Bridging Deep Neural Networks and Differential Equations for Image Analysis and Beyond

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Deep learning continues to dominate machine learning and has been successful in computer vision, natural language processing, etc. Its impact has now expanded to many research areas in science and engineering. In this talk, I will start with a brief overview of pre-deep-learning image restoration methods. These models inspired some of our recent work on bridging numerical differential equation and deep convolutional architecture design. We can interpret some of the famous deep CNNs in terms of numerical (stochastic) differential equations, and propose new deep architectures that can further improve the prediction accuracy of the existing networks in image classification. We further expand this perspective to introduce a new moving endpoint control model to denoise images with unknown noise levels. We also show how to design transparent deep convolutional networks to uncover hidden PDE models from observed dynamical data and to predict the dynamical behavior accurately.