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Lecture 1: Mathematics of Deep Learning

The past few years have seen a dramatic increase in the performance of recognition systems thanks to the introduction of deep networks for representation learning. However, the mathematical reasons for this success remain elusive. For example, a key issue is that the neural network training problem is nonconvex, hence optimization algorithms are not guaranteed to return a global minima. The first part of this tutorial will overview recent work on the theory of deep learning that aims to understand how to design the network architecture, how to regularize the network weights, and how to guarantee global optimality. The second part of this tutorial will present sufficient conditions to guarantee that local minima are globally optimal and that a local descent strategy can reach a global minima from any initialization.

Lecture 2: Segmental Spatio-Temporal Deep Networks for Discovering the Language of Surgery

Robotic Minimally Invasive Surgery (RMIS) has several advantages over traditional surgery, such as better precision, smaller incisions and reduced recovery time. However, the steep learning curve together with the lack of fair, objective, and effective criteria for judging the skills acquired by a trainee may reduce its benefits. To address this issue, machine learning and computer vision techniques use RMIS recordings to model surgeon expertise and perform automatic skill assessment and gesture classification. This talk will present two deep learning architectures for decomposing kinematic and video data of a surgical task into a series of pre-defined surgical gestures, such as "insert a needle", "grab a needle", "position a needle", etc. and classifying the performance of a surgeon as “novice” or “expert”.