachen.de`) has been one of the main academic players in the area of DP/AD for more than two decades. This collaboration, including various B.Sc. and M.Sc. projects, is meant to set the pace in DP for dataflow architectures. You could become part of it!

2. B.Sc. / M.Sc. Projects. All topics focus on the exploratory application of DP/AD to various types of dataflow programs including (basic) linear algebra kernels, finite difference methods for partial differential equations, and Monte Carlo methods for stochastic differential equations. Potential real-world applications range from the solution of problems in science and engineering (including aspects of scientific machine learning) to risk calculations in computational finance. Individual projects will be shaped during a series of (virtual and in-person) meetings taking into account your specific capabilities. Interested? → Send an e-mail to `info@stce.rwth-aachen.de`. Include a transcript of your current grades and a brief statement of reasons for your interest in this topic.
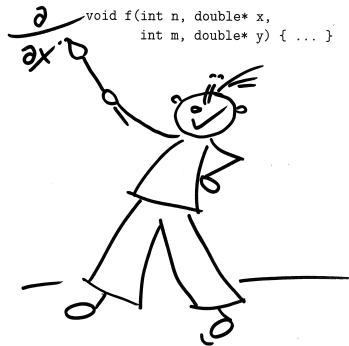
References.

[1] U. Naumann: *The Art of Differentiating Computer Programs. An Introduction to Algorithmic Differentiation* SIAM 2012.

[2] U. Naumann: *Differentiable Programming: A Desirable Paradigm for Scientific Computing?* GAMM Newsletter 1/2025.

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*Software and Tools for Computational Engineering