2024 Distinguished Lecture Series Presents

GITTA KUTYNIOK

May 7th to 9th, 2024

LECTURE 1 // MAY 7 AT 3PM

The Mathematics of Artificial Intelligence

The new wave of artificial intelligence is impacting industry, public life, and the sciences in an unprecedented manner. A similarly strong impact can currently be witnessed within mathematics on areas such as inverse problems and numerical analysis of partial differential equations. However, one major drawback worldwide, in particular, in light of regulations such as the EU AI Act and the G7 Hiroshima AI Process, is the lack of reliability of such methodologies. The goal of this first lecture is to first provide an introduction into this new vibrant research area. We will then survey recent advances on a profound mathematical understanding of deep neural networks, in particular, concerning their expressive power, the learning process, and overall performance guarantees. Due to the importance of explainability for reliability, we will also touch upon this area by highlighting an explainability approach which is itself reliable due to its mathematical foundation.

LECTURE 2 // MAY 8 AT 3PM

Artificial Intelligence for Mathematics

Novel approaches based on artificial intelligence have already shown their impressive potential in mathematical research areas such as imaging sciences or numerical analysis of partial differential equations, sometimes by far outperforming classical mathematical approaches for particular problem classes. In this second lecture, we will focus on optimal combinations of traditional model-based methods with AI-based approaches in the sense of true hybrid algorithms for imaging sciences. In this realm, we will present some recent advances for the ill-posed problems of (limited-angle) computed tomography and shape reconstruction. Finally, we will also touch upon mathematical insights into the ability of deep neural networks to circumvent the curse of dimensionality for high-dimensional partial differential equations and their benefits as solvers.

LECTURE 3 // MAY 9 AT 3PM

Overcoming the Boundaries of Artificial Intelligence: A Mathematical Approach

Classical approaches of artificial intelligence typically employ digital hardware. However, it turns out that such computing platforms impose serious restrictions to AI-based algorithms in terms of computability, reliability, legal requirements, and energy requirements. In this third lecture, we will first discuss current mathematical limitations of artificial intelligence imposed by digital hardware modeled as a Turing machine. We will then show how those boundaries can be overcome by embracing analog computing approaches, modeled by the Blum-Shub-Smale machine. This will reveal the tremendous importance of novel computing hardware such as neuromorphic hardware for future AI computing. Finally, we will discuss mathematical aspects of spiking neural networks, which mimic natural neural networks much closer than classical artificial neural networks and are perfectly adapted to neuromorphic hardware.

UNIVERSITY OF MUNICH

RESEARCH AREA

- Applied Harmonic Analysis, Artificial Intelligence, Data Science, Imaging Science, and Inverse Problems

VISIT

- May 7 to 9, 2024

LOCATION

- MS 6627

UCLA College | Physical Sciences Mathematics

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