

LSU Control and Optimization Zoom Seminar

10:30 AM US Central Time, Friday February 24, 2023

<https://lsu.zoom.us/j/98176468969>, Passcode 123123

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Control and Machine Learning

Abstract: We present 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 (or 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, using the same control. We present a genuinely nonlinear and constructive method, allowing us 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 deformation of 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 by joint work, among others, with Borjan Geshkovski, Carlos Esteve, Domènec Ruiz-Balet, and Dario Pighin.

Biography: Enrique Zuazua Iriondo was awarded the Alexander von Humboldt Professorship, and holds secondary appointments as Professor of Applied Mathematics (UAM) and Director of CCM – Chair of Computational Mathematics (Deusto). His applied mathematics research includes topics in partial differential equations, systems control, numerical analysis, and machine learning, and industrial collaborations, such as optimal shape design in aeronautics, the management of electrical and water distribution networks, and the design of recommendation systems. He holds a degree in mathematics from the University of the Basque Country, and a dual PhD degree from the same university (1987) and the Université Pierre et Marie Curie, Paris (1988). In 1990, he became a professor of applied mathematics at the Complutense University of Madrid, to later move to UAM in 2001. His numerous awards include the SIAM W.T. and Idalia Reid Prize for 2022. He is a member of the editorial boards of leading journals in applied mathematics and control theory.