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Self-Organized Information Processing in Neuronal Networks: Replacing Layers in Deep Networks by Dynamics CHRISTOPH KIRST, Rockefeller University — It is astonishing how the sub-parts of a brain co-act to produce coherent behavior. What are mechanism that coordinate information processing and communication and how can those be changed flexibly in order to cope with variable contexts? Here we show that when information is encoded in the deviations around a collective dynamical reference state of a recurrent network the propagation of these fluctuations is strongly dependent on precisely this underlying reference. Information here 'surfs' on top of the collective dynamics and switching between states enables fast and flexible rerouting of information. This in turn affects local processing and consequently changes in the global reference dynamics that re-regulate the distribution of information. This provides a generic mechanism for self-organized information processing as we demonstrate with an oscillatory Hopfield network that performs contextual pattern recognition. Deep neural networks have proven to be very successful recently. Here we show that generating information channels via collective reference dynamics can effectively compress a deep multilayer architecture into a single layer making this mechanism a promising candidate for the organization of information processing in biological neuronal networks.

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