Mathematics for Computer Science and Applications M4CSA

Online Seminar

http://ii.pk.edu.pl/~m4csa/

Tuesday, September 6, 2022

15.00 CEST(GMT+2)

Join Zoom Meeting

https://zoom.us/j/94722402566

Meeting ID: 947 2240 2566

Passcode: 456787

Any questions regarding the seminar can be directed to niemaga@matman.uwm.edu.pl and radoslaw.kycia@gmail.com

Cracow University of Technology

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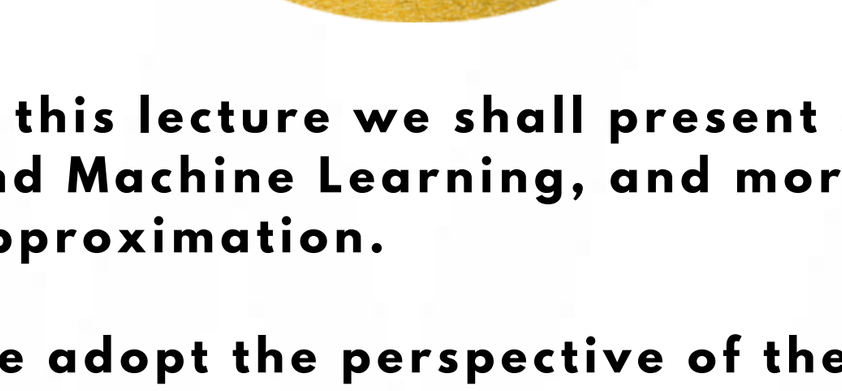

Seminar Topic:

Control and Machine Learning

Enrique ZUAZUA

Friedrich Alexander Universität Erlangen Nürnberg - Alexander von Humboldt Professorship, Germany

In this lecture we shall present some recent results on the interplay between control and Machine Learning, and more precisely, Supervised Learning and Universal Approximation.

We adopt the perspective of the simultaneous or ensemble control of systems of Residual Neural Networks (ResNets). Roughly, each item to be classified corresponds to a different initial datum for the Cauchy problem of the ResNets, leading to an ensemble of solutions to be driven to the corresponding targets, associated to the labels, by means of the same control.

We present a genuinely nonlinear and constructive method, allowing to show that such an ambitious goal can be achieved, estimating the complexity of the control strategies.

This property is rarely fulfilled by the classical dynamical systems in Mechanics and the very nonlinear nature of the activation function governing the ResNet dynamics plays a determinant role. It allows deforming half of the phase space while the other half remains invariant, a property that classical models in mechanics do not fulfill.

The turnpike property is also analyzed in this context, showing that a suitable choice of the cost functional used to train the ResNet leads to more stable and robust dynamics.

This lecture is inspired in joint work, among others, with Borjan Geshkovski (MIT), Carlos Esteve (Cambridge), Domènec Ruiz-Balet (IC, London) and Dario Pighin (Sherpa.ai).

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Seminar Topic:

Continuous-time dynamical systems in machine learning

Vladimir Jacimovic

University of Montenegro

Neural networks experienced a tremendous growth in XXI century. Nowadays, many models in AI and ML are based on neural networks that consist of hundreds of millions of neurons and millions of layers. Quantitative growth brought new opportunities and challenges in Machine Learning. This led to emergence of thefield named Deep Learning (DL). The number of layers in NN is usually called its depth.

In the limit of infnitely many layers, NN's can be approximated by continuous-time dynamical systems. This observation has recently led to new models, such as Neural ODE and continuous-time Normalizing Flows. Such an approach makes it reasonable to talk about "ingnitely deep NN's".

Algorithms for training infnitely deep NN's are based on classical results from ODE's and Control Theory (such as adjoint sensitivity method and Pontryagin maximum principle).

In the present talk I will provide a brief survey of some ideas and concepts that generated new paradigms of Infnitely Deep Learning and Geometric Deep Learning. I will focus on the question how sophisticated theories from Mathematics and Physics might play an important role in the future progress of DL and AI.

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