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Recurrent neural networks for visual processing

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Convolutional neural networks (CNNs) process information sequentially – through a feedforward cascade of filtering, rectification and normalization operations. These networks now approach and sometimes even surpass human accuracy on complex visual recognition tasks. However, several failure cases have been reported in recent years highlighting critical aspects of visual cognition that are not explained by current networks. A growing body of neuroscience literature suggests that feedback mechanisms play a significant role in biological vision. In this talk, we will summarize recent effort by our group towards the development of recurrent neural networks inspired by the visual cortex.

We will present synthetic visual recognition challenges which demonstrate the limitations of CNNs -- suggesting distinct contributions from short-range horizontal connections (within a processing stage) vs. long-range top-down connections (between processing stages). We will further demonstrate an application of the proposed recurrent network to the 3D reconstruction of neural circuits from electron microscopy images (a.k.a. connectomics). We will show that the proposed architecture generalizes significantly better than state-of-the-art feedforward architectures. Our network models are a first step towards bridging PDE vision models with deep learning methods, and our hope is to engage mathematicians to help us improve the efficiency of this approach.