PHYSIK

PHYSIKALISCHES KOLLOQUIUM

UNIVERSITÄT DES SAARLANDES

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University Heidelberg | CeNTech - Center for Nanotechnology (University Münster)

Embracing Uncertainty: A Photonic Neuromorphic Approach to Probabilistic Computing

Thursday, May 15th, 2025, at 2.00 p.m. **c. t.**

Building C6.4, Lecture Hall II (00.9)

Unlike artificial neural networks (ANNs), which maximize accuracy, biological systems excel at handling uncertainty, crucial for adaptability and efficiency. Traditional ANNs, implemented on deterministic hardware, fail to capture the full probabilistic nature of inference. To address this, Bayesian neural networks (BNNs) replace deterministic parameters with probability distributions, distinguishing between epistemic uncertainty (due to limited data) and aleatoric uncertainty (from noise). BNNs provide a more robust approach, especially with incomplete data. However, processing probabilistic models is challenging for conventional hardware, which relies on deterministic von Neumann architectures.

To overcome this, I propose a neuromorphic computing approach that uses hardware noise as a computational resource. In electronic crossbar arrays, memristors' inherent stochasticity makes them suitable for probabilistic inference, but issues like sequential sampling and material variability remain. Transitioning to photonic computing enables parallel probabilistic operations using chaotic light, an ideal source for random number generation. I will present a photonic neuromorphic architecture utilizing chaotic light for probabilistic computing, demonstrating Bayesian inference in a LeNet-5-based image recognition model with an incomplete MNIST dataset. This approach enables energy-efficient, high-speed probabilistic machine learning beyond conventional hardware limitations.

You can participate online via MS Teams: https://tinyurl.com/Pernice15-05

Interested people are cordially invited.

Coffee and cookies are served at 2.00 p.m. in front of the Lecture Hall

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