MULTIAFFINE REPRESENTATIONS MEDIATE TRADEOFF BETWEEN GENERALIZATION AND PARALLEL PROCESSING CAPACITY IN NETWORKS TRAINED TO MULTITASK

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ABSTRACT

Artificial systems currently outperform humans in diverse computational domains, but none has achieved parity in speed and overall versatility of mastering novel tasks. A critical component to human success, in this regard, is the ability to redeploy and redirect data passed between cognitive subsystems (via abstract feature representations) in response to changing task demands. The present work formalizes this coordination procedure in terms of multiaffine functions of stimulus and control states. In experiments, the resulting model robustly predicts behavior and performance of multitasking networks on natural language data (MNIST) using common deep network architectures. Consistent with existing theory in cognitive control, representation structure varies in response to (a) environmental pressures for representation sharing, (b) demands for parallel processing capacity, and (c) tolerance for crosstalk. Implications for geometric (dimension, curvature), functional (automaticity, generalizability, modularity), and applied aspects of representation learning are discussed.