

Synchronization Opponent Networks: Dynamics, Computation, and Coding for Similarity and Object Recognition

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Shape similarity, categorization and recognition of objects from outline shapes are addressed with a time varying coupled logistic map lattice trained by a genetic algorithm. Synchronization and spatial cooperation are key underlying principles, thus the network is designated a synchronization opponent cooperative activity (Soca) network. The computations are described in terms of well known frameworks – the dynamical recognizer and probabilistic finite state automata.

The network orders curve exemplars of parameterized curves by constructing a *partition cell metric space*, in which partitions of the network's dynamical phase space are considered as dimensions and the occupancy of all partitions locates an in the representation space. This statistical population representation contrasts with many connectionist representation spaces, in which dimensions capturing statistics of the modeled world are bound to individual output or internal nodes, even in a distributed representation. The latter style *-local or place coding -* remains the most widespread assumption in neuroscience and connectionism, but is increasing questioned by the neuroscience community.

Next I study a family of such networks acting as classifiers for paperclip objects rotated in depth. Recognition rates up to 85% are obtained for a set of 20 objects. The approach builds on the theory of view based recognition, but posits an alternative spatiotemporal computation and population code whose computation serves to combine local features (binding), capture local structural relationships, and handle view invariance.

The work raises principled issues in biological computation. It departs from previous recurrent networks and high dimensional chaotic networks by introducing two stages with sharp parameter changes, rather than stationary or smoothly changing dynamics. It is hypothesized that slow wave dynamics and oscillations observed in inferotemporal cortex are signatures of such a recognition process. Extensive neuroscience review, justification of the CML formulation via lower level models, and discussion of experiments to discriminate various hypotheses are included.